PEBBLE PROJECT
ENVIRONMENTAL BASELINE DOCUMENT
2004 through 2008

CHAPTER 8.
GROUNDWATER HYDROLOGY
Bristol Bay Drainages

PREPARED BY:
SCHLUMBERGER WATER SERVICES

TABLE OF CONTENTS

TABLE OF CONTENTS 8-i
LIST OF TABLES 8-iii
LIST OF FIGURES 8-iii
LIST OF APPENDICES 8-v
ACRONYMS AND ABBREVIATIONS 8-vi
8. Groundwater Hydrology 8-1
8.1 Mine Study Area 8-1
8.1.1 Introduction 8-1
8.1.2 Study Objectives 8-1
8.1.3 Study Area 8-2
8.1.4 Previous Studies 8-2
8.1.5 Scope of Work 8-2
8.1.6 Methods 8-4
8.1.6.1 Data Review 8-4
8.1.6.2 Determination of Monitoring Requirements 8-4
8.1.6.3 Field Program 8-4
8.1.6.4 Analysis of Response Tests and Pumping Tests 8-15
8.1.6.5 Site-Wide Water Balance 8-15
8.1.6.6 Hydrogeologic Characterization 8-16
8.1.6.7 Development of Numerical Groundwater Model 8-17
8.1.7 Results and Discussion 8-17
8.1.7.1 Bedrock Geology 8-17
8.1.7.2 Surficial Geology 8-19
8.1.7.3 Summary of Site Subsurface Investigations 8-23
8.1.7.4 Response Tests 8-24
8.1.7.5 Pumping Tests 8-27
8.1.7.6 Bedrock Testing by Knight Piésold Ltd. 8-30
8.1.7.7 Deep Bedrock Testing and Monitoring 8-31
8.1.7.8 Groundwater Elevations 8-32
8.1.7.9 Seep Monitoring 8-34
8.1.7.10 Surface Water-Groundwater Interaction 8-34
8.1.7.11 Groundwater Sampling 8-36
8.1.7.12 Regional Hydrogeologic Setting 8-38
8.1.7.13 Hydrogeologic Characterization of South Fork Koktuli River Drainage 8-38
8.1.7.14 Hydrogeologic Characterization of North Fork Koktuli Drainage 8-46
8.1.7.15 Hydrogeologic Characterization of the Upper Talarik Creek Drainage 8-49
8.1.7.16 Site-Wide Water Balance 8-51
8.1.7.17 Numerical Groundwater Model 8-57

8.1.8 Summary 8-62
8.1.8.1 Overview of Groundwater Baseline Program 8-62
8.2 Transportation Corridor 8-70
8.3 References 8-70
8.4 Glossary 8-72

LIST OF TABLES

Table 8.1-1, Summary of Response Tests in the Pebble Deposit Area

Table 8.1-2, Summary of Response Tests in the Frying Pan Lake Area

Table 8.1-3, Summary of Response Tests in the South Fork Koktuli Flats Area

Table 8.1-4, Summary of Response Tests in the North Fork Koktuli Area

Table 8.1-5, Summary of Response Tests in the Upper Talarik Area

Table 8.1-6, Results of Pumping Tests

Table 8.1-7, Tritium Concentrations

LIST OF FIGURES

Figure 8.1-1a, Mine Hydrogeology Study Area

Figure 8.1-1b, Mine Hydrogeology Study Area - Detailed

Figure 8.1-2, Bedrock Geology

Figure 8.1-3a, Contours of Top of Bedrock

Figure 8.1-3b, Surficial Geology Legend

Figure 8.1-3c, Surficial Geology Legend

Figure 8.1-4, Locations of Hydrogeologic Investigations

Figure 8.1-5, Longitudinal Hydrogeologic Cross Section

Figure 8.1-6, Cross Section E10 – Pebble Deposit Area

Figure 8.1-7, Cross Section S1 – South Fork Koktuli Discharge Area

Figure 8.1- 8a, Underdamped Response Test P-08-62M

Figure 8.1-8b, Overdamped Response Test P-08-55D

Figure 8.1-9a, Cumulative Frequency of Calculated Hydraulic Conductivity

Figure 8.1-9b, Cumulative Frequency of Calculated Hydraulic Conductivity in General Pebble Deposit Area

Figure 8.1-9c, Cumulative Frequency of Calculated Hydraulic Conductivity Outside of General Pebble Deposit Area

Figure 8.1-10, Example of Pumping Test Response

Figure 8.1-11a, Hydraulic Conductivity vs. Depth in Pebble Deposit Area (from Knight Piésold)

Figure 8.1-11b, Hydraulic Conductivity vs. Depth Outside of Pebble Deposit Area (from Knight Piésold)

Figure 8.1-11c, Deep Bedrock Hydraulic Conductivity Profile

Figure 8.1-12, Shallow Groundwater Contours

Figure 8.1-13a, Time Series of Piezometric Elevations – MW-11

Figure 8.1-13b, Time Series of Piezometric Elevations – MW-5

Figure 8.1-14, Stream Gaging Stations and Watershed Boundaries

Figure 8.1-15a, Comparison of Observed Streamflow with Water Balance Model - South Fork Koktuli River

Figure 8.1-15b, Comparison of Observed Streamflow with Water Balance Model – North Fork Koktuli River

Figure 8.1-15c, Comparison of Observed Streamflow with Water Balance Model – Upper Talarik Creek

Figure 8.1-16, Groundwater Model Domain

Figure 8.1-17, Groundwater Model Cross-Section A-A'

Figure 8.1-18, Simulated Groundwater Elevations, Layer 1, Overburden, Full Study Area (September, 2007)

Figure 8.1-19, Simulated Groundwater Elevations, Layer 1 Overburden, Area of Interest (September, 2007)

Figure 8.1-20, Modeled vs. Observed Heads, Scatter Plot – All Layers, All Times

Figure 8.1-21, Observed and Simulated Hydrographs: P-4AS, P-4, P-4AD, MW-5S, MW-5M and MW-5D

Figure 8.1-22, Cumulative Annual Flow: Modflow Model vs. Water Balance Model (2007)

Figure 8.1-23a, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Tributaries (2007)

Figure 8.1-23b, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Main Channel (2007)

Figure 8.1-23c, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, flow from SFK (2007)

Figure 8.1-23d, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, Main Channel (2007)

Figure 8.1-23e, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli – Areas 13 and 14 (2007)

Figure 8.1-23f, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli – Areas 12 and 15 (2007)

Figure 8.1-24, Streamflow vs. Distance Upstream (SFK)

LIST OF APPENDICES

Appendix 8.1A, Drillhole and Installation Logs

Appendix 8.1B, Geologic Cross Sections

Appendix 8.1C, Response Testing Results

Appendix 8.1D, Pumping Test Results

Appendix 8.1E, Snapshots of Water Levels

Appendix 8.1F, Snapshots of Vertical Gradients

Appendix 8.1G, Time Series of Piezometric Elevations (Uniform Scale)

Appendix 8.1H, Time Series of Piezometric Elevations (Expanded Scale)

Appendix 8.1I, Water Balance Model Results

Appendix 8.1J, Groundwater Model Results

Appendix 8.1K, Multi-level Groundwater Monitoring System

Appendix 8.1L, Packer Testing Results

Appendix 8.1M, Drillhole Coordinates and Installation Details

Appendix 8.1N, Lugeon Tests by Knight Piésold Ltd.

ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
ASTM	American Society for Testing and Materials
BEESC	Bristol Environmental & Engineering Services Corporation
bgs	below ground surface
cfs	cubic feet per second
CH2M	CH2M Hill, Inc.
DO	dissolved oxygen
gpm	gallons per minute
ID	internal diameter
in/yr	inches per year
KP	Knight Piésold Ltd.
HDR	HDR Alaska
m	meter(s)
m/s	meter(s) per second
m^2/s	square meter per second
mg/L	milligram per liter
mi	mile(s)
mi^2	square mile(s)
MSD	Midnight Sun Drilling LLC
NDM	Northern Dynasty Mines Inc.
NFK	North Fork Koktuli
OD	outside diameter
PVC	polyvinyl chloride
SFK	South Fork Koktuli
SLR	SLR Alaska
SWS	Schlumberger Water Services
TDS	total dissolved solids
TU	tritium units
UT	Upper Talarik Creek

8. GROUNDWATER HYDROLOGY

8.1 Mine Study Area

8.1.1 Introduction

This report presents the findings of the hydrogeology study tasks carried out from 2004 to 2008 for the Pebble Project. The study included the installation of background monitoring wells and piezometers, the collection of groundwater samples, and the collection of additional information leading to the characterization of the groundwater regime in the study area.

This environmental baseline document presents the drillhole logs for the wells and piezometers that were installed as part of this program, discusses the results of the analysis of well test data, describes the water balance and groundwater modeling to date, and provides an overview of the current understanding of the site hydrogeological conditions. Supporting data are provided in appendices to this chapter and include the following:

- Drillhole and Installation Logs (Appendix 8.1A).
- Geologic Cross Sections (Appendix 8.1B).
- Response Testing Results (Appendix 8.1C).
- Pumping Test Results (Appendix 8.1D).
- Snapshots of Water Levels (Appendix 8.1E).
- Snapshots of Vertical Gradients (Appendix 8.1F).
- Time Series of Piezometric Elevations (Uniform Scale) (Appendix 8.1G).
- Time Series of Piezometric Elevations (Expanded Scale) (Appendix 8.1H).
- Water Balance Model Results (Appendix 8.1I).
- Groundwater Model Results (Appendix 8.1J).
- Multi-level Groundwater Monitoring System (Appendix 8.1K).
- Packer Testing Results (Appendix 8.1L).
- Drillhole Coordinates and Installation Details (Appendix 8.1M).
- Lugeon Tests by Knight Piésold Ltd. (Appendix 8.1N).

8.1.2 Study Objectives

The objectives of the groundwater hydrogeology study were as follows:

- To characterize the existing groundwater flow regime within the study area and define how the local regime interacts with the regional groundwater system. This aspect of the study also

involved the evaluation of the interaction between groundwater and surface water, and of the presence of cross-basin transfers of groundwater, both of which appear to occur within the study area.

- To use the baseline data and analyses of these data to develop baseline water flow and water chemistry models.
- To support aquatic, fish resource, and wetlands habitat assessments.

To achieve these objectives, the baseline study program included the collection of surface and subsurface geologic data, the measurement of hydrogeologic parameters such as piezometric levels and hydraulic conductivities, the delineation of groundwater recharge and discharge zones, and the characterization of groundwater quality within areas of mineralized and barren rock, as well as within the alluvial aquifers.

8.1.3 Study Area

The study encompasses areas in the vicinity of the Pebble Deposit. The areal extent of the groundwater study area is presented on Figure 8.1-1a.

The Pebble Deposit is located in the headwater areas of the Koktuli River and Upper Talarik Creek. The main stems of the river and creek primarily flow within floodplain channels eroded into widespread glacial deposits. The valley glacial infill is bounded by bedrock mantled with glacial and colluvial deposits.

The Pebble Deposit is located along the margins of the valley infill deposits. The baseline groundwater program was intended to quantify the baseline groundwater conditions in a broad area in the vicinity of the Pebble Deposit.

8.1.4 Previous Studies

The hydrogeology of this site has not been studied prior to 2004.

8.1.5 Scope of Work

The research and field work for this study were conducted from 2004 to 2008. CH2M was the lead consultant for hydrogeological issues in 2004, reporting to Northern Dynasty Mines Inc. (NDM, a predecessor of Pebble Partnership). SWS provided guidance to CH2M on these issues as their sub-consultant. Groundwater subsurface investigations were completed by SWS following the departure of CH2M in early October 2004.

From 2005 to 2008, SWS led the hydrogeology program. SLR carried out all aspects of the field investigation and reported directly to NDM.

The hydrogeology program was conducted according to the approach described in the proposed 2004 and 2005 Study Plans and in the 2006, 2007, and 2008 Study Plan addendums (Appendix E). These plans included selecting investigation locations and methodologies. Investigations were modified throughout the work to take advantage of the knowledge gained during the programs. As such, the tasks completed for the groundwater study by SWS were as follows:

- Evaluation of all data provided or collected.
- Recommendation of the monitoring locations, drilling equipment, and well completion details.
- Recommendation of the locations and methodology for pump tests.
- Preparation of the groundwater sampling protocol.
- Oversight of the field work and ongoing review of the site investigation locations and methods.
- Oversight of cross-hole aquifer testing at nine locations.
- Collection of groundwater samples.
- Analysis of monitoring well response tests and pumping tests.
- Preliminary evaluation of hydrogeology in the area of the deposit and in the overall study area.

The work to date has been carried out by a number of firms, including the following:

- CH2M Hill, Inc. (CH2M) led the hydrogeology and hydrology programs until mid-October of 2004.
- Bristol Environmental & Engineering Services Corporation (BEESC) collected the first complete round of groundwater samples in October 2004.
- SLR Alaska (SLR) assembled and prepared field data in January 2005 and conducted the field hydrogeology program from 2005 to 2008. SLR also installed shallow piezometers during 2005 and 2007 in the vicinity of small pools as specified by Three Parameters Plus, Inc. (3PPI).
- HDR Alaska (HDR) collected surface water hydrology data from 2004 to 2008. Low-flow streamflow data were included in this program, partially in support of the hydrogeology program, as well as a seep and spring inventory, and seep and spring monitoring.
- Schlumberger Water Services (SWS) (formerly Water Management Consultants Inc. or WMC) provided hydrogeological advice to CH2M until mid-October 2004, completed the field program at the end of the 2004 season, and led hydrogeological input to the groundwater program and site hydrogeology characterization activities from 2005 to 2008.

Separate from this program, but an important element of the site hydrogeology characterization, are the following contributions:

- Knight Piésold Ltd. (KP), within their mandate to collect geotechnical information for design purposes, installed and tested many additional piezometers in the study area.
- KP also provided the lead for hydrologic data collection and analysis, and thereby provided considerable input into the understanding of the hydrologic regime in the study area.
- Frontier Geosciences performed seismic refraction surveys at many locations in support of the KP geotechnical program.
- Hoefler Consulting Group (Hoefler) collected climate data from 2004 through 2008.
- ABR Inc. (ABR) performed snow surveys from 2004 through 2008.

- Paug-Vik Development Corporation provided hydrogeological reviews of work plans and reports in 2006.
- Westbay Instruments Inc. provided equipment for, and field assistance with, the installation and use of the multi-level groundwater monitoring system installed in one deep drillhole in the area of the Pebble Deposit in 2006 and in two deep drillholes in 2008.

8.1.6 Methods

8.1.6.1 Data Review

This activity included a review of available studies and geologic information for the area.

An understanding of bedrock geology was derived from the following sources:

- Examination of bedrock geology maps provided by NDM.
- Examination of bedrock outcrops on site.
- Discussion with NDM and NDM contractor staff regarding drilling performance in bedrock.
- Examination of bedrock drill logs provided by KP for NDM.

The review also included an evaluation of basin and sub-basin drainage areas, channel lengths, annual precipitation, relief, typical flow regimes, and stream characteristics. This geologic, meteorologic, and hydrologic information was used to prepare a preliminary conceptual understanding of the study area hydrogeology.

8.1.6.2 Determination of Monitoring Requirements

The number and locations of investigations and monitoring activities were defined on the basis of the groundwater regime in the vicinity of the Pebble Deposit. A primary objective was to install monitoring wells as early as possible in the field program cycle. The locations of wells were modified as new data became available and the overall understanding of the site evolved.

8.1.6.3 Field Program

The field program consisted of multiple components, including monitoring well installation, groundwater sampling, seep and spring sampling, stream seepage evaluation, and piezometer installation and hydraulic testing. Instrumentation installed (including piezometers installed as part of the geotechnical program) included the following: 39 nested groundwater monitoring wells at 21 locations, 240 nested piezometers at 103 locations, 216 single piezometers that were not part of a nest, one deep multi-level groundwater instrumentation system, and nine cross-hole aquifer well tests at eight locations. This network of instrumentation was supplemented by 70 piezometers that were installed as part of the wetlands program. The groundwater field activities were primarily the responsibility of CH2M until early October 2004. After that time, the field work was carried out as follows:

- SWS supervised the installation of one pumping well and two pumping tests in 2004, and four pumping wells and seven pumping tests in 2005.

- SLR supervised two pumping tests in 2008.
- BEESC collected the 2004 groundwater samples; SLR collected the 2005, 2006, 2007, and 2008 samples.
- SLR prepared drillhole logs from the hydrogeology field program each year from 2004 to 2008.
- SLR, KP, and SWS assisted Westbay with the installation of a deep multi-level monitoring system in 2006 and 2008.
- HDR collected seep and spring samples in 2005, 2006, 2007, and 2008.
- HDR measured streamflows during low-flow periods in September 2004; March 2005; February and April 2006; February and April 2007; and March 2008.

The primary goals of the hydrogeology program were to install background monitoring wells and to define the baseline groundwater flow system. The standard practice for installing monitoring wells was to use 2-inch polyvinyl chloride (PVC) casing and screens. Schedule 80 PVC was used preferentially due to the limited joint strength of the Schedule 40 PVC that made it less suitable for the ground conditions and depths at this site. A slot size of 0.020 inch was generally used, although the schedule 40 PVC screen had a slot size of 0.010 inch. During 2004, pre-pack filters were used around the screens. From 2005 to 2008, slotted screens were used with sand backfill. Above the monitored zone, the drillhole annulus was backfilled by placing a high density bentonite grout using a pump and tremie to a nominal depth of 10 feet below ground surface (bgs). The top 10 feet of the annular space was backfilled with cement grout. A protective casing was installed at the surface with a whip flag to enable locating the well during the winter months. Piezometers were installed with the same protocols as the monitoring wells.

Well Location and Surveying

Before drilling, SLR, SWS, and Foundex Explorations Ltd. (Foundex) personnel located each well and piezometer to cadastral survey coordinates using a global positioning system (GPS) receiver. No drill pad preparation began until SLR, NDM, and Foundex agreed that drilling rigs could be safely moved to the site without causing harm to human health and the environment.

After the wells and piezometers were installed, a crew surveyed the installations under the supervision of a surveyor designated by NDM. Well elevations were surveyed at the top of the PVC riser pipe and at the ground surface. All surveying data were recorded in a bound field logbook. The surveyed coordinates and elevation of each well location were provided to SLR and SWS. In 2009 almost all piezometers and wells were re-surveyed to correct a few errors that had been detected and to provide a consistent set of survey data. The latest survey data are summarized in Appendix 8.1M.

Identification

Wells and piezometers were identified using the following well identification system:

- MW, P, or PW = for monitoring well, piezometer, or pumping well, respectively (although some of the “P” installations are being sampled and are therefore effectively monitoring wells).
- Year = two-digit number for the last two digits of the date.
- Well-site location number = sequential number starting with 1.

- Well type (if in a cluster) = single character denoting general well depth, as follows:
  - SS = super shallow
  - S = shallow
  - M = medium
  - D = deep

Well and piezometer numbers were assigned sequentially by completion. For example:

- MW-05-20S denoted the shallow monitoring well drilled in 2005 at the twentieth well location.
- MW-05-20M and MW-05-20D respectively denoted the medium and deep monitoring wells drilled in 2005 at the twentieth well location.
- P-05-25S denoted the shallow piezometer drilled in 2005 at the twenty-fifth piezometer location.

Drilling Method

During the early part of the site investigation in 2004, some piezometers were installed as part of the geotechnical drilling program. A mud rotary drilling method was used during that program that could not keep the holes open during installation of the piezometers. Therefore, piezometers were installed only at shallow depths. As a result, alternate drilling methodologies were investigated to meet the needs of the hydrogeology program. An ODEX heliportable rig eliminated the problems associated with hole caving and the addition of drilling mud, and minimized potential site disturbance. In 2004 a rig with 5-inch casing, capable of drilling over 200 feet in the sand and gravel materials at the site, was supplied by Midnight Sun Drilling (MSD) based in Whitehorse, Yukon. The 5-inch diameter casing was advanced with a downhole hammer. Samples were retrieved from a cyclone that was used to separate air from solid/liquid discharge. Soil cuttings were discharged to upland ground away from the soil boring. Soil boring logs are included as Appendix 8.1A.

Each year from 2005 to 2008, Foundex provided the drill crew and equipment. Drilling activities consisted of two drilling methods. The majority of the holes were drilled with the ODEX drilling system, which used a down-hole hammer, reverse air cuttings return, and a 5-inch internal diameter (ID) continuous casing. To a lesser extent, a mud-rotary drilling system with a 4.75-inch tri-cone rotary bit was used. During mud rotary drilling, the hole was supported by a bentonite drilling mud slurry that also circulated the cuttings to the surface.

Where required, heaving sands in air-drilled holes were controlled with water. Occasionally heaving sands affected well construction requiring additional temporary casing to be used.

The sample collection method varied with the drilling method. During mud rotary drilling, samples were collected with a split-spoon sampler. Split-spoon sampling methods were in accordance with the American Society for Testing and Materials (ASTM) Method D 1586-99, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM, 1999). For plastic materials, undisturbed soil samples were periodically collected using a Shelby Tube and the push-barrel sampling method. The Shelby Tube consisted of a 24-inch-long, thin-walled steel tube that was steadily pushed into the formation. After collection, the tube was immediately sealed with PVC caps and tape. During ODEX

drilling, grab samples were collected directly from the cyclone at regular intervals. All samples were used for describing the sub-surface materials.

Samples were bagged and labeled at 5-foot intervals and stored for future reference. The soils were classified in the field according to the Unified Soil Classification System (USCS). The bagged samples were stored in white buckets labeled with the drillhole number and depths of samples. Visual inspection of the cuttings together with observations of drilling activity provided the basis for describing the geologic materials.

Each soil boring was logged to provide a record of subsurface conditions encountered during drilling. The logs were prepared and maintained by the field supervisor overseeing the drilling activities. Observations were recorded on soil-boring log forms. Boring logs were prepared in accordance with ASTM Method D 2488-00 Standard Practice for Description and Identification of Soils (Visual Manual Procedure) (ASTM, 2000). Other drilling observations documented included the following:

- Drilling behavior, such as penetration rate and chatter, plugging of return hose, and driller's observations.
- Water levels in the casing during rod changes.
- Rate of water flow into or out of hole (if any).
- Photos of cuttings at 5-foot intervals.

Monitoring Well Installation

Monitoring wells constructed in 2004 and 2005 specifically to include groundwater sampling were labeled with a prefix "MW." Wells drilled and installed for other primary purposes, but later converted to monitoring wells, may have other prefixes. Well drilling, installation, and construction followed requirements outlined in the Work Plan (CH2M Hill 2004) and consolidated study program for Pebble Project (Appendix E), and other industry publications (ASTM, 1990; ADEC, 1992). Wells were constructed in completed soil borings after the drilling bit was withdrawn and concurrently with the removal of the casing.

In a given well cluster, each well was installed in a separate hole with about 15 feet of separation between holes. The first boring in the cluster was drilled into bedrock or to a reasonable capability of the rig. The drive shoe was knocked off to create a rathole (portion of hole extended beyond the required depth). The bottom boundary of the monitored horizon was determined based on the measured top of the seal placed on top of the rathole. Depths for subsequent wells in the cluster were determined based on the lithology of the first hole. Each of these subsequent wells was overdrilled by about 10 feet before the drive shoe was knocked off and the well constructed.

Screens were typically completed across two or three depth intervals (shallow, medium, and/or deep) in each well cluster as follows:

- In shallow wells, well screens were installed across or close to the water table.
- In medium depth wells, well screens were installed beneath the water table in a permeable horizon within deeper overburden.

- In deep wells, well screens were placed beneath the water table in deeper overburden (often below an aquitard), at the contact of overburden and bedrock surface or sealed into a permeable zone within deeper bedrock.

The terms “shallow,” “medium” and “deep” are relative terms within each well cluster.

Well Construction

In 2004 monitoring wells were installed with pre-packed well screens at most locations. Pre-packed screens consisted of 5- and 10-foot lengths of 2-inch-diameter, Schedule-40 PVC material with machine-cut 0.020-inch-wide slots and flush-threaded joints. The pre-packed screen contained 10-20 sieve silica sand as an internal sand filter. The well riser consisted of both 10-foot and 5-foot lengths of 2-inch-diameter, Schedule-80 PVC flush-threaded joints.

Before installing the well screen assembly, borings were either backfilled to the completion depth with 3/8-inch or 1/4-inch bentonite chips or by allowing the drillhole to collapse to the base of the well completion depth. Typically, a 1- to 3-foot-thick layer of 10-20 sieve silica sand was placed at the base of the well completion depth to support the well assembly. The well assembly was placed on this sand layer. The drill casing was then slowly removed and the boring was either backfilled with 10-20 sieve silica sand placed around the well screen (either pre-pack or non-pre-pack) concurrent with casing withdrawal or the formation was allowed to collapse around the well screen.

A 2- to 3-foot-thick layer of 10-20 sieve silica sand was then placed above the top of the well screen and a 2-foot-thick layer of finer, 20-40 sieve silica sand was placed above the 10-20 sand. Several feet of 3/8-inch or 1/4-inch bentonite chips were placed above the 20-40 sieve silica sand. The bentonite seal thickness ranged from 2 to 6 feet. A high-solids bentonite grout seal was tremied into place above the bentonite chip seal up to about 10 feet bgs. The annulus was then grouted to surface with a cement-bentonite grout. A 5-foot-long, 6-inch-diameter steel monument was then placed over the top of the well assembly and set into the cement-grout seal. A whip flag was placed adjacent to the well to improve well location visibility.

From 2005 to 2008, subsurface well construction included (from the bottom up) the following salient features:

- If a non-retrievable casing shoe was used, the casing shoe was sealed at the bottom of the drillhole beneath at least 3 feet of bentonite pellets and 3 feet of transition sand before the PVC riser pipe was placed in the casing.
- Monitoring wells were constructed of 2-inch-diameter, Schedule 80, flush-joint threaded PVC riser pipe with O-rings, extending about 2.5 feet above surface grade.
- Well screens were constructed of 0.020-inch machine-slotted PVC pipe capable of retaining the filter sand used.
- Filter sand packs were 10-20 silica sand, placed to at least 5 feet above the top of the screen while pulling the casing in small increments and maintaining the filter sand below the bottom of casing. Filter sand was not added if sands were heaving after the screen was placed.

- A 5-foot bentonite pellet plug was placed above the filter sand, where feasible, to seal the annulus above the filter pack sand. This plug was not placed when heaving sands were collapsing around the riser. Instead, the casing was pulled until the heaving stopped, and then the plug was installed. In a few cases, if bentonite plug placement was not feasible, the grout was placed directly on top of the filter pack sand. An additional 1 foot of filter pack sand was placed for every 10 feet of grout to prevent the grout from penetrating the monitoring zone.
- Bentonite grout was placed above the plug through a tremie pipe from the bottom up, with at least 30 percent solids by weight. The grout was pumped until return was observed at the surface. The casing was removed in sections and grout was pumped until return was again observed. The bentonite grout was completed to a depth of 10 feet bgs.
- At a depth of 10 feet bgs in each well, a cement-bentonite grout mixture (10 gallons water; 10 pounds bentonite; 100 pounds Portland cement) was used to seal the annular space to ground surface and set the protective casing.

The length of PVC riser installed in the hole was verified with the following procedure:

- The length of each PVC pipe was verified before it went into the well. The PVC pipe was laid out, lengths were checked and recorded, and the number of PVC screen and pipe sections placed in the hole was recorded.
- The cutoff was also measured.
- The total length of PVC installed in the hole was then calculated.
- The total depth of the well from the top of the PVC casing was measured prior to placing any backfill and the on-site geologist verified that the measured total length of PVC matched what was placed in the well.

Surface completion included cementing a 5-foot steel protective surface casing into place, placing filter sand in the annulus between the casing and the riser pipe, and attaching a reflective whip flag to the steel casing.

Piezometer Installation

Piezometers were installed to collect information on stratigraphy, hydraulic conductivity, and groundwater levels at the well sites. A series of clustered piezometers was often installed to provide vertical potentiometric data with up to four piezometers at a site. The maximum depth of a piezometer installation was 232 feet bgs. The number of piezometers at each site and the actual depths varied depending on site conditions. Piezometers were designed, drilled, installed, constructed, and documented in the same manner as monitoring wells. The piezometers installed are summarized in Appendix 8.1M.

Pumping Well Construction

Three pumping wells (PW-1, PW-3, and PW-4) were installed during 2004, four (PW-5, PW-6, PW-7, and PW-8) during 2005, and two during 2008 (PW08-9 and PW08-10). The wells were drilled with the ODEX rig but used welded rather than threaded casing. The design depth of each well was established from logs of nearby monitoring wells and piezometers. After reaching the design depth, a telescoping, continuous-slot, stainless-steel well screen and K-packer assembly was lowered into the well for those

wells that were installed in overburden. The casing was then retracted to expose the screen to the formation. Wells installed in bedrock did not have screens.

The pumping-well screen was placed in the most permeable horizon encountered during drilling. Well-screen placement and length varied to allow for screening and sampling of the target aquifer materials and was short enough to avoid bridging aquitards and connecting adjacent aquifers.

Well and Piezometer Development

Newly constructed wells and piezometers were developed to remove fines from the monitoring zone, to enhance the flow of formation water into the well, and to minimize the suspended solids in the subsequent groundwater samples. Wells were developed after the surface seal had hardened and a minimum of 24 hours had passed after installation.

All development data were recorded on a well development log form. The following parameters were monitored during development:

- Volume of water pumped.
- Quantity, color, and size of sediment removed.
- pH, temperature, and specific conductance of the water.
- Comments on well yield and results of development.

The following technique was used for developing monitoring wells and piezometers:

- The water level and total depth of the well were measured by means of a water-level indicator. Any accumulated sediment thickness was recorded in a logbook.
- The pump tubing and foot valve with a surge block attached was then lowered to the bottom of the screen, and the actuator was started.
- Development continued until a noticeable decrease in sediment yield was observed or until a maximum of 45 to 60 minutes had passed.
- The surge block was then moved about 2 feet up the screen and the process was repeated.
- The surge block was moved up the screen in 2-foot intervals until the full screen length was developed.
- After completing the screen surging, the surge block was removed, and the tubing and foot valve were lowered to the bottom of the well to remove accumulated sediment in the base of the well casing. The foot valve was then raised to about 5 feet above the top of the screen, and the well was pumped as the final step of development.
- The well was considered adequately developed if the water was clear and included less than 1 tablespoon of fine sand per 5 gallons. If more sand than this was present, the process was repeated for up to 4 hours.
- After stabilization (or 4 hours of surging and pumping), pH, temperature, and specific conductance of the final developed water were measured.

- As a final step, the foot valve was lowered to the bottom of the well again to collect any sediment that accumulated during final development of the well.

Piezometers were developed using procedures similar to those for monitoring wells, but for a shorter duration, because filter pack development is only required to improve response to piezometric level changes rather than to remove suspended sediment during subsequent water sampling.

Pumping wells were developed by airlifting, with the exception of PW-6, where a submersible pump was used. Wells were developed until the sediment load had decreased substantially. The development water was discharged to uplands where the water infiltrated the ground in all cases, with no visible discharge to surface water.

Response Testing

The monitoring wells and piezometers were response (slug) tested after well development was completed by CH2M in 2004 and SLR from 2005 to 2008. Response tests were completed in all wells with sufficient water and followed the standard test method in ASTM Method D 4044 (ASTM, 2002). A response test included the following:

- Before the response test was conducted, the depth to water was measured from the top of the PVC riser pipe with a water level indicator. The stickup of the PVC riser above ground surface was also recorded.
- An In-Situ Inc. miniTROLL electric pressure transducer/datalogger was lowered into the well. After the transducer was placed in the well, the depth to groundwater was monitored until the water level stabilized or was responding only to regional changes in piezometric head. Manual water level readings were recorded to correlate to the transducer readings.
- After the well water level stabilized, a 1-inch-diameter Waterra tube with a foot valve was quickly inserted into the well, thereby raising the water column in the well. In 2004 the method of sealing the Waterra tube was not fully sealed due to technical issues. From 2005 through 2008, the end of the tube was positively sealed. The water level was monitored with the pressure transducer and datalogger as it returned to the static level.
- The Waterra tubing was then quickly extracted from the well, thereby lowering the water level in the well. The water level in the well was again allowed to recover, comprising a rising head test.
- This process was typically repeated.
- The transducer was removed from the well.

Small Pool Well Points

Shallow piezometers were installed by SLR at locations identified by Three Parameters Plus, Inc. (3PPI) near small pools. Two types of pools were identified: perched precipitation pools and groundwater flow-through pools. The purpose of these well-point installations was to collect information and develop a better understanding of the hydrologic processes in the two types of pools.

Pilot holes were drilled with a mobile, wheel-mounted Minuteman 2.5-inch solid stem auger drill. The pilot boring was extended to about 24 inches short of the pre-determined depth. After the boring was

completed, the well point was driven to the final pre-determined depth with a sledge hammer. The annular space was backfilled with 0.25-inch bentonite pellets, and the well point was labeled and marked with a whip flag. The well point materials consisted of 1.25-inch diameter stainless steel well points with 20-inch slotted screens installed at depths of 2 meters and 4 meters. Fifty well points were installed.

Deep Multi-level Piezometer Installation

A multi-level piezometer supplied by Westbay Instruments Inc. was installed in the Pebble Deposit area in 2006 in exploration drillhole 6349 (Appendix 8.1K). An HQ vertical mineral exploration hole was drilled to a depth of 4,050 feet. Drill circulation fluid was then flushed from the hole. A string of 50 packers, 50 measurement ports, and 25 pumping ports supplied by Westbay Instruments was then installed in the hole by a team comprised of the drillers and members from Westbay Instruments, SWS, SLR, and KP. Piezometric levels were measured at the 50 monitoring levels in this well monthly except short durations when the instrument required repair or when hydrogeologic testing was underway.

Other Piezometers

Piezometers were installed in geotechnical drillholes where possible and were constructed of 2-inch-diameter PVC casing. Slug testing and injection testing in the completed piezometers were attempted to provide information from the completion zone. Drilling and installation supervision was provided by KP.

Pumping Tests

Pumping tests were conducted in three areas identified as (i) the Pebble Deposit and surrounding area; (ii) downgradient of the Pebble Deposit beside the South Fork Koktuli River at four locations; and (iii) the North Fork Koktuli drainage area. Test wells were completed in both overburden and bedrock. Each test site included a pumping well and multiple piezometers for monitoring water levels.

The air-lift technique was used to pump all but one of the wells. The air-lift method was selected primarily to maximize the potential pumping rate from the wells. The heliportable ODEX rig was equipped to drill with 5-inch diameter casing. This casing size provides clearance for a conventional submersible pump of up to 4 inches in diameter, which will pump up to 100 gallons per minute (gpm). In contrast, air lifting from a 5-inch casing can yield over 300 gpm. Because high permeabilities were expected, the higher pumping rates were desirable. In addition, the necessary air compressors for air lifting were part of the ODEX drilling equipment.

The flow rate of each pumping well was recorded continuously with a weir, and checked regularly with a tank and stopwatch. The water levels in the pumping well and observation wells were recorded frequently, both with transducers and with manual sounding tapes. Barometric pressure was monitored during the test so that the necessary corrections could be applied to the water level measurements, if required. The recovery of water levels was also recorded after the pump was turned off. Water level monitoring of the pumped well was not possible with the air lift pumping technique. Pump discharge was to land with no runoff to surface water, with the discharge point located 800 to 1,000 feet from the pumping well. At this distance, little influence would be expected on piezometric levels measured during the test.

The duration of the pumping test ranged from about 6 hours up to a maximum of 24 hours, with a minimum of an equivalent duration of monitored recovery. The pumping test was preceded by a step test to determine the optimal pumping rate when using a submersible electric pump or trials with varying the depth and air pressure settings to obtain the maximum sustainable pumping rate using the air-lift method.

The following steps were completed before each pumping test:

- Transducers were installed in background monitoring wells or piezometers to measure groundwater levels and regional trends before the test started.
- Transducers were installed in piezometers located near the pumping wells before drilling of the pumping well.
- When possible, a barometric pressure logger was installed in a nearby piezometer at the time the first water level transducer was installed.
- During the pumping test and recovery period, water levels were measured manually at regular intervals to confirm the transducer readings and to relate the transducer water level data to a surveyed elevation point.
- The maximum sustainable well yield for tests that used a submersible electric pump was determined from a step test. The pumping rate was increased in steps while the water level in the pumping well and adjacent observation wells was monitored. The time-drawdown of the water level in the pumping well was examined to determine the maximum production rate that would be feasible for the planned pumping duration, as well as to look for indication of excessive frictional loss in the well screen. The pumping rate for the constant-rate test was selected based on the results of the step test.
- The maximum sustainable well yield for tests that used the air-lift method was determined by a step test in which the submergence of the pipe used for injecting compressed air was varied in steps and water was produced during each step. The duration of each step was 1 to 4 hours. The submergence for the pipe during the constant-rate test was based on the optimal pumping rate found from the step test.
- The recovery from the step test was verified by manual measurements and review of the transducer data.
- The constant-rate test was initiated at the chosen rate after the water levels recovered fully.
- The constant rate test continued until one of the following conditions was observed:
  - The water levels stabilized and were judged unlikely to change.
  - 24 hours had passed.
- After groundwater pumping stopped, recovery was monitored for a period equal to or greater than the duration of the test and the pre-test monitoring.

Monitoring Well Sampling

Sampling events were timed to coincide with high groundwater levels in spring (May) and early fall (November), and low groundwater levels in summer (August) and winter (March), and to be coincident with the surface water chemistry sampling programs. Before sampling, the depth to groundwater was

measured using an electric well probe. The depth to groundwater was referenced to the top of sample access port in the outlet pipe after it was installed or top of PVC before the outlet pipe and sample access port were installed. A dedicated Fultz® electric submersible pump was used for sampling. This pump was used to purge groundwater from the well at rates of less than 0.5 liters per minute. During well purging, water quality parameters were measured using a Horiba® model U-22 (2004) or YSI Model 556 (2005 and 2006) multi-meter. Parameters measured included pH, specific conductivity, dissolved oxygen, temperature, and oxidation-reduction potential. The meter was calibrated daily before use with the calibration specifics recorded in field reports. At the end of purging, the purged water was tested for ferrous and ferric iron using a Hach® model 890 field kit. Samples were collected from the tubing discharge and placed directly into laboratory-prepared sample containers. Groundwater quality is described in Chapter 9.

Seep Sampling

Seeps were sampled at nine sites in 2004 by CH2M Hill. In 2005, 2006, 2007, and 2008, additional sites were added by HDR and a quarterly sampling cycle was started. In addition, two substitutions were made to the 2004 sample list where seeps dried out toward the end of the year. Samples were collected in March, July, August, and October 2005. Nine sites were sampled in March, 23 in July, and 24 in both August and October. Sampling was expanded in 2006, with eight in March, 25 in June, 24 in August, and 59 in October. Sampling expanded again in 2007, with 12 in March, 65 in May, 100 in August, 102 in September, and 114 in October. Sampling in March was limited by snow cover. During 2008, 19 samples were collected in June, 28 in August, 28 in September, and 28 in November.

Samples were collected via direct capture method or as flow over a 60° or 90° V-notch weir, as dictated by flow volume. All weir-derived flow rates were validated with direct capture readings. In-situ measurements of temperature, specific conductivity, dissolved oxygen, pH, and turbidity were made at the beginning of sampling events using a YSI 555 multiprobe meter and a Hach 2100P turbidimeter. Chapter 9 includes a more detailed description of seep sampling methodologies.

Groundwater Level Measurements

Groundwater levels were measured in monitoring wells during sampling. Water levels were also measured at several additional times during the year. As wells were not completed until late in 2004, a regular program of water level monitoring was started in 2005. In 2005, 2006, 2007, and 2008, water levels were measured monthly.

Water levels in wells and piezometers were measured with a water level indicator. Water levels were documented on water-level measurement forms. The following protocol was used while collecting water-level data:

- A water-level indicator was used to measure water levels and total depths in all wells and groundwater piezometers. The total depth of wells with dedicated sampling pumps installed was not measured.
- Water level indicators were kept clean and were maintained in accordance with manufacturer's instructions.

- The reference point for water-level measurements was the outlet pipe sample access port on those installations that had submersible pumps or the high point of the PVC casing on those installations that did not have submersible pumps.

Water levels in selected piezometers were measured using electronic transducers and data loggers. The water levels were measured at a minimum interval of once every 6 hours. The data from the loggers were downloaded onto a handheld computer during the monthly water level measurement visits.

Field Data Review

The field team leader reviewed all data measured in the field, and senior personnel performed final data validation by checking procedures used in the field and comparing the data with previous results, changes in other wells, and changes to other environmental conditions.

Data that could not be validated were so documented; corrective action followed as necessary. Corrective actions for field sampling included procedures to be followed when field data results were not within the acceptable error-tolerance range. These procedures included the following:

- Replacing or repairing faulty equipment.
- Adjusting established methods due to extreme weather conditions.

The field-team leader was responsible for ordering appropriate corrective actions when deemed necessary. All field corrective actions were recorded in the field logbook. Alterations to established methods were discussed with project managers at SLR and SWS offices.

8.1.6.4 Analysis of Response Tests and Pumping Tests

Response test data, including transducer data, manual water level data, and field notes were assembled in spreadsheets for each of the tested wells and piezometers. The data were analyzed to determine apparent hydraulic conductivities of the formation materials surrounding the test well. The primary analytical methods used are those described by Hvorslev (1951), Cooper et al. (1967), and Van der Kamp (1976). The results of the analyses are presented for each well in Appendix 8.1C.

The pumping test data–including transducer data, manual water level recordings, field notes, and pumping rates–were assembled in spreadsheets for each of the tests. The data were analyzed to determine apparent transmissivities, as well as horizontal and vertical hydraulic conductivities. Methods used include the Hantush method (Hantush, 1960), the Hantush and Jacob method (Hantush and Jacob, 1955), the Neuman method (Neuman, 1972), the Moench method (Moench, 1993), and the ratio method (Neuman and Witherspoon, 1972). The test results were analyzed in Excel spreadsheets or commercial software packages.

8.1.6.5 Site-Wide Water Balance

A monthly water balance approach commonly used for hydrologic evaluations was used to evaluate groundwater recharge and discharge (see Alley, 1984 and Steenhuis and Van der Molen, 1986). This method provides a simple technique to include the interaction of surface water and groundwater components of a flow system, as well as climate data, streamflow data, and groundwater level data in

characterizing a flow system. Furthermore, the recharge rate estimated from the water balance can be used as a recharge estimate for a more rigorous groundwater flow model. Output from the groundwater flow model can then be used to refine the water balance. Details of the water-balance model are provided in Appendix 8.1I. The following paragraphs briefly summarize the approach used.

The study area was divided into sub-catchments (Figure 8.1-1b). Sub-catchment areas were defined by topographic controls on drainage and the need to examine water flow rates and volumes. For example, most of the sub-catchment boundaries were defined by the drainage area reporting to surface water gaging stations. Each of the sub-catchments was further discretized by elevation. The elevation bands selected were 500-foot intervals, starting at 300 feet above sea level. Representative climate conditions (temperature and precipitation) were calculated for the center elevation of each elevation band.

For each sub-catchment, the water available for runoff and recharge was calculated based on the sub-catchment area and the net precipitation that was determined as rainfall plus snowmelt less evapotranspiration and sublimation. Recharge was calculated according to surface conditions, soil permeability and available storage capacity, and then added to groundwater in storage. Groundwater was released at a rate proportional to the average volume in storage using a linear reservoir model. The groundwater released was passed on to the next sub-catchment downstream as groundwater up to an amount controlled by Darcy's Law. The remainder of the released water was discharged within the sub-catchment and was passed on to the next sub-catchment downstream with the surface water. The water that was not recharged was either passed on to the next sub-catchment downstream as immediate runoff or was added to surface water detained in the sub-catchment. In the cases with surface water detention, that water not detained was passed on as immediate runoff. Detained water was released as a proportion of the average volume of water detained, using the same type of detention and linear reservoir model used for the groundwater storage.

The water balance was calibrated to the cumulative water volumes at selected stream gages by adjusting climate variables (precipitation and evapotranspiration). The estimated division of flow as immediate runoff, groundwater recharge, and groundwater discharge was then refined by adjusting the groundwater recharge and discharge rates to produce a match between estimated and measured monthly values of streamflows and groundwater levels.

8.1.6.6 Hydrogeologic Characterization

Preliminary hydrogeologic characterizations have been developed and refined from 2004 through 2008 to assist with the planning of ongoing investigations and to provide input to site layout and design. Since 2005 hydrogeological analysis included the development of a detailed hydrogeologic model to assist with characterizing the existing groundwater flow regime; and generating groundwater estimates to support aquatic, fish resource, and wetlands habitat assessments. To meet these objectives the following components were included:

- Assembly of a working geologic model from the preparation of subsurface cross sections using drillhole logs and seismic data.
- Preparation of water-level time series for the period of October 2004 to December 2008.
- Comparison of measured streamflows with variances in drillhole water levels, on both spatial and temporal scales.

- Preparation of groundwater equipotential plots.
- Assessment of recharge volumes as derived from the Site Wide Water Balance Model.
- Development of potential recharge pathways as suggested from data sets.
- Preparation of a hydrostratigraphic model via analysis of the drillhole logs, water level time series, and hydraulic conductivity data (derived from response and pumping tests).
- Conceptualization of site hydrogeology in three dimensions.
- Development of a numerical groundwater model for quantitative analysis of groundwater flow rates, flow directions, and travel times.

8.1.6.7 Development of Numerical Groundwater Model

A numerical groundwater model was developed using the finite-difference code MODFLOW SURFACT. The details of the model development and the results are included in Appendix 8.1J. The model domain encompassed most of the study area and consisted of five simplified layers to represent the following general hydrogeologic units: overburden (three layers), upper bedrock (one layer), and lower bedrock (one layer). Boundary conditions were assigned to represent the following:

- Surface-water-groundwater interaction between the aquifers and the rivers.
- Discharge to the numerous seeps that have been identified on the hillsides.
- Meteoric recharge.
- Groundwater outflow across the exterior model boundaries.

The input parameters (hydraulic conductivity, river-boundary conductance, drain-boundary conductance, meteoric recharge) were adjusted to obtain a reasonable match between modeled and measured targets, including:

- Groundwater levels at a range of groundwater monitoring locations and times of year.
- Groundwater flow rates that were calculated by the Water Balance Model within each watershed.

The methods used for developing the groundwater model are described in more detail in Appendix 8.1J.

8.1.7 Results and Discussion

8.1.7.1 Bedrock Geology

The bedrock geology in the study area is described in Chapter 3 of this EBD. The geology is summarized in the following paragraphs, specifically as it may apply to the hydrogeology of the study area.

The mine study area is within the Kahiltna Terrane, a geologic basin filled by Jurassic to Cretaceous volcanic and sedimentary formations. In the area of the deposit, the Late Cretaceous volcanic and sedimentary formations were intruded by granites and monzonites. Tertiary volcanic rocks and sediments were deposited on top of the older volcanic sediments and intrusives. The bedrock geology in the study area therefore falls into three general categories listed below (Figure 8.1-2).

- Jurassic and Cretaceous sedimentary and volcanic rocks, including the following:
  - Basalt flow and flow breccia.
  - Conglomerate-wacke interval.
  - Fragmental andesitic siltstone.
  - Andesitic mudstone to siltstone.
- Cretaceous intrusions into the older Jurassic and Cretaceous sedimentary and volcanic units, including the following:
  - Various intrusives including Pyroxenite, Gabbro, and Monzodiorite.
  - A diverse zone of stocks, dykes, and sills that host the Pebble Deposit.
  - Kaskanak Batholith (granodiorite) west of the Pebble Deposit area.
- Tertiary intrusions, volcanic and sedimentary rocks including the following:
  - Tertiary intrusions (monzonite), primarily underlying Koktuli Mountain.
  - Clast-supported and matrix-supported fragmental rocks–these volcaniclastic units are characterized by angular clasts with little indication of bedding.
  - Basalt and andesite–these occur as flows, dykes, and sills, and are typically black or dark green, and may be massive or include a variety of macro textures.
  - Conglomerate–a conglomerate frequently occurs at the base of the Tertiary west of the ZG fault. Thinner occurrences have been noted but cannot be reliably traced.
  - Wacke–the term wacke encompasses a variety of strongly to weakly bedded pebble conglomerates to fine sandstone with sub-angular to sub-rounded grains.
  - Siltstone and mudstone–siltstone and mudstone generally occur as thin interbeds in complex, rapidly alternating clastic sequences, but in a number of places they form relatively thick units (300 to 400 feet).

The west side of the property is dominated by granodiorite of the Kaskanak Batholith. The east side of the property is dominated by a cover of Tertiary rocks. Near the deposit, the older sedimentary and volcanic rocks have been intruded. On the east side of the Cretaceous mineralized zone, the intruded sequence has been covered by the Tertiary volcanic and sedimentary rocks.

The structural fabric of the Pebble claim property is broadly defined by northeast-trending faults that are related to translational motion along the Lake Clark Fault (about 10 miles east of the deposit). Seven major fault zones (ZA to ZG) have been identified in the Pebble Deposit area and are described in detail in Chapter 6.

A northeast-trending graben (East Graben) extends along the valley northeast of Koktuli Mountain. Fault ZG1 on the northwest side of the graben drops the Tertiary-Cretaceous boundary 2,000 to 3,000 feet. Faults ZH and ZI are mapped on the southeast side of the East Graben.

Many of the faults within the deposit may have movement related to formation of the graben (ZA to ZF). Of these, ZE has one of the largest documented displacements, which increases to the east. Detailed mapping has identified several faults aligned sub-parallel to the ZE fault.

Other faults have been mapped within the study area, and these are identified on Figure 8.1-2. Valleys and other topographic linears are likely related to faults and fractures within the study area. Evidence of at least one fault or fracture zone is common in each of the core logs for the GH series of drillholes. Most of these holes were drilled about 100 feet into bedrock over a broad area and over a range of rock types. Faults may result in increased fracturing, which may increase groundwater flow in the vicinity of the fault. However, intense shearing often results in formation of a very fine grained fault gouge, which inhibits flow across the fault. Faults can also offset permeable zones resulting in discontinuous zones of elevated permeability.

The buried bedrock valley along the South Fork Koktuli River has a thalweg elevation that ranged from a maximum of over 1,000 feet in the headwaters to a minimum of about 600 feet near the groundwater discharge area at the west end of the study area (Figure 8.1-3a). Under Frying Pan Lake, there is a local minimum in the bedrock surface of about 800 feet. A buried bedrock saddle between Frying Pan Lake and the South Fork Koktuli Flats recharge area results in slightly lower overburden thickness in that area. The thalweg of the buried valley continues to slope gradually to the west along the course of the South Fork Koktuli River. In contrast the thalweg of the channel into tributary UT1.190 slopes very steeply to the southeast. This is probably the result of a paleo drainage system different from the current drainage system.

Rubble, or felsenmeer, formed by frost action on bedrock, covers many of the gently rounded hilltops and upland surfaces. Where there is an overburden cover, the upper bedrock is not expected to form felsenmeer, as the material is partly constrained by the overburden cover. However, periglacial activity did result in disturbance and weathering of the upper bedrock. In some locations, granodiorite has been weathered to sand. Low RQD (a measure of rock quality based on fracture density) is common in the top 5 to 30 feet in core logged in the GH series of drillholes. This pattern is consistent with high water returns from holes drilled into bedrock with the air rotary ODEX method. The top of rock is therefore expected to provide a relatively continuous aquifer across the study area.

8.1.7.2 Surficial Geology

The surficial deposits of the Iliamna Quadrangle have been described by Detterman and Reed (1973) and Detterman (1986). More recently, the surficial deposits within the mine study area were described by Hamilton and Klieforth, 2010, (Figures 8.1-3b and 8.1-3c). The surficial deposits are primarily glacial, with modification by glacio-fluvial and lacustrine processes. The deposits are mapped as:

- Mak Hill Glaciation of early Wisconsin Age.
- Kvichak Stade of the late Wisconsin Brooks Lake Glaciation.
- Iliamna Stade of the late Wisconsin Brooks Lake Glaciation.
- Newhalen Stade of the late Wisconsin Brooks Lake Glaciation, which did not inundate the study site but was mapped east of Upper Talarik Creek.

Glaciers advanced into the study area from the north, northeast, and south. At various times, glaciation blocked each of the three major drainages, resulting in glacial lakes. Ice wastage by stagnation resulted in extensive areas of ice-contact meltwater deposits and in numerous meltwater channels. The surficial geology is dominated by end moraines, meltwater deposits with abundant kettle depressions, broad outwash aprons and elongated valley trains, and striking meltwater channels. Former glacial lakes are marked by broad expanses of unusually smooth, poorly drained and gently sloping terrain that terminates abruptly upslope at consistent altitudes and is commonly bordered by beach and deltaic deposits.

Upslope from the glacial deposits, the ground cover was mapped as bedrock, glaciated bedrock, talus, colluvium (including rock rubble, rock debris, frost creep, and solifluction) and some local drift deposits from small glaciers in small elevated basins. Bedrock is mapped primarily on hill tops where periglacial activity and weathering have disturbed the original bedrock fabric to depths of up to 30 feet. Talus and rubble both represent frost activity, with talus moving downslope from the source and rubble remaining at the source. Solifluction features are primarily a periglacial feature and are most likely associated with the Wisconsin Glaciation.

The upper boundary of the Mak Hill deposits was mapped at an elevation exceeding 1,400 feet within the study area, which is up to 600 feet higher than the following Brooks Lake Glaciation. The Mak Hill glacial deposits include ice-abraded uplands with thin patches of drift. Both the North Fork and South Fork Koktuli rivers were dammed by glaciers at this time. The Mak Hill glacial deposits have been modified and subdued primarily by running water during melting of the Kvichak Stade. Locally, surface expression is often a washed sand and gravel fabric on the slopes.

Most of the surficial deposits in the study area are the result of the Kvichak Stade of the Brooks Lake Glaciation. The study area contains a complex system of deposits, including terminal moraines, recessional moraines, drift deposits, meltwater deposits, and glacial lake (lacustrine) deposits. The primary locations of these deposits in the study area are described below.

Terminal Moraines

Terminal moraines in the North Fork Koktuli River Valley were mapped near streamflow gaging station SK100B and in the South Fork Koktuli River Valley near streamflow gaging station SK100C.

Recessional Moraines

Recessional moraines were mapped upstream of terminal moraines in the North Fork Koktuli River Valley, downstream of Frying Pan Lake, and along the topographic boundary between the South Fork Koktuli River and Upper Talarik Creek drainages in the Pebble Deposit area.

Drift Deposits

Drift deposits, including lateral moraines with a silty component, have a considerable volume west of the Frying Pan Lake basin, west of Upper Talarik Creek and just east of low flow measurement site SK100D, and to the south of the headwater area of the North Fork Koktuli River. These larger lateral moraines form typical knob and kettle topography. Other drift deposits appear to be primarily a coarser fabric, probably the result of a different source area. This is particularly noticeable south of Frying Pan Lake

where silty (low permeability) drift deposits are present immediately north of coarser fabric (permeable) drift.

Meltwater Outwash Deposits

The meltwater outwash deposits include deposits with abundant kettle depressions, broad outwash plains and elongate valley trains, and meltwater channels. These deposits occur downstream of end and recessional moraines. The largest plains border the fronts of the end moraines because of a protracted standstill of the Kvichak Stade. Other outwash deposits occur downstream of Frying Pan Lake, and from standstills between Frying Pan Lake and the end moraine. Pitted outwash borders the fronts of moraines where the deposits covered blocks of ice that subsequently melted. Many of these pits are internally drained.

Lacustrine Deposits

Former glacial dammed lakes are marked by broad expanses of unusually smooth, poorly drained and gently sloping terrain that terminates abruptly upslope at consistent altitudes and are commonly bordered by beach and deltaic deposits. Such lake deposits underlie and border Frying Pan Lake, most of the Upper Talarik Creek Valley within the study area, and the headwaters area of the North Fork Koktuli River. The distribution of these materials is described below, by drainage.

South Fork Koktuli Drainage: In the South Fork Koktuli River drainage of the Pebble Deposit area, the surficial geology is dominated by glacial lake (gl_2) and deltaic (fd, dt) deposits (Figure 8.1-3b and 8.1-3c) below an elevation of about 1,000 feet, with glacial drift (d_1) to the east and west. The top of the lacustrine deposits include beach (b) and delta (dt) deposits. The glacial drift (d1) includes silty sand and gravel deposits with sand and gravel layers (about 10 percent of thickness). In boreholes drilled through the valley floor, interbedded silty sand and gravel, and silts were present, likely resulting from the multiple advances of glaciers and related lakes in this valley. In many boreholes, clean sand and gravel was present near the top of rock. In bedrock lows, the sand and gravel was often thick enough to represent a continuous aquifer.

Southward toward Frying Pan Lake, materials on the valley slopes (d1) were similar to those in the Pebble Deposit area. However, underlying the valley floor, thicknesses of sand, and sand and gravel increased to as much as 40 percent of total overburden thickness. Some boreholes had much of that thickness near the bedrock contact. The sand and gravel units may have been deposited during periods when the glacial lake drained.

Drilling data together with streamflow gaging and piezometric level monitoring indicated that the ground within the valley at the outlet to Frying Pan Lake contains little permeable material. However, the shallow fractured bedrock provides a potential pathway for seepage.

A terminal moraine and a recessional moraine are present downstream of Frying Pan Lake (black dots on Figure 8.1-3b). The recessional moraine closest to Frying Pan Lake, perhaps combined with ice damming, created a glacial lake much larger than the present-day Frying Pan Lake. Remnants of beaches were observed at many locations. Lake deposits and peat were present on the lake bed. Alluvial fans and fan deltas were co-depositional with the lake deposits where streams flowed out of the hills.

Downstream of the two moraines south of Frying Pan Lake, the valley deposits were mapped as glacial drift (d_1). Although mapped as the same age as the drift adjacent to Frying Pan Lake, this drift arrived from the east, whereas the drift near the deposit and Frying Pan Lake was derived from the north. This drift to the south of the lake is composed of a considerable thickness of clean sand and gravel. This relatively clean glacial drift, which is the dominant fill material for the South Fork Flats, appears to be the result of glacial transport of sand and gravel deposits.

Glacial lake deposits (gl_3) are mapped on the southeastern boundary of South Fork Flats. These deposits, together with additional silt-rich deposits at depth, provide a partial barrier to groundwater flow from the sand and gravel underlying South Fork Flats to Upper Talarik Creek. These silt-rich deposits are over 300 feet thick. At least three sand and gravel horizons are within this section. The surficial horizon is an outwash (o_{1b} and o_{1b}/d_1), and the drift (d_1) is sand and gravel. A middle sand and gravel layer encountered by drilling appears to carry most of the seepage from South Fork Flats to tributary UT1.190. The deepest sand and gravel deposits appear to have limited ability to transport seepage. Drill cuttings from this unit were described as silty sand and gravel, and sand and gravel.

Further downstream along the South Fork Koktuli River (downstream of stream gage SK100C), extensive outwash (o_1), terrace (tg), and alluvial (al) deposits are continuous with the clean drift (d_1) to form a long and continuous valley aquifer. Both the thickness of the sand and gravel materials and the width of the valley floor decrease in a downstream direction. This decrease in width and thickness partly accounts for the many springs in the river channel in this part of the valley.

Upper Talarik Creek Drainage: The headwaters of the Upper Talarik Creek drainage include glacial lake deposits (gl) below an elevation of about 1,000 feet with primarily glacial drift (d_2) at higher elevations. Beach deposits (b) were mapped along abandoned shorelines. Glacial lake (gl_1/d) and outwash deposits (o_2) were mapped above 1,000 feet in the saddle between the North Fork Koktuli and Upper Talarik drainages. These materials were probably deposited within a glacial lake stranded between ice lobes filling the North Fork Koktuli drainage and the Upper Talarik Creek drainage. Boreholes within the upper reaches of the drainage typically encountered silt to silty sand and gravel, with some cleaner sand and gravel near the top of rock. On the eastern margin of the deposit, sand and gravel infills a bedrock low. Boreholes that penetrated this aquifer and that had collar elevations below about 970 feet had relatively high artesian flow rates. There was no indication of springs from this aquifer closer to Upper Talarik Creek, indicating that the aquifer is not continuous over a long distance.

Glacial lake deposits (gl_3) were mapped downstream to the southern margin of the geologic map sheet (Hamilton and Klieforth, 2010) (Figures 8.1-3b and 8.1-3c). West of the creek valley, the glacial lake deposits overlie and border glacial drift (d_1) and older glacial lake deposits (determined from drilling southeast of South Fork Flats). Boreholes to the east of Upper Talarik Creek encountered sand and gravel, and silt-rich layers. Hamilton and Klieforth 2010 mapped an assemblage of glacial outwash (o_2), ice contact (i-c), deltaic (dt_1, dt_2, dt_3), and drift deposits (d_2). Extensive areas of kettled terrain with internally drained ponds and dry depressions indicate permeable materials are present in this area east of Upper Talarik Creek.

North Fork Koktuli River Watershed: The headwaters of the North Fork Koktuli River (Big Wiggly Basin, Figure 8.1-3b) include drift deposits (d_1, d_2), glacial lake deposits (gl), deltaic deposits (dt), fan delta deposits (fd), and outwash deposits (o_1, o_2). Immediately downstream of this assemblage was a terminal moraine of the Kvichak Stade (d_1). Between the headwaters and the terminal moraine, glacial

topography remains. This includes combinations of glacial lake deposits, recessional moraines, and outwash deposits.

The terminal moraine and associated outwash of the Kvichak Stade were mapped further downstream (o_1). This area downstream also includes alluvium (al) and terrace gravel (tg). Boreholes encountered some silt material below the outwash consistent with glacial damming in the past, which would have resulted in glacial lakes.

The Kvichak Stade advanced only a short distance into tributary NK1.190 (Area G). As a result, the base of the valley near the lower end has thin overburden. Overburden was thicker on degraded terraces along the valley walls. At the headwaters, a considerable thickness of sand and gravel was penetrated during the investigation program, which may be outwash sand and gravels associated with the Mak Hill glacial advance. However, in some boreholes it was difficult for field staff to differentiate between sand and gravel, and weathered, clast-supported fragmental rocks of Tertiary age.

8.1.7.3 Summary of Site Subsurface Investigations

Site subsurface investigation were conducted from 2004 through 2008 to characterize the site geology, and to install monitoring wells and piezometers to sample the groundwater, monitor water levels, and measure hydraulic conductivity. Appendix 8.1A contains all documentation for drillhole geology and monitoring wells and piezometers completed during 2004 to 2008. The documentation includes the following:

- Logs of soil lithology.
- Water levels measured during drilling.
- Monitoring well or piezometer completion details.
- Development records.
- Response test records.

Appendix 8.1M summarizes well construction and sampling details. The well and piezometer locations are shown on Figure 8.1-4.

To summarize the groundwater conditions, the surficial geologic materials within the study area were classified into three groups: sand or gravel with limited clay or silt content; silty sand or gravel; and silt or clay sometimes with low contents of gravel or sand. Sixty six cross sections were drawn to represent the surficial hydrogeologic units at the site (Appendix 8.1B). Of these, three cross sections were selected to represent the geology within the study area: a longitudinal section along the South Fork Koktuli River from the Pebble Deposit area south to the headwaters of tributary UT1.190 (Figure 8.1-5); an east-west cross section between the Pebble Deposit area and Frying Pan Lake (Figure 8.1-6); and a north-south cross section across the South Fork Koktuli River at the western end of the study area (Figure 8.1-7). All cross section locations are shown on Figure 8.1-4.

The cross sections indicate that the overburden geology within the study area is relatively complex with units of highly contrasting fabric layered on top of one another and showing variable lateral continuity across the study area. In general, the thicker silty layers occur north of Frying Pan Lake and in the upper

reaches of tributary UT1.190 (see stream gage site UT119B on Figure 8.1-4). The north-south longitudinal section (Figure 8.1-5) shows relatively thick layers of silt, and silty sand and gravel north of P05-22 and south of GH04-03. The intervening area along the South Fork Koktuli River south of Frying Pan Lake shows a relative absence of silty layers. The sand and gravel material is continuous throughout this section, which passes through a bedrock high. This distinction is reinforced by cross section E-10 (Figure 8.1-6), which is located between Frying Pan Lake and the Pebble Deposit area. This section includes clay and silt, which were probably deposited in glacial lakes similar to the surficial glacial lake deposits mapped in this basin. In contrast, cross-section S-1, which is across the South Fork Koktuli River near the west end of the study area (Figure 8.1-7), shows overburden that is dominated by sand and gravel, and is mostly devoid of silty material.

Cross sections across valleys proximate to the Koktuli Mountain Block all indicate relatively thin but permeable overburden under valley floors (Appendix 8.1B). Traces of till-like material are present along some valley walls, but most locations are dominated by colluvium and shallow bedrock.

The subsurface information is consistent with the surficial geology mapping, which is consistent with historic glacial activity.

The top of bedrock was consistently fractured and almost always produced water when drilling with an air rotary method. Faulting was common across the site, which is typical of this type of geologic environment. Although faulting is expected to result in more permeable zones in the vicinity of the fault, the offsets caused by faulting and the fine-grained fault gouge likely contribute to compartmentalization of the bedrock groundwater system. This compartmentalization limits the regional groundwater flow through these types of systems.

8.1.7.4 Response Tests

Groundwater monitoring wells and piezometers installed by MSD and Foundex were response tested at the study area from 2004 through 2008. Most of the 2004 response testing was completed by CH2MHill. SWS and SLR conducted a few response tests in 2004 and all of the response tests from 2005 to 2008. SWS analyzed the data to determine the apparent hydraulic conductivity near each installation. As part of the geotechnical program, KP also conducted response tests in piezometers that they installed. A summary of the response test results is presented in Tables 8.1-1 through 8.1-5, including the results from KP. A complete set of analytical plots for the SWS and SLR tests is presented in Appendix 8.1C.

The response test procedure for the SWS and SLR tests was very effective at defining the response of the wells. A few conditions for these tests are worth noting, as follows:

- Piezometers and monitoring wells were installed in the more permeable horizons to provide information along the dominant groundwater pathways. The tests therefore are representative of the higher permeability materials but not the lower permeability materials.
- Many of the well water levels responded very quickly and oscillated after the water level was changed. This quick response would not have been observed without the transducers.
- On inserting or extracting the Waterra tubing, the transducer cable appears to have been shifted enough to distort the response in a few wells because the water level did not return to its original level.

- Wells where water levels oscillated were analyzed using an underdamped analysis (Van der Kamp, 1976), with example calculated response results shown on Figure 8.1-8a. The remaining wells were analyzed with the Cooper method (Cooper et al., 1967) or the Hvorslev method (1951), with an example Hvorslev analysis shown on Figure 8.1-8b.
- Some of the responses were fast enough that only a portion of the response was observed, even with the transducer in place. In these cases, the available data were used to calculate the hydraulic conductivity.
- Some of the highest hydraulic conductivity values determined may be within the range of the effective value for the screen and filter pack. In these cases, the actual hydraulic conductivity of the formation might be higher than the calculated value.

During 2004, the method for preparing the foot valve on the end of the Waterra tubing for submergence below the water level was not recorded. Therefore, the effective diameter inside the well was not known and, when available, rising head test data were used instead of falling head test data to provide a known effective radius of the water column.

The hydraulic conductivities calculated from the response tests across the whole study area ranged from about $1x10^{-8}$ meters per second (m/s) to about $1x10^{-2}$ m/s (Figures 8.1-9a, 8.1-9b, and 8.1-9c). However, the vast majority of the calculated hydraulic conductivities ranged from $3x10^{-6}$ to $1x10^{-3}$ m/s. In general, a greater proportion of the tests in overburden had a higher hydraulic conductivity than those tests in bedrock. The results of response testing by area are discussed below.

Pebble Deposit Area

Forty-seven response tests were conducted in or around the Pebble Deposit area. Thirty-three tests were conducted in overburden and 14 in or near the top of bedrock. The hydraulic conductivity from tests in overburden ranged from $5x10^{-8}$ m/s to $1x10^{-3}$ m/s (Table 8.1-1), and had a geometric mean of $2x10^{-5}$ m/s, and a median of $3x10^{-5}$ m/s. The upper end of this range represented sandy and/or gravelly units while the lower end represented silty units. These statistics indicate that the measured hydraulic conductivities were distributed fairly evenly throughout the range.

Response tests in bedrock in the Pebble Deposit area were performed near the top of rock (shallow bedrock). Hydraulic conductivities ranged from $4x10^{-7}$ to $3x10^{-4}$ m/s (Table 8.1-1). The geometric mean of the calculated values was $1x10^{-5}$ m/s and the median was $1x10^{-5}$ m/s. The minimum and maximum hydraulic conductivity values in the overburden were lower and higher, respectively, than those measured in shallow bedrock, and the average value was a little higher.

Frying Pan Lake Area

Eight response tests were completed in the Frying Pan Lake area, three in overburden and five in shallow bedrock. The overburden hydraulic conductivities ranged from $6x10^{-8}$ m/s to $1x10^{-4}$ m/s (Table 8.1-2), and had a geometric mean and median of $6x10^{-6}$ and $4x10^{-5}$ m/s, respectively. The upper end of this range and the geometric mean were lower than measured in the Pebble Deposit area.

The shallow bedrock conductivities ranged from $2x10^{-8}$ to $9x10^{-5}$ m/s (Table 8.1-2). The geometric mean and median were $2x10^{-6}$ to $1x10^{-6}$ m/s, respectively. These values were lower than measured in the Pebble Deposit area.

South Fork Koktuli "Flats" Area

Sixty Five tests were conducted in the South Fork Koktuli "Flats" area, including 45 in overburden and 20 in shallow bedrock. The hydraulic conductivities in overburden ranged from $7x10^{-8}$ to $1x10^{-3}$ m/s (Table 8.1-3) and had a geometric mean and median of $1x10^{-4}$ and $4x10^{-4}$ m/s, respectively. These values were about an order of magnitude greater than those in the overburden of the Pebble Deposit and Frying Pan Lake areas. The measurement of hydraulic conductivities at the high end of this range is likely limited by the monitoring well slots and filter pack, resulting in lower than actual conductivity values.

The hydraulic conductivities in shallow bedrock ranged from $1x10^{-8}$ to $3x10^{-3}$ m/s (Table 8.1-3), and had a geometric mean and median of $2x10^{-5}$ and $5x10^{-5}$ m/s, respectively. These values were somewhat higher than those measured in the bedrock in the Pebble Deposit area but were about an order of magnitude lower than those measured in the overburden in the South Fork Koktuli "Flats" area.

North Fork Koktuli Area

Seventy tests were conducted in the North Fork Koktuli area, including 22 in overburden and 48 in shallow bedrock. The relatively small number of overburden tests reflected the relatively thin overburden in parts of this area. The hydraulic conductivities in overburden ranged from $8x10^{-9}$ to $2x10^{-3}$ m/s (Table 8.1-4), and had a geometric mean and median of $1x10^{-4}$ and $3x10^{-4}$ m/s, respectively. These values were about an order of magnitude greater than those for the overburden in the Pebble Deposit and Frying Pan Lake areas.

The hydraulic conductivities in shallow bedrock ranged from $9x10^{-9}$ to $3x10^{-4}$ m/s (Table 8.1-4), and had a geometric mean and median of $8x10^{-7}$ and $8x10^{-7}$ m/s, respectively. These values were more than an order of magnitude lower than the bedrock values in the Pebble Deposit area and more than two orders of magnitude lower than the overburden values in the Pebble Deposit area.

Upper Talarik Area

Eleven tests were conducted in the Upper Talarik area, including 4 in overburden and 7 in shallow bedrock. The hydraulic conductivities in overburden ranged from $2x10^{-6}$ to $4x10^{-5}$ m/s (Table 8.1-5), and had a geometric mean and median of $1x10^{-5}$ and $1x10^{-5}$ m/s, respectively. These values were comparable to those measured in the overburden of the Pebble Deposit area.

The hydraulic conductivities in shallow bedrock ranged from $2x10^{-7}$ to $2x10^{-5}$ m/s (Table 8.1-5), and had a geometric mean and median of $3x10^{-6}$ and $5x10^{-6}$ m/s, respectively. These values were somewhat lower than those measured in shallow bedrock in the Pebble Deposit area and were about an order of magnitude lower than measured in the overburden in the Pebble Deposit area.

Summary of Response Tests

In summary, the hydraulic conductivities of the overburden materials in the Pebble Deposit area (geometric mean of about 10^{-5} m/s) were four to six times lower than those measured in the North Fork Koktuli and South Fork Koktuli "Flats" areas based on the geometric mean, and an order of magnitude lower based on the median. In contrast, the overburden hydraulic conductivities in the Pebble Deposit area were somewhat higher than those measured in the Frying Pan Lake and the Upper Talarik areas.

The hydraulic conductivities of shallow bedrock measured in the Pebble Deposit area (geometric mean of about 10^{-5} m/s) were about an order of magnitude higher than those measured in the North Fork Koktuli and Frying Pan Lake areas. The shallow bedrock conductivities in the Upper Talarik area were between those measured in the North Fork Koktuli and Pebble Deposit areas. The bedrock conductivities measured in the South Fork Koktuli "Flats" area were somewhat higher than those measured in the Pebble Deposit area.

8.1.7.5 Pumping Tests

Pumping tests comprise pumping from one well and measuring response to pumping in adjacent wells. A pumping test provides more reliable and representative aquifer parameters than a response test because the pumping rates are relatively high, which increases the radius of influence of the test and minimizes the effects of formation damage that result from drilling and well construction on measured hydraulic conductivity. Pumping tests were completed at nine locations: PW-1, PW-3, PW-4, PW-5, PW-6, PW-7, PW-8, PW-08-9, and PW-08-10 (PW-2 was not drilled). Several piezometers were monitored during each pumping test. Table 8.1-6 summarizes the results of the test analyses, which are also included in the frequency plots of calculated hydraulic conductivity values (Figures 8.1-9a, 8.1-9b, and 8.1-9c). Pumping test analyses and results are included in Appendix 8.1D and an example result is shown on Figure 8.1-10. The hydraulic conductivities calculated for overburden pumping tests were almost an order of magnitude higher than the highest values calculated from the response tests, indicating that the response tests in these overburden materials tend to underestimate the hydraulic conductivities of the overburden. The pumping test results are more reliable because the hydraulic conductivity of the aquifer may be higher than that of the combination of the well screen and the filter sand. Consequently single-well response tests may be measuring the hydraulic conductivity of the screen and/or filter pack. Also drill-hole wall damage may decrease the hydraulic conductivity of a single-well test zone relative to the native formation. The pumping tests in bedrock indicated hydraulic conductivities within the same range as the response tests, with the hydraulic conductivity values for the bedrock generally lower than for the sand and gravel aquifers.

Pumping (aquifer) tests in the shallow bedrock were analyzed using conventional porous media theory. This approach is appropriate at this site because the fractures within the test horizon were numerous, flows within fractures are probably laminar, and the individual fractures cannot be characterized individually. The fracture density is high enough that the representative elemental volume is well within the scale of a pump test.

The following paragraphs discuss the pumping test results for the following sub-areas within the study area: Pebble Deposit Area, South Fork Koktuli River near Frying Pan Lake, South Fork Koktuli River near tributary UT1.190, and South Fork Koktuli River near discharge zone.

Pebble Deposit Area

Pumping well PW-1 was completed in shallow bedrock in the Pebble Deposit area (Figure 8.1-4). During the pumping test, the water levels were monitored by piezometers installed in both shallow bedrock and overburden. The results of the analysis indicated a transmissivity of about $8x10^{-5}$ square meters per second (m^2/s). The analysis was completed using the Hantush method (Hantush, 1960) for vertical recharge with contribution of aquitard storage, and a barrier boundary at 100 meters (m). The transmissivity calculated using the Theis method (Theis, 1935) was very similar. Assuming an aquifer thickness of 5 m based on the drillhole logs, the average horizontal hydraulic conductivity was about $2x10^{-5}$ m/s. This result is about one order of magnitude lower than the average hydraulic conductivity of the shallow bedrock response tests of about $2x10^{-4}$ m/s. The test results suggest that the typical local hydraulic conductivity in the study area is greater than the larger scale hydraulic conductivity at this location. This difference may be due to the discontinuous and anisotropic nature of fractured bedrock and sand and gravel overlying the bedrock, or the natural variation in properties over a large area.

The two shallow overburden piezometers monitored did not respond to the pumping test. At the low pumping rate and limited duration of the test, measurable response would not necessarily be expected in these wells, which were completed near the water table.

Pumping well PW-8 was also completed in shallow bedrock and was located southeast of PW-1 (Figure 8.1-4). The data were analyzed using the Hantush method (Hantush, 1960) for vertical recharge with contribution of aquitard storage. The calculated transmissivity was about $3x10^{-4}$ m^2/s, which was very similar to the transmissivity calculated using the Theis method (Theis, 1935). The transmissivity for PW-8 was about four times greater than the results from PW-1. Assuming an aquifer thickness of 13 m based on the drillhole logs, the average horizontal hydraulic conductivity was estimated to be about $2.5x10^{-5}$ m/s, which was very similar to the hydraulic conductivity calculated at PW-1.

Pumping well PW-08-9 was located in Upper Talarik Creek watershed at the southeast boundary of the deposit (Figure 8.1-4), and was completed in sand and gravel. This well was intended to test the material in the infilled bedrock valley along the eastern edge of the deposit. The data were analyzed with the Theis method (Theis, 1935) with a recharge boundary to simulate leakage from the proximal natural ponds. The calculated transmissivity was about $5x10^{-4}$ m^2/s. Assuming an aquifer thickness of about 40.5 m based on the drillhole logs, the estimated horizontal hydraulic conductivity was about $1.2x10^{-5}$ m/s.

North Fork Koktuli River

Pumping well PW-08-10 was located close to gaging station NK100B, which is also close to the boundary between the glacial drift and glacial outwash zones (Figure 8.1-4). The well was cased to the overburden-bedrock contact and completed in the upper 14 feet (4.5 m) of bedrock, which was weathered. Permeable, unconfined sands and gravels overlaid the weathered bedrock. Therefore, the overburden and weathered bedrock likely acted as a single aquifer unit in this area. The data were analyzed with the Neuman method for unconfined aquifers. The estimated transmissivity was $5x10^{-3}$ m^2/s. The estimated horizontal hydraulic conductivity (assuming a saturated aquifer thickness of 108 feet [33 m] from the drillhole logs) was $1.5x10^{-4}$ m/s.

South Fork Koktuli River near Frying Pan Lake

Pumping well PW-5 was completed in upper bedrock near the South Fork Koktuli River about halfway between stream gaging stations SK110D and SK100F (Figure 8.1-4). The data were analyzed using the Moench method (Moench, 1993), which considers the response of an unconfined aquifer. The calculated transmissivity was about $1.4x10^{-2}$ m^2/s. A silty aquitard has been recognized in the PW-5 area. This silty aquitard seems to thicken towards P-05-25 and to pinch out towards MW-14S, but it is absent in well MW-14D, where the shallow bedrock is overlain by sand and gravel overburden up to the ground surface. Furthermore, the groundwater levels were below the aquitard for the pumping test at PW-5. Assuming an aquifer thickness of 100 feet (30 m) based on the drillhole logs, which includes the bedrock and the overlying overburden, the estimated hydraulic conductivity was about $4.6x10^{-4}$ m/s.

The drawdown trend in MW-14S, which was installed in overburden, indicated the silty aquitard was discontinuous as aforementioned. An alternative interpretation would indicate the silty aquitard was very leaky, which would allow for a good hydraulic connection between the aquifers overlying and underlying this bedding, and additionally allow for the shallow bedrock aquifer and the sand and gravel aquifer between the bedrock and the aquitard to respond as a single unit hydraulically.

Pumping well PW-6 was completed in overburden (gravel) close to PW-5 (Figure 8.1-4). The Hantush method (Hantush, 1960) was used to analyze the drawdown data from MW-14S. This method considers vertical leakage and assumes aquitard storage. This method was appropriate because the groundwater levels were considerably above the aquitard during this test. The calculated transmissivity of the gravel aquifer was about $1.8x10^{-2}$ m^2/s. Assuming an aquifer thickness of 98 feet (30 m) based on the drillhole logs, the horizontal hydraulic conductivity was estimated to be about $6.0x10^{-4}$ m/s.

The results from the pumping test in PW-6 indicate that the aquifer in the area overlain by the silty aquitard is a leaky confined aquifer. Results from pumping tests in PW-5 and PW-6 suggest that both the shallow bedrock aquifer together with the sand and gravel overburden aquifer, lying between the silty aquitard and the shallow bedrock, constitute a single leaky confined aquifer when the groundwater levels are above the confining layer.

Pumping well PW-7 was completed in overburden (sand and gravel) south of Frying Pan Lake and west of the South Fork Koktuli River (Figure 8.1-4). The Neuman method (Neuman, 1972) was used to analyze the drawdown data from P-05-26D. This method considers a delayed gravity response in an unconfined aquifer. It was used because the drawdown followed a typical response trend in unconfined aquifers subject to delayed drainage. The calculated transmissivity of the sand and gravel aquifer was about $1.1x10^{-1}$ m^2/s. A silty aquitard was identified in the area of PW-7 but not at P-05-26D. In any case, the groundwater levels were well below the bottom of the aquitard. Assuming a saturated aquifer thickness of 45 feet (13.7 m) based on the drillhole logs, the estimated horizontal hydraulic conductivity was about $8.0x10^{-3}$ m/s.

South Fork Koktuli River near Gaging Station SK100D

PW-3 was completed in overburden just south of the South Fork Koktuli River near gaging station SK100D and just north of the surface water divide separating the South Fork Koktuli River watershed from the tributary UT1.190 watershed (Figure 8.1-4). The Neuman method was used to analyze the drawdown data from the MW-11 nest. The calculated transmissivity of the gravel aquifer was about

$6.0x10^{-3}$ m^2/s. The flattening of the response was most probably attributable to delayed yield from the water table. Because the aquifer was underlain by silty sand and gravel, the contribution from the underlying aquifer was expected to be small compared to drainage from above. Assuming an aquifer thickness of 85 feet (26 m) based on the drillhole logs, the estimated horizontal hydraulic conductivity was about $2.3x10^{-4}$ m/s.

Response tests in the immediate area were completed in the three MW-11 cluster wells. MW-11M is within the pumped horizon. The response test indicated a hydraulic conductivity of $9x10^{-4}$ m/s. The higher value than the pump test value may be due to natural variation of materials.

South Fork Koktuli River near Discharge Zone

Pumping well PW-4 was installed in overburden (gravel) just south of the South Fork Koktuli River at the eastern end of the study area (Figure 8.1-4). The Neuman method was used to analyze the drawdown data from the MW-1 cluster. This method considers delayed yield in unconfined aquifers. The calculated transmissivity of the gravel aquifer was about $5.3x10^{-1}$ m^2/s. As the aquifer was underlain by silty sand and gravel, the contribution from the underlying aquifer was expected to be small compared to drainage from above. Assuming an aquifer thickness of 128 feet (39 m) based on the drillhole logs, the estimated horizontal hydraulic conductivity was about $1.3x10^{-2}$ m/s. This conductivity is the highest value measured at the site.

Response tests in the immediate area were completed in the three MW-1 cluster wells. MW-1M was completed within the pumped horizon. The response test indicated a hydraulic conductivity of about $1x10^{-5}$ m/s. The other two wells had response test results of about $6x10^{-4}$ m/s and $2x10^{-4}$ m/s. These values were all less than the pumping test value, which may indicate the limitation of the slug test method (permeability of filter and screen) and/or the natural variation of material properties.

8.1.7.6 Bedrock Testing by Knight Piésold Ltd.

While drilling geotechnical holes, KP conducted packer tests (also known as Lugeon tests) from 2004 through 2008 to measure hydraulic conductivity at discrete intervals within the bedrock. The results of these tests are presented in Appendix 8.1N. The hydraulic conductivity values do not appear to depend directly on the rock type (Appendix 8.1L).

Within the Pebble Deposit area, the hydraulic conductivities were measured to depths of up to 4,500 feet but were mostly in the upper 1,000 feet. The values ranged from $1x10^{-10}$ to $4x10^{-6}$ m/s but were mostly between $1x10^{-9}$ and $1x10^{-6}$ m/s. The highest conductivities were typically measured in the upper 500 feet of rock, but comparable values were also measured at depths of up to 2,700 feet. This is much lower than the shallow bedrock in the Pebble Deposit area, where response test results ranged from $4x10^{-7}$ to $3x10^{-4}$ with a median of $3x10^{-5}$ m/s. The upper boundary of the hydraulic conductivity generally decreased with depth. This trend is illustrated on Figure 8.1-11a.

Outside the Pebble Deposit area, hydraulic conductivities were measured to depths of up to 400 feet but were mostly at depths of less than 200 feet. The values ranged from $1x10^{-9}$ to $1x10^{-5}$ m/s but were mostly between $1x10^{-8}$ and $1x10^{-5}$ m/s (Figure 8.1-11b). In Area G, which is a tributary watershed in the North Fork Koktuli River basin that is monitored by stream gage NK119A, a depth trend was not apparent. In

contrast, the bedrock hydraulic conductivities measured in the South Fork Koktuli River basin tended to be less than $1x10^{-6}$ m/s below a depth of 100 feet (Figure 8.1-11b).

KP also conducted rising and falling head tests in piezometers installed throughout the study area. These results are presented in Appendix 8.1N. These shallow tests are in the upper range of hydraulic conductivities measured by KP with packer tests, which is consistent with the conceptual model of relatively high conductivity in upper bedrock.

A sounding tape was used to monitor water levels during the rising and falling head tests. As a result, many of the well responses could not be measured because the water level had stabilized before the water level reading could be recorded. Also, the test results were probably influenced by the piezometers not being developed prior to testing. Without development, the calculated hydraulic conductivities from these tests are likely biased on the low side.

8.1.7.7 Deep Bedrock Testing and Monitoring

A Westbay ® multi-level groundwater monitoring system (WB-1) was installed in drillhole 6349 to a depth of 4,054 feet during the fall of 2006. A description of the installation was reported by Westbay Instruments Inc. (2007). The installation is described in Appendix 8.1K.

The installation included 50 monitoring zones varying in length from 10 to 125 feet and placed at depths of 148 feet to 4,054 feet. A measurement port for measuring piezometric pressure was installed in each monitoring zone, and a pumping port (to provide purging and response testing capability) was installed in 24 of the 50 zones.

Eighteen pressure profiles were measured to the end of 2008. The data provided an understanding of the connectivity of groundwater zones with depth. The data are reported with depth and time in Appendix 8.1K. Observations include the following:

- Piezometric pressures vary to a depth of about 700 feet and are responsive to near-surface seasonal and barometric variations.
- Piezometric pressures from about 700 feet to 1,500 feet are decreasingly responsive to seasonal and barometric variations with increasing depth. The piezometric pressures within this zone, although variable, are higher than those in shallower and deeper zones. It is not known if the response in this zone is related to the geology (basal conglomerate) or structures (ZE and related normal faults).
- Piezometric pressures below about 1,500 feet (below ZE fault and below tertiary deposits) are fairly similar (little vertical gradient) and are not responsive to seasonal variations. The piezometric pressures in this lower part of the hole have decreased slowly since installation, indicating a poor connection with recharge or discharge zones. This is consistent with a hydrogeologic environment that is compartmentalized.

The results from packer and response tests are restricted to just that borehole being tested. Pumping tests whereby one borehole is pumped while other adjacent or proximal boreholes are monitored are cross hole tests. The results from the pumping well and the monitoring wells are representative of the intervening

aquifer material. The results are more representative of the aquifer as a whole rather than individual boreholes.

A second hole (DH8417) was drilled approximately 100 feet southwest of WB-1 to provide a location for cross-hole test pumping so that response could be measured within WB-1 and hydrogeologic properties calculated (cross-hole testing). This type of test incorporates larger volumes of rock than response tests or packer tests.

The cross-hole testing was carried out from July 4 to September 22, 2008. DH8417 was drilled in nine stages that varied in length from 310 to 550 feet. After drilling each stage, the borehole was flushed and the hole pumped using an air lift technique. He upper sections of the hole were isolated by cementing, casing or with a packer. During drilling, flushing, and pumping, the pressure response was monitored with up to 20 pressure probes in WB-1. Based on the geology and the observed responses, hydrogeologic units were interpreted with depth, and hydraulic conductivity values were calculated (Appendix 8.1K). The hydraulic conductivity values are plotted versus depth on Figure 8.1-11c. The hydraulic conductivity decreases with depth down to the ZE fault. Below the ZE fault, the hydraulic conductivity increases to a moderate value, and then again decreases with depth.

The following information from this installation supports the presence of a compartmentalized deep bedrock groundwater system:

- The deep groundwater system is isolated from barometric and seasonal pressure changes at the ground surface.
- The hydraulic conductivity below the ZE fault is similar to some shallower bedrock.
- Piezometric levels decreased slowly over time below the ZE fault despite hydraulic conductivity similar to shallower bedrock, consistent with very low hydraulic conductivity compartment boundaries.
- Water quality samples collected during the air lift testing (Chapter 9.2.5) were more mineralized at depth, indicative of an environment with much less groundwater circulation.

8.1.7.8 Groundwater Elevations

Groundwater levels were measured immediately following well installation, during well development and testing, and throughout all phases of the field program. Each monitoring well and piezometer has been monitored monthly since being installed. Selected monitoring wells and piezometers have dedicated transducers installed that record the water level each hour. The water level data have been processed in a variety of ways and are presented in the following appendices:

- Appendix 8.1E: Snapshots of Water Levels
- Appendix 8.1F: Snapshots of Vertical Gradients
- Appendix 8.1G: Time Series of Piezometric Elevations (uniform scale)
- Appendix 8.1H: Time Series of Piezometric Elevations (expanded scale)

Groundwater Divides

The interpreted contours of water level data indicated locations of the following three groundwater divides within the study area (Figure 8.1-12):

- Between the Upper Talarik Creek (UT) drainage and the North Fork Koktuli (NFK) drainage.
- In the area of the Pebble Deposit between the South Fork Koktuli River (SFK) drainage and the Upper Talarik Creek drainage.
- Between the South Fork Koktuli River drainage and the tributary UT1.190 drainage.

The groundwater divide between the UT drainage and the NFK drainage is aligned southwest-northeast. Groundwater flows northwest from this divide into the NFK drainage and southeast into the UT drainage. The gradient in the NFK drainage is quite flat, while the gradient in the UT drainage is quite steep. Based on this interpretation, there is a potential for a relatively small quantity of groundwater that originates in the NFK drainage basin to discharge in the UT basin.

The groundwater divide between the SFK and UT drainage is aligned northwest-southeast. Groundwater flows northeast from this divide into the UT basin and southward into the SFK basin. The southward gradient along the South Fork Koktuli River drainage is relatively flat downstream to Frying Pan Lake, steepens temporarily south of Frying Pan Lake in the area of MW-3, and then becomes relatively flat across the South Fork Koktuli Flats. The potential for flow of groundwater across the drainage divide is very low based on this interpretation.

A third interpreted groundwater divide occurs between the SFK and tributary UT1.190 (Figure 8.1-12) which is located approximately 4.5 miles downstream of the Pebble Deposit. Unlike the other two major groundwater divides in the study area, this divide is substantially north of the surface water divide. The difference between the surface water and groundwater divides indicated that some of the groundwater from the South Fork Koktuli River basin discharges into the UT1.190 basin. The groundwater gradient north of the divide is quite gentle, while the gradient south of the divide is quite steep.

Depth to Groundwater

The groundwater table can be a muted image of the ground surface. As such, the water table is usually deepest on high ground and near ground surface in valley bottoms. Although this is generally true, there are conditions worth noting within the study area. These are:

- Over most of the site, springs and seeps have been mapped relatively high, even on steeper slopes. This may be due to lower permeability cover material on lower slopes and also due to heterogeneity of the disturbed shallow bedrock combined with the relatively moist environment.
- Relatively deep groundwater levels have been documented under permeable valley fill deposits in all three drainages.
- Relatively high groundwater levels are present over extensive flat-lying valley bottom deposits, including Frying Pan Lake Basin and Big Wiggly Lake Basin.

Seasonal Groundwater Variations

The time series readings from the monthly data indicate that the system is responsive to seasonal changes (Figures 8.1-13a and 8.1-13b; Appendix 8.1G and Appendix 8.1H). The lowest groundwater levels were typically recorded just before spring runoff, and the highest groundwater levels were recorded during spring runoff and/or during the fall rains, as indicated by the consistent correlation between streamflow and groundwater elevation. Groundwater elevations commonly varied by 10 to 20 feet between the seasonal low and seasonal high (Appendix 8.1G). From year to year, the changes in snowmelt and rainfall were reflected in the piezometric response. At MW-1, for example, the snowmelt in the spring of 2005, 2006, and 2008 resulted in bedrock piezometric elevations in the range of 813 to 814 feet, and overburden piezometric elevations of 810 to 813 feet (Figure 8.1-13a). In contrast, the relatively small snowmelt in 2007 resulted in lower bedrock and overburden piezometric elevations of about 809 feet. Although not as pronounced because of the lower permeability strata, a similar contrast was evident at MW-5 (Figure 8.1-13b).

Some monitoring locations had relatively consistent vertical gradients over time, while others varied widely. For example, the direction of the vertical gradient at MW-1 was consistent over time (Figure 8.1-13a). The elevations of the top of PVC were checked and confirmed to be correct. At this location, the shallowest well consistently had the lowest water level, the intermediate well consistently had an intermediate water level, and the deepest well had the highest water level. These results indicate that the groundwater gradient is consistently upward from bedrock to overburden, and from deep overburden to shallow overburden. This upward gradient is consistent with the observed groundwater discharge in this section of SFK.

In contrast, the vertical gradient between bedrock and overburden varied widely at MW-5 (Figure 8.1-13b) because of the large seasonal changes in piezometric elevation in the bedrock well (MW-5D). Consistently from 2005 to 2008, well MW-5D had piezometric elevations that were considerably lower than the overburden wells in late winter, resulting in a downward gradient to the bedrock from the overburden. During spring runoff and fall rains, however, the large increase in piezometric elevation in the bedrock well consistently reversed the gradient so that it was upward from the bedrock to the overburden. Other piezometer nests in the area of the deposit and Frying Pan Lake behave similarly (Appendix 8.1G).

8.1.7.9 Seep Monitoring

Many groundwater seeps have been identified in the study area (Chapter 7), and some of these seeps were sampled for water quality and monitored for flow rate (Figure 8.1-4). The seep water quality is discussed in Chapter 9. Some seep flows were measured during 2004, but a more comprehensive flow monitoring program started in 2005 and continued through 2008. Over this period of record, some seeps showed highly variable flow while others were relatively steady. The flow rates at some seeps varied by up to a factor of 10, but most varied by less than a factor of three. Average minimum flow was 2 gpm, average maximum was 240 gpm, and average median was 44 gpm.

8.1.7.10 Surface Water-Groundwater Interaction

Relatively detailed streamflow surveys were completed during low-flow periods to examine the interaction between surface water and groundwater in order to determine which stream reaches were

gaining water and which were losing water. These surveys were conducted by HDR (Chapter 7) in September 2004, March 2005, April 2006, March through April 2007, and March 2008. Flows were measured in the North Fork Koktuli River, the South Fork Koktuli River, and Upper Talarik Creek. The gaging stations used in these surveys include the continuous monitoring stations and those stations named with the initials "LF" to indicate "low flow" (Figure 8.1-4). Although the magnitudes of flows were different for each of the surveys, the pattern was similar each time, which indicates that the measurements were repeatable and the interpretation of gaining and losing reaches was reliable. The details of these low-flow surveys are described in Chapter 7. The following paragraphs summarize the findings.

North Fork Koktuli River

The low flows on the North Fork Koktuli River were measured at gages NK100C, NK100B, NK100LF1, NK100LF3, NK100LF4, NK100LF5, and NK100A1 ordered from upstream to downstream (Figure 8.1-14). Upstream of NK100C (the highest station in the watershed), low flows were near average for the study area. The flows measured at NK100B indicated that groundwater discharge was below average between NK100C and NK100B. This below-average discharge may be the result of inflow of relatively flashy, low baseflow from tributary NK1.190 and/or as a result of losses to the underlying aquifer (outwash sands and gravels) near NK100B. Between NK100B and NK100LF1, streamflows were losing (i.e., surface water was seeping to the underlying aquifer). The losses of streamflow to groundwater continued downstream, at least part way to NK100LF3. As the unit loss rate is somewhat lower downstream of NK100LF1 than upstream, the boundary between the losing reach and the gaining reach may be upstream of NK100LF3. This is consistent with the presence of open water during low winter flow periods from a point between NK100LF1 and NK100LF3 (Chapter 7). This groundwater discharge is probably occurring because the extensive outwash sand and gravel deposit pinches out under this reach. The decrease in aquifer size correspondingly decreases its capacity to transmit groundwater, which forces the groundwater to discharge to the stream. Downstream of NK100LF4 to NK100A1, the low flow measurements indicate low to moderate groundwater discharge to the stream channel. This is consistent with the relatively consistent alluvial channel aquifer mapped under this reach.

South Fork Koktuli River

The low flows on the South Fork Koktuli River were measured at gages SK100G, SK100F, SK100LF2, SK100D, SK100LF4, SK100C, SK100B2, SK100B1, SK100LF9, SK100LF10, and SK100A ordered from upstream to downstream. Low flows were near average at SK100G (the gage highest in the watershed). Between SK100G and SK100F, unit discharge decreased, which indicated that the rate of groundwater discharge was lower or perhaps surface flow was lost to groundwater despite available storage in Frying Pan Lake. The paleo lake basin between SK100G and SK100F is dominated by lacustrine deposits, which tend to limit the interaction of surface water and groundwater. However, the fans and fan deltas contribute groundwater discharge to stream baseflows. There is potential for stream losses near the outlet of Frying Pan Lake, where the stream bed is near the relatively permeable bedrock surface. From SK100F to SK100C, the stream-flow measurements indicate that the river is losing water to the aquifer. The location of the boundary between the losing reach and the gaining reach depended partly on the elevation of the groundwater table in this region, which varied seasonally. The water level at P-05-10, just upstream of SK100C, fluctuated more than 6 m seasonally. As the groundwater level decreased, the losing reach extended further downstream. Within this reach of South Fork Koktuli River, some of the groundwater flows under the surface-water divide to a tributary of Upper Talarik Creek. Downstream of

the confluence with tributary SK1.190 was an upwelling area where groundwater contributed higher than average discharges to streamflow. The groundwater discharges were the result of two factors:

- The decrease in aquifer cross section, which reduced the capacity of the aquifer to transmit groundwater and correspondingly forced the groundwater to discharge to the stream.
- The confluence with two relatively large tributaries (SK1.190 and SK1.210), each contributing additional groundwater to the South Fork Koktuli River Valley.

This higher than average discharge appears to continue downstream to SK100LF9 and SK100B. Analysis of the data indicates that there is loss of streamflow between SK100B and SK100LF10, but that this flow returns to the stream between SK100LF10 and SK100A. This also is consistent with open water surveys. In addition, stream gaging on Kaskanak Creek (Chapter 7) does not identify any additional flow that could have originated from the SFK drainage.

Upper Talarik Creek

The low flows on Upper Talarik Creek were measured at gages UT100E, UT100D, UT100C2, UT100C1, UT100LF5, UT100C, UT100LF7, UT100B, and UT100LF8 ordered from upstream to downstream. Flows in the upper reaches of Upper Talarik Creek were measured at stream gage UT100E. Permeable outwash sands and gravels mapped upstream of UT100E contributed to higher than average baseflows at this gage. Surficial geology downstream of UT100E is dominated by glacial lake deposits. This geology is consistent with the lower than average discharge of groundwater to streamflow between UT100E and UT100C2. Discharge of groundwater increased between UT100C2 and UT100C1 to a level that was about average for the basin, and increased to above average downstream of UT100C1. The increase in groundwater discharge in this part of the creek may be a result of extensive outwash and ice contact deposits, much with no visible runoff east of Upper Talarik Creek, as well as additional cross boundary flow from the South Fork Koktuli drainage area.

Summary of Gaining and Losing Reaches

In summary, the losing reaches in each of the three major drainages are summarized as follows (Figure 8.1-14):

- North Fork Koktuli : NK100B to NK100LF1
- South Fork Koktuli : SK100G to SK100F; K100F to SK100C; SK100B to SK100 LF10

8.1.7.11 Groundwater Sampling

The monitoring wells have been sampled quarterly since the hydrogeology program started in 2004 (Figure 8.1-4). The detailed results of the groundwater sampling are discussed in Chapter 9. The following paragraphs briefly summarize the results of groundwater sampling that are most pertinent to the physical hydrogeology.

Groundwater chemistry can often provide insights into the recharge rate and groundwater velocity in a groundwater system. One technique that is often used to infer groundwater recharge rates is analysis of groundwater for tritium. As described by Robertson and Cherry (1989), the natural level of tritium in

precipitation prior to the start of thermonuclear testing in 1952 was about 3 tritium units (TU). Tritium concentrations increased to peak levels of about 5,000 TU in 1963-64 and then decreased to lower levels of 50 to 100 TU by 1972. Since 1980, tritium concentrations in monthly average precipitation on continental North America (Ottawa station) have ranged from about 10 to 50 TU. The tritium concentrations in precipitation at the Ottawa station were similar to those measured at Anchorage, Alaska (USGS, 2002). Recharge water retains its tritium signature in groundwater flow systems. After correcting concentrations for radioactive decay to 2005 (the date of tritium sampling), tritium concentrations that exceed about 30 TU indicate precipitation that originated between 1952 and 1972. Similarly, 2005 tritium concentrations that exceed about 50 TU suggest precipitation that originated between 1962 and 1968. Therefore, any tritium concentrations that exceeded 30 TU in present-day groundwater would indicate pre-1972 recharge water, and concentrations that exceeded 50 TU would indicate pre-1966 recharge water. Except for one well that was below the detection limit of 0.8 TU, the tritium concentrations from the mine study area ranged from 1.8 to 11.3 TU (Table 8.1-7). The average concentration was 4.8 and the median was 4.5 TU, indicating that the average was not skewed by anomalous results. The results suggest that most of the groundwater was likely recharged after 1972, which suggests that groundwater moves through much of the system relatively quickly. This interpretation is consistent with the high hydraulic conductivities, the seasonal responsiveness of the piezometric levels, and the recharge rates that have been estimated from the Water Balance Model.

Some parts of the groundwater system are probably exceptions to this interpretation, as indicated by the sample from MW-5D. This sample had a tritium concentration less than 0.8 TU, which suggests that groundwater from this well might have been recharged prior to 1952. This well was relatively deep and the geologic materials at this depth had a fairly low hydraulic conductivity, which would be consistent with older water as suggested by the tritium result.

The inorganic geochemistry also provided some insight into the physical hydrogeology. In general, groundwater that has low total dissolved solids (TDS) and high dissolved oxygen (DO) is recharging and moving through the system relatively quickly. Groundwater within the study area was characterized by very low TDS (median concentrations typically less than 100 milligrams per liter [mg/L]) and high DO (most wells greater than 8.5 mg/L). The wells with higher TDS were typically located close to the Pebble Deposit and were therefore likely influenced by oxidation of sulfides and the associated acid-neutralization reactions. The median TDS concentrations from overburden wells in the North Fork Koktuli (NFK) were tightly clustered between 32 and 70 mg/L, whereas the median concentrations in the South Fork Koktuli (SFK) and Upper Talarik (UT) watersheds depended on the well location relative to the Pebble Deposit. Specifically, the wells with highest TDS were located in proximity to the Pebble Deposit. The balance of the overburden wells in the SFK and UT watersheds had median concentrations that were comparable to the wells in the NFK watershed. Similar to the overburden, the TDS concentrations were generally higher in the SFK watershed. Unlike the overburden, which had a few wells with noticeably higher TDS, the variability across locations in the TDS medians in the bedrock was generally lower than in the overburden.

The median concentrations of DO in overburden ranged from 10 to 13 mg/L in the NFK watershed, from 0.5 to 13 mg/L in the SFK watershed, and from 0.2 to 13 in the UT watershed. The consistently high median DO concentrations in the NFK watershed indicated that oxidation processes were limited, which suggests partly that recharge rates and groundwater velocities are relatively high. The low DO concentrations measured in the SFK and UT watersheds, particularly in proximity to the Pebble Deposit,

indicated that oxygen was being consumed by oxidation processes. The median concentration of DO in bedrock ranged from 10 to 13 mg/L in the NFK watershed, from 0.5 to 13 mg/L in the SFK watershed, and from 0.1 to 5 in the UT watershed. The median DO concentrations were very similar between the bedrock and overburden. Low DO concentrations (less than 2 mg/L) were observed in only nine wells (MW-5M and 5D, MW-12S and 12D, SRK2, SRK3, PQ4, P-06-37M, and MW-14D), seven of which were located in proximity to the general Pebble Deposit area. These wells likely had oxygen consumed by oxidation of the sulfides contained in the ore.

In summary, the low concentrations of tritium and TDS, and high concentrations of DO are consistent with relatively high recharge rates and groundwater velocities.

8.1.7.12 Regional Hydrogeologic Setting

The Pebble Deposit area is located on an upland (elevation 970 to 3,000 feet) that includes mountain blocks (Kaskanak, Koktuli, Sharp, Groundhog, and Cone) separated by upland valleys. Several lowlands surround this upland: Iliamna Lake (elevation 100 feet), about 15 miles to the south of the deposit; the Newhalen River (elevation 300 feet), about 15 miles to the east of the deposit; and the Chulitna River (elevation 325 feet), about 12 miles to the north of the deposit. The lowland is much further away to the west. The groundwater system includes local, intermediate, and regional-scale flow systems. The regional flow system to the surrounding lowlands likely has relatively low groundwater velocities and small seepage rates. The combination of the long flow paths and the expected low hydraulic conductivity at depth for the regional system, compared to steep mountain gradients and higher hydraulic conductivities in the uplands, is expected to result in much of the groundwater flow system concentrated in the local upland flow systems. Although qualitative in nature, only local systems develop in areas of pronounced relief (Freeze and Cherry, 1979). This characteristic combined with the presence of high-permeability materials infilling the bedrock valleys in the upland and faults in bedrock that form groundwater compartments at depth, results in a focus of most of the groundwater flow within local or at most intermediate flow regimes. This interpretation is supported by streams that gain water as a result of groundwater discharge over most of the study area. Although the flow system has a small regional component, no aquifer has been identified that would preferentially result in flow from the study area to regional discharge areas. In summary, the contribution to regional flows from the Pebble Deposit area is expected to be a very small portion of the groundwater budget.

The following sub-sections discuss the hydrogeologic characteristics of the South Fork Koktuli River, North Fork Koktuli River, and Upper Talarik Creek drainages in the upland.

8.1.7.13 Hydrogeologic Characterization of South Fork Koktuli River Drainage

The headwater of the South Fork Koktuli River is within the Pebble Deposit area. The river flows downstream through the Frying Pan glacial lake basin and through Frying Pan Lake. The river then flows through a deep cut eroded through glacial moraines, finally flowing out onto South Fork Koktuli Flats. The river then turns east through an upwelling area (South Fork Koktuli Discharge Area). From there, the river flows on towards the confluence with North Fork Koktuli River. Following is a description of the hydrogeologic setting along the river.

Pebble Deposit Area

The Pebble Deposit area straddles the watershed divide between the headwaters of the South Fork Koktuli River and Upper Talarik Creek, or Areas 3 and 9, respectively (Figure 8.1-14). The Pebble Deposit area within the South Fork Koktuli River Drainage (Area 3) is located primarily on the gentle, east-facing slope between elevations of 950 and 1,400 feet and across the valley floor.

The bedrock includes the mineralized sedimentary, volcanic, and intrusive rocks covered by overburden on both the west and east sides, and by Tertiary sedimentary and volcanic rocks on the east side. The Tertiary rocks form a wedge thickening eastward to a thickness of about 1,500 feet. Further east the Tertiary is downthrown more than 4,000 feet into a narrow graben. Much of the graben fill is volcanic flows. West of the graben, there is a well cemented basal conglomerate, overlain by interbedded sediments and volcanics. A series of faults (ZA to ZI) have been mapped or interpreted in the Pebble Deposit area. In addition, several faults sub-parallel to these have been mapped (ZG1, ZG2, ZEa through ZEd). These faults probably act as flow conduits parallel to the fault structures and flow barriers perpendicular to the structures so that a compartmentalized groundwater system is developed.

The overburden includes interbedded glacial lake and glacio fluvial materials. Several aquifers have been identified within the overburden, including the following:

- **Surficial aquifers** composed of clean sand or sand and gravel. These include beach, delta, and fan deposits.

- An **intermediate aquifer**, which was interpreted to lie between silty deposits. It appears to be continuous with sand and gravel located in two bedrock lows (Figure 8.1-3a), one trending west up the hillside on the south side of the deposit and a second bedrock low that trends north.

- A **deep aquifer** identified within a bedrock low on the east side of the deposit (Figure 8.1-3a). Holes collared below about 970 feet on the Upper Talarik side of the divide flowed, some at rates in excess of 300 gpm. A pump test was performed in these materials (PW-08-09).

The bedrock aquifers can be identified as follows:

- **Weathered bedrock**, within the upper 10 to 50 feet of bedrock, was the most consistent aquifer in this area. The presence of this aquifer was based on observed drilling returns when using the air rotary technique, circulation losses when drilling with water, artesian conditions observed in diamond drillholes, and measured hydraulic conductivities. This interpretation is also consistent with conditions in the area south of the old exploration camp where the camp water supply was pumped from an exploration hole that flows from the top of rock. Where there is no overburden cover, felsenmeer or rock block field are present on upper slopes. This is an extreme version of this upper bedrock aquifer. Two pump tests were performed in these materials (PW-1 and PW-8).
- Although considerably less permeable than the top of rock, the data support the presence of an **upper bedrock** zone that is of higher permeability than deep bedrock. Packer testing indicates that this “zone” may be approximately 600 feet thick. Stratigraphic influence was not identified.
- Fault zones provide both conduits and barriers to groundwater flow. Conduits are provided through fractured ground adjacent to a fault, and barriers are due to fault gouge with the fault

itself. Packer testing identified elevated hydraulic conductivities near faults. Evidence of barriers to flow are provided by descriptions of fault gouge material, and the behavior of groundwater pressures during drilling and pumping adjacent to WB-1. This is further enhanced by the change in water quality across the ZE fault at WB-1. The faults, therefore, are expected to result in a compartmentalized groundwater flow system within the deep bedrock.

Groundwater within the Pebble Deposit area is derived from local recharge. Groundwater recharge sites include the following:

- **Broken and fractured rock on hilltops and hillsides.** Recharge from these areas provides groundwater for deeper bedrock materials and also flows within the top of rock downslope. Many seeps were identified on hillslopes in the area. These seeps are probably due to the relatively high recharge rates on the upper slopes, the highly variable hydraulic conductivity, and the variable thickness of the top of rock fractured zone.
- **Moraine deposits on valley sides and on the northern drainage divide.** These materials are silty and therefore resist high recharge rates. In many cases, local recharge occurs on local high zones with discharge into nearby ponds and streams. Some of this recharge continues into underlying overburden aquifers, the top of rock, and into the upper bedrock.
- **Valley floor.** In the Pebble Deposit area, the valley floor includes delta deposits as well as ponds and lacustrine deposits. Generally, the valley floor is more likely to be a discharge area than a recharge area. In this area, however, piezometric data at MW-5 (Figure 8.1-13b) indicate the discharge conditions underlying the valley floor are seasonal. Piezometric levels in the deep piezometer are higher than in the shallow piezometers in the spring and fall recharge periods, and lower than in the shallow piezometers in the winter and mid-summer periods. This variability indicates that the valley floor recharges the lower aquifer and top of rock during the dry periods.

The ground surface is often mantled with granular material due to the tendency of ground frost to push pebbles up through the soil profile. This material probably acts as surface storage, which slows runoff and enhances groundwater recharge.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites. Groundwater flows are concentrated within relatively high permeability materials or aquifers, as follows:

- On the west slope, flows are concentrated within the intermediate aquifer in the bedrock low and within the top of rock aquifer. Lower on the slope, groundwater discharges to ponds and the stream that flows within the topographic lows that overlie this aquifer.
- There are many small ponds on the west slope of the valley. There is local discharge into these ponds from the nearby topographic highs and from the underlying top of rock.
- On the east and west slopes of the valley, groundwater flow is downslope in the top of rock aquifer. Much of this downslope groundwater flow discharges to streams and ponds on the valley floor, thereby contributing to baseflows. The balance of the groundwater continues downstream.
- Under the valley floor, groundwater moves downstream towards Frying Pan Lake within the intermediate and deep overburden aquifers. Water is contributed to these aquifers from above and

laterally from the slopes, with discharge during the wet season to the valley floor and year round to the main stream channel.

Frying Pan Lake Area

The Frying Pan Lake area, south of the Pebble Deposit area, has an elevation range of 950 to 1,950 feet and is within Area 3 (Figure 8.1-14). The upper slopes are dominated by bedrock outcrops. Lower elevations have been subject to Brooks Lake age glacial activity. The top of rock under Frying Pan Lake is at an elevation of about 800 feet, so that the maximum overburden thickness is about 150 feet. The contact between Tertiary and pre-Tertiary is mapped near the west side of Frying Pan Lake. The west boundary of the East Graben is expected to be close to that contact.

Several aquifers have been identified in this area. These include:

- Some surficial aquifers composed of clean sand or sand and gravel. The largest of these is a fan delta immediately upstream of Frying Pan Lake.
- An intermediate aquifer has been interpreted to lie between silty deposits under most of the valley floor. This aquifer thins to the east and to the south.
- A deep aquifer was identified within the valley thalweg (Figure 8.1-3a). This deep aquifer appears to be in contact with the top of rock but is not continuous with the deep aquifer in the Pebble Deposit area. This deep sand and gravel aquifer results in thicker sand and gravel deposits near Frying Pan Lake than near the deposit.
- The most consistent aquifer in this area is the top of rock, defined as rock within the upper 10 to 30 feet of bedrock. The presence of this aquifer is based on observed drilling returns when using the air rotary technique, circulation losses when drilling with water, artesian conditions observed in diamond drillholes, and measured hydraulic conductivities.

A moraine is mapped adjacent to Frying Pan Lake. This moraine is silty and commonly has ponded water within depressions. Downstream of this moraine, although the topography is still disorganized, the many depressions are either dry or are internally drained (no surface discharge). This downstream moraine is a clean sand and gravel, whereas the moraine adjacent to Frying Pan Lake is silty. The difference between this drift south of the Frying Pan Lake basin and the drift within the Frying Pan Lake Basin is consistent with glaciers of Kvichak age entering this valley from the north and south and meeting near the outlet of present-day Frying Pan Lake.

Groundwater within the Frying Pan Lake area is derived from local recharge and as flow from the Pebble Deposit area. Groundwater recharge sites include the following:

- **Broken and fractured rock on hilltops and hillsides.** This recharge provides groundwater for deeper bedrock materials and also flows downslope within the top of rock. Many seeps have been identified on hillsides in the area. These seeps are due to the relatively high recharge rates on the upper slopes, the highly variable hydraulic conductivity, and the thickness of the top of rock fractured zone.
- **Moraine deposits on valley sides and within tributary valleys.** These materials are silty and therefore resist high recharge rates. In many cases local recharge occurs on local highs with

discharge into nearby ponds and streams. Some of this recharge continues into underlying overburden aquifers, the top of rock, and into the upper bedrock.

- **Valley floor.** The valley floor includes delta and lacustrine deposits. Generally, the valley floor is more likely to be a discharge area. Piezometric levels near Frying Pan Lake are above the valley floor (piezometers flow). For piezometers with a high collar, the deep piezometers have more seasonal variation than shallow piezometers. This indicates that some of the valley floor recharges the lower aquifer and top of rock during the seasonally dry periods of the year.

The ground surface is often mantled with granular material due to the tendency of ground frost to push pebbles up through the soil profile. This provides a surface storage site that slows runoff and enhances groundwater recharge.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites. Groundwater flows are concentrated within higher permeability materials or aquifers as follows:

- There are many small ponds on the west slope of the valley. There is local discharge into these ponds from both the nearby topographic highs and from the underlying top of rock.
- On both the east and west slopes of the valley, groundwater flow is downslope in the top of rock aquifer. Much of this downslope groundwater flow discharges to streams and ponds on the valley floor, thereby contributing to baseflow, with some continuing downstream as groundwater.
- Under the valley floor, groundwater moves downstream towards Frying Pan Lake within the intermediate and deep overburden aquifers. Water is contributed to these aquifers from above and laterally from the slopes, with discharge during the wet season to the valley floor and year round to the main stream channel. These aquifers do not appear to be continuous downstream of Frying Pan Lake. The downstream gradient in the deep aquifer is very flat, indicating that much of the flow in this aquifer transmits water from the valley sides towards the drainage system in the valley center.

Immediately downstream of the outlet to Frying Pan Lake, the river is steep and has rapids. Bedrock is shallow along this length of the stream channel. Drillhole data and seismic reflection data (SL-3 and SL-4, (Figure 8.1-4) indicate that most of the overburden is unsaturated downstream of Frying Pan Lake. The hydraulic gradient between Frying Pan Lake (elevation 950 feet) and monitoring well MW3 (elevation 870 feet) is very large. This gradient is consistent with lower permeability materials (glacial drift), effectively forming a dam to groundwater flow immediately downstream of Frying Pan Lake.

South Fork Koktuli Flats

This part of the study area extends southwesterly approximately 5.5 miles from Frying Pan Lake downstream along the South Fork Koktuli River (Figure 8.1-14, Area 5). The catchment for this portion of the river ranges from an elevation of about 830 feet to above 2,700 feet. The upper slopes are dominated by bedrock outcrops. The shape of the bedrock surface underlying the flats indicates that the paleo-drainage cut across the present South Fork Koktuli River alignment towards Upper Talarik Creek (Figure 8.1-3a). This paleo channel is infilled with overburden. The bedrock elevations near the drainage

boundary with the Upper Talarik Creek were interpreted to be below 500 feet, resulting in overburden thicknesses exceeding 300 feet.

The overburden material in the basin ranged from clay to clean gravel, but mostly consisted of sands and gravels. Permeable material was encountered in every drillhole, but quantities varied. Thicknesses of permeable material over 100 feet were encountered at 14 locations, the most notable being MW-3 (198 feet), GH04-03 (177 feet), GH06-76 (176 feet), GH04-16 (175 feet), GH06-75 (165 feet), and GH04-04 (165 feet). Smaller but still notable thicknesses were intercepted by boreholes MW-11D (124 feet), GH04-44 (120 feet), and GH04-39 (105 feet).

Several aquifers have been interpreted in this area, including the following:

- **South Fork Koktuli Valley Aquifer.** This aquifer includes the clean sand and gravel moraine that extends from the silty terminal moraines immediately downstream of Frying Pan Lake and is continuous with outwash, terrace, and alluvial sand and gravel deposits within the valley to the west.
- **South Fork Koktuli Channel Aquifer.** Alluvium and terrace gravels are mapped along the channel from downstream of Frying Pan Lake to the east to an area of a bedrock high mantled with drift (d_0).
- **MW11 Aquifer.** A sand and gravel aquifer is present near monitoring well MW11 and south of the bedrock high mantled with drift (d_0).
- A **surficial aquifer** including outwash sand and gravel between the South Fork Koktuli River and the slope of Upper Talarik Creek Valley.
- An **intermediate aquifer** that lies beneath the surficial aquifer, providing a groundwater pathway between the South Fork Koktuli River and Upper Talarik Creek Tributary UT1.190.
- A **deep aquifer** that may be present underlying the intermediate aquifer. However this was logged in drillholes as sand and gravel and silty sand and gravel. Logging was of drill cuttings only. There is no direct evidence of direction of groundwater flow in this material.
- The **top of rock aquifer**, within the upper 10 to 50 feet of bedrock. The presence of this aquifer is based on observed drilling returns when using the air rotary technique, circulation losses when drilling with water, artesian conditions observed in diamond drillholes, and measured hydraulic conductivities.

The surficial geology mapping identified a terminal moraine of the Kvichak Stade along the northwest side of the valley and around the downstream end of this area. Drillhole logs confirmed that most of the moraine consisted of clean sands and gravels. However there were limited areas of discontinuous silty material penetrated by drillholes. This discontinuous silty moraine material, combined with the outwash sands and gravels, limits groundwater flow from the area of Frying Pan Lake. The outwash sands and gravels extend down South Fork Koktuli River Valley and form an extensive valley aquifer along the South Fork Koktuli River downstream from the moraine.

Groundwater originates within the South Fork Koktuli Flats (Figure 8.1-1b) as recharge from rainfall and snowmelt (meteoric recharge), and surface water loss from stream channels and from the upstream area (Frying Pan Lake).

Meteoric recharge is expected along the bedrock ridges and through the overburden in the valley bottom. In this area there are several areas of high meteoric recharge:

- In the valley, within 2.5 miles of Frying Pan Lake, the ground surface is situated well above the water table. The high ground surface (moraine) and the generally high permeability of the drift in this area are responsible for high meteoric recharge to the groundwater (including runoff from adjacent slopes). The numerous enclosed depressions (with no outlet stream) enhance this recharge.
- The outwash sands and gravels southeast of South Fork Koktuli River are elevated above the water table and include enclosed depressions, resulting in a high proportion of precipitation recharging groundwater.
- The moraine along the northwest side of the valley and along the downstream end of the area provides additional areas for high meteoric recharge of groundwater.

Within this area, both South Fork Koktuli River Main Stem and tributary SK1.240 lose a noticeable proportion of streamflow to the groundwater system. The main stem river probably recharges the groundwater system almost immediately downstream of Frying Pan Lake. This interpretation is based on piezometric levels in MW-3, which are 80 feet lower than the adjacent river level. The shallow piezometer at P-05-26, close to MW-3, had a water level that was about 100 feet higher than the deep piezometer. This strong downward gradient reinforces the interpretation of the river recharging the groundwater system (Figure 8.1-4) (Appendix 8.1B, Geologic Section S-8). Streamflow loss probably continues for several miles downstream. The loss is visually obvious in the vicinity of GH04-35, where the channel often dries during seasonal low-flow periods. Again, analysis of piezometer measurements indicates that groundwater levels are considerably below the channel bottom in this area. The location separating the gaining from the losing sections of the channel is transient, moving upstream as groundwater levels rise and downstream as groundwater levels decline. Low-flow streamflow measurements, presented in Section 8.1.7.10, identify areas of losses and gains to the streams.

Tributary SK1.240 exits a narrow bedrock valley and flows south between the valley wall and the sand and gravel glacial moraine (South Fork Koktuli Valley Aquifer). The stream then flows southeast through the moraine to the main stem. Losses from the stream to groundwater occur throughout this section of the stream adjacent to and overlying the permeable moraine material.

Besides these sources of groundwater recharge, additional water originates upgradient from the Frying Pan Lake catchment, flowing through the low-permeability moraine and the permeable upper bedrock.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites within the tributary valleys. Groundwater flow directions under the flats are complicated due to the multiple aquifers and the varying groundwater levels.

- Groundwater within the surficial aquifer may flow to the southeast towards the Upper Talarik Creek system. Springs have been mapped from this aquifer along its southeastern boundary. Groundwater within this aquifer also flows to the northwest, toward the South Fork Koktuli system. The flows report to the aquifers and do not have surface expression except for standing water levels in at least one kettle hole. Much of the water recharging this aquifer is expected to flow down into the underlying intermediate aquifer.

- Groundwater within the intermediate aquifer carries water from the overlying surficial aquifer and from the two aquifers to the northwest (South Fork Koktuli Valley Aquifer and MW-11 aquifer to the southeast), and discharges primarily to tributary UT1.190.
- Piezometric data are not available for the deep aquifer, so flow directions have not been defined. However, at this time, this aquifer is not expected to account for very much of the groundwater budget.
- The South Fork Koktuli channel aquifer transports water from channel loss and meteoric recharge downstream, with most if not all of the groundwater flowing into the MW-11 aquifer.
- Most of the water entering the MW-11 aquifer (meteoric recharge, channel losses, inflow from the surficial aquifer, inflow from the channel aquifer, and inflow from the valley aquifer) enters the intermediate aquifer and flows toward UT1.190.
- Almost all of the water entering the valley aquifer flows to the west along the South Fork Koktuli River, with some flows to aquifer MW-11 and to the intermediate aquifer.

Groundwater leaves the South Fork Flats area (Figure 8.1-1b) by two routes, which is unusual for a river valley. A large portion of the groundwater entering the Upper Talarik Creek watershed appears to discharge into tributary UT1.190. The measured low flow at UT119A is about 25 cubic feet per second (cfs), which is almost the same as the high flow, indicating that the basin is dominated by groundwater discharge. Figure 8.1-12 illustrates an interpretation of groundwater equipotentials and groundwater flow directions consistent with this groundwater system concept. The remainder of the groundwater flows downstream along the South Fork Koktuli River. Additional water level data are presented in Appendix 8.1E. In this appendix, an interpretation of both the groundwater table and a deeper piezometric level are presented. In the area where Figure 8.1-12 indicated groundwater crossing the surface water divide, the water table is much higher and flatter, held up by the underlying lacustrine silts. The primary flow direction in this upper water table zone is down through the silts towards the primary aquifer (continuous sand and gravel layer within the silt).

South Fork Koktuli (SK) Discharge Area

This study sub-area extends from about 1 mile upstream of the confluence of the South Fork Koktuli River and SK1.190 to a point that is about 2.4 miles downstream (Figure 8.1-14, Area 8). The catchment for this portion of the river ranges from an elevation of about 780 feet to more than 2,315 feet. The upper slopes are dominated by bedrock outcrops. The mid slopes are mapped as colluvium and drift of the Pre-Brooks Lake glaciation. A notable outwash gravel deposit is present in the upstream 2 miles of the valley with extensive terrace gravels further downstream. The stream is undersized in a depression within the outwash deposit. The drillhole testing and material descriptions indicate that the gravels are very permeable in this area. The main aquifer is therefore the outwash sands and gravels and the terrace deposits and alluvium that infill the valley (Valley Aquifer).

Meteoric recharge is expected along the bedrock ridges and through the overburden in the valley bottom. A large portion of precipitation falling on the outwash sand and gravels and the terrace deposits along the valley floor is expected to recharge the aquifer. Additional recharge occurs from stream channels as they flow out into the valley, particularly from the large catchments, SK1.190 and SK1.210. Similar but less concentrated recharge of groundwater is expected adjacent to the valley sand and gravel deposits where runoff and shallow groundwater exit the adjacent slopes.

A relatively large groundwater flow enters the SK Discharge Area from the South Fork Koktuli River Flats area (Figure 8.1-14, Area 5). At times when the groundwater level is high, groundwater might discharge to the streambed near the boundary of Areas 5 and 8. However, during low-flow periods, the South Fork Koktuli River streambed is dry upstream of the confluence with tributary SK1.190. Additional water recharges the groundwater system in this area, both as direct recharge from rainfall and snowmelt and as run-on from adjoining slopes.

Immediately downstream of the confluence with tributary SK1.190, groundwater discharges into the bottom of the stream channel. This discharge results from a reduction of the aquifer thickness and width in this area, and additional water contributed to the aquifer from SK1.190 and SK1.210. In the dry season, with little to no visible surface water flow upstream of the confluence with tributary SK1.190, the surface water flow is up to 50 cfs about 2.4 miles downstream of the confluence with SK1.190.

8.1.7.14 Hydrogeologic Characterization of North Fork Koktuli Drainage

Big Wiggly Basin

The Big Wiggly Basin is the headwaters area for the North Fork Koktuli River, or Area 13 (Figure 8.1-14). The area is separated by a low saddle to the north from the Chulitna River system, by a low saddle to the east from the Upper Talarik Creek drainage, and by a ridge to the south from the South Fork Koktuli River drainage. The area includes a large, relatively flat area from elevation 1,050 to 1,250 feet, and surrounding slopes with peaks over 3,000 feet.

Boreholes are relatively sparse in this basin. Boreholes MW-8 and P07-42 penetrated sand and gravel aquifers near the eastern boundary of the area. Boreholes along the southern margin generally encountered shallow bedrock. Two holes on a low ridge within the basin also intersected some gravels. Although this basin was probably repeatedly submerged by glacial lakes, glacial moraines and outwash sands and gravels also were deposited between lake events. Therefore, although the available information does not indicate a thick sand and gravel aquifer within the basin, continuous aquifers underlying the valley floor are probably present.

Groundwater within the Big Wiggly Basin is derived from local recharge and perhaps some groundwater flow from Area E. Groundwater recharge sites include the following:

- Broken and fractured rock on hilltops and hillsides. This recharge provides groundwater for deeper bedrock materials and also flow within the top of rock downslope.
- Recharge into ridges, probably recessional and ground moraines on the valley floor, and elevated delta and outwash deposits. This recharge is mostly within a very local system, discharging into nearby ponds, topographic lows, and streams. However, some of this recharge moves downstream within the valley.

The ground surface is often mantled with granular material due to the tendency of ground frost to push pebbles up through the soil profile. This provides a surface storage site, which slows runoff and enhances groundwater recharge.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites. Groundwater flow directions also include local recharge and discharge on the many small ridges in this basin. These local groundwater flows contribute to the baseflow of North Fork Koktuli River and its tributaries. Groundwater also moves downstream sub-parallel to the river, interacting with streamflow as groundwater flow rates and aquifer capacity vary.

NK119B or Area 12

The Area 12 drainage is separated from the Pebble Deposit area to the east by a low ridge, on the south by a saddle, on the west by high ridges, and on the north by very low ridges separating it from Big Wiggly Basin (Figure 8.1-14). Elevations range from 1,200 feet to over 2,000 feet.

Two aquifers have been identified in this area, including the following:

- Overburden aquifer underlying glacial till (map unit d_{1A}), which covers the valley floor. Two boreholes intersected this sand and gravel. Upstream from this aquifer, considerable water ponding was observed on the valley floor. This ponding was not observed over the aquifer.
- The top of rock, as with all areas of this site, is expected to behave as an aquifer.

Groundwater within this area is derived from local recharge. Groundwater recharge sites include the following:

- Broken and fractured rock on hilltops and hillsides. This recharge provides groundwater for deeper bedrock materials and also flows within the top of rock downslope. Many seeps were identified on the hillsides in the area. These seeps are likely due to the relatively high recharge rates on the upper slopes, the highly variable hydraulic conductivity, and the variable thickness of the top of rock fractured zone.
- Valley floor. Generally, the valley floor is more likely to be a discharge area. In this valley, the valley floor is predominantly comprised of drift deposits, with some sand and gravel and a depressed piezometric level.

The ground surface is often mantled with granular material due to the tendency of ground frost to push pebbles up through the soil profile. This provides a surface storage site, which slows runoff and enhances groundwater recharge.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and groundwater-discharge sites. Groundwater is expected to flow north, parallel to the stream. Where the stream swings west and is confined by a moraine ridge, some groundwater flow under the moraine ridge to the north is expected.

Area G

Area G, shown on Figure 8.1-4 as the valley in the northwest part of the study area that includes MW-10, is the catchment of the NK1.190 tributary of the North Fork Koktuli River. Area G has also been identified as Area 14 for the purpose of water balance and hydrogeologic modeling (Figure 8.1-14). The catchment elevation ranges from 1,030 feet to over 2,700 feet. The south end of the valley includes a saddle separating this catchment from the catchment to the south. The elevation of the saddle is about 1,525 feet. For this relatively small catchment, the stream gradient in the upper reaches is relatively flat with gentle lower slopes. The upper slopes are steeper and dominated by bedrock outcrops. An assessment of limited drilling results and outcrop distributions indicates that overburden is thin over much of the valley. However, several holes intercepted up to about 100 feet of permeable overburden materials. Hamilton and Klieforth, 2010 mapped colluvium, drift of pre-Brooks Lake (Mak Hill) age, undifferentiated gravel, undifferentiated drift, and bedrock within this drainage. Bedrock includes fragmental rocks, diorite, basalt, and gabbro. Sand and gravel logged in MW-9 may be weathered fragmental rocks. Response testing in monitoring wells indicates that overburden materials have a high hydraulic conductivity (e.g., MW-6D, MW-7S). Testing also indicates that upper bedrock has high hydraulic conductivity (e.g., MW-7D, GH04-23, GH04-24). A few tests in deeper bedrock also indicated a high hydraulic conductivity (e.g., GH04-25 at 125 feet to 185 feet depth, and GH07-90D at 75 to 95 feet depth), but most of the tests in deep bedrock had relatively low hydraulic conductivity.

Groundwater recharge occurs on the valley slopes. Some of this water discharges at relatively high elevations on the slopes, and the balance moves downslope towards the stream channel in the center of the valley. Groundwater then likely migrates downstream within the overburden and bedrock materials. Because the overburden is expected to be thin along the valley floor, most groundwater likely discharges to the streambed, contributing to the stream baseflow. Piezometric pressures are, therefore, expected to be near ground surface over much of the catchment and at or above ground surface near the stream channel.

Although the available information indicates that bedrock has a high hydraulic conductivity, the high piezometric levels measured in piezometers near the south saddle imply that the bedrock with high hydraulic conductivity is probably not widespread or that the high-conductivity zone is limited to upper bedrock if it is widespread and/or that the elevated hydraulic conductivity zones are compartmentalized by discontinuities.

Two drillholes along the ridge west of the valley were completed with vibrating wire piezometers. Results from one of these piezometers (GH08-170) indicate that piezometric pressures under the ridge are quite low. If the piezometer was functioning correctly, the measured pressures indicate that a very permeable feature is located near the installed piezometer.

North Fork Glacial Outwash Area

The North Fork Glacial outwash area (within Area 15 on Figure 8.1-14) is located downstream of Big Wiggly Basin. The area is immediately downstream of a terminal moraine and includes an extensive outwash plain. The elevations range from 700 feet to over 2,300 feet.

The primary aquifers in the area are:

- The North Fork outwash aquifer, which includes the outwash sand and gravel as well as alluvium.
- Terrace and alluvium downstream of the outwash.
- The top of rock aquifer, within the top 10 to 50 feet of bedrock.

Groundwater within this area is derived from upstream and from local recharge. Groundwater from upstream includes groundwater migrating from Big Wiggly Basin, Area G, and Area E. Groundwater recharge sites include the following:

- Broken and fractured rock on hilltops and hillsides. Recharge from these sites provides recharge into deeper bedrock materials and also flows within the top of rock downslope. Many seeps were identified in the area. These seeps are likely due to the relatively high recharge rates on the upper slopes, the highly variable hydraulic conductivity, and the variable thickness of the top of rock fractured zone.
- Outwash sand and gravel. Most precipitation over much of this deposit likely recharges the aquifer because piezometric levels indicate that the groundwater table is well below the ground surface except near the stream channel.
- On the terrace sands and gravels downstream of the outwash deposit.
- From channel losses, particularly on the upstream half of the outwash sand and gravel. Piezometric data and low-flow streamflow measurements confirm that the stream loses flow into the outwash sand and gravel and that groundwater discharges to the stream in the lower section of the aquifer.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites. Groundwater is expected to flow downstream within the outwash aquifer, with some discharging to the stream as the aquifer width and thickness diminishes. The remaining groundwater continues downstream within the alluvial aquifer.

8.1.7.15 Hydrogeologic Characterization of the Upper Talarik Creek Drainage

Upper Talarik Creek Pebble Deposit Area

The Pebble Deposit area straddles the watershed divide between the headwaters of the South Fork Koktuli River and Upper Talarik Creek, or Areas 3 and 9, respectively (Figure 8.1-14). The deposit within the Upper Talarik Creek Drainage is located primarily on the southwest side of the upper reaches of the drainage. The drainage varies in elevation from about 800 feet to over 2,500 feet. The bedrock includes the mineralized sedimentary, volcanic, and intrusive rocks covered by overburden on the far southwest side, and on the east side covered by overburden and by barren Tertiary sedimentary and volcanic rocks.

The Tertiary rocks form a wedge thickening eastwards to a thickness of about 1,500 feet. Further east the Tertiary is downthrown more than 4,000 feet into a narrow graben. Much of the graben is filled with volcanic flows. West of the graben, there is a well cemented basal conglomerate, overlain by interbedded sediments and volcanics. Surficial geologic mapping identified a moraine (d_2) up to an elevation of about 1,200 feet. An outwash sand and gravel is mapped west of the terminal moraine. Downslope of the terminal moraine, glacial lake deposits (gl_2 and gl_3) are mapped up to an elevation of about 1,000 feet.

The primary aquifers in the area include the following:

- Glacial outwash deposit upstream of steam gage UT100E.
- The top of rock aquifer, within the top 10 to 50 feet of bedrock.

As with the Pebble Deposit area within the South Fork Koktuli drainage, a deep infilled bedrock gulley was identified. Boreholes into this bedrock depression resulted in high flows from the hole that required plugging. The available information (piezometric data, streamflow data, drill data) does not support continuation of this permeable material downstream. If a bedrock low persists downstream, the data indicate that it is infilled with low permeability material.

Groundwater within this area is derived from local recharge. Groundwater recharge sites include the following:

- Broken and fractured rock on hilltops and hillsides. Recharge from these sites provides groundwater for deeper bedrock as well as flow within the top of rock.
- Additional recharge as loss of flow from Upper Talarik Creek and tributaries into the outwash sand and gravel upstream of stream gage UT100E.
- Loss of all water to groundwater from an internally drained pond immediately to the west of stream gage UT100E.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites. Groundwater flows are concentrated within higher permeability materials or aquifers as follows:

- Groundwater flows within the outwash sands and gravels upstream of stream gage UT100E. As the outwash is not present downstream, and the overburden geology includes silts and clays, there are many springs in this vicinity.
- Groundwater from the aquifer within a deep bedrock low east of the deposit discharges slowly toward Upper Talarik Creek. The relatively low baseflows measured at station UT100D within Upper Talarik Creek support the interpretation of an aquifer that is not continuous under Upper Talarik Creek.
- Groundwater is concentrated in the top of rock throughout the basin. However, the presence of glacial lake deposits results in less groundwater flow within this basin compared with many others. This conclusion is supported by stream baseflow measurements. Where overburden is thin near the stream, groundwater recharge from top of rock is expected to be enhanced.

Outwash Plain

Downstream of the Pebble Deposit area (Area 10 of Figure 8.1-14), there is a wide variety of bedrock and glacial geology. Notable in this area is the presence of glacial lake deposits within Upper Talarik Basin and the presence of extensive permeable deposits west of Upper Talarik Creek, including deltas, outwash sand and gravel, and ice-contact deposits. Most of this extensive area is internally drained.

The primary aquifers in the area include the following:

- Glacial deposits, including delta, outwash, and ice-contact sands, and sand and gravel east of Upper Talarik Creek. Only two holes were advanced into these materials. These two boreholes, together with standing water levels within internally drained systems, indicate that the surficial aquifer is underlain by a low permeability aquitard that, in turn, may be underlain by additional aquifers.
- Upstream of steam gage UT100B, groundwater inflow originating from the South Fork Koktuli drainage discharges into the Upper Talarik Creek system. This flow is primarily through the intermediate aquifer within the South Fork Flats area described above.
- The top of rock aquifer, within the top 10 to 50 feet of bedrock.

Groundwater flow directions are generally downslope from recharge sites towards the valley floor and discharge sites. Groundwater flows are concentrated within higher permeability materials or aquifers as follows:

- Upstream, groundwater flows are limited primarily to the top of rock as much of the overburden is derived from glacial drift and lacustrine deposits. Flow directions are downslope and downstream under the valley floor.
- In the extensive aquifer east of Upper Talarik Creek, groundwater is expected to flow towards tributary UT1.135 and the main stem. Low flow data indicate that much of the flow enters Upper Talarik Creek downstream of gage UT100LF3.
- Over 20 cfs of groundwater appears to be diverted from the South Fork Koktuli River drainage and discharges to tributary UT1.190. The groundwater flow direction is therefore towards Upper Talarik Creek through this aquifer.

8.1.7.16 Site-Wide Water Balance

A Site-wide Water Balance Model was developed to provide input to the characterization of the site hydrology, to help with understanding groundwater-surface water interactions in the study area, and to provide estimates of groundwater recharge and discharge for use in the site-wide Groundwater Model. Furthermore, the model provides a means for validating precipitation measurements and quantifying the variability of precipitation in the study area. The water balance was calibrated to 4.5 years of continuous streamflow records from streamflow gaging stations SK100A, SK100B, SK100C, SK100F, SK119A, SK124A, NK100A, NK100C, NK119A, UT100B, UT100D, and UT119A (Figure 8.1-14). A sub-catchment was defined for each of these gaging stations, and the drainage areas were calculated for input to the model (Figure 8.1-1b). Details of the water balance model development are provided in Section 8.1.6.5 and Appendix 8.1I.

The Water Balance Model provides a basis for verifying that the flows calculated by the Groundwater Model are reasonable in the context of the hydrologic regime at the site. Conversely, the Groundwater Model is being used to assess the hydrogeologic feasibility of the groundwater recharge and discharge rates calculated in the Water Balance Model.

The water balance was developed as a series of interconnected sub-catchments, which allows for the calibration of predicted flows with flows measured at the streamflow gages (Figure 8.1-14). The sub-catchments were further discretized into 500-foot elevation bands to allow for variation in temperature and precipitation by elevation. The climate inputs were monthly temperature and precipitation data from the Iliamna Airport climate station, for the period of 1942 through 2008. Where data were missing prior to 2005, the data gaps were filled with average values. Missing data from later dates were interpolated based on a correlation with Pebble site data.

The precipitation measured at Iliamna Airport was adjusted and input to the model on a basin by basin basis so that the streamflows calculated by the water balance would agree closely with the actual flows measured at the gages. Other meteorologic variables were estimated according to generally accepted patterns and empirical equations (e.g., lapse rates, evaporation, sublimation, etc.). Groundwater components of flow were estimated based on stream baseflow and knowledge of the geologic materials in the stream valleys.

The fit of the water balance with measured values is moderately good. The most obvious deviation of predicted flows from measured values was for the spring of 2008, when calculated flows were less than measured flows. This difference was consistent with a measured snowpack that was larger than the snowpack calculated by the water balance for late winter of 2008.

The following paragraphs describe the calibration results of this water balance. The discussion is divided into sections pertaining to the South Fork Koktuli River basin, the North Fork Koktuli River basin, and the Upper Talarik Creek basin.

South Fork Koktuli River Basin Results

SK100B (Area 4). Data from gage SK100B were selected as the base case for this drainage because this gage provides the most complete set of data available. The catchment area for this gage is approximately 69.3 square miles. The following is a summary of the water balance results for this gage:

- The annual average flow was 188 cfs for a unit flow of 2.7 cfs per square mile (cfs/mi^2).
- The average March flow was 51 cfs for a unit low flow of 0.7 cfs/mi^2.
- The average groundwater underflow was estimated to be 14.5 cfs.
- The annual average recharge in this sub-catchment (Area 4) was 19.8 inches, or 41 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.4 (to account for orographic and snow blow effects) for Area 4 to provide a match between the measured and predicted flows.

SK100A (Area 8). Gage SK100A is located downstream of gage SK100B, close to the confluence with the North Fork Koktuli River (Figure 8.1-14). A large portion of the catchment between these two

stations is relatively flat land and perhaps is the surface of overburden fill within a paleo valley. The southern boundary of the catchment is the top of a gentle slope into the Kaskanak Creek catchment. The lack of a prominent topographic divide and the probable presence of deep overburden fill provide an opportunity for the transfer of groundwater from the South Fork Koktuli River basin into the Kaskanak Creek basin. However, many small ponds are mapped throughout the Kaskanak Creek basin and over the divide into the South Fork Koktuli River basin, indicating probable high groundwater levels in this area. The relatively flat topography, the presence of ponds, the relatively low flows measured in Kaskanak Creek, and the similar unit flows at SK100A and SK100B suggest that seepage losses across the divide are probably limited. The cumulative volumes calculated by the water balance for gage SK100A compare well with those measured in the field (Figure 8.1-15a). The catchment area for this gage is approximately 106.9 square miles (mi^2).

Baseflow measurements completed by HDR in the South Fork Koktuli River indicated that the unit baseflow at station SK100A ranged from 0.6 to 1.0 cfs/mi^2. If the groundwater loss to Upper Talarik Creek upstream of station SK100C of about 20 cfs is considered, the baseflow would have been from 0.77 to 1.2 cfs/mi^2. The relatively high unit baseflows (higher than SK100B) support the assumption of relatively low seepage losses from the catchment.

The following is a summary of the water balance results for this gage:

- The annual average flow was 263 cfs for a unit flow of 2.5 cfs/mi^2.
- The average March flow was 88 cfs for a unit low flow of 0.8 cfs/mi^2.
- The groundwater underflow was estimated to be 19.9 cfs.
- The annual average recharge in this sub-catchment (Area 8) was 21.2 inches, or 74 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.1 (to account for orographic and snow blow effects) for Area 8 to provide a match between the measured and predicted flows.

SK100F (Area 3). Gage SK100F is located immediately downstream of Frying Pan Lake and has a catchment of about 11.9 square miles (Figure 8.1-14). The catchment area includes the lake and a considerable wetlands area. Therefore, a second linear reservoir to represent water stored in the lakes, ponds, and wetlands, and a wetland area with enhanced ET, were included in the calculations for this catchment. The northern boundary of the catchment is a low topographic divide south of the Upper Talarik Creek Drainage (UT100D). Although there is considerable overburden fill in the valley, most of the drilling results indicate that the hydraulic conductivity of the overburden is generally lower than at downstream locations.

Measured groundwater levels around Frying Pan Lake are higher than lake levels and some piezometers flow, suggesting that groundwater is discharging to Frying Pan Lake. In contrast, groundwater levels downstream of Frying Pan Lake are lower than adjacent river elevations, suggesting that water is discharging from the river in this reach. A relatively low permeability material is controlling groundwater losses from the Frying Pan Lake area. The measured flows at gage SK100G, which is upstream of gage SK100F and near the lake inlet, indicate that flows at gage SK100F need to be increased by an average of about 5 cfs for the unit flow rates at the two gages to be equivalent. Therefore, about 5 cfs of underflow

was modeled at the SK100F gage. It is likely that groundwater flows under the gage are largely the result of loss from the lake near the outlet.

The cumulative volumes calculated by the Water Balance Model for SK100F were consistent with those measured in the field (Figure 8.1-15a). The following is a summary of the water balance results for this gage:

- The annual average flow was 28 cfs for a unit flow of 2.4 cfs/mi^2.
- The average March flow was 6.5 cfs for a unit low flow of 0.5 cfs/mi^2.
- The groundwater underflow was estimated to be 3.6 cfs.
- The annual average recharge in this sub-catchment (Area 3) was 11.8 inches, or 33 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.16 (to account for orographic and snow blow effects) for Area 3 to provide a match between the measured and predicted flows.

SK124A (Area 2). Gage SK124A is located near the mouth of a steep tributary stream and has a catchment area of approximately 8.5 mi^2. Because the gage is located downstream of the headwater valley and the stream flows across permeable materials in its lower reaches, large losses from the channel to groundwater upstream of the gage were included in the water balance. The calculated cumulative monthly flow for this gage matched the measured flows reasonably well (Figure 8.1-15a). The following is a summary of the water balance results for this gage:

- The annual average flow was 21 cfs for a unit flow of 2.4 cfs/mi^2.
- The average March flow was 1.4 cfs for a unit low flow of 0.2 cfs/mi^2.
- The groundwater underflow was estimated to be 6.7 cfs.
- The annual average recharge in this sub-catchment (Area 2) was 16.3 inches, or 37 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.25 (to account for orographic and snow blow effects) for Area 2 to provide a match between the measured and predicted flows.

SK100C (Area 5). Gage SK100C is located at a site that goes dry most years during the low-flow season. The catchment area for this gage is approximately 37.5 mi^2. A large portion of the Area 5 catchment is comprised of upland sands and gravels with almost no surface runoff, which indicates relatively high recharge rates. In addition, the stream channels upstream at gages SK100F and SK124A are well above the water table, which facilitates large losses from the stream channels to groundwater. In August 2004, when the stream channel at SK100C dried completely, flows at SK100F averaged 9.5 cfs. Similar documented losses occurred during the early months (winter) of each year. During those low-flow periods, losses would have also occurred from the channel upstream of SK124A. The losses at these stations in any given month were estimated by selecting a flow rate from each of the streams that would be completely lost to groundwater, and then adding a percentage of the incremental flow above this flow rate. For gage SK100F, all of the first 20 cfs and 45 percent of the incremental flow were recharged to groundwater. For gage SK124A, the first 10 cfs and 45 percent of the incremental flow was recharged.

The hydraulic conductivity under gage SK100C is modeled to be very high, which is consistent with the results of the pumping test at PW-4. The calculations include a discharge under gage SK100C of 10 to 44 cfs, depending on the calculated volume of water in storage. In addition, groundwater upstream of SK100C flows eastward toward Upper Talarik Creek. To achieve the best overall fit to observed streamflows, a flow of approximately 20 cfs was modeled across the catchment boundary into the Upper Talarik Creek basin.

The cumulative volumes calculated by the Water Balance Model agreed well with flows measured in the field (Figure 8.1-15a). The most distinctive feature of these plots is the low flows and dry periods recorded in the river due to the high hydraulic conductivity in this area. The following is a summary of the water balance results for this gage:

- The annual average flow was 54 cfs for a unit flow of 1.4 cfs/mi^2.
- The average March flow was 4.4 cfs for a unit low flow of 0.1 cfs/mi^2.
- The groundwater underflow was estimated to be 53 cfs.
- The annual average recharge in this sub-catchment (Area 5) was 46.8 inches, or 122 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.25 (to account for orographic and snow blow effects) for Area 5 to provide a match between the measured and predicted flows.

North Fork Koktuli River Basin Results

NK100C (Area 13). Gage NK100C is located near the headwater area of the North Fork Koktuli River (Figure 8.1-14), and its catchment area of approximately 24.3 mi^2 represents approximately one quarter of the total watershed area. Ice-contact deposits and pothole lakes are common throughout the lower elevations of the catchment.

The cumulative volumes calculated by the Water Balance Model agreed well with flows measured in the field (Figure 8.1-15b). The following is a summary of the water balance results for this gage:

- The annual average flow was 54 cfs for a unit flow of 2.2 cfs/mi^2.
- The average March flow was 18 cfs for a unit low flow of 0.7 cfs/mi^2.
- The groundwater underflow was estimated to be 4.3 cfs.
- The annual average recharge in this sub-catchment (Area 13) was 13.0 inches, or 40 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.07 (to account for orographic and snow blow effects) for Area 13 to provide a match between the measured and predicted flows.

NK119A (Area 14). Gage NK119A is located on a tributary stream that joins the main stem of the North Fork Koktuli River immediately upstream of gage NK100B (Figure 8.1-14). Drillholes within this catchment all indicated thin overburden. Therefore, groundwater flow from the basin was restricted to less than 1 cfs.

Figure 8.1-15b presents the measured and calculated cumulative volumes, which agree closely. The following is a summary of the water balance results for this gage:

- The annual average flow was 25 cfs for a unit flow of 3.2 cfs/mi^2.
- The average March flow was 5 cfs for a unit low flow of 0.6 cfs/mi^2.
- The groundwater underflow at gage NK119A was estimated to be 0.9 cfs.
- The annual average recharge in this sub-catchment (Area 14) was 10.2 inches, or 22 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.23 (to account for orographic and snow blow effects) for Area 14 to provide a match between the measured and predicted flows.

Upper Talarik Creek Results

UT100D (Area 9). Gage UT100D measures the flow from the headwater areas of Upper Talarik Creek immediately north of the headwaters of the South Fork Koktuli River and east of the headwaters of the North Fork Koktuli River, and has a drainage area of 12.0 mi^2. Gage UT100E is upstream of gage UT100D (Figure 8.1-14) and contained within Area 9. Baseflows dominate the hydrograph for gage UT100E, which is consistent with the many springs and a glacial outwash sand and gravel mapped immediately upstream of this gage. The internally drained pond immediately to the west of gage UT100E also contributes to the high baseflow at UT100E. The unit discharge at UT100D is lower than UT100E because of the low permeability glacial lake deposit downstream of UT100E, which limits the amount of groundwater recharge between UT100E and UT100D, which therefore limits the amount of groundwater discharge. The relatively low discharge between these two gages results in a lower unit runoff at UT100D because the increase in drainage area is proportionately larger than the increase in discharge.

The cumulative volumes calculated by the Water Balance Model agreed well with flows measured in the field (Figure 8.1-15c). The following is a summary of the water balance results for UT100D:

- The annual average flow was 30 cfs for a unit flow of 2.5 cfs/mi^2.
- The average March flow was 13 cfs for a unit low flow of 1.1 cfs/mi^2.
- The groundwater underflow was estimated to be 0.26 cfs.
- The annual average recharge in this sub-catchment (Area 9) was 12.2 inches, or 37 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.12 (to account for orographic and snow blow effects) for Area 9 to provide a match between the measured and predicted flows.

UT119A (Area 7). Gage UT119A is located on the UT1.190 tributary to Upper Talarik Creek that confluences just upstream of station UT100B (Figure 8.1-14) and has a drainage area of 4.1 mi^2. Flows at gage UT119A are mostly due to groundwater discharge, as indicated by its very small seasonal flow variation. About 20 cfs is derived from the South Fork Koktuli River watershed (both from river leakage into the aquifer and from meteoric recharge within the South Fork Koktuli River basin near the basin divide). The remainder of the groundwater discharge originates as recharge within the UT119A catchment area. The exact location of the groundwater catchment area is uncertain, as there are internally drained

areas near the topographic boundaries, and the groundwater catchment boundaries are likely not the same as the surface water boundaries. This difference in surface water and groundwater catchments is not a concern on the boundary with Area 5 (SK100C) because groundwater is modeled as crossing the boundary. However, groundwater conditions near the boundaries to the northeast and southwest are less certain.

Figure 8.1-15c presents the measured and calculated cumulative flow volumes for gage UT119A, which agree very closely. The following is a summary of the water balance results for this gage:

- The annual average flow was 28 cfs for a unit flow of 6.9 cfs/mi^2.
- The average March flow was 24 cfs for a unit low flow of 6.0 cfs/mi^2.
- The groundwater underflow was estimated to be 0.68 cfs.
- The annual average recharge in this sub-catchment (Area 7) was 25 inches, or 68 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.24 (to account for orographic and snow blow effects) for Area 7 to provide a match between the measured and predicted flows.

UT100B (Area 10). Gage UT100B is located in the lower reaches of Upper Talarik Creek (Figure 8.1-14) and has a catchment area of approximately 86.2 mi^2. High baseflows are expected as a result of the discharge from tributary UT1.190 and from groundwater discharge from permeable units within the drainage area.

Figure 8.1-15c presents the measured and calculated cumulative volumes, which agree well with one another. The following is a summary of the water balance results for this gage:

- The annual average flow was 231 cfs for a unit flow of 2.7 cfs/mi^2.
- The average March flow was 120 cfs for a unit low flow of 1.4 cfs/mi^2.
- The groundwater underflow was estimated to be 7.8 cfs.
- The annual average recharge in this sub-catchment (Area 10) was 17.7 inches, or 51 percent of the net precipitation (after sublimation and evapotranspiration).
- The Iliamna precipitation had to be multiplied by 1.24 (to account for orographic and snow blow effects) for Area 10 to provide a match between the measured and predicted flows.

Site-Wide Water Balance Outputs

The volume of water recharged to the ground and subsequently discharged to streams as determined with the linear reservoir approach to the groundwater regime in the Water Balance Model was used as input to the numerical groundwater model.

8.1.7.17 Numerical Groundwater Model

A numerical groundwater model (Groundwater Model) was developed to simulate the existing baseline groundwater conditions. The model was calibrated to the observed groundwater elevations (head), and to the total groundwater recharge and discharge flow rates calculated with the Water Balance Model. The

total groundwater recharge calculated with the Water Balance Model includes meteoric recharge and stream leakage. Meteoric recharge is an input to the Groundwater Model, and stream leakage is an output of the Groundwater Model. Therefore, total groundwater recharge is a calibration target for the Groundwater Model. By calibrating to both observed groundwater elevations and estimated groundwater flows, a more unique and representative model calibration was achieved than would be possible with just elevation data. A detailed discussion of the model is included as Appendix 8.1J. The following paragraphs give an overview of the results.

The model domain (Figure 8.1-16) encompasses most of the study area and all of the sub-catchments that were included in the Water Balance Model. A simple five-layer structure was used to represent the complex stratigraphy at the site, as follows (Figure 8.1-17):

- Three layers for the overburden (variable thickness).
- One layer for the upper 50 feet of bedrock.
- One layer for the rest of the bedrock down to an elevation of -200 feet.

A transient model was developed because the water level data clearly indicated that the system was transient (e.g., Figures 8.1-13a and 8.1-13b). The period of simulation was 37 months, from December 2004 to December 2007. The simulation period of the Groundwater Model coincides with that of the Water Balance Model.

The area of interest includes the upper reaches of the South Fork Koktuli River (Areas 3, 4, and 5), the upper reach of Upper Talarik Creek (Area 9), Upper Talarik Creek tributary UT1.190 (Area 7), and the upper reaches of the North Fork Koktuli River (Areas 12, 13, 14, and 15) (Figure 8.1-16). Most of the calibration effort was focused in Areas 3, 4, and 5 because the most comprehensive data were collected in these areas.

Modeled Groundwater Elevations

Contours of water-table elevations generated by the model give the same general pattern as the contours of the field data (compare Figures 8.1-18 and 8.1-19 with Figure 8.1-12). In particular, the groundwater divide between the South Fork Koktuli catchment and the UT1.190 catchment is generally reproduced by the model.

Head Calibration Statistics

The calibration of the Groundwater Model was assessed, in part, by examining the head calibration statistics. These statistics were calculated from the head residuals. A residual is defined as the difference (in feet) between the simulated and observed groundwater elevations at head target locations. A positive residual indicates that the simulated groundwater elevation is lower than the observed elevation, and a negative residual indicates that the simulated groundwater elevation is higher than observed. The absolute residual is the absolute value of a residual, and the Mean Absolute Residual (MAR) is defined as the mean of the absolute residuals. The mean residual should be close to zero in a calibrated model. However, the model may not be well calibrated to heads, even if the mean residual is close to zero because negative residuals can cancel positive residuals. In other words, the mean residual measures the average fit of the model to site conditions but does not assess local areas within the model. Therefore, the mean absolute

residual is calculated to eliminate the cancellation of positive residuals by negative residuals and provide insight into the calibration throughout the model domain.

Two hundred twenty piezometers with up to 35 measurements each were used to calibrate the heads and calculate the head target residuals (Appendix 8.1J). Figure 8.1-20 shows a scatter plot of modeled versus observed groundwater elevations, which is a common qualitative analysis tool for calibrating groundwater flow models. The ideal plot for a model calibration will show all points plotting on a straight line that extends from left to right at a 45 degree angle (i.e., when the observed and simulated groundwater elevations are in close agreement). The scatter plot in Figure 8.1-20 shows model output for the key calibration targets for all stress periods in the transient model. Although the heads tend to be too low in bedrock (layer 4) in the uplands, the simulated heads cluster around the ideal line very well on average for the lower elevations, which represent the most important part of the groundwater flow system.

Plots of residuals versus time (Appendix 8.1J) signify that the residuals at some wells start to increase during 2006 and 2007, which indicates that the model needs to be improved to simulate the conditions for these years in some areas (e.g., P05-07D, SRK-5M, and MW-3 in Upper SFK; MW-2D, GH04-30, and GH04-33 in Lower SFK; and MW-7 and MW-8 in NFK). In other cases (e.g., MW-5D and MW-5M in Upper SFK; GH04-17, MW-1D, MW-1D, MW-1S, and MW-11D in Lower SFK), however, the residuals over the 3 years average out around a uniform value.

Plots of the geographic distribution of residuals (Appendix 8.1J) indicate that the highest residuals are in layer 4 (fractured bedrock) and tend to occur along or near the bedrock ridges outside the area of interest. The head residuals in layers 1 to 3 (the three layers representing overburden) are smaller and indicate a more uniform distribution of positive and negative residuals.

The Root Mean Square Error (RMSE) is calculated as a percentage of the range of the observed head. Ideally, a calibrated model will have RMSE values less than 10 percent of the observed range in groundwater elevations for the corresponding target area. The ratio of RMSE values relative to the observed range in groundwater elevations can be summarized as follows:

- All areas: 3 percent
- Areas included in calibration focus:
  - Area 3 (Frying Pan Lake): 4 percent
  - Area 4 (South Fork Koktuli Discharge Area): 12 percent
  - Area 5 (South Fork Koktuli Flats): 7 percent
  - Area 7 (UT1.190): 10 percent
  - Area 9 (headwaters of Upper Talarik Creek): 4 percent
- Areas not included in calibration focus:
  - Area 1 (SK1.190): 8 percent
  - Area 2 (SK1.124): 25 percent
  - Area 10 (Upper Talarik Creek): 12 percent
  - Area 12 (adjacent to Area G): 15 percent

- Area 13 (headwaters of NFK): 11 percent
- Area 14 (Area G): 9 percent
- Area 15 (lower reach of NFK): 5 percent

Within the areas included in the calibration focus, these results indicate that the head calibration requires improvement in Areas 4 and 7 but is good in most areas. For the areas not included in the calibration focus, most require improvement. Details of these statistics for each layer within the calibration focus area indicate that the largest errors occur within the bedrock (Appendix 8.1J).

Head Hydrographs

Figure 8.1-21 presents hydrographs of observed and simulated groundwater elevations for selected head targets situated in the focus areas (a complete set of plots is presented in Appendix 8.1J). In general, these hydrographs demonstrate that transient heads calculated by the model agree reasonably with the measured heads for this phase of the calibration at most key target wells.

The seasonal fluctuations simulated by the model were not as strong as in the observed data at MW-5D near Frying Pan Lake, but the average simulated groundwater elevations agreed reasonably with the observed data (Figure 8.1-21). The difference in seasonal response could indicate that lower permeability horizons in the overburden not yet represented in the model are dampening the seasonal changes in the field. The seasonal fluctuations simulated for MW-5S and 5M were comparable to field conditions.

Figure 8.1-21 also shows simulated and observed hydrographs for some targets in the Pebble Deposit area (P-4, P-4AS, and P-4AD). These charts show that both the average head and the transient response of the observed groundwater levels were well represented by the model.

Vertical Head Differences

Some nested piezometers indicated large vertical hydraulic gradients between hydrogeologic layers. The shallow piezometer in three of the nests appeared to be monitoring a perched water table. For example, the water level in P-05-26S was about 100 feet higher than P-05-26D. Similar conditions were noted at P-05-16 and MW-05-02. Because the model is not currently intended to simulate these local conditions, the shallow wells were not used as targets at these locations. Besides these three special cases, the vertically nested wells generally fell in different model layers based on the screen elevation, which allowed the vertical head differences to be simulated by the model. In a few cases, two nested wells fell within a single model layer, and both targets were considered during model calibration.

The times series of vertical head differences (Appendix 8.1J) indicated that the temporal variation in vertical flow direction between bedrock and overburden was not always replicated. his detail will be addressed in the next phase of calibration. However, the average direction of vertical flow between the bedrock and overburden matched reasonably with observed conditions at nine out of 13 locations. The heads calculated by the model fit the observed heads in the overburden better than the bedrock because more attention was focused on heads in the overburden during calibration. A reliable representation of flow in the overburden is probably most important because most of the groundwater probably flows through the overburden.

Recharge and Discharge Rates

The flow rates calculated by the Groundwater Model were compared with the corresponding flow rates calculated by the Water Balance Model. Figure 8.1-22 compares the total annual recharge, discharge on site, and discharge off site estimated by the Water Balance Model and the Groundwater Model for each sub-catchment for 2007. The recharge and discharge values estimated by the Groundwater Model and the Water Balance Model agree quite well, particularly in the South Fork Koktuli River watershed. A more detailed assessment of this aspect of the calibration is presented below.

South Fork Koktuli River. In addition to comparing the total annual flows of the two models, the cumulative monthly flows were also compared to assess the transient behavior of the model. The cumulative monthly recharge and discharge calculated by the Water Balance Model and the Groundwater Model for Areas 1, 2 and 8 (SK119A, SK124A, and SK100A, respectively) agree well in most cases (Figure 8.1-23a). The off-site discharge calculated by the Groundwater Model for Area 8 is consistently about 30 percent higher than the Water Balance Model, but the recharge and on-site discharge match well. Additional iterations will be required between the Water Balance Model and Groundwater Model to make them more consistent. All components of flow agree well for Areas 1 and 2.

For Area 3 (SK100F), the on-site discharge and recharge calculated by the Groundwater Model was consistently about 30 percent higher than the Water Balance Model (Figure 8.1-23b). However, the off-site discharge agrees well. The flows for Areas 4 and 5 (SK100B and SK100C) agree well. Even though the Groundwater Model predicted a higher off-site discharge from Area 3 than the Water Balance Model, the off-site discharge specifically from Area 3 to Area 5 matched reasonably well (Appendix 8.1J). The difference between the two models was in the discharge from Area 3 to Area 9 (i.e., from the upper SFK catchment into the headwaters of Upper Talarik Creek). The Water Balance Model assumed zero off-site discharge from Area 3 to Area 9, but the Groundwater Model calculated a non-zero flow to Area 9. The potential for inter-catchment flow between Areas 3 and 9 will be evaluated in more detail in Phase II of the Groundwater Model calibration.

For Area 7 (UT119A), the off-site discharge calculated by the Groundwater Model was higher than the Water Balance Model (Figure 8.1-23c). The recharge and on-site discharge agreed well.

A key aspect of the flow system along the South Fork Koktuli River is the off-site discharge that crosses the surface-water divide from Area 5 (SFK) to Area 7 (tributary UT1.190). The Water Balance Model calculated that about 66 percent of the off-site discharge from Area 5 was transmitted to Area 4 and about 34 percent to Area 7. The results from the Groundwater Model were similar, with 64 percent of the off-site discharge from Area 5 being transmitted to Area 4 and 36 percent to Area 7. Thus, the routing of flows downstream of Area 5 in the Groundwater Model agreed closely with results from the Water Balance Model.

Upper Talarik Creek and North Fork Koktuli River. The flow rates for these catchments are presented in Appendix 8.1J. Summaries for the Upper Talarik are presented on Figure 8.1-23d and for North Fork Koktuli on Figures 8.1-23e and 8.1-23f.

Low-Flow Streamflow Comparison

Although the Groundwater Model does not represent channel flow in streams, it does simulate the exchange of water between streams and groundwater. Therefore, the groundwater model was used to estimate streamflows during periods when the only contribution to streamflow was due to groundwater. These estimates were compared with low-flow streamflow measurements, which were obtained when surface runoff was zero or close to zero (Figure 8.1-24). The pattern of variation in low-flow streamflow from the downstream point was relatively consistent in all years that were measured (2005, 2006, and 2007). The streamflow was highest (70 to 80 cfs) at the downstream point (distance=0), decreased to about 10 cfs, increased again to 30 to 50 cfs, decreased to zero between gaging stations SK100B and SK100C, and then increased slightly again in the headwaters of the river (Figure 8.1-24). Except for the decrease in flow observed at SK100B, the Groundwater Model replicated this pattern very well (Figure 8.1-24). Accordingly, the model is believed to be simulating interactions between groundwater and surface water reasonably well.

Summary

The Groundwater Model calculated recharge rates, inter-watershed flows, and local groundwater discharge rates that were within a reasonable range of the Water Balance Model estimates. The model also simulated the distribution of piezometric heads for the selected head calibration targets with reasonable accuracy.

8.1.8 Summary

8.1.8.1 Overview of Groundwater Baseline Program

This report describes hydrogeology work completed from 2004 to the end of 2008 to characterize the groundwater flow regime within the study area, including the interaction between surface water and groundwater. The study is based on an extensive field investigation as well as a calibration of a site-wide water balance and a numerical groundwater model. The field investigation included logging of investigative borings, installation of pumping wells, piezometers and monitoring wells, streamflow gaging and monitoring, monitoring of precipitation and other climatological variables, routine monitoring of streamflow, groundwater levels, and water quality.

The Water Balance Model was developed to provide a tool for characterizing the groundwater flows throughout the study area within the context of the overall hydrologic regime. The Groundwater Model was developed to confirm that the recharge rates and groundwater flows estimated with the Water Balance Model were reasonable in light of the current interpretation of geology and considering the measured groundwater gradients.

Topography, climate, and drainage

The study area is located on an upland (elevation 970 to 3,000 feet) that includes mountain blocks (Kaskanak, Koktuli, Sharp, Groundhog, and Cone) separated by upland valleys. Several lowlands surround this upland: Iliamna Lake (elevation 100 feet), about 15 miles to the south of the study area; the Newhalen River (elevation 300 feet), about 15 miles to the east of the study area; and the Chulitna River (elevation 325 feet), about 12 miles to the north of the study area.

Precipitation is greatest from late summer through early winter and is primarily generated by maritime storm systems. The most common circulation pattern consists of atmospheric lows moving in from the North Pacific Ocean along the Aleutian Island chain into the central and eastern Bering Sea (see Chapter 7). These storms produce a strong southeasterly air flow near ground surface. The storms result in considerable precipitation within the watershed, especially on higher terrain with southerly to easterly exposure. The long-term average annual precipitation measured at Iliamna Airport is approximately 27 inches. Average annual precipitation in the Pebble Deposit area is estimated to be approximately 46 inches.

The Pebble Deposit is located in the headwater areas of the South Fork Koktuli River (SFK) and Upper Talarik Creek (UT). The North Fork Koktuli River (NFK) drainage lies to the west of the deposit. Numerous tributaries and small ponds feed these main drainages. Many of the streams are underfit as the valleys were eroded during the late glacial period when glacial melt resulted in much higher flows than the current setting. Some minor portions of the study area are internally drained. These include kettle ponds and depressions that are underlain by permeable glacial outwash and glacial contact deposits. Water is transmitted from these areas to the main drainages by groundwater flow.

Regional streamflow is dominated by spring snowmelt and autumn rainfall runoff, with the relative proportions of flow in these two seasons depending mainly on basin elevation and corresponding temperatures, which control the timing of snowfall onset in the autumn. Streamflows are generally lower in the summer. The lowest flows of the year occur in late winter throughout the region.

Investigation Methods

The study is based on an extensive field investigation that has included the studies listed below:

- Geologic logging of investigative borings at 107 locations.
- Quarterly groundwater sampling from a network of 36 wells at 20 locations.
- Monthly groundwater level measurements from 472 piezometers.
- Installation of a deep multi-level groundwater monitoring well with 50 monitoring zones.
- Response tests at 151 piezometers and cross-hole pumping tests at nine sites.
- Four hundred ninety-two packer tests in bedrock.
- An extensive spring and seep inventory characterization program, including flow measurement at 114 of the seeps.
- A streamflow-gaging program at 29 continuous gages.
- Low-flow streamflow-measurement programs at 55 low-flow gages.
- Groundwater sampling rounds in September and October 2004 and quarterly from 2005 to 2008.
- Groundwater level monitoring rounds in October 2004 and monthly from 2005 to 2008.

The available information was examined, and plans, sections, temporal plots, and comparative plots were prepared to allow development of a detailed conceptual hydrogeologic model of the entire study area.

Geology

Bedrock in the study area includes Jurassic and Cretaceous sedimentary and volcanic rocks, intruded by Cretaceous granodiorite to monzonite, and overlain by Tertiary sedimentary and volcanic rocks. Below the upper bedrock zone (upper 50 feet), the hydraulic conductivity generally decreases with depth but includes some elevated-permeability zones that are typically associated with faults. The available data suggest that many of the faults act as flow barriers perpendicular to their strike, while some of the structures demonstrate an enhanced permeability in the direction of strike. As is often observed in bedrock groundwater systems, the pattern of faulting has resulted in the formation of groundwater compartments. These compartments are most evident within the deeper groundwater system.

The upper slopes and ridges of the study area include exposures of highly fractured bedrock, talus, rubble, and solifluction deposits. The highly fractured bedrock provides a pathway for elevated rates of groundwater recharge beneath the bedrock ridges. High rates of water return during air-rotary drilling indicate that the hydraulic conductivity is usually relatively high in the upper bedrock due to weathering. The zone of weathering is typically up to about 50 feet thick.

The lower slopes and valley bottoms are infilled primarily with glacial deposits, with some over-riding alluvial deposits. Several glacial periods have resulted in glacial advances and retreats within the study area. The landforms in the study area mostly formed during the Kvichak Stade of the Wisconsin Brooks Lake Glaciation. These landforms include end, lateral, and recessional moraines, ground moraines, outwash sands and gravels, and glacio-lacustrine deposits. Of these deposits, outwash sands and gravels are typically observed to have the highest hydraulic conductivity.

Three permeable and extensive glacial sand and gravel deposits are of particular note in the valley fill sequence. These are:

- Along the South Fork Koktuli River south of Frying Pan Lake (“South Fork Koktuli Flats”). These deposits include a sand and gravel moraine, and sand and gravel outwash deposits.
- In the North Fork Koktuli River Valley downstream of the Kvichak Stade terminal moraines.
- East of Upper Talarik Creek where there is extensive outwash and glacial contact sand and gravels.

Extensive low-permeability lacustrine deposits underlie the glacial Frying Pan Lake basin. Consistent with this low permeability, the lacustrine deposits are overlain by marshes. Similar low-permeability lacustrine deposits are present within the North Fork Koktuli River and Upper Talarik Creek drainages. In addition to reducing the groundwater recharge, the lacustrine deposits serve to limit the flow of groundwater from the South Fork Koktuli Flats area to Upper Talarik Creek.

Regional Hydrogeologic Setting

Several aspects of the regional hydrogeologic setting reduce the potential for regional groundwater flow to be an important aspect of the site groundwater conditions. These aspects are listed below:

- The presence of permeable shallow aquifers, upward hydraulic gradients, and strong local relief, which suggest that local and intermediate groundwater flow systems within the study area predominate over regional groundwater flow systems.
- The presence of high water tables in the bedrock ridges, as indicated by numerous seeps with large flows high on the slopes of the ridges separating the drainages.
- Packer testing confirms that hydraulic conductivity decreases with depth, inhibiting the potential for development of substantial deep groundwater flows.
- The deep groundwater quality up to 5,000 feet (Chapter 9) near the deposit has much higher TDS values than shallow groundwater, indicating much higher residence times and therefore slower pathways than the shallow groundwater regime, again supporting the concept that deep regional groundwater flow is limited.
- The presence of many local, cross-cutting faults have resulted in formation of groundwater compartments that have low hydraulic conductivity boundaries, again reducing the potential for substantial regional groundwater flow.
- A regional flowpath developed on a pervasive and permeable fault would result in locally apparent deviations in piezometric levels. Only one such anomaly has been observed, on a ridge approximately 7 miles west of the Pebble Deposit area.

Although faults with higher permeability than surrounding rock have been identified (and were expected), the available data support the concept that these elevated permeabilities are terminated within the study area, probably by cross cutting faults, changes in rock properties, or pinching out of the fault. This condition is typical of bedrock groundwater systems developed in crystalline volcanic and metamorphic rock settings. The local and intermediate flow systems dominate the overall groundwater regime. Most groundwater flow occurs at shallow levels within the overburden and shallow bedrock.

The following paragraphs discuss hydrogeologic conditions within each of the three main drainages.

North Fork Koktuli River Groundwater Conditions. In the North Fork Koktuli River tributary NK1.190 (Area G), drilling indicated that overburden was relatively thin on the valley floor and thicker on the lower slopes. Groundwater appears to be recharged on the upper slopes and then seeps downslope toward the valley floor. Numerous seeps mapped along the slopes of the bedrock ridges even at high elevations and sustained streamflows at high elevations support this conceptualization. Seepage mapped on valley margins may be the result of discontinuous fracture systems and supports the concept of lower hydraulic conductivity at depth. Groundwater levels are generally near ground surface (as noted by piezometric levels and seeps), even near the saddle at the south end of the catchment. One notable exception is indicated by a piezometer installed in the southwestern part of the area along the ridge, which had a very low piezometric level. If this piezometer is functioning properly, its piezometric reading may indicate a high-permeability feature through the ridge to the North Fork Koktuli River, which would need to be investigated further.

In the lower reaches of tributary NK1.190, the overburden is relatively thin, which limits the flow of groundwater out of the catchment. Most of the groundwater within this area appears to discharge to the stream channel. Recharge is expected to be relatively low and the observed flashy streamflows generally support a low recharge rate for this area.

The headwaters of the main stem of the North Fork Koktuli River upstream of stream gage NK100C (Big Wiggly Lake Basin) are mantled with glacial drift and glacial lake deposits. Hydrogeologic drilling investigations are more limited in this area, but the available data suggest the presence of continuous, albeit relatively thin, aquifer systems.

Downstream of the terminal moraine that is located close to the confluence of the main stem and tributary NK1.190, the surficial deposits change to outwash materials. Low-flow streamflow measurements indicate that the main stem of the North Fork Koktuli loses water to groundwater over the upper reaches of this outwash deposit and gains water from groundwater over the lower reaches.

The estimated average recharge in the North Fork Koktuli drainage above gage NK100A (the most downstream in the watershed) is 11 inches per year (in/yr), while the calculated groundwater flow under gage NK100A is about 0.3 in/yr. The low groundwater flow rate is due to the thinning and narrowing of the aquifer, which causes the groundwater to discharge to the river rather than continue downstream as underflow. The difference between the recharge rate and groundwater flow (10.7 in/yr) represents the groundwater discharge within the drainage, assuming that the change in groundwater storage from year to year is zero. This discharge amounts to about 97 percent of the recharge.

Overall, the rate of recharge and underflow in North Fork Koktuli is the lowest of the three main study drainages (NK, UT, SK). Within the North Fork Koktuli drainage, the lowest recharge rate (4.7 in/yr) is within Area 12, above gage NK119B. This low recharge results from the relatively low-permeability materials and steep relief in that area. Although the Water Balance Model did not explicitly consider the outwash sands and gravels immediately downstream of NK100C, the recharge rate to these sands and gravels is probably the highest rate within North Fork Koktuli. The next highest recharge rate within the North Fork Koktuli (13 in/yr) is within Area 13, above gage NK100C. This area is relatively flat-lying and is covered by a relatively large proportion of medium to higher permeability glacial drift materials.

South Fork Koktuli River Groundwater Conditions. In the South Fork Koktuli River watershed near the Pebble Deposit, piezometric data indicate that groundwater gradients are upward under the valley floor, with downstream lateral migration. Overburden material underlying the valley floor is primarily silty sand and gravel, with some cleaner layers of sand and gravel. Overburden is up to 100 feet thick over most of the area, with one deeper bedrock channel on the east side of the valley. The relatively low permeability material, the upward vertical gradients, and the relatively flat horizontal gradient tend to infer that groundwater in the upper South Fork catchment near the Pebble Deposit discharges to the upper South Fork Koktuli River rather than migrating across catchment boundaries or downgradient along the valley.

Intensive bedrock groundwater investigations have been carried out within the Pebble Deposit area. Consistent with other areas, the top 10 to 50 feet of bedrock is observed to be much more permeable than the bedrock below this depth. Available information indicates that hydraulic conductivities decrease below this depth, with decreasing values measured down to at least 500 feet. As noted for other parts of the site, most of the groundwater recharge within the Pebble Deposit area circulates in the upper part of the bedrock and in the overlying alluvial deposits.

Near Frying Pan Lake, south of the Pebble Deposit area, the overburden materials thicken, with a notable increase in the thickness of sand and gravel. Between the Pebble Deposit and Frying Pan Lake, the piezometric elevations in the upper bedrock show a more seasonal variation than those within the

overburden. Specifically, the piezometric elevation in the bedrock is observed to be higher than in the overburden in response to seasonal recharge events. In contrast, the piezometric elevations in the bedrock prior to seasonal recharge events are lower than in the overburden. The relative responsiveness of the piezometric levels in the bedrock suggests connection with recharge zones along the ridge tops, discharge zones that are located downgradient, and relative isolation from shallow groundwater and surface water. They are also indicative of lower groundwater storage in the bedrock compared to the overburden.

At the south end of Frying Pan Lake, a thick sequence of silty overburden probably limits groundwater losses from the lake to the downstream groundwater system. Piezometric levels measured in piezometers close to the lake are above lake elevation, indicating that the vertical component of groundwater movement is upward and groundwater is discharging to the lake. The horizontal groundwater gradient downstream of the lake is very steep as a result of the silt deposits. Surface water losses to the upper bedrock probably occur in proximity to the lake outlet.

The broad glacial valley floor downstream of the lake is elevated, with sand and gravel exposed on the ground surface. Enclosed depressions and lack of surface water drainages indicate that most of the available water recharges the sand and gravel aquifer in this area. This alluvial aquifer is thick, extensive, and very permeable. Because the creek bed is above the groundwater table downstream of the lake, the water in the river leaks into the groundwater system. The leakage rates into the aquifer are so high that the South Fork Koktuli River goes dry between gages SK100C and SK100D during periods of seasonal low runoff. Leakage from tributary SK1.240 provides an additional contribution to the groundwater system.

Groundwater movement in this part of the flow system is divided between two pathways: about two-thirds migrates downstream along the South Fork Koktuli River drainage, and about one-third migrates under the surface-water divide and discharges in tributary UT1.190 of Upper Talarik Creek. The overburden between the South Fork Koktuli sand and gravel aquifer and tributary UT1.190 includes at least three sandy aquifers inter-layered with two silty aquitards. Of these, the middle aquifer appears to transmit most of the flow toward tributary UT1.190.

Downstream of stream gage SK100C and at the confluence of the South Fork Koktuli River and tributary SK1.190, groundwater discharge to the river of more than 30 cfs was estimated within the Water Balance Model. These discharges likely result from a decrease in the cross-sectional area of the aquifer, as well as an increased contribution to the aquifer from tributaries SK1.210 and SK1.190.

Although there is limited subsurface information downstream of tributary SK1.190, the available surficial geology and low-flow data indicate that groundwater discharge to the stream continues down to gage SK100B. The data also indicate that the river loses water to groundwater downstream of SK100B. However, upstream of gage SK100A, those losses are recovered by the surface water system, as much of the groundwater discharges back to the stream.

The estimated average recharge rate for the South Fork Koktuli catchment above gage SK100A (the most downstream gage) was 23 in/yr, and the groundwater flow under the gage was 2.5 in/yr. This average recharge rate is about 40 percent higher than the average recharge rate in Upper Talarik Creek and is almost double the average recharge rate in the North Fork Koktuli drainage. The difference between the recharge rate and groundwater flow in South Fork Koktuli (about 20 in/yr) is mostly due to groundwater discharge, which amounts to about 87 percent of groundwater recharge, which is similar to the other two

main drainages. The groundwater underflow is about double that of North Fork Koktuli and about eight times that of Upper Talarik.

Overall, the recharge rates vary widely within South Fork Koktuli drainage depending on the surficial geology. The lowest recharge rate (12 in/yr) was estimated for Area 3, which is mantled with glaciolacustrine deposits. The groundwater flow out of this area is about 4.1 in/yr. In contrast, the highest recharge rate (47 in/yr) was calculated for Area 5, which is mantled primarily with glacial drift and outwash.

Upper Talarik Creek Groundwater Conditions. In the headwaters of the Upper Talarik Creek watershed, groundwater is recharged on the upper slopes. This groundwater moves downslope, primarily within the upper fractured bedrock. In some locations, lateral moraines and discontinuous fracture systems limit the movement of water into the valley bottom, resulting in abundant springs relatively high on the slopes.

The overburden in the upper reaches of Upper Talarik Creek is primarily silty sand and gravel, with some layers of clean sand and gravel. Groundwater moves downstream in the limited sand and gravel, and within the upper bedrock. Large vertical head differences have been measured, indicating that some low-permeability layers occur locally in this area. Abundant springs occur near and upstream of stream gaging station UT100E, probably related to the presence of outwash sands and gravels upstream of the gage, and glacial lacustrine deposits downstream of the gage, together with an internally drained pond adjacent to the gaging station.

The overburden to the east of the intermediate reaches of Upper Talarik Creek, between tributary UT1.135 and tributary UT1.190, includes a large area filled with delta, outwash, and ice-contact sands, and sand and gravel. The absence of surface drainage indicates these high-permeability materials likely form a strong groundwater-recharge area. This interpretation is confirmed by depressed peak streamflows and high baseflows.

Downstream of these high-permeability materials, tributary UT1.190 enters the Upper Talarik drainage. This tributary receives and transmits almost all of the groundwater that originates in the South Fork Koktuli surface water drainage area and migrates under the surface-water divide to the Upper Talarik Creek surface water drainage area.

The estimated average recharge in Upper Talarik above gage UT100B (the lowest in the catchment for which the Water Balance Model was calibrated) is 16 in/yr and the groundwater flow under gage UT100B is 1 in/yr. The recharge rate in Upper Talarik is about 50 percent higher than North Fork Koktuli. The difference between recharge and groundwater flow in Upper Talarik (15 in/yr) is mostly due to groundwater discharge, which amounts to about 94 percent of groundwater recharge. This proportion of groundwater discharge is similar to North Fork Koktuli.

In the upper reaches of Upper Talarik, above gage UT100D, the average recharge rate (12 in/yr) is about 50 percent lower than the average for the whole watershed, and the groundwater flow (0.3 in/yr) is about 75 percent lower. The lower recharge rate and groundwater flow for the upper reaches are a result of the low-permeability glaciolacustrine deposits present in this part of the watershed. The higher average recharge rate for the entire watershed is mainly due to the high-permeability ice-contact deposits along the east side of Upper Talarik Creek between gage UT100D and UT100B.

Overall Characteristics of the Groundwater Flow System

In summary, the overall groundwater flow system in the study area is characterized as follows:

- In general, most groundwater flow in the study area occurs along local and/or intermediate flow paths. There is limited regional groundwater flow to the surrounding lowlands (Newhalen River, Chulitna River, Iliamna Lake). This is supported by the geologic and topographic setting, and by the hydrogeologic testing work carried out to date.
- The overall groundwater flow pattern across the study area is dominated by flow in approximately the upper 50 feet of the bedrock from the margins of the valley towards the valley floor, and groundwater underflow in a downstream direction along the axis of the valley, predominantly within the overburden deposits.
- Except for some cross-catchment flow between South Fork Koktuli River and Upper Talarik Creek, the Water Balance Model analysis indicates that 90 percent or more of the water that recharges the groundwater system within each of the three main drainages tends to discharge within that drainage.
- To varying degrees, continuous permeable overburden units fill the bedrock valleys along each of the three main drainages. In most of the valley reaches, the majority of groundwater flow occurs within the overburden deposits. Groundwater underflow down the valley is much lower where the alluvium is dominated by lower permeability deposits (silts and clays). In these areas, the groundwater system tends to discharge to surface water, leading to gaining streamflow reaches. onversely, where the alluvial deposits become more permeable downstream, or where the profile of the valley widens, the surface water system tends to leak into groundwater, leading to losing stream reaches. The main reaches of streamflow losses and gains have been characterized as part of the baseline study.
- The upper reaches of tributaries tend to have limited groundwater storage capacity, and therefore streamflows in the upper reaches are typically flashy, and late winter baseflows are relatively low.
- Further downstream, the sustained winter baseflows for the main stems in most parts of the study area indicate considerable groundwater is contained in storage within the main part of the valleys. Baseflows are mostly higher where a substantial thickness of permeable alluvium is present upstream. The overall nature of the baseflow patterns tends to indicate that most of the groundwater storage on site occurs within the alluvium, and that most bedrock units demonstrate limited groundwater storage potential.
- The average groundwater recharge rates for the North Fork Koktuli, Upper Talarik, and South Fork Koktuli watersheds are 11, 16, and 23 in/yr, respectively. The variation in recharge rates primarily reflects the differences in the surficial geology.
- Within each of the drainages, the surficial geology varies from low-permeability glaciolacustrine deposits to high-permeability glacial outwash and ice-contact deposits. The large differences in the permeability, coupled with variations in the topographic gradient, result in estimated localized recharge rates within each drainage that vary from 5 to 47 in/yr (including leakage from streams).
- The largest cross-catchment flow in the study area occurs from Area 5 in South Fork Koktuli to Area 7 in Upper Talarik Creek, and is estimated to be about 6 in/yr, or about one-third of the total underflow within Area 5.

- As surface drainage divides and groundwater divides are seldom, if ever, exactly the same, other small, localized cross-basin groundwater flows are possible.
- The large seasonal changes in piezometric levels in many parts of the study area (often 10 to 20 feet, sometimes up to 30 feet) indicate that the seasonal changes in groundwater storage are relatively large because of the high recharge rates. However, the relatively consistent amplitude of the piezometric variations from year to year indicates that the groundwater system is in a state of dynamic equilibrium, and that groundwater storage is relatively constant from one year to the next.

8.2 Transportation Corridor

No groundwater hydrology study was conducted in the transportation-corridor study area in 2004 through 2008.

8.3 References

Alaska Department of Environmental Conservation (ADEC). 1992. *Recommended Practices for Monitoring Well Design, Installation, and Decommissioning*. April, 1992. Guidance No. 001, Version 2.2.

Alley, William M. 1984. "On the Treatment of Evapotranspiration, Soil Moisture Accounting, and Aquifer Recharge in Monthly Water Balance Models." *Water Resources Research,* 20, 1984. pp1137-1149.

American Society for Testing and Materials (ASTM). 2002. ASTM D4044-96(2002), *Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*

———. 2000. D2488-00 *Standard Practice for Description and Identification of Soils (Visual Manual Procedure)*.

———. 1999. D1586-99, *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*.

———. 1990. *D5092, Design and Installation of Ground Water Monitoring Wells in Aquifers*.

CH2M Hill, Inc. 2004. *Draft Baseline Environmental Studies for Groundwater Work Plan*.

Cooper, H.H. Jr., J.D. Bredehoeft and I.S. Papadopoulos. 1967. "Response of a Finite-Diameter Well to an Instantaneous Charge of Water." *Water Resources Research,* 3, 1967. pp 263-269.

Detterman, R.L. 1986. Glaciation of the Alaskan Peninsula, in Hamilton, T. D., Reed, K.M. and Thorson, R.M. eds, Glaciation in Alaska–The Geologic Record: Anchorage, Alaska Geological Society, p 151-170.

Detterman, Robert L., and Bruce L. Reed. 1973. *Surficial Deposits of the Iliamna Quadrangle, Alaska*. Geological Survey Bulletin 1368-A.

Freeze, R.A. and J. A. Cherry. 1979 Groundwater. Prentice-Hall, 604 pp.

Hamilton, Thomas and Klieforth. 2010. Surficial Geologic Map of the Pebble Limited Partnership's Pebble Project. A study prepared for the Pebble Limited Partnership.

Hantush, M.S. 1960. "Modification of the Theory of Leaky Aquifers." *Journal of Geophysical Research.* Vol. 65: 1960. pp 3713-3725.

Hantush, M.S. and C.E. Jacob. 1955 "Nonsteady Radial Flow in an Infinite Leaky Aquifer." *Transactions American Geophysical Union.* Vol. 36: 1955. pp 95-100.

Hvorslev, M.J. 1951. "Time Lag and Soil Permeability in Ground-Water Observations." Bulletin. No. 36, Waterways Experimental Station, Corps of Engineers, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

Moench, Allen F. 1993. "Computation of Type Curves for Flow to Partially Penetrating Wells in Water Table Aquifers." *Groundwater,* 31(6). 1993.

Neuman, Shlomo P., 1972. "Theory of Flow in Unconfined Aquifers Considering Delayed Response of the Water Table." *Water Resources Research*, 8(4). 1972.

Neuman, Shlomo P. and Paul A. Witherspoon, 1972. "Field Determination of the Hydraulic Properties of Leaky Multiple Aquifer Systems." *Water Resources Research,* 8(5). 1972.

Northern Dynasty Mines Inc. (NDM). 2004. *Draft Baseline Study Plan for Environmental Baseline Studies*.

Robertson, W. D., and Cherry, J. A. 1989. "Tritium as an Indicator of Recharge and Dispersion in a Ground-water System in Central Ontario," *Water Resources* Research 25(6), pp 1097-1109.

Steenhuis T.S. and W.H. Van der Molen. 1986. The Thornthwaite–Mather Procedure as a Simple Engineering Method to Predict Recharge. Journal of Hydrology, 84, Pages 221–229.

Theis, C.V. 1935. The Relation between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage. *Transactions American Geophysical Union,* 2: 1935. pp 519-524.

United States Geological Survey (USGS). 2002. USGS Fact Sheet 022-02, *Ground-Water Age and its Water-Management Implications, Cook Inlet Basin, Alaska.* April, 2002.

Van der Kamp, Garth. 1976. "Determining Aquifer Transmissivity by Means of Well Response Tests: The Underdamped Case." *Water Resources Research,* 12(1): 1976. pp 71–77.

Westbay Instruments, Inc. 2007. Completion Report Westbay System Monitoring Well: NDM-6349 Iliamna Alaska, January 15, 2007.

8.4 Glossary

Alluvium	A general term for clay, silt, sand gravel or other unconsolidated material deposited by a stream or other body of running water.
Andesite	Andesite is an extrusive igneous, volcanic rock, of intermediate composition, with a fine grained texture.
Anisotropic	Having a physical property that varies with direction.
Annulus	The space between the drill string or casing and the wall of the borehole or outer casing.
Aquitard	A geological or group of geological formations through which virtually no water moves.
Basalt	Basalt is a common extrusive volcanic rock. It is usually grey to black and fine-grained due to rapid cooling of lava at the surface.
Batholith	A very large igneous intrusion extending deep in the earth's crust.
Bedrock	A general term for the rock, usually solid, that underlies soil or other unconsolidated material.
Bentonite Grout	A mixture of bentonite clay and cement.
Boundary Conditions	In mathematics, in the field of differential equations, a boundary value problem is a differential equation together with a set of additional restraints, called the boundary conditions. A solution to a boundary value problem is a solution to the differential equation which also satisfies the boundary conditions.
Boundary Conductance	It is the product of hydraulic conductivity times the saturated thickness for a particular boundary condition.
Breccia	Breccia is a rock composed of broken fragments of minerals or rock cemented together by a fine-grained matrix, that can be either similar to or different from the composition of the fragments.
Casing Shoe	Re-enforced steel ring that goes at the base of the lowest piece of temporary or conductor casing (See also Drive Shoe)
Chatter	The bouncing of the down-hole percussive drill bit on hard rock.
Colluvium	Colluvium is the name for loose bodies of sediment that have been deposited or built up at the bottom of a low-grade slope or against a barrier on that slope, transported by gravity.
Completion Zone	That portion of a borehole that is open to the surrounding geological material.
Conglomerate	A conglomerate is a rock consisting of individual clasts within a finer-grained matrix that have become cemented together. Conglomerates are sedimentary rocks consisting of rounded fragments and are thus differentiated from breccias, which consist of angular clasts.
Cretaceous	The Cretaceous is a geologic period and system from circa 145.5 ± 4 to 65.5 ± 0.3 million years ago.

Cross-Hole Test Pumping	Normally involves one pumping well and the monitoring of water levels or pressures in one or more observation wells adjacent to the pumping well.
Darcy's Law	A derived equation for the flow of fluids on the assumption that the flow is laminar and that inertia can be neglected.
Drive Shoe	Re-enforced steel ring that goes at the base of the lowest piece of temporary or conductor casing (See also Casing Shoe).
Dykes	A dyke is a body of rock that cuts across the layers of its surrounding or country rocks.
Equipotential	Line of equal water level or piezometeric pressure (See piezometric elevation and potentiometric surface).
Evapotranspiration	Loss of water from a land area through transpiration of plants and evaporation from the soil.
Fault Gouge	Fault gouge is an unconsolidated rock with a very small grain size, formed by tectonic forces.
Felsenmeer	Felsenmeer refers to the freeze-thaw weathering that has broken up the top layer of the rock, covering the underlying rock formation with jagged, angular boulders.
Finite-Difference Code	It is the translation of the finite difference equation governing ground water flow into computer code.
Foot Valve	A non return valve located at the base of a rising main.
Gabbro	Gabbro refers to a large group of dark, coarse-grained, intrusive mafic igneous rocks chemically equivalent to basalt.
Graben	Depressed block of land bordered by parallel faults
Granodiorite	Granodiorite is an intrusive igneous rock similar to granite, but containing more plagioclase than potassium feldspar
Hydraulic Conductivity	The rate of flow of water (L^3/T) through a cross sectional area (L^2) under one unit of hydraulic gradient.
Hydrostratigraphic Model	The combining of different lithological and geological structural units into hydrogeological units with similar properties.
Injection Testing	The pumping of water into the ground via a well at a known pressure and discharge rate and measuring the response within the well and in any surrounding wells.
Jurassic	The Jurassic is a geologic period and system that extends from about 199.6± 0.6 Mya (million years ago) to 145.5± 4 Mya.
Kettle Ponds	Depressions in the landscape caused by large blocks of ice entrained in glacial till, moraines or outwash gravels melting.
K-Packer Assembly	Compression joint used for sealing annulus in an open hole when installing well screen and/or casing.
Lacustrine Deposits	Unconsolidated material deposited at the bottom of a lake.
Lateral Moraines	Unconsolidated material deposited on the side of a valley by a retreating glacier.

Lithology	Rock type.
Lugeon Test	A Lugeon test is used to measure the amount of water injected into a segment of a borehole under a steady pressure.
Modflow Surfact	MODFLOW SURFACT is a comprehensive 3D finite difference flow and contaminant transport model based on the USGS MODFLOW code. With more enhanced simulation capabilities for handling complex saturated/unsaturated subsurface flow and transport processes, MODFLOW-SURFACT is specifically designed to address the many limitations and short-comings of the standard MODFLOW code.
Monitoring Wells	Boreholes specifically drilled and design for measuring water levels and obtaining ground water samples from a specific depth in the underlying overburden or rock.
Monzodiorite	A coarse-grained igneous rock consisting of essential plagioclase feldspar, orthoclase feldspar, hornblende, and biotite, with or without pyroxene.
Monzonite	Monzonite is an intermediate igneous intrusive rock composed of approximately equal amounts of sodic to intermediate plagioclase and orthoclase feldspars with minor amounts of hornblende, biotite and other minerals.
Odex	A drilling technique whereby an eccentric bit is used to under ream the casing at a slightly larger diameter thus permitting the casing to follow behind the bit as the hole is progressed.
Overburden	Unconsolidated clays, sand, gravels and glacial tills (See alluvium and colluvium)
Packer Testing	Test for measuring the permeability of ground in sections of boreholes. An inflatable tube (‘packer’) is lowered down a borehole and expanded so that the sections above and below are isolated. Alternatively, two packers may be used to isolate a certain section.
Paleo-Channel	Ancient buried river channel
Periglacial	Periglacial is an adjective originally referring to places in the edges of glacial areas but has later on been widely used in geomorphology to describe any place where geomorphic processes related to freezing of water occur
Piezometer	Very narrow diameter borehole open only over a very small section to measure the potentiometric pressure at that precise depth (See potentiometric)
Piezometric Elevation	The potentiometric pressure at a particular point converted into feet (or meters) above or below a datum.
Porous Media Theory	It is the theory whereby fractured hydrogeological material can be modeled using equivalent porous media models if the scale is large enough.
Potentiometric surface	An imaginary surface representing the total head of ground water in a confined aquifer that is defined by the level to which water will rise in a well.
Pressure Transducer	A device that generates an analog electrical signal as a function of the pressure applied. The conversion of pressure into an electrical signal is

	achieved by the physical deformation of strain gages which are bonded into the diaphragm of the pressure transducer and wired into a wheatstone bridge configuration. Pressure applied to the pressure transducer produces a deflection of the diaphragm which introduces strain to the gages. The strain will produce an electrical resistance change proportional to the pressure
Pyroxenite	Pyroxenite is an ultramafic igneous rock consisting essentially of minerals of the pyroxene group, such as augite and diopside, hypersthene, bronzite or enstatite
Rat Hole	Extra depth of hole drilled at the end of the well (beyond the last zone of interest) to ensure that the zone of interest can be fully evaluated.
Reach	A river or stream segment of a specific length.
Recessional Moraines	Unconsolidated material deposited by the temporary halting of a retreating glacier
Response Testing	The addition or removal of a definite quantity of water to or from a well and measuring the subsequent fall and rise of the water level. They are also known as falling or rising head tests (See slug testing)
RQD	RQD is an acronym for Rock Quality Designation. It is a rough measure of the degree of jointing or fracturing in a rock mass, measured as a percentage of the drill core in lengths of 10 cm or more.
Shelby Tube	3" (76.2mm) dia. x 10" long, thin-walled, open-tube sampler whose lower end is chamfered to form a cutting edge and upper end includes holes for securing tubes to a drive head. It is used for retrieving undisturbed samples of unconsolidated material usually sands, silts and clays.
Sill	A sill is a tabular sheet intrusion that has intruded between older layers of sedimentary rock, beds of volcanic lava or tuff, or even along the direction of foliation in metamorphic rock.
Slug Testing	A slug test is a particular type of aquifer test where water is quickly added or removed from a groundwater well, and the change in hydraulic head is monitored through time, to determine the near-well aquifer characteristics
Solifluction	Type of mass wasting where waterlogged sediment moves slowly downslope, over impermeable material.
Split-Spoon Sampler	It is a hollow tube consisting of two halves split lengthwise. They are held together by circular connector head at top and drive shoe at bottom.
Stade	A short period of time (less than 10,000 years) characterized by climatic conditions associated with maximum glacial extent.
Stocks	Discordant igneous intrusion having a surface exposure of less than 40 sq mi (100 km^2), differing from batholiths only in being smaller.
Surge Block	Normally a wooden device with rubber seals attached to a drill rod which is then moved up and down to cause a surging action to agitate granular material outside of screened sections of wells. It is used to develop and clean wells.
Terrane	A short-hand term for a tectonostratigraphic terrane, which is a fragment of crustal material formed on, or broken off from, one tectonic plate and

	accreted or "sutured" to crust lying on another plate.
Tertiary	A deprecated term for a geologic period 65 million to 2.6 million years ago.
Thalweg	In hydrological and fluvial landforms, the thalweg is a line drawn to join the lowest points along the entire length of a stream bed or valley in its downward slope, defining its deepest channel. The thalweg thus marks the natural direction (the profile) of a watercourse.
Transmissivity	The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.
Travel Time	It is the unit time it takes a particle of groundwater to move a unit distance under natural groundwater flow conditions.
Tremie Pipe	It is a narrow diameter pipe inserted into the annulus of the borehole to introduce gravel, sand, cement or bentonite in to the annulus as part of the construction and completion of a well.
Tri-Cone Rotary Bit	Consists of conically shaped rollers on spindles and bearings set at an angle to the axis of the bit.
Tritium	It is a radioactive isotope of hydrogen.
Wacke	Wacke is a name for a poorly sorted sandstone, a mixture of grains of sand, silt and clay size
Waterra	The Waterra consists of an inertial pump which is installed in the well to be sampled. It consists of a one way foot valve which permits water into the tubing. Initially the water level within the tube is the same as the head level in the well. Operation of the inertial pump begins with a rapid upstroke. The weight of the water column within the tube keeps the valve closed during the upstroke. The water level within the tube is raised above the head level in the well by the length of the pumping stroke. At the end of the upward stroke, the water within the tubing continues to move upwards because of its momentum. The distance it moves is to a large degree determined by how rapidly the upstroke was applied to the tubing and how effectively this energy was transferred to the bottom of the well where the valve is located. As the water within the tubing moves upwards, the valve opens and more water is drawn into the tubing. The rate at which water enters the tubing is effected by how much momentum was imparted to the water in the tube and the depth of submergence of the valve. Greater submergence increases the pressure differential at the end of the upward stroke and increased the inflow rate. Water continues to flow into the tubing during the downward stroke. The valve closes at the end of the downward stroke. The cycle is repeated and the water rises in pulses with each pumping stroke to discharge at surface.
Well Riser	This is the pipe coming from the pump to the surface.

TABLES

TABLE 8.1-1
Summary of Response Tests in the Pebble Deposit Area

Overburden or Bedrock	Drillhole #	K (m/s)
Overburden	GH07-106	
Overburden	GH05-58	1.60E-06
Overburden	GH05-64	1.10E-06
Overburden	GH06-80	5.10E-08
Overburden	GH07-104	7.10E-08
Overburden	GH07-105	2.70E-05
Overburden	KP-P3M/SRK-5M	8.00E-05
Overburden	KP-P3S/SRK-5S	3.00E-04
Overburden	KP-P4	2.00E-05
Overburden	MW-05-12S	5.00E-06
Overburden	MW-5D	5.00E-06
Overburden	MW-5M	3.40E-04
Overburden	MW-5S	5.00E-05
Overburden	P-05-07S	2.00E-04
Overburden	P-05-08	4.50E-06
Overburden	P-05-09D	7.40E-04
Overburden	P-05-28D	6.00E-04
Overburden	P-05-30S	8.50E-06
Overburden	P-05-31S	1.30E-07
Overburden	P-05-33D	1.00E-04
Overburden	P-05-36M	1.50E-04
Overburden	P-05-36S	1.30E-03
Overburden	P-08-55S	2.74E-04
Overburden	P-08-56M	1.05E-05
Overburden	P-2M	3.00E-05
Overburden	P-3	2.50E-04
Overburden	P-4 mid	2.00E-05
Overburden	P-4 mid	2.00E-04
Overburden	P-4AD	6.00E-07
Overburden	P-4AS	4.00E-05
Overburden	P-6D	2.00E-04
Overburden	P-6M	5.00E-06
Overburden	P-6S	4.00E-05
Overburden	SRK-2 (AKA 4251)	1.20E-05
	Count	33
	Geometric Mean	2.23E-05
	Median	3.00E-05
	Max	1.30E-03
	Min	5.10E-08

Overburden or Bedrock	Drillhole #	K (m/s)
Bedrock	GH05-57	1.50E-06
Bedrock	GH05-59	9.60E-06
Bedrock	KP-P3D/SRK-5D	2.80E-04
Bedrock	MW-05-12D	2.90E-06
Bedrock	P-05-07D	1.80E-05
Bedrock	P-05-30D	4.00E-06
Bedrock	P-05-31D	6.50E-05
Bedrock	P-05-32D	5.00E-05
Bedrock	P-05-36D	2.50E-06
Bedrock	P-08-55D	5.99E-06
Bedrock	P-08-56D	1.20E-05
Bedrock	P-08-57D	3.95E-07
Bedrock	P-2D	3.00E-05
Bedrock	PQ-4	1.50E-05
	Count	14
	Geometric Mean	9.90E-06
	Median	1.08E-05
	Max	2.80E-04
	Min	3.95E-07

Key: K = hydraulic conductivity.
m/s = meter(s) per second.

TABLE 8.1-2
Summary of Response Tests in the Frying Pan Lake Area

Overburden or Bedrock	Drillhole #	K (m/s)
Overburden	GH06-74	6.10E-08
Overburden	P-05-20S	3.50E-05
Overburden	P-05-22D	1.20E-04
	Count	3
	Geometric Mean	6.35E-06
	Median	3.50E-05
	Max	1.20E-04
	Min	6.10E-08
Bedrock	GH04-46	3.60E-07
Bedrock	GH05-54	1.30E-06
Bedrock	GH05-56	1.60E-08
Bedrock	P-08-58D	2.56E-05
Bedrock	P-08-58M	9.13E-05
	Count	5
	Geometric Mean	1.77E-06
	Median	1.30E-06
	Max	9.13E-05
	Min	1.60E-08

Key: K (m/s) = Hydraulic conductivity in meters per second.

TABLE 8.1-3
Summary of Response Tests in the South Fork Koktuli Flats Area

Overburden or Bedrock	Drillhole #	K (m/s)
Overburden	GH05-52	1.90E-07
Overburden	GH06-76	7.10E-08
Overburden	MW-05-13S	9.00E-04
Overburden	MW-11D	8.00E-04
Overburden	MW-11M	9.00E-04
Overburden	MW-11S	7.00E-04
Overburden	MW-1M	1.30E-05
Overburden	MW-1M	4.00E-05
Overburden	MW-1S	6.00E-04
Overburden	MW-2D	1.10E-03
Overburden	MW-3D	6.40E-04
Overburden	P-05-10D	4.00E-04
Overburden	P-05-10S	8.50E-04
Overburden	P-05-11D	4.20E-04
Overburden	P-05-11M	8.00E-04
Overburden	P-05-12	3.50E-04
Overburden	P-05-13	6.00E-04
Overburden	P-05-14D	3.00E-04
Overburden	P-05-14S	1.90E-05
Overburden	P-05-15D	5.00E-04
Overburden	P-05-15S	6.00E-04
Overburden	P-05-16D	1.70E-05
Overburden	P-05-16M	4.00E-04
Overburden	P-05-16S	2.50E-04
Overburden	P-05-16SS	5.00E-05
Overburden	P-05-17D	3.00E-04
Overburden	P-05-17S	1.50E-04
Overburden	P-05-19M	2.60E-05
Overburden	P-05-24D	2.40E-04
Overburden	P-05-24S	8.90E-04
Overburden	P-05-26D	5.00E-04
Overburden	P-05-26S	4.30E-05
Overburden	P-05-27M	1.00E-05
Overburden	P-05-27S	9.00E-04
Overburden	P-08-60S	8.49E-06
Overburden	P-08-62M	9.52E-04
Overburden	P-08-63M	7.10E-06
Overburden	P-08-63S	8.41E-05
Overburden	P-08-65M	1.93E-04
Overburden	P-08-67S	9.86E-06
Overburden	P-08-82M	9.49E-04
Overburden	P-08-82S	6.00E-04
Overburden	P-08-83M	4.00E-04
Overburden	P-08-83S	9.00E-04
Overburden	P-08-84S	4.50E-07

Overburden or Bedrock	Drillhole #	K (m/s)
	Count	45
	Geometric Mean	1.31E-04
	Median	4.00E-04
	Max	1.10E-03
	Min	7.10E-08
Bedrock	GH04-20	1.40E-06
Bedrock	GH04-28	5.40E-07
Bedrock	GH05-55	3.50E-08
Bedrock	MW-05-13D	3.50E-06
Bedrock	MW-1D	2.60E-04
Bedrock	P-05-23	6.30E-06
Bedrock	P-05-25	8.00E-05
Bedrock	P-08-59D	1.79E-04
Bedrock	P-08-59S	2.75E-03
Bedrock	P-08-60D	2.10E-06
Bedrock	P-08-61D	1.10E-04
Bedrock	P-08-62D	6.91E-07
Bedrock	P-08-63D	1.52E-04
Bedrock	P-08-64D	1.20E-04
Bedrock	P-08-65D	1.89E-04
Bedrock	P-08-66D	1.00E-08
Bedrock	P-08-67D	4.38E-06
Bedrock	P-08-82D	3.46E-04
Bedrock	P-08-83D	1.22E-05
Bedrock	P-08-84D	7.00E-04
	Count	20
	Geometric Mean	1.52E-05
	Median	4.61E-05
	Max	2.75E-03
	Min	1.00E-08

Key: K (m/s) = Hydraulic conductivity in meters per second.

TABLE 8.1-4
Summary of Response Tests in the North Fork Koktuli Area

Overburden or Bedrock	Drillhole #	K (m/s)
Overburden	GH07-102D	7.80E-09
Overburden	GH07-95	3.60E-06
Overburden	MW-6D	5.50E-04
Overburden	MW-7S	3.00E-04
Overburden	MW-8D	3.20E-04
Overburden	MW-8M	7.50E-04
Overburden	MW-9D	8.00E-04
Overburden	P-07-50S	2.00E-04
Overburden	P-08-68D	1.34E-03
Overburden	P-08-74S	1.04E-03
Overburden	P-08-75M	1.63E-04
Overburden	P-08-75S	5.00E-05
Overburden	P-08-76S	1.00E-03
Overburden	P-08-78D	2.83E-05
Overburden	P-08-79D	7.07E-06
Overburden	P-08-79M	2.95E-06
Overburden	P-08-79S	3.00E-04
Overburden	P-08-80M	1.50E-05
Overburden	P-08-80S	4.47E-04
Overburden	P-08-81D	1.00E-03
Overburden	P-08-86D	1.32E-05
Overburden	P-08-87S	1.78E-03
	Count	22
	Geometric Mean	9.74E-05
	Median	3.00E-04
	Max	1.78E-03
	Min	7.80E-09
Bedrock	GH06-65	1.40E-07
Bedrock	GH06-66	2.20E-08
Bedrock	GH06-67	7.80E-08
Bedrock	GH06-68	6.95E-07
Bedrock	GH06-69	1.00E-06
Bedrock	GH07-100	1.10E-06
Bedrock	GH07-101	1.52E-07
Bedrock	GH07-102S	3.80E-08
Bedrock	GH07-103D	9.40E-09
Bedrock	GH07-103S	9.00E-08
Bedrock	GH07-82D	1.40E-07
Bedrock	GH07-82S	5.20E-08
Bedrock	GH07-84	9.10E-07
Bedrock	GH07-85	4.50E-08
Bedrock	GH07-87D	3.30E-08
Bedrock	GH07-87S	1.10E-07
Bedrock	GH07-88	2.60E-06
Bedrock	GH07-89D	1.90E-08
Bedrock	GH07-89S	1.60E-08
Bedrock	GH07-90D	3.80E-06
Bedrock	GH07-91	2.70E-06

Overburden or Bedrock	Drillhole #	K (m/s)
Bedrock	GH07-92D	2.00E-07
Bedrock	GH07-92S	2.50E-06
Bedrock	GH07-93	3.00E-06
Bedrock	GH07-94	9.20E-07
Bedrock	GH07-96D	2.90E-07
Bedrock	GH07-96S	1.40E-07
Bedrock	GH07-97D	9.40E-07
Bedrock	GH07-97S	3.60E-07
Bedrock	GH07-98D	5.70E-06
Bedrock	GH07-98S	2.80E-06
Bedrock	GH07-99	4.80E-06
Bedrock	MW-7D	3.00E-04
Bedrock	P-07-50D	4.00E-06
Bedrock	P-07-51D	1.64E-07
Bedrock	P-07-51S	2.88E-05
Bedrock	P-07-52D	1.97E-05
Bedrock	P-08-69D	1.73E-07
Bedrock	P-08-70D	2.21E-06
Bedrock	P-08-70S	1.19E-04
Bedrock	P-08-71D	1.09E-04
Bedrock	P-08-72D	7.39E-07
Bedrock	P-08-73D	5.69E-07
Bedrock	P-08-74D	6.75E-07
Bedrock	P-08-75D	4.50E-05
Bedrock	P-08-76D	1.73E-05
Bedrock	P-08-80D	8.94E-06
Bedrock	P-08-87D	2.99E-06
	Count	48
	Geometric Mean	8.09E-07
	Median	8.24E-07
	Max	3.00E-04
	Min	9.40E-09

Key: K (m/s) = Hydraulic conductivity in meters per second.

TABLE 8.1-5
Summary of Response Tests in the Upper Talarik Area

Overburden or Bedrock	Drillhole #	K (m/s)
Overburden	P-05-35	2.00E-05
Overburden	P-06-39S	1.60E-06
Overburden	P-08-88D	8.94E-06
Overburden	P-08-88S	4.24E-05
	Count	4.00E+00
	Geometric Mean	1.05E-05
	Median	1.45E-05
	Max	4.24E-05
	Min	1.60E-06
Bedrock	P-06-37D	5.50E-06
Bedrock	P-06-37M	5.00E-06
Bedrock	P-06-39D	7.00E-06
Bedrock	P-06-41M	4.00E-06
Bedrock	P-07-47D	2.72E-07
Bedrock	P-08-89D	2.00E-05
Bedrock	P-08-89S	1.73E-07
	Count	7
	Geometric Mean	2.56E-06
	Median	5.00E-06
	Max	2.00E-05
	Min	1.73E-07

Key: K (m/s) = Hydraulic conductivity in meters per second.

TABLE 8.1-6
Results of Pumping Tests

Pump Test	Area	Piezo Location	Aquifer Thickness (ft)	Pumping Rate (usgpm)	Distance (m)	Aquifer Penetration Assumption %	T (ft^2/day)	T (m^2/s)	K_h (m/s)	S	S_y	r/B	Kv/Kh	ß	Method	Comments
PW-1	Deposit	P4-AS		10.4	29											No response
		P-6S			75											No response
		P-6D	16		73	partial	7.4E+01	8.00E-05	2.E-05	1.E-05					Hantush	Bedrock aquifer, anisotropic?
PW-3	SFK near hw of UT1.190	MW-11S		49.5	10.3											No response
		MW-11M	85		8.4		5.6E+03	6.0E-03	2.E-04	7.E-04	1.E-01		1.E-01		Neuman	Partial penetration impacts ?
PW-4	SFK near SK100C	MW-1S		356	11.7											No response, 1.5 ft daily fluctuations
		MW-1M	128		8.4		4.9E+05	5.30E-01	1.E-02	1.E-02	1.E-01				Neuman	Partial penetration impacts ?
PW-5	SFK betw. SK110D and SK100F	MW05-14D	100	85	8.2	partial	1.1E+04	1.1E-02	1.1E-04	3.1E-03	7.6E-02		0.443	0.03	Neuman	Bedrock
		MW05-14D	100			full	1.3E+04	1.4E-02	4.6E-04	2.8E-03	7.4E-02		0.250	0.02	Moench	
PW-6	Beside PW-5	MW05-14S	100	45	6.0	partial	1.6E+04	1.8E-02	6.0E-04	2.5E-02		0.200	0.500		Hantush and Jacob	Overburden
		MW05-14S	100			full	1.1E+04	1.2E-02	1.7E-03	6.4E-03		0.094	0.080			
		P05-25	100			partial	1.5E+05	1.6E-01	1.6E-03	2.4E-02		0.150	0.002			
PW-7	South of Frying Pan Lake	P05-26D	45	50	4.6	full	9.7E+04	1.1E-01	8.0E-03	1.1E-02	2.0E-01		0.251	0.03	Neuman	Overburden. Aquifer pinches out north, expands south
PW-8	Deposit	P05-29D	42	50	5.1	partial	3.4E+02	3.6E-04	3.3E-06	2.4E-03		0.010	0.001		Hantush and Jacob	Bedrock
		P05-29D	42			full	3.5E+02	3.8E-04	6.8E-06	2.3E-03		0.037	0.001			
		P05-29D2	42			partial	2.3E+02	2.5E-04	2.3E-06	1.3E-03		0.009	0.452			
		P05-29D2	42			full	2.4E+02	2.6E-04	2.0E-05	1.3E-03		0.009	0.270	5.0E-03		
PW-9	Deposit	P-08-57D														
		P05-28S													Theis	Overburden
		P05-28D	133	52	12.5	partial	4.7E+02	5.0E-04	1.2E-05	2.0E-04						
		GH-05-64			231.3	partial	2.8E+03	3.0E-03	7.4E-05	7.0E-04						
PW-10	Deposit	P07-53S														
		P07-53D	108	84	14	partial	4.9E+03	5.3E-03	1.6E-04	2.7E-04	4.0E-02		2.7E-03		Neuman	Bedrock
		P07-50D	108		10	partial	4.7E+03	5.0E-03	1.5E-04	6.7E-04	1.0E-01		2.0E-03			

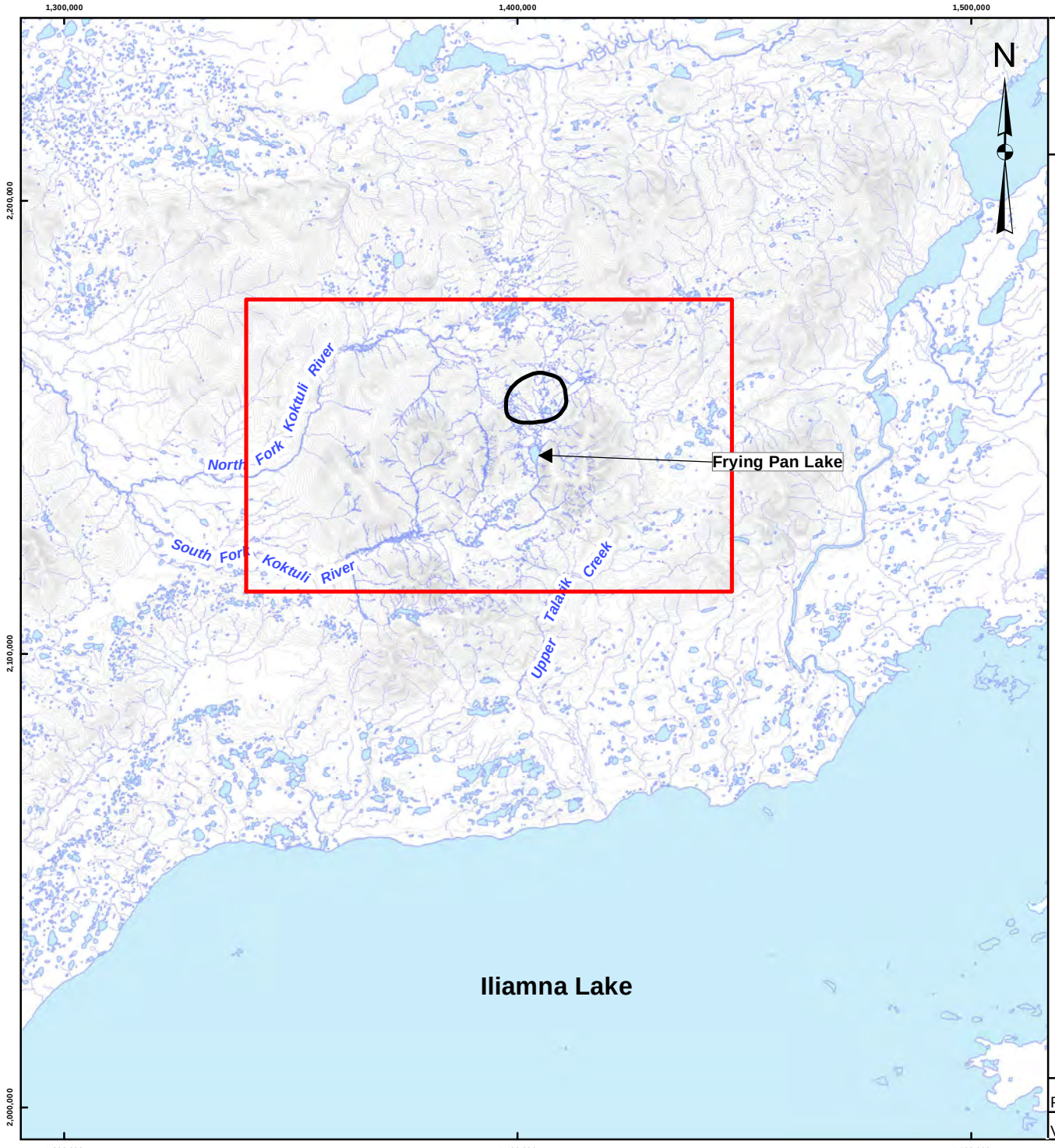
Key:

Aquifer Thickness = Saturated aquifer thickness
B = Leakage Factor (L)
ft = feet
ft^2/day = square feet per day
Kh = Horizontal Hydraulic Conductivity
Kv = Vertical Hydraulic Conductivity
m = meters
m/s = meters per second
m^2/s = square meters per second
m^2/day = square meters per day
r = Distance from pumping well to piezometer
S = Confined Aquifer Storativity
ß = dimensionless parameter of water table aquifer
Sy = Specific Yield
T = Transmissivity
usgpm = US gallons per minute

TABLE 8.1-7
Tritium Concentrations

Well ID	Sample Date	Sample ID	Lab ID	Result (TU)	Repeat (TU)
MW-1D	August 2005	0805MW1DWG001	113077	5.5 +/- 0.8	4.9 +/- 0.6
MW-1D	August 2005	0805MW1DWG201	113078	4.5 +/- 0.7	
MW-1M	August 2005	0805MW1MWG001	113079	4.8 +/- 0.7	
MW-1S	August 2005	0805MW1SWG001	113080	4.2 +/- 0.6	
MW-2D	August 2005	0805MW2DWG001	113081	5.2 +/- 0.7	
MW-3D	August 2005	0805MW3DWG001	113063	5.5 +/- 0.8	5.5 +/- 0.7
MW-5D	August 2005	0805MW5DWG001	113082	<0.8 +/- 0.5	
MW-5M	August 2005	0805MW5MWG001	113083	3.3 +/- 0.6	
MW-5S	August 2005	0805MW5SWG001	113084	3.9 +/- 0.6	
MW-6D	August 2005	0805MW6DWG001	113064	3.6 +/- 0.6	
MW-7D	August 2005	0805MW7DWG001	113065	4.7 +/- 0.7	
MW-7D	August 2005	0805MW7DWG201	113066	4.6 +/- 0.6	
MW-7S	August 2005	0805MW7SWG001	113067	5.9 +/- 0.9	
MW-8D	August 2005	0805MW8DWG001	113068	6.5 +/- 0.8	
MW-8M	August 2005	0805MW8MWG001	113069	4.9 +/- 0.7	
MW-8S	August 2005	0805MW8SWG001	113070	4.4 +/- 0.7	4.1 +/- 0.6
MW-9D	August 2005	0805MW9DWG001	113071	5.6 +/- 1.6	
MW-10	August 2005	0805MW10WG001	113057	4.6 +/- 0.6	
MW-11D	August 2005	0805MW11DWG001	113074	3.1 +/- 0.6	
MW-11M	August 2005	0805MW11MWG001	113075	4.1 +/- 0.6	
MW-11S	August 2005	0805MW11SWG001	113076	3.8 +/- 0.7	
MW-12D	August 2005	0805MW12DWG001	113058	10.1 +/- 0.8	
MW-12D	August 2005	0805MW12DWG201	113059	11.3 +/- 0.9	
MW-12S	August 2005	0805MW12SWG001	113060	4.7 +/- 0.7	
MW-13D	August 2005	0805MW13DWG001	113061	4 +/- 0.8	
MW-13S	August 2005	0805MW13SWG001	113062	4.4 +/- 0.7	
KP-P4	August 2005	0805KPP4WG001	113073	4.5 +/- 0.7	
SRK2	August 2005	0805SPK2WG001	113072	1.8 +/- 0.6	
SRK5D	August 2005	0805SRK5DWG001	113085	3.4 +/- 0.7	
SRK5M	August 2005	0805SRK5MWG001	113086	3.4 +/- 0.6	
SRK5S	August 2005	0805SRK5SWG001	113087	3.6 +/- 0.6	

FIGURES

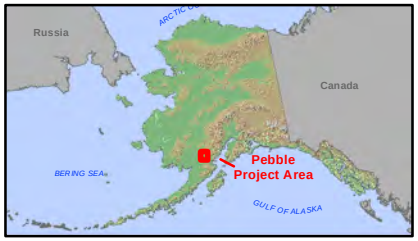


THE pebble PARTNERSHIP

Figure 8.1-1a
Mine Hydrogeology Study Area

Legend

- Study Area
- General Deposit Location
- Lakes
- Rivers
- 50 ft Contour Interval



Feet
0 15,000 30,000 45,000 60,000

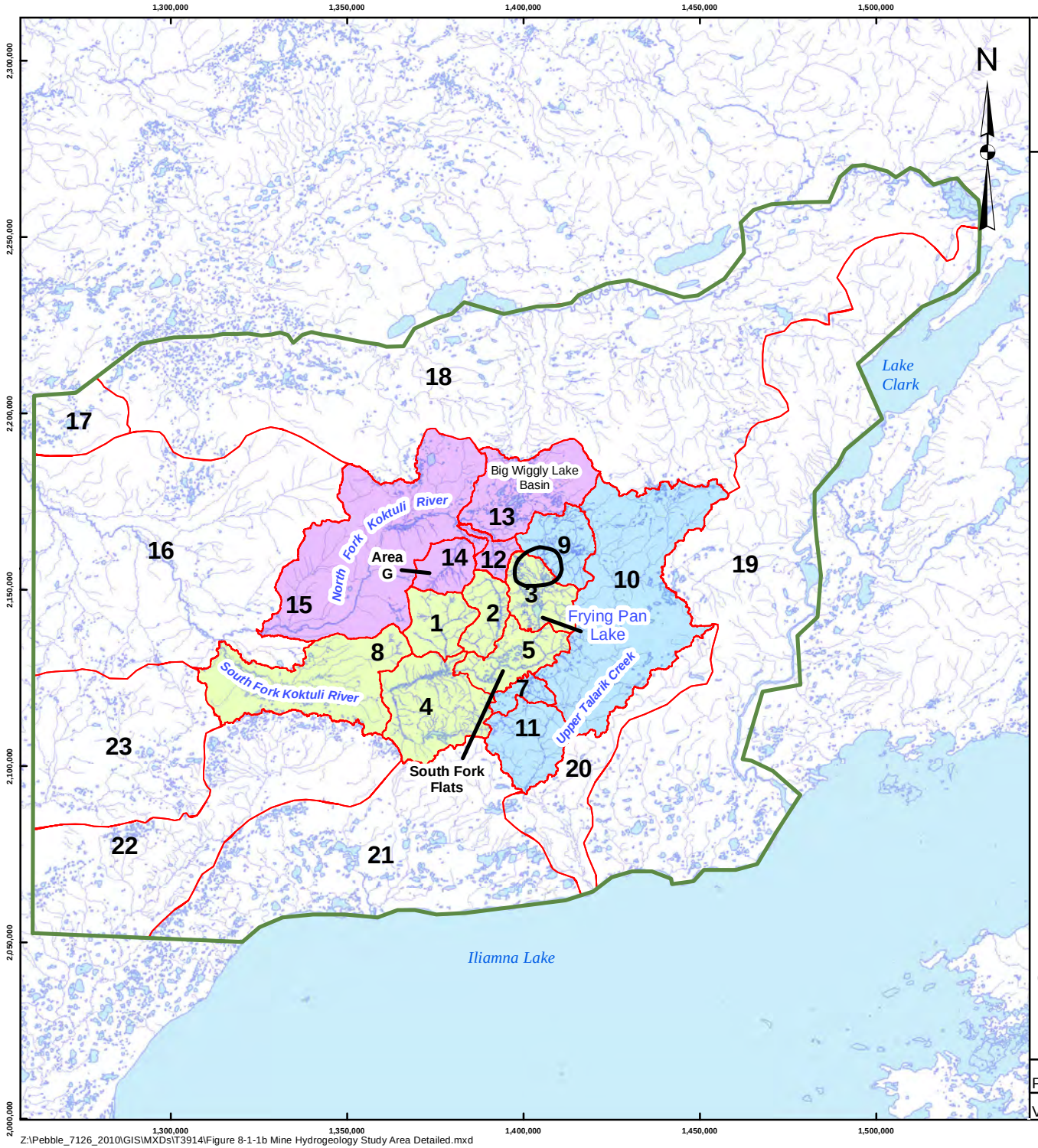
Meters
0 4,100 8,200 12,300 16,400 20,500

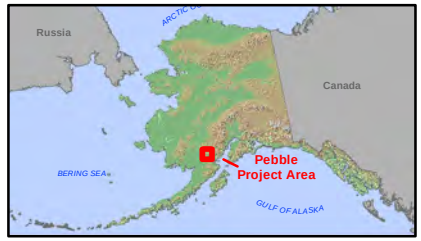
Scale 1:395,822

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Section_8.1\Figure 8.1-1 Mine Hydrogeology Study Area.mxd





THE pebble PARTNERSHIP

Figure 8.1-1b
Mine Hydrogeology Study Area - Detailed

Legend

- General Deposit Location
- Groundwater Model Boundary
- Subcatchment Areas
- Rivers
- Lakes

Watershed

- North Fork Koktuli River
- South Fork Koktuli River
- Upper Talarik Creek

Feet
0 20,000 40,000 60,000 80,000

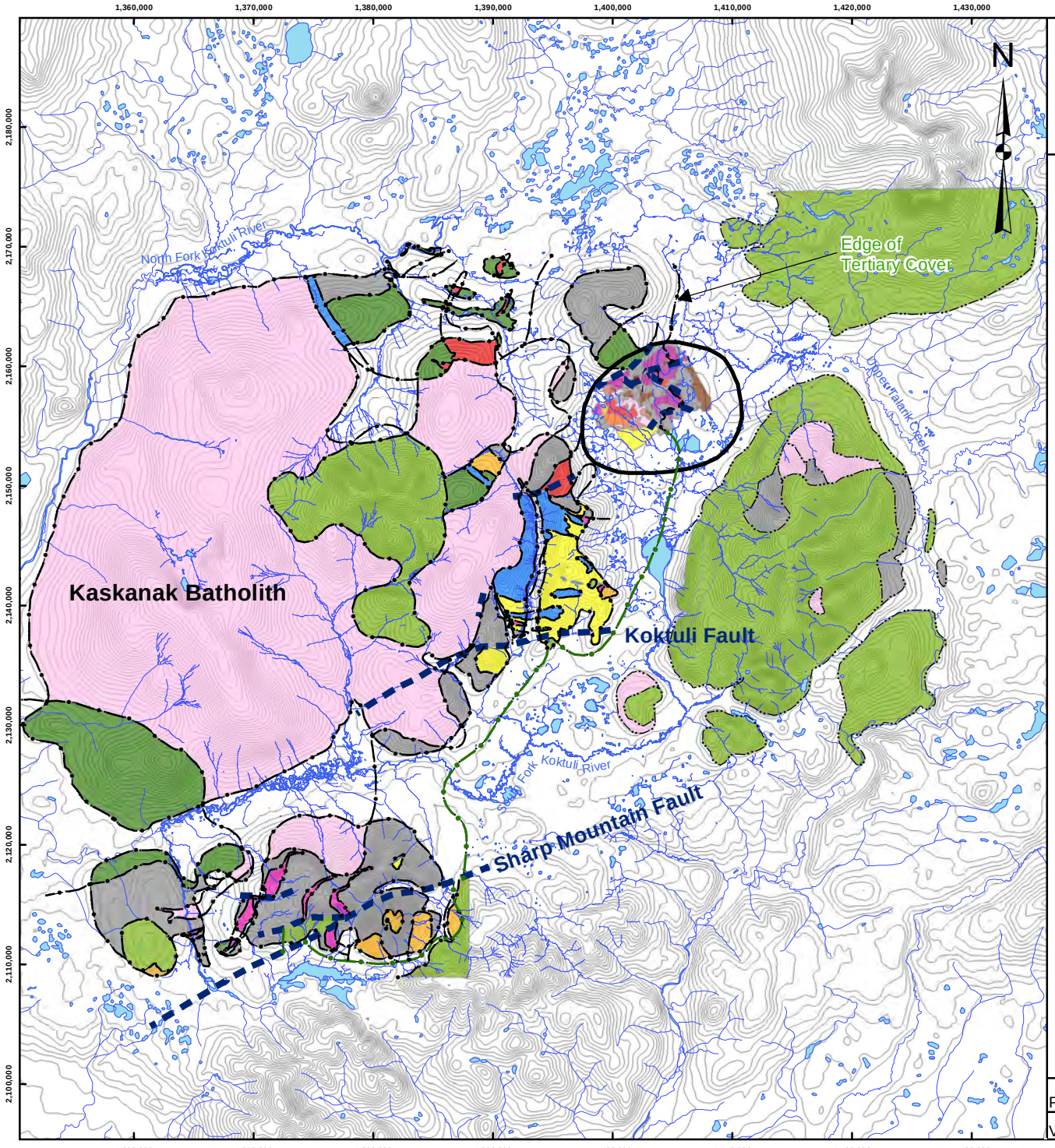
Meters
0 5,200 10,400 15,600 20,800 26,000

Scale 1:500,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3914\Figure 8-1-1b Mine Hydrogeology Study Area Detailed.mxd



THE pebble PARTNERSHIP

Figure 8.1-2
Bedrock Geology

Legend

- General Deposit Location

Tertiary

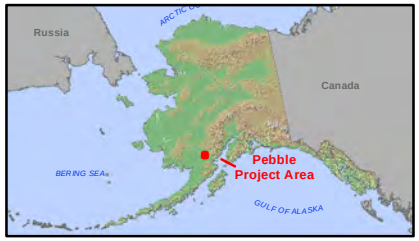
- Volcanic and Sedimentary Rocks

Cretaceous

- Quartz Monzodiorite, Granodiorite, porphyritic
- Monzodiorite, common K-feldspar megacrysts
- Monzodiorite, porphyritic locally with fragments of Pyroxenite
- Monzodiorite, south end of property
- Diorite
- Pyroxenite, locally brecciated
- Granodiorite, (Kaskanask batholith)

Jurrassic/Cretaceous

- Basalt Flow, Flow Breccia, Gabbro
- Conglomerate-Wacke interval
- Andesitic Mudstone, Siltstone
- Tertiary Cover
- River/Stream
- Faults
- Contour (50 Ft. Interval)



Feet
0 5,100 10,200 15,300 20,400 25,500

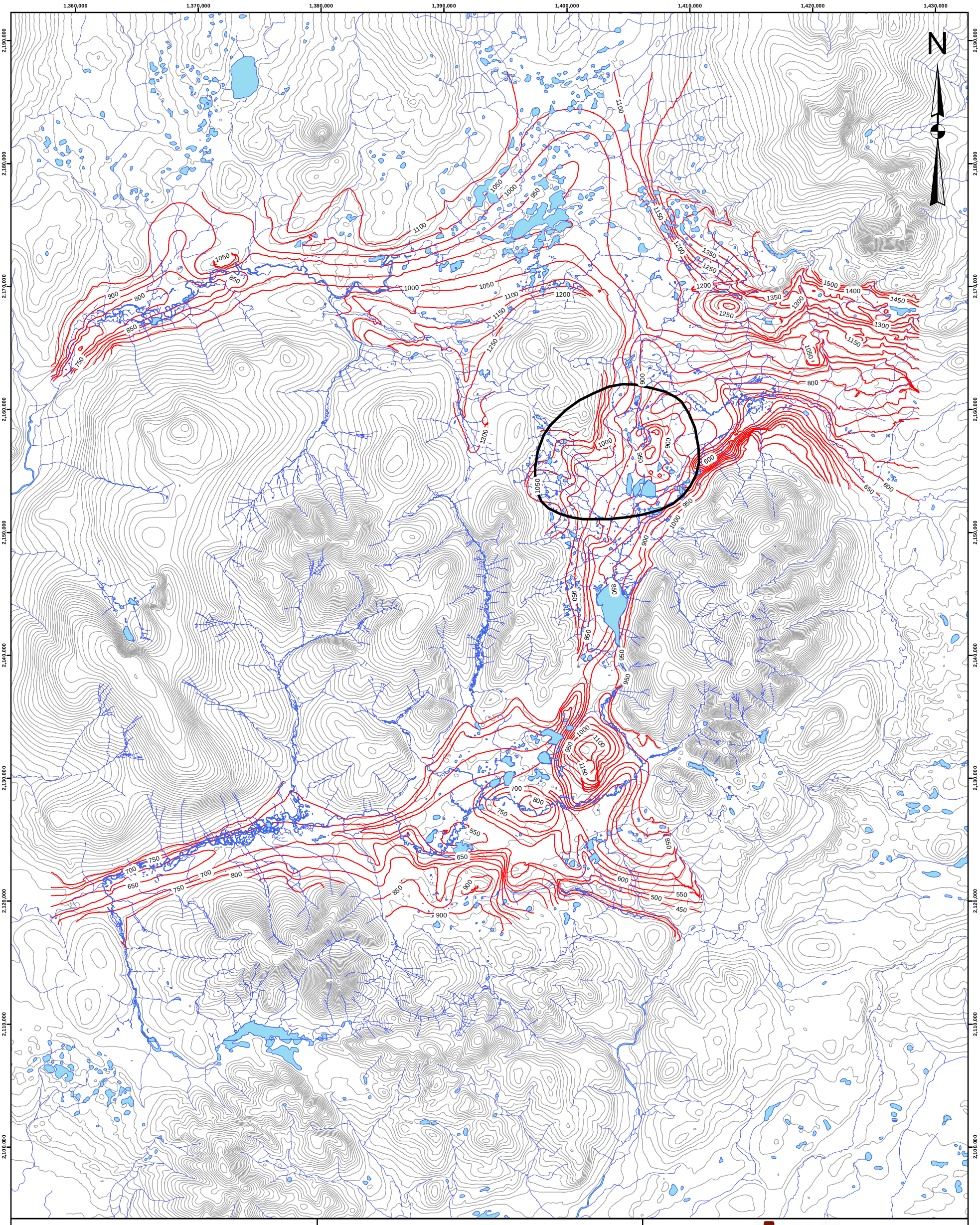
Meters
0 1,000 2,000 3,000 4,000 5,000

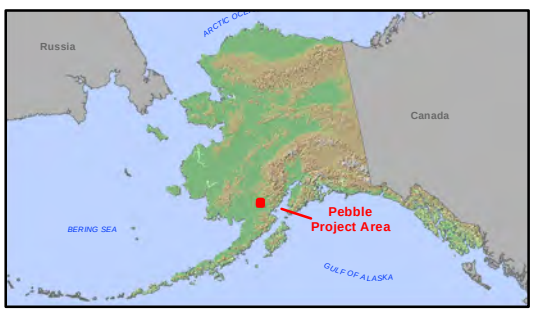
Scale 1:150,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3911\Figure 8-1-2 Bedrock Geology.mxd





Legend

- General Deposit Location
- Lake
- River
- Bedrock Contours (50 Ft. Interval)
- 50-ft Contour Interval

0 5,100 10,200 15,300 20,400 Feet

0 1,250 2,500 3,750 5,000 Meters

Scale 1:93,445

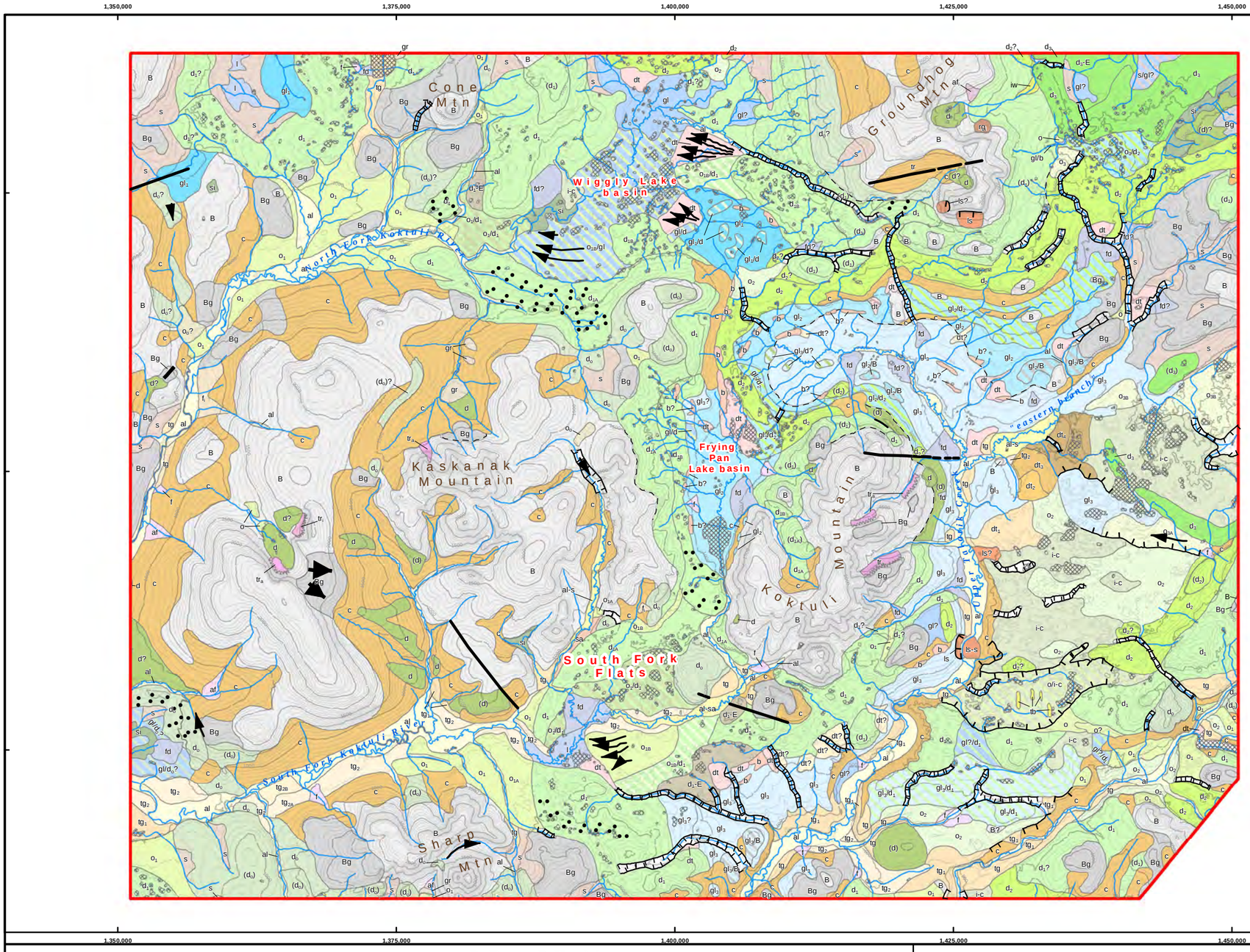
Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1-3a
Contours of
Top of Bedrock

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3912\Figure 8-1-3 Bedrock Contours.mxd

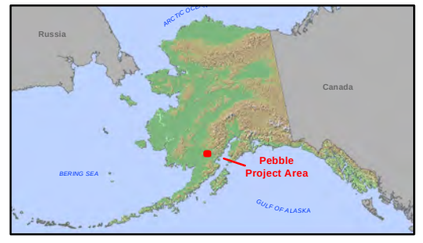


THE pebble PARTNERSHIP

Figure 8.1-3b
Surficial Geology

Legend

See Figure 8.1-3c



Feet
0 4,100 8,200 12,300 16,400 20,500

Meters
0 860 1,720 2,580 3,440 4,300

Scale 1:120,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS - BL
Version: 1	Date: April, 2011

THE pebble PARTNERSHIP

By Thomas D. Hamiltion
2007

Miles
0 0.3 0.6 1.2 1.8 2.4 3

Kilometers
0 0.30.6 1.2 1.8 2.4 3 3.6 4.2 4.8 5.4 6

Contour Interval 50 feet

Alaska State Plane Zone 5 (units feet) 1983 North American Datum **Digital representation by M.R. Anderson, RDI**

Digital files avaliable at www.pebblepartnership.com

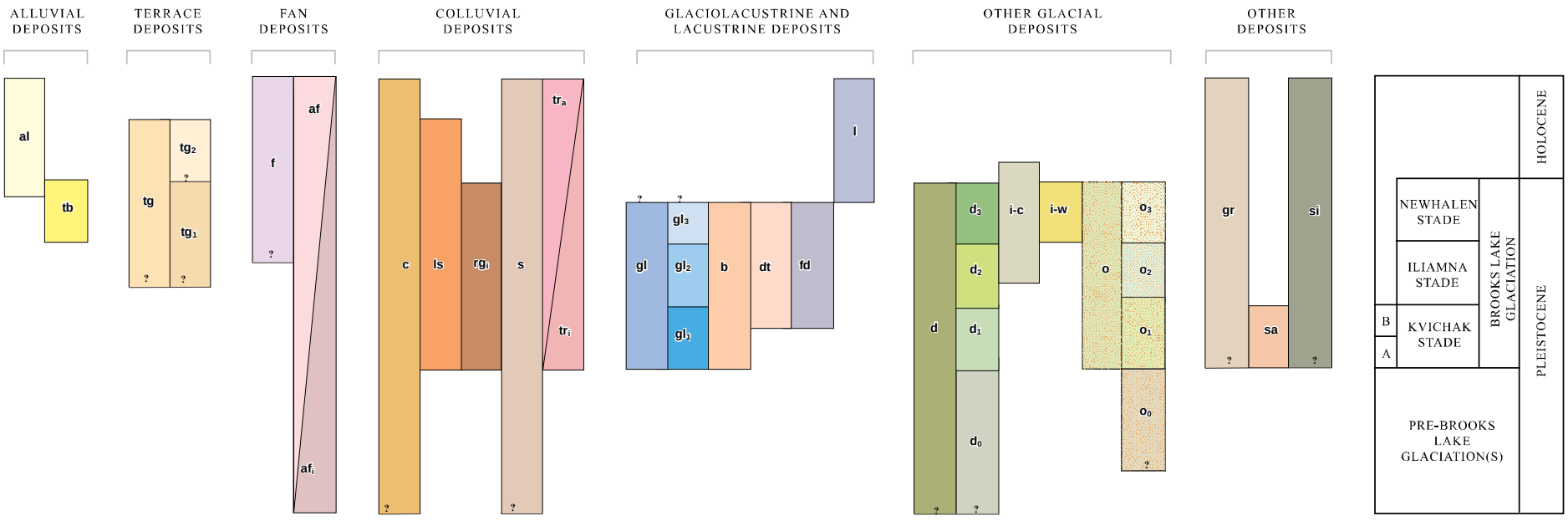
N

MAP SYMBOLS

- Direction of glacier flow across topographic divide
- Meltwater channel showing flow direction
- Crest of morainal ridge
- Contact - dashed where approximately located or inferred
- Probably fault line (no offsets noted)
- Scarp
- Drainage channel - abandoned or containing underfit stream
- Lake

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Section_8.1\Figure 8.1-3a - Surficial Geology

CORRELATION OF SURFICIAL MAP UNITS



BEDROCK SURFACE FORMS

B **Bedrock, undifferentiated**—May bear thin and discontinuous cover of rock rubble.

Bg **Bedrock, glaciated**—Bedrock smoothed and abraded by overriding glacier ice. Generally well exposed rock surfaces; commonly streamlined in direction of ice flow and channeled by glacial meltwater. Dispersed glacial erratic boulders and cobbles typically present.

ALLUVIUM

al **Alluvium, undivided**—Varies from moderately sorted, stratified, coarse gravel in upper valleys to muddy fine gravel or gravelly sand in depositional basins. Along smaller streams, unit includes fan, floodplain, and low terrace deposits that are too small to be designated separately.

Subunit **al-sa** designates alluvium in which sand dominates. Mapped only within South Fork Flats.

Subunit **al-s** designates alluvium in which silt dominates. Mapped only on east fork of Upper Talarik Creek and on stream that flows south into South Fork Flats.

tb **Transverse bars**—Alluvial gravel forming elongate deposits oriented normal to inferred former flow direction. Flanks facing downcurrent are steeper (20°-24°) than flanks facing upcurrent (14°-16°). Mapped only in broad west-trending outwash channel (map unit **o/i-c**) in southeast sector of map area.

TERRACE DEPOSITS

tg **Terrace gravel**—Alluvial gravel and sandy gravel, capped locally by floodplain deposits of silt, sand, or peat. Older terrace deposits commonly have thicker mantles of eolian silt or thaw-lake deposits.

Differentiated into $\mathbf{tg_1}$ (highest and oldest terrace) and $\mathbf{tg_2}$ (lower and younger terrace) where multiple terrace units present.

FAN DEPOSITS

f **Fan deposits**—Range from poorly sorted, weakly stratified, silty, sandy coarse gravel at mouths of mountain valleys to gravelly sand and silt within lowlands.

Subunit $\mathbf{f_i}$ designates inactive fan deposits, as described above. These generally stand above modern stream levels, and commonly are graded to river terraces that rise above modern floodplains.

af **Deposits of steep alpine fans**—Coarse, very poorly sorted, angular to subrounded silty sandy gravel at mouths of avalanche chutes and steep canyons. Upper segments generally channeled, with levees of angular to subangular coarse debris. Lower segments commonly littered with similar coarse debris. Subject to snow avalanches during winter, slushflows during spring snowmelt, and debris flows during heavy summer rainstorms. Surface gradients intermediate between talus cones and alluvial fans. Mapped only on west flank of Kaskanak Mountain block.

Subunit $\mathbf{af_i}$ designates steep alpine fan, as described above, that appears no longer active. Mapped only on east flank of Groundhog Mountain.

COLLUVIAL DEPOSITS

c **Colluvium, undivided**—Widespread slope deposits consisting of rock rubble on upper slopes grading downslope into rock debris mixed with finer sediment. Frost creep may dominate on upper slope segments; solifluction on lower slopes.

ls **Landslide deposits**—Very poorly sorted, nonstratified, coarse to fine angular rubble, commonly with matrix of finer debris. Forms lobes below detachment scars and slide tracks on steep rock walls. Commonly formed by rapid downslope movement followed by period of relative stability, but may alternatively form by slow and progressive creep. Recognized only on southeast corner of Groundhog Mountain block and along east side of Upper Talarik Creek.

Subunit **ls-s** designates slump deposits (nearly intact blocks of rock or debris formed by sudden or progressive downslope movements, commonly with rotational component. Mapped only along west side of Upper Talarik Creek in southeast part of map area.

rgi **Inactive rock-glacier deposit**—Very poorly sorted, nonstratified, coarse angular rock debris, with matrix of silt and fine rubble; formerly contained abundant interstitial ice. Frontal slope stable, gradually rounding back to upper surface. Mapped only near southeast corner of Groundhog Mountain block, where it forms lobate deposit at base of steep north-facing valley wall.

s **Solifluction deposits**—Slope deposits consisting of very poorly sorted, nonstratified to weakly stratified, stony silt and organic silt. Form smoothly graded, gently to moderately sloping sheets and aprons.

tr **Talus rubble, undivided**—Angular, unsorted rock debris, forming cones and aprons at bases of cirque headwalls and other steep bedrock slopes. Areas of active talus (unvegetated, unweathered to slightly weathered, with lichen cover sparse to absent) commonly are interspersed with vegetated talus that may have become stabilized following late Pleistocene (Brooks Lake) glaciation. Also forms thin and generally discontinuous sheets over many uplands mapped as "Bedrock".

Locally differentiated into $\mathbf{tr_a}$ (active talus) and $\mathbf{tr_i}$ (inactive talus), as described above, where these form sufficiently large mappable units.

GLACIOLACUSTRINE AND LACUSTRINE DEPOSITS

gl **Glacial-lake deposits, undifferentiated**—Stratified to weakly stratified silt, organic silt, and silty fine sand, commonly with dispersed dropstones. Grades into gravelly sand to sandy fine gravel near former stream mouths. Marked by smooth and poorly drained surface morphology, with sharp upper limit that coincides with beach and delta deposits (as described below). Mapped as compound unit (for example, **gl/d**) where drapes or overlies bedrock or other glacial deposits.

gl3 **Glacial-lake deposits, youngest**—Glacial-lake deposits, as described above, rising to altitudes of 800-850 ft above sea level (asl) along Upper Talarik Creek, and to about 900 ft asl along the Talarik's east and west forks. Postdate Iliamna-stade glaciation; persisted into Newhalen stade.

gl2 **Glacial-lake deposits, intermediate age**—as described above. Rise to altitudes of about 900 ft asl along Upper Talarik Creek near south margin of map and 1050 ft asl farther north along Upper Talarik Creek, in proposed Pit Area, and in basin north of Frying Pan Lake. Accompanied Iliamna-stade glaciation, and persisted during deglaciation.

gl1 **Glacial-lake deposits, oldest**—Glacial-lake deposits, as described above, rising to altitudes of about 1150 ft asl in Wiggly Lake area. A smaller remnant may also occur on northwest flank of basin that extends north from Frying Pan Lake. Accompanied Kvichak-stade glaciation, and persisted during deglaciation.

b **Beach deposits**—Moderately well sorted gravelly sand or sandy fine gravel. Forms ridges parallel to topographic contours along upper margins of glacial-lake deposits; their steepest flanks face lake basin. Wave-abraded platform with dispersed relict glacial boulders commonly lies beyond beach face, with platform and beach face meeting at sharp angle.

dt **Deltaic deposits**—Well sorted to very well sorted sand to sand with fine gravel. Form lobes with axes normal to topographic contours that extend across margins of former glacial-lake deposits. Where preserved, surface channels have digitate pattern. Generally border modern streams or abandoned meltwater channels. Queried where interpreted from aerial photographs but not field checked.

Subunits $\mathbf{dt_1}$, $\mathbf{dt_2}$, $\mathbf{dt_3}$, and $\mathbf{dt_4}$ are successively lower deltaic deposits built into moraine-dammed lake near junction of east and west forks of Upper Talarik Creek as lake level progressively lowered from 880 to 770 ft asl.

fd **Fan-delta deposits**—Alluvial-fan deposits (as described in unit **f**) that grade downslope into deltaic and lacustrine facies (as described in units **dt** and **gl**). Generally have fan-shaped surface form, but distal (lower) segment is broader, more poorly drained, and more gently sloping than normal alluvial fan.

l **Lake deposits**—Silt and silty fine sand, stratified to weakly stratified. Probably of postglacial (Holocene) age. Mapped only on floor of South Fork Flats and near northwest corner of map area.

OTHER GLACIAL DEPOSITS

d **Drift, undifferentiated**—Unsorted to poorly sorted, generally nonstratified, compact till ranging in composition from muddy gravel to sandy coarse gravel. Contains local stratified ice-contact meltwater deposits consisting of moderately sorted sand and sandy gravel. Pebbles and small cobbles generally dominant, but faceted and striated stones up to boulder size are generally dispersed throughout deposit. Surface morphology commonly includes morainal ridges, dry and water-filled kettle depressions, conical to subdued mounds, and meltwater channels.

d3 **Drift of Brooks Lake glaciation, Newhalden stade**—Glacial deposits, as described above. Moraines sharp crested, with irregular topography little modified by weathering or erosion. Forms arcuate end moraines in northeast corner of map area and near its east-central margin.

d2 **Drift of Brooks Lake glaciation, Iliamna stade**—Glacial deposits, as described above. Moraine crests irregular, but generally less sharp than those of Newhalen Stade. Forms large crescentic end moraine north of Frying Pan Lake basin that encloses proposed Pit Area and is traceable farther east along south and southeast flanks of Groundhog Mountain block. Other end moraines occur north of Wiggly Lake basin at north-central margin of map area and at southeast corner of map area.

d1 **Drift of Brooks Lake glaciation, Kvichak stade**—Glacial deposits, as described above. Moraine crests more subdued than those of younger Brooks Lake stades, and drift is more eroded on mountainsides. Form extensive end moraines that (1) cross North Fork Koktuli River near its head, (2) enclose South Fork Flats, and (3) extend west-southwest to Upper Talarik Creek in southeast sector of map area. A small portion of the massive Kvichak moraine around Iliamna Lake extends into extreme southwest corner of map area.

Subunits $\mathbf{d_{1A}}$ (older) and $\mathbf{d_{1B}}$ (younger) differentiated west and south of Frying Pan Lake and in Wiggly Lake area. The younger subunit, a recessional moraine, dams Frying Pan Lake.

Subunit $\mathbf{d_1}$**-E** designates areas of Kvichak-Stade drift that have been eroded by an uncertain agent (either flowing meltwater or wave action along margin of glacial lake).

do **Drift of pre-Brooks Lake age**—Highly modified glacial deposits, generally remaining only as thin and discontinuous patches of drift on uplands beyond limits of younger glacial advances. A conspicuous moraine segment north of South Fork Koktuli River near southwest corner of map area was deposited by a glacier that expanded northward from Iliamna Lake area and dammed the South Fork. Drift and (or) outwash may also have dammed North Fork of Koktuli River at this time.

i-c **Ice-contact meltwater deposits**—Meltwater-washed sand and gravel deposited in contact with stagnating glaciers. Commonly forms conical to subdued mounds with well drained surfaces interspersed with dry and water-filled kettle depressions and abandoned meltwater channels.

iw **Inwash deposit**—Alluvial sand and gravel, commonly with interstratified silt, deposited where stream partly dammed against moraine flank. Mapped only on east flank of Groundhog Mountain at western edge of Newhalen stade drift (unit $\mathbf{d_3}$).

o **Outwash, undifferentiated**—Moderately well sorted and stratified sandy gravel forming broad aprons and elongate valley trains in front of moraines, and also terrace remnants farther downvalley. Largest stones decrease in size downvalley from large cobbles and very small boulders near moraine fronts to pebble-small cobble gravel in more distal locations.

o3 **Outwash associated with drift of Newhalen stade**—Gravel aprons and valley trains, as described above. Associated with moraines of Newhalen stade in northeast and east-central sectors of map area.

Subunits $\mathbf{o_{3A}}$ and $\mathbf{o_{3B}}$ differentiate outwash generated during maximum Newhalen advance (o_{3A}) from recessional outwash that formed during glacier retreat (o_{3B}).

o2 **Outwash associated with drift of Iliamna stade**—Valley train, as described above. Mapped only in southeast sector of map area, where broad terrace remnants extend west-southwest toward Upper Talarik Creek from end moraines near southeast corner of map.

o1 **Outwash associated with drift of Kvichak stade**—Extensive outwash aprons and valley trains, as described above. Mapped within and west of South Fork Flats and west of Wiggly Lake at head of North Fork drainage. Also associated with Kvichak moraine in extreme southwest corner of map area.

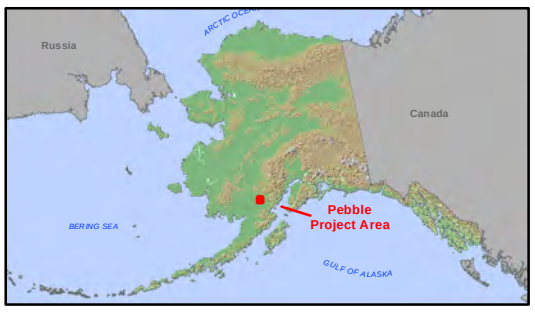
Subunits $\mathbf{o_{1A}}$ (older) and $\mathbf{o_{1B}}$ (younger) are differentiated only southwest of Frying Pan Lake and in South Fork Flats, where they are related to older and younger end moraines of Kvichak stade.

OTHER DEPOSITS

gr **Gravel, undifferentiated**—Isolated, gravelly erosion remnants of uncertain composition and origin. Mapped primarily in north-trending valley that bisects Koktuli Mountain block.

sa **Sand deposits, undifferentiated**—Well sorted fine to medium sand of uncertain origin near north margin of South Fork Flats.

si **Silt, ice-rich**—Poorly drained areas on lowlands that contain abundant small ponds interpreted as thaw lakes. Common on floors of lake basins in proposed Pit Area and north of Wiggly Lake, where they generally are not differentiated from glaciolacustrine deposits.



THE pebble PARTNERSHIP

Figure 8.1-3c
Surficial Geology Legend
(see Figure 8.1-3b)

Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Section 8.1 Hydrogeology Figures\Figure 8.1-3b - Surficial Geology Legend

THE pebble PARTNERSHIP

Figure 8.1-4
Locations of Hydrogeologic Investigations

Legend

Location Type (Prefix)

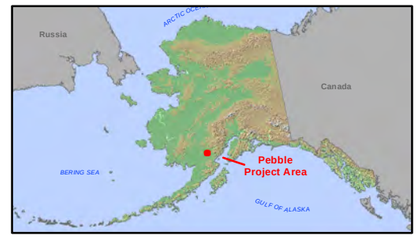
- Piezometer (P, GH, I, M)
- Monitoring Well (MW)
- Pumping Well (PW)
- Stream Gaging Station
- Seep Sampling Locations
- General Deposit Location
- Lakes
- Rivers
- 2004 Seismic Lines
- 2005 Seismic Lines
- Cross Section Line
- 50-ft Contour Interval

Key: Well Name

Watershed

- North Fork Koktuli River
- South Fork Koktuli River
- Upper Talarik Creek

Note: For explanation of well names please refer to Section 8.1.6.1 of the report



0 5,100 10,200 15,300 20,400 Feet

0 1,000 2,000 3,000 4,000 5,000 Meters

Scale 1:82,500

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

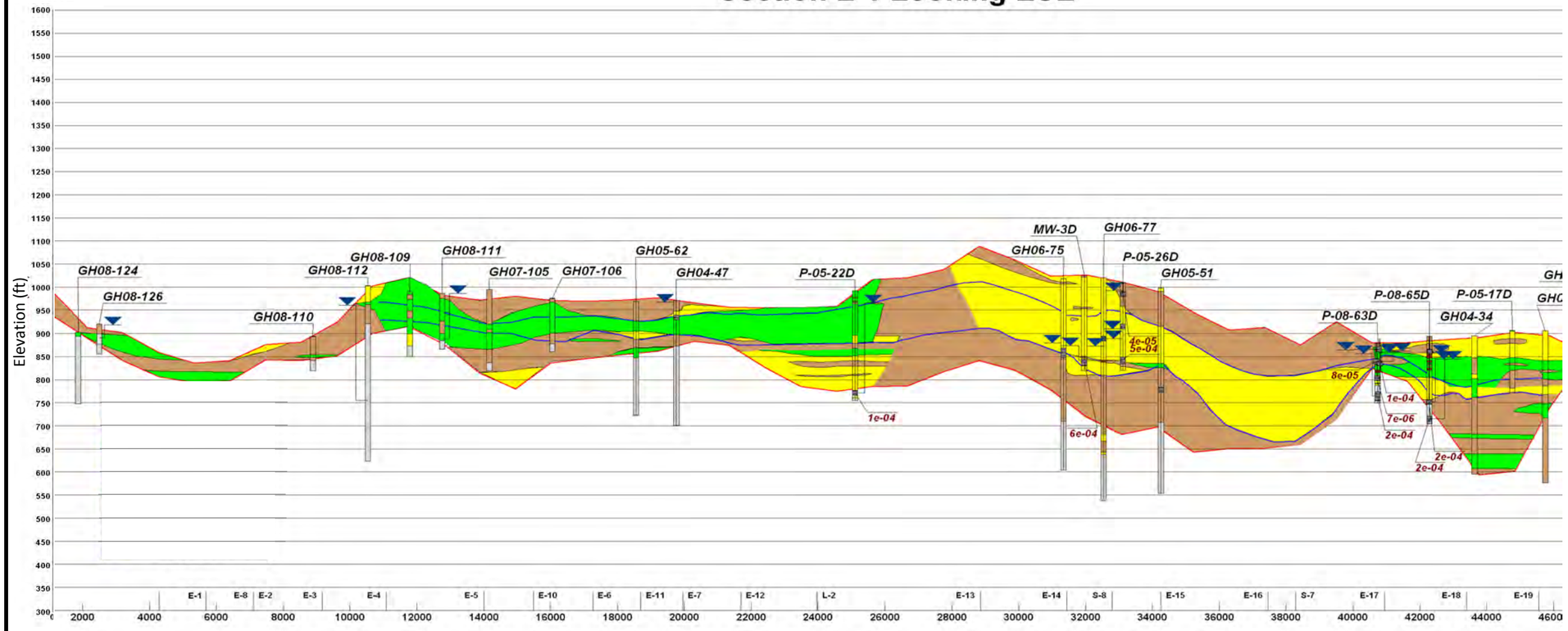
Project No: 7126	Author: SWS-BL
Version 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3915\Figure 8-1-4 Locations of Hydrogeologic Investigations.mxd

Section L-1 Looking ESE

NNE

SSW



Cross-Section Distance (ft)

THE pebble PARTNERSHIP

Figure 8.1-5
Longitudinal Hydrogeologic
Cross Section

Legend

Lithology

- sand, silty sand
- clay, silty clay
- gravel, gravelly sand
- no recovery
- bedrock
- weathered bedrock

Water level elevation (data from October, 2008)

Model Layer Surfaces

4e-06 Hydraulic Conductivity (m/s)

Screened Interval

GH05-62 Well Name

E-13 Intersecting Cross-Section

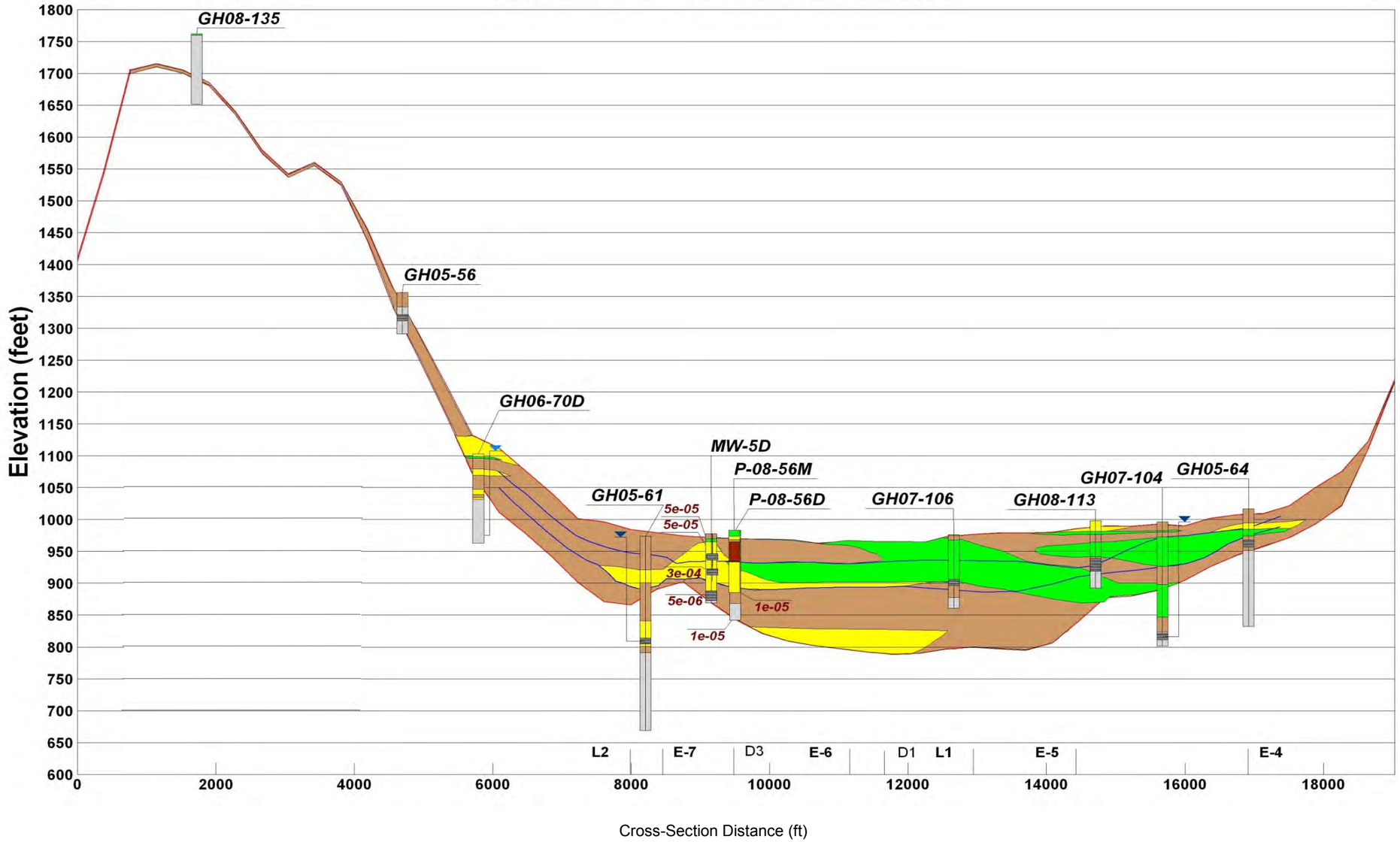


Project No: 7126	Author: SWS-KB
Version: 1	Date: April , 2010

Section E-10 Looking Northwest

SW

NE



THE pebble PARTNERSHIP

Figure 8.1-6
Cross Section E10 - Pebble Deposit Area

Legend

Lithology

- sand, silty sand
- clay, silty clay
- gravel, gravelly sand
- no recovery
- bedrock
- weathered bedrock

Water level elevation (data from October, 2008)

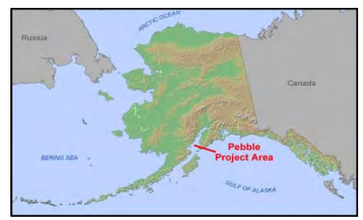
Model Layer Surfaces

4e-06 Hydraulic Conductivity (m/s)

Screened Interval

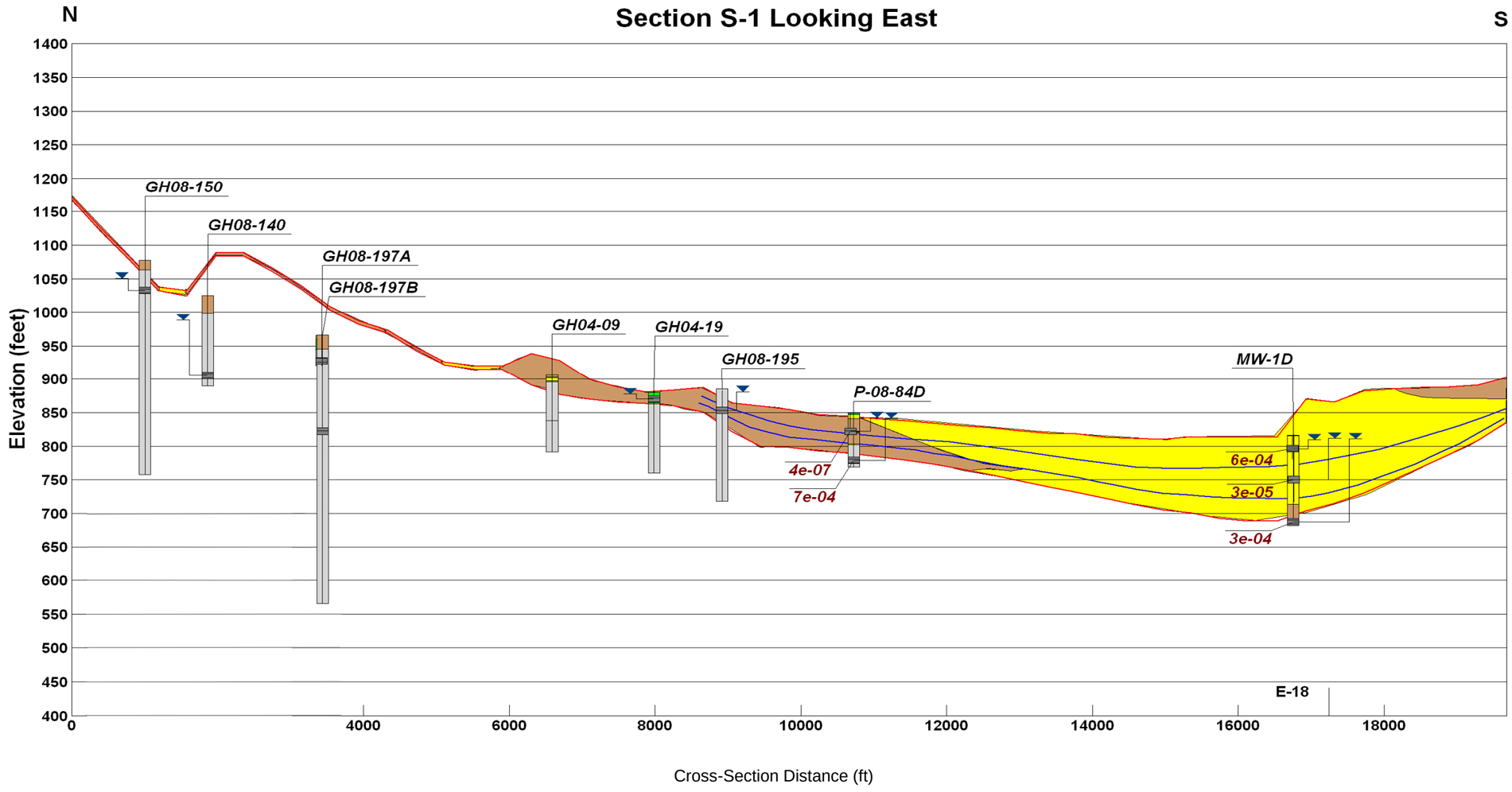
GH05-62 Well Name

E-13 Intersecting Cross-Section



Project No: 7126	Author: SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3917\Figure 8.1-6 Cross Section E-10 - Pit Area.xlsx



THE pebble PARTNERSHIP

Figure 8.1-7
Cross Section S-1
South Fork Koktuli Discharge Area

Legend

Lithology

- sand, silty sand
- clay, silty clay
- gravel, gravelly sand
- no recovery
- bedrock
- weathered bedrock

Water level elevation (data from October, 2008)

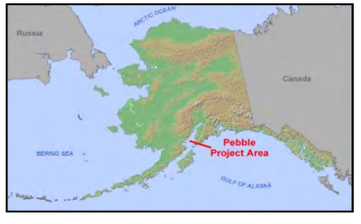
Model Layer Surfaces

4e-06 Hydraulic Conductivity (m/s)

Screened Interval

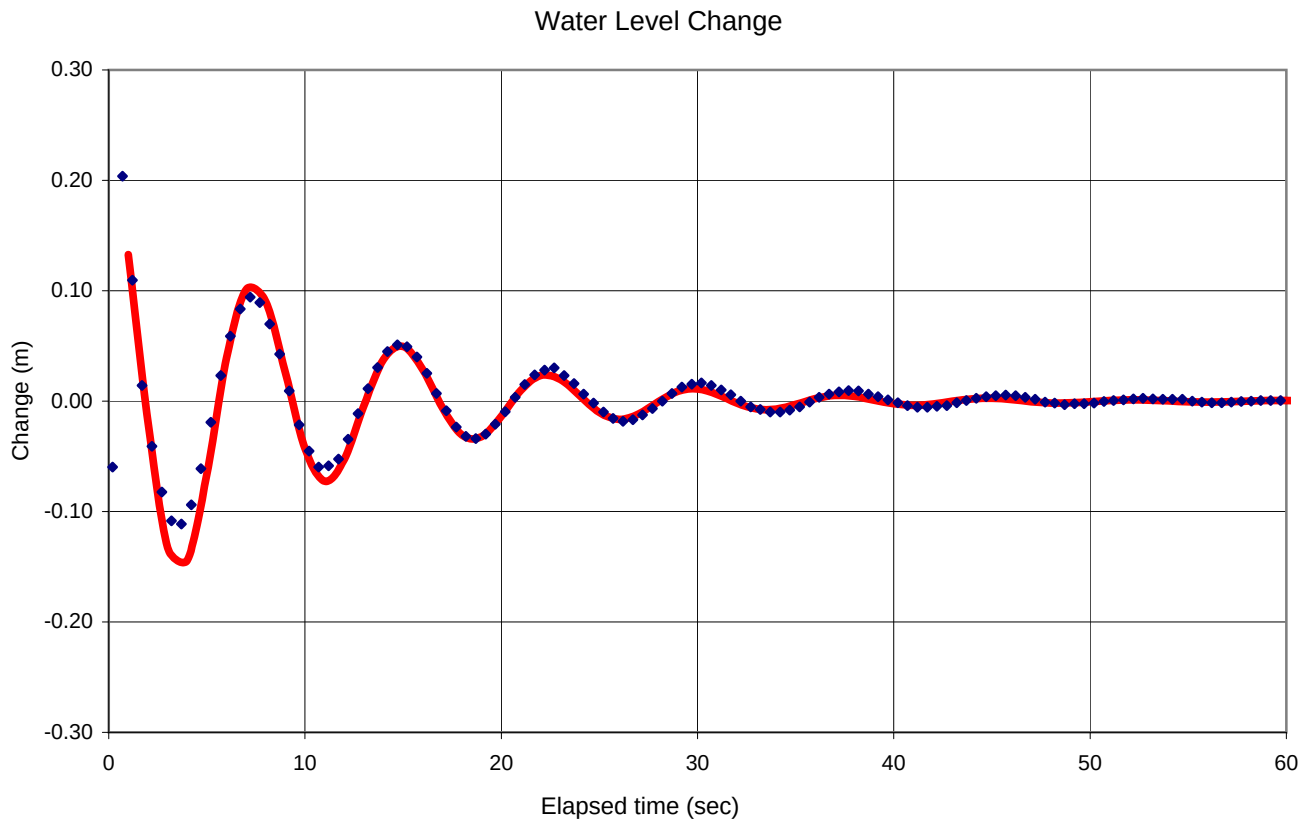
GH05-62 Well Name

E-13 Intersecting Cross-Section



Project No: 7126	Author: SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3918\Figure 8.1-7 Cross Section S-1 - South Fork Koktuli Discharge Area.pdf



THE pebble PARTNERSHIP

Figure 8.1-8a
Underdamped Response Test
P-08-62M

Legend

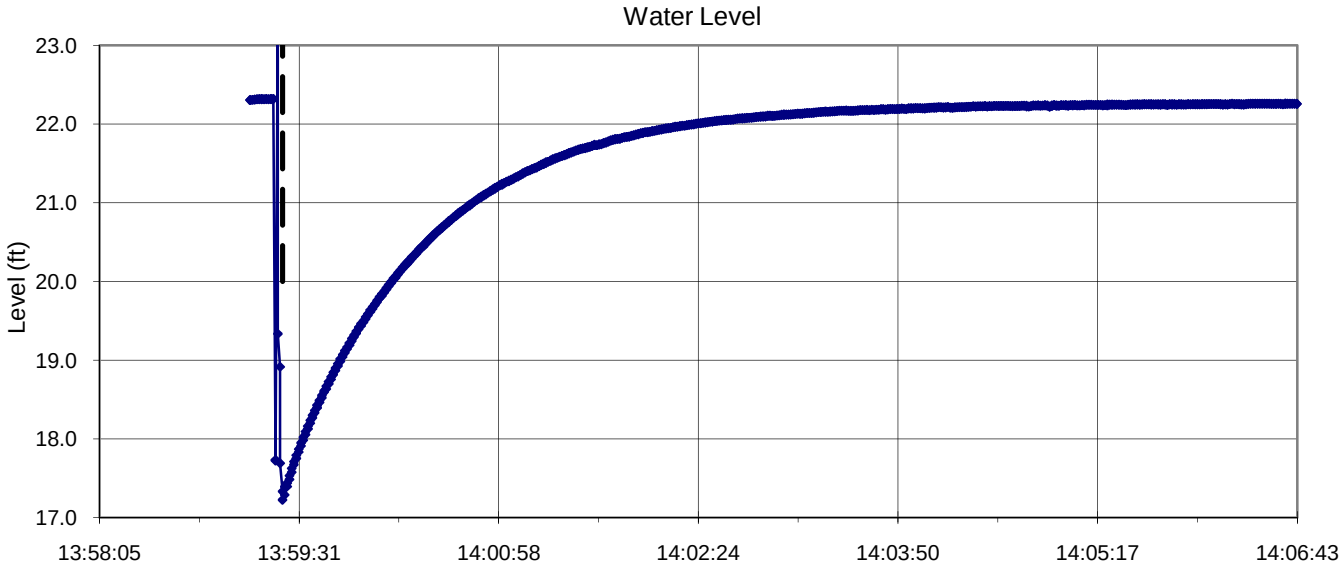
Data

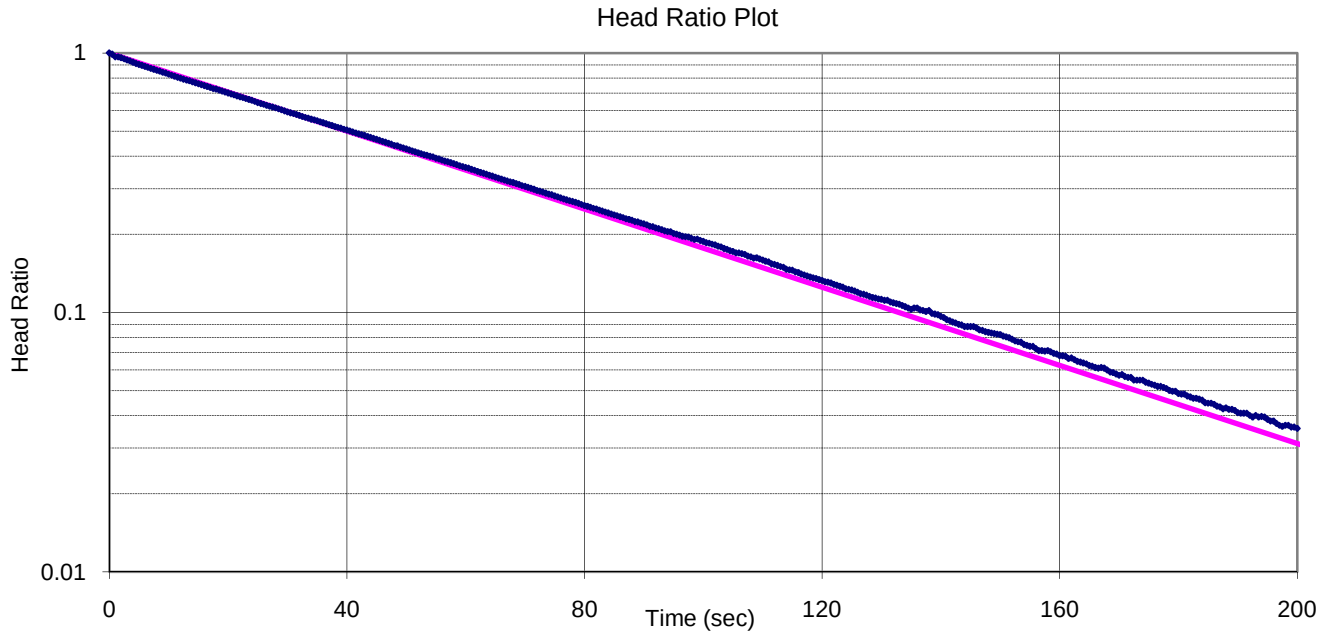
Calculated Response



Project No: 7126	Author: WMC-AUB
Version: 1	Date: May 25, 2010

Z:\Pebble_7-075\reporting\WMC 2009 EBD\Section 8.1 Hydrogeology Figures\sub files\Figure 8.1-8a Underdamped Response Test P-08-62M.xls





THE pebble PARTNERSHIP

Figure 8.1-8b
Overdamped Response Test
P-08-55D

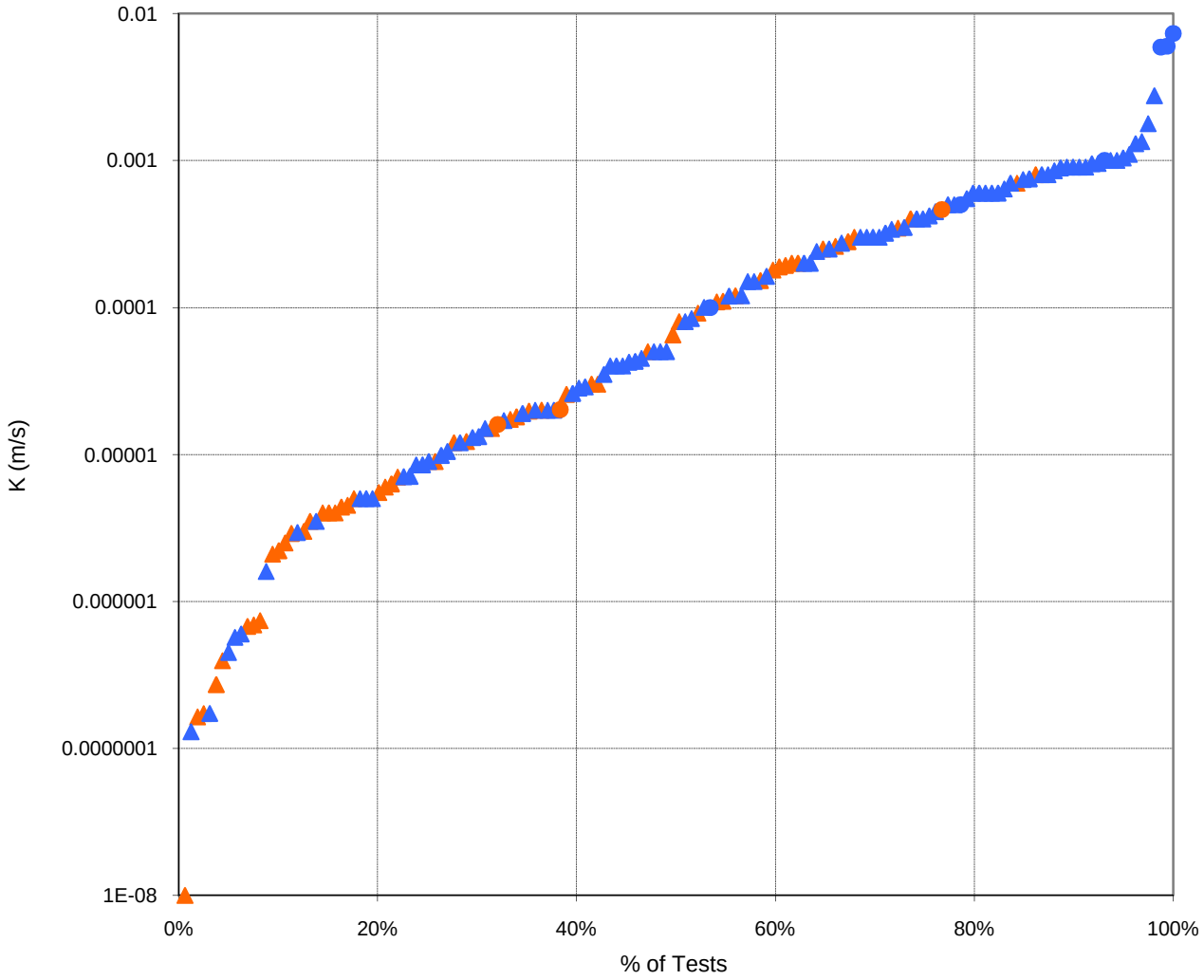
Legend

- Data
- Hvorslev Plot
- Test Start



Project No: 7126	Author: SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3919\Figure 8.1-8b Overdamped Response Test P-08-55D.xlsx

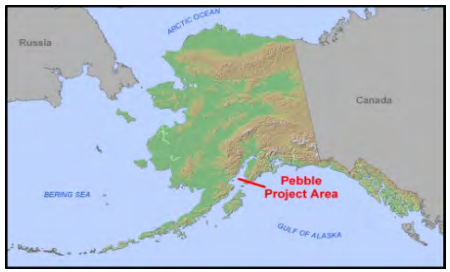


THE pebble PARTNERSHIP

Figure 8.1-9a
Cumulative Frequency of Calculated Hydraulic Conductivity

Legend:

- Pumping test - bedrock
- Pumping test - overburden
- Response test - bedrock
- Response test - overburden

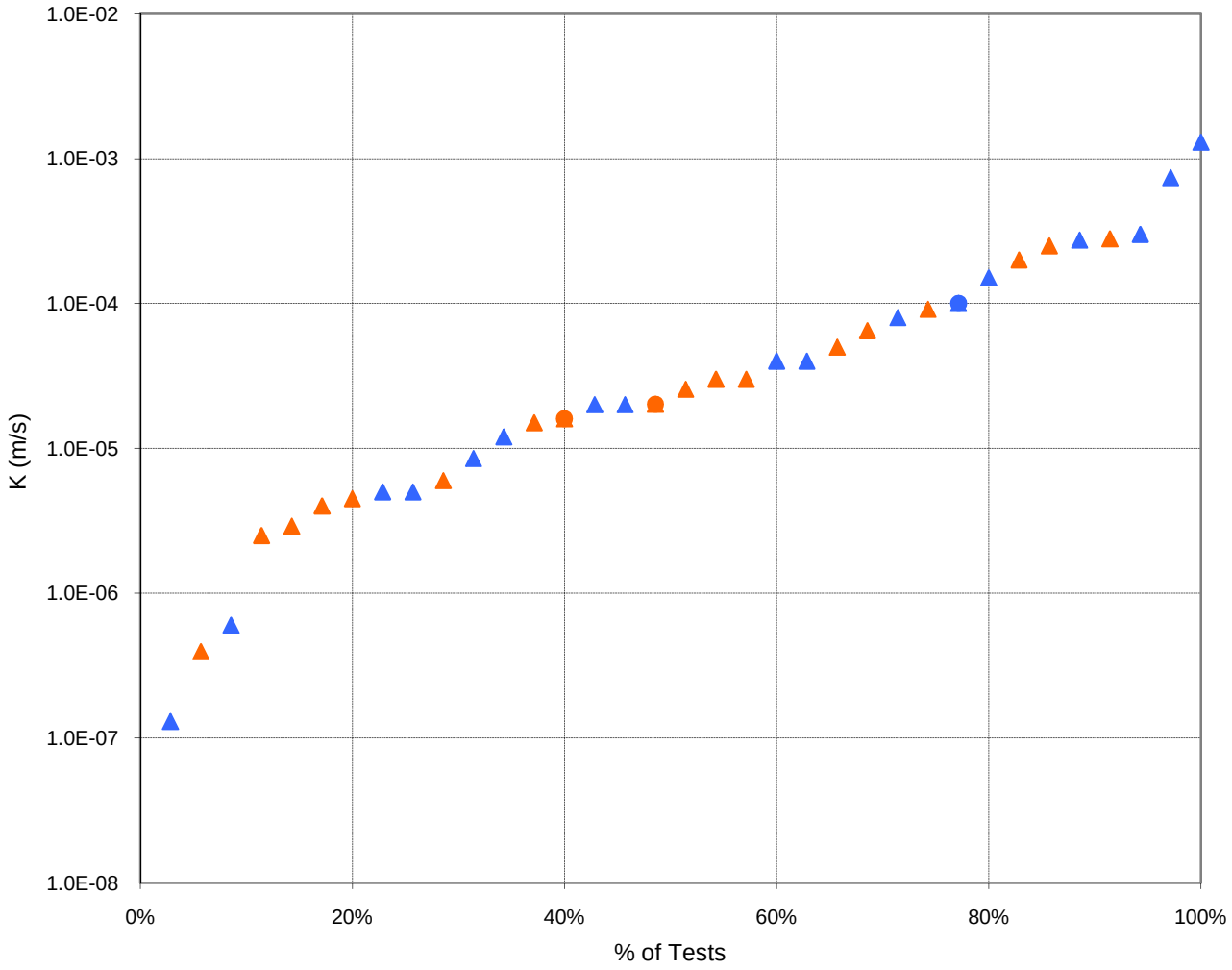


Project No: 7126	Author: WMC-LC
Version: 1	Date: April, 2011

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Section 8.1 Hydrogeology Figures\Figure 8.1-9 Cumulative Frequency of Calculated Hydraulic Conductivity.xls

Cumulative Frequency of Hydraulic Conductivity

Pebble Project, Response and Pumping Test Results 2008 - Deposit Area

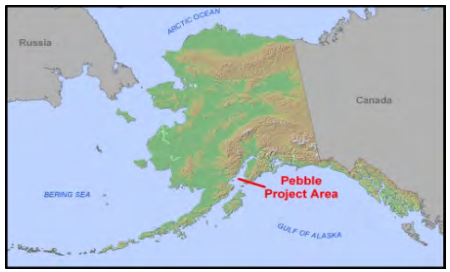


THE pebble PARTNERSHIP

Figure 8.1-9b Cumulative Frequency of Calculated Hydraulic Conductivity in General Pebble Deposit Area

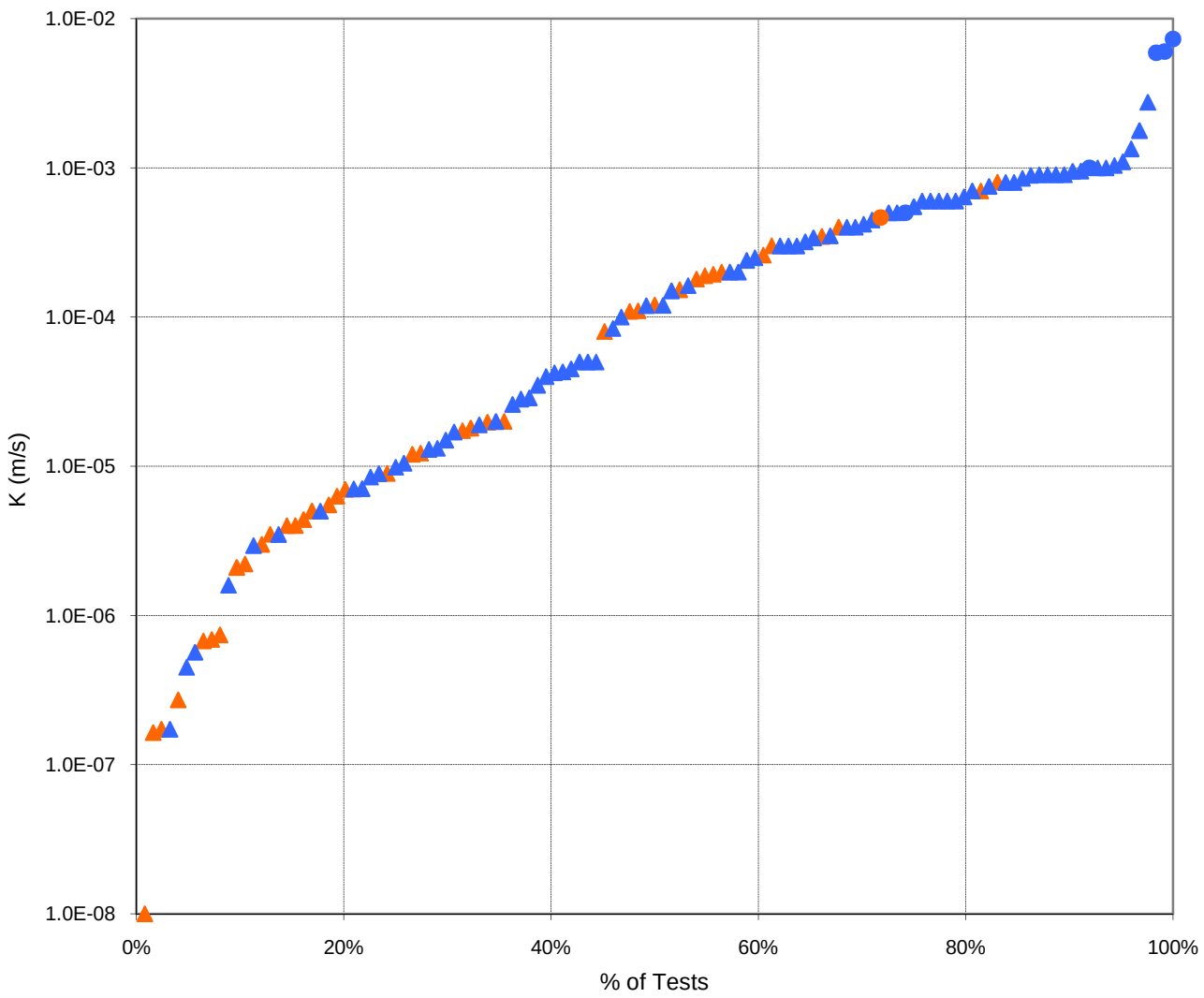
Legend:

- Pumping test - bedrock
- Pumping test - overburden
- Response test - bedrock
- Response test - overburden



Project No: 7126	Author: WMC-LC
Version: 1	Date: April, 2011

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Section 8.1 Hydrogeology Figures\Figure 8.1-9 Cumulative Frequency of Calculated Hydraulic Conductivity.xls

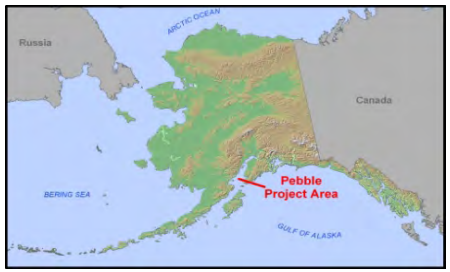


THE pebble PARTNERSHIP

Figure 8.1-9c Cumulative Frequency of Calculated Hydraulic Conductivity Outside of General Pebble Deposit Area

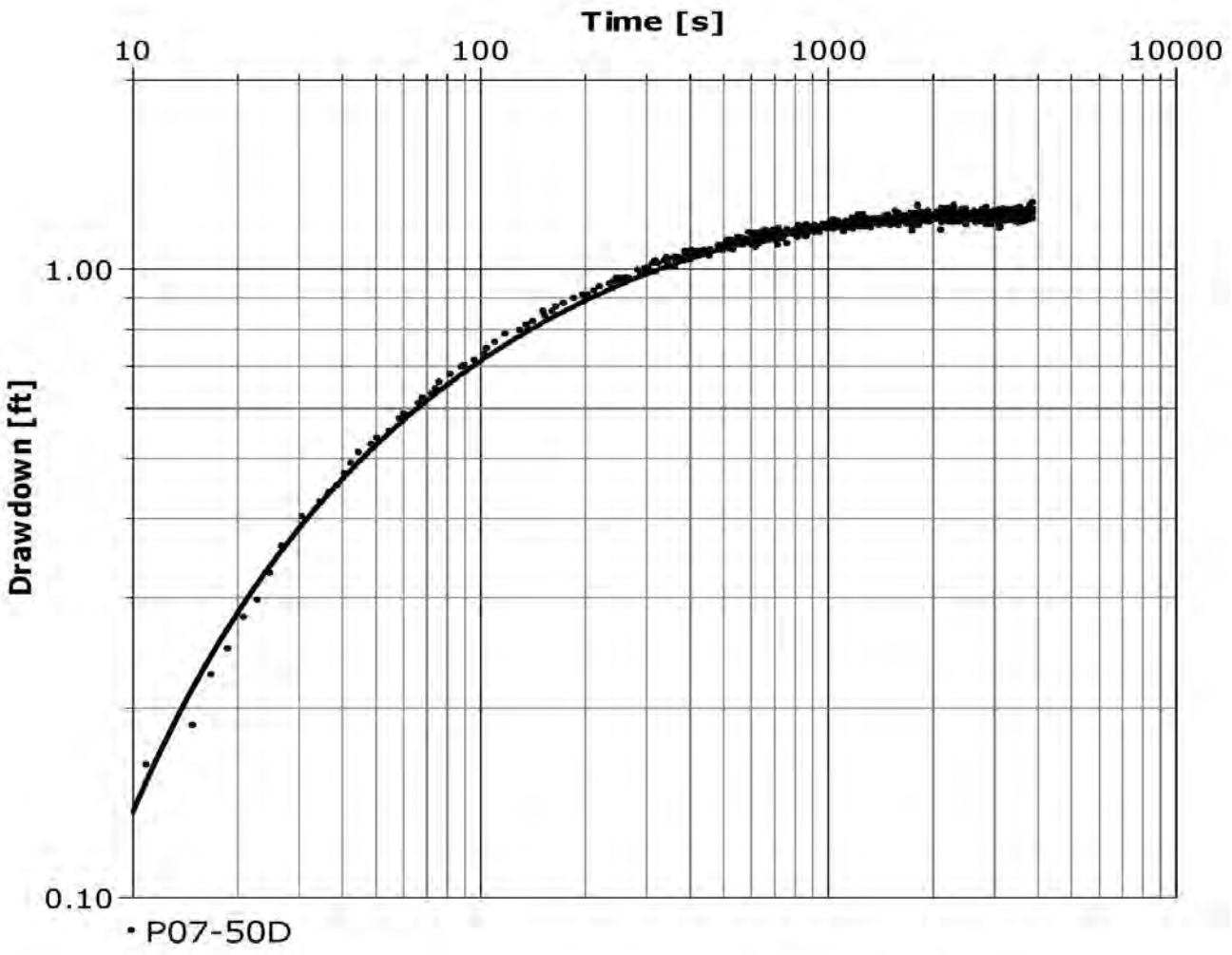
Legend:

- Pumping test - bedrock
- Pumping test - overburden
- Response test - bedrock
- Response test - overburden

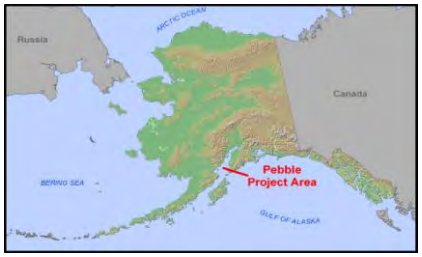


Project No: 7126	Author: WMC-LC
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3922\Figure 8.1-9c Cumulative Frequency of Calculated Hydraulic Conductivity Outside of General Deposit Area.xlsx



Pumping Well:	PW-08-10	**Transmissivity (m^2/s):**	3.6×10^{-3}
Observation Well:	P07-50D	**Aquifer Thickness (m):**	33
Test Date:	7/15/2008	**Aquifer K (m/s):**	1.1×10^{-4}
Pumping Rate (m^3/s):	5.3×10^{-3}	**Aquifer K_v/K_h:**	1.5×10^{-3}
Pumping Method:	Airlift	**Aquifer S:**	5.0×10^{-4}
Analysis Method:	Neuman	**Aquifer S_y:**	0.045



Legend

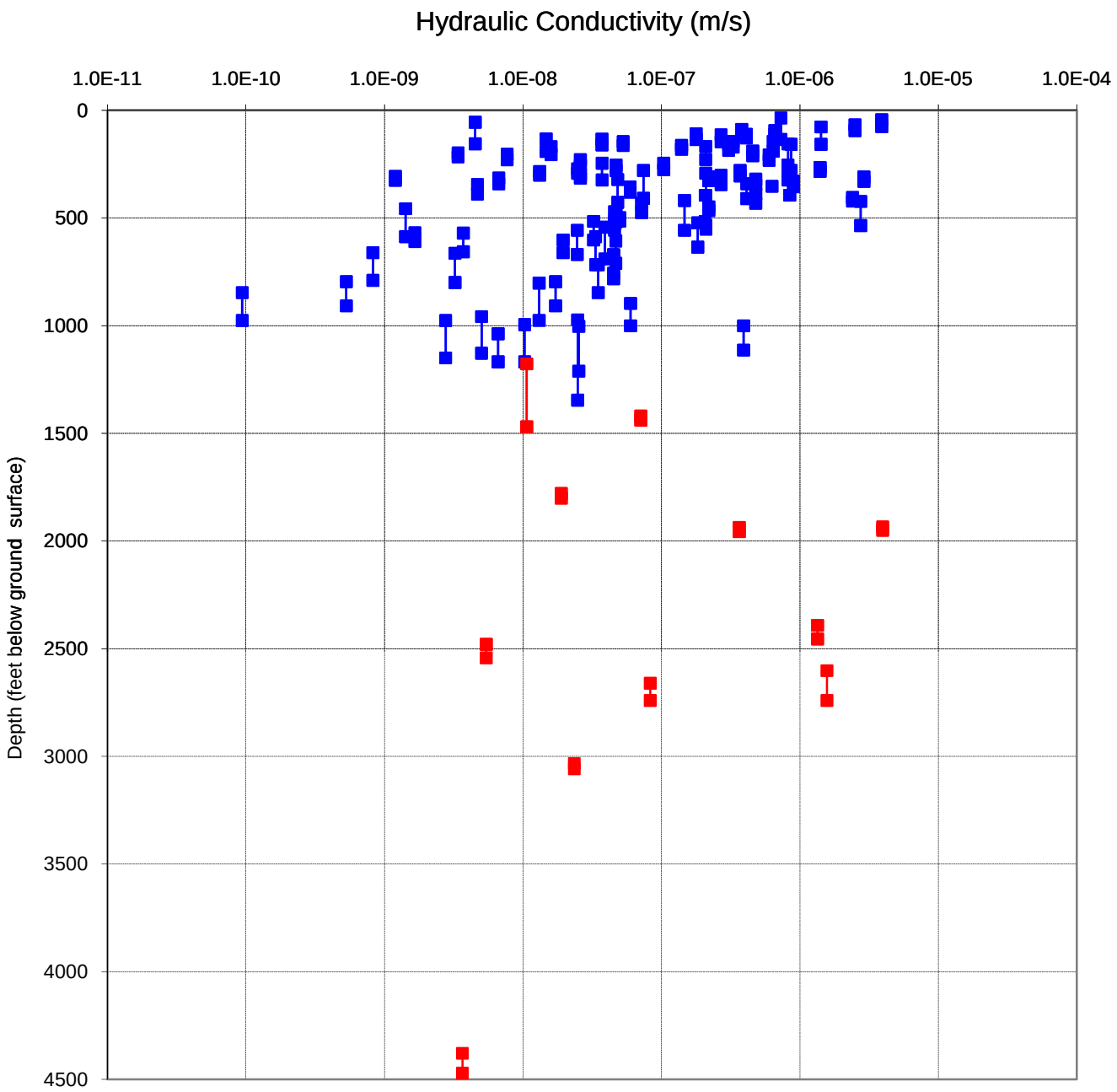
- Field Data
- Leaky Aquifer Model

THE pebble PARTNERSHIP

Figure 8.1-10
Example of Pumping Test Response

Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3923\Figure 8.1-10 Example of Pumping Test Response.xls



THE pebble PARTNERSHIP

Figure 8.1-11a
Hydraulic Conductivity vs. Depth in General Pebble Deposit Area

Legend

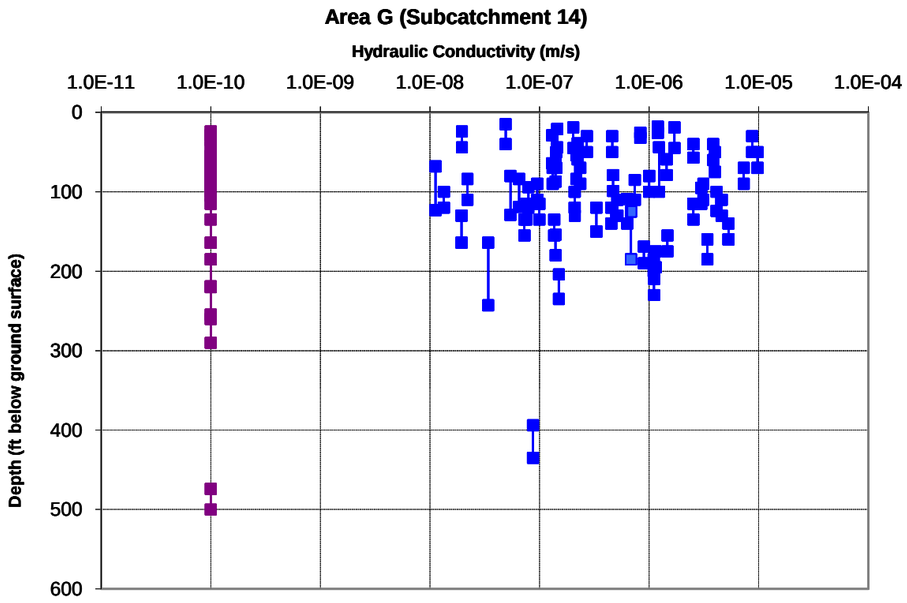
Packer Testing Interval Collected by Knight Piesold (2004 to 2008)

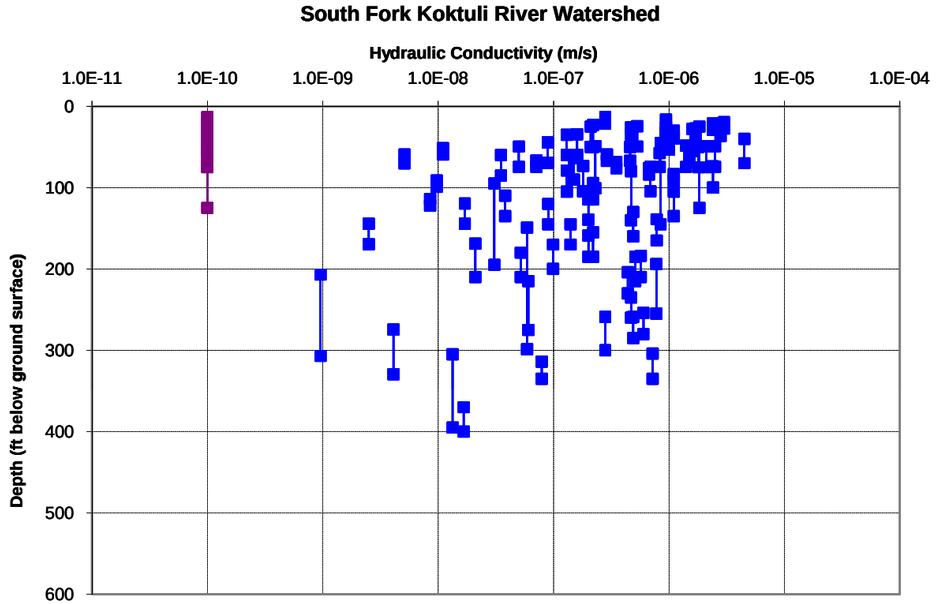
Packer Testing Interval Collected by SLR

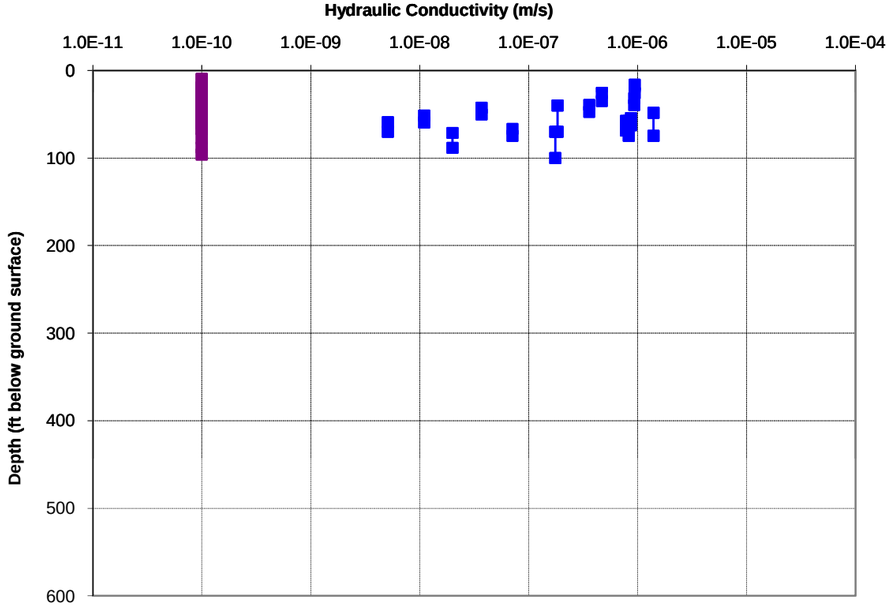


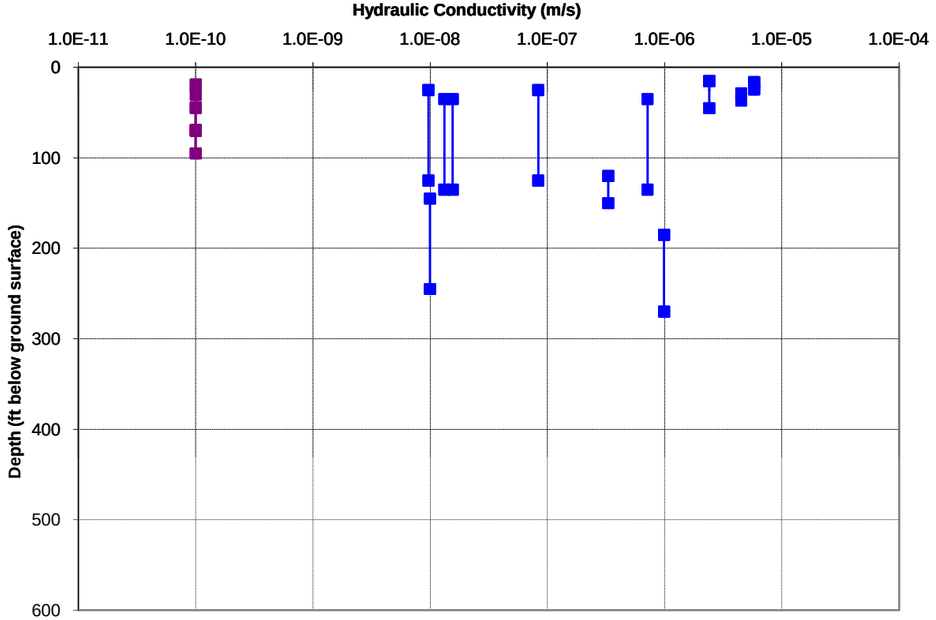
Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3924\Figure 8.1-11a Hydraulic Conductivity vs. Depth in Pit Area (from Knight Piesold).xlsx









THE pebble PARTNERSHIP

Figure 8.1-11b
Hydraulic Conductivity vs. Depth
Outside of Pebble Deposit Area

Legend

Packer Testing Intervals Collected by Knight Piesold (2004 to 2008)

Packer Testing Interval with No Water Take

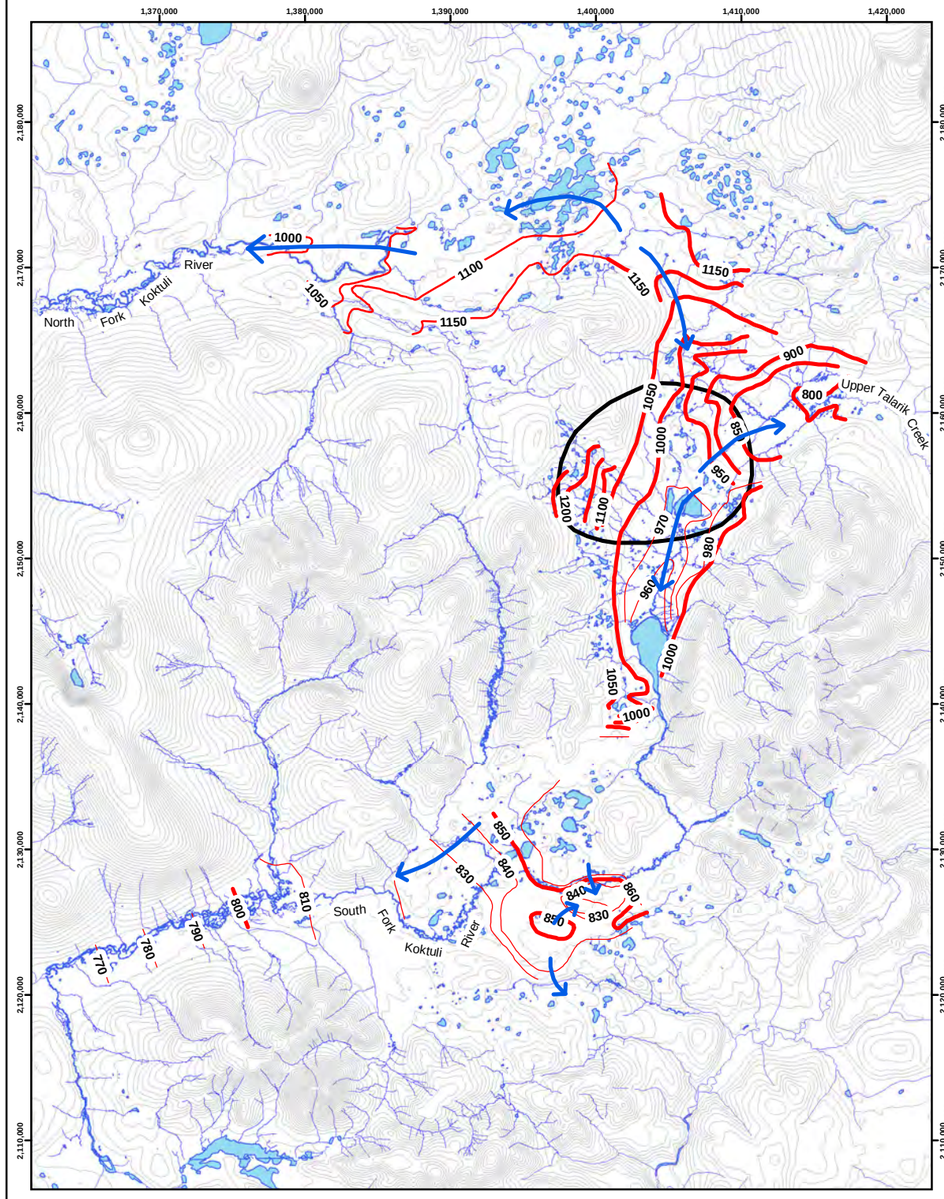


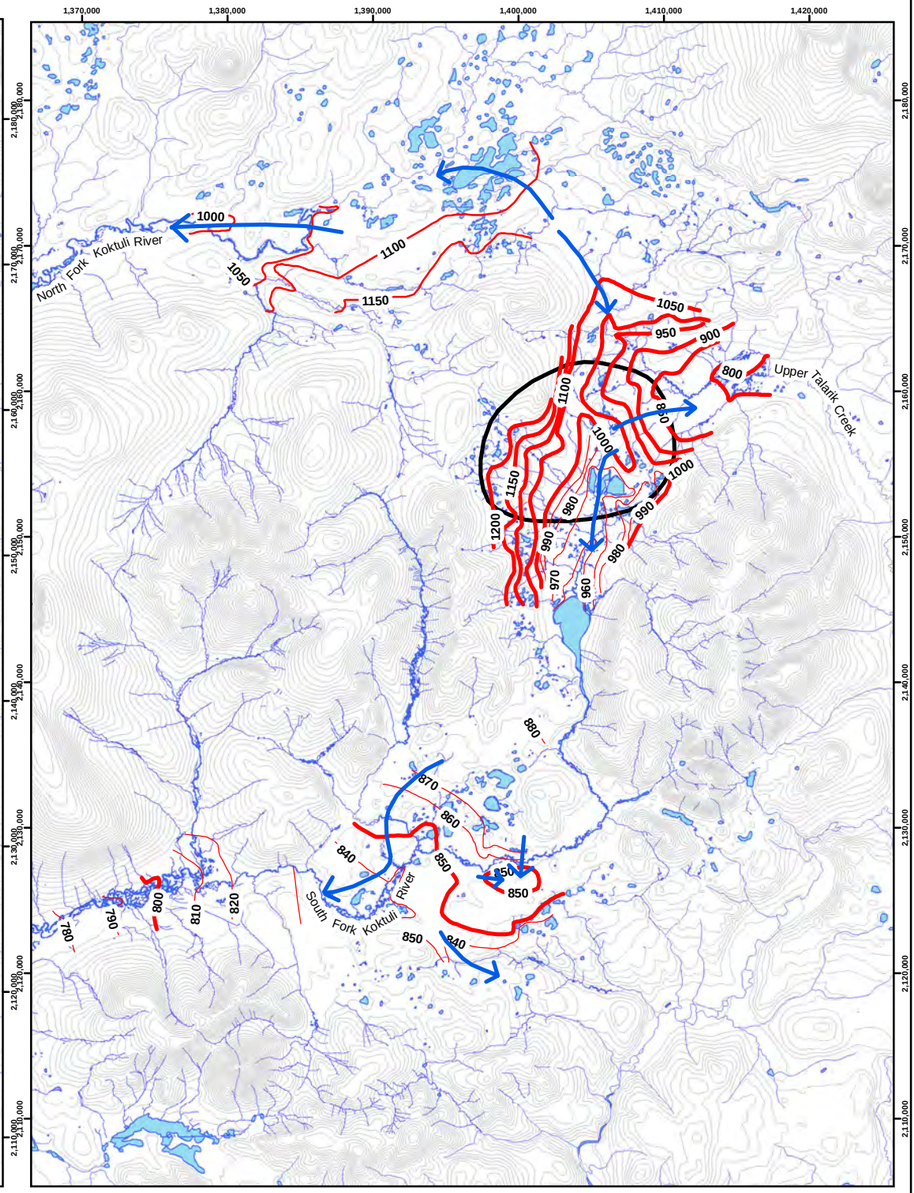
Project No: 7126	Author: SWS-KB
Version: 1	Date: April , 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3925\Figure 8.1-11b Hydraulic Conductivity vs. Depth Outside of Deposit Area(from Knight Piesold).xlsx

Low Water
(May 2008)

High Water
(June 2008)





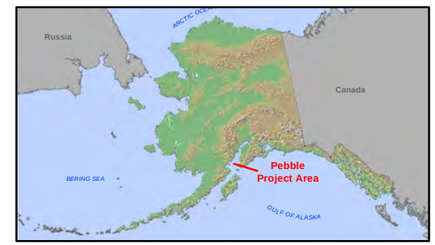
N

THE pebble PARTNERSHIP

Figure 8.1-12
Shallow Groundwater Contours

Legend

- 10 ft
- 100 & 50 ft
- General Deposit Location
- Lakes
- Rivers
- 50-ft Contour Interval
- Groundwater Flow Direction



Feet
0 6,400 12,800 19,200 25,600

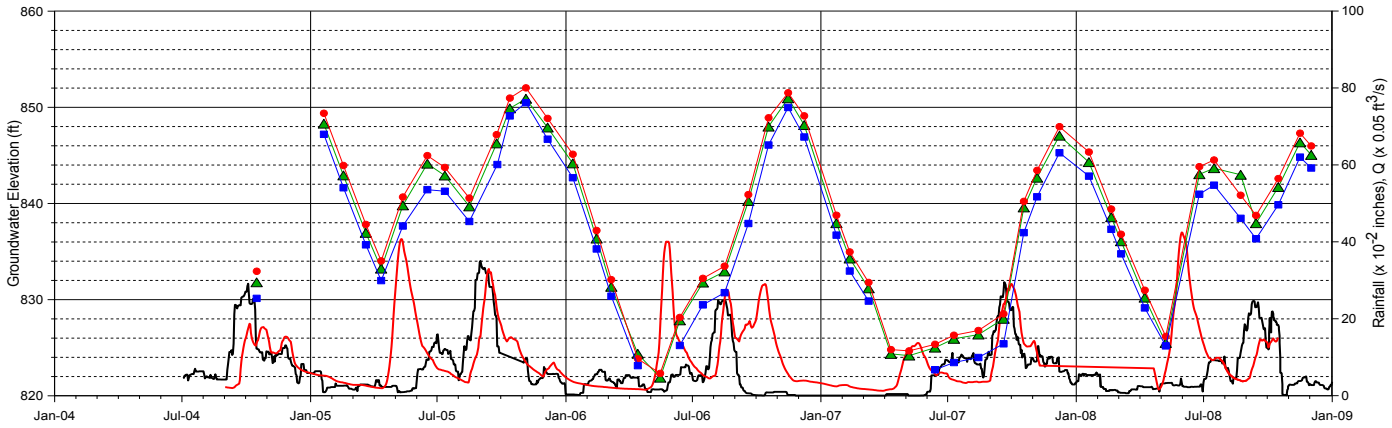
Meters
0 1,500 3,000 4,500 6,000

Scale 1:125,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-BL
Version 1	Date: April, 2011

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Section_8.1\Figure 8.1-4 - Locations of Hydrogeologic Investigations.mxd



THE pebble PARTNERSHIP

Figure 8.1-13a
Time Series of Piezometric Elevations
MW-11

Legend

- MW-1S
- MW-1M
- MW-1D
- Streamflow at SK100B: 15 day Running average
- Rainfall at Iliamna Airport: 31 day running average

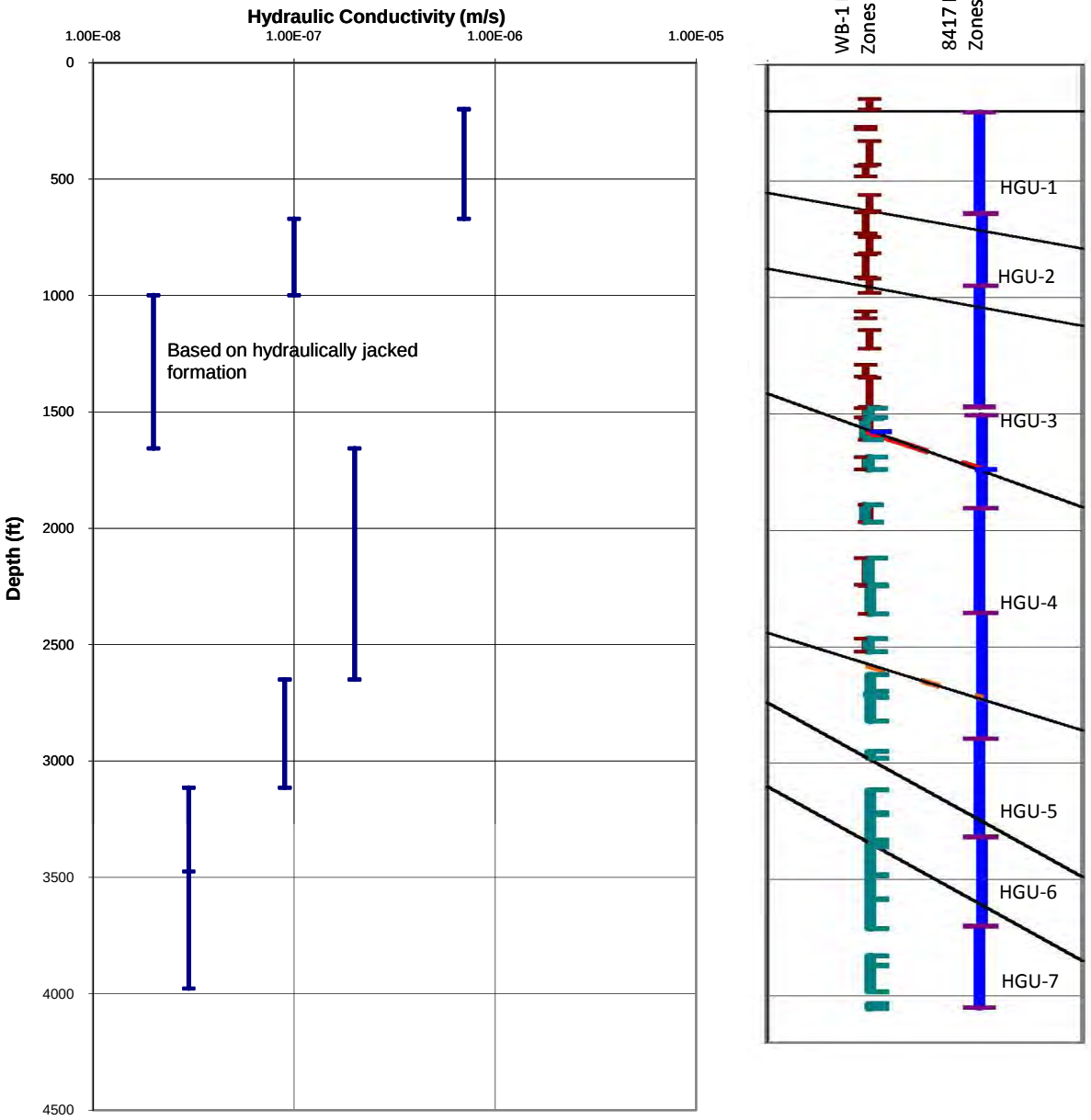
S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone

Screens (ft asl):
MW-11S : 810.4 - 830.4
MW-11M : 769.3 - 779.3
MW-11D : 745.2 - 755.2

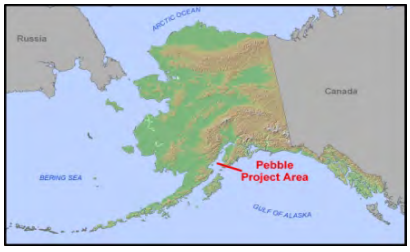


Project No: 7126	Author: SWS-LC
Version: 1	Date:Sept. 10, 2010

Z:\Pebble_7-075\reporting\WMC 2009 EBD\Section 8.1 Hydrogeology Figures\sub files\Figure 8.1-13a Time Series of Piezometric Elevations - MW-11.xls



Note: HGU = Hydrogeologic Unit



Legend

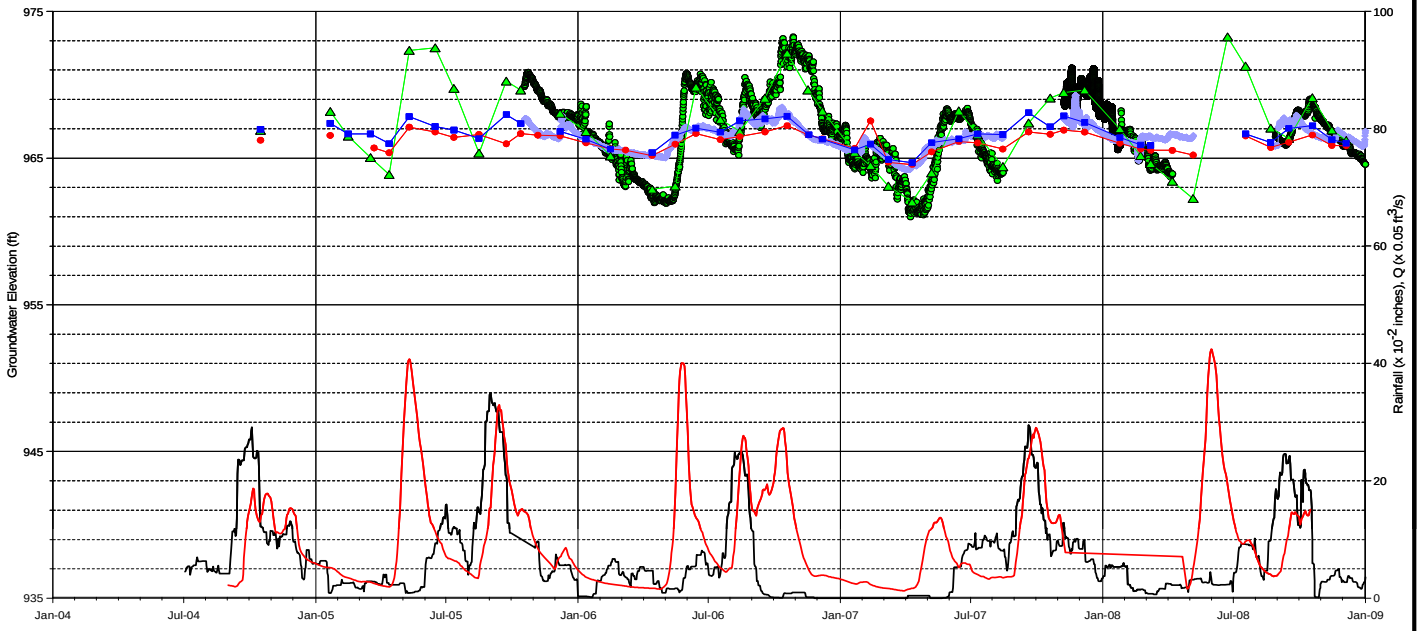
- Avg K in Depth Interval measured at WB-1
- top of HGU
- bottom of HGU
- pump test intervals
- 1st Set of Probes
- 2nd set of probes
- ZE
- ZEC

THE pebble PARTNERSHIP

Figure 8.1-11c
Deep Bedrock
Hydraulic Conductivity Profile

Project: 7126	Author: SWS-KB
Version: 1	Date: April 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3929\Figure 8.1-11c Deep Bedrock Hydraulic Conductivity Profile.xlsx



THE pebble PARTNERSHIP

Figure 8.1-13b
Time Series of Piezometric Elevations
MW-5

Legend

- MW-5S
- MW-5M
- MW-5D
- MW-5S(Transducer)
- MW-5D(Transducer)
- Streamflow at SK100B: 15 day Running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone

Screens (feet above sea level)
MW-5S: 936.6 - 922.9
MW-5M: 912.9 - 922.9
MW-5D: 873.0 - 888.0



Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2010

Z:\Pebble_7126_2010\GIS\MXDs\T3931\Figure 8.1-13b Time Series of Piezometric Elevations - MW-5.xlsx

1,350,000
1,400,000
1,450,000
2,200,000
2,150,000
2,100,000

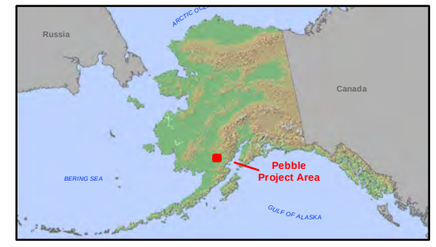
N

Pebble Snow Course 1 & 1A (ss1)
Pebble Snow Course 2 (ss2)
Pebble 1
Pebble 3
Pebble 4

13
15
14
12
9
10
3
2
1
8
5
7
4
11

NK1.190
SK1.240
SK1.310
SK1.190
UT1.190
SK1.210

NK100LF1
NK100B
NK100C
NK100LF3
NK119B
NK119A
NK100LF4
NK100LF5
NK100A
SK100A
NK100LF10
SK100LF9
SK100B
SK100LF6
SK100C
SK100LF8
SK100LF7
SK119A
SK124A
SK100LF4
SK100LF5A
SK100D
SK100LF2
SK100F
SK136B
SK136A
SK134A
SK100G
SK133A
SK131A
UT100E
UT146A
UT100LF1
UT138A
UT141A
UT100D
UT135A
UT100LF3A
UT 100LF4
UT100LF5A
UT10LF6
UT119B
UT122LF1
UT119A
UT10LF7
UT100B
UT10LF8
KC100A
UT100APC1



Feet
0 6,100 12,200 18,300 24,400 30,500
Meters
0 2,000 4,000 6,000 8,000 10,000

Scale 1:155,600
Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1-14
Stream Gaging Stations and Watershed Boundaries

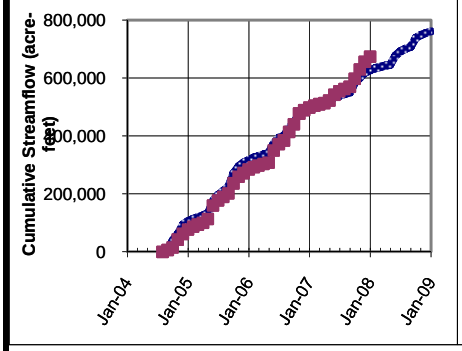
Legend

- Snow Course Station
- Meteorological Station
- Stream Gaging Station
- Low Flow Stream Gaging Station
- General Deposit Location
- Lakes
- Rivers

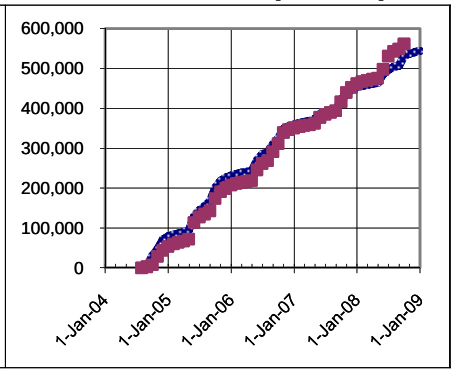
Project No: 7126	Date: September 10, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Section_8.1\Figure 8.1-14 - Stream Gaging Stations and Watershed Boundaries.mxd

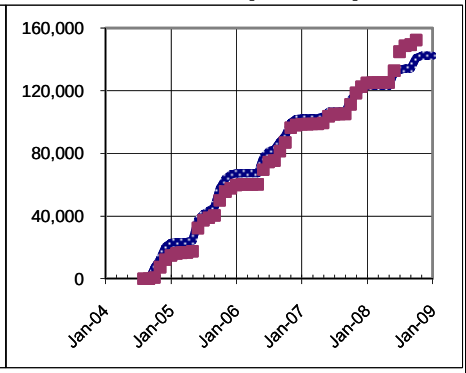
SK100A (Area 8)



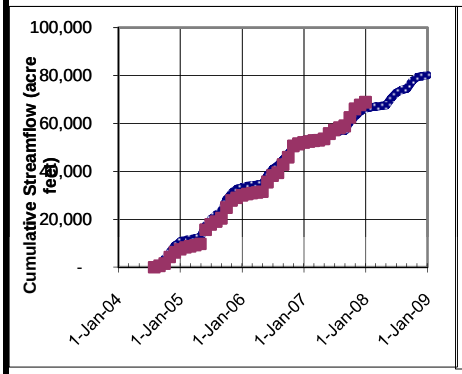
SK100B (Area 4)



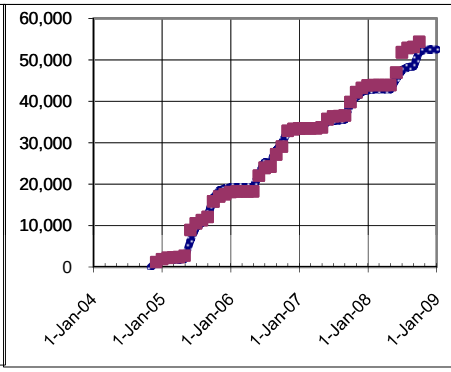
SK100C (Area 5)



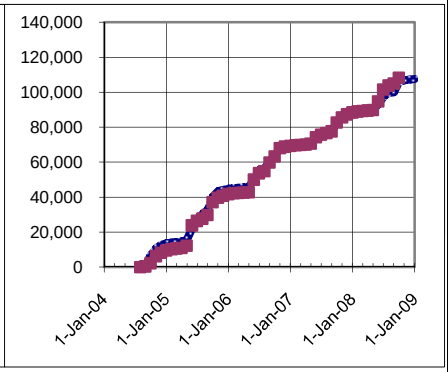
SK100F (Area 3)



SK124A (Area 2)



SK119A (Area 1)





Legend

calculated

measured

Note: Refer to Figure 8.1-1b to see sub-catchment areas

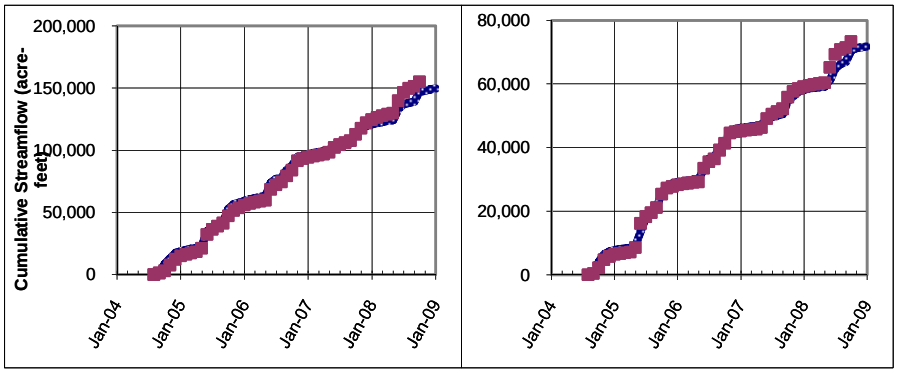
THE pebble PARTNERSHIP

Figure 8.1-15a
Comparison of Observed Streamflow with Water Balance Model
South Fork Koktuli River Sub-catchment Areas

Project: 7126	Author: SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3932\Figure 8.1-15a Comparison of Observed Streamflow with Water Balance Model - South Fork Koktuli.xls

NK100C (Area 13) **NK119A (Area 14)**





Legend

calculated

measured

Note: Refer to Figure 8.1-1b to see sub-

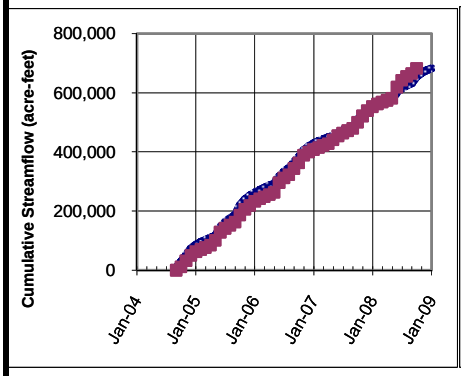
THE pebble PARTNERSHIP

Figure 8.1-15b
Comparison of Observed Streamflow with Water Balance Model
North Fork Koktuli River Sub-catchment Areas

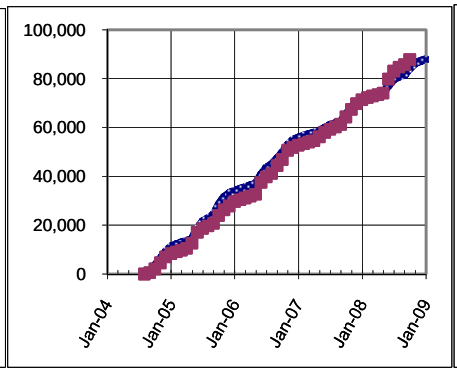
Project: 7126	Author: SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3933\Figure 8.1-15b Comparison of Observed Streamflow with Water Balance Model - North Fork Koktuli.xlsx

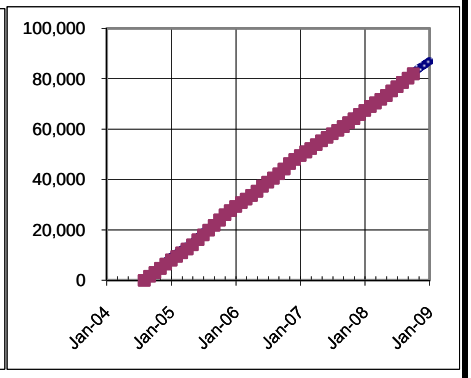
UT100B (Area 10)



UT100D (Area 9)



UT119 (Area 7)





Legend

Calculated

Measured

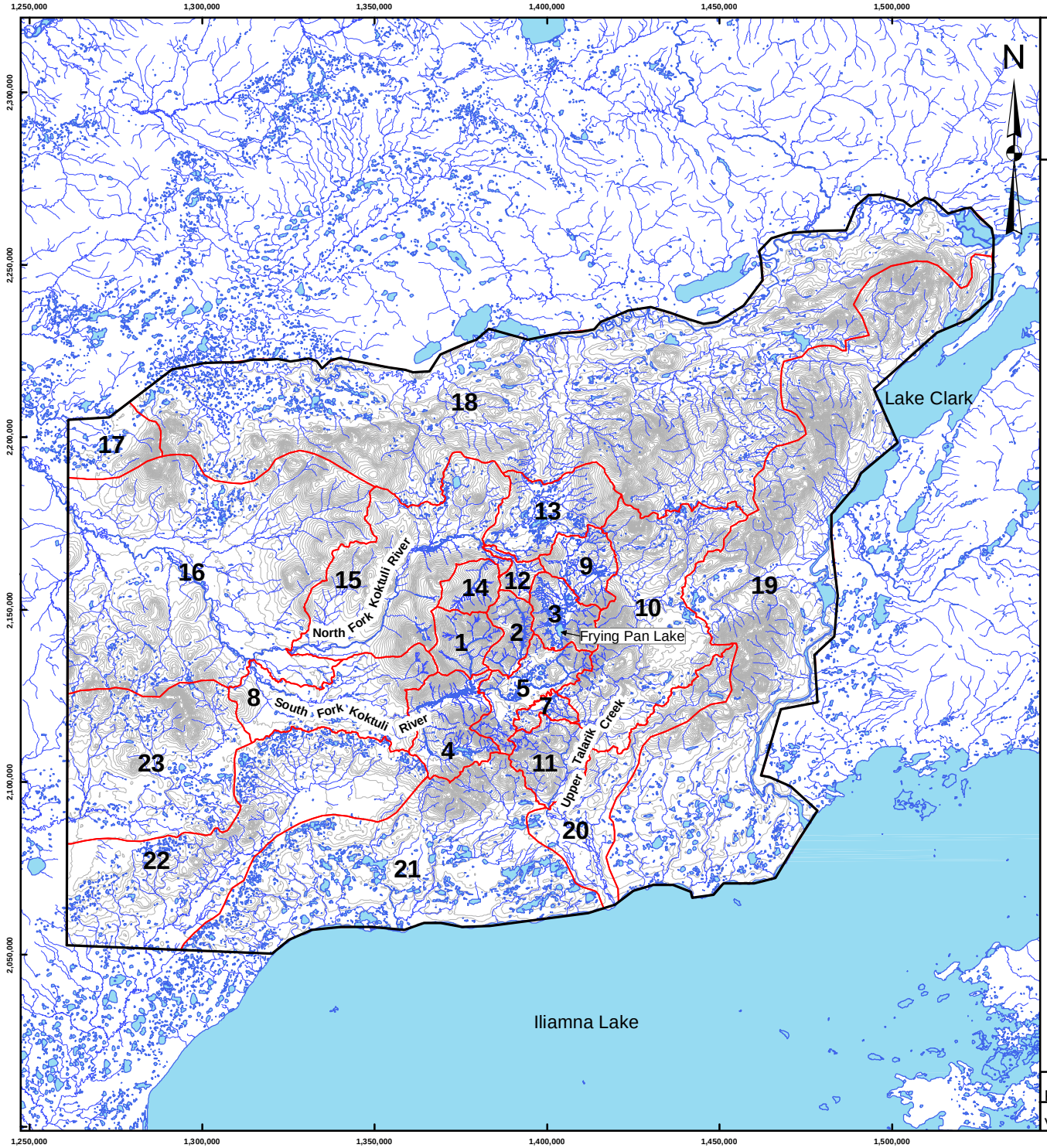
Note: Refer to Figure 8.1-1b to see sub-catchment areas

THE pebble PARTNERSHIP

Figure 8.1-15c
Comparison of Observed Streamflow with Water Balance Model
Upper Talarik Creek Sub-catchment Areas

Project: 7126	Author:SWS-KB
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3934\Figure 8.1-15c Comparison of Observed Streamflow with Water Balance Model - Upper Talarik Creek.xlsx

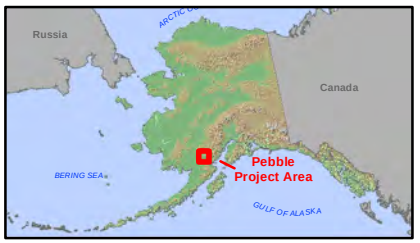


THE pebble PARTNERSHIP

Figure 8.1-16
Groundwater Model Domain

Legend

- Model Boundary
- 10 — Watershed Boundary and Corresponding ID Number
- Lakes
- Rivers
- 50-ft Contour Interval



Feet
0 25,000 50,000 75,000 100,000

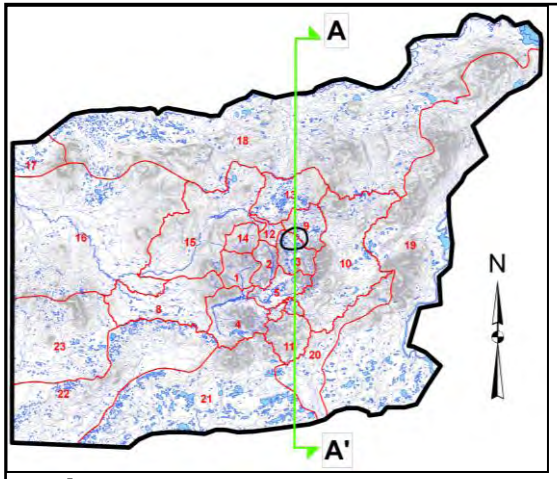
Meters
0 5,100 10,200 15,300 20,400 25,500

Scale 1:516,529

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-PP
Version: 1	Date: Sept. 10, 2010

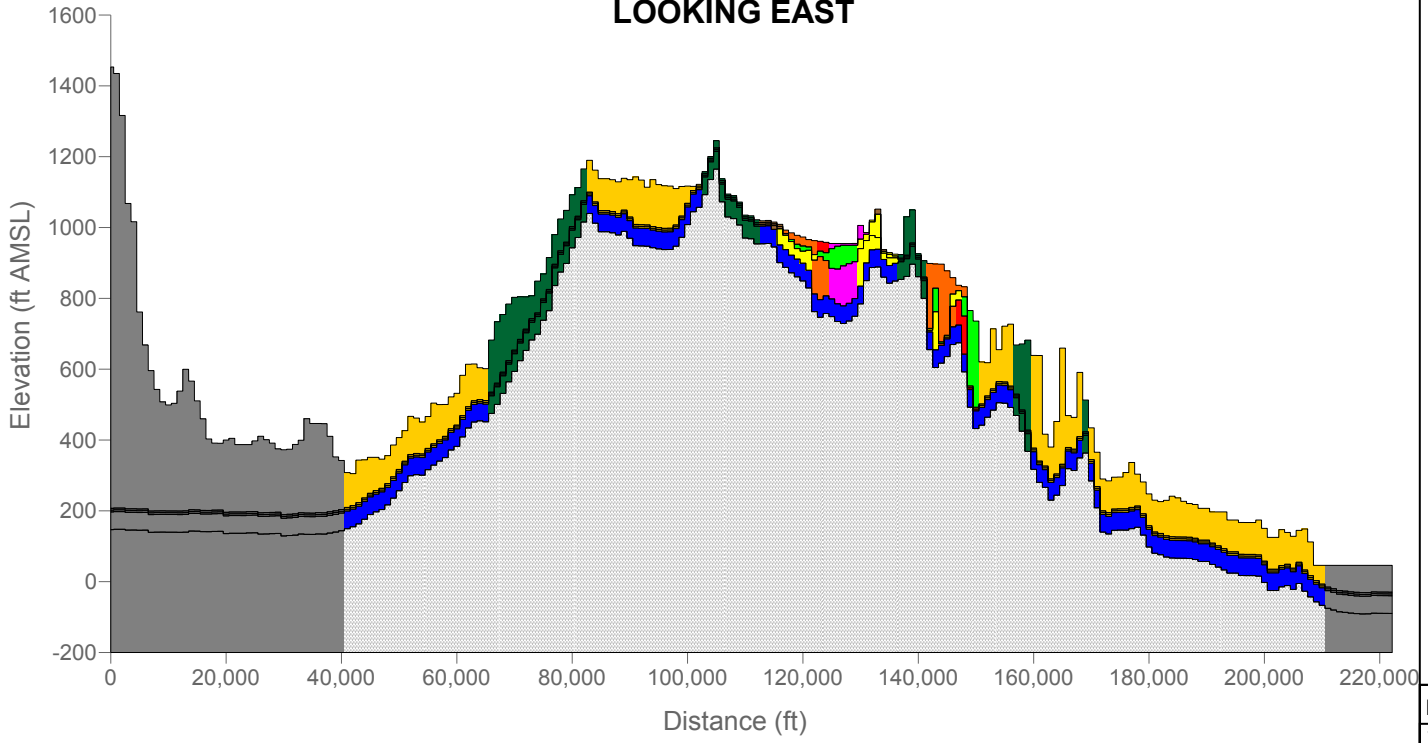
Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Section_8.1\Figure 8.1-16 Groundwater Model Domain.mxd



A
North

A'
South

LOOKING EAST



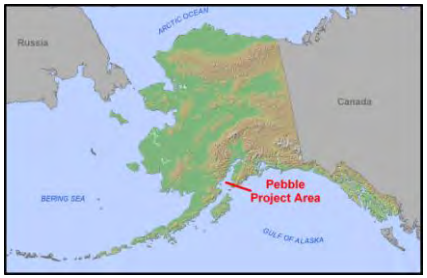
THE pebble PARTNERSHIP

Figure 8.1-17
Groundwater Model
Cross-Section A-A'

Legend

- gravel, gravelly sand
- gravel, gravelly sand with sand, silty sand
- sand, silty sand
- sand, silty sand with clay/silt lenses
- gravel, gravelly sand with clay/silt lenses
- clay, silty clay
- overburden valley outside of investigation area
- uplands bedrock
- non-weathered bedrock
- bedrock valley
- inactive

Note - AMSL = above mean sea level



Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3935\Figure 8.1-17 Groundwater Model Cross-Section A-A'.xlsx

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

Frying Pan Lake

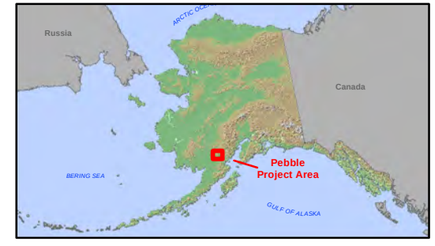
Iliamna Lake

THE pebble PARTNERSHIP

Figure 8.1-18:
Simulated Groundwater Elevations, Layer 1, Overburden, Full Study Area (September, 2007)

Legend

- Simulated Watertable Elevation - 25 ft Contour Interval
- Expanded Groundwater Model Domain
- General Deposit Location
- Lakes
- Rivers



Feet
0 15,000 30,000 45,000 60,000

Meters
0 5,300 10,600 15,900 21,200

Scale 1:285,796

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3936\Figure 8-1-18 - Simulated Groundwater Elevations, September 2007 (Layer 1).mxd

1,350,000

1,400,000

2,150,000

N

Frying Pan Lake

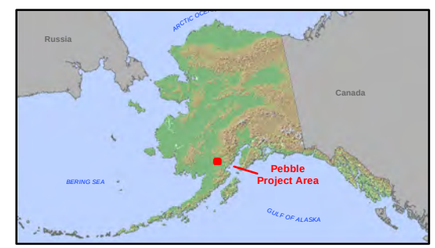
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550

THE pebble PARTNERSHIP

Figure 8.1-19:
Simulated Groundwater Elevations,
Layer 1, Overburden, Area of Interest
(September, 2007)

Legend

- Simulated Watertable Elevation - 10 ft Contour Interval
- General Deposit Location
- Lakes
- Rivers
- 50-ft Contour Interval
- Direction of Simulated Groundwater Flow



0 5,100 10,200 15,300 20,400 Feet

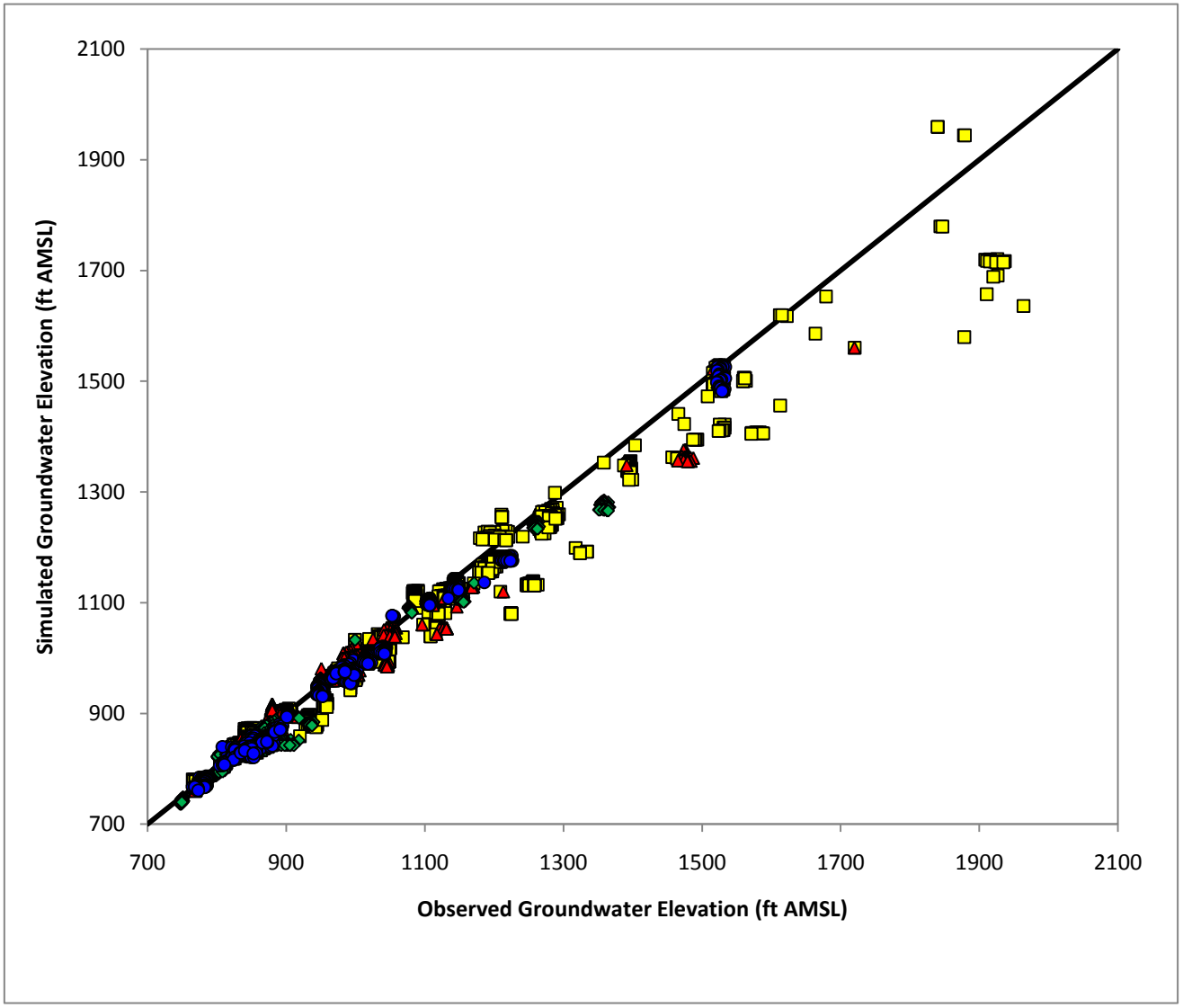
0 1,000 2,000 3,000 4,000 5,000 Meters

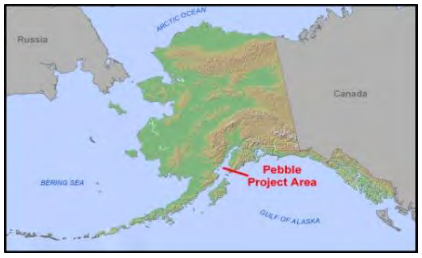
Scale 1:105,773

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-PP
Version: 1	Date: September 10, 2010

Z:\Pebble_7126_2010\GIS\MXDs\T3937\Figure 8-1-19 - Simulated Groundwater Elevations, September 2007 (Layer 1 - Study Area).mxd





Legend

- Simulated = Observed
- Layer 4
- Layer 3
- Layer 2
- Layer 1

THE pebble PARTNERSHIP

Figure 8.1-20
Modeled vs. Observed Heads
Scatter Plot - All Layers, All Times

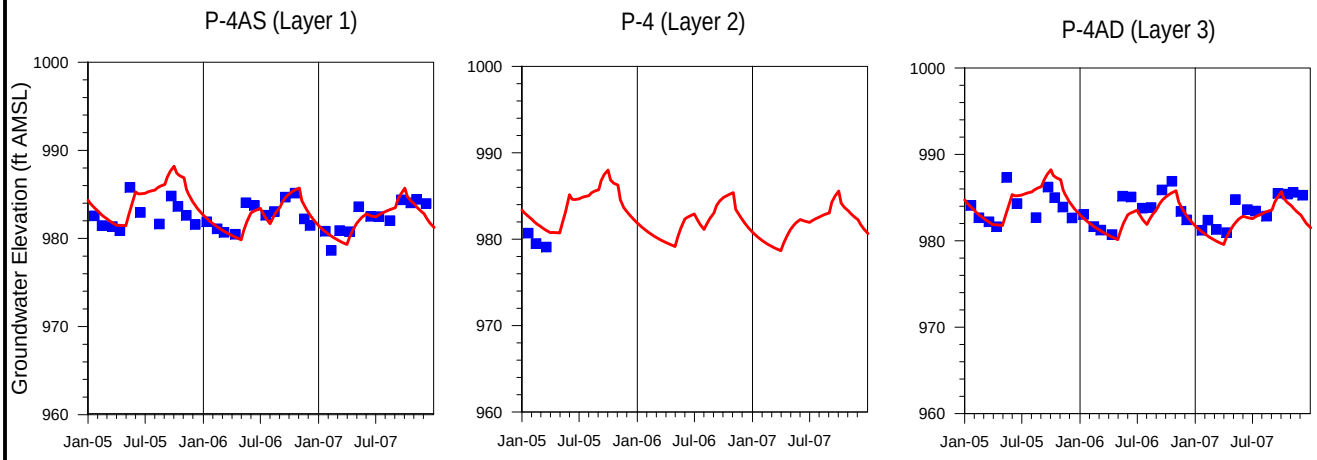
Note: AMSL= Above Mean Sea Level

Project: 7126	Author: WMC-LC
Version: 1	Date: Dec 5, 2008

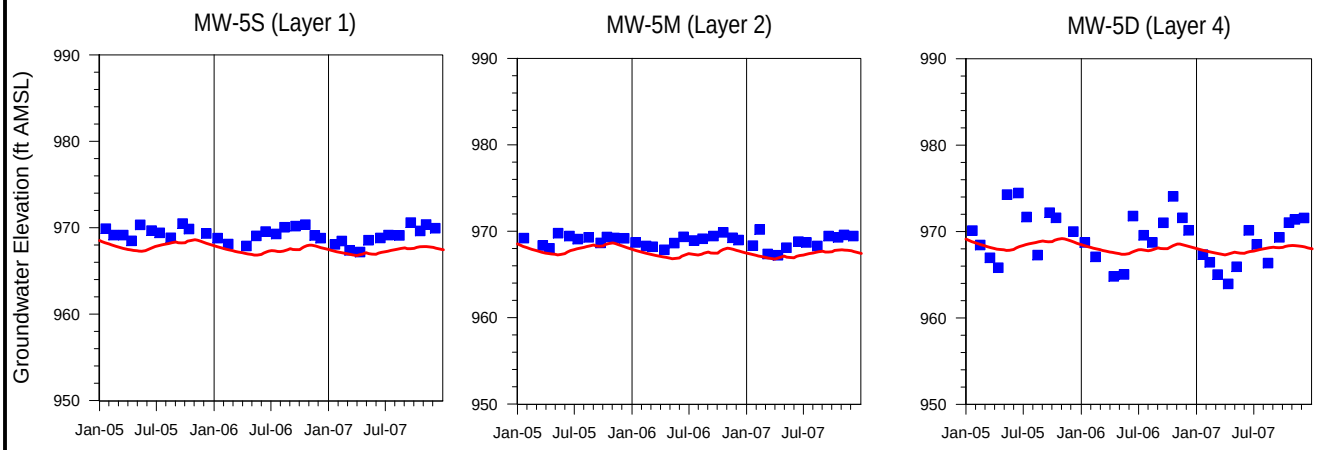
Z:\Pebble_7126_2010\GIS\MXDs\T3938\Figure 8.1-20 Heads Residuals vs Observed Scatter Plot - All .xlsx

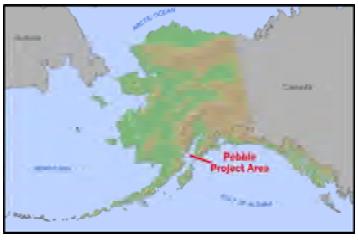
Simulation TR-753

Proposed Open Pit Area - Area 3



Frying Pan Lake - Area 3





Legend

Observed — Model

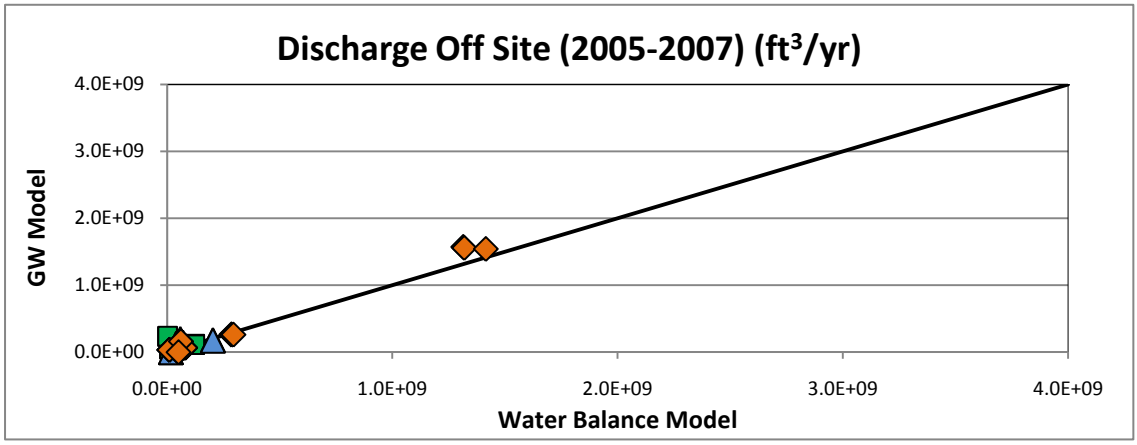
AMSL = above mean sea level

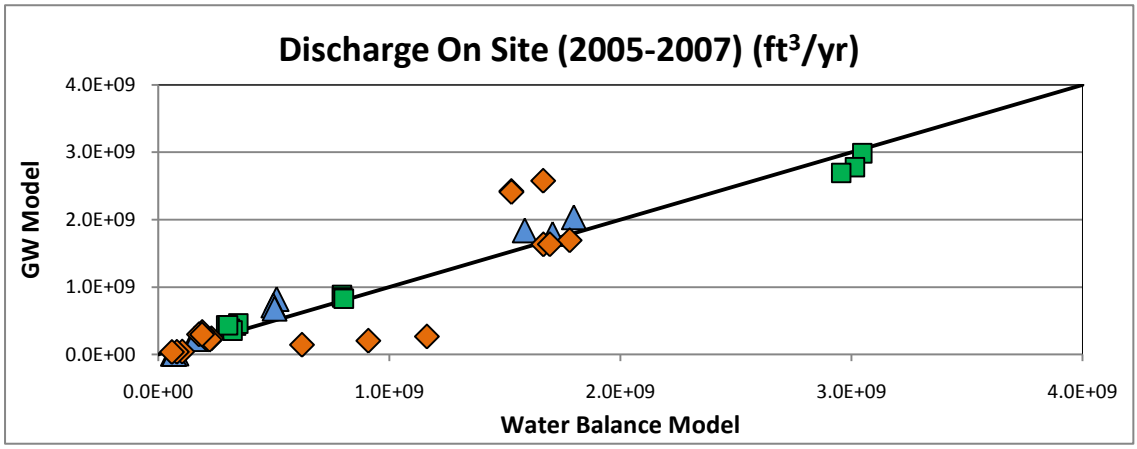
Area = Sub-catchment

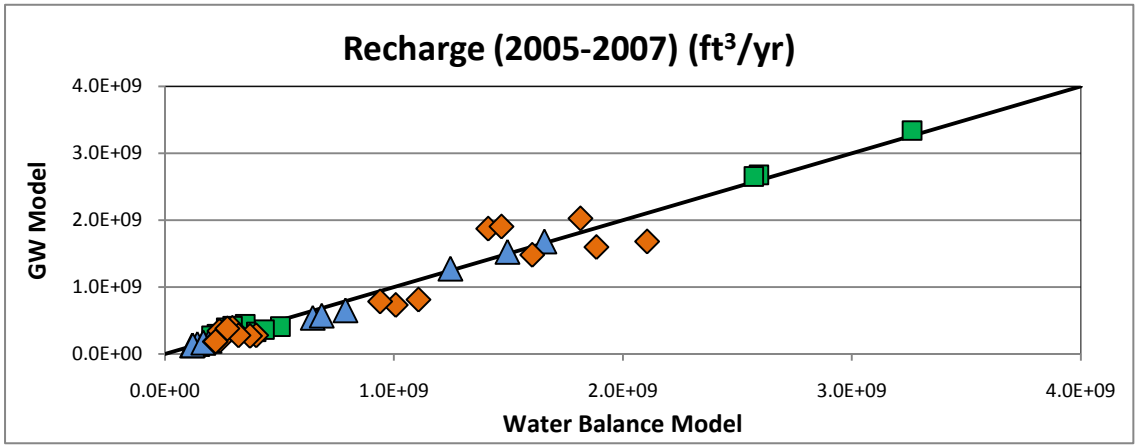
Figure 8.1-21:
Observed and Simulated Hydrographs:
P-4AS, P-4, P-4AD, MW-5S,
MW-5M and MW-5D

Project: 7126	Date: April-2011
Version: 3	Author: SWS-RR

Z:\Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F8.1-21 Observed and simulated hydrograph.grf









Legend

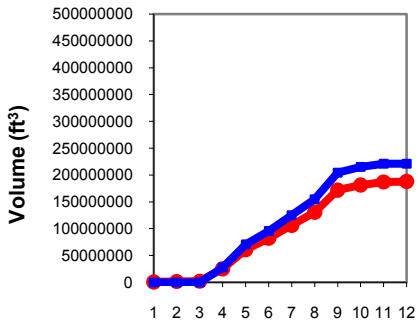
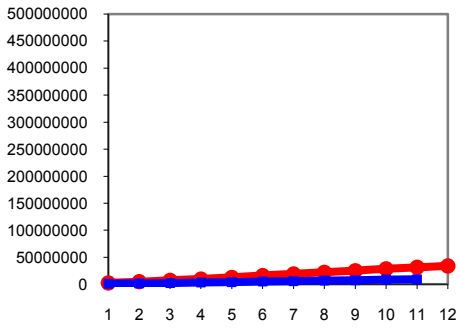
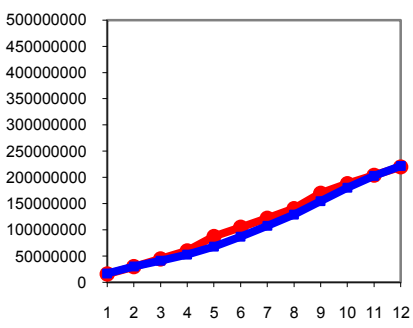
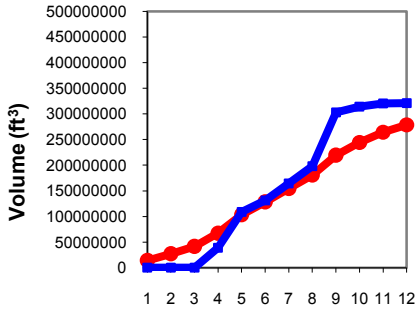
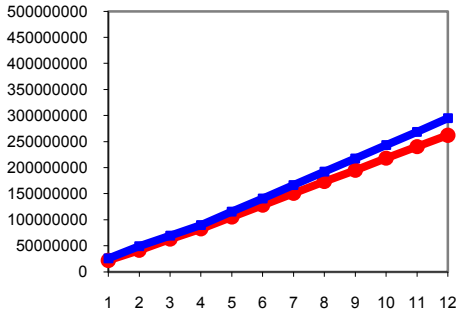
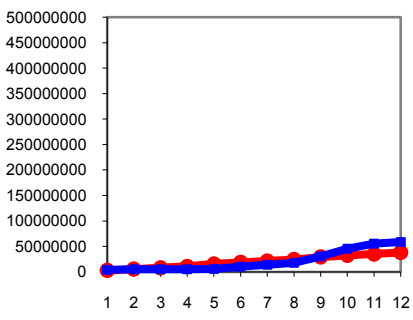
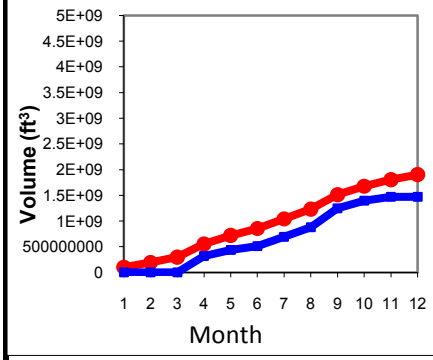
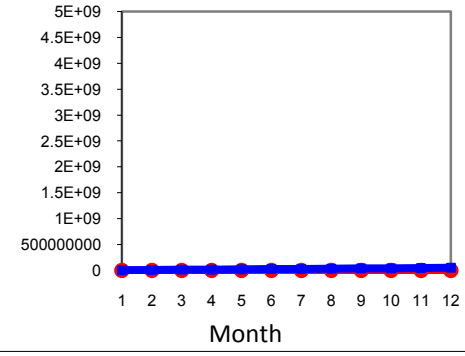
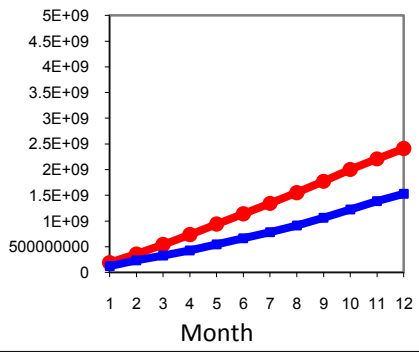
GW Model = WB Model
UT
NK
SK

THE pebble PARTNERSHIP

Figure 8.1-22
Cumulative Annual Flow:
Modflow Model vs. Water
Balance Model (2007)

Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3940\Figure 8.1-22 Cumulative Annual Flow Modeflow model vs Water .xlsx

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	AREA 1 (SK119A)	
		
	AREA 2 (SK124A)	
		
	AREA 8 (SK100A)	
		



Legend

Groundwater Model

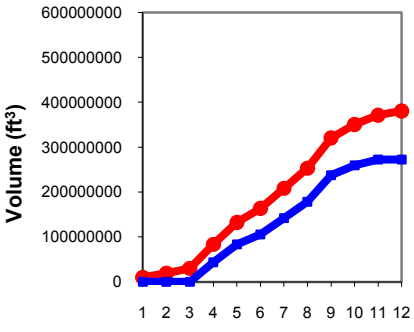
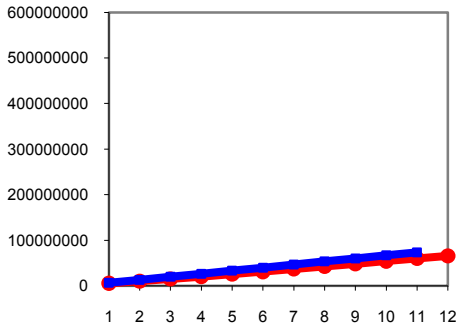
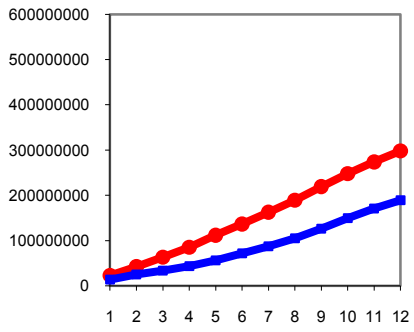
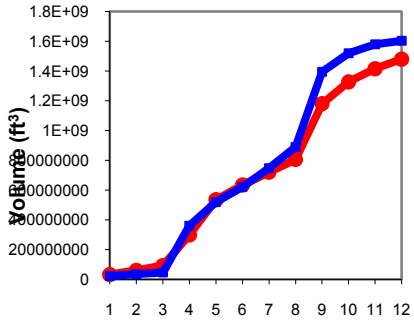
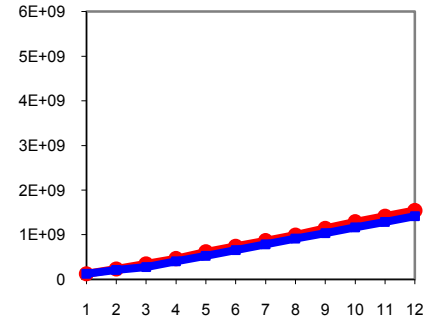
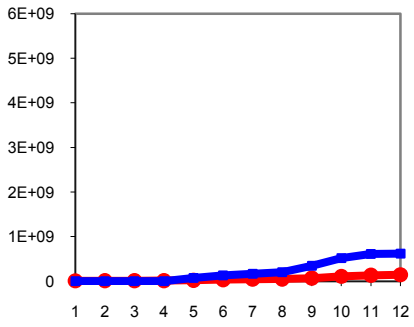
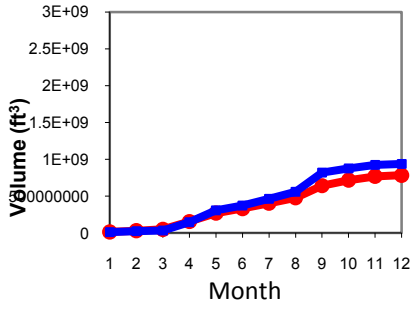
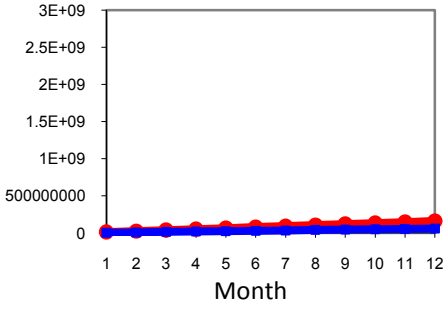
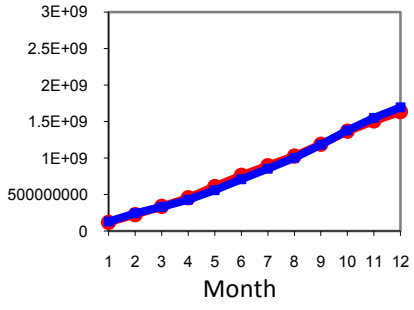
Water Balance Model

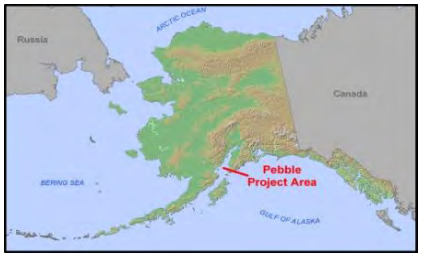
Area refers to Subcatchment Area
(see Figure 8.1-1b)

THE pebble PARTNERSHIP

Figure 8.1-23a
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli Tributaries (2007)

Project: 7126	Author: SWS-BL
Version: 1	Date: April , 2011

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
AREA 3 (SK100F)		
		
AREA 5 (SK100C)		
		
AREA 4 (SK100B)		
		



Legend

Groundwater Model

Water Balance Model

Area refers to Subcatchment Area
(see Figure 8.1-1b)

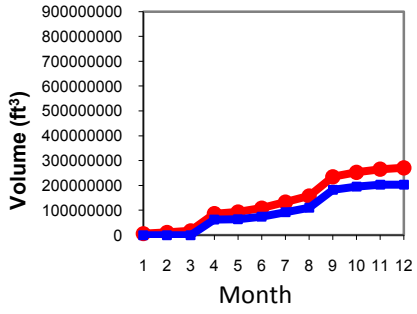
THE pebble PARTNERSHIP

Figure 8.1-23b
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli Main Channel (2007)

Project: 7126	Author: SWS- BL
Version: 1	Date: April, 2011

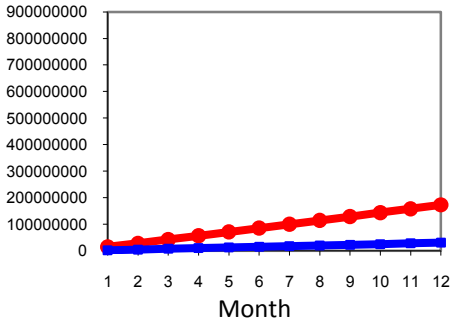
Z:\Pebble_7126_2010\GIS\MXDs\T3942\Figure 8.1-23b - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK Main Channel (2007).xlsx

RECHARGE

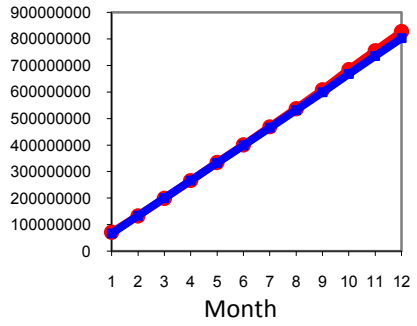


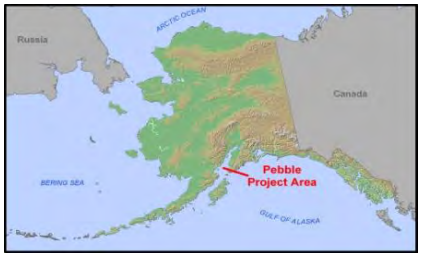
OFF SITE DISCHARGE

AREA 7 (UT119A)



ON SITE DISCHARGE





Legend

Groundwater Model

Water Balance Model

Area refers to Subcatchment Area
(see Figure 8.1-1b)

THE pebble PARTNERSHIP

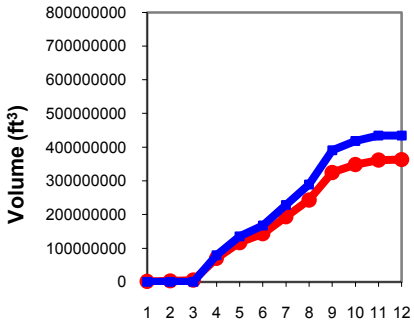
Figure 8.1-23c
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik,
flow from SFK (2007)

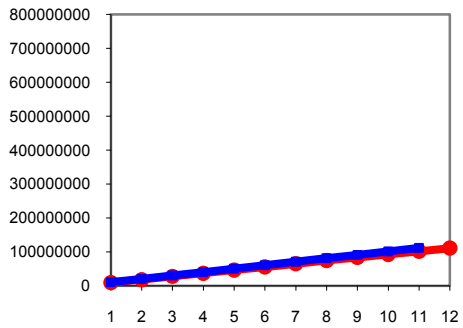
Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

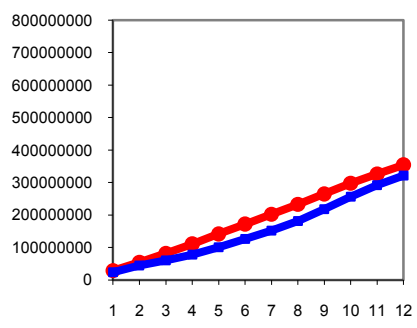
Z:\Pebble_7126_2010\GIS\MXDs\T3943\Figure 8.1-23c - Comparison of Recharge and Discharge from Groundwater and Water Balance Models -UT flow from SFK (2007).xlsx

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

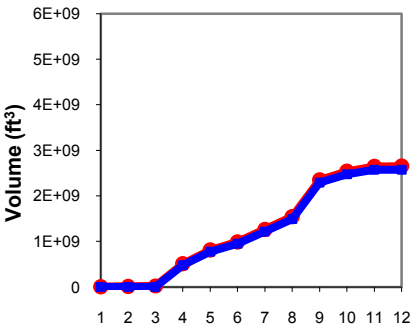
AREA 9 (UT100D)

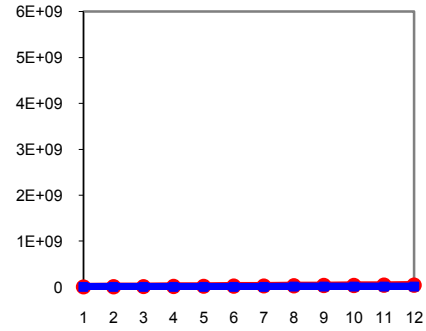


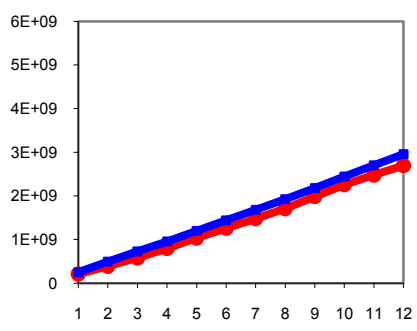




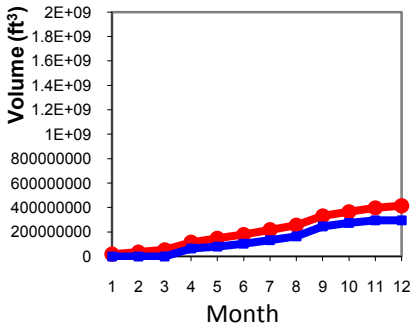
AREA 10 (UT100B)

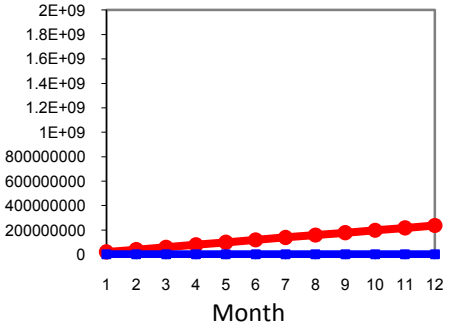


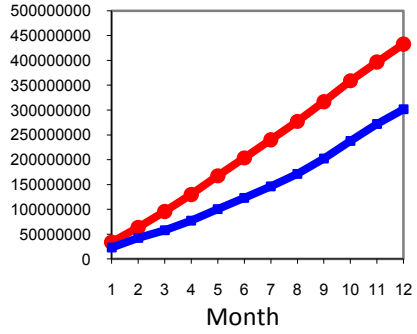


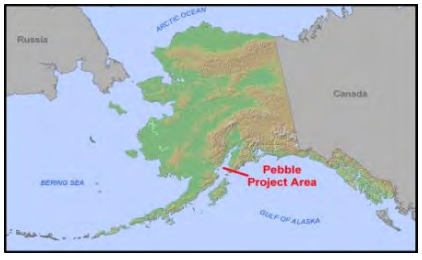


AREA 11 (UT100A)









Legend

Groundwater Model

Water Balance Model

Area refers to Subcatchment Area
(see Figure 8.1-1b)

THE pebble PARTNERSHIP

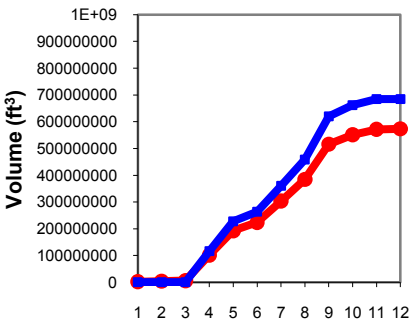
Figure 8.1-23d
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik, Main Channel (2007)

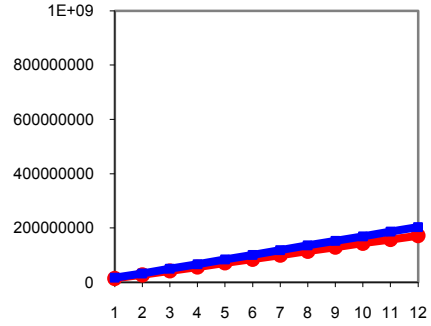
Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

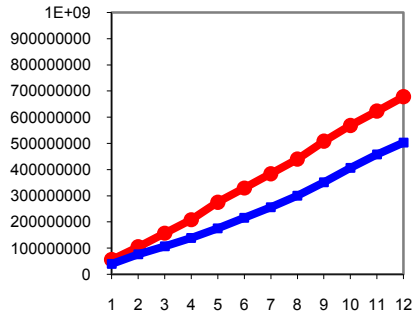
Z:\Pebble_7126_2010\GIS\MXDs\T3944\Figure 8.1-23d - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - UT Main Channel (2007).xlsx

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

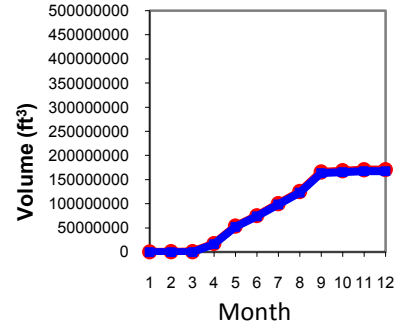
AREA 13 (NK100B)

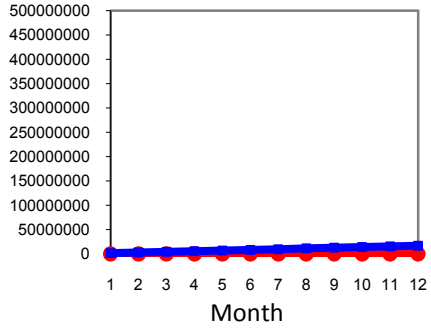


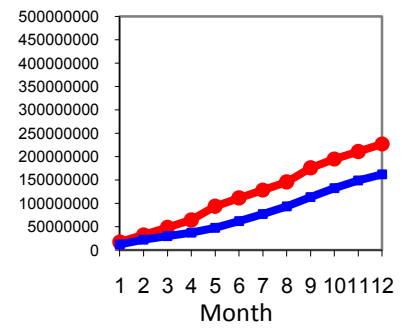




AREA 14 (NK119A)









Legend

Groundwater Model

Water Balance Model

Area refers to Subcatchment Area (see Figure 8.1-1b)

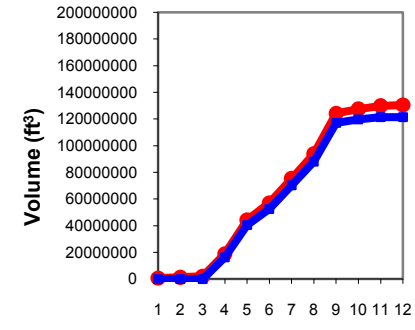
THE pebble PARTNERSHIP

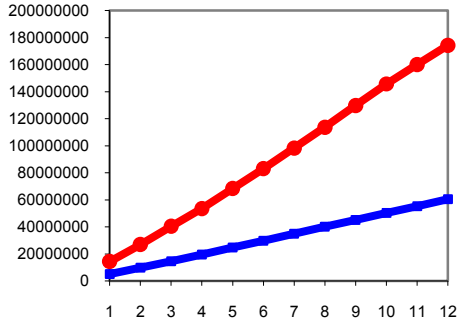
Figure 8.1-23e
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli - Areas 13 and 14 (2007)

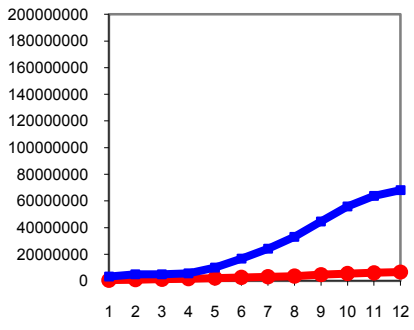
Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

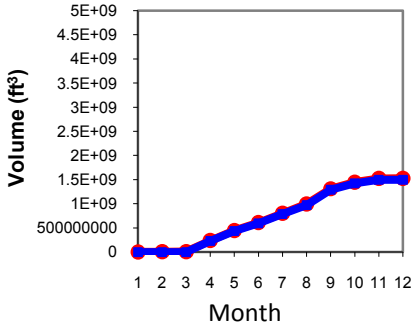
AREA 12 (NK119B)

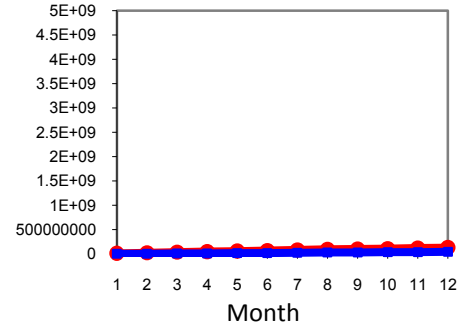


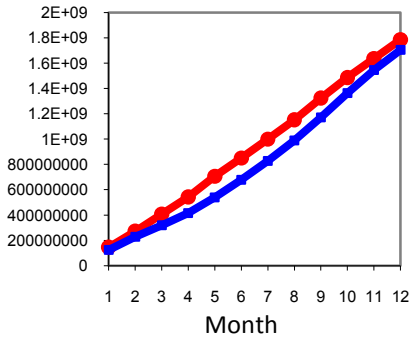


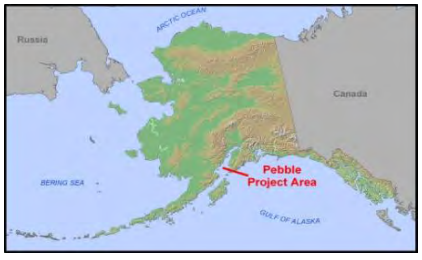


AREA 15 (NK100A)









Legend

Groundwater Model

Water Balance Model

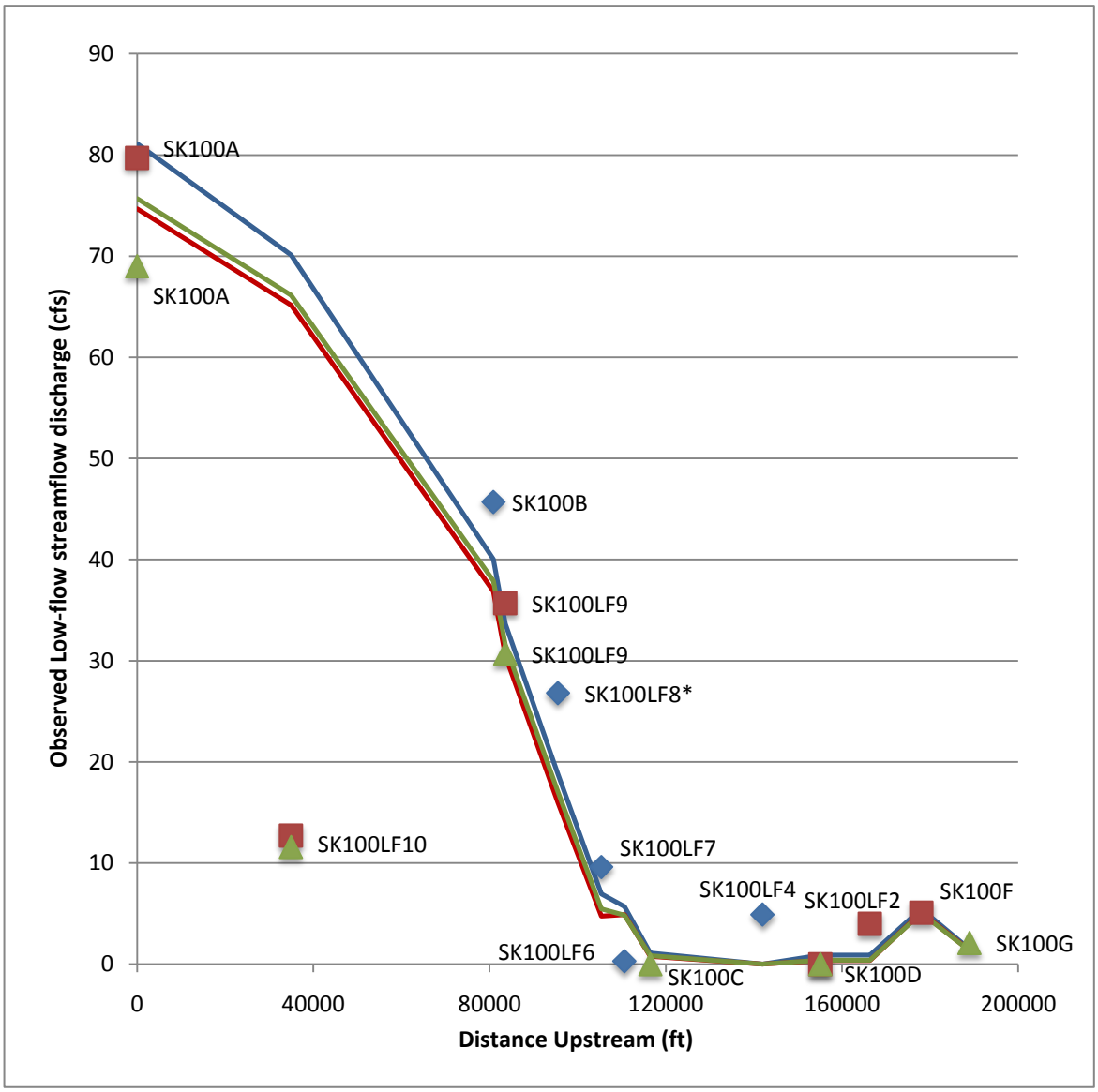
Area refers to Subcatchment Area
(see Figure 8.1-1b)

THE pebble PARTNERSHIP

Figure 8.1-23f
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli - Areas 12 and 15 (2007)

Project: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3946\Figure 8.1-23f - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - NFK 12 and 15 (2007).xlsx





Legend

- 2005-Measured
- 2006-Measured
- 2007-Measured
- 2005-Modelled
- 2006-Modelled
- 2007-Modelled

THE pebble PARTNERSHIP

Figure 8.1-24
Streamflow vs Distance Upstream (SFK)

Project: 7126	Author: WMC-LC
Version: 1	Date: Sept. 10, 2010

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Section 8.1 Hydrogeology Figures\Figure 8.1-24 Streamflow vs Distance Upstream (SFK).xls

APPENDICES

APPENDIX 8.1A

Drillhole and Installation Logs

Hydrogeology - 2008 Environmental Baseline Document
Appendix 8.1 A Drill-hole and Installation Logs

Drill-hole and Installation Log List

Well	Installation Year
HH-07-S	2007
KP-P1/SRK-2	2004
KP-P1/SRK-2A	2004
KP-P2/SRK-4	2004
KP-P3D/SRK-5D	2004
KP-P3M/SRK-5M	2004
KP-P3S/SRK-5S	2004
KP-P4	2004
MW1-D	2004
MW-1M	2004
MW-1S	2004
MW-2D	2004
MW-2S	2004
MW-3D	2004
MW-4	2004
MW5-D	2004
MW5-M	2004
MW5-S	2004
MW-6D	2004
MW-7D	2004
MW-7S	2004
MW-8D	2004
MW-8M	2004
MW-8S	2004
MW-9D	2004
MW-10	2004
MW-11D	2004
MW-11Db	2004
MW-11M	2004
MW-11S	2004
MW-11Sb	2004
MW-05-02M	2005
MW-05-2SR	2005
MW-05-11SS	2005
MW-05-12D	2005
MW-05-12S	2005
MW-05-13D	2005
MW-05-13S	2005
MW-05-14D	2005
MW-05-14S	2005
P-1	2004

P-2D	2004
P-2M	2004
P-3	2004
P-4M	2004
P-4AD	2004
P-4AS	2004
P-6D	2004
P-6M	2004
P-6S	2004
P-05-07D	2005
P-05-07S	2005
P-05-08	2005
P-05-09D	2005
P-05-09S	2005
P-05-10D	2005
P-05-10S	2005
P-05-11D	2005
P-05-11M	2005
P-05-11S	2005
P-05-12	2005
P-05-13	2005
P-05-14D	2005
P-05-14S	2005
P-05-15D	2005
P-05-15S	2005
P-05-16D	2005
P-05-16M	2005
P-05-16S	2005
P-05-16SS	2005
P-05-17D	2005
P-05-17S	2005
P-05-18 (Attempt #1)	2005
P-05-18	2005
P-05-19M	2005
P-05-19S	2005
P-05-20D	2005
P-05-20S	2005
P-05-21D	2005
P-05-21M	2005
P-05-21S	2005
P-05-22D	2005
P-05-23	2005
P-05-24D	2005
P-05-24S	2005
P-05-25	2005
P-05-26D	2005
P-05-26M	2005
P-05-26S	2005
P-05-27D	2005
P-05-27M	2005

P-05-27S	2005
P-05-28D	2005
P-05-28S	2005
P-05-29D2	2005
P-05-29D	2005
P-05-29M	2005
P-05-29S	2005
P-05-30D	2005
P-05-30S	2005
P-05-31D	2005
P-05-31S	2005
P-05-32D	2005
P-05-33D	2005
P-05-34D	2005
P-05-35D	2005
P-05-36D	2005
P-05-36M	2005
P-05-36S	2005
P-06-37D	2006
P-06-37DA	2006
P-06-37M	2006
P-06-37S	2006
P-06-38D	2006
P-06-38M	2006
P-06-39D	2006
P-06-39S	2006
P-06-40D	2006
P-06-40M	2006
P-06-40S	2006
P-06-41D	2006
P-06-41M	2006
P-06-41S	2006
P-07-42D	2007
P-07-42S	2007
P-07-43D	2007
P-07-43M	2007
P-07-43S	2007
P-07-44D	2007
P-07-44S	2007
P-07-45D	2007
P-07-46D	2007
P-07-47D	2007
P-07-48D	2007
P-07-48S	2007
P-07-49D	2007
P-07-49S	2007
P-07-50D	2007
P-07-50S	2007
P-07-50SS	2007
P-07-51D	2007

P-07-51S	2007
P-07-52D	2007
P-07-52S	2007
P-07-53D	2007
P-07-53S	2007
P-08-54D	2008
P-08-54S	2008
P-08-55D	2008
P-08-55S	2008
P-08-56D	2008
P-08-56M	2008
P-08-56S	2008
P-08-57D	2008
P-08-58D	2008
P-08-58M	2008
P-08-59D	2008
P-08-59S	2008
P-08-60D	2008
P-08-60S	2008
P-08-61D	2008
P-08-61S	2008
P-08-62D	2008
P-08-62M	2008
P-08-62S	2008
P-08-63D	2008
P-08-63M	2008
P-08-63S	2008
P-08-64D	2008
P-08-64S	2008
P-08-65D	2008
P-08-65M	2008
P-08-65S	2008
P-08-66D	2008
P-08-66S	2008
P-08-67D	2008
P-08-67S	2008
P-08-68D	2008
P-08-69D	2008
P-08-69S	2008
P-08-70D	2008
P-08-70S	2008
P-08-71D	2008
P-08-71S	2008
P-08-72D	2008
P-08-72S	2008
P-08-73D	2008
P-08-73S	2008
P-08-74D	2008
P-08-74S	2008
P-08-75D	2008

P-08-75M	2008
P-08-75S	2008
P-08-76D	2008
P-08-76S	2008
P-08-77D	2008
P-08-77S	2008
P-08-78D	2008
P-08-78S	2008
P-08-79D	2008
P-08-79M	2008
P-08-79S	2008
P-08-80D	2008
P-08-80M	2008
P-08-80S	2008
P-08-81D	2008
P-08-81S	2008
P-08-82D	2008
P-08-82M	2008
P-08-82S	2008
P-08-83D	2008
P-08-83M	2008
P-08-83S	2008
P-08-84D	2008
P-08-84S	2008
P-08-85D	2008
P-08-85S	2008
P-08-86D	2008
P-08-86S	2008
P-08-87D	2008
P-08-87S	2008
P-08-88D	2008
P-08-88S	2008
P-08-89D	2008
P-08-89M	2008
P-08-89S	2008
PW-1	2004
PW-1B	2004
PW-3	2004
PW-4	2004
PW-5	2005
PW-6	2005
PW-7 (Attempt #1)	2005
PW-7	2005
PW-8	2005
PW-08-9	2008
PW-08-10	2008

THE pebble PARTNERSHIP

HH-07-S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** HH-07-S

DATE STARTED 10/4/07 **COMPLETED** 10/4/07 **GROUND ELEVATION** 1375 feet **TOC ELEVATION** N/A

DRILLING CONTRACTOR Foundex **NORTHING** 2147420.2 feet **EASTING** 1372153.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-6 feet
5					6.0 SW **Silty Sand and Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 5/8"; fine to coarse grained sand, wet	DTW measurement attempted, too much silt inside rods, 7 feet
					8.0 SW **Silty Sand** brown, some subangular to subrounded gravel, <25% of clasts are fractured, clasts up to 1/2"; fine to coarse grained sand, moist to wet	
10	GB				10.0 GM **Sandy Gravel** brown, angular to rounded gravel, predominantly subrounded, <10% of clasts are fractured, clasts up to 1"; predominantly coarse grained sand, some silt, moist	Clast supported breccia contains subangular to rounded clasts varying in size up to 2"; Fracturing and drilling speed vary throughout unit, 11-126.7 feet DTW measurement attempted, too much silt inside rods, 12 feet
					11.0 **Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, mostly fractured, clasts up to 3/4", weathered, moist to wet	
15	GB				14.0 **Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, mostly fractured, clasts up to 1", weathered, wet	
		Above ground surface	0.25		17.0 **Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, wet	Start seeing water flowing up around casing, flow test may be biased low, 17 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type:
Diameter:

WELL CASING
Stickup:
Type:
Diameter:

SURFACE SEAL
Mix Used:

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type:

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Borehole backfilled but grout and cement not able to set due to flowing water; Piezometer not installed

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

HH-07-S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** HH-07-S

DATE STARTED 10/4/07 **COMPLETED** 10/4/07 **GROUND ELEVATION** 1375 feet **TOC ELEVATION** N/A

DRILLING CONTRACTOR Foundex **NORTHING** 2147420.2 feet **EASTING** 1372153.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				**Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, wet	
			0.1			
25	GB					
			0.25			
30	GB					Periodically adding water while drilling beginning at 31 feet
35	GB					
			0.75			Significant water flowing up around casing, flow estimated at 5-10 GPM, 37 feet
40	GB					
45	GB					
		29.58	1.0			Depth to water rising, 47 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

HH-07-S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** HH-07-S

DATE STARTED 10/4/07 **COMPLETED** 10/4/07 **GROUND ELEVATION** 1375 feet **TOC ELEVATION** N/A

DRILLING CONTRACTOR Foundex **NORTHING** 2147420.2 feet **EASTING** 1372153.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB				**Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, wet	
55	GB	Above ground surface	5			Flow rates based on visual flow into sump, most water coming up around casing rather than through the cyclone, 57 and 62 feet
60	GB	24.0	5			
65	GB					
70	GB		5			Not able to do an accurate flow measurement due to artesian conditions, 72 feet
75	GB					

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

HH-07-S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** HH-07-S

DATE STARTED 10/4/07 **COMPLETED** 10/4/07 **GROUND ELEVATION** 1375 feet **TOC ELEVATION** N/A

DRILLING CONTRACTOR Foundex **NORTHING** 2147420.2 feet **EASTING** 1372153.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB		>75		**Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, wet	Hit saturated zone, very clean water; DTW attempted, unstable water level in borehole, 82 feet
85	GB					
			20			Little recovery, 88-94 feet
90	GB					
95	GB		>30			
100	GB		20 to 30			
		Above ground surface	>50			
105	GB					
	GB	Above ground surface	60 to 80			
			60 to 80			

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

HH-07-S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** HH-07-S

DATE STARTED 10/4/07 **COMPLETED** 10/4/07 **GROUND ELEVATION** 1375 feet **TOC ELEVATION** N/A

DRILLING CONTRACTOR Foundex **NORTHING** 2147420.2 feet **EASTING** 1372153.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB				**Bedrock (Clast Supported Breccia)** brown matrix with multicolored clasts, wet	
			60 to 80			
115	GB				115.0 **Bedrock** predominantly gray to black multicolored, fractured, clasts up to 1", wet	Bedrock contact; Increase in water production; Slower drilling, 115-126.7 feet
			100 to 120			Move to open hole drilling
					118.0 **Bedrock** gray with brown clasts, fractured to pulverized, some small granitic looking clasts, <1/4", wet	
			100 to 120			
120					120.0 **Bedrock** predominantly grayish black and brown multicolored, fractured to pulverized, wet	
			100 to 120			
			100 to 120			
						Mostly pulverized; Little recovery, 124-126.7
125	GB		100 to 120			
					126.7	
			100 to 120		Bottom of hole at 126.7 feet.	Very competent bedrock, further drilling not beneficial

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

Pebble Project
NORTHERN DYNASTY MINES INC.

BORING NUMBER KP-P1/SRK-2

CLIENT | **PROJECT NAME** Pebble Gold Copper Project
PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska
DATE STARTED 8/23/04 **COMPLETED** 8/24/04 | **GROUND ELEVATION** | **WATER LEVELS** 50.7 feet
DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6642931 | **EASTING** 50372826
DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Stacey Cooper
NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat (PT)** Dark brown, moist, organic tundra, roots. **Clay (CL)** Light brown, dry to moist, 10% sub-angular gravel to 1/2", 5% fine sand, 85% clay fines.	SRK-2 sample.
10					Becoming more gravelly.	SRK2 sample. Driller adding water Flow IN
					14.0	SRK2 sample.
					Well-graded gravel w/ sand and clay (GW-GC) Brown, moist, 60% angular to sub-angular gravel to 3/4", 20% sub-angular to sub-rounded well-graded snad, 20% clay fines. 19.0	
20					**Well-graded gravel w/ snad (GW)** Gray/brown, moist, 70% well-graded sub-angluar to sub-rounded gravel, 25" well-graded angular to sub-angular fine to coarse sand, 5% fines.	Flow IN
					Slightly more fines, light brown.	Water- 8/24/04 Probably just a pool of water here- not water level (SC 8/26/04) Flow OUT
					28.0	
30					**Well-graded sand w/ gravel and clay (SC)** Gray to light brown, wet, 30% well-graded sub-angular to sub-rounded gravel to 1/2", 50% sub-angular sand fine to coarse, 20% fines.	Driller says soil is saturated, but not flowing anymore.
					35.0	

WELL COMPLETION INFORMATION

CASING
Top elevation (feet): 309m
Vent hole?:

WELLHEAD PROTECTION COVER
Type: steel monument
Weep hole?:
Concrete pad dimensions:

WELL CASING
Dia.: 2 inches
Type: Schedule 80 PVC

SURFACE CASING
Dia.: 5 inch
Type:

SCREEN
Type: 2-inch/Schedule 40 PVC Insta-pack
Slot size: 0.020"

SCREEN FILTER
Type: 10/20 Colorado Silica Sand
Quantity used: 3 bags

SEAL
Type: Coated Bentonite Pellets
Quantity used: 3 5-gallon buckets

GROUT
Mix used: Volcay, granular grout
Method of placement: Tremie pipe
Vol. in surface casing:
Vol. in well casing:

DEVELOPMENT
Method
Time:
Estimated purge volume:

Comments: TD was 174'. Filled rat hole with cuttings and transition sand- no natural cave-in. Grout was seeping into formation (gravels) so mixed some

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/7/05

(Continued Next Page)

Pebble Project
NORTHERN DYNASTY MINES INC.

BORING NUMBER KP-P1/SRK-2

CLIENT | **PROJECT NAME** Pebble Gold Copper Project
PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska
DATE STARTED 8/23/04 **COMPLETED** 8/24/04 | **GROUND ELEVATION** | **WATER LEVELS** 50.7 feet
DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6642931 | **EASTING** 50372826
DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Stacey Cooper
NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Well-graded gravel w/ sand (GW)** Gray/brown, moist, 60% well-graded sub-anglar to round gravel, 25% well-graded medium to coarse sand, 15% fines.	Gravel to 1/2". Driller adding water. Flow IN
						Flow IN
					As above.	SRK sample
50					A little more sand here. ▽	Flow IN SRK sample
60					50% gravel, 40% sand, 10% fines. Otherwise as above.	Flow IN SRK sample
						SRK sample
70					More gravel here again- like at 35'.	Flow IN SRK sample
						SRK sample
					Color beginning to change here- slightly rusted color with a few white limestone gravels and sands- 1st sign of bedrock?	
					74.0	Water. SRK sample 1650. Flow OUT Driller added water to get silt out of drill rig. Flow IN
80					**Silty sand (SM)** Gray, wet, 10% well-graded sub-angular gravel to 1/2", 60% well-graded medium to coarse sand, 30% fines.	
					80.0	Water here. SRK sample 1715. Flow OUT
					Sandy clay (CL) Gray, moist to wet, 5% sub-angular gravel to 1/4", 30% sub-angular well-graded sand, 65% fines.	
					85.0	SRK sample 1750. Flow OUT
90					**Sandy gravel w/ clay (GC)** Gray, wet 45% well-graded angular to sub-angular gravel to 1/2", 40% well-graded medium to coarse sand, 15% fines.	Flow IN SRK sample.
					As above.	Flow OUT

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/7/05

(Continued Next Page)

Pebble Project
NORTHERN DYNASTY MINES INC.

BORING NUMBER KP-P1/SRK-2

CLIENT | **PROJECT NAME** Pebble Gold Copper Project
PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska
DATE STARTED 8/23/04 **COMPLETED** 8/24/04 | **GROUND ELEVATION** | **WATER LEVELS** 50.7 feet
DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6642931 | **EASTING** 50372826
DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Stacey Cooper
NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					As above.	Driller reports water and that we're on top of some heaving sands, will shut down here for the night. 8/24/04
100					As above. Slightly more fines.	Flow OUT Driller still adding water too.
					As above.	SRK sample Flow OUT
110					As above.	SRK sample Flow OUT
					As above.	Flow OUT SRK sample
120					Still a Sandy Gravel with Clay (GC), but more clay here to at least 125'.	Flow IN & OUT SRK sample at 1023.
						Flow IN & OUT SRK sample 1040.
130					Back to 45% gravel, 50% sand, 15% Fines. (GC)	SRK sample 1050.
					As above.	SRK sample Flow IN/OUT
140					140.0 **Clay (CL)** Gray, wet, 10% well-graded sub-angular sand, 90% fines.	Nothing to sample at 140'. Just water and a tiny bit of clay and sand. Flow IN/OUT
						Flow IN/OUT Nothing to sample here. As above. Goes through strainer.
150					As above.	SRK sample 1230. Water sample practically. This is what 140' and 145' were like.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/7/05

(Continued Next Page)

Pebble Project
NORTHERN DYNASTY MINES INC.

BORING NUMBER KP-P1/SRK-2

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/23/04 **COMPLETED** 8/24/04 | **GROUND ELEVATION** | **WATER LEVELS** 50.7 feet

DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6642931 | **EASTING** 50372826

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Stacey Cooper

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					Some more cohesive clay here. Clay is high plasticity.	SRK sample 1255.
160					As above- (CL)	SRK sample. Flow IN/OUT
					165.0	
					167.0 **Silt (ML)** Light gray, wet, 10% sub-angular well-graded sand, 90% fines.	SRK sample 1330 Flow IN/OUT
170					**Well-graded gravel w/ sand (GW)** Gray (dark), wet, 70% well-graded angular gravel to 3/4", 20% angular to sub-angular sand, 10% fines.	SRK sample 1345 Flow IN/OUT
					Less sand here, more angular gravel. This is bedrock. Hit bedrock at 167'.	Drilling is slow due to tight gravels. Flow IN/OUT
					174.0	We're 7' into bedrock- Driller does not want to proceed further because he's afraid he will not be able to get the casing out. TD = 174' 15:45
					Bottom of hole at 174.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/7/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
KPPR	SRK-2	

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek LOCATION:
DEVELOPMENT CONTRACTOR: CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED: 1-inch Waterra foot valve with Surge block
START WATER LEVELS: 51.23 START: END: LOGGER:

MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 2 gpm
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER: Very cloudy after development

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Suction Depth (BTOC)
1648	5		>990				(Very Cloudy/Gray) - Heavy silt load, 2 Cups fine sand/silt	140
~~1652~~ 1708	40		>990	3.86	8.52	352	(Same as above) - Heavy silt load, 6 Tbs fine sand/silt	"
1715	50		>990				(Same As Above) - Heavy silt load 2 Tbs fine sand/silt	to 139.5
1728	75		>990	4.11	8.68	349	(Same As Above) - Heavy silt load 2 Tbs fine sand/silt	
1733	78		>990				(Same as Above) - Heavy silt load 1 Cup Fine Sand/silt	137.0
1745	110		>990	3.79	8.68	348	(Same as above) - Heavy silt load 1 Tbs fine sand/silt	
1752	120		>990				(Same as above) - Heavy silt load 2 Tbs Fine Sand	135.5
1812	160		>990	4.80	8.98	346	(Same as above), Less silt than above, 1 Tbs fine sand	
1818	170		>990				(Same as above) 2 Tbs Fine Sand	134
1835	220	92.5	>990	4.09	9.14	349	(Same as Above) Trace sand	
1844	230	Water level dropping below suction depth	>990				(Same as above), Less cloudy than above, 1 Tbs sand	132.5
1855	245		>990	3.89	9.53	362	(Same as above), Less cloudy than above, Trace sand	
1900	255		>990				(Same as above), Less cloudy than above, 1 Tbs sand	131
1910	275		630	4.33	8.85	346	(Same as above), Less cloudy than above, Trace	
Removed Surge block, cleared bottom								
1930	295		950	5.15	9.19	360	(Very Cloudy) Trace Sand	127
1938	310		>990	4.78	8.99	365	Still very cloudy with Trace sand. Stop development	
							* Lots of sand on bottom of well at end of development. Probably need down closer to 100 feet.	

Start: Total Depth = 140.50 End: Total Depth = 139.50

Pebble Project
NORTHERN DYNASTY MINES INC.

BORING NUMBER KP-P1/SRK-2A

CLIENT | **PROJECT NAME** Pebble Gold Copper Project
PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska
DATE STARTED 8/25/04 **COMPLETED** 8/26/04 | **GROUND ELEVATION** | **WATER LEVELS** feet
DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6642933.685 **EASTING** 372821.856
DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Stacey Cooper
NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat (PT)** Brown, moist, roots, trace gravel and sand. **Clay (CL)** Light brown, moist, 10% sub-angular gravel to 1/2", 5% fine sand, 85% clay fines.	IN-driller adding water OUT- Water out of hole Flow IN
10					10.0 **Well-graded gravel w/ sand and clay (GW/GC)** 60% angular to sub-angular gravel to 3/4", 20% angular to sub-angular sand, 20% clay fines. Fewer fines here.	Flow IN 1640
20					Back to 20% fines.	1655 Flow IN
					24.0 **Well-graded gravel w/ sand (GW)** Gray, moist, 65% well-graded sub-angular gravel to 1/2", 25% angular to sub-angular medium to coarse sand, 10% fines.	Flow IN
30						

WELL COMPLETION INFORMATION

CASING
Top elevation (feet): 290m
Vent hole?:

WELLHEAD PROTECTION COVER
Type: steel monument
Weep hole?:
Concrete pad dimensions:

WELL CASING
Dia.: 2 inches
Type: Schedule 40 PVC

SURFACE CASING
Dia.: 5 inch
Type:

SCREEN
Type: 2-inch/Schedule 40 PVC Insta-pack
Slot size: 0.020"

SCREEN FILTER
Type: 10/20 Silica sand
Quantity used: 5 bags

SEAL
Type: Bentonite Pellets
Quantity used: 4 5-gallon buckets

GROUT
Mix used: Volcay granular grout
Method of placement: Poured in dry hole @ 48'
Vol. in surface casing:
Vol. in well casing:

DEVELOPMENT
Method
Time:
Estimated purge volume:

Comments: TD=84'. Rat hole filled w/ 1' bentonite pellets, 3' filter sand. Bentonite bridged @ 53'. Screen separated from riser around 60' by about 6".

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/7/05

(Continued Next Page)

Pebble Project

NORTHERN DYNASTY MINES INC.

BORING NUMBER KP-P1/SRK-2A

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/25/04 **COMPLETED** 8/26/04 | **GROUND ELEVATION** | **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6642933.685 **EASTING** 372821.856

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Stacey Cooper

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Well-graded gravel w/ sand (GW)** Gray, moist, 65% well-graded sub-angular gravel to 1/2", 25% angular to sub-angular medium to coarse sand, 10% fines. Slightly more sand here.	Flow IN 1800 1155 8/26/2004 Flow IN
50					**Well-graded gravel w/ sand (GW)** Gray, moist, 65% well-graded sub-angular gravel to 1/2", 25% angular to sub-angular medium to coarse sand, 10% fines.	A little water here. Dripping from cuttings bin. Flow OUT Flow IN
60					**Well-graded gravel w/ sand (GW)** Gray, moist, 65% well-graded sub-angular gravel to 1/2", 25% angular to sub-angular medium to coarse sand, 10% fines. **Well-graded gravel w/ sand (GW)** Gray, moist, 65% well-graded sub-angular gravel to 1/2", 25% angular to sub-angular medium to coarse sand, 10% fines.	A little water here. A little water. Flow OUT
70					69.0 **Well-graded silty gravel w/ sand (GM)** Gray, moist, 50% well-graded sub-angular gravel to 1/2", 25% sub-angular to angular sand, 25% fines.	A little water here. Driller also adding water. Flow IN/OUT
80						Water here. More shooting out of casing. Flow OUT Change casing- more water then settles down. Greg adding water again. Flow IN
					84.0 **Well-graded silty gravel w/ sand (GM)** Gray, moist, 50% well-graded sub-angular gravel to 1/2", 25% sub-angular to angular sand, 25% fines. TD= 84' Bottom of hole at 84.0 feet.	Flow rate=5 gallons/minute. In well construction, well was lost. Bentonite bridged and screen was pulled apart from riser. Driller thinks 1" well could be installed within this. See well installation diagram.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/7/05

BORING NUMBER KP-P2/SRK-4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/14/04 **COMPLETED** 8/15/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641876 **EASTING** 5372904

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5	
					Sandy silt with gravel (ML) Brown, moist, fine sand, sub-angular gravel.	
					4.5	Collect sample at 4-5'. 1705.
					Well-graded sand w/ gravel (SW) Brown, moist, fine to coarse angular to sub-angular sand, gravel angular to sub-rounded up to 1/2".	Begin using water at 7'.
					8.5	
10					**Silty sand w/ gravel (SM)** Brown, moist, gravel is >3/4" possibly cobble.	Collect sample at 9-10'. 1720.
					12.0	(Well graded/poorly graded?)
					Gravel/cobbles w/ sand Brown, sands moist, gravels 1/2 to 3/4" fractured/angular.	Collect sample at 14-15'. 1740.
					17.0	
20					**Silt/clay w/ gravel (ML/CL)** Brown, moist, gravel is angular to sub-rounded 1/2-3/4", possibly larger rocks exist. Gravel = 10%.	Collect sample at 19-20'. 1810.
					24.0	Collect sample at 24-25'. 1830.
					Gravel/cobbles Brown, moist to dry, highly fractured material from medium samd to 3/4" gravel size, all appears to be broken rock.	
					27.5	
30					**Silty gravel/cobbles (GM)** Brown, moist, angular sand to angular/sub-angular gravels. Medium sand to 1/2" gravels.	Collect sample at 29-30'. 1845.
					31.5	
					Bedrock Bedrock or large boulder at 31.5', color changing to green/gray.	Collect sample at 34-35'. 0805.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): Boring abandoned

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: _____

Type: _____

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: _____

Slot size: _____

SCREEN FILTER

Type: _____

Quantity used: _____

SEAL

Type: _____

Quantity used: _____

GROUT

Mix used: _____

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: _____

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

(Continued Next Page)

BORING NUMBER KP-P2/SRK-4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/14/04 **COMPLETED** 8/15/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641876 **EASTING** 5372904

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					39.0 Bottom of hole at 39.0 feet.	Bedrock to 39'. End of boring. No well/ Abandon hole.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

BORING NUMBER KP-P3D/SRK-5D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/16/04 **COMPLETED** 8/17/04 **GROUND ELEVATION** _____ **WATER LEVELS** 1.71 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641294 **EASTING** 5371532

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat (OL)** Brown, moist, organics.	
					3.0 **Silty Gravel (GM)** Brown, dry to moist, gravel is angular to subrounded to greater than .75 inches. Less silty with depth.	
					Well-Graded Gravel with Sand and Silt (GW) Brown, dry, fine sands, round to angular gravel greater than .75 inches.	
10					As above, trace silts. Moist, subangular fine to coarse sand. Gravel subround to round to .5 inches.	Using water.
					As above, less silt, brown/gray, wet. Medium to coarse subangular to subround sand. Gravel angular to round up to .75 inches.	Water off.
20					21.0	
					Silty Gravel (GM) Brown, wet, gravel sub-angular to subround up to .75 inches, trace sands. 23.5	
					Clay with Trace Gravel (CL) Gray, moist.	Water on.
30					31.0 Increased gravel.	
					Well-Graded Gravel with Sand (GW) Brown, moist, angular to subround gravel to >.75 inches; fine to coarse subangular to round sand.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Sand

Quantity used: 4 50-lb bags

SEAL

Type: bentonite

Quantity used: _____

GROUT

Mix used: 30% solids Volclay

Method of placement: Tremie pipe

Vol. in surface casing: 50 gallons

Vol. in well casing: _____

DEVELOPMENT

Method N/A

Time: _____

Estimated purge volume: _____

Comments: Sealed off bottom bit with 6-12" bentonite plug topped with silica sand. Completed top with bentonite/cement mix, about 10 feet bgs to surfa

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

(Continued Next Page)

BORING NUMBER KP-P3D/SRK-5D

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/16/04 **COMPLETED** 8/17/04 | **GROUND ELEVATION** | **WATER LEVELS** 1.71 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 6641294 **EASTING** 5371532

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Matt Flynn

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	
					Well-Graded Sand with Gravel (SW) Brown, wet, medium to coarse, subangular to subrounded sand, subangular to subround gravel to .75 inches.	Sampled 44-45.
50					As above, more silt and clay (SW-SC) Brown to gray, wet, subangular to subround gravel to .5 inches.	
					Small lenses of clay, brown, moist, starting at 51 feet.	
					54.0	Drilled to 54 feet by COB 8/16/04.
					Clay (CL) Brown, moist, trace gravel.	
60					59.0	
					Well-Graded Sand with Gravel (SW) Gray, wet, medium to coarse, subangular to subround sand, subangular to subround gravel to .75 inches.	
					65.0	
70					**BEDROCK** White/reddish brown, wet, highly fractured.	
					79.0	
					Bottom of hole at 79.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
	SRK-5 Deep	SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek
DEVELOPMENT CONTRACTOR: CH2M Hill LOCATION:
DEVELOPMENT METHOD AND EQUIPMENT USED: 1 inch Waterra foot valve and surge block
START WATER LEVELS: 2.10 START: 9-3-04 END: LOGGER:
MAXIMUM DRAWDOWN DURING PUMPING: 0.9 - feet
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED: 215 - Gal
DISPOSITION OF DISCHARGE WATER: Water cleared up quickly. Very small amount of silt observed in water, Trace amount of Litter pack observed in water during development.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Surge Depth
1300								
1305	5	—	~~29~~ 290	3.05	5.39	62	Pump depth 80.00 (Very Cloudy, Light Brown) ½ cup Sand / 5 gal	80
1313	20	2.9	-	-	-	-	(Cloudy) water clearing up quickly, 1 Tbs Sand / 5 gal	~~70~~ 78.5
1320	40	3.0	130	2.79	5.39	62	(") Trace Litter pack Sand	"
1323	45	-	~~71~~ 71	2.90	5.63	63	(") ~~Same as above~~ Slightly less Cloudy	77
1333	70		59	2.74	5.85	66	(Same as Above)	76.5
~~1340~~ 1348	~~140~~ 105	~~3.15~~ 3.2	48	2.92	6.19	65	(Clear) Trace Litter pack	74.0
1401	140	3.15	48	2.85	6.15	65	~~(Clear)~~ (Slightly ~~Cloudy~~ Cloudy)	72.5
1413	165	—	41	2.80	6.05	65	(Slightly Cloudy)	71.0
1430	190	Remove	Surge	block,	clear	bottom	of well	
1440	200	—	49	2.90	6.19	64	(Slightly Cloudy)	68
1447	215	—	52	2.85	6.01	64	(Slightly Cloudy)	68

Start: Total Depth = 80.45
Depth to Water = 2.10
Stick Up = 2.20

End: Total Depth = 80.45
Depth to Water = 2.4

ANC/Pebble_Att_1_Forms.xls/980560014

BORING NUMBER KP-P3M/SRK-5M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/17/04 **COMPLETED** 8/17/04 **GROUND ELEVATION** _____ **WATER LEVELS** 16.1 feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641298 **EASTING** 5371535

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peet (PT)**	
					2.0 **Organic Soil (OL)** Brown, moist, organics.	
					3.0 **Silty Gravel (GM)** Brown, dry to moist, gravel is angular to sub-rounded up to >3/4", less silt with depth.	Flow IN. Adding water to drill.
					Well-graded gravel w/ sand (GW) Brown, dry to moist, medium to coarse sub-angular to sub-rounded sand, angular to rounded gravels up to >3/4".	Flow IN
10					**Well-graded gravel w/ sand (GW)** Brown, dry to moist, medium to coarse sub-angular to sub-rounded sand, angular to rounded gravels up to >3/4".	Flow IN
					Medium to coarse sub-angular to sub-rounded sand and gravels to >3/4". ▽	Wet at 13.5'
20						Flow OUT at 2-4 gpm.
					23.5	
					Clay w/ gravel (CL) Gray, moist.	
30					Some medium sand and gravel in clay. Approximately 10-15%.	
					32.0	
					Well-graded gravel w/sand (GW) Light brown to yellowish gray, moist, sands are sub-angular to	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: N/A

WELLHEAD PROTECTION COVER

Type: 6" steel casing

Weep hole?: N/A

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: 5 inches

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Silica sand

Quantity used: 6 50-lb bags

SEAL

Type: Bentonite

Quantity used: 2 50-lb buckets

GROUT

Mix used: 30% Solids Volclay

Method of placement: Tremmie Pipe

Vol. in surface casing: 40 gallons

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Bottom of hole 2' bentonite w/ 1' of silica. Volclay grout to about 8' bgs. Cement grout to surface.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

(Continued Next Page)

BORING NUMBER KP-P3M/SRK-5M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/17/04 **COMPLETED** 8/17/04 **GROUND ELEVATION** _____ **WATER LEVELS** 16.1 feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641298 **EASTING** 5371535

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					sub-rounded, medium to coarse, gravel is angular to sub-rounded up to >3/4". Trace silts.	Wet at 40'
					41.0 **Well-graded sand w/gravel (SW)** Brown to yellow orange, wet, med to coarse sand sub-angular to sub-rounded, gravel is sub-rounded to 1/2".	Flow OUT at 5 gpm.
50					Color change to gray at about 49'.	Flow OUT at 3-6 gpm.
					52.0 Small pellets of Clay (CL), grey mixed in with well graded sand w/ gravels (SW) begining at 51'.	
					53.0 **Clay (CL)** Gray, moist.	
					Bottom of boring 53' on 8/17/04	
					Bottom of hole at 53.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	SRK-5 mid	

WELL DEVELOPMENT LOG

PROJECT: Pebble Mine LOCATION:
DEVELOPMENT CONTRACTOR: Layne Hill
DEVELOPMENT METHOD AND EQUIPMENT USED: 1-inch Waterra with surge block
START WATER LEVELS: ~~8.90~~ 16.40 feet START: 1555 9.1.09 END: 1920 LOGGER: DC
MAXIMUM DRAWDOWN DURING PUMPING: NA
RANGE AND AVERAGE DISCHARGE RATE: 2.3 gpm
TOTAL QUANTITY OF WATER DISCHARGED: 450 gallons
DISPOSITION OF DISCHARGE WATER:
water slightly cloudy at the end of development

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Depth to Sediment
1555	-	-					Very cloudy, High silt/sand Gray	53.5'
1630	85	-	>990	3.13	6.89	95	" Did not clear up much, slightly less silt	52
1638	100	-	770	3.36	6.83	94	Vcl, Gray, 1Tbs silt	50.5
1658	150	-	640	3.41	6.86	92	Vcl, Light Brown 0.5 Tbs Sand	49
1719	200	-	7990	3.72	6.89	92	Same as above, 0.5Tbs Sand	47.5
1740	250	-	620	3.70	6.87	92	Same as above 2.0 Tbs silt	46
1800	300	-	~~510~~	-	-	-		"
1815	335	-	~~240~~ 510	3.45	6.80	92	Same as above, Slightly less cloudy	44.5'
1823	345	-	240	3.55	6.74	92	Same as above Slightly less cloudy	Pump set to 46'
1858	410	-	56	4.16	6.87	94	Same as above, slightly more cloudy	52
1900	Removed surge block, cleaned bottom of well							
1909	425	-	99	3.72	6.83	89	Cloudy, Gray	42
1920			58	3.47	6.75	92	Slight cloudy	"

* No water levels collected because of poor access

Start
Total Depth - 54.17'
Depth to Water - 16.40'
Stickup - 2.7'

End

ANC/develop form.xls/980560014

BORING NUMBER KP-P3S/SRK-5S

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/18/04 **COMPLETED** 8/18/04 | **GROUND ELEVATION** | **WATER LEVELS** 11.36 feet

DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6641294 **EASTING** 5371541

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Matt Flynn

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** 1.5 **Organic Soil (OL)** 3.5 **Silty gravel (GM)** Brown, dry to moist, gravel is angular to sub-angular >3/4".	
					Well-graded gravel w/ sand (GW) Brown, dry to moist, med-course sand sub-angular to sub-rounded, angular to rounded gravels up to >3/4".	60% gravel and 40% sands
					7.0 **Well-graded sand w/ gravel (SW)** Brown, moist, med-course sand sub-angular to sub-rounded, angular to rounded gravels up to >3/4".	Driller notes water at 8'. Cuttings are shiny wet but no flowing water out of hole.
10					**Well-graded sand w/ gravel (SW)** Brown, moist, med-course sand sub-angular to sub-rounded, angular to rounded gravels up to >3/4".	70% sands and 30% gravel
					Well-graded sand w/ gravel (SW) Brown, moist, med-course sand sub-angular to sub-rounded, angular to rounded gravels up to >3/4".	60% sands and 40 %gravel
					16.5 **Well-graded sand w/ gravel (SW)** Brown, moist, med-course sand sub-angular to sub-rounded, angular to rounded gravels up to >3/4".	75% sands and 25% gravel
					18.0 **Poorly-graded sand (SP)** Brown, moist to wet, medium sub-angular sand.	30% sands and 70% fines
20					**Clay w/ sand (CL)** Brown, moist, sand is medium and sub-angular.	
					24.0 Mottled color of brown/gray starting at 23'	5% gravels, 25% sands, and 70% fines
					Bottom of boring at 25' on 8/18/2004 Bottom of hole at 24.0 feet.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet):

Vent hole?:

WELLHEAD PROTECTION COVER

Type: 6" steel casing

Weep hole?: N/A

Concrete pad dimensions:

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: 5 inch

Type:

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Silica sand

Quantity used: 6 bags

SEAL

Type: Bentonite

Quantity used: 1 5-gallon buckets

GROUT

Mix used: N/A

Method of placement:

Vol. in surface casing:

Vol. in well casing:

DEVELOPMENT

Method

Time:

Estimated purge volume:

Comments: Cement 3' to surface.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	SRK-5 Shallow	

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek LOCATION:
DEVELOPMENT CONTRACTOR: CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED:
START WATER LEVELS: 11.76 ft START: 1023 9/2/04 END: LOGGER: D. Lacey

MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 2-gpm - 1 gpm - Ave = 1.6 gpm
TOTAL QUANTITY OF WATER DISCHARGED: 400 gals
DISPOSITION OF DISCHARGE WATER: Heavy silt load at each step of development. It took approximately 30 min. at each step to reduce sediment load. Final water Crystal clear. NTU = 23.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Suction Depth BTOC
~~1023~~ ~~1025~~								
1026	5						(Light Brown, Very Cloudy) Heavy sediment load, 1.5 Cups Fine Sand	21'
1102	80	12.11	>990	5.28	5.94	41	(Same as above) Less silt & Tbs Fine Sand/Silt	
1109	95	-	-	-	-	—	(Same as above) ½ Cup Fine Sand/Silt	19.5'
1134	145	11.99	>990	5.37	5.95	37	(Same as Above), Less silt than Above, 1 Tbs Fine Sand/Silt	
1140	155		>990				(Same as Above) 2 Tbs Fine Sand/Silt	18'
1203	215	12.03	690	5.48	6.18	37	(Same as above), Less silt than Above, 1 Tbs Fine Sand	
1216	225		>990				(Same as above), Heavy silt load, 2 Tbs Fine Sand/Silt	16.5'
1246	285	12.02	570	5.77	6.12	36	(Same as Above), Less silt than above 0.5 Tbs Sand/Silt	
1250	290		>990				(Same as Above), Heavy Silt Load, ½ Cup Fine Sand/Silt	15.0
1323	325		740	4.16	6.08	37	(Same as Above), Less Silt than above, 1 Tbs Fine sand/Silt	
1333	335	11.95	>990				(Same as Above) Heavy Silt load, ½ Cup Fine Sand/Silt	13.5
1352	355		640	4.72	5.95	36	(Same as Above), Less Silt than above 0.5 Tbs Sand/Silt	
1355	360		97	5.10	5.84	37	(Slightly Cloudy), Above Screen Trace Sand/Silt	12.00
1406	370		8.80	4.08	5.98	38	(Very Cloudy/Light Brown, Heavy Silt load, Cleared up quickly	21.0'
Removed Surge Block, Cleaned bottom of Well								
1425	395		4.4	6.24	6.05	32	(Crystal Clear)	
1434	400		23	4.99	6.05	34	"	

Start: Total Depth = 21.68 - 6' BTOC
End: Total Depth =

ANC/attach1sampleforms.xls/980560014

BORING NUMBER KP-P4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/15/04 **COMPLETED** 8/15/04 **GROUND ELEVATION** _____ **WATER LEVELS** 23 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641705 **EASTING** 5372842

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** 2.0 **Silt with Sand and Gravel (SM)** Dark brown, moist.	
					Silty Sand with Gravel (SM) Brown, moist, fine to medium sand. Angular to subround gravel .25 to >.75 inches.	Collected sample 4-5 feet.
					7.0 More gravel with depth.	
10					**Gravel/Cobble with Silt (GP)** Brown, moist (almost dry). Gravel is .125 to .75 inches angular to subangular.	Collected sample 9-10 feet.
					12.0 Increasing sand.	
					Silty Gravel (GM) Brown, moist.	Collected sample 14-15 feet.
					16.0 Increasing silt with depth.	
20					**Silt/Clay with Sand and Gravel (ML)** Brown, moist, with subangular to subround medium to coarse sand.	Collected sample 19-20 feet.
					20.0 Angular to subround gravel .125 to .5 inches.	
					Cobbly Gravel with Silt (GM) Brown, moist. Angular gravel from small to .75 inches.	Collected sample 24-25 feet.
					Olive green rock with brown silts.	
30						Only small amout sampled 29-30 feet at 1600.
					34.0	Sampled 34-35 feet at 1630.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. steel casing with lid.

Weep hole?: no

Concrete pad dimensions: 8 inches

WELL CASING

Dia.: 2 inches

Type: Schedule 80 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10-20 Silica sand.

Quantity used: 1/2 bag on filter/screen

SEAL

Type: Bentonite pellets

Quantity used: 1 5-gallon bucket.

GROUT

Mix used: 30% solids Volclay

Method of placement: Tremie pipe

Vol. in surface casing: 60 gallons

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Backfilled bottom of hole 1042 feet with cuttings/bentonite mix. Top of this was 2' layer of bentonite with 1 foot layer of sand.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER KP-P4

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/15/04 **COMPLETED** 8/15/04 | **GROUND ELEVATION** | **WATER LEVELS** 23 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 6641705 **EASTING** 5372842

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Matt Flynn

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40				35.5	**Gravelly Sand with Silt (SP)** Brown/grey, wet, medium poorly graded, subangular to subround sand, angular to subround gravels to 0.5 inches. Becoming siltier with depth. *(continued)*	Sampled.
					Silty Sand with Gravel (SM) Brown, moist. Fine, subround to coarse subround sand. Gravels subround to round up to .5 inch. Approximately 10-15% silt.	
				42.0	**Poorly Graded Gravelly Sand (GP)** Brown/green, moist. Subangular to subround, medium to coarse sand; subangular to subround gravel to .5 inch, trace silts.	Collected sample 44-45 feet.
50					**Sandy Gravel/Cobble (GP)** Brown/gray, moist (almost dry) trace green. Subangular to subround, medium to coarse sand. Subangular to subround gravel to .5 inch.	14-50 feet at 1750.
				53.0		
				54.0	**BEDROCK** Gray/green, dry. Fractured and angular. Bottom of hole at 54.0 feet.	1820.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER KP-P4	SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek LOCATION: 371532 E 6641710 N
DEVELOPMENT CONTRACTOR: CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED: 1-inch Waterra
START WATER LEVELS: 25.45 START: 1151 9-3-04 END: LOGGER: D. LACEY
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 1.5 to 1.0 gpm
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER: Slow pumping rate, < 1.0 gpm sustainable. End development water still cloudy.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	
1154	5		>990				(Very Cloudy / Brown) - Heavy silt load 1 cup fine sand	45.5
1200	20	44.6	>990				(Same as above) - " ½ cup fine sand	
1207	25		>990				(Same as above) - " ½ cup fine sand	44.0
1227	30		>990				(Same as above) - Less silt than above, ½ cup fine sand	42.5
1244	40		>990				(Same as above) - Less silt than above, ¼ cup fine sand	
1253	45		>990		7.90	144	(Same as above) " Trace sand	41.0
1305	55		700	3.60	7.70	145	(Same as above) - Less silt than above, Trace sand	39.5
1316	60		>990	4.80	7.80	144	(Same as above) - Trace sand	38.0
1335	70						(Same as above) Trace	36.5
1341	80		>990				(Same as above) - Less cloudy Trace	
Remove surge block clean bottom of well.								
1402	90	33	310	4.61	7.95	141	(Cloudy/Brown) Ab sand	33
1412	95		640	4.01	7.61	138	Same as above	
1425	103		250	5.52	7.55	139	End development	

Note: Slow recharge. I had to stop several times to allow the well to recharge

Start: Total Depth = 46.10 Depth to Water = 25.45 End: Total Depth = 46.10

ANC/Pebble_Att_1_Forms.xls/980560014

BORING NUMBER MW-1D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/24/04 **COMPLETED** 7/24/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6632496 **EASTING** 364146

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Peat (PT)** Brown, moist, soft.	
					3.0 **Well-graded sand w/ trace gravel to 3/8" (SW)** Brown, moist, fine to medium sand.	
					6.0 **Poorly-graded sand (SP)** Brown, moist, medium to fine sand, trace gravel to 3/8".	
10					Wet at 11-12'	
					13.0 **Well-graded gravel with sand (GW)** Brown, moist, sub-angular to rounded gravel to 1/2"	Lost shoe. Pull string and move 3'.
20					Gravel is sub-angular to rounded up to 1". Medium to fine sand approximately 25%.	
30					Sand content approximately 40%. Gravel same as above.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80 PVC

SURFACE CASING

Dia.: 5 inches

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Silica sand

Quantity used: _____

SEAL

Type: Bentonite

Quantity used: 0.5 5-gallon bucket

GROUT

Mix used: 30% Solids Volclay

Method of placement: Tremmie Pipe

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: _____

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-1D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/24/04 **COMPLETED** 7/24/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6632496 **EASTING** 364146

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Sandy well-graded gravel (GW)** Brown, wet, sub-angular to rounded gravel to 1", medium sand.	Flow YES/OUT
					Sandy well-graded gravel (GW) Brown, wet, sub-angular to rounded gravel to 1", medium sand.	Cond=0-1, pH=6.1 Flow YES/OUT
					70% gravel, 30% sand	
50					Sand content increasing. 60% gravel, 40% sand.	
					54.5	
					Well-graded sand with gravel (SW) Brown, moist to wet, medium to coarse sub-angular sand, sub-angular to rounded gravel up to 3/4". 60% sand, 40% gravel.	
60						Collect water at 65'. Specific Condition=5.7, pH=6.55
					Same as above.	
70					Same as above.	
					Same as above.	
80					**Gravelly well-graded sand (SW)** Brown, wet, sand is fine to coarse, gravel up to 3/4". Approximately 65% sand, 35% gravel.	
						Flow YES/OUT
					Decreasing sand.	
90					90.0	
					Well-graded gravel with sand (GW) Brown, wet, find sand to 3/4" gravel. Sub-angular gravel and sub-angular sand. 35% sand and 65% gravel	Flow YES/OUT, Specific Condition=5.3,

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-1D

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/24/04 **COMPLETED** 7/24/04 | **GROUND ELEVATION** | **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun | **NORTHING** 6632496 **EASTING** 364146

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Matt Flynn

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					45% sand and 55% gravel	pH=6.04 Collect water at 95'. Flow YES/OUT
					105.0 Same	
					Silty gravel with sand (GM) Tan/brown, saturated. 20% silt, 30% sand, 50% gravel	
110						Flow YES/OUT
120					**Poorly-graded sand with gravel and silt (SP-SM)** Brown, wet, fine sand, sub-rounded gravel to 1/2".	Flow YES/OUT, Specific Condition=5.2, pH=6.52
					128.0	
130					**Bedrock** White/green, wet, calcified rock with pyrite. HCl test confirmed.	Flow YES/OUT, Specific Condition=5.9, pH=6.14 Water sample at 132'.
					134.5	
					Bottom of boring at 134.5' at 16:00 on 7/24/04 Bottom of hole at 134.5 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-1D SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : START : 8/17/04 925 END : 8/17/04 1200 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 5 Gallons / 2 minutes
TOTAL QUANTITY OF WATER DISCHARGED: ~ 310
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
0927	5		990	3.94	6.65	80	Coffee w/cream, ½ c. very fine sand, silt. @ 134'
0945	50		990	3.93	6.83	68	Same color - 1 Tbs Fines,
0950	60		990	3.94	6.57	69	Same color, little lighter ½ Tbs fines - move to 130'
0955	70						Tan, ½ Tbs fine Sand. ~~Moved to 130'~~ (fines)
~~1005~~ 1012	~~82~~ 105						Tan, tiny bit of Sand, moved to 130'
1010	90						Tan, ½ Tbs fines.
1020	115						Lighter tan, few fines - hardly any. Moved to 128'
1025	125						Tan ~ 2 Tbs Fines.
1035	150						Lighter Tan ~ 0.5 Tbs Fines moved to 126'
1037	155						Lighter Tan ~ 0.5 Tbs Fines
1047	165						Light tan, no fines - Moved to 124'
1050	170						" " Moved to "122' - above screen?
1052	175						Light tan - no fines, Took bottom Surge block off & went to ~~134~~ 135
1105	190						Light tan ~ 0.25 c. Fine Sand.
1120	215		610	5.02	6.94	68	Light tan - no fines.
1127	230		280	4.37	6.39	67	Very light tan, cloudy, air bubbles. no fines. Moved to ~123'.
1131	240		230	4.62	6.35	68	White, cloudy - no (
1144	270		610	4.48	6.42	67	Light tan, cloudy, no fines - a little PVC Pipe.
1158	305		200	4.51	6.87	65	" " "
1201	310		190	4.49	6.89	66	Tan/white, cloudy, no fines no more pipe. Stopped here. "After" Filter is White.

BORING NUMBER MW-1M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/22/04 **COMPLETED** 7/22/04 **GROUND ELEVATION** App. 1,000 ft. AMSL **WATER LEVELS** 8.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5954.44 **EASTING** -15518.37

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Dark brown, moist, blocky, fibrous mat with fine sand and subangular gravel to 0.5 inches.	Drill cuttings, drilling action and rate indicate organics, silts and fine sands. Drilling rate is 2.5 ft/min.
					Silty Gravel (GM) Light brown, wet, subangular gravel to 0.5 inches with fine to medium subangular sand and trace silt.	Drill cuttings, drilling action and rate indicate gravels and sands.
					7.0	Drill cuttings, drilling action and rate indicate gravels and sands. Increasing sand fraction. Drilling rate is 1 ft/min.
					9.0 ▽ **Poorly Graded Sand (SW)** Brown, moist to wet, uniform subangular, medium sand with trace round gravel to 0.5 inches and trace silt.	Drill cuttings, drilling action and rate indicate sands. Drilling rate is 1 ft/min. Increasing gravel fraction.
10					**Well Graded Gravel with Sand (GW)** Brown, wet, platy, subround gravel to >1 inch with fine to coarse subangular sand and trace silt.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Flow rate is < 0.1gpm. Flow IN
					17.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Increasing gravel fraction.
					Poorly Graded Gravel with Sand (GP) Brown, wet, platy, subround gravel to >1 inch with medium to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 2 ft/min. Flow rate is < 0.1 gpm. Flow IN
20					Increasing gravel fraction and coarse sands.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
30						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 2 ft/min.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 2.5 cubic feet

SEAL

Type: PureGold medium bentonite chips

Quantity used: 1 5-gallon bucket

GROUT

Mix used: 10 lbs VOLCLAY grout, 100 lbs Portland cem

Method of placement: Tremie pipe from bottom up

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: 3 foot rathole filled with PureGold medium bentonite chips/ 1 5-gallon pail CSSI 10-20 silica sand/ 1 cubic foot.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-1M

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/22/04 **COMPLETED** 7/22/04 | **GROUND ELEVATION** App. 1,000 ft. AMSL **WATER LEVELS** 8.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 5954.44 **EASTING** -15518.37

DRILLING DRILLING METHOD | **EQUIPMENT** **LOGGER** Rob Crotty

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					Increasing sand fractions.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1.5 ft/min. Flow rate is < 0.3 gpm. Flow IN
					40.0	
					Gravelly Sand (SP) Brown, wet, medium to coarse, subangular sand with subround gravel to >1 inch.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					46.0	Drill cuttings, drilling action and rate indicate gravels and sands.
50					**Poorly Graded Gravel with Sand (GP)** Brown, wet, platy, subround gravel to >1 inch with medium to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 2 ft/min. Increasing gravel fraction. Flow is 2 gpm - IN. 6.3 mS/m, pH = 6.3
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					55.0	Flow rate = 10 gpm. Specific Conductivity = 5.6 mS/m, pH = 6.3
					Gravelly Sand (SP) Brown, wet, medium to coarse subangular sand with subround gravel to >1 inch.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Same flow rate.
60						
					62.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Poorly Graded Gravel with Sand (GP) Brown, wet, platy, subround gravel to >1 inch with medium to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Same flow rate.
70						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 0.5 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 0.5 ft/min. Flow rate = 10 gpm. Specific conductivity = 6.1 mS/m. pH = 6.3. Flow IN
80					80.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Poorly Graded Gravel with Sand (GP) Brown, wet, subround gravel to >1 inch with medium to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1.5 ft/min. Flow rate = 10 gpm, Specific conductivity = 1 mS/m, pH = 6.3.
90					Increasing sand fraction.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					93.0	
					Silty Gravel (GM) Light brown, wet, subangular	Flow Rate = 7gpm. IN. Specific

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-1M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/22/04 **COMPLETED** 7/22/04 **GROUND ELEVATION** App. 1,000 ft. AMSL **WATER LEVELS** 8.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5954.44 **EASTING** -15518.37

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					gravel to 0.5 inches with fine to medium subangular sand. 100.0 Bottom of hole at 100.0 feet.	Conductivity = 6.1 mS/m. pH=6.2. Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	NAW-1M	

WELL DEVELOPMENT LOG

PROJECT: Kodiak GW LOCATION:
DEVELOPMENT CONTRACTOR: CH2M
DEVELOPMENT METHOD AND EQUIPMENT USED: Waterra hydropulsar
START WATER LEVELS: 8.39 btoc START: 820 7/23/01 END: LOGGER: MMF
TD = 73.60'
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 2.0 gpm
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER: ground

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU) Not working right	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
822A	1.0		9914	4.31	5.47	5.0	DO 12.59 SAL 0.0 TDS 0.03
850A	4.0		7360	3.67	5.60	48	14.73 0.0 0.03
857	10.0		6604	4.35	5.81	4.9	1325 0.0 0.03 * sight methane
900	13.0		732	3.71	5.77	4.9	1381 0.0 0.03
903	14.5		8832	3.71	5.79	4.9	1380 0.0 0.03
910	16.0		6871	3.80	5.80	4.9	1366 0.0 0.03
915	21.0		6881	3.79	5.80	4.9	1354 0.0 0.03

Note: Sond plugged last value 3 times Able to clean. Turbidity meter broken. Will, verify, clean upon completion of well development

ANC/attach1sampleforms.xls/980560014

BORING NUMBER MW-1S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/21/04 **COMPLETED** 7/21/04 **GROUND ELEVATION** App. 1,000 ft AMSL **WATER LEVELS** 6.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5954.1076801 **EASTING** -15516.1340719

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Dark brown, moist, blocky, fibrous organic mat	Drill cuttings, drilling action and rate indicate organics, silts, and fine sands. Drilling rate is 2.5 ft/min.
					3.5 **Organics with Silt (OL)** Dark brown, moist, includes mat and roots, trace fine sand and subangular gravel to 0.2 inches.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					7.0 ▽ **Poorly Graded Gravel with Sand (GP)** Brown, moist, platy, subround gravel to 1 inch with fine to medium subangular sand and trace silt.	Drill cuttings, drilling action and rate indicate sands. Drilling rate is 1.5 ft/min.
10					**Poorly Graded Sand (SP)** Brown, moist, uniform subround medium sand with trace round gravel to 0.5 inches and trace silt.	
					13.0 **Gravelly Sand (SP)** Brown, moist, subround medium to coarse sand with trace round gravel to <1 inch along with trace silt.	Increasing gravel fraction.
					Poorly Graded Gravel with Sand (GP) Brown, moist to wet, elongated, subround gravel to >1 inch with fine to coarse subangular sand and trace silt.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 0.8 ft/min. Increasing gravel fraction.
20					**Poorly Graded Gravel with Sand (GP)** Brown, wet, elongated, subround gravel to >1 inch with medium to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Increasing gravel fraction and coarse sands.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
30						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. 65% gravel, 35% sand, and <5% fines.
					32.0	
					35.0 **Gravelly Sand (SP)** Brown, moist, subangular fine to coarse sand with trace round gravel to 0.5 inches along	Drill cuttings, drilling action and rate

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 5" dia. by 6 ft Steel

Weep hole?: Yes

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 4 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 1 5-gallon bucket

GROUT

Mix used: None due to shallow groundwater

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: 96 hour lag after installation

Estimated purge volume: _____

Comments: 3 foot rathole filled with PureGold medium bentonite chips, 1 5-gallon pail. Note; Northing and Easting in WGS 84.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-1S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/21/04 **COMPLETED** 7/21/04 **GROUND ELEVATION** App. 1,000 ft AMSL **WATER LEVELS** 6.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5954.1076801 **EASTING** -15516.1340719

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					with trace silt. Bottom of hole at 35.0 feet.	indicate gravels and sands. Drilling rate is 1 ft/min. 45% gravel, 55% sand, and <5% fines.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	OMW-1S	

WELL DEVELOPMENT LOG

PROJECT: PEBBLE LOCATION:

DEVELOPMENT CONTRACTOR: D3L WATER CHECK VALVE w/ 1" Ø HOSE & POWER PUMP (CH2M HILL)

DEVELOPMENT METHOD AND EQUIPMENT USED:

START WATER LEVELS: 10.3 (AFTER) START: 1030 7/24/04 END: 7/24/04 LOGGER:

MAXIMUM DRAWDOWN ~~DURING~~ PUMPING:

RANGE AND AVERAGE DISCHARGE RATE:

TOTAL QUANTITY OF WATER DISCHARGED:

DISPOSITION OF DISCHARGE WATER: ON GROUND

Time	Water Volume Discharged (gal)	Water Level (ft BTOC) / (ft BGS)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
(A) 1630/23	90	10.3/8.8	—	—	—	—	Well used to make water for grout.
1030/24-7/24	0.5		999	7.25	5.39	2.9	DO 13.81 3.4L 0.0 TDS 0.02
11:00	2.0			5.47	5.47	2.9	13.05 0.0 0.02
11:05	3.5			5.50	5.26	2.8	12.9 0.0 0.02
11:09	6.0			5.10	5.5	2.8	13.09 0.0 0.02
11:11	8.0			5.18	5.51	2.7	12.58 0.0 0.02
11:13	9.0			5.40	5.52	2.7	12.45 0.0 0.02
11:15	11.0			5.07	5.55	2.6	12.44 0.0 0.02
11:20	15			5.24	5.53	2.5	12.12 0.0 0.02
11:26	20			5.59	5.6	3.2	12.51 0.0 0.02
11:31	25		*	4.71	5.6	3.0	*TURBID. PROBE BROKEN 12.51 0.0 0.2
11:35	29	15.1/13.6		6.33	—	—	(1) — — —
		(Well DRY @ 15.1 ft BTOC and/or 13.6 ft BGS)					(1) METHOD OF DEVELOPMENT PREVENTS MEASURING WATER LEVELS DURING DEVELOPMENT (2) WELL PUMPED DRY AFTER 30 gallons

(A) * check valve ~1' above bottom ~ 15.5' BTOC

ANC/attach1sampleforms.xls/980560014

BORING NUMBER MW-2D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/27/04 **COMPLETED** 7/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6631411 **EASTING** 370600

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Brown, moist.	
					Silty Sand with Gravel (SM) Brown, moist, fine to medium sand, gravel subangular to subround to 0.7 inches. Gravel 10%, sand 60%, fines 30%.	
10					Same as above.	
					Same as above. 17.0	
20					**Silt with Sand and Gravel (ML)** Brown, moist.	
					Becoming clay-like. Less coarse.	
					Silt. Brown, moist. Trace subangular to subrounded gravel to 0.5 inches.	
30					34.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 and Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: Native collapse

Quantity used: _____

SEAL

Type: Natural Cave-in

Quantity used: _____

GROUT

Mix used: 30% solids

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: Thursday: 4 bags Friday: 8 bags

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: 5' rathole filled with 1 5-gal bucket Bentonite chips.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-2D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/27/04 **COMPLETED** 7/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6631411 **EASTING** 370600

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Poorly-Graded Sand (SP)** Light brown to off-white. Dry to moist. Very fine sand, more silt with depth. Color changing to brown, moist.	
					40.0	
50					**Poorly-Graded Sand with Silt (SP-SM)** Moist, brown, fine-grained sand. Trace silt. Silt 5 to 10%.	
					Increasing silt. SM?	
					57.0	
60					**Silt/Clay with Sand (ML/CL)** Brown, moist to wet. Very fine-grained sand - 15%.	
					Same as above. Low plasticity.	
70						
					Silt/clay. Moist, trace sand. Low plasticity.	Broken shoe at 75'. Able to pull out and re-drill same hole.
80						
					Silt/clay (ML/CL) Brown, moist. Trace sand and gravel.	Driller using water to keep return hose clean and lubricate clay in well.
90					Increased gravel content.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-2D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/27/04 **COMPLETED** 7/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6631411 **EASTING** 370600

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					97.0	
					98.5 **Silty Sand (SM)** Brown, moist to wet. Very fine sand.	
100					**Poorly Graded Sand with Gravel (SP)** Brown, moist to wet. Fine sand, trace silt. Subangular gravel to 0.5 inches.	
					102.0	Very soft drilling.
					Well-Graded Sand with Gravel (SW) Brown, wet, medium to course subangular sand. Gravel is subangular to 0.75 inches. Trace silt.	
110					Same as above.	
					112.0	
					Well-Graded Gravel with Sand (GW) Brown, wet, medium to coarse sand. Subangular gravel to 0.75 inches. Very soft/loose.	
					117.0	
					119.0 **Poorly Graded Sand (SP)** Brown, moist, loose. Fine-grained.	
120					**Well-Graded Gravel with Sand (GW)** Moist to wet. Subangular to round medium grained sand. Gravel to 0.75 inches.	
					Same as above.	
130					133.0	Driller using water and unable to tell if moist or wet.
					133.5 **Silt (ML)** Lense of silt or clay. Wet, gray.	
					Well-Graded Gravel with Sand (GW) Brown/gray, moist to wet, subangular to round gravel to 0.75". Medium-grained sand.	
140					Same as above. Very wet.	
					143.0	
					Clay/Silt (CL-ML) Gray, moist to wet, trace gravel to 0.25 inches.	Driller using water to clean casing.
					147.0	Broken shoe.
					Bottom of hole at 147.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-2D SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR :
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : 86.91' BTOC START : 1130 8/17/04 END : 8/18/04 1830 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 5 Gal / 2 minutes
TOTAL QUANTITY OF WATER DISCHARGED: 675
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1736	5		990	3.74	8.50	62	Dark Brown, 1/4" layer sc fine silt in bot. @ ~~86~~ 139'
1750	40						Dark Brown - 2 Tbs fines Cloudy
1756	55		840	4.05	8.64	61	Brown - ~~2~~ 1 Tbs fines.
1823	125						Brown gray - 2 Tbs Fines,
8/18/04 0850	130						Brown/gray ~ 0.25 c. Fines
0925	215						Brown/gray ~ 1 Tbs Fines Moved to ~~84~~ 137' sc
0935	225						Brown/gray - ~ 0.25 c. Fines Sand
1015	275						Brown/gray, 1 3/4 1/2 Tbs fines moved to ~~88~~ -replaced broke waterra.
1022	285						Brown/gray - 0.25 c. Fines
1050	355						Brown/gray - 1 Tbs fines moved to ~~80~~ 134' sc
1115	415						Light Brown - 1 Tbs Fines, moved to ~~78~~ 132' sc
1120	425						Brown/gray ~ 2 Tbs fine Sand.
1203	500						moved to ~~90~~ 130' Brown/gray 1 Tbs Fines.
1206	505						Dark gray/Brown ~ 2 Tbs Fines.
1225	555						" " 1 Tbs Fines moved to ~~94~~ 128' sc
1230	560						" " 2 Tbs Fines.
1240	585						Clear water, no fines - moved to ~~92~~ (above Scrn?)
1250	610						Water clear - took of surge block & moved to bottom.
1305	645		96	8.85*	8.86	66	water clear, slight gray - no fines. moved to top of Screen for this reading above
1325	670		49	6.93	8.83	61	
1328	675		46	6.69	8.29	60	Water clear, slight gray, no fines stop here

* These readings not taken in flow through cell due to blown valve setup.

BORING NUMBER MW-2S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/25/04 **COMPLETED** 7/26/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6631406 **EASTING** 370601

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat (PT)** Dark brown, moist, with organics.	
					Silty Sand with Gravel (SM) Tan, moist. Gravel subangular to subround to 0.75 inches. Gravel = 10 to 15%, sand = 65-70%, fines = 20%.	
10					Same as above.	
					Same as above. 17.0	
20					**Silt with Sand and Gravel (ML)** Tan/brown, moist.	
					Silt, tan/brown, moist. Possibly with clay (not enough moisture to tell). Trace subangular gravel to 0.5 inches.	
30					34.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" Steel casing with lid

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: Native collapse

Quantity used: _____

SEAL

Type: .25" bentonite coated pellets

Quantity used: 1 5-gallon bucket

GROUT

Mix used: Volclay approx. 30% solids

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Waterra

Time: _____

Estimated purge volume: _____

Comments: 3 foot rathole filled with Bentonite pellets.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-2S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/25/04 **COMPLETED** 7/26/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6631406 **EASTING** 370601

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Poorly Graded Sand (SP)** Light brown/white, dry to moist. Very fine sand. Color changing to brown at 36 feet.	
					Brown, moist sand, poorly graded. Fine grained.	Drill string plugged at 45 feet.
50						
					57.0	
60					**Silt with Sand (ML)** Brown, wet, with 10-15% very fine sand; occasional clayey silt layers.	
					Clayey silt layer	
70						Very few cuttings making it to surface. Pushing aside with drill head.
						Very wet, lots of water in drill string. Unable to determine water carrying layer.
80					Silt/clay, brown, moist to wet.	
90					Trace gravel.	
					Increasing gravel with depth.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-2S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/25/04 **COMPLETED** 7/26/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6631406 **EASTING** 370601

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					98.0 99.0 **Well-graded Sand with Gravel (SW)** Brown, moist , fine to coarse subangular sand. Subangular to subround gravel to 0.5 inches. 101.0 **Well-graded Gravel with Sand (GW)** Brown/gray, moist, gravel to 0.75 inches subangular to round. Sand medium, coarse, subangular. Bottom of hole and drill string at 101 feet. Bottom of hole at 101.0 feet.	Broken shoe, pulled out and moved.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

BORING NUMBER MW-3D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/4/04 **COMPLETED** 8/4/04 **GROUND ELEVATION** _____ **WATER LEVELS** 171 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5950.44 **EASTING** -15518.37

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Dark brown, moist, blocky, fibrous mat. **Silty Gravel (GM)** Reddish brown, moist, subround gravel to 0.8 inches with some fine sand. 5.0	Drill cuttings, drilling action and rate indicate organics, silts and fine sands. Drilling rate is 2.5 ft/min.
					Well-Graded Gravel with Sand (GW) Brown, moist, platy, subround gravel to >1 inch with fine to coarse subangular sand and trace silt and occasional boulder and cobble.	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is 1 ft/min.
10					Increasing sand fraction.	Drill cuttings, drilling action and rate indicate gravels and sands. Increasing sand fraction. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Broken shoe at 14 feet.
					Increasing gravel fraction.	
20						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 0.5 ft/min.
						Decrease in drill rate
30						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <0.5 ft/min.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 8 cubic feet

SEAL

Type: PureGold medium bentonite chips

Quantity used: 1 5-gallon bucket

GROUT

Mix used: 20 lbs VOLCLAY grout, 200 lbs Portland cem

Method of placement: Tremie pipe from bottom up

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: No Rathole. Heaving sands from 205 to 195 ft.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-3D

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/4/04 **COMPLETED** 8/4/04 | **GROUND ELEVATION** | **WATER LEVELS** 171 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 5950.44 | **EASTING** -15518.37

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Rob Crotty

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					37.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <0.5 ft/min. Drillers notes boulders at 37 ft.
40					**Poorly Graded Gravel w/ Boulders (GP)** **GP and Boulders** 40.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Gravelly Sand (SP) Brown, moist, medium to coarse subangular sand with subround gravel to >1 inch and some silt 44.0	Note. Driller using water to supplement air rotary beginning at 42 ft.
					Increasing gravel fraction.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 2 ft/min.
50					**Poorly Graded Gravel with Sand (GP)** Brown, moist, platy, subround gravel to >1 inch with medium to coarse subangular sand. Occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands.
					55.0	Drill cuttings, drilling action and rate indicate gravels and sands.
60					**Gravelly Sand (SP)** Brown, moist, fine to coarse subround sand with subround gravel to >1 inch. 62.0	Drill cuttings, drilling action and rate indicate gravels and sands.
					Poorly Graded Gravel with Sand (GP) Brown, moist, subround gravel to >1 inch.	Drill cuttings, drilling action and rate indicate gravels and sands.
70					70.0	
					Silty Gravel (GM) Brown, moist, subround gravel to >1 inch with some fine sand. 73.0	Drill cuttings, drilling action and rate indicate gravels, silts and sands. Drilling rate is <1 ft/min.
					Well-Graded Gravel with Sand (GW) Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand; trace silt and occasional boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller notes casing is tight, sticking.
80						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No freestanding water encountered.
					Well-Graded Gravel with Sand (GW) Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand; trace silt and occasional boulder or cobble.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
90						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-3D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/4/04 **COMPLETED** 8/4/04 **GROUND ELEVATION** _____ **WATER LEVELS** 171 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5950.44 **EASTING** -15518.37

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100						Drill cuttings, drilling action and rate indicate gravels and sands.
						Drill cuttings, drilling action and rate indicate gravels and sands.
110						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
					110.0	
					Gravelly Sand (SP) Brown, moist, fine to coarse subangular sand with subround gravel to >1 inch, trace silt and occasional cobble or boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
					116.0	
120					**Poorly Graded Gravel with Sand (GP)** Brown, moist, subround gravel to >1 inch with coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
					120.0	
					Well Graded Gravel with Sand (GW) Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand, trace silt and occasional cobble.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
130						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
					135.0	
140					**Gravelly Sand (SP)** Brown, moist, fine to coarse subangular sand with subround gravel to >1 inch, trace silt and occasional cobble or boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
150					150.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
					Well-Graded Gravel with Sand (GW) Brown, moist, subround gravel >1 inch with fine to coarse subangular sand and trace silt.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-3D

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/4/04 **COMPLETED** 8/4/04 | **GROUND ELEVATION** | **WATER LEVELS** 171 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 5950.44 | **EASTING** -15518.37

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Rob Crotty

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
160					160.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
					Poorly Graded Gravel with Sand (GP) Brown, moist, subround gravel to 1 inch uniform medium subangular sand, trace silt and occasional cobble and boulder. Increasing sand fraction at 164 feet.	
					166.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min. Driller continued drilling with water. No (or very limited) freestanding water encountered.
170					**Gravelly Sand (SP)** Brown, moist, fine to coarse subangular sand with subround gravel to >1 inch, trace silt and occasional cobble or boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
					171.0▽	
					Poorly Graded Gravel with Sand (GP) Brown, moist, subround gravel to 1 inch uniform medium subangular sand, trace silt and occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
					175.0	
					176.0 **Silty Clay (CL)** Light brown, wet, with some fine sand and trace subround gravel to 0.5 inches.	Drill cuttings, drilling action and rate indicate clays, silts and sands. Flow line plugged at 176 ft.
					Interbedded Sands and Silt (SM and ML) Brown, wet, fine sand with trace subangular gravel to 0.4 inches.	Drill cuttings, drilling action and rate indicate gravels and sands.
180					179.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Poorly Graded Gravel with Sand (GP) Brown, moist, subround gravel to 1 inch uniform medium to coarse subangular sand, trace silt and occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					184.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
190					**Interbedded Gravelly Sand and Well-Graded Gravel with Sand (SP and GW)** Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand, trace silt and occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is <1 ft/min.
						Note: 10 ft of heaving sands and gravels after drilling rod pulled despite casing filled with water. Well was set with bottom of screen at 194 ft.
200					205.0	
					Bottom of hole at 205.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-3 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : 184.75' START : 8/18/04 1825 END : 8/19/04 1350 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 5 Gal/2 minutes
TOTAL QUANTITY OF WATER DISCHARGED: 875
DISPOSITION OF DISCHARGE WATER:

* no Flow through cell used here due to blown valve setup

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1832	5		990	7.05	7.00	165	PH keeps going down- no flow @ 194' through cell. H2o Dark Brown- ¼" Fines layer
1845	35						Stopped pumping for night water still dark brown
0800 8/19	35						Started developing again @ 194' - bottom
0807	50		840	5.42	5.93	284	Dark Brown ~ 0.25 c. Fines.
0824	95						Water Brown - ½ Tbs Fines moved to 192'
0827	100		310	4.64	6.50	170	Dark Brown - ½ Tbs Fines
0850	155						Barely Brown, 0.25 Tbs Fines moved to 190'
0900	190		990	4.72	7.19	167	Dark Brown, ½ c. Fines.
0930	255						Brown ~ ½ Tbs Fines moved to 188'
0935	265						Dark Brown ~ 2 Tbs Fines.
0950	300						Brown - ½ Tbs Fine Sand moved to 186'
0957	315						Brown, 1 Tbs Fines
1050	475						Brown, 1 Tbs Fines moved to 184'
1057	500						Dark Brown, 2 Tbs Fines
1120	555						Brown, 2 Tbs Fines - not cleaning up well, moved to 182'
1126	570						Brown, 2 Tbs fines
1204	665						replaced waterra, water Brown 0.5 Tbs Fines, moved to 180'
1245	765						Brown 0.5 Tbs fines. took surge block off - to bottom.
1345	865		260	4.57	7.42	176	Been above screen for ~20 minutes Brown, clearer, no fines - using Pale as Flow through cell
1350	875		370	4.06	6.80	163	Brown, still Cloudy, no fines 0.5 Tbs fines been developing for 7 hours - stopping now - not getting clearer

BORING NUMBER MW-4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/20/04 **COMPLETED** 7/21/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5954.92446286 **EASTING** -15516.1340719

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.5 **Organics with Silt (OL)** Dark brown, moist, includes mat and roots, trace fine sand and subangular gravel to 0.2 inches. **Sandy Silt (ML)** Brown, moist, fine to subangular medium sand with trace subangular gravel to 0.5 inches and trace organics.	Drill cuttings, drilling action, and rate indicate organics, silts, and fine sands. Drilling rate is 2.5 ft/min. Drill cuttings, drilling action, and rate indicate silts and fine sands. Drilling rate is 1 ft/min. Drill cuttings, drilling action, and rate indicate silts and fine sands.
10						Drill cuttings, drilling action, and rate indicate silts and fine sands. Drilling rate is 1 ft/min. Drill cuttings, drilling action, and rate indicate silts and fine sands. Drilling rate is 1 ft/min. Drill cuttings, drilling action, and rate indicate silts and fine sands. Drilling rate is 1 ft/min.
20					17.0 **Bedrock (Tertiary Sediments)** Light brownish buff with siltstone fragments.	Drill cuttings, drilling action, and rate indicate silts and fine sands. Drilling rate is 1 ft/min. Drill cuttings, drilling action, and rate indicate organics, silts and fine sands. Driller noted cuttings and rate indicate rock. Cuttings include rock dust, pulverized material with consistency of clay. Drilling rate 0.5 ft/min.
30						Driller noted cuttings and rate indicate rock. Cuttings include rock dust, pulverized material with consistency of clay. Drilling rate 0.5 ft/min. Driller note cuttings and rate indicate rock. Cuttings include rock dust, pulverized material. Driller noted cuttings and rate indicate

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 5" dia. by 6 ft steel

Weep hole?: Yes

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 2 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 1 5-gallon bucket

GROUT

Mix used: 10 lbs PureGold bentonite grout to 100 lbs P

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: 96 hour lag after installation

Estimated purge volume: _____

Comments: Rathole backfill included one 5-gallon pail PureGold medium bentonite chips. Transition sand included two 50lb bags of CSSI 10-20 silica sand. Nor

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/20/04 **COMPLETED** 7/21/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 5954.92446286 **EASTING** -15516.1340719

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Bedrock (Tertiary Sediments)** Light brownish buff with siltstone fragments.	rock. Cuttings include rock dust, pulverized material with consistency of clay. Drilling rate 0.5 ft/min.
					Color change to brown.	Driller noted cuttings and rate indicate rock. Cuttings include rock dust, pulverized material with consistency of clay. Drilling rate 0.5 ft/min.
50					Color change to light brownish buff.	Driller noted cuttings and rate indicate rock. Cuttings include rock dust, pulverized material with consistency of clay. Drilling rate 0.5 ft/min.
					Light brownish buff with siltstone fragments.	Driller noted cuttings and rate indicate rock. Cuttings include rock dust, pulverized material with consistency of clay. Drilling rate 0.5 ft/min.
					55.0 Bottom of hole at 55.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

No well development at MW-4. Well dry.

BORING NUMBER MW5-D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/30/04 **COMPLETED** 7/31/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639808 **EASTING** 371890

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat (PT)**	
					Silty Gravel with Sand (GM) Brown, moist, gravels to greater than 1".	
					As above. Becoming ML.	
10					10.0	
					Silt with Gravel (ML) Brown, moist, trace sand, some gravel to approximately 0.5" Slightly more gravel.	
					15.0	Driller will set next piece of casing to 25'. Will need water in the morning to fight silt. Added water to hole.
					Well-Graded Gravel (GW) Brown, moist, subangular gravel to 1".	
20						Driller reports Well-graded Gravel (GW) here.
					As above, Gray-brown, trace sand, ~95% gravel, trace silt.	
					Becoming sandier with depth	Some water with cuttings.
30					30.0	
					Well-Graded Sand with Gravel (SW) Gray, wet, medium-grained sand, some gravel to 0.5". Trace fines.	
					35.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10-20 Sand

Quantity used: 2 bags

SEAL

Type: 0.25" bentonite pellets

Quantity used: 1 5-gallon bucket

GROUT

Mix used: 50% solids

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: 3-batches - 6 bags before casing is

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Grout level fell 20 feet bgs. Will add more in conjunction with monitoring well. One more batch

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW5-D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/30/04 **COMPLETED** 7/31/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639808 **EASTING** 371890

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Sandy Silt (ML)** Brown, moist, less sand with depth.	Driller reports that he is drilling with water. Doesn't believe it's too wet yet.
					40.0	
					Poorly Graded Sand (SP) Grey, wet, very fine sand, trace silt .	Turned water off. Wet - not super-saturated.
					47.0	Hammer was silted in - now free.
50					**Well-Graded Gravel with Sand (GW)** Gray, moist, coarse sand, gravels to 0.75".	Still drilling with water. Specific conductivity (SC) = 0.257 mS/cm.
					As above. Gravel is coarser - to greater than 1".	
60						
70					Gravels smaller and more round, trace silt.	Slower drilling 65' to 75'.
					More coarse gravels observed near 75'.	Still drilling with water.
					Continued GW. Trace silt only. Coarse sand also.	
80						SC = 0.206 mS/cm.
					Well-Graded Gravel with sand (GW) Wet, coarse sand, tan fines, more than above. Gravel to 0.75".	Continued slower drilling rate.
					Same as above. Fines still in substrate, but gravel is cleaner.	
90						
					As above. Coarse sand, gravels to 0.75". Wet.	Return water turns rusty. Driller thinks he is on a rock. SC = 0.236 mS/cm.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW5-D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 7/30/04 **COMPLETED** 7/31/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639808 **EASTING** 371890

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					Lighter material - more angular. Still GW. 99.0 **Bedrock** Angular, whitish-grey material. No reaction to HCl test. Small, pulverized bedrock on re-drill. Bedrock - return water is light gray, pulverized pieces. 109.0 Bottom of hole at 109.0 feet.	Driller suspects bedrock. No positive reaction to HCL test. SC = 0.128 mS/cm. "Got tight". SC = 0.069 mS/cm.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-5D SHEET 1 OF 2

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : Chem Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : 14.84' BTOC START : 1430 8/12/04 END 8/13/04 1523 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED: 155 Gal +
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	DO Remarks color, odor, sheen, sediment, etc.
1455	10		990	4.01	11.81	0.429	
1500	15		990	4.00	11.25	0.517	5.17
1510	20		"	4.09	11.37	0.470	6.17
1515	25		"	4.10	11.22	0.479	6.97
1520	30		"	4.08	~~10~~ 11.00 to 9 sc	0.409	8.09 Water is getting a little clearer
1525	35		"	4.38	11.05	0.404	7.21 ~~moved pump up~~
1530	40		990	4.12	10.96	0.379	8.50 moved pump up here
1535	45		"	6.66	10.93	0.382	15.80 Parameters taken in Sampling Cup.
1600	55		990	5.80	10.91	0.449	Too much air in pumping action & flow through to measure DO
1605	60		"	4.65	10.82	0.448	
1610	65		"	4.18	10.48	0.402	
1630	70		990	4.34	10.78	0.386	
1635	75		720	4.15	10.77	0.389	Pump was stopped for a few minutes
1640	80		6600	3.95	10.60	0.378	~~moved~~
1645	85		996	3.97	10.67	0.375	moved pump up ~ 2' 3'
1649	90		990	3.98	10.94	0.398	
1652	95		990	4.02	11.08	0.419	
1655	105		990	4.13	11.00	0.407	
1705	115		990	3.94	10.98	0.392	
1710	120		990	4.05	10.84	0.376	

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW5D SHEET 2 OF 2

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK

DEVELOPMENT CONTRACTOR : CH2MHill

DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra pump w/surge

START WATER LEVELS : 14.84' BTOC START : 1430 END : LOGGER : Stacey Cooper

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE:

TOTAL QUANTITY OF WATER DISCHARGED:

DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1718	125		990	4.08	10.89	0.375	
1725	135		990	3.93	10.77	0.353	
1728	140		990	3.96	10.57	0.351	
1730	145		990	3.85	10.47	0.341	
1735	155		990	3.94	10.40	0.335	water not getting cleaner Params stabilized. will stop here.
8/13 1450	165		560	4.57	10.60	0.348	Developing w/o surge Block pump is near bottom of screen ~ 105'
1500	190		590	4.63	10.18	0.326	
1507	200		490	4.42	9.98	0.316	
1513	210		600	4.53	9.93	0.314	moved pump to ~ 89' Above screen.
1520	220		990	4.26	9.91	0.306	water looks cleaner than turbidity reading
1523	225		130	4.28	9.84		turbidity meter unstable water looks clear - will stop here.

BORING NUMBER MW5-M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/1/04 **COMPLETED** 8/1/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639808 **EASTING** 371896

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Organic Silt (OL)** Brown, dry, loose for about first 5 feet.	Drilling with water.
5.0						
					Silt with Sand and Gravel (ML) More gravel than sand - was initially a GM, then ML zone.	
10						
15.0						
					Well-Graded Sand with Gravel (SW) Light brown, moist. Less gravel, less silt. 20' to 25': More gravel and more silt than above. All else the same.	
20						
25.0						Driller drilled without water.
					Poorly-graded Sand (SP) Brown, moist, fine-grained. At approximately 30', bands of silt.	At approximately 30', not very wet, but silt layer is present.
30						

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10-20 Sand

Quantity used: 3.25 bags

SEAL

Type: 0.25" bentonite pellets

Quantity used: 1.5 5-gallon buckets

GROUT

Mix used: 30% solids

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: 3-batches - 6 bags

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Hole stayed open when casing removed.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW5-M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/1/04 **COMPLETED** 8/1/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639808 **EASTING** 371896

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	Air only at 40' to obtain samples.
					Poorly-Graded Sand (SP) Moist, medium-grained. More silt with depth, bedded until 45'.	
					48.0	
50					**Silt (ML)** Gray with brown, moist, stiff. Some sand and gravel overlies GW.	Specific Conductivity = 0.062 mS/cm.
					55.0	Slower drilling. Still using water.
60					**Well-graded Gravel with Sand (GW)** Grey, moist, coarse sand, subangular gravel to 0.75".	
					Less sand than above.	Continued slower drilling. Driller reports silt unit, bouncing bit.
70					75.0 Wet, gray, trace silt.	Turned water off, blew air for five minutes. Wet hole.
					Bottom of hole at 75.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-5M SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : waterra
START WATER LEVELS : 15.14' START : 0845 8/13/04 END : 8/13/04 1127 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED: 205 Gallons
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
906	10		990	5.81	7.88	0.295	Dark brown, muddy - Pump@ Bottom of Screen -65'
0915	20		990	4.33	8.17	0.285	
0925	30		990	4.23	8.27	0.284	moved pump up 2' to 63'
1000	100		990	NA	8.33	0.282	moved pump up ~3' 60' Forgot Temp. reading
1020	120		950	4.33	8.59	0.280	
1035	135		990	4.41	8.67	0.281	moved pump up ~ 3' to 57'
1045	150		990	4.31	8.71	0.281	
1055	160		990	4.24	8.72	0.262	Removed Surge Block - Back @ 65'
1105	170		430	4.21	8.79	0.263	Water looking Cleaner
1112	185		890	4.16	8.75	0.278	moved pump to just above screen ~ 54'
1121	195		810	4.28	8.76	0.273	
1127	205		820	4.12	8.79	0.271	Water has looked Consistently cleaner - will Stop development Here.

BORING NUMBER MW5-S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/1/04 **COMPLETED** 8/2/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639813 **EASTING** 371894

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0						
					Organic Silt (OL)	
					3.0	
					Silt (ML) Red-brown, moist, medium-stiff, occasional gravels and sands. Gravels subangular to 0.25"	Driller is drlling with air only.
10						
20					More sand and gravel by 20'.	
					More moist, more sand.	
					One wet zone observed.	Driller observes connection to other wells. PMW5-D bubbling, pushed grout from PMW5-D and PMW5-M. Hole had produced some water overnight.
30						Hammer silted in (continue on with water).
					As above, with slightly more sand and gravel.	
					35.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: Native collapse

Quantity used: 1/8 bag of sand

SEAL

Type: 0.25" bentonite pellets

Quantity used: 2.5 5-gallon buckets

GROUT

Mix used: 30% solids

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: 1-batch - 2 bags

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Hole heaved closed - well at 41' rather than desired 45'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW5-S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/1/04 **COMPLETED** 8/2/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6639813 **EASTING** 371894

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Silty Sand with Gravel (SM)** Red-brown, moist, subround gravel to 0.5". 40.0	Driller reports gravel at 35'.
					Poorly-Graded Sand (SP) Gray, moist to wet. Very fine-grained. 47.0	Drilled soft.
50					**Silt (ML)** Gray, moist, some gravel. 50.0	
					Bottom of boring. Bottom of hole at 50.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-55 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra Motor Pump w/Surge block
START WATER LEVELS : 14.63' BTOC START : 1215 8/13/04 END 8/13/04 1438 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 5 Gallons / 2 minutes
TOTAL QUANTITY OF WATER DISCHARGED: 300 Gal.
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1220	2 Gal		440	16.64	8.44	0.240	"Before" Filter - Pump @ 41'
1225	15 Gal		990	5.08	6.87	0.136	Lots of sand in the water 1 to 2 cups Sand on bottom of bucket
1237	45 Gal		990	5.00	6.31	0.137	½ as much sand on bottom
1247	55 Gal.		990	4.95	6.39	0.125	moved Pump to 38'
1257	80 Gal.		990	4.96	6.75	0.143	
1305	100 Gal.		990	4.73	6.87	0.139	
1310	110		990	4.72	6.78	0.131	moved Pump to 34'
1325	145		990	4.77	6.86	0.139	
1330	170		990	4.87	6.84	0.138	
1335	190		990	4.84	6.84	0.136	moved Pump to 31'
1347	210		990	4.87	6.79	0.137	
1400	220		990	4.65	6.77	0.139	Removed Surge Block & moved pump back to 41'
1412	250		990	4.96	6.93	0.140	
1422	275		990	5.13	6.96	0.140	
1429	280		250	5.22	6.89	0.134	moved Pump to 30' Water clearer
1438	300		230	5.18	7.02	0.141	

Pumping @ ~ 5 Gallons / 2 minutes

BORING NUMBER MW-6D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/9/04 **COMPLETED** 8/10/04 **GROUND ELEVATION** _____ **WATER LEVELS** 74.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6645685 **EASTING** 365569

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0						
					2.0 **Sandy Silt (ML)** Brown, moist, fine sand with trace gravel to 0.4 inches.	Drill cuttings, drilling action and rate indicate organics, silts and fine sands. Drilling rate is 2.5 ft/min.
					Silty Gravel with Sand (GM) Reddish brown, moist subround gravel to >1 inch with some fine to medium subangular sand. Occasional cobble.	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is 2 ft/min.
						Note driller using water to supplement air starting at 5 feet.
						Drilling rate is 1 ft/min.
10					10.0 Increasing gravel and sand fraction/decreasing fines	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is 2 ft/min.
					Poorly Graded Gravel with Sand and Cobbles (GP) Brown, wet, subround gravel to 0.5 inches with medium coarse angular sand and trace silt.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 2 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Increasing gravel fraction
20						Drill cuttings, drilling action and rate indicate gravels and sands.
						Drill cuttings, drilling action and rate indicate gravels and sands.
					25.0	
					Well-Graded Gravel with Sand (GW) Brown, moist, subround gravel to >1 inch fine to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
30						Drill cuttings, drilling action and rate indicate gravels and sands.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 1 50-lb bag

SEAL

Type: PureGold medium bentonite chips

Quantity used: 2.5 5-gallon buckets

GROUT

Mix used: VOLCAY grout, >30% solids 12 50-gal. buck

Method of placement: Tremie pipe from bottom up

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: 5 foot rathole filled with PureGold medium bentonite chips/1.5 buckets CSSI 10-20 silica sand/Three 50-pound bags.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-6D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/9/04 **COMPLETED** 8/10/04 **GROUND ELEVATION** _____ **WATER LEVELS** 74.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6645685 **EASTING** 365569

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Gravelly Sand (SP) Brown, moist, fine to coarse subangular sand with subround gravel to >1 inch and some silt. Increasing gravel fraction.	Drill cuttings, drilling action and rate indicate gravels and sands.
					46.0	
					Poorly Graded Gravel with Sand (GP) Brown, moist, subround gravel to >1 inch with uniform medium subangular sand. Occasional cobble.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
50						Drill cuttings, drilling action and rate indicate gravels and sands.
					56.0	
					Well-Graded Gravel with Sand (GW) Brown, moist, subround gravel to 0.5 inches with fine to coarse subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands.
60					Note: Boulders at 65 to 66 ft.	
70					Decreasing gravel size at 70 ft to <0.5 inches. Increasing sand fraction.	
					75.0 ▽	
					Gravelly Sand (SP) Brown, wet, medium to coarse subangular sand with subround fine gravel to 0.5 inches. Trace silt with occasional cobble.	
80					80.0	
					82.0 **Poorly Graded Gravel with Sand and Boulders (GP and Boulders)** Brown, wet, subangular gravel with medium to coarse angular sand.	Drill cuttings, drilling action and rate indicate gravels and sands.
					Poorly Graded Gravel with Sand (GP) Brown, wet, subround gravel to >1 inch with medium to coarse subangular sand. Occasional cobble and boulders.	
					89.0	
90					**Bedrock (Bedrock)** Dark gray, massive, fresh, fine to medium-grained and hard. No reaction to 12% HCL solution.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-6D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/9/04 **COMPLETED** 8/10/04 **GROUND ELEVATION** _____ **WATER LEVELS** 74.9 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6645685 **EASTING** 365569

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					100.0 Bottom of hole at 100.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW6D SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK

DEVELOPMENT CONTRACTOR :

DEVELOPMENT METHOD AND EQUIPMENT USED :

START WATER LEVELS : 77.32' BTOC START : 1745 8/14/04 END 8/15/04 1135 LOGGER : Stacey Cooper

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE: 5 Gallons / 2 minuks

TOTAL QUANTITY OF WATER DISCHARGED: ~435 Gallons

DISPOSITION OF DISCHARGE WATER: Slightly cloudy, white-ish, but clear.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (~~µmhos~~ mS/cm)	Remarks (color, odor, sheen, sediment, etc.)
1750	5		990	4.54	5.93	0.060	Dark Brown, mostly fines not much sand. Pump@94'
1802	35		990	3.94	5.96	0.058	A little lighter brown, fewer fines, but still dirty
1820	85						lighter brown, still cloudy & dirty, but few fines in pale. Moved Pump
1822	90						water darker brown - more fines. to 92'
1831	115						Tan, Fewer fines, cleaning up.
845	150						moved pump to 90'. Dark Brown, Many fines.
0945 8/15/04							Started developing again.
0955	200						Tan, about 1 Tbs of fines
1005	225						Lighter tan, 1/2 Tbs fines, moved pump to 88'.
1010	235						Dark Brown ~2 Tbs Fines.
1023	265						Light Tan, ~0.5 Tbs Fines moved pump to 86'.
1040	310						Tan, 0.5 Tbs Fines - moved Pump to 84' - assuming 15' of screen.
1053	340						Light tan, Nearly no fines - above screen?
							moved pump up to 83' to see what happens.
1103	350						Water Tan, no fines. Took Surge block off & moved Pump to bottom, water ~~Dark Brown~~, 2 Tbs Fines.
1111	370		360	3.96	6.44	0.055	Water Clearing up - still cloudy, Light Tan.
1122	395		190	3.67	5.85	0.054	Light Tan, no fines. Moved Pump to above screen - no surge block.
1130	415		240	3.97	5.85	0.055	
1135	435		83	4.07	5.90	0.055	water Clear - slightly cloudy still but will stop developing

BORING NUMBER MW-7D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/11/04 **COMPLETED** 8/11/04 **GROUND ELEVATION** _____ **WATER LEVELS** 24.5 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6640222 **EASTING** 362763

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat with Cobbles and Boulders (PT)** Black, moist, round cobbles and boulders to 0.9 feet with some fine sand.	Drilling rate is >5 ft/min.
					5.0 **Silty Gravel (GM)** Light brown, wet, gravel to >1 inch with uniform fine sand, and an occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is >3 ft/min. Note: driller using water to supplement air rotary.
					8.0 **Sandy Silt (ML)** Light brown, wet, fine to medium subround sand with some gravel to 0.3 inches.	
10					10.0 **Silty Gravel (GM)** Light brown, wet, gravel to >1 inch with some fine to medium sand, and an occasional cobble and boulder	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is >3 ft/min. Driller notes increasing cobbles.
					12.0 **Well-Graded Gravel with Sand (GW)** Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand, trace silt, occasional cobble and boulder.	
					Poorly Graded Gravel with Sand and Cobbles (GP) Brown, moist, subround gravel to >1 inch with uniform fine to medium angular sand. Some silt and occasional boulder.	Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling rate is >2 ft/min. Driller notes water flowing at 2gpm.
20					21.0 **Well-Graded Gravel with Sand (GW)** Brown, wet, subround gravel to >1 inch with fine to coarse subangular sand. Trace silt along with occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling rate is >2 ft/min. Driller notes water flowing at 2gpm.
					Well-Graded Gravel with Sand (GW) Brown, wet, subround gravel to >1 inch with fine to coarse subangular sand. Trace silt.	Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling rate is >2 ft/min.
30					32.0 **Boulders (Boulder)** Erratics.	Drill cuttings, drilling action and rate indicate boulders. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate boulders. Drilling rate is 1 ft/min.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 6 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 2 5-gallon buckets

GROUT

Mix used: VOLCAY grout, >30% solids 6 50-gallon buc

Method of placement: Tremie pipe from bottom up

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: 2 foot rathole filled with PureGold medium bentonite chips/1 bucket CSSI 10-20 silica sand/1 50-pound bag.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-7D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/11/04 **COMPLETED** 8/11/04 **GROUND ELEVATION** _____ **WATER LEVELS** 24.5 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6640222 **EASTING** 362763

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					39.0 **Bedrock (Bedrock)** Dark gray, red-stained, fractured, soft, fine-grained siltstone and mudstone. No HCL reaction.	Drill cuttings, drilling action and rate indicate boulders. Drilling rate is 1 ft/min. Drilling cuttings indicate fractured bedrock is uniform 0.5 inches. Drilling cuttings indicate fractured bedrock is uniform 0.5 inches.
50					**Bedrock (Bedrock)** Brown to gray, angular fractured, hard, fine to coarse-grained conglomerate. No HCL reaction	Drilling cuttings are uniform, angular, about 0.2 inches in size.
60						
70					**Bedrock (Bedrock)** Dark gray, red-stained, rounded 0.6 inch diameter, soft, fine-grained siltstone and mudstone. 75.0 Bottom of hole at 75.0 feet.	Note: dramatic increase in flow rate (10 gpm).

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-7D SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : 22.46' BTOC START : 8/15/04 1425 END : 8/15/04 1625 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 5 Gallons/1.5 Minutes
TOTAL QUANTITY OF WATER DISCHARGED: 285 Gal
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1430	5		990	4.77	6.82	57	Dark Brown, 1 Tbs fines on bottom of pail, no sand. At 74'
1438			410	4.04	5.98	50	water milky, tan, no fines @ bottom of pail - move pump to 72'
1445							water milky, light tan, 1/2 Tbs fine @ bottom.
1455	60						milky-gray/white, light, no fines in bottom. moved to 70'
1500	75						milky-gray/white - tiny bit of filter sand in bottom of pail.
1505	90						Milky white, no fines/sand in Bottom of Pail. Moved to 68'
1518	120		530	4.11	6.73	50	Milky-white, no fines, Move to 66'
1530	150		180	3.98	5.97	52	" " Move to 64'
1545	185						" " move to 62'
1550	195						Lighter milky white - no fines move to 60'
1555	205						" " Took surge block off, back @ bottom
1600	215.		130	3.21	6.55	54	water a little darker, grayer, 1 tsp fines @ bottom.
1610	225		190	3.53	6.16	52	Milky, light Gray, no Fines moved to above Screen 58'
1615	235		170	3.78	6.25	57	milky - light Gray, no fines
1617			280	3.78	6.24	50	
1622			460	3.76	6.29	50	
1625	285		180	3.69	6.38	51	Light-gray, milky, maybe air bubbles, ob Fines. Stop here

BORING NUMBER MW-7S

PAGE 1 OF 1

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/12/04 **COMPLETED** 8/12/04 **GROUND ELEVATION** _____ **WATER LEVELS** 20 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6640231 **EASTING** 362683

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Silty Gravel with Sand (GM)** Brown, moist, subround gravel to >1 inch with fine to medium subangular sand. Occasional cobble and boulders throughout.	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >5 ft/min.
						Note: driller using water to supplement air starting at 5 feet.
						Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >2 ft/min.
10					**Well-Graded Gravel with Sand (GW)** Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand, trace silt and occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is >3 ft/min.
						Driller notes increasing cobbles.
					Poorly-Graded Gravel with Sand and Cobbles (GP) Brown, moist, subround gravel to >1 inch with uniform fine to medium angular sand. Some silt.	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >2 ft/min.
20						Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >2 ft/min.
						Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >2 ft/min.
					Well-Graded Gravel with Sand(GW) Brown, wet, subround gravel to >1 inch with fine to coarse subangular sand and cobbles/boulders throughout along with some silt.	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >2 ft/min.
30						Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is >2 ft/min.

9.0 15.0 25.0 35.0

Bottom of hole at 35.0 feet

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 2 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 2 5-gallon buckets

GROUT

Mix used: none

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: 2 foot rathole filled with PureGold medium bentonite chips/1 buckets CSSI 10-20 silica sand/1 50-pound bags.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW 75 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2MHill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : 23.57' BTOC START 8/15/04 1645 END 8/16/04 1040 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 5Gal/1.5minutes
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1648	5		990	4.26	6.84	44	chocolate milk, 1/2 cup fines, no sand - pump @ 33'
1658	30						Lighter Brown, 1 Tbs fines
1715	70		990	4.33	6.68	41	Brown, 1/2 Tbs Fines - very fine sand / silt. Move to 31'
1723	90						Choc. milk, coffee w/cream, 1/2 cup fines.
1750	155						Brown, ~ 1 Tbs Fines moved 1 ft. to 30'.
1820	230						Developing Slowly! Brown → 2 Tbs Fines. Moved to 28'.
1900	330						Brown, opaque, 1 Tbs fines, moved to 26'
0848 8/16/04	340						Brown, ~ 2 Tbs fines at bottom.
910	395						Tan, almost no fines moved to 24' - no water moved back to 28' to pump a little more.
~~0940~~							
0940	470						Tan water - 1/2 Tbs Fines removed surge block - went to bottom.
0945	480						Dark Tan, 1 Tbs fines.
1015	555		150 est	4.09	6.24	43	Lighter Tan - few fines
1020	565		81	3.90	5.68	42	
1025	575		99	4.10	5.67	42	Light Tan, no fines moved to 26' - make sure fines are gone.
1035	600		13	4.79	5.82	41	Very light tan, a little cloudy, no fines.
1040	610		0	4.67	5.82	41	Light tan, clear, see bottom of bucket, no fines. Stop here.

BORING NUMBER MW-8D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/6/04 **COMPLETED** 8/7/04 **GROUND ELEVATION** _____ **WATER LEVELS** 15 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6646958 **EASTING** 371003

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Dark brown, moist, blocky, fibrous mat with fine sand.	Drill cuttings, drilling action and rate indicate organics, silts and fine sands. Drilling rate is 2.5 ft/min.
					Sandy Silt (ML) Brown, moist, fine sand with trace gravel to 0.4 inches.	
					4.0 **Silty Gravel with Sand (GM)** Brown, moist, subround gravel to 1 inch with some fine to medium subangular sand. Occasional boulder and cobble.	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is 1 ft/min.
					7.0 **Silty Sand (SM)** Brown, moist, fine to medium sand with some subround gravel to 0.5 inches. Increasing gravel and sand fractions/decreasing fines.	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is 1 ft/min.
10					9.0 **Well-Graded Gravel with Sand (GW)** Brown, moist, fine to coarse subangular sand and trace silt and occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					15.0 ▽	Broken shoe at 14 ft.
					Poorly Graded gravel (GP) Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand. Occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
20					Increasing coarse sands.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					24.0 **Gravelly Sand (SP)** Brown, moist, medium to coarse subangular with subround gravel to >1 inch with some silt and occasional boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
30						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 1 50-lb bag

SEAL

Type: PureGold medium bentonite chips

Quantity used: 1.5 5-gallon bucket

GROUT

Mix used: VOLCAY grout, >30% solids by weight

Method of placement: Tremie pipe from bottom up

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: Rathole backfill included 4 50-lb bags of CSSI 10-20 silica sand.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-8D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/6/04 **COMPLETED** 8/7/04 **GROUND ELEVATION** _____ **WATER LEVELS** 15 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6646958 **EASTING** 371003

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Heaving sands.
					Poorly Graded Gravel with Sand(GP) Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					44.0 Increasing sand fraction	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Gravelly Sand (SP) Brown, moist, medium to coarse subangular sand with subround gravel to >1 inch with trace silt and occasional boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
50						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					53.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Poorly Graded Gravel with Sand (GP) Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand. Occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate silts, clays and sands. Drilling rate is <1 ft/min.
					57.0	Drill cuttings, drilling action and rate indicate silts, clays and sands. Drilling rate is <1 ft/min. No reaction with 12% HCL solution. Driller using water to supplement air rotary beginning at 57 ft
60					**Sandy Silty Clay (CL)** Gray, wet, with fine to medium sand and trace subangular gravel to 0.4 inches.	Drill cuttings, drilling action and rate indicate silts and clays. Drilling rate is <1 ft/min. No reaction with 12% HCL solution. Driller using water to supplement air rotary.
					60.0 Decreasing sand fraction/increasing silts and clays.	Drill cuttings, drilling action and rate indicate silts and clays. Drilling rate is <1 ft/min. No reaction with 12% HCL solution. Driller using water to supplement air rotary.
					Silty Clay (CL) Gray, wet, with trace fine sands.	
70						
80					80.0	Drill cuttings, drilling action and rate indicate silts and clays. Drilling rate is <1 ft/min. No reaction with 12% HCL solution. Driller using water to supplement air rotary.
					82.0	Drill cuttings, drilling action and rate indicate silts and clays. Drilling rate is <1 ft/min. No reaction with 12% HCL solution. Driller using water to supplement air rotary.
					Gravelly Sand (SP) Brown, wet, medium to coarse subangular sand with subround fine gravel to 0.5 inches. Occasional cobble.	Drill cuttings, drilling action and rate indicate silts and clays. Drilling rate is <1 ft/min. No reaction with 12% HCL solution. Driller using water to supplement air rotary.
90						Drill cuttings, drilling action and rate indicate silts and clays. Drilling rate is <1 ft/min. No reaction with 12% HCL solution.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-8D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/6/04 **COMPLETED** 8/7/04 **GROUND ELEVATION** _____ **WATER LEVELS** 15 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6646958 **EASTING** 371003

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					95.5 **Siltstone (Bedrock)** Dark gray, massive. with quartz lenses. 103.0 Bottom of hole at 103.0 feet.	is 1 ft/min. Driller turns off water to help evaluate if gravels and sands below aquitard is wet. Heaving sands at 85 feet. Shoe lost while trying to trip in/out of hole. Trip out of hole. End of 6-August-04 shift. Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Driller notes bedrock. Drilled 8 feet to confirm. No reaction with 12% HCL solution.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-8D SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra
START WATER LEVELS : 10.78' START : 1805 8/13/04 END : 8/14/04 0930 LOGGER : Stacey Cooper
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED: 200
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (~~µmhos~~ mS/cm)	Remarks (color, odor, sheen, sediment, etc.)
1810	5		990	3.90	7.22	0.114	a lot much sand in here - just fines
1815	15		590	3.92	7.32	0.112	Pump @ 97'
1825	40		570	4.25	7.57	0.113	
1833	60		680	3.77	7.61	0.111	moved pump to 93'
1845	80		350	3.90	7.80	0.112	
1850	90		640	3.91	7.86	0.111	Water is clear.
8/14/04 0838	95		250	3.71	6.93	0.117	pH drop - water sitting overnight? moved pump up to 85'
0853	130		810	3.68	7.68	0.116	
0900	145		80	3.58	8.06	0.115	
0915	165		250	3.57	8.24	0.116	Took surge block off & moved pump to bottom.
0924	175		140	3.61	8.36	0.114	moved ~~Surge~~ pump up to above screen - 85'
0930	200						Water clear - stopped developing

BORING NUMBER MW-8M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/8/04 **COMPLETED** 8/8/04 **GROUND ELEVATION** _____ **WATER LEVELS** 13.3 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6646954 **EASTING** 370998

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Dark brown, moist, blocky, fibrous mat with fine sand	Drill cuttings, drilling action and rate indicate organics, silts and fine sands. Drilling rate is 2.5 ft/min.
					Sandy Silt (ML) Brown, moist, with fine sand and trace gravel to 0.4 inches.	
					5.0	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is 3 ft/min.
					Silty Gravel with Sand (GM) Brown, moist, subround gravel to 1 inch with some fine to medium subangular sand. Occasional boulder and cobble. 7.0	Drill cuttings, drilling action and rate indicate silts, gravels and sands. Drilling rate is 1 ft/min.
10					**Silty Sand (SM)** Brown, moist, fine to medium sand, with some subround gravel to 0.5 inches. 10.0	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is 1 ft/min.
					Increasing gravel and sand fractions/decreasing fines.	
					Well-Graded Gravel with Sand (GW) Brown, moist, platy, subround gravel to >1 inch with fine to coarse subangular sand and trace silt and occasional cobble and boulder. 15.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Increasing gravel fraction.
20					**Poorly Graded Gravel with Sand (GP)** Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand. Occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Increasing coarse sands. 26.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
30					**Gravelly Sand (SP)** Brown, moist, medium to coarse subangular sand with subround gravel to >1 inch and some silt.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
						Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 4 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 3 5-gallon buckets

GROUT

Mix used: none

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: No rathole. Heaving sands.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-8M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/8/04 **COMPLETED** 8/8/04 **GROUND ELEVATION** _____ **WATER LEVELS** 13.3 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6646954 **EASTING** 370998

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Heaving sands.
					Poorly Graded Gravel with Sand (GP) Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand. Occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					43.0 Increasing sand fraction.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					Gravelly Sand (SP) Brown, moist, medium to coarse subangular sand with subround gravel to >1 inch and trace silt.	Drill cuttings, drilling action and rate indicate gravels and sands.
50						Drill cuttings, drilling action and rate indicate gravels and sands.
					53.0	Drill cuttings, drilling action and rate indicate gravels and sands.
					55.0 **Poorly Graded Gravel with Sand (GP)** Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand. Occasional cobble and boulder.	
					Bottom of hole at 55.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW8M SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble Mine LOCATION: Iliamna, AK

DEVELOPMENT CONTRACTOR: CH2M Hill

DEVELOPMENT METHOD AND EQUIPMENT USED: Waterra

START WATER LEVELS: 16.40' BTOC START: 8/14/04 1000 END: 8/14 1240 LOGGER: Stacey Cooper & Gary Manhilla

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE:

TOTAL QUANTITY OF WATER DISCHARGED: ~425 Gallons based on 5 Gallons/2 minutes

DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
4th 11:08							water brn. ↑sp sand
11:13							water lighter brn. very little sand
5th 11:19							water brn. 1-2 Tbsp sand
11:24							water lighter ≥ tsp sand
6th 11:38							brn - 2 ↑bsp. sand
11:44							getting lighter brn 1 tsp sand
11:47							light brn. ≥ tsp sand
7th 11:54							brn. ~ 1-2 ↑bsp. sand
11:59							light brn ≥ tsp sand
8th 12:06							light brn - very little sand ≥ tsp
							removed Surge Block down to the bottom
12:35							water very clear.
							moved pump to above screen
1240			42	4.71	6.38	0.067	water clear - Took after Filter

ANC/Pebble Field Forms.xls/980560014

BORING NUMBER MW-8S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/8/04 **COMPLETED** 8/8/04 **GROUND ELEVATION** _____ **WATER LEVELS** 13.8 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6646959 **EASTING** 370997

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)** Dark brown, moist, blocky, fibrous mat with fine sand **Sandy Silt (ML)** Brown, moist, with fine sand and trace gravel to 0.4 inches.	Drill cuttings, drilling action and rate indicate organics, silts and fine sands. Drilling rate is 2.5 ft/min.
					6.0 **Silty Sand (SM)** Brown, moist, fine to medium sand with trace subround gravel to 0.5 inches. Increasing gravel and sand fractions/decreasing fines.	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is 3 ft/min.
10					11.0	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is 1 ft/min.
					Well-Graded Gravel with Sand (GW) Brown, moist, platy, subround gravel to >1 inch with fine to coarse subangular sand, trace silt and occasional boulder and cobble.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.
					15.0 **Poorly-Graded Gravel with Sand (GP)** Brown, wet, subround gravel to 0.5 inches with uniform medium subangular sand.	Broken shoe at 14 ft.
20					20.0	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min. Increasing gravel fraction.
					Bottom of hole at 20.0 feet.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is 1 ft/min.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 1.5 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 1 5-gallon bucket

GROUT

Mix used: none

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: Rathole backfill included .5 5-gallon pail PureGold medium bentonite chips/1 50-lb bags of CSSI 10-20 silica sand.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW8S SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK
DEVELOPMENT CONTRACTOR : CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra Foot Pump w/surge
START WATER LEVELS : 16.59' BTOC START : 8/14/04 1300 END 8/14/04 1400 LOGGER : Stacey Cooper

MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED: 125 gallons
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1305	5		480	5.39	5.97	0.061	Dark Brown, ~1 Tbs Sand @ Bottom. Turbid. Pump @ 25', 20'
1307	10		240	5.13	5.95	0.060	
1315	30						Lighter Tan, Cloudy, no Sand moved pump to 23' 18'
1325	55						Light tan, clearer, no Sand moved Pump to ~~23'~~ 16'
1327	60						Water Dark Brown, some fines @ bottom, Turbid
1337	85						Light tan, Clear, very little fines. Moved pump up to 14' and realized we are above water. So Remove Surge block & go to bottom.
1355	115						Water Clear & clean @ bottom So move Pump to ~17' & Continue
1400	125		7	6.34	6.50	0.051	Water clear, no fines, nothing Took "After" Pic & stopped developing.

ANC/Pebble Field Forms.xls/980560014

BORING NUMBER MW-9D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/11/04 **COMPLETED** 8/11/04 **GROUND ELEVATION** _____ **WATER LEVELS** 24.5 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6640166 **EASTING** 362830

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat with Cobbles and Boulders (PT)** Black, moist, round cobbles and boulders to 0.9 feet with some fine sand	Drilling rate is >5 ft/min.
					5.0 **Silty Gravel (GM)** Light brown, wet, gravel to >1 inch with uniform fine sand, and an occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate silts and sands. Drilling rate is >3 ft/min. Note driller using water to supplement air rotary.
					8.0 **Sandy Silt (ML)** Light brown, wet, with fine to medium subround sand and some gravel to 0.3 inches.	
10					10.0 **Silty Gravel (GM)** Light brown, wet gravel to >1 inch with uniform fine to medium sand, and an occasional cobble and boulder.	Drill cuttings, drilling action and rate indicate gravels and sands. Drilling rate is >3 ft/min. Driller notes increasing cobbles.
					12.0 **Well-Graded Gravel with Sand (GW)** Brown, moist, subround gravel to >1 inch with fine to coarse subangular sand, trace silt, occasional cobble and boulder.	
					Poorly Graded Gravel with Sand and Cobbles (GP) Brown, moist, subround gravel to >1 inch with uniform fine to medium angular sand. Some silt and occasional boulder.	Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling rate is >2 ft/min. Driller notes water flowing in at 2 gpm.
20					21.0 **Well-Graded Gravel with Sand (GW)** Brown, wet, subround gravel to >1 inch with fine to coarse subangular sand. Trace silt with occasional cobble.	Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling is >2 ft/min. Driller notes water flowing in at 2 gpm.
					23.0 **Silty Gravel with Sand(GM)** Light brown, wet, gravel to >1 inch with fine to medium sand, and occasional cobble and boulder.	
					28.0 **Well-Graded Sand (SW)** Brown, wet, fine to coarse subangular sand with some gravel to >1 inch, some silt and occasional boulders and cobbles.	Driller notes water flowing in at 2 gpm. Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling is >2 ft/min.
30						

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. by 5 ft stainless steel

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: 5 inch

Type: Steel

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: CSSI 10-20 silica sand

Quantity used: 6 50-lb bags

SEAL

Type: PureGold medium bentonite chips

Quantity used: 2 5-gallon buckets

GROUT

Mix used: VOLCAY grout, >30% solids 6 50-gall bags

Method of placement: Tremie pipe from bottom up

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: 3 foot rathole filled with PureGold medium bentonite chips/ 1 bucket CSSI 10-20 silica sand/ one 50-lb bag.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-9D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/11/04 **COMPLETED** 8/11/04 **GROUND ELEVATION** _____ **WATER LEVELS** 24.5 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6640166 **EASTING** 362830

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Rob Crotty

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40						Driller notes water flowing in at 2 gpm. Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling is >2 ft/min.
					45.0	
					Silty Gravelly Sand (SM) Brown, wet, fine to coarse subround sand with fine gravel to 0.4 inches, trace silt and occasional cobble and boulder.	Driller notes water flowing in at 2 gpm.
50					50.0	
					Well-Graded Sand (SW) Brown, wet, fine to coarse subround sand with some gravel to >1 inch, some silt and occasional boulders and cobbles.	Driller notes water flowing in at 2 gpm. Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling is >2 ft/min.
						Driller notes water flowing in at 2 gpm. Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling is >2 ft/min. Driller notes boulder to 1.5 feet in diameter.
60						Driller notes water flowing in at 2 gpm. Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling is >2 ft/min. Note dramatic increase in flow rate; 5 gpm.
70						Drill cuttings, drilling action and rate indicate gravels, sands, cobbles. Drilling rate is >2 ft/min. Flow rate increased to 8 gpm.
					73.0	
					Bedrock (Bedrock) Dark gray, red-stained, fracture (angular) soft, fine grained siltstone and mudstone, no HCL reaction. **Bedrock (Bedrock)** Brown to gray, fracture (angular) hard, fine- to coarse-grained conglomerate. No HCL reaction.	Drilling cuttings indicate fractured bedrock is uniform 0.5 inches. Flow rate 8 gpm. Drilling cuttings are uniform, angular, about 0.2 inches in size. Easily mistaken for gravelly sand.
					80.0	
					Bottom of hole at 75.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER ~~MW-7M~~ MW-9 SC 8/31/04 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : Pebble Mine LOCATION : Iliamna, AK

DEVELOPMENT CONTRACTOR : CH2M Hill

DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra

START WATER LEVELS : 5.15' START : 8/16/04 1125 END : 8/16/04 1421 LOGGER : Stacey Cooper

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE: 5 gallons/2 minutes

TOTAL QUANTITY OF WATER DISCHARGED:

DISPOSITION OF DISCHARGE WATER: 370 Gallons

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1130	10		280	3.43	5.73	50	Dark Tan, 1Tbs Fine sediment. At 80'
1142	40		120	3.25	5.68	49	Clear & MILKY a little no fines. moved to 78'
1148	55						Tan - Tiny bit of fine sand.
1205	95						Clear, no fines. moved to 76'.
1210	105						Light tan - tiny bit of sand.
1220	130						Clear, no fines, moved to 75'
1225	140						Clear, cloudy, Tiny bit of Sand.
1240	175						Clear-no fines - moved to 73'
1244	185						Light tan, 1/2 Tbs Fines.
1300	220						Clear, no fines - moved to 71'
1305	230						Tan, 1Tbs Fines
1315	240						Clear - no Fines, moved to 70'
1320	250						Tan, 1 Tbs Fines. Fine Sand.
1330	~~270~~ 275						Clear, no fines - moved to 69'
1332	280						Water Clear no fines
1342	290						moved to 69' - water Clear Immediately - no fines above screen.
1356	310						moved to bottom w/o surge block
1400	320		260	3.23	5.79	49	Tan/Gray ~ 1 Tbs Fines.
1412	350		50	3.17	5.82	48	Water Clear - Slightly gray no fines. moved to 69'
1417	360		32	3.49	5.86	48	Clear - no fines
1421	370		88	3.52	5.84	48	" " Stop Here.

BORING NUMBER MW-10

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/25/04 **COMPLETED** 9/25/04 **GROUND ELEVATION** _____ **WATER LEVELS** 28.3 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6644802 **EASTING** 365803

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Orangic Silt (OL)** Moist, dark brown.	Drilling with air
					Poorly-graded Gravel with Silt and Cobbles (GP) Gray, moist, 1/4-inch and greater, sub-angular to rounded.	12:08 at 3-feet. Varying amounts of silt 10 to 20%.
10					Color change - Light brown. More silt than above. Color change - Light gray. Color change - Light brown.	Hammer clogged. Start drilling with water 2 gpm. 13:27 at 13-feet. Return line clogged.
20					Color change - Brown. Color change - Light brown.	Water line broken 14:30 to 15:00. 15:30 at 23-feet. Stop drilling with water. Start drilling with water 2 gpm.
30						14:00 at 33-feet.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" dia. steel casing with lid.

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 silica sand.

Quantity used: 4 50-lb bags

SEAL

Type: 0.25" bentonite pellets CETCO

Quantity used: 2 5-gallon buckets

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: 50 gallons

Vol. in well casing: 1-batch - 2 bags

DEVELOPMENT

Method Surge and block with 1" Waterra pump

Time: 2.5 hours

Estimated purge volume: 400 gallons

Comments: Boring TD-44'. Sealed shoe with 2-feet 1/4-inch bentonite pellets. Heave from 25' to 13' during grouting. Seal from 25' to 20' with 1/4-inch bentonite

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-10

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/25/04 **COMPLETED** 9/25/04 **GROUND ELEVATION** _____ **WATER LEVELS** 28.3 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6644802 **EASTING** 365803

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					36.0 Color change = Light gray. **Bedrock** Black, fractured cuttings - Well-graded Sand, angular, light greenish gray. **Bedrock** Black, fractured cuttings - Well-graded Sand, angular, light greenish gray. 44.0 Bottom of hole at 44.0 feet.	Slow drilling. TD - 44-feet.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW-10 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble GW LOCATION:
DEVELOPMENT CONTRACTOR: CH2M HILL
DEVELOPMENT METHOD AND EQUIPMENT USED: 1" Waterra w/ surge block
START WATER LEVELS: START: 9-22-04 1200 END: 9-22-04 LOGGER: D. LACEY
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE: 4 gals - 5gpm
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER: Initially very cloudy but low silt load. cleaned up greatly

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Suction Line Depth
1214	Start Pump							45'
1215	5gals	-	3990				Very cloudy, Gray 1/2 Cup Fine Sand	"
1234	60	28.5	250	3.55	6.47	111	Cloudy, Gray, 0.5 Tbs Fine SAND	"
1240	65	—	295	3.36	6.54	65	Cloudy, Gray 0.5 Tbs Fine SAND	41.5
1300	125	28.10	64	3.25	6.66	61	Slightly cloudy Trace Fine Sand	"
1305	130	—	425	3.27	6.69	61	Cloudy, Brown 2C.5 Tbs SAND	40
1320	175	28.20	60	3.19	6.60	60	Slightly Cloudy Trace	"
1324	180	—	798	3.23	6.61	58	Very Cloudy, Brown 1 Tbs Fine SAND	38
1340	225	28.5	61	3.20	6.68	59	Slightly Cloudy Trace	"
1345	230	—	605	3.30	6.74	57	Very Cloudy, Brown 1 Tbs Fine SAND	36
1405	270	29.35	478	3.30	6.78	57	Slightly cloud Trace	"
1408	275	—	65	3.36	6.78	56	Slightly Cloudy Trace	34
1420	340		45	3.55	6.78	57	Slightly Cloudy Trace	
Remove surge block, clean bottom of well								
1445	400		20	3.63	6.85	57	Clear, No SAND	30

* Water levels after pump shut off

Start TD = 44.10 - BTOC End TD = 44.12
DTW = 29.30 - BTOC DTW = 28.30
Stick up - 2.7 - AGS

ANC/attach1sampleforms.xls/980560014

BORING NUMBER MW-11D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/29/04 **COMPLETED** 10/1/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632824 **EASTING** 370302

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Organic Silt with Gravel (OL)** Brown, moist.	17:15 at 3-feet Start drilling with water 2 gpm Add 10 gallons of diluted (1:20) polymer to out side of casing.
					3.0 **Poorly Graded Gravel with Sand (GP)** Brown, subrounded to subangular gravel to >1 inch, medium to coarse sand, with some cobbles.	Varying amounts of sand
					7.0 8.0 **Boulder**	
10					**Poorly-graded Gravel with Sand (GP)** Gray, subrounded to subangular gravel to >1 inch; medium to coarse sand.	18:30 at 13-feet Casing getting binded up in formation. Lots of action need to keep it free.
20						Added 10 gallons of diluted polymer. 19:10 at 23-feet. Stop for day. Start 10-1-2004 9:50.
					27.0 Cobbles	Casing binding. Add 15 gallons diluted polymer.
30					29.0 **Poorly Graded Sand (SP)** Gray, medium grain, 5% gravel, 5% clay.	
					Clay with Gravel (CL) Gray.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Sand

Quantity used: NA

SEAL

Type: 0.25" bentonite pellets

Quantity used: 1 5-gallon bucket

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: 120 gallons

Vol. in well casing: 3-batches - 8 bags

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: NA

Estimated purge volume: NA

Comments: Used portland grout from 11' bgs to surface, 4 100 lb bags. 1/4-inch bentonite pellet seal from 125' to 120'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/29/04 **COMPLETED** 10/1/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632824 **EASTING** 370302

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					36.0	
					Well-graded Sand (SW) Brown, very fine grain.	
40					42.0	
					Poorly-graded Sand with Gravel (SP) Brown, coarse and medium grain.	11:00 at 43-feet.
					45.0	Varying amounts of sand 5 to 50%.
					Sandy Gravel with Cobbles (GP) Brown, subrounded to subangular gravel, coarse sand.	Casing binding. Added 15 gallons of diluted polymer.
50						11:40 at 53-feet. Varying amounts of sand 0 to 90%.
						Casing moving freely.
60						Casing binding up. 12:42 at 63-feet. Add 1 gallon of diluted polymer through hammer, 10 gallons to outside of casing.
					65.0	
					Poorly-graded Sand (SP) Dark brown, fine to medium grain.	
70					Finer than above.	13:30 at 73-feet. Flow = 5 gpm.
					74.0	
					76.0 **Poorly-graded Gravel with Sand (GP)** Dark brown, up to 1-inch, sub-rounded and sub-angular gravel, 10% sand.	
					78.0 **Poorly-graded Sand with Gravel (SP)** Brown, medium and coarse sand, 10% gravel.	
80					**Sandy Gravel (GP)** Brown, subrounded to subangular gravel to >1 inch.	Varying amounts of sand 10 to 90%.
						14:10 at 83-feet. Flow = 5 gpm. Varying amounts of sand 10 to 40%.
90						
					95.0	14:50 at 93-feet. Flow = 8 gpm.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/29/04 **COMPLETED** 10/1/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632824 **EASTING** 370302

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					96.0 **Poorly-graded Gravely Sand (SP)** Brown, medium sand, gravel up to >1-inch, sub-rounded and sub-angular.	Varying amounts of sand 10 to 50%.
100					**Sandy Gravel (GP)** Brown, up to >1-inch, sub-rounded and sub-angular gravel, medium to coarse sand.	Return line clogged. Flow = 10 gpm.
						15:35 at 103-feet. Flow = 10 gpm.
					105.0	Varying amounts of Gravel 10 o 50%.
					Gravely Sand (SP) Brown, coarse and medium sand, gravel up to >1-inch.	
110					0.5-foot layer of fine sand. Color change dark brown.	
120					121.0	Casing binding up, can not move upward.
					123.0 **Sandy Gravel (GP)** Brown, subrounded to subangular gravel to >1-inch, 40% sand.	17:17 at 123-feet. Flow = 10 gpm.
					Gravely Sand (SP) Brown, medium and coarse sand, 30% gravel. 126.0	Return water very cloudy with balls of clay. Flow = 15 gpm. Varying amounts of sand 30 to 40%.
130					128.0 **Clayey Gravel (GC)** 20% clay. **Sandy Gravel with Cobbles (GP)** Rounded, sub-rounded and sub-angular, up to >1-inch, sand-coarse, 40% sand.	18:23 at 133-feet. Flow = 15 gpm.
					136.0 137.0 **Bedrock** Cuttings-Black, angular. Bottom of hole at 136.0 feet.	TD - 137.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW11D SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble GW LOCATION:
DEVELOPMENT CONTRACTOR: CH2M
DEVELOPMENT METHOD AND EQUIPMENT USED: Waterra
START WATER LEVELS: 52.55' START: 1130 10/6/08 END: 1505 LOGGER:

MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1155	0	52.55					6" from bottom
1225	150	52.88	221	4.52C	6.46	.059	Change level-up 18" from Btm. < TBSP Sand-little silty
1250	275		26.2	4.53	6.52	.057	Change level up 2.5' f/ btm Clear, < tsp sand
1301	330	52.8	22	4.50	6.43	.057	Change level up 3.5 f/ btm few grains sand
1316	405	52.76	46.3	4.55	6.48	.057	" " " " 4.5 f/ btm
1330	475	52.78	29.2	4.49	6.51	.056	" " " " 5.5 f/ btm
1350	575	52.8	24.7	4.49	6.42	.056	" " " " 6.5 f/ btm
1405	650	52.8	24.4	4.51	6.41	.057	" " " " 7.5 f/ btm
1420	725		31.3	4.51	6.46	.057	8.5 f/ btm
1432	810	52.8	48	4.5	6.39	.056	" " " " 9.5 f/ btm
1455	885		6.4	4.53	6.48	.057	

TD = 138.55'

ANC/attach1sampleforms.xls/980560014

BORING NUMBER MW-11Db

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/27/04 **COMPLETED** 9/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** 53 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Organic Silt with Gravel (OL)** Brown, moist.	Start drilling with water 2 gpm.
					Poorly-graded Gravel with Sand (GP) Brown, sub-rounded to sub-angular gravel to >1-inch, Some cobbles, coarse sand, trace silt.	Drilling slowly in order to make a larger bore hole.
10						16:00 at 13-feet. Return line leaking, stop to fix resume drilling at 16:40.
						Varying amounts of sand 10 to 50%.
					Color change - Light gray.	
20						Casing vary tight, difficult to pull up. Added 5 gallons of dilute polymer from the top outside the casing.
					Color change - Light brown.	17:50 at 23-feet.
					27.0	
					29.0 **Lean Clay with Gravel (CL)** Light gray, 20% gravel.	
30					30.0 **Well-graded Sand (SW)** Brown, fine.	
					31.0 **Poorly Graded Sand (SP)** Gray, fine to medium sand.	
					Poorly Graded Sand with Gravel (SP) Brown, medium to coarse sand, subangular to subrounded fine	19:00 at 33-feet. Stop for the day. Start drilling 9-28-2004 9:10.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): Boring abandoned.

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: _____

Type: _____

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: _____

Slot size: _____

SCREEN FILTER

Type: _____

Quantity used: _____

SEAL

Type: _____

Quantity used: _____

GROUT

Mix used: _____

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Casing locked in boring. Casing broke apart 5-feet below ground surface. Boring abandoned. 140-feet of casing abandon in hole. Bottom and top o

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11Db

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/27/04 **COMPLETED** 9/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** 53 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					gravel to >1 inch.	Varying amounts of gravel 20 to 80%.
40					Coarser than above, gravel up to >1-inch.	9:30 at 43-feet.
					Cobbles	
50					50.0	Varying amounts of sand 5 to 30%.
					53.0 ▽ **Well-graded Sand (SW)** Brown, fine.	10:15 at 53-feet. Production = <0.5 gpm (Difficult to tell if this is groundwater or drilling water) Return rate (cutting, drilling water, formation water) = 1 gpm. Specific Cond. = 0.031 mS pH = 7.42
60					**Poorly Graded Gravel with Sand (GP)** Sub-rounded and sub-angular, up to >1-inch, light brown coarse to fine grain sand.	Return water Specific Cond. = 0.033mS pH = 7.62.
					62.0	
					63.0 **Clay with Sand and Gravel (CL)** Gray, fine sand, 40% sand, 10% gravel.	12:00 at 63-feet. Production = 1 gpm
					Well-graded Sand (SW) 66.0	
70					**Poorly-graded Sand with Gravel (SP)** Coarse and medium grain sand, gravel up to 1-inch. 40% gravel, with cobbles 71.0	Slow drilling through cobbles.
					Poorly-graded Gravel with Sand (GP) Light brown, sub-rounded, up to >1-inch	13:03 at 73-feet. Production = 2 gpm. Specific Cond. = 0.050 mS, pH = 7.35 Varying amounts of sand 0 to 20%.
80					80.0 81.0	
					Well-graded Sand (SW) Brown, fine grain. **Poorly Graded Gravel with Sand (GP)** Fine to coarse gravel, sand coarse to medium grain. 87.0	13:42 at 83-feet. Produciton = <0.5 gpm. Varying amounts of sand 10 40%.
					89.0 **Gravely Sand (SP)** Coarse and medium grain, 40% gravel	
90					90.0 **Sandy Gravel (GP)** Sub-angular and sub-rounded, up to 1-inch, 40% sand. **Poorly Graded Sand with Gravel (SP)** Medium and coarse grain, gravel up to 1-inch. 30% gravel.	14:40 at 93-feet. Production = 1 gpm. Specific Cond. = 0.044 mS pH = 7.60

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11Db

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/27/04 **COMPLETED** 9/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** 53 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					Finer than above, Medium to fine grain.	
					Coarser than above, Medium and coarse grain.	
					Finer than above, Medium and fine grain.	Production = 2 gpm. Specific Cond. = 0.036 mS pH = 7.80
110					Coarser than above, Coarse and medium grain.	
					112.0	Increased flow rate, stoped adding water. Flow = 8 gpm.
					Sandy Gravel (GP) Sub-rounded gravel to 1-inch; coarse grain sand, 40% sand.	
					115.0	
					117.0 **Gravely Sand (SP)** Medium to coarse grain, 30% gravel.	
					Poorly-graded Sand (SP) Dark brown, fine sand.	
120					120.0	Flow rate = 15 gpm.
					121.0	
					122.0 **Poorly-graded Sand with Gravel (SP)** Medium sand, gravel to >1-inch, 20% gravel.	
					Clayey Gravel (GP)	
					124.0 **Clay (CL)** Light gray.	18:30 at 123-feet. Stop for the day. Specific Cond. = 0.040 mS pH = 7.80 Difficult to estimate clay content. Water very cloudy. Cuttings 1% clay balls. Flow rate = 1 gpm. Flow rate = 10 gpm.
					Clayey Gravel with Sand (GC) 20% clay.	
					129.0	
130					**Sandy Gravel with Cobbles (GP)** Light gray, some sub-rounded, mostly cobble fragments.	Flow rate = 15 gpm.
					132.0	
					Sandy Gravel (GP) Light brown, sub-rounded, up to >1-inch. Up to 5% clay.	Flow rate = 15 gpm. Less than 1% clay balls. Slow drilling 1-foot/20mins.
						Flow rate 15 gpm
140					140.0	Return up to 70% sand but mostly angular. Flow = 15 gpm.
					Sandy Gravel (GP) Sub-rounded, up to >1-inch, fine to coarse grain sand.	
					143.0	Flow rate = 1 gpm. Start adding water 2 gpm.
					145.0 **Fractured Bedrock** Traces of clay.	
					147.0 **Bedrock** Cuttings - fine to medium sand, angular.	TD - 147. Casing locked in boring. Casing broke apart 5-feet below ground surface. Abandoned boring.
					Bottom of hole at 147.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

BORING NUMBER MW-11M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/2/04 **COMPLETED** 10/3/04 **GROUND ELEVATION** _____ **WATER LEVELS** 52.51 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632820 **EASTING** 370303

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Organic Silt (OL)**	
					4.0	Adding water with polymer.
					Poorly Graded Gravel with Silt and Sand (GP-GM) Brown, moist, gravel-sub-rounded to angular, up to >3/4-inch, medium to coarse grain sand.	
10					Occasional cobble -12-inches.	Difficult drilling, using polymer. Pull casing up many times because of sticking with rocks or casing.
					Occasional large cobble, difficult drilling.	
					18.0	
20					**Poorly Graded Gravel with Sand (GP)** Trace silt, brown, moist, gravel is sub-rounded to angular, up to >3/4-inches, medium to coarse sand, sub-angular to sub-rouned sand.	Adding water down rods and polymer/water outside casing.
					Cobble ~12 inch.	
30						

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: Native collapse

Quantity used: NA

SEAL

Type: 0.25" bentonite pellets CETCO

Quantity used: 1 5-gallon bucket

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: NA

Vol. in well casing: NA

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: NA

Estimated purge volume: NA

Comments: Boring TD-113.5-feet. Top 6-feet sealed with portland grout. 1/4-inch bentonite pellet seal from 99' to 94'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11M

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/2/04 **COMPLETED** 10/3/04 | **GROUND ELEVATION** | **WATER LEVELS** 52.51 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 6632820 **EASTING** 370303

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Matt Flynn

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					35.5 **Well-graded Sand (SW)** Brown, moist, fine to medium grain, sub-rounded.	Reached 35-feet at 19:02 on 10/02/2004.
40					40.0 **Well-graded Sand (SW)** Brown, moist, fine to coarse sand, sub-rounded to sub-angular.	Occasional cobbles. 5 gallons mixed polymer to outer casing.
					45.0 **Well-graded Sand (SW)** Moist, Grayish brown, fine to coarse, subrounded sand.	Drilling with water
50					49.0 51.0 **Well-graded Sand with Gravel (SW)** Grayish brown, fine to coarse subrounded sand; gravel rounded to sub-rounded to 3/4-inch, 30% gravel	
					53.0 **Well-graded Gravel with Sand (GW)** Medium to coarse subangular to subrounded sand; rounded to sub-angular gravel to >3/4-inch.	Drilling with water.
					56.0 **Well-graded Sand (SW)** Moist, grayish brown, fine to coarse grain, sub-angular to sub-rounded.	
60					**Well-graded Sandy Gravel (GW)** Moist, medium to coarse subrounded to subangular sand, rounded to angular gravel to 3/4-inch. 30% sand.	Drilling with water.
					66.0	100% sand
70					**Poorly Graded Sand (SP)** Brown, moist, medium, sub-angular sand.	Water at 68-feet.
					74.0	100% sand.
					Poorly Graded Sand (SP) Brown, wet, very fine grain. 77.0	60% gravel 40% sand.
80					**Well-graded Sandy Gravel (GW)** Angular to rounded gravel >3/4-inch, medium to coarse grain sand, 40% sand.	Flow at 83-feet = 5 to 7 gpm. 30% sand
90					93.0	Flow at 93-feet = 8 gpm.
					Well-graded Sandy Gravel (GW) Wet, small up to	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/2/04 **COMPLETED** 10/3/04 **GROUND ELEVATION** _____ **WATER LEVELS** 52.51 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632820 **EASTING** 370303

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					>3/4-inch, rounded to angular gravel; medium to coarse subangular to subrounded sand.	
					103.0	Flow at 103-feet = 10 gpm.
					Well-graded Sandy Gravel (GW) Small to >3/4-inch, rounded to angular gravel, medium to coarse sand.	
110						
					113.5	Flow at 113 = 10 gpm. TD - 113.5-feet on 10/03/2004
					Bottom of hole at 113.5 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER MW11M SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble GW LOCATION:
DEVELOPMENT CONTRACTOR: CH2
DEVELOPMENT METHOD AND EQUIPMENT USED: Waterra
START WATER LEVELS: 52.25 START: 1510 END: 1922 LOGGER:
10-6-04
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1525		52.25			~~6.34~~	.	6" from bottom
1553	140	52.35	199	4.58	6.34	.050	move up 12" Silty - ¼C sand
1620	280	52.30	155	4.56	6.35	.050	move up 12" brown (light) <TBSP sand
1642	390	52.30	180	4.57	6.35	.050	move up 12" light brn < TBSP sand
1718	540	52.32	135	4.53	6.36	.050	move up 12" light brn <TBSP sand
1741	655	52.34	~10	4.5	6.46	.049	move up 12" very lt. brn. < tsp sand
1810	755	52.38	40.1	4.47	6.34	.049	move up 12" lt. brn. < ½ tsp sand
1835	860	52.38	63	4.40	6.32	.049	" " " " " "
1852	935	52.38	26.9	4.43	6.43	.049	move up 12" very lt. brn. <½ tsp sand
1907	1010	51.88	14.8	4.43	6.42	.049	" "
1920	1060	52.18	9.5	4.47	6.41	.049	Cleared up above screen

115.4'

BORING NUMBER MW-11S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/4/04 **COMPLETED** 10/4/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632813 **EASTING** 370304

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Organic Silt (OL)**	Using water and polymer to drill.
					4.0 **Silty Gravel with Sand (GM)** Brown, Moist, sub-rounded to angular gravel to >3/4-inch; medium to coarse subrounded to subangular sand; 15% silt, 60% gravel, 25% sand. **Poorly-graded Sandy Gravel (GP)** Moist, 1/2 to >3/4-inch, angular to sub-angular gravel, medium to coarse, angular to sub-rounded sand.	
10						
					18.0 **Well-graded Sandy Gravel (GW)** Moist, rounded to angular, fine to >3/4-inch gravel, medium to coarse, angular to subrounded sand, 20% sand.	
20						
30						
					34.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Sand

Quantity used: 6 50-lb bags

SEAL

Type: 0.25" bentonite pellets

Quantity used: 1 5-gallon bucket

GROUT

Mix used: 30% solids Volclay

Method of placement: Tremie pipe

Vol. in surface casing: NA

Vol. in well casing: NA

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: _____

Estimated purge volume: _____

Comments: Boring TD-84'. Portland grountt (2 100 lb bags) in to 6-feet of well.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/4/04 **COMPLETED** 10/4/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6632813 **EASTING** 370304

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Well-graded Sand (SW)** Brown, moist, fine to medium grain, sub-rounded sand; trace gravel to 1/2-inch.	
					40.0	
					Well-graded Sand (SW) Brown, moist, fine to coarse grain, sub-rounded, trace rounded gravel to 1/2-inch.	
					47.0	
50					**Well-graded Sand with Gravel (SW)** Fine to coarse grain, sub-rounded sand; rounded to sub-rounded gravel to 1/2-inch, 20% gravel.	
					Increasing gravel with depth 65% sand, 35% gravel.	
60						Bottom of boring at 84-feet. 18:30 10/04/2004
					60.0	
					Well-graded Sandy Gravel (GW) Brownish gray, moist, fine to 3/4-inch, rounded to sub-rounded, sand-medium to coarse. 35% sand.	
					66.5	
70					**Poorly Graded Sand (SP)** Brown, moist, wet at 69-feet, medium, sub-angular.	100% sand
					Finer than above- very fine grain.	
					77.0	100% sand
80					**Well-graded Sandy Gravel (GW)** Brown, wet, rounded, gravel to >3/4-inch; medium to coarse sand; 35% sand.	
					84.0	flow at 84-feet = 6 to 7 gpm.
					Bottom of hole at 84.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	MW11S	

WELL DEVELOPMENT LOG

PROJECT: Pebble GW LOCATION:
DEVELOPMENT CONTRACTOR: CH2
DEVELOPMENT METHOD AND EQUIPMENT USED: Waterra
START WATER LEVELS: 54.6 START: 0900 END: 1530 LOGGER:
10-7-04
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
0940	0	54.6	2		~~6.68~~	.063	up 6" from bottom
1015	160	54.8	230	4.45	6.68	.063	move up 15" lt brn. < 1/4 C fine sand/silt
1045	285	54.8	85.9	4.45	6.76	.062	move up 15" lt. brn, < TBSP fine sand/silt
1110	385	54.7	32	4.47	6.79	.062	move up 15" Very lt. brn < tsp sand/ "
1125	435	54.65	99	4.52	6.75	.061	move up 15" very lt. brn < 1/2 tsp. sand/ "
1145	535	54.59	191	4.6	6.82	.062	move up 15" lt. brn < tsp. sand
1210	660	54.57	171	4.62	6.78	.062	move up 15" lt. brn, silty < TBSP fine sand
1236	760	54.55	191	4.7	6.86	.060	" " "
1300	870	54.74	245	4.76	6.77	.061	" " "
1327	995	54.75	235	4.86	6.87	.061	" " lt brn. 2 TBSP silt
1349	1095	55.21	194	5.08	6.87	.062	" " "
1407	1165	54.62	101	4.69	6.83	.061	" " "
1451	1215	54.65	361	4.8	6.81	.061	" " "
1525	1255	54.67	142	4.92	6.82	.060	Almost clear some silt

Find 74.27'

BORING NUMBER MW-11Sb

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/26/04 **COMPLETED** 9/26/04 **GROUND ELEVATION** _____ **WATER LEVELS** 53 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Organic Silt with Gravel (OL)** Brown, moist.	Drilling with air.
					Poorly Graded Gravel with Silt (GP-SM) Brown, moist, sub-rounded tosub-angular, up to >1-inch, some cobbles.	13:20 at 3-feet.
						Start drilling with water 2 gpm.
					8.0	
10					**Poorly Graded Sandy Gravel (GP)** Brown, moist, sub-rounded and sub-angular gravel to >1-inch, some cobbles, coarse sand, 5% silt.	13:50 at 13-feet.
						Varying amounts of sand 10 to 50%.
20						14:12 at 23-feet.
					26.0	
					Clay (CL) Light gray, 5% sand, 5% gravel.	
30					31.0	
					Silty Sand (SM) Brown, moist, very fine grain. Change in grain size - Fine grain, coarser than above.	14:56 at 33-feet.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): Boring abandoned.

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: _____

Type: _____

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: _____

Slot size: _____

SCREEN FILTER

Type: _____

Quantity used: _____

SEAL

Type: _____

Quantity used: _____

GROUT

Mix used: _____

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: Drill casing broke at 80'. Boring abandoned. 15' of casing lost in hole.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER MW-11Sb

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/26/04 **COMPLETED** 9/26/04 **GROUND ELEVATION** _____ **WATER LEVELS** 53 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					37.0	
40					**Poorly Graded Gravel with Sand (GP)** Sub-rounded and sub-angular gravel o 1-inch, coarse sand.	
					Coarser than above with cobbles.	15:15 at 43-feet.
50					Cobbles	Slow drilling Faster drilling
					53.0 ▽	15:40 at 53-feet. Production = No water.
					54.0 **Well-graded Sand (SW)** Brown, Fine grain.	
					Poorly Graded Gravel with Sand (GP) Brown, sub-rounded to sub-angular gravel to >1-inch.	Drilling rate 0.5-feet/min.
60						16:20 at 63-feet. Production = 1 gpm. Water between 53' and 63'
70						17:00 at 73-feet.
					75.0	
					Poorly Graded Sand with Gravel (SP) Brown, coarse sand, fine gravel.	Varying amounts of gravel 5 to 30%
80					80.0	
					Bottom of hole at 80.0 feet.	Casing broke. Abandon boring. Move 5-feet east and start MW-11(A).

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-02M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/ 2004 Site Revisit
DATE STARTED 9/9/05 **COMPLETED** 9/10/05
GROUND ELEVATION 833.399 feet **TOC ELEVATION** 835.131 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631409.841 meters **EASTING** 370594.406 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silty sand** Brown, poorly-graded, fine, saturated.	
5	GB					No water added.
						No water added.
9.0						
10	GB				**Silty sand** Brown, well-graded with silt and rounded 1-3/8"-diameter gravel clasts, moist.	
14.0						
15	GB				**Silt with sand** Brown, well-graded, rounded gravel clasts to 3/8"-diameter.	
19.0						
20	GB				**Silty gravel with sand** Angular to subangular, gravel clasts 1/2"-diameter to well-graded sand.	Driller is adding water.
23.0						Driller notes back into tight silt at 21', no indication formation is making water. Lots of water added. Driller indicates back in gravel.
25	GB				**Silty gravel with sand** Brown, angular to subangular, gravel clasts to 1/2"-diameter, well-graded sand.	Water added.
29.0						Driller indicates ~1 ft. of gravel at 26'. Back in to high silt unit, adding water. Stopped for 5 min. to see if there was water, too low flow for bucket test. Drilling sound changed, gravel.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.73 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4 " coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 16 Oct., 2005
Purge Volume: 227 gallons

RESPONSE TEST
Response Method: 20', 1" OD Watera Tube
Date: 17 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 53.13 Date: 9/10/05 Time: 0500

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-02M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/ 2004 Site Revisit
DATE STARTED 9/9/05 **COMPLETED** 9/10/05
GROUND ELEVATION 833.399 feet **TOC ELEVATION** 835.131 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631409.841 meters **EASTING** 370594.406 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silty gravel with sand** Brown, subangular to subrounded, 1/2"-diameter gravel clasts, well-graded sand.	Added water frequently.
					34.0	No water added.
35	GB				**Silty gravel with sand** Brown, angular to subangular, 3/8"-diameter gravel clasts, well-graded sand, wet. (Small sample.)	Added water and foam. Minimal water, foam added, 5 sec.
					39.0	Intervals of water followed by air to depth.
40	GB				40.0 **Silty gravel with sand** Brown, subangular to subrounded, 1/2"-diameter gravel clasts, poorly-graded sand, moist.	Formation is producing very little water from air return.
					Sand Brown, poorly-graded, moist.	Different drilling tone beginning at 41', fine sand in returns.
					44.0	
45	GB				**Sand** Brown, poorly-graded, fine, moist.	
					49.0	
50	GB				**Sand** Brown, poorly-graded, fine, moist. Sand becomes more moist with depth. Sand becomes siltier with depth.	
					54.0	
55	GB				**Sand** Brown, poorly-graded, fine, trace silt, moist.	
					58.0	
60	GB				**Silty sand** Brown, poorly-graded, fine, wet.	Water in casing.
					62.0	Sharp contact with tighter unit at 62'.
					No cuttings returns, water return has high silt content. Drilled to 63'.	Hole left for 20 min at 63', 10".
					63.9	DTW = 63 ft. = sand in cohesive material.
					Bottom of hole at 63.1 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: MW-05-2M
Date: 10/6/05 - 10/7/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer, Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		47.94	49.7
Total depth		64.5	56.2
pH		6.39	7.01

Screen interval (btoPVC): 10'
Top: 54.5
Bottom: 64.5
PVC stick-up height (above ground surface):

(After Reading Tape)

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on	START Pump @ 1716							
1750	64.5	47.94	—	—	—	—	—	STOP Pump FOR DAY
10/7/05 0908	"	—	—	—	—	—	—	RESTART Pump
0937	"	—	1.2	34.8	0.04	[E 3]	5.13	Thick Brown Muddy, 1 1/4 Gallon SILT
0951	62.5	—	—	—	—	—	—	Move up. RESTART Pump
1055	"	—	1.4	123	0.03	[E 3]	4.43	Thick Brown Muddy, 1 1/2 gallons SILT, 6.90 PH
1103	60.5	—	—	—	—	—	—	Move up. RESTART Pump
1158	"	—	1.9	227	"	"	4.34	" , 1 1/4 gallons SILT PH 7.10
1206	58.5	—	—	—	—	—	—	Move up. RESTART Pump
1308	"	—	—	—	"	"	4.23	2 1/2 gallons in 8.03 min, REPLACE FOOT. PH 7.01
1325	54.5	—	—	—	—	—	—	Move up. RESTART Pump
↓	↓							Won't Pump Anymore WATER
1348	↓	—	—	—	—	—	—	STOP Pump.
								(Unclogged FOOT & HOSE, RESTARTed, No luck.)
1400								END
Surge block off	START Rebound Surge @							

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-2SR

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/ 2004 Site Revisit
DATE STARTED 9/10/05 **COMPLETED** 9/10/05
GROUND ELEVATION 832.569 feet **TOC ELEVATION** 835.381 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631405.845 meters **EASTING** 370596.597 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat**	
	GB				**Silty sand** Brown, 80% very fine sand, 20% silt, damp.	Soft easy drilling.
5					6.0	Air injection only.
					7.0 **Gravelly silty sand** Brown.	Easy soft drilling.
	GB				**Silty sand** Brown, 65% very fine sand, 20% silt, 15% 1/4"-diameter gravel, damp.	Injected a little water to get cutting out of return lines.
10					Increasing gravel.	
					12.0 Increasing gravel.	
	GB				**Gravelly silty sand** Brown, 75% very fine sand, 25% silt, 25% 1/4"-diameter gravel, damp to wet. Probably groundwater.	Injected small amount of water. Hard to tell water content due to injected water.
15					15.0 **Silty sand** Brown, 20% 1/4"-diameter subangular to subrounded gravel, wet.	Injected small amount of water. Hammer is working due to smaller gravels.
					17.0 **Silty sand and gravels** Brown, very silty sand, 40% coarse sand, 40% silt, 10% gravel.	
					18.5 **Silt** Elastic, 10% coarse sand, damp. Bottom of hole at 18.5 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.81 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 6 Oct., 2005
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: Insufficient Water

Comments: Static Water Depth is denoted by solid triangle (ftoc): 17.62 Date: 9/10/05 Time: 1330

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: MW-05-2S-R
Date: 10/6/05 - 10/7/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		19.20	17.7
Total depth		22.2	21.09
pH		—	—

Screen interval (btoPVC): 5'
Top: 17.2
Bottom: 22.2
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on START Pump @ 1718								
1730	22.2	19.20	—				—	STOP Pump / Take Surge Block
	↓	↓						~~RESTART Pump~~
								NOT Enough WATER TO Pump out
								HAVE TO WAIT FOR Recharge TO
	↓	↓						RESTART Surge.
10/7/05 0912	22.2	—						RESTART PUMP.
1022	20.0	—						MOVE UP. RESTART Pump
1122	19.0	—						MOVE UP. RESTART Pump
"	"	—						(moved TO Top of WATER)
1216	"	—						STOP Pump // Remove Surge Block
Surge block off								
1220	22.2	—						START ReBi.S Surge
								CONTINUED TO choke. split SILT
								BiT By BiT let RUN 1HR.
1320	"	—						STOP DeBRiS Surge

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-11SS

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/ 2004 Site Revisit
DATE STARTED 9/11/05 **COMPLETED** 9/11/05
GROUND ELEVATION 882.635 feet **TOC ELEVATION** 885.230 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632825.78 meters **EASTING** 370286.406 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.2 **Peat** **Sand and gravel** Coarse. 2.0	Air injection only.
5	GB				**Sand and gravel** Brown, 85% coarse to medium sand, 10% 1/4"-diameter subrounded to subangular gravel, 5% fines, damp. 4.0 **Sand and gravel** Light brown, medium sand, little to no gravel, damp. 5.0	Air injection only.
10	GB				**Gravel with sand** Light brown, well-graded 1/2"-diameter subangular gravel, 30% coarse sand, 20% medium sand, <15% fines, damp. 7.0 **Gravel with sand** Light brown, well-graded 1/2"-diameter subangular gravel, 20% coarse sand, 30% medium sand, <15% fines, damp. Little to no fines.	Injected small amount of water to clear air return of cuttings.
15	GB				Small cobbles. 12.0 Small cobbles. **Gravel with sand** 60% coarse to medium sand, 40% poorly-graded, 1/4"-diameter subrounded pea gravel, little to no fines. 15.0 Occasional small cobble. 15.5 **Gravel with sand** 1/2"-diameter subrounded to subangular gravel, 10% coarse sand. 17.0	Formation is loose and has yet to get any returns up hole, has both air and water in the hole. Injected water to try to get some returns. Injected small amount of water.
20	GB				18.0 **Sand** Brown to multicolored, coarse to medium sand. 19.0 **Gravel** 55% 1/4"- to 1/2"-diameter, well-graded, subangular to subrounded gravel, 45% coarse sand, <5% fines. 20.0 **Gravel** Poorly-graded 1/4"-diameter gravel, coarse sand. 22.0	
25	GB				**Gravel** Well-graded, subangular to subrounded gravel, coarse to medium sand, <8% fines. 24.0 **Gravel** Well-graded, subangular to subrounded gravel, coarse to medium sand. 25.0 **Gravel** 50% well-graded, 1/4"- to 1/2"-diameter subangular to subrounded gravel, 20% coarse sand, 30% medium sand, 3% fines. 27.0	Injected air. Air injection only.
30	GB				**Gravel** Light brownish gravel, coarse to medium sand, 5% fines. 29.0 29.5	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.60 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 7 Oct., 2005
Purge Volume: 140 gallons

RESPONSE TEST
Response Method: N/A
Date: Insufficient Water

Comments: Water Depth (ftoc): Dry Date: 9/11/05 Time: 1515

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-11SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/ 2004 Site Revisit

DATE STARTED 9/11/05 **COMPLETED** 9/11/05 **GROUND ELEVATION** 882.635 feet **TOC ELEVATION** 885.230 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6632825.78 meters **EASTING** 370286.406 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				30.0 **Sand** Light brown, coarse to medium, 20% gravel. 31.0 **Sand** Light brown, coarse to medium sand, 20% subangular to subrounded gravel, damp. 32.0 **Gravel** Small, well-rounded gravel, loose. 33.0 **Sand** Coarse to medium. **Silt** Brown, no water, dry. **Silt** Brown, elastic, dry to slightly damp. **Silt** Gray, elastic, damp to dry. Bottom of hole at 33.0 feet.	Air injection only. Cuttings are powdered silt. Air injection only. Stopped drilling to see if water will seep.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: MW-05-11SS ~~MW-05-SS~~
Date: 10/7/05 - 10/8/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Jonathan Hobson

Summary * No Monument *

	Installed (Well Log)	Start	End
Water level		30.4	30.25
Total depth		33.95	33.90
pH		7.05	7.01

Screen interval (btoPVC): 10'
Top: 23.9
Bottom: 33.9
PVC stick-up height (above ground surface):

Development Observations * Only 3.5 ft WATER In Well

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on	START Pump 1S1S							Mud Brown In color, Alot of Suspended Sediment, Fine Sand, 3 Tsp.
1542	33.9	30.4	1.6	38.4	0.02	762	4.87	
1602	"	—	1.6	70.4	0.02	338	4.78	Shade lighter, Still Opaque, 1 Tsp Fine sand.
1614	"	—	1.6	89.6	0.02	284	4.77	Mud/LT Brown, Opaque, < 1 Tsp Fine sand. PH 6.76
1621	32.4	—						MOVE UP. RESTART Pump
1638	"	—	1.6	116.8	0.02	96	4.73	LT Brown, Slightly Clear, 1 Tsp Fine sand PH 6.78
1642	30.9	—						MOVE up. RESTART Pump, Ve.
1700	"	—						STOP Pump FOR DAY. (Very Slow) (Top of WATER)
10/8/05 0846	"	—						RESTART Pump
0853	"	—	1.5	127.3	0.02	167	4.18	MED TO LT Brown, 1 Tsp Fine Sand.
0856								STOP pump.
Surge block off	START Debris Surge @ 0906							
0914	33.9	—	1.6	140	0.02	127	4.45	WATER CLEAR, Very Slightly cloudy. TRACE SAND.
0921								STOP Debris Surge/End

$33.4 - 1.5 = 30.9$ $33.9 - 1.5 = 32.4$

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-12D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AF

DATE STARTED 6/11/05 **COMPLETED** 6/11/05 **GROUND ELEVATION** 1228.60 feet **TOC ELEVATION** 1230.81 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641742.198 meters **EASTING** 370670.555 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Klieforth/Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Peat	
					2.0	
					3.0 Sand and Gravel beginning at 2'.	Drilling with one Air Compressor.
					Sand with Gravel and Silt, Well Graded, Moist, Dark Brown, Subrounded.	
5					5.0	
					Silty Sand with Gravel Brown, Well graded, Subangular to subrounded, moist.	
					7.0	
					Gravel with Sand Subrounded, well graded, Moist, Brown, trace Silt.	
10					10.0 Boulder, Rock fragments.	Boulder
					Gravel with Sand Subrounded, well graded, Moist, Brown, trace Silt.	
					13.0	
					14.0 **Silty Sand**, well graded, subrounded, moist, light brown with subrounded gravel, trace clay.	Hole was deflected by the bolder at 8 ft. Putting stabilizer drill rod in to help straighten hole. Add Water
15					15.0 **Silty Sand**, well graded, subrounded, moist, light brown with subrounded sand, trace clay.	Add Water
					17.0 **Sandy Silt with gravel**, sand, graded, subrounded, brown, trace clay.	Slow drilling in Silt. Add Water
						Add Water
					19.0 **Sand with Silt and Gravel**, brown, sand is well graded subrounded.	Add second air compressor, No Water Added.
20					20.0 **Sand with Silt and gravel**, brown, moist, sand is subrounded.	No Water Added.
					Gravel with Well Graded Sand, brown, moist, subangular to subrounded.	No Water Added.
						No Water Added.
25						No Water Added.
					27.0	
					Sandy Silt with Gravel, brown,Sand is well graded, subangular to subrounded. Gravel is subrounded, moist.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.2 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 June, 2005
Purge Volume: 392 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 28 June 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 23.6 Date: 6/12/05 Time: 1255

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-12D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AF
DATE STARTED 6/11/05 **COMPLETED** 6/11/05
GROUND ELEVATION 1228.60 feet **TOC ELEVATION** 1230.81 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641742.198 meters **EASTING** 370670.555 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen/Klieforth/Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					Sandy Silt with gravel, brown, moist, Sand is well graded, subangular to subrounded. Gravel is subrounded. Trace clay.	Water Added.
					32.0	
					Sand with Silt and Gravel, Dark brown, moist, Sand is well graded and subangular to subrounded.	No Water Added.
					33.0	
35					**Silty Gravel with Sand**, light brown, saturated, well graded sand.	No Water Added, saturated soil may be from added water. Driller says "muck" at 33ft was from formation, water added below at 15 gallons / 5ft.
			14.70			June 9th TD = 38'. June 10th Begin drilling again.
40	GB		0.2			"Easy drilling Relatively". Add Water
						Stabilize Rig (compressor idling high) Add water.
45					45.0	Drilling slower
					Silt with Sand trace gravel, saturated, subround - subangular, brown.	wetland mappers ask for assist sharpening shovels. Change seal.
					49.5	
50	GB				**Gravel with Sand**, well sorted, wet, subround - subangular,	"Easy Drilling"
	GB				51.0 **Sand with Silt**, well sorted, moist, yellowish orange. Silty Sand = SM, rounded - subrounded.	"Easy Drilling"
					Well sorted = Fluvial?	
55	GB				55.0 Fine silty Sand, Rounded, Dry to moist. SM	
					Coarser fraction = Course Sand, brown and red.	"Easy Drilling"
					57.0	
		25.3	6.8		58.0 **Sand with Silt** Well graded, subrounded - subangular, wet, yellowish brown.	Using one compressor.
60	GB				Weathered Bedrock, Granitic.	"Easy Drilling"
			14			
		29.5				
					64.7	
65	GB				65.5 **Sand with Gravel** well graded and Silt, yellow brown, subangular - subround, wet.	Drilling slower
					Silt with Sand, moist yellow orange, well graded sand. Potential silt and clay sized fragments of VERY weathered bedrock.	
					68.0	
70	GB				**Sand with Silt** . moist. Potential weathered Granitic Bedrock.	
					71.0	
			4		**Sand with Silt** Well sorted fine, wet, rounded, yellow brown. Potential weathered Granitic Bedrock.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-12D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AF
DATE STARTED 6/11/05 **COMPLETED** 6/11/05 **GROUND ELEVATION** 1228.60 feet **TOC ELEVATION** 1230.81 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641742.198 meters **EASTING** 370670.555 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Klieforth/Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		0.5		76.0 Increased Silt slightly.	
					Sandy Silt, yellow brown, wet, Fine Sand.	
					Bedrock Potential segregegration fine weathered Granitic Bedrock.	Add Water. No Recovery.
80	GB				80.0	Add Water. No Recovery.
					81.0 **Silt with Sand**, minor sand, moist, yellow brown.	
					Silt with Sand, well graded sand, yellow brown, moist, subrounded.	Add Water.
					Bedrock Potential segregegration fine VERY weathered Granitic Bedrock.	
85	GB				84.0 **Silt with Sand**, fine medium sand, moist, yellow brown.	
					86.0	
					Silt with Sandfine medium Sand, dry/moist, subround-round, yellow brown.	Foundex casing broken at unknown depth.
			57			Resume drilling at 87 bgs. Water in collum from casing exaction.
90	GB				89.7	"Extremely high Torque"
			13.5		**Bedrock** Weathered Granitic Bedrock, Fragments are angular-subangular and have similar mineralogy. Rounded Quartz grains and Iron-Oxide surfaces, Surfaces=0.1mm-25mm.	
95	GB		13.5			
					Bedrock weathered Granitic Bedrock, Subrounded Quartz, abundant Fe Ox.	
100	GB					
	GB				Granitic Matrix = Dark Sulfides.	
105	GB					Weatherport Arrives.
			4.5			
110	GB					
			89.0			
115	GB				Orange and Grey in color.	
			5			

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-12D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AF

DATE STARTED 6/11/05 **COMPLETED** 6/11/05 **GROUND ELEVATION** 1228.60 feet **TOC ELEVATION** 1230.81 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641742.198 meters **EASTING** 370670.555 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Klieforth/Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB	77.0	15.0		**Bedrock** Weathered Granitic Bedrock, Fragments are angular-subangular and have similar mineralogy. Rounded Quartz grains and Iron-Oxide surfaces, Surfaces=0.1mm-25mm. Visible Pyrite to 1mm in size.	"Soft Drilling" aprox 1 rod a minute.
125	GB				Increased Sulfer content and Pyrite. Less FE MH, Iron Oxide. **Brdrock**, Dark Grey weathered bedrock, Quarts grains subangular to subrounded fragments range from 1mm-20mm, Dark grey water, No fragments over 1/2". Visible Pyrite.	"Hard Drilling" "Still Weathered" Casing Broke at unknown depth. Clear water.
					130.5 Bottom of hole at 129.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: MW-05-12D
Date: 6/13/05
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: K Sagansky

pg 1 of 2

Summary YSI (no flow cell)

	Installed (Well Log)	Start	End
Water level		23.82	
Total depth			
pH			

Screen interval (~~btoPVC~~ bgs): Top: 102' Bottom: 122'
PVC stick-up height (above ground surface): 2.23

Development Observations Op = opaque clr = clear Cldy Slightly Cldy = SCldy Cloudy =

Time	Foot valve depth (ft ~~btoPVC~~ bgs)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1150	121			0				Orange-brown, fine to med. sand
1200	"		1.6	16	0.170	Op	5.73	~ 1/2 tbsp, predominantly fine
1217			2	50	0.161	"	4.38	foam on surface - same as previous
								~1 tsp. meter not visible below water surface
1228	119							
1231	"		2	56	0.134	"	6.49	same as previous but all fine sand ~1 tsp.
1305	"		2	124	0.126	Cldy	4.48	~1/4 tsp fines, meter visible to 2" below surface (bs)
1310	117							
1320	"		2	144	0.129	"	4.03	~1/8 tsp fines, meter visible to 2-3" bs
1324	"		2.5	154	0.133	SCldy	3.81	<1/8 tsp ~~pinch~~ fines, meter visible to 3" bs
1330	"		"	169		"		same
1333	115							
missed time ~~1350~~ ?	"		"	~~211.5~~	0.127	Cldy	4.04	1 tsp fines, meter visible to 1" bs
1350	"		"	211.5	0.135	SCldy	3.65	~1/8 tsp fines, meter visible to 3" bs
1352	113		"					
1356	"		"	221.5	0.129	SCldy	3.83	~1.5 tsp fines, meter visible to 3.5" bs
1408	111							
1415	"		"	239	0.135	Cldy	4.01	~1/8 tsp fines, meter visible to ~2" bs
1420	"		"	251.5		SCldy		<1/8 tsp fines
1421	109		3		~~0.130~~			
missed time 1434	"		"	~~228~~	0.130	Cldy	4.10	~1 tsp fines, meter visible to 1" bs
1434				290.5	0.134	SCldy	3.97	<1/8 tsp ~~pinch~~ fines, meter visible to ~4" bs
1435	107		"					
Surge block off								

WELL DEVELOPMENT LOG

Well ID: MW-05-12D
Date: 6/13/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: K Rzegarski

pg 2 of 2

Summary

	Installed (Well Log)	Start	End
Water level		23.82	
Total depth			
pH			

Screen interval (~~btoPVC~~ bgs): Top: 102' Bottom: 122'

PVC stick-up height (above ground surface): 2.23

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1439	107	cont.	3	302.5	0.131	cloudy to slightly cloudy	3.93	~ 1/8 tsp fines, meter visible to ~2"
1447	"		"	326.5	0.132	slightly cloudy	3.83	pinch fines, meter visible to ~4"
1449	105		"					
1453	"		"	338.5	0.131	cloudy	3.81	1/2 tblsp fines, meter visible to ~2"
1500			"	359.5	0.132	slightly cloudy	4.48	pinch fines, meter visible to ~3.5"
1501	103		"					pinch fines, meter visible to ~3.5"
1506	"		"	374.5	0.135	slightly cloudy	4.09	
Polish 19 June/05				WL	23.57' btoc			
0925	121							
0927	off "		2.5	5		opaque		~ 1 tbs fine to med sized, opaque
0931	"							
0935	off "		2.0			cloudy		
0937	"							
0940	off "		1.6			slightly cloudy		< 1/8 tsp fines
Surge block off								
1516	97		3	386.5	0.132	slightly cloudy	4.40	pinch, fines, meter visible to ~ 4"
1520	off							

DRILLING WATER LEVEL MEASUREMENTS

WATER MANAGEMENT CONSULTANTS

SLR Alaska

Water Level Meter

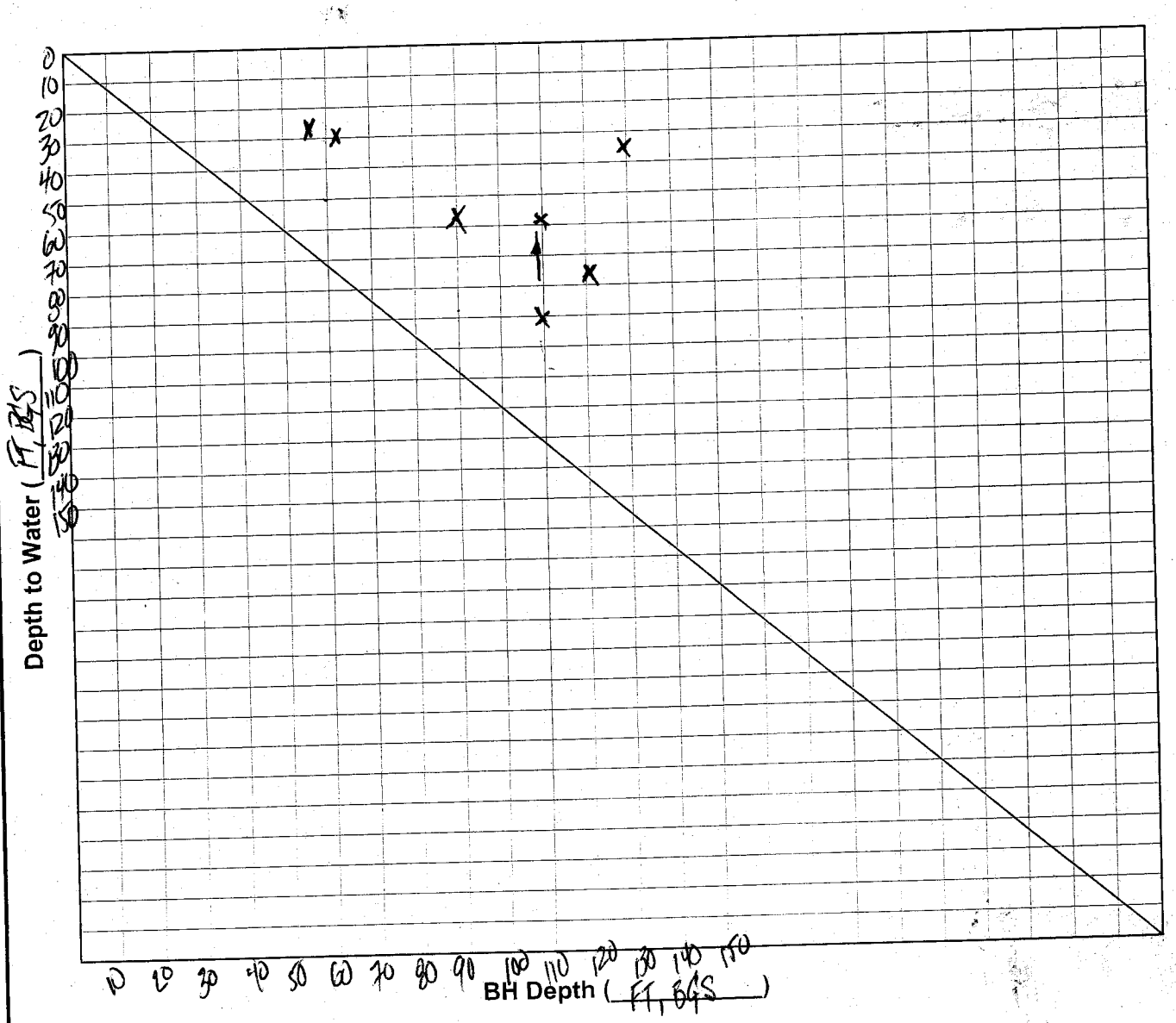
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: AF
Name: KLIEFOTH
Date start 9 JUNE 2005
Date finish 11 JUNE 2005

Water Level Measurements FT, BGS FT, BGS

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
10 JUNE	0919	58'	25.3 ↑	~~10 June~~	~~1940~~	~~11 1/4~~					
"	0937	63'	29.3 ↑	10 June	2001	123	77' ↑				
"	1655	~~87.5'~~	57.0' ↓	11 June	0205	11.2	11.2 ↑				
"	1830	113'	~~89.0~~ ↑	"	0555	~~123.8~~	33.8 –				
"	1855	113'	58.0 ↑								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-12S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AF

DATE STARTED 6/11/05 **COMPLETED** 6/12/05 **GROUND ELEVATION** 1227.94 feet **TOC ELEVATION** 1230.25 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641746.131 meters **EASTING** 370676.706 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					Soft easy drilling.	Soft Easy Drilling.
1.5					**Silt with Sand and Gravel** moist, brown, poorly graded, Subangular. Grains from coarse to medium.	No H2O Added.
4.0	GB					Loose, Soft.
5						No H2O Added.
6.0					**Silt with Sand and Gravel**,Poorly Graded , Subround-Subangular, Moist.	No H20.
10	GB					No H20.
10.0					**Silt with Sand and Gravel**, Sand Poorly Graded. Moist, Light Brown, Subround to Subangular. Trace Clay.	No H20.
12.5	GB				**Sand** Well Graded Angular, Subrounded, Dry, Light Grey.	No H20.
14.0					**Silt with Sand and Gravel**, Poorly Graded , Subround-Subangular, Moist, Light brown.	
15	GB					
16.0					**Sand with Gravel**, Well Graded , Subround-Subangular, Dry, Brown.	No H20 Added.
17.0	GB				**Sand with Silt and Gravel,** Well Graded , Blue-Grey, Dry, Subangular to Subround. Increased Silts.	Hard-Slow Drilling.
20.0					**Silty Sand with Gravel**, Subround-Subangular Sand, Olive Grey, Dry.	No H20, Add Rod.
20	GB					No H20.
25						No H20.
26.0					**Silty Sand with Gravel**, well graded sand, subrounded, Moist, Olive-Grey.	No H20.
25	GB					No H20.
30						No H20 Added.
						No H20.
						No H20.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 28 June, 2005
Purge Volume: 430 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 20 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 26.9 Date: 6/12/05 Time: 0105

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-12S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AF
DATE STARTED 6/11/05 **COMPLETED** 6/12/05
GROUND ELEVATION 1227.94 feet **TOC ELEVATION** 1230.25 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641746.131 meters **EASTING** 370676.706 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silty Sand with Gravel**, well graded sand, subrounded, Moist, Olive-Grey.	No H20.
						No H20.
						No H20.
35						
	GB				36.0 **Sand with Silt and Gravel**, Well Graded , Moist, Brown, Angular to Subround.	No H20 Added.
40					40.0	
	GB				**Sand with Silt and Gravel**,Well Graded , dry, Blue-Grey, Subrounded Gravels.	
	GB					
45					45.0	
	GB				46.0 **Silt with Sand and Trace Gravel**, Subround grains.	
					Silt with Sand and Gravel Well Graded, Moist, Light brown, Subangular-Subrounded grains.	No H20 Added.
					49.0 **Silt with Sand and Trace Gravel**, Sand Grains are Subangular and Well Graded, Moist, Brown.	
	GB				51.0 **Silt with Sand**well Graded, Subrounded to Subangular and Well Graded, Moist, Brown.	
					53.5	
					54.0 **Sand with Silt and Gravel**, Moist.	
					Sand with Silt and Gravel, Wet, well graded, Yellowish Orange.	
	GB		6		57.0	Drills like Bedrock.
			10		**Bedrock**	Clear Water.
	GB					Hard Rock.
			9		**Weathered Bedrock**	Clear Water.
					65.0	
	GB				66.0 **Sand with Silt**, Well Graded, Orange, Wet, Subangular-Subrounded grains.	Muddy water.
					Bottom of hole at 45.5 feet.	Lost Shoe.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Page 1 of 2

Well ID: MW-05-12S
Date: 19 June 05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Sagonski, Scala

Summary YSI (no flow cell) Turbidimeter (2100P)

	Installed (Well Log)	Start	End
Water level			8.90
Total depth			43.39
pH			~~[illegible]~~

Screen interval (~~bto~~bgs PVC): 41 - 36'
Top: 36' bgs
Bottom: 41' bgs
PVC stick-up height (above ground surface): 2.15'

2.33
.18
2.15

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1020	42.39		~~1~~	~~5~~				
1025			1	5	0.646		4.55	muddy, no sand, brown
1030			1	~~10~~				
1037			.5	15				
1042			1.6	~~20~~				~1 Tbs fine sand + silt, muddy
1048				25				~1/2 Tbs " + ", muddy
1049	off							
1058	on							
1102			1.25	~~30~~				muddy, ~1/2 Tbs fine sand + silt
1107			1	35	0.658			"
1112			1	40	~~5.29~~		5.29	1 tsp fines, muddy but
1117			"	45				color getting lighter
1122			"	50				
1127			"	55				
1132			1	60				1/2 tsp fines, color getting lighter but
1137			1	65				~~[illegible]~~ Opaque
1142			"	70				
1147			"	75				
1150	40.39							
1155			1	80			ok	same - opaque, 1/4 tsp fines
1200			1	85	0.657		~~6.27~~	
June 28, 2005								
0852	42.39							
0957			1	5	0.664	>1000	~~6.56~~	opaque, 1 tbsp fines
Surge block off								

WELL DEVELOPMENT LOG

Continued Page 2 of 2

Well ID: MW-05-125
Date: 28 June 05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Soola, Saganski

Summary

	Installed (Well Log)	Start	End
Water level			8.73
Total depth			43.39
pH		5.98	

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
08:05	42.39		1	10	0.669	71000	5.68	1 TSP. Opaque fines - silt + v. fine sand + brown
08:10								
0821				15				
0827				20				Opaque, < 1/8 teaspoon, brown
0831				25				Opaque, < 1/8 t.p, brown
0851				45				Ran out of gas in generator
0920								fueled + pumping again
0925			1		.012		11.93°	~ 1 tsp of sediment, opaque
0944			1	60	.651	71000	6.55°	Opaque, brown, ~ tsp sediment
0950	40.39		1					
0955				5	.652	71000	10.33	Opaque, brown 3 Tsp sed
1045			1	50	.654	71000	9.22	Opaque, brown 2 tsp sed
1055			1	60	.652	71000	8.69	Opaque brown 2 TSP sed
1109			1	5	.646	71000	10.77	Start upper Interval
1105			1	5	.646	71000	10.77	Opaque, brown, 3 Tsp sed
1145			1	45	.644	71000	9.18	Opaque, brown 2 Tsp sed
1205			1	65	.656	922	8.99	Opaque brown 2 tsp sed clearing sufficiently
Surge block off								

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

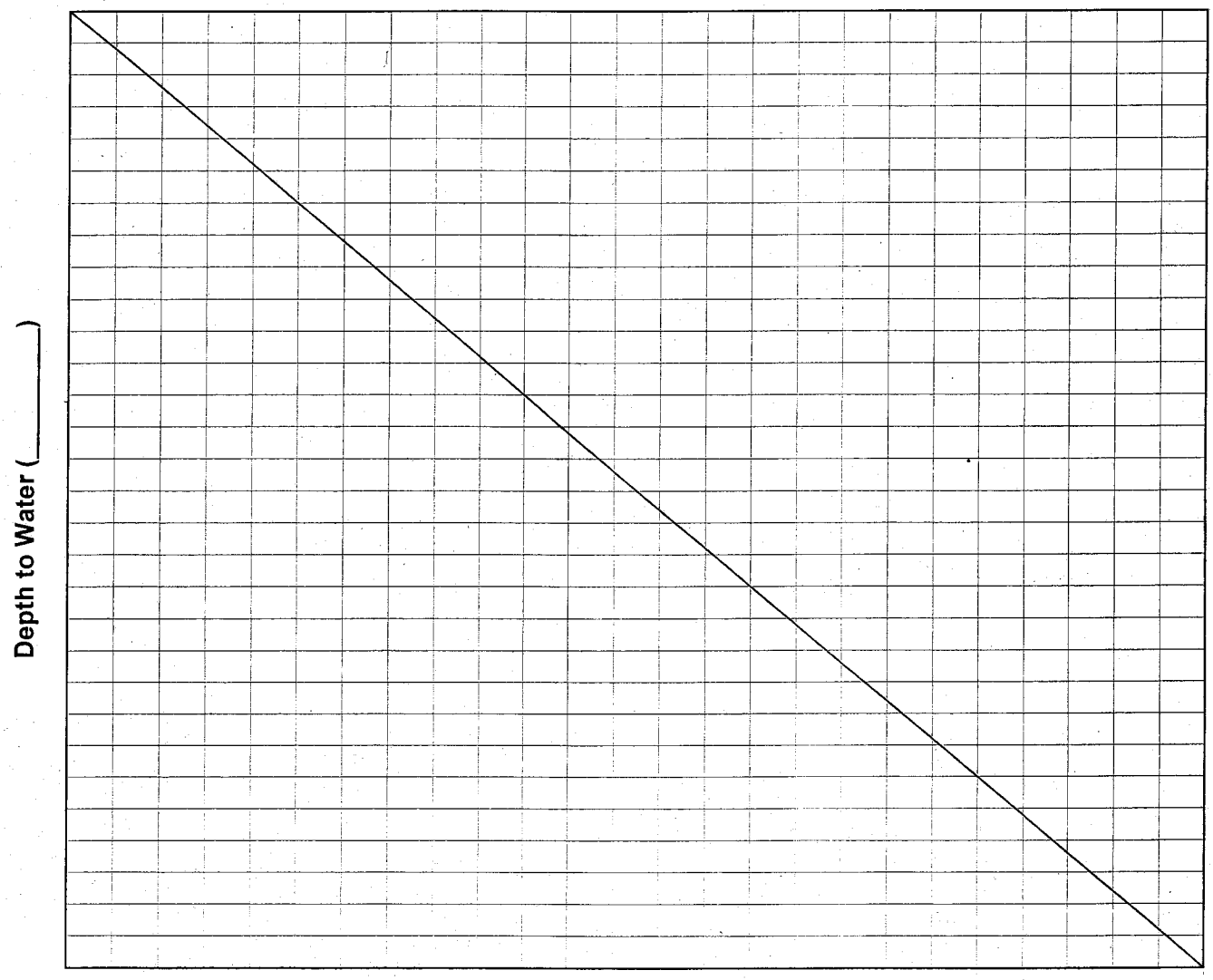
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: AF-S/MW-05-12S
Name: KLIEFORTH
Date start 11 JUNE
Date finish

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
11 JUN	0105	58'	26.9								
	0126										

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-13D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site X

DATE STARTED 6/17/05 **COMPLETED** 6/18/05 **GROUND ELEVATION** 813.05 feet **TOC ELEVATION** 815.41 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6633194.325 meters **EASTING** 363716.202 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					No recovery.	
3.0					**Sand with Silt and Gravel** well graded, moist, round to subround.	Rod pushes through easily.
6.0	GB				**Sand with gravel and Silt** Well graded, round to subround.	
10.0					**Gravel with Sand** Sand well graded, round, subangular. Gravel is subangular. Wet.	
15	GB	4.1			Increased Sand and Silt. Increased Silt.	Turbid water.
20	GB					
21.0					**Sand with Silt and Gravel** Sand Light brown. Gravel subangular/round.	
25						
26.0	GB		0.1		**Sand with Silt and Gravel**, Sand well graded. Light brown, subround to subangular.	Fast drilling.
30.0					Increased silt and gravel.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.37 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Aug, 2005
Purge Volume: 516 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 26 July 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 5.95 Date: 6/19/05 Time: 0450

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-13D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site X

DATE STARTED 6/17/05 **COMPLETED** 6/18/05 **GROUND ELEVATION** 813.05 feet **TOC ELEVATION** 815.41 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6633194.325 meters **EASTING** 363716.202 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravel with Silt and Sand**	Very turbid outflow.
		3.8				
35					Light brown, wet, round to subangular.	Very turbid water
			7-8			
40	GB					
		20.75				
45					46.0	
	GB				**Sand and Silt**	Driller guesses 10 gpm.
50					50.0	
	GB				**Sand with Silt and Gravel** Well graded.	
		47.5				
55						Air hose repair.
	GB		10-15			
60	GB					
		38.8				
65						
	GB	11			Gravel is rounded to subangular	
70					70.0	
	GB				**Sand and Silt**Subrounded to subangular.	Drilling easy.
		30.0				

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-13D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site X

DATE STARTED 6/17/05 **COMPLETED** 6/18/05 **GROUND ELEVATION** 813.05 feet **TOC ELEVATION** 815.41 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6633194.325 meters **EASTING** 363716.202 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen/Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		20		76.0 **Sand and Silt** Subrounded to subangular. **Sand with Silt** Brown, round to subangular.	Turbid water.
80	GB	46			80.0 Increased fines. **Sand with Silt** well graded, subround to subangular.	Drill rate slowing.
85	GB GB		30 30		85.5 **Bedrock** Granitic Matrix.	Slow drilling.
90	GB	3.8	30-35 60			
95	GB GB		60 55 48			Hard slow drilling. Stop - Air fitting broke.
100	GB	3.5				
105	GB		45			Hard slow drilling.
110	GB	3.4	50		112.0 Bottom of hole at 112.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

RESPONSE TEST

Date: 30 Sept 2005 Well ID: MW-05-13D

Project: Northern Dynasty Mines, Pebble Mine Site Ground Water Project #: 005.0189.05002, Task 5

Technician: Mike Riesen

Depth to water (ft, bto port): (previous) _____ Screened interval (bgs): 94.5-110

WL meter: SI, #24315

Transducer particulars

Brand: In-Situ Installation depth: 35 feet

Model: Mini Troll Time of installation: _____

Serial number: 9707

Pressure range: 30 PSI

Slug description: 20-foot slug of 1" Dia PVC Waterra Tubing

Correlation of manual and transducer measurements confirmed on graph? Yes _____ No _____

Manual water level readings and timing of slug insertion and removal

	Date	Time	DTW (ft, PVC)
1	30Sept	1104	5.74
2		1130	Slug In *
3		1135	Slug out
4		1140	slug in *
5		1145	slug out
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

	Date	Time	DTW (ft, ____)
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			

* - water to top of casing, some overfill on first cycle

Page 1 of 2

WELL DEVELOPMENT LOG

Well ID: MW-05-13D
Date: 26 July 2005
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Mike Rieser

Summary 0805

	Installed (Well Log)	Start	End
Water level		6.95	6.98
Total depth		113.3	113.4
pH		9.62	7.42

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
0826	112.8	6.95	3.3	0	0.			pump on	
0836	"	—	"		0.228	60.2	4.43	1/4 tsp. fine sand, brown	
0846	"	—	"		0.051	33.3	3.74	trace of fine sand, brown	pH=8.7
0850	110.8	—			—	—	—	moved up, S gpl. in 1 min, 25 sec	
0856	"	—			0.051	61.5	3.81	2 tsp. of fine brown sand	pH=7.4
0909	"	—			0.054	260	3.98	1 1/2 tsp " " " "	pH=8.03
0924	"	—			0.056	170	4.19	1 tsp " " " "	pH=7.53
0945	"	—			0.056	116	4.16	1/2 tsp " " " "	pH=7.53
0950	108.8	6.95			—	—	—	moved up, S gpl. in 1 min, 20 sec.	
0959	"	—			0.055	39.3	3.80	<1/2 tsp of fine brown sand	pH=7.45
1010	"	—			0.054	17.3	3.88	<1/4 tsp " " " "	
1020	106.8	7.04			—	—	—	moved up, S gpl. in 1 min, 20 sec.	
1028	"	—			0.053	10.9	4.39	trace of fine brown sand	
1036	104.8	7.01			—	—	—	moved up, S gpl. in 1 min, 22 sec.	
1046	"	—			0.053	13.4	4.11	trace of fine brown sand	pH=7.2
1052		—						stopped surging	
0940	102.8	-			0.154	197	4.2+	S gpl. in 1 min, 35 sec - foreman reads, 1/2 tsp fine	
0955	"	—			0.154	197	4.21	trace foam, 1/2 tsp fine sand, brown	pH=8.10 brown sand in bail
0815	"	—			0.064	87.8	4.06	trace foam, <1/2 tsp " " "	
0826		—			0.060	54.0	4.09	<1/4 tsp sand, move up 2' @ 0830	pH=6.2
0840	100.8	—			0.059	36.3	4.00	S gpl. in 1 min 30 sec, time to no foam,	pH=5.81
0850	"				0.059	29.7	4.20	trace sand, 1 foam, move up 2' @ 0855	pH=5.92
0905	~~98.8~~ 98.8	—			0.058	30.3	3.70	trace sand	pH=5.59
0915	"				—	—	—	S gpl. in 1 min, 29 sec, trace sand	pH=5.78
Surge block off								surging complete	
1100	98.3				—	—	—	start polishing	
1104	"				0.053	13.7	4.58	S gpl. in 1 min 18 sec.	pH=7.42
1106	112.8				—	—	—	new down to clean bottom	
1115	"	6.98			—	—	—	trace sediment, stop pumping	
29 July 0915	1093.3				—	—	—	start polishing, trace foam	
0930					—	—	—	end polishing	

Page 2 of 2

WELL DEVELOPMENT LOG

(SITEX)

Well ID: MW-05130
Date: 8/4/05
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: William Weimer Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		6.67	
Total depth		33.02	
pH		7.16	

Screen interval (btoPVC): 15'
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations Resumed Purge From 24.6 ft (FTOC)

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
0837	22.6	6.67	—	0	0.04	786	4.03	Medium TO Fine grain Sand, Orangish	Ph 7.16
0853	"	—	2.0	32	0.04	2.54	3.73	Brown, 2½ TBS [" 2Tsp]	Ph 6.60
0918	"	—	3.5	84.5	0.03	98.4	3.30	" ≤ ½ Tsp	
0937	"	—	3.7	70.3	0.03	22.9	3.25	TRACE Sediment, Moved Foot Valve	
0945	20.6	—	3.7	99.9	0.03	1000	3.35	Medium/Fine Sand, Orangish Brown, ≥ 3½ TBS	PH 6.31
1009	"	—	3.8	191.0	0.03	900	3.92	Alot of Suspended Sed, 1½ TBS.	PH 6.30
1036	"	—	3.75	225	0.03	900	3.74	≤ ½ Tsp, Still Orange Brown Sediment Suspended, Sand Medium TO Fine	
1110	"	—	3.64	381	0.03	49.3	4.36	WATER Clearing, Lt brown. TRACE Sand,	
1129	18.6	—	3.64	441.97	0.03	371	5.03	Moved Foot Valve ↑, 1 TBS, large/Medium grains	
1147	"	—	1.35	516.27	0.03	74.6	5.05	TRACE Sand, WATER Clear.	
1155								Stop Purge	
1203									
Surge block off									
1203								START Polish @ 13.6 ft (FTOC)	
1207								Stop Polish, Clear	
1210								START Debris Surge	
1231								Stop Debris Surge.	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

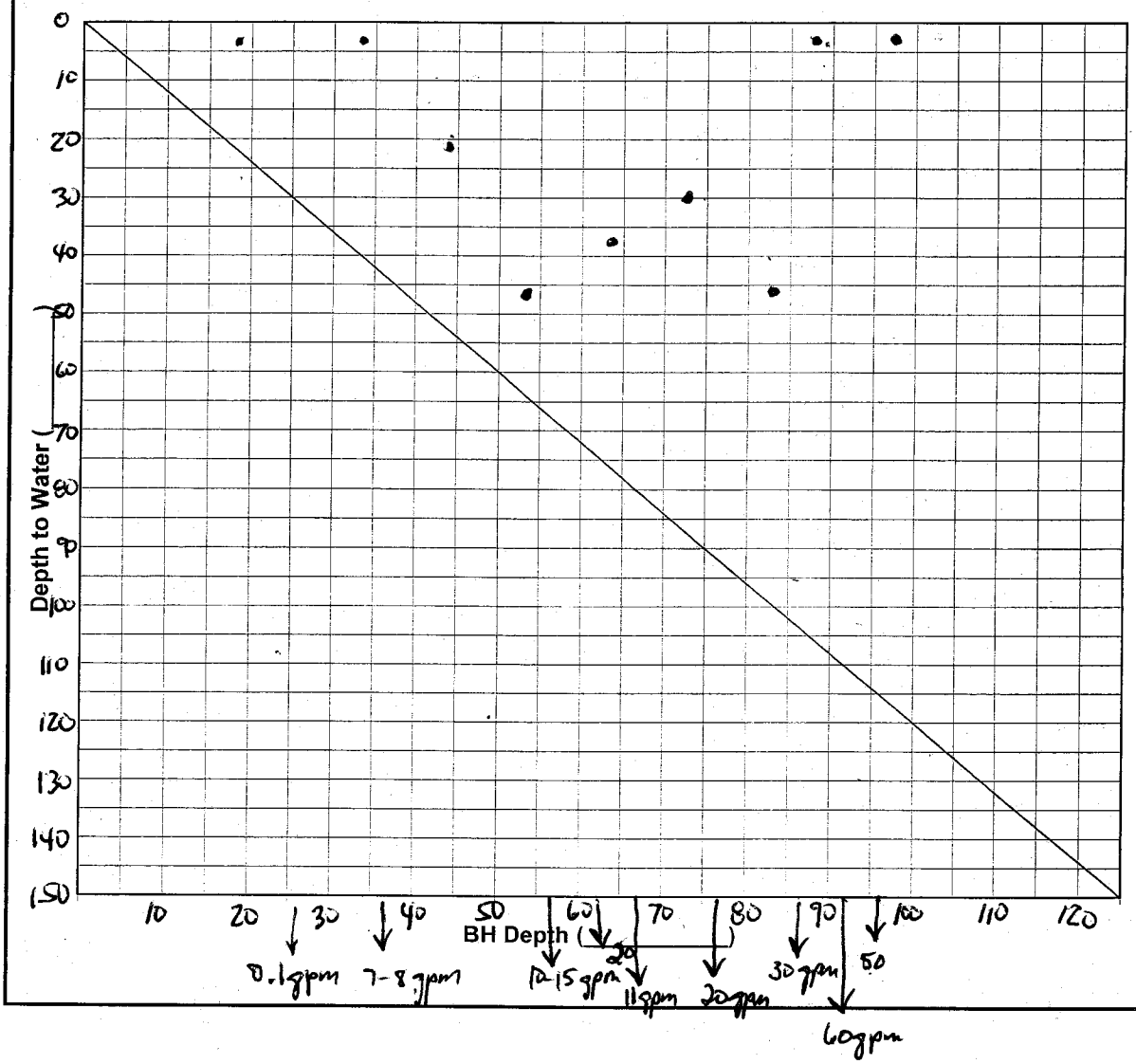
Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	
Name:	
Date start	
Date finish	

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
17 June	2054	18'	4.1 ↑	17 June	2341	73	30.1 ↑				
"	2124	33	3.8 ↑	18 June	0005	83	46.4				
"	2147	43	20.75 ↑	"	0040	88	3.8 ~				
"	2220	53	47.5 ↑	"	0538	98	3.5 ~				
"	2245	63	38.8								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-13S
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site X
DATE STARTED 6/18/05 **COMPLETED** 6/18/05
GROUND ELEVATION 813.18 feet **TOC ELEVATION** 815.14 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633189.538 meters **EASTING** 363721.497 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					No recovery.	
5					5.0	
					6.0 **Sand with gravel and silt.**	
	GB	3.83			**Sand with gravel and silt.** Angular to subangular grains wet, dark brown, coarse to medium grained sand.	
10					Increased Silts.	
	GB	6.4			Gravels angular to subround.	
15					Well graded sand.	
					16.0	
	GB		2.1		**Gravel** with well graded sand and silt. Angular to subround, brown, wet.	
	GB	3.6				
20					20.0	
					Sand Well graded with gravel and silt. brown, wet, subround to angular.	
	GB	15.8			24.0	
25	GB		3		**Gravel** with well graded sand and silt.	
					26.0	
					Gravel with sand and silt. Turbid water.	
	GB	3.5				
30	GB		6			

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.96 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 26 June, 2005
Purge Volume: 499 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 5.65 Date: 6/19/05 Time: 0215

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-13S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site X

DATE STARTED 6/18/05 **COMPLETED** 6/18/05 **GROUND ELEVATION** 813.18 feet **TOC ELEVATION** 815.14 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6633189.538 meters **EASTING** 363721.497 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravel** with sand and silt. Turbid water.	
	GB	3.7			33.0 Bottom of hole at 33.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: MW-05-13S
Date: 26 July 2005
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Mike Riesser, Pete S.

Summary

	Installed (Well Log)	Start	End
Water level		6.66	6.81
Total depth		33.1	33.1
pH		7.1	6.81

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
1212	32.6	6.66	3.3	0	—	—	—	pump on, reddish water	pH=7.1
1218	"	—	"		0.036	>1000	2.95	1/4 tsp. fine sand, brown	
1227	"	—	"		0.035	188	2.43	trace " " "	pH=7.06
1230	30.6	—	4.0		—	—	—	Sgpl in 1 min, 15 sec - valve raised	
1235	"	—	"		0.041	576	2.27	1 tsp fine sand/brown, and silt	pH=6.77
1245	"	—	"		0.038	72.2	1.98	1/4 tsp fine brown sand	pH=7.30
1250	28.6	6.65	3.3		—	—	—	raise valve, Sgpl. in 1 min, 30 sec.	
1300	"	—	"		0.038	650	2.12	1/2 tsp brown fine sand, silt in water	
1310	"	—	"		0.037	204	2.26	1/4 tsp. " " " " "	pH=7.32
1318	"	—	"		0.037	101	2.12	trace " " " " "	pH=7.46
1322	26.6	6.64			—	—	—	raised valve, Sgpl in 1 min 21 sec.	
1329	"	—	"		0.037	398	2.28	1/2 tsp brown fine sand, silt in water	pH=6.84
1343	"	—	"		0.040	66.3	2.55	1/4 " " " " , water clear	pH=6.76
1348	24.6	6.64			0.03	—	—	valve raised, Bgpl Sgpl in 1 min 31 sec	
1356	"	—	"		0.037	>1000	2.49	1/2 tsp. brown fine sand, silt in water	pH=7.23
1416	"	—	"		0.037	358	2.68	1/4 tsp brown fine sand, silt in water	pH=6.99
1430	"	—	"		0.038	202	2.85	trace " " " " "	pH=6.82
1433	"	6.65	"		—	—	—	pump off	
Surge block off									
1436	18.1	—	3.3		—	—	—	polish	
1444	"	—	"		0.038	185	3.08	trace sand	pH=6.81
1450	32.6	—	"		—	—	—	Drop to clean sediments from bottom	
1455	"	—	"		—	—	—	pump off, water clear	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

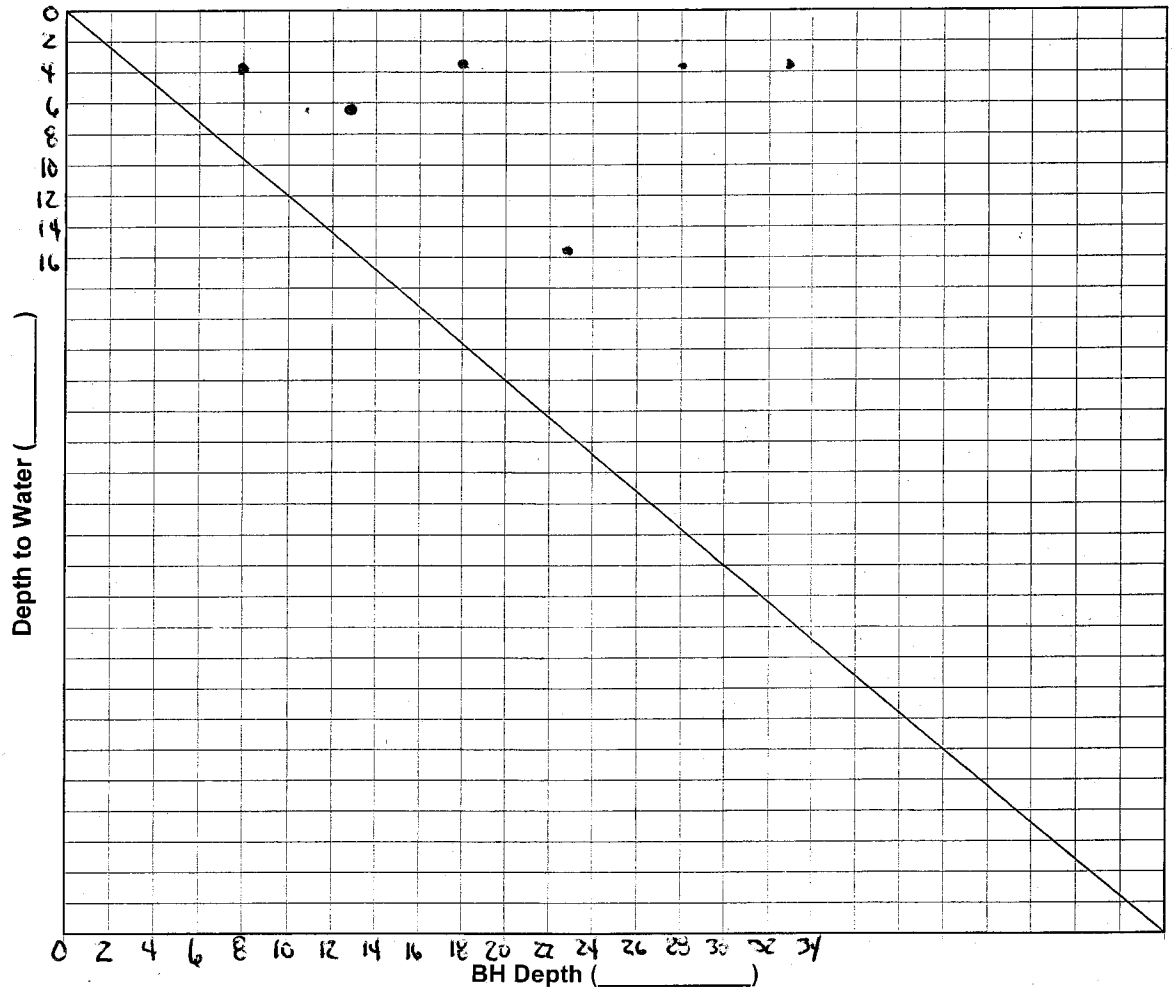
Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	MW-05-135
Name:	HAGEN
Date start	18 JUNE
Date finish	18 JUNE

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
18 JUNE	2138	8.0	3.8	18 JUNE	2238	33	3.7				
"	2150	13	06.4								
	2202	18	3.6								
	2218	23	15.8								
	2229	28	3.5								

MW 6.4

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-14D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site O

DATE STARTED 7/29/05 **COMPLETED** 7/30/05 **GROUND ELEVATION** 886.72 feet **TOC ELEVATION** 888.91 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6634196.067 meters **EASTING** 369409.296 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	No water added.
5	GB				5.0 **Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, well-graded sand, moist.	No water added.
10	GB				10.0 **Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, well-graded sand, trace fines, moist.	
15	GB				15.0 **Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, many fragments, well-graded sand, trace fines, moist.	No water added.
20	GB				20.0 **Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, many fragments, well-graded sand, trace fines, moist.	
25	GB				25.0 **Gravel** Brown, to 1/2"-diameter rounded to subrounded clasts, well-graded sand, trace fines, moist.	No water added.
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.60 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 1 Aug., 2005
Purge Volume: 840 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 2 Aug 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 35.87 Date: 7/30/05 Time: 1058

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-14D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site O
DATE STARTED 7/29/05 **COMPLETED** 7/30/05 **GROUND ELEVATION** 886.72 feet **TOC ELEVATION** 888.91 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6634196.067 meters **EASTING** 369409.296 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, many fragments, well-graded sand, trace fines, dry. Sand in cuttings beginning at 32 feet, driller indicates thin layer encountered with hard drilling, ash layer? Cuttings color back to brown at 33 feet.	
35	GB				35.0 Water at 34.9 feet. **Gravel** Brown, to 3/4"-diameter subrounded to rounded clasts, well-graded sand, trace fines, moist. Driller indicates water encountered at joint, hole is making water after rod added.	No water added.
40	GB				40.0 **Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, many fragments, well-graded sand, trace fines, wet. Cuttings have increasing silt content, cuttings are balling up. No water in casing.	
45	GB				45.0 **Gravel** Brown, to 1/2"-diameter subrounded to subangular clasts, well-graded silty sand, wet. Depth to water = 37 feet when casing open.	Foam added to water, small quantity of water added as required. No water added.
50	GB				50.0 **Gravel** Same as above.	Well is making water, but air pressure is heaping it out of hose.
55	GB				55.0 **Gravel** Brown, to 1/2"-diameter subangular to angular clasts or fragments, well-graded silty sand, wet.	No water added.
60	GB				60.0 **Gravel** Same as above.	
65	GB				65.0 **Gravel** Same as above.	No water added.
70	GB				70.0 **Gravel** Brown, to 1/2"-diameter subangular to subrounded clasts or fragments, well-graded silty sand, wet.	
75					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-14D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 7/29/05 **COMPLETED** 7/30/05
GROUND ELEVATION 886.72 feet **TOC ELEVATION** 888.91 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634196.067 meters **EASTING** 369409.296 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Siltstone** Black, some weathered fragments. Lots of water during drilling.	No water added. Easy drilling.
			20		Casing lifted 0.5 foot for flow test, very low flow to no flow with 25 psi and 50 psi.	Drilling is harder after 78.5 feet. Flow test during drilling. 3 gal. in 14 sec., ~20 gpm.
80	GB				80.0 **Siltstone** Black, no weathered fragments observed.	
			30		Casing breaks, pull rod, night crew goes down some boring.	Flow test ~5 gal. = 10 sec., ~30 gpm.
					84.0 **Bedrock** Siltstone, black	Flow test ~5 gal. = 10 sec., ~30 gpm.
85	GB		30			Slow penetration rate. Flow test 4 gal. = 10 sec., ~24 gpm.
			24			
			24-25			Flow test 4 gal. = 10 sec., ~24 to 25 gpm. at 75 psi air. Drill rate ~3 min. = 1 ft., 3 min. = 1 ft.
90	GB		30			Flow test 5 gal. = 10 sec., ~30 gpm. at 75 psi air. Drill rate is at 6 min. per foot.
			30		93.5	
					94.0 **Rock Fragments** Light gray, smaller.	Rock changes color to a light grayish blue.
95	GB		30		**Bedrock** Grayish blue, siltstone?	Flow test 5 gal. = 10 sec., ~30 gpm. at 75 psi air. Drill rate ~1 ft. = 3 min. Flow test 2 gal. = 10 sec., ~12 gpm.
			12		99.0	
100			6		**Bedrock** Black, siltstone?	Drill rate ~1 ft. = 4 min. Flow test 1 gal. = 10 sec., ~6 gpm.
			3			Drill rate ~1 ft. = 4 min. Flow test 0.75 gal. = 15 sec., ~3 gpm.
105			3			Flow test 1.5 gal. = 30 sec., ~3 gpm.
			5			Flow test 2.5 gal. = 30 sec., ~5 gpm. Short break, back to drilling.
110			4		110.0	Slow penetration rate. Flow test 4 gal. = 1 min., ~4 gpm.
					Bottom of hole at 110.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: MW-05-14D
Date: START 8/1/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: WILLOW WEIMER

Summary END PH = 6.94

	Installed (Well Log)	Start (FTOC)	End
Water level		37.85	37.98
Total depth		104.5	104.5
pH		7.98	6.94

Screen interval (btoPVC): 10'
Top: 94' bgs 94' FTOC
Bottom: 104' bgs 104' FTOC
PVC stick-up height (above ground surface): 2.42

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on = 7 STARTED PUMPING @ 14:45									
1451	104.0	37.85	1.5	69	1.27	[E 3]	5.48	DARK GRAY, SILTY. 1 cup Fine Sand/SILT.	
1508	"	"	4.4	83.8	0.56	"	5.18	GRAY, SAND, FINE SAND, SILT 4 TBS.	
1525	"	"	4.6	162.0	0.48	[E 5]	5.08	" 3 TBS.	
1540	"	"	4.3	226.5	0.30	[E 5]	4.95	" 1½ TBS	
1553	102.0	~~37.85~~	3.7	274.6	0.33	974	5.09		PH 6.0
1610	"	"	3.7	337.5	0.21	517	5.30	Fine Sand/SILT Gray, > ¼ Tsp.	PH 7.7
1625	"	"	"	393.0	0.19	429	5.10	"	
1637	100.0	"	4.1	442.2	0.24	965	5.43	" 2 Tsp	PH 8.27
1703	"	"	3.0	520.2	0.19	823	5.13	" 1½ Tsp	PH 8.21
1713	"	"	3.8	558.2	0.17	564	5.15	" ~~≤~~ 1 Tsp	PH 8.59
1725	98.0	"	1.5	576.2	0.19	564	4.51	" ≤ 1 Tsp.	
1742	"	"	3.7	639.1	0.17	615	5.90	" 1 TBS	
1803	"	"	3.7	716.8	0.116	609	5.60	≤ 1 Tsp.	
1817	96.0	"	4.1	778.3	0.20	609	4.98	≤ 1 Tsp	
1829	STOPPED	37.90							
1950	94.0		4.1	798	0.408	609	4.97	Fine Sand + Silt < ¼ Tsp	ph: 8.83
2003	"		3.5	840	0.174	431	4.09	trace < 1/16 Tsp	ph = 8.74
2008	Stopped								
2011	6" off bottom	Pump	Sediment						
Surge block off									
	SEE Yellow Book	(COMPLETED BY M. Hagin)						START POLISHING	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

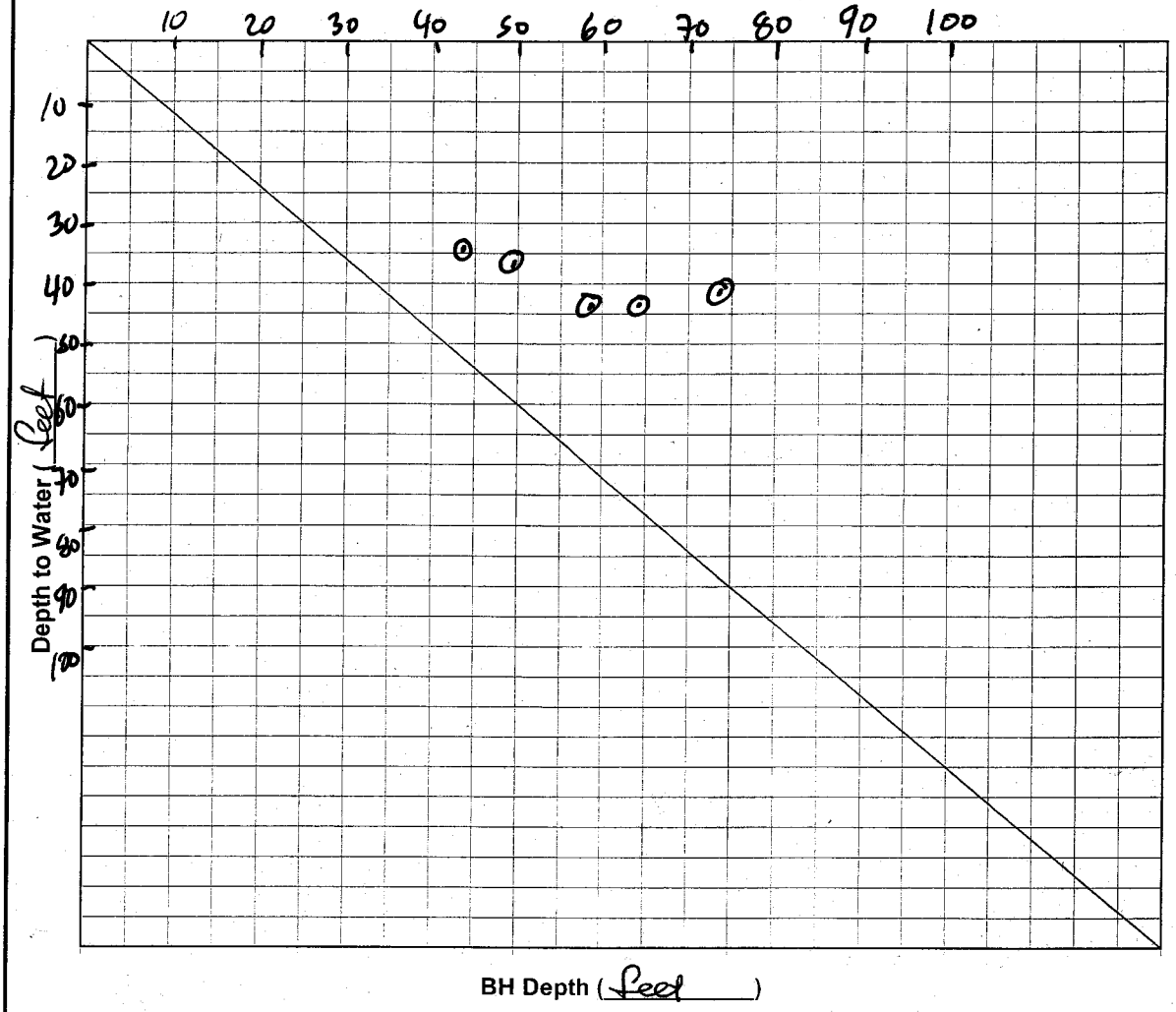
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: 01/mw-05-14D
Name: Mike Riesgo
Date start: 29 July 2005
Date finish:

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-29-05	13:14	43	34.9								
"	13:35	48	37								
"	14:05	58	43.7								
"	14:15	63	43.4								
"	14:47	73	41.1								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-14S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 7/30/05 **COMPLETED** 7/30/05
GROUND ELEVATION 925.23 feet **TOC ELEVATION** 927.27 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634393.342 meters **EASTING** 372488.122 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	Fast penetration rate.
4.0						
5	GB				**Silty sandy gravel** Brown, 50% 1/2"-diameter gravel, 40% sand, 10% silt, dry.	
9.0						Fast penetration rate.
10	GB				**Gravel and sand** Poorly-graded, subrounded, 1/4"-diameter pea gravel, <15% fines, dry.	
14.0						Fuel filter problem. Filter cleaned, back to drilling. Fast penetration rate. Smooth fast drilling.
15	GB				**Silty sand and gravel** Coarse to fine, slightly silty sand, ~10% 1/2"-diameter gravel, damp.	
19.0						
20	GB				**Gravel** Well-graded gravel, coarse to fine sand, <15% fines, dry.	Fast drilling, 1 min. per foot.
24.0						
25	GB				**Gravel with sand and silt** Brown, well-graded, 1/2"-diameter gravel, >15% coarse to fine sand, 10% silt, damp.	
25.0						
26.0					**Gravel and sand** Gravel with >15% sand, ~10% silt.	
					Gravel and sand 1/2"-diameter gravel, >15% sand, ~10% silt.	
29.0						
29.5					**Sand** Gray, very fine sand or silt layer, dry.	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.03 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 3 Aug., 2005
Purge Volume: 907 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 17 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 37.20 Date: 7/31/05 Time: 0850

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

MW-05-14S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 7/30/05 **COMPLETED** 7/30/05
GROUND ELEVATION 925.23 feet **TOC ELEVATION** 927.27 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6634393.342 meters **EASTING** 372488.122 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Gravel** Poorly-graded, 1/2"- to 3/4"-diameter gravel, >15% fine sand.	
					32.5 **Silty sand** Coarse to fine sand, slight silt.	Driller says we are in a slightly silty sand at end of drilling interval.
					34.0 **Gravel with sand and silt** Well-graded gravel, >15% coarse to fine sand, 15% silt, damp.	Drill cuttings are starting to get backed up with silt and gravel is coated with silt.
35	GB					
					39.0 First water at 38 feet.	First water at 38 feet, very little. Not enough water for flow test.
40	GB				40.0 **Gravel with sand and silt** Well-graded gravel, >15% coarse to fine sand, 5% silt, wet.	
					Gravel with sand and silt Well-graded gravel, more silt with gravel, gravel is coated with silt and fine sand, damp.	Water in ODEX at 35' 8", approx. 7 to 8 feet of water in casing.
			1/8		44.0	Flow test, 1 min. = 1/8 gal. of water, 1/8 gpm.
45	GB				**Gravel with sand and silt** Well-graded gravel, >15% coarse to fine sand, 8% silt, wet.	
	GB		2		49.0	Flow test, 2 gpm at 50 psi., water is mostly from inside ODEX casing.
50	GB		13		50.0 **Gravel with sand and silt** Well-graded gravel, >15% sand and silt, 20% silt, very wet.	Producing a lot more water and silt in cuttings, approx. 1/2 gpm.
					50.5 **Bedrock**	Water is clear of silt, flow test = 13 gpm.
					51.0 **Siltstone** Black siltstone rock chips, wet.	
					53.0 **Bedrock**	
					Bottom of hole at 53.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: O/MW-05-145
Date: 8/2/05-8/3/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Women, Paul Taylor, Bob Hillsforth.

Summary

	Installed (Well Log)	Start	End
Water level	~~47.70~~	37.56	37.70
Total depth	~~50.35~~	50.27	50.15
pH		6.52	6.39

Screen interval (btoPVC): 5'
Top: 41' + 2 => 43' (FTOC)
Bottom: 46' + 2 => 48' (FTOC)
PVC stick-up height (above ground surface): 2'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on			4.0 gpm						
1700	49.5	37.56		0	0.09		4.94	Brown, Murky, Fine Sand & SILT	
1711	"	START Again.	4.34	—	0.09	1000	4.55	Medium to fine grain.	4 TBS
1731	"	—	4.34	86.6	0.08	308	5.04	Light Brown, Fine Sand & Silt	PH 6.39
1743	"	—	4.42	139.84	0.08	189	4.52	" ≥2 TBS	PH 6.49
1752	"	—	4.67	181.87	0.08	125.	4.39	light Brown, Fine Sand & Silt. 1½ tsp	PH 6.64
1802	47.5	—	4.76	229.47	0.08	1000	4.63	" 2½ TSP	PH 6.65
1817	"	—	4.62	298.77	0.08	E 7	4.45	" 1½ TSP.	PH 6.25
1830		—						END of Day	
8/3/05 0858	47.5	—						Resumed Purging	
0903	"	—	4.34	330.47	0.10	276	5.01	Brown, Fine Sand/Silt Suspended Sediment, in water 2 TBS.	
0918	"	—	4.34	385.57	0.09	116	5.05	" 1½ TBS	
0929	"	—	4.38	424.99	0.08	77.2	4.57	" 1 TBS	PH 6.42
0948	"	—	4.42	508.97	0.08	526	4.35	" 2 TSP.	PH 6.43
1009	"	—	4.38	592.19	0.08	31.7	4.34	light Brown, Silt & Fine Sand 1 tsp	PH 6.42
1031	45.5	—	4.34	676.99	0.08	1000	5.0	Dark Brown, Suspended Sediment, 3 TBS	PH 6.37
1051	"		4.42	767.39	0.08	49.6	4.78	light Brown, Silt & Fine Sand, 1½ TSP.	PH 6.80
1115	"		4.54	871.81	0.08	30.8	5.0	light Brown, ≤1 TSP	PH 6.28
1147	44.5		4.42	907.17	0.08	23.6	5.01	" <½ TSP.	PH 6.39
								STOP Purge	
								Remove Surge Block	
Surge block off									
1200	39.5							START Polish @ 39.5	
1230								STOP Polish	
1232	49.5							START Bottom Purge, 1½ TBS.	
1251								STOP Bottom Purge, ≤½ TSP	

BORING NUMBER P-1

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/21/04 **COMPLETED** 8/21/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641340 **EASTING** 5371341

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Silty gravel w/ sand (GM)** Brown, moist, medium to coarse sub-angular to sub-rounded sand, angular to sub-rounded gravel up to >3/4".	10-15% fines, 60% gravel, 25-30% sands
						Flow IN
					8.0 **Well-graded sand w/ gravel and silt (SW-SM)** Brown, moist, medium to coarse sub-angular to sub-rounded sand, angular to sub-rounded gravel up to 3/4".	Adding water at 8'. 10% fines, 50% sands, 40% gravel Flow IN
10						
					16.0 **Clayey gravel w/ sand (GC)** Brown, moist, sub-rounded fine to coarse sand, sub-angular to rounded gravel to 1/2".	30% fine, 40% gravel, 20% sand Flow IN
20						
						Flow IN
					26.0 **Well-graded sand w/ silt (SW-SM)** Yellowish orange, moist, sub-angular to rounded fine to coarse sand, layers where silt increases to 20- 30%.	90% sand, 10% silt
30					31.0 **Bedrock** Yellowish orange and off-white, moist.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): Boring abandoned

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: _____

Type: _____

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: _____

Slot size: _____

SCREEN FILTER

Type: _____

Quantity used: _____

SEAL

Type: _____

Quantity used: _____

GROUT

Mix used: _____

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: _____

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-1

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/21/04 **COMPLETED** 8/21/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641340 **EASTING** 5371341

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					44.0 TD. No water encountered. No well installed. Bore hole abandoned. 1710 8/21/2004. Bottom of hole at 44.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER P-1 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek
DEVELOPMENT CONTRACTOR: CH2M Hill LOCATION:
DEVELOPMENT METHOD AND EQUIPMENT USED: 1-inch Waterra with surge block
START WATER LEVELS: START: END: LOGGER: D. Lacey
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED:
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)

Well Not Installed.

Start: Depth to Bottom = Depth to Water =
End: Depth to Bottom = Depth to Water =

ANC/Pebble_Att_1_Forms.xls/980560014

BORING NUMBER P-2D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/18/04 **COMPLETED** 8/19/04 **GROUND ELEVATION** _____ **WATER LEVELS** 8.59 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641241 **EASTING** 5371688

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat**	
					Silty Gravel (GM) Yellowish orange and light brown, moist, angular to subangular gravel to greater than .75 inches.	Water in.
					8.0 ▽	
10					**Silty Sand with Gravel (SM)** Yellowish brown, moist (wet at 9 feet). Medium, subangular to subround sand, subangular to subround gravel to .5 inches. 20% fines.	
					As above, fines 10-15%.	
					18.0	
20					**Well-Graded Sand with Gravel (SW)** Yellowish brown, wet, medium to coarse subangular to subround sand, subangular gravel to .75 inches.	
					22.5	
					23.0 **Silty Sand with Gravel (SM)** Small lense of silty sand or sandy silt, yellow brown, wet, fine to medium sand	
					25.0 **Well-Graded Sand with Gravel (SW)**	Water in.
					26.0 **Silty Sand with Gravel (SM)** Small lense of silty sand/sandy silt, yellow-brown, wet	
30					**Clay (CL)** Gray, moist, trace gravel.	
					33.0	
					Clayey Gravel with Sand (GC) Gray, moist, angular	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: N/A

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 silica sand.

Quantity used: _____

SEAL

Type: bentonite coated pellets

Quantity used: _____

GROUT

Mix used: 30% volclay grout

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: _____

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-2D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/18/04 **COMPLETED** 8/19/04 **GROUND ELEVATION** _____ **WATER LEVELS** 8.59 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641241 **EASTING** 5371688

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					36.0 to subround gravel to .75 inches, subangular to subround medium sand.	
					37.0 **Well-Graded Sand with Gravel (SW)** Yellow, brown, moist, subangular to subround medium to coarse sand, angular to subround gravel up to .75 inches.	
40					38.0 **Clay with Gravel (CL)** Gray, moist, lense 6-12 inches.	
					Well-Graded Sand with Gravel (SW) Gray, moist to wet, subangular to subround medium to coarse sand, gravel subround to .5 inches. Small lense of gray clay. Large cobble. Small lense of clay.	
					49.0	
50					51.0 **Large Cobble** Calcified off-white/rust colored, wet, angular sands and gravels.	
					Well-Graded Sand with Gravel (SW) Gray, wet Increased Fines.	
					56.0	
					58.0 **Boulder**	
60					**Well-Graded Sand with Gravel and Clay (SW)** Brown, moist, subangular sand , medium to coarse. Subround gravel to .5 inches. Clay approx. 10%.	
					63.0	
					BEDROCK Calcified off white/rust colored, wet, angular sands and gravels. w	
					68.0	
70					**Weathered Bedrock** Possibly Siltstone. Brown, most likely wet, soft.	
					75.0	
					BEDROCK Calcified, off white/rust colored. Angular sands and gravels, wet.	
80					**BEDROCK** Highly fractured, off white/reddish brown, wet.	
					88.5	
					Bottom of hole at 88.5 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

P-2D incorrectly labelled P-3D

CH2MHILL

PROJECT NUMBER	WELL NUMBER P-3D	SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek LOCATION:
DEVELOPMENT CONTRACTOR: CH2M HILL
DEVELOPMENT METHOD AND EQUIPMENT USED: 1" Waterra foot valve assembly with surge block
START WATER LEVELS: 10.21 START: 1946 8-31-04 END: 1109 9-1-04 LOGGER: D. LACEY
MAXIMUM DRAWDOWN DURING PUMPING: 5.74 feet BTOC
RANGE AND AVERAGE DISCHARGE RATE: 2.5 gal/min
TOTAL QUANTITY OF WATER DISCHARGED: 250 gal
DISPOSITION OF DISCHARGE WATER: Water slightly cloudy after development. ~~Silt load in water~~

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Surge Depth BTOC
1946	10	15.30	—	—	—	—	(Very cloudy, Gray) ½ cup SAND / 5gal	88.50
Stop for the day								
9-1-04								
0934	15	15.95	>990	—	—	—	(Same as Above) Trace sand / 5gals	"
0940	30	—	540	2.81	6.02	107		
0944	35	—	—	—	—	—	(Same as above) less cloudy than above	87.0
0952	75	15.95	660	2.91	6.91	114	(Same as above) 2 Tbs Sand / 5gal	85.5
1010	120	15.85	500	2.85	6.90	110	(Same as above) 0.5 Tbs / 5gal	84.0
1020	145	15.93	250	2.95	6.53	108	(Cloudy, Gray), less cloudy than above, Trace Sand	82.5
1030	170	—	150	3.01	6.41	105	(Slightly cloudy), Trace SAND	81.0
1040	195	—	320	3.08	6.51	108	(Very cloudy, Gray) 1 Tbs Sand / 5gals	79.5
1055	225	Remove surge block, clear bottom of well						
1109	250	—	82	3.07	6.42	99	(Clear to slightly cloudy) No sand	76.0

Start: Total Depth = 89.20
Depth to Water = 10.21

END: Total Depth = 89.22
Depth to Water = 9.92

ANC/Pebble_Att_1_Forms.xls/980560014

BORING NUMBER P-2M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/20/04 **COMPLETED** 8/20/04 **GROUND ELEVATION** _____ **WATER LEVELS** 8.61 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641256 **EASTING** 5371690

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					0.5 **Peat (PT)**	
					Silty Gravel (GM) Yellow-orange, moist. Gravel is angular to subround to greater than .75 inches.	
					7.0	Adding water to drill.
10					▽ **Well-Graded Sand with Gravel and Silt (SW-SM)** Medium to coarse subangular-subround sand. Subangular to subround gravel to .5 inches. 10-15% fines.	Best guess at water level.
					Less fines-about 5%.	Adding water to drill. Confirmed water is also coming from aquifer.
20					24.0 Small lense of silt.	
					25.5 **Sandy Silt (SM)** Brownish gray, moist, possibly wet.	
					Clay (CL) Gray, moist, trace gravel.	
30						
					33.5 Increased Gravel to about 30%.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: N/A

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC

Slot size: 0.020"

SCREEN FILTER

Type: 20/20 Silica Sand

Quantity used: 4 50-lb bags

SEAL

Type: 0.25" bentonite pellets

Quantity used: 1 5-gallon bucket

GROUT

Mix used: Volclay

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: 8" Bentonite plug with 4" silica sand on top.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-2M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/20/04 **COMPLETED** 8/20/04 **GROUND ELEVATION** _____ **WATER LEVELS** 8.61 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641256 **EASTING** 5371690

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Clayey Gravel (GC)** Gray, moist, gravel to .5 inches, subround to round.	
					Gray, moist, subangular to subround gravel to .5 inches.	
					46.0	
					Boulder (BLDRCBBL)	
					49.0	
50					50.0 **Well-Graded Sand with Gravel (SW) Interbedded with layers of Gravel and Clay (GC)** wet, gray, layers 6-12 inches. GC/SW layers to 55 feet.	Some water in gravel layers. However, layers are too small to install screen. Water is sporadic.
					51.0	
					52.0	
					53.0 **Gravel and Clay (GC)**	
					54.0 **Well-Graded Sand with Gravel (SW)**	
					55.0 **Gravel and Clay (GC)**	
					56.0 **Well-Graded Sand with Gravel (SW)**	
					Gravel and Clay (GC)	
					58.0 **Boulder (BLDRCBBL)** 12 inch boulder.	
60					**Well-Graded Sand with Gravel and Silt (SW-SM)** brown/tan, moist to wet. Subangular to subround sand, medium to coarse. Gravel is subangular to subround to .75 inches.	Lots of water in the fractured bedrock.
					Bedrock (BEDROCK) Degraded/highly fractured bedrock, off-white/reddish brown, wet.	
					68.0	
					69.0 **Siltstone (SILTSTONE)**	
					Bottom of hole at 69.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	P-2 M	

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek
DEVELOPMENT CONTRACTOR: CH2M Hill LOCATION:
DEVELOPMENT METHOD AND EQUIPMENT USED: 1 inch Waterra foot valve with surge block
START WATER LEVELS: 8.80 START: 17.15 8-31-04 END: 1902 8-31-04 LOGGER: D. Lacey
MAXIMUM DRAWDOWN DURING PUMPING: 9.7 feet
RANGE AND AVERAGE DISCHARGE RATE: 2.5 gals/min
TOTAL QUANTITY OF WATER DISCHARGED: 290 gals
DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Suction Depth (BTOC)
1715	—	18.50					(Very Cloudy / Gray)	
1755	90	—	>990	—	7.17	8130	1 Cup fine sand / 5gal (Same as Above)	69-ft
1757	100	17.20					1 Tbs sand / 5gal (Same as above)	"
1807	120	—	81	2.91	6.68	129	1 Tbs sand / 5gal (Same as Above), less cloudy than above, Trace sand	67.5-ft
1809	130	—					(Same as above), Trace sand	
1814	135		390	2.61	6.51	129	(Cloudy / Light Brown), less cloudy than above, Trace Sand	66.0-ft
1816	140	17.80					~~(Very Cloudy, Gray)~~, More cloudy than above, 2Tbs Sand/5gals	
1833	235	18.45	930	3.50	6.64	127	(Same as above) Trace sand	64.5-ft
1835	240	—	0				(Very Cloudy / Gray) Trace sand	
1845	270	—	620	2.88	6.62	129	(Same as above) less cloudy than above, Trace sand	63
1847	275	-	-	-	-	-	(Same as above), Pump's above screen.	61.5
	Remove	surge	block,	clean out	bottom	of well.		
1902	290	—	460	2.82	6.65	126	(Cloudy / Gray), No sand, Water still cloudy, can not see bottom of 5gal bucket. No sand ~~above~~ production above screen	

Start:
Total Depth: 70.20
Depth to Water: 8.80
Stick Up: 2.01 (Feet of casing above ground)

End:
Total Depth: 70.31
Depth of Water: 10.80

ANC/Pebble_Att_1_Forms.xls/980560014

PZM - 8/31/04

Total Depth: 70.20
Depth to Water: 9.80
Stick up: 2.01 - casing above ground

Time	DTW	Volume	RATE	Recovery	Temp	pH	Cond	Turb	DO	Suction	Comments
1715	18.50	—	5 3/4 gpm	1 bucket		7.17	0.130	>990	10.78	59	Very cloudy / Gray 2nd bucket = 1 Tbs
1757	~~17.20~~ ~~16.20~~	100	~~100~~	1 Tbs min	2.41	6.69	0.129	810	7.27	↑1.5 ~~2.0~~	2nd bucket = < 0.5 Tbs less cloudy than above
1809	—	150	"	< 0.5 Tbs	2.61	6.51	0.129	534	6.19	↑1.5	cloudy / ~~Gray~~ Light Brown less cloudy than above
1510	17.80	140	"	2 Tbs	3.50	6.64	0.127	550	12.01	↑1.5	VC / LB more cloudy than above 2nd bucket: < 0.5 Tbs
1835	1845	240	"	< 0.5 Tbs	2.33	6.66	0.128	620	7.54	↑1.5	VC / Gray (w/o. Orange) less cloudy than above
1847		270	"	0	—	—	-	-	-	↑1.5	Sticking above screen. Remove surge tool clean bottom
1907		290	"	0	2.82	6.65	0.126	400	5.18	58	cloudy / Gray

End: Total Depth: 70.31 Start Pumping Depth: 64
Depth Water: 10.80
Total Purge 295

BORING NUMBER P3

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/22/04 **COMPLETED** 8/22/04 **GROUND ELEVATION** _____ **WATER LEVELS** 10.82 feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** 6641467 **EASTING** 5371948

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Stacey Cooper

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Peat (PT)** Brown, moist, trace sand and gravel, gravel to 1/4". **Well-graded gravel with silt and sand (GW)** Dark brown, moist, sub-angular to sub-round gravel to 3/4", angular to subangular fine to coarse sand, 70% gravel, 20% sand, 10% fines. Becomes less gravelly, more sandy- lighter brown.	5% gravel, 5% sands, 90% fines
10					11.0 ▽ **Silt w/ sand (ML)** Yellowish orange, dry, sand is sub-angular, 5% gravel, 15% coarse to medium sand, 80% silt. 14.0 **Well-graded gravel w/ sand (GW) Bedrock** Yellowish orange, wet, 70% well-graded angular to sub-angular gravel, metamorphics (?) and white limestone, 20% subangular to sub-round sand, 10% silt. Becomes dry at 16'. Same material.	Water level at 14' Flow OUT Dry again.
20					More sandy at 20'. Still a mix with white limestone. Dry. 23.0 Color change- whitish gray at 23' **Gravelly sand w/ silt (SW/SM)** Driller reports this is unweathered bedrock, 35% gravel to 1/2", 50% well-graded angular to sub-angular sand, 15% silt, dry. 25.0 Bottom of hole at 25.0 feet.	TD = 24.5'

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): 311m

Vent hole?: N/A

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40 PVC

SURFACE CASING

Dia.: 5 inches

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Silica sand. Filter sand

Quantity used: 4.5 50-lb bags

SEAL

Type: Bentonite pellets

Quantity used: 1.5 5-gallon buckets

GROUT

Mix used: Portland Cement

Method of placement: Poured in directly (only 4' from g

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: 6" Bentonite @ bottom of hole. 1.5' filter sand above that.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

BORING NUMBER P-4 M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/27/04 **COMPLETED** 8/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** 12 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641549 **EASTING** 372473

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0						
					2.0 **Low Plasticity Organic Silt or Clay (OL)** Light brown.	
					Well-Graded Gravel with Sand (GW) Moist, gravel to 1 inch. As above, trace silt.	
10					▽	
					19.0 More moist, more silt.	Began drilling with water.
20					**Silt with Sand (ML)** Reddish-brown, moist, fine sand. (Wet.)	On re-drill more gray silt noted than in original drilling. Swivel messed up. (8/28)
30					31.0	
					Silty Gravel (GM) Reddish-brown, moist, more gravel than above. 35.0	Still drilling with water.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): about 300m

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 40

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC

Slot size: 0.020"

SCREEN FILTER

Type: 10-20 Sand

Quantity used: 7 bags

SEAL

Type: .25" bentonite tablets

Quantity used: 1 5-gallon bucket

GROUT

Mix used: usual

Method of placement: Tremie pipe

Vol. in surface casing: _____

Vol. in well casing: 2 batches, 4 bags inside casing

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: 3' same-2 bags-55-lb bags. 2' bentonite chips -1/2 bucket-58-lb bags. Native cuttings/rocks-approximate 8 buckets rocks to 60-lb bags. Boring log s

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-4 M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/27/04 **COMPLETED** 8/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** 12 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641549 **EASTING** 372473

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Poorly-Graded Sand (SP)** Red-brown, moist.	Driller notes substrate is "soft." On re-drill, there is a zone of sand around 40 feet. Driller says coarser.
					40.0 **Well-Graded Gravel with Sand (GW)** Reddish brown, wet, subround gravel to 1 inch, trace silt reddish tinge.	
					45.0 **Poorly-Graded Sand (SP)** Reddish-brown, wet, some silt, gravel to <1 inch.	Driller says water there, just not making water, like some of other wells. Casing broken. (8/27)
50					More gray in color, more gravel observed.	
					57.0 **Well-Graded Sand with Gravel (SW)** Varied colors, light gray matrix, wet, coarser than above, some gravels to 1 inch, coarse sand.	Expelled around 20 gallons at rod change. Wet, not flowing. Looks like return hose is plugged. Driller reports clay? Looks bedrocky.
60						
					67.0 **Well-Graded Gravel with Sand (GW)** Gravel -varied colors, wet, subround to 1 inch. Sand-orange, subangular.	Driller notes that they often see silt before bedrock.
70						Driller indicates ther is more clay around 69 feet, becoming gravel by 72 feet. Slow drilling rate. Negligible flow rate at 75 foot rod sweep.
					78.0 **BEDROCK** (Suspected.) Erratic.	
80					80.0 **Well-Graded Gravel with Sand (GW)**	
					85.0 **BEDROCK** (Suspected.) Erratic.	Not much water in casing at rod change.
					87.0 **Basal Till (TILL)**	
					89.0 **BEDROCK**	
90					91.0 **Basal Till (TILL)**	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-4 M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 8/27/04 **COMPLETED** 8/28/04 **GROUND ELEVATION** _____ **WATER LEVELS** 12 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641549 **EASTING** 372473

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Andy Larson

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					98.0	Pretty good water, 40 gallons at 95 foot rod change.
100					**BEDROCK** Black, angular.	Not making water yet.
					103.0	
					Bottom of hole at 105.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER
	P-4(M) SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT: Pebble Creek
DEVELOPMENT CONTRACTOR: CH2M Hill LOCATION: West of Camp
DEVELOPMENT METHOD AND EQUIPMENT USED: 1" Waterra pump & Surge block
START WATER LEVELS: 17.17 ft BTOC START: 1025 8-31-04 END: 1230 8-31-04 LOGGER: DL
MAXIMUM DRAWDOWN DURING PUMPING: 29.95
RANGE AND AVERAGE DISCHARGE RATE: 2.5 gpm to 1.6 gpm Ave. = 1.6 gpm
TOTAL QUANTITY OF WATER DISCHARGED: 225
DISPOSITION OF DISCHARGE WATER: Well recharge to slowly compared to most other wells,
After 2hrs of development ~~across~~ water still cloudy. Minimum turbidity 240 NTUs.
Start purging @ 57.5 feet BTOC

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Recovery Sgal	Remarks (color, odor, sheen, sediment, etc.)
1035	10	44.51	>990	4.00	6.96	330	½ cup	Light Brown / Very Cloudy / Reduced Rate 5g/3min
1103	Raised surge block 1.5' higher						2nd bucket 1 Tbs	less cloudy than above
1112	95	44.50	480	3.91	7.39	202	½ Tbs	〃 / 〃 / (5g 1Tbs)
	Raised surge block 2.0' higher						2 Tbs	〃 / 〃 / 〃
1121	120	—	600	4.39	7.41	200	1 Tbs	〃 / 〃 / 〃
1128	Raised surge block 2.0' higher						2 Tbs	〃 / 〃 / 〃
1138	150	42.17	530	4.21	7.25	199	<0.5 Tbs	〃 / 〃 / 〃
1141	Raised surge block 2.0' higher						2 Tbs	〃 / 〃 / 〃
1148	165	—	>990	4.25	7.27	198	<0.5 Tbs	〃 / 〃 / 〃
1150	Raised surge block 2.0' higher						Water did not silt up after move → Above screen	
1154	180	42.12	460	4.66	7.31	198	<0.5 Tbs	less cloudy than above
1200	Removed surge block, Pump from bottom of well → Very cloudy, lots of sand (1 cup)							
	Cleaned up after 10 gals							
1214	200	—	380	4.14	7.18	185	0	Cloudy - less than above
1220	210	—	240	4.25	7.16	193	0	Cloudy - less than above
1230	225	—	280	4.19	7.20	193	0	Same as above.

Total Depth Start: 58.24

5g/2m

ANC/Pebble_Att_1_Forms.xls/980560014

BORING NUMBER P-4A D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/8/04 **COMPLETED** 9/9/04 **GROUND ELEVATION** _____ **WATER LEVELS** 20.4 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641728 **EASTING** 372532

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Silty Gravel with Sand (GM)** Brown, dry, gravel .25 inch to 1 inch, subrounded.	
5.0						14:44 at 5-feet
					Poorly-Graded Gravel with Silt and Sand (GP-GM) Brown, dry.	6 inch cobble.
10						14:49 at 10-feet
					Poorly-Graded Gravel with Sand and Silt (GP-GM) Light brown, dry.	15:01 at 15-feet. Start drilling with water.
20					▽ Color change to brown.	15:16 at 20-feet (Water level 090904=20.4 ft bgs.)
					Color change to gray.	Water stands between 15 and 24 feet. Production < 1gpm.
27.0						
30					**Poorly-Graded Sand with Silt (SP-SM)** Gray, wet, coarse grain. **Poorly-Graded Sand with Silt (SP-SM)** Light gray, wet, fine grain.	15:46 at 34-feet Wet but not producing.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: None

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 silica sand.

Quantity used: 5 50-lb bags

SEAL

Type: 0.25" bentonite pellets CETCO

Quantity used: 2 5-gallon buckets

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: 150 gallons

Vol. in well casing: 3-batches - 6 bags before casing is

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: 4.5 hours

Estimated purge volume: 130 gallons

Comments: TD - 123-feet. Filled rat hole with cuttings and site gravel from 123' to 97'. Bentonite pellets from 97' to 92' and 10/20 sand from 92' to 90'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-4A D

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/8/04 **COMPLETED** 9/9/04 | **GROUND ELEVATION** | **WATER LEVELS** 20.4 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 6641728 **EASTING** 372532

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Dave Lacey

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					Same as above, with 5% gravel.	
					37.0	
					39.0 **Silt (MH)** Gray, wet.	
40					**Poorly Graded Sand with Silt (SP-SM)** Gray, wet, medium to coarse grain.	
					41.0 Color change - Dark brown.	
					Well-Graded Sand (SW) Brown-orange, medium grain, 10% silt.	16:00 at 44-feet Production = 3 gpm.
					Color change - Brown.	
					49.0	
50					50.0 **Poorly Graded Sand with Silt and Gravel (SP-SM)** Gray, wet, medium grain, 5% gravel.	
					Clay with Sand and Gravel (CL) Gray, wet.	16:35 at 54-feet Production = 1 gpm.
					57.5	
60					60.0 **Poorly Graded Gravel with Silt (GP-GM)** Gray, wet, subangular.	
					Poorly Graded Gravel (GP) Gray, wet, subangular.	
					63.0	
					Poorly Graded Sand with Gravel (SP) Gray, wet, coarse grain.	17:10 at 64-feet Production = 2 gpm. Hammer not working, may be frozen or blocked line. Trip out of hole. Repaired hammer. Startup 090904 09:45. Adding water at about 2gpm.
					68.0	
70					**Poorly Graded Gravel with Sand (GP)** Gray, wet, fine to coarse.	
					71.0	
					Clay (CL) Gray, wet, minor gravel and sand up to 20%.	Small return volume. Clay mostly in suspension. 3 cups/foot. 10:30 at 73-feet Production appoximately 2 gpm.
					79.0	
80					**Poorly Graded Sand with Silt and Gravel (SP-SM)** Gray, wet, 40% subangular gravel, coarse sand.	11:25 at 83-feet Production = 3 gpm.
					91.0	
90					**Poorly Graded Sand with Silt (SP-SM)** Gray, wet, fine sand, 5% gravel.	12:20 at 93-feet Production = 1 gpm.
					94.0	
					Silty Sand with Gravel (SM)	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-4A D

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/8/04 **COMPLETED** 9/9/04 | **GROUND ELEVATION** | **WATER LEVELS** 20.4 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 6641728 **EASTING** 372532

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Dave Lacey

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					96.0	
					Silt (ML) Gray, wet.	
					99.0	
100					**Clay with Silt and Sand (CL)** Gray, wet.	
					101.0	
					Poorly Graded Sand (SP) Gray, wet, fine to coarse sand.	13:36 at 103-feet
					106.0 Color change, light orange/brown.	Cutting water very thick with fines. Slow drilling @106 feet.
					Bedrock Cuttings - Well-Graded Sand with Silt (SM) Light orange/brown. Suspended fines-light orange/brown. Sand-dark gray.	
110						Slow drilling; may be bedrock.
						14:45 at 113-feet. Production = 2gpm. Slow drilling, may be bedrock.
120					Same as above	
					122.0	
					123.0	1604 Drilling very slow. Driller thinks bedrock. Backfilled with rock to 97 bgs. Grout to 91 feet.
					Bottom of hole at 123.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER P-41 Deep SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : LOCATION :

DEVELOPMENT CONTRACTOR :

DEVELOPMENT METHOD AND EQUIPMENT USED :

START WATER LEVELS : START : 9-13-04 END : 9-13-04 LOGGER : D. Lacey

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE: < 0.5 gpm

TOTAL QUANTITY OF WATER DISCHARGED:

DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Sediment Depth
1204		20.2	7990				GRAY, very cloudy, LARGE SAND, Heavy SILT load	89.5'
1231	35	"	>990	4.03	6.64	758	" " Slightly less silt " " "	~~88~~
1240	40	"	7990	3.44	~~7.94~~	~~0.758~~ .742	Gray, Very Cloudy, Heavy silt load	88
1310	50	Range Depth	>990	4.31	8.41	.714	" " " Slightly less silt than last	"
1330	55	"	>990	4.44	8.48	.727	" " " slightly less silt "	86.5
1350	65	"	>990	4.31	8.53	.742	About Same silt same	"
1401	70	"	>990	4.54	8.49	.737	same gray little less silt	85
1422	80	"	>990	4.84	8.53	.742	Gray cloudy same amt. silt	"
1435	85	"	>990	5.12	8.63	.736	Gray cloudy silty	83.5
1456	95	"	>990	5.66	8.52	.745	Not a noticable change	"
1519	100	"	>990	5.14	8.48	.742	slightly cleaner silty	82
1542	110	"	>990	5.61	8.52	.755	Not any change	
Pumping @ <1gpm, had to shut the pump off several times to allow ppt to recharge								
Final 1646	130		490	7.45	8.50	.763	Somewhat Cloudy	

BORING NUMBER P-4A S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/10/04 **COMPLETED** 9/11/04 **GROUND ELEVATION** _____ **WATER LEVELS** 20 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641728 **EASTING** 372532

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Organic Silt with Sand and Gravel (OL)** Moist, light brown.	14:28 at 3-feet
					7.0	Start drilling with water 2 gpm
10					**Poorly Graded Gravel with Sand and Silt (GP-GM)** Light Brown, moist, subangular gravel up to 1-inch.	
					More fines than above.	14:31 at 13-feet
					Less fines than above.	
20					▽ 21.0 Color change - Dark brown.	
					22.0 **Silt (ML)** Dark brown.	
					Poorly-graded Gravel (GP) Dark brown, Coarse.	15:23 at 23-feet Production = 0.75 gpm Very fast drilling through sand = 6-mins/10-feet
					25.0 Color change - Light orange brown.	
					Well-graded Sand with Silt (SW-SM) Light gray, very fine grain.	
30						15:52 at 33-feet Production = 1 gpm (Lots of sand in water) Specific

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: None

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 silica sand.

Quantity used: 4.5 50-lb bags

SEAL

Type: 0.25" bentonite pellets CETCO

Quantity used: 1 5-gallon bucket

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: NA

Vol. in well casing: NA

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: 3 hours

Estimated purge volume: 405 gallons

Comments: TD of boring 59-feet. Bentonite bottom seal 59' to 57'. Sand and formation 57' to 50'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-4A S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/10/04 **COMPLETED** 9/11/04 **GROUND ELEVATION** _____ **WATER LEVELS** 20 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641728 **EASTING** 372532

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	Cond=0.213 mS, pH=6.83
					Well-graded Sand with Silt (SW-SM) Orange brown, Medium grain.	Very fast drilling through sand.
						16:45 at 43-feet. Production = 1.5 gpm (Lots of sand in water) Specific Cond = 0.240 mS, pH=6.82 Heaving sands.
					Color change - gray.	
50					51.0	
					53.0 **Clay with Gravel (CL)** Gray, plastic, firm.	Attempted to install well on 9-11-04. Heaving sands locked well casing in the drill casing. Drove to 59-feet.
					Clay (CL) Gray, plastic, firm.	
					59.0	TD - 59-feet bgs. Installed well screen 40' to 50'.
					Bottom of hole at 59.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER P-4A Shallow SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : LOCATION :

DEVELOPMENT CONTRACTOR :

DEVELOPMENT METHOD AND EQUIPMENT USED : Waterra w/surge block

START WATER LEVELS : START : 9/13/04 END : 9/13/04 LOGGER : G. Mahlla

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE:

TOTAL QUANTITY OF WATER DISCHARGED:

DISPOSITION OF DISCHARGE WATER:

~~2.58~~

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)
1652		22.19					
1741	20		>990	4.87	6.02	.220	Brown, muddy sand - ½ cup
1803	130		>990	3.90	7.88	.243	lighter brown < TBSP sand
1810	140		>990	3.97	7.32	.250	" 1/4C sand
1825	185		>990	3.76	7.40	.266	" TBSP sand
1834	195		>990	3.66	7.31	.270	Brown 1/4C sand
1850	245		>990	4.19	7.42	.283	little lighter TBSP sand
1858	255		>990	3.62	6.97	.274	Brn. 1/4C sand
1911	320		580	3.56	6.98	.276	lighter < TBSP sand
1917	330		>990	3.39	6.95	.273	Brn. < 1/4C sand
1928	385		580	3.35	7.05	.277	Lighter Brown < TBSP sand
1948	405 final		140	3.36	7.06	.205	Almost Clear
pumping 5 gal min							

~~51.~~ 11 ~~44.05~~ ~~43~~48. ~~48.84~~ ~~50~~45.

BORING NUMBER P-6 D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/12/04 **COMPLETED** 9/12/04 **GROUND ELEVATION** _____ **WATER LEVELS** 15 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0						
					2.0 **Silt with Gravel (ML)** Brown, moist.	
					Gravel with Silt (GP-GM) Gravel up to one inch, subrounded, 10% silt, 5% sand.	9:45 at 3-feet
					8.0	
10					10.0 **Poorly-Graded Sand (SP)** Brown, moist, coarse grain, 5% silt.	Start drilling with water 2 gpm.
					Gravel with Sand (GP) Brown, gravel up to one inch, subrounded.	
					▽	Varying amounts of sand 5-25%.
					Color change-light brown/orange	
20					**Poorly Graded Gravel with Sand and Silt (GP-GM)** Dark brown gravel up to one inch, subrounded, 10% silt.	
					Color change-light orange/brown	Varying amounts of sand 5-40%.
					25.0	Clogged air line.
					Silty Sand with Gravel (SM) Brown, coarse grain.	Varying amounts of gravel 5 to 40%. 11:05 at 28. Production at about 5 gpm. Specific cond. = 0.243 mS. pH = 6.55.
30						
						Varying amounts of silt 15-30%.

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: None

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 silica sand.

Quantity used: 5 50-lb bags

SEAL

Type: 0.25" bentonite pellets CETCO

Quantity used: 1 5-gallon bucket, plus 1/2 bucket of 3/4

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: NA

Vol. in well casing: NA

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: 3 hours

Estimated purge volume: 780 gallons

Comments: Boring TD - 113'. Sealed shoe with 1-foot 1/4-inch bentonite pellets. 10/20 sand from 112' to 112.4'. 1/4-inch bentonite pellet seal from 98' to 92'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-6 D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/12/04 **COMPLETED** 9/12/04 **GROUND ELEVATION** _____ **WATER LEVELS** 15 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					37.0 **Well-Graded Sand with Silt (SM)** Light orange/brown, fine grain. **Silt (ML)** Gray, very soft. 45.0	11:30 at 43-feet. Very fast drilling through silt. Drill shoe fell off, got it re-attached. Production 0 gpm -1/2 bucket of silt.
50					**Clay with Gravel (CL)** Gray, stiff, plastic, 20% gravel. Boulder. **Clay with Sand and Gravel (CL)** Gray, firm, plastic, 10% gravel, 10% sand.	12:12 at 53-feet Production = 0 gpm.
60					**Clay (CL)** Gray, firm, plastic	12:42 at 63-feet
70					70.0 **Silt (ML)** Gray, soft, 5% sand.	
80					**Silt with Sand and Gravel (MH)** Gray, soft, 20% sand, 5% gravel. 88.0	13:13 at 83-feet. No significant water.
90					91.0 **Poorly-Graded Sand with Gravel (SP)** Sand-gray, coarse grain, gravel-fine, subrounded, 20% gravel, 5% sand. **Clay (CL)** Gray, firm, plastic.	14:02 at 93-feet. No significant water.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-6 D

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/12/04 **COMPLETED** 9/12/04 **GROUND ELEVATION** _____ **WATER LEVELS** 15 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					97.0	
					98.0 **Silt (ML)** Gray.	
100					**Clay (CL)** Gray, firm, plastic.	
					102.0	
					Poorly Graded Gravel with Sand (GP) Fine, some sub-rounded mostly angular to subangular. Boulder.	14:42 at 103-feet. Production = 0..75 gpm. Specific cond. = 0.506 mS. pH = 8.55. May be bedrock.
					109.0	
110					**Bedrock** Black, angular, water light brown.	Appears to be bedrock, very slow drilling. 15:49 at 110-feet. Production = 5 gpm. Specific cond. = 0.668 mS. pH=8.51.
					113.0	TD - 113-feet.
					Bottom of hole at 113.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	RBD	

WELL DEVELOPMENT LOG

PROJECT: Rock Creek LOCATION:
DEVELOPMENT CONTRACTOR: CH2M Hill
DEVELOPMENT METHOD AND EQUIPMENT USED: 1" Waterra with Sump below it
START WATER LEVELS: START: 1700 BTOC END: 9-15-04 LOGGER: A. Lacey
9-6-04
MAXIMUM DRAWDOWN DURING PUMPING: ≈ 4'
RANGE AND AVERAGE DISCHARGE RATE: 5 gpm
TOTAL QUANTITY OF WATER DISCHARGED: 780
DISPOSITION OF DISCHARGE WATER: Water slightly cloudy at end of development

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	Suction Depth
1225	5	-	>990	-	-	-	Gray, Very Cloudy, Rate = 5 gpm 2 TBS SAND & Fine Sand & Silt, Heavy load	116
1245	100	-	>990	3.95	9.14	812	Same as above, slightly less cloudy 0.5 TBS SILT & SAND	"
1253	110	-	>990	-	~~8.8~~	-	Same as above 2 TBS Fine Sand & Silt	114.5
1308	185	-	760	-	8.89	790	Slightly less cloudy than above 0.5 TBS SAND & SILT	"
1310	190	-	>990	-	-	-	Gray, Very cloudy 2 TBS SAND-SILT	113
1320	240	-	~~4510~~	3.76	8.75	792	Same as above, less cloudy 0.5 TBS SAND & SILT	"
1325	250		940	-	-	-	Same as above 1 TBS SAND & SILT	111.5
1335	300	-	580	3.50	8.79	772	Same as above, slightly less cloudy <0.5 TBS SAND	"
1340	315	-	>990	-	~~8.95~~	~~767~~	More cloudy than above 1 TBS SAND	110
1350	365	19.5 *	890	3.51	8.95	767	less cloudy than above	"
1355	370		>990				More cloudy than above 2 TBS SAND	109.5
1410	445	19.3 *	680	3.76	8.92	777	Slightly cloudy than above 1 TBS - Fine Sand	
* Water level recovers quickly.								
1412	450	-	>990				more cloudy than above	108
1442	600		300	3.54	8.72	760	Gray, cloudy 0.5 TBS SILT & SAND	"
1448	610		>990	-	-	-	Very cloudy, much more cloudy than above, 2 TBS SAND, SILT, CLAY	106.5
1506	710		220	4.78	8.72	749	Slightly Colored, Less cloudy than above	
	Clean Bottom of Well, Remove Sump block							116
1530	780	20.5	180	3.78	8.75	779	slightly cloudy	105

START: Total Depth = 116.41 END: Total Depth = 116.42 BTOC
DTW = 17.00' BTOC DTW = 18.26 BTOC
Stickup Height = 2.45' Ags

ANC/attach1sampleforms.xls/980560014

BORING NUMBER P-6 M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/13/04 **COMPLETED** 9/13/04 **GROUND ELEVATION** _____ **WATER LEVELS** 33 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					**Gravely Silt (ML)** Brown, moist.	13:30 at 3-feet
					3.0 **Poorly-graded Gravel with Silt and Sand (GP-GM)** Up to 1-inch, sub-rounded.	Start drilling with water 2 gpm.
						Varying amounts of sand 5 to 15%. Varying amounts of Silt 5 to 15%.
10						
					Color change - Dark brown.	13:52 at 13-feet
					Color change - Brown.	Varying amounts of sand 5 to 20%. Varying amounts of silt 5 to 30%.
					Color change - Dark brown.	
20					22.0 Color change - Light brownish orange.	
					Silty Sand (SM) Wet, light brownish orange, medium grain, 20% silt.	
					27.0 **Silty Sand with Gravel (SM)** Wet, light brownish orange, medium grain, 20% silt, 10% gravel.	
30					▽	14:30 at 33-feet. Production = 1 gpm.
					35.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: None

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 Sand

Quantity used: 5 50-lb bags

SEAL

Type: 0.25" bentonite pellets

Quantity used: 2 5-gallon buckets

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: NA

Vol. in well casing: NA

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: 2.5 hours

Estimated purge volume: 105 gallons

Comments: Boring TD - 93'. Sealed shoe with 1-foot 1/4-inch bentonite pellets. 10/20 sand from 90' to 86'. 1/4-inch bentonite seal from 81' to 79'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-6 M

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/13/04 **COMPLETED** 9/13/04 **GROUND ELEVATION** _____ **WATER LEVELS** 33 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					36.0 **Well-graded Sand with Silt (SW-SM)** Light grayish brown, fine grain. **Silt (ML)** Gray, 5% gravel.	Vary fast drilling through silt.
40						
					44.0 **Silt with Gravel (ML)** Gray, 20% gravel.	15:04 at 43-feet. Production = 0.5 gpm.
					48.0	
50					50.0 **Clay with Sand and Gravel (CL)** Gray, plastic, firm, 10% sand, 10% gravel.	
					52.0 **Clay (CL)** Gray, plastic, firm.	
					Clay wuth Gravel (CL) Gray, firm, plastic, angular gravel to 1/2-inch.	15:40 at 53-feet. No significate water. Varying amounts of gravel 5 to 40%. Varying amounts of sand 0 to 10%.
60						
						16:20 at 63-feet. No significant water.
70						
					74.0 **Silt (ML)** Gray.	16:40 at 73-feet. Production = 3 gpm.
					79.0	
80					**Silt with Sand (ML)** Gray, 10% sand. 82.0	Varying amounts of gravel 0 to 20%. 17:45 at 83. (Hammer clogged during production test)
					Poorly-graded Sand with Silt and Gravel (SP-SM) Gray, coarse grain sand, sub-rounded gravel, 10% sand, 10% gravel. 86.0	
					87.0 **Silt (ML)** Gray.	
90					**Clay with Gravel (CL)** Gray, plastic, firm, 20% gravel. 91.0	
					93.0 **Clay (CL)** Gray, plastic, firm. Bottom of hole at 93.0 feet.	TD - 93-feet

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
	PG Mid	

WELL DEVELOPMENT LOG

PROJECT: Pebble Mine Groundwater LOCATION:
DEVELOPMENT CONTRACTOR:
DEVELOPMENT METHOD AND EQUIPMENT USED: 1" Waterra w/ Surge Block
START WATER LEVELS: 19.21 START: 1729 END: 1236 LOGGER: D. CACEY

MAXIMUM DRAWDOWN DURING PUMPING: ~~90~~ 70-feet
RANGE AND AVERAGE DISCHARGE RATE: 1 gpm
TOTAL QUANTITY OF WATER DISCHARGED: 105
DISPOSITION OF DISCHARGE WATER:
Discharge limited by recovery. No before and after photos- camera battery dead, water still cloudy at end of development.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	
								90
1731	5	-	>990	-	-	-	GRAY, Very Cloudy, Heavy Sediment Load, 2 cups SILT	~~18.5~~
1750	~~20~~ 20	80.1	>990				SAME as above 1 cup- SILT & CLAY	"
1800	25	-	>990				same as above 1 cup - silt & clay	88.5
1815	40		>990				same as above	"
1824	45		>990	5.7			~~less silt~~ silt than above, ½ cup - Silt & clay	87
1833	50		>990	5.21	8.83	535	same as above, slow pumping, stop/start	"
1843	55		>990				same as above 2 Tbs SILT/CLAY	86.5
1855	60		840				less silty than above	
	Stop for the day. Will continue tomorrow.							
1916	65		-	-	-	-	Slightly Cloudy	
9:15-04	Remove surge	black and clean	bottom of well.			-> 15 gals -> add 15 gals	pond, Cloudy, 2 Tbs silt/sand	90
1215	~~80~~ 95		-	-	-	-	Cloudy, 1 Tbs sand	90
1230	105	Suction. Depth	700	5.12	8.37	500	Cloudy, <0.5 Tbs sand	80

Start: Depth to Water = 19.21' End: Depth to Water =
Depth to Bottom = 90.30' Depth to Bottom =
Stickup = 3.00' AGS

BORING NUMBER P-6 S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/15/04 **COMPLETED** 9/15/04 **GROUND ELEVATION** _____ **WATER LEVELS** 23 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **SILT with GRAVEL (ML)** Brown, Moist.	
					Gravel with Sand and Silt (GP-GM) Sub-rounded to rounded, gravel up to >1-inch.	9:10 at 3-feet Varying amounts of sand 10 to 40%. Varying amounts of silt 5 to 40%. Start drilling with water 2 gpm.
10					Color change - Light orangish brown.	9:50 at 13-feet
					Color change - Dark brown. Color change - Brown.	Varying amounts of sand 10 to 30%. Varying amounts of silt 10 to 15%.
20					22.0 ▽ **Silty Sand (SM)** Brown, wet, medium to fine grain, 30% silt.	10:16 at 23-feet. Production = 0.5 gpm (Lots of sand and silt in water)
					26.0 **Silty Sand with Gravel (SM)** Coarse to medium grain sand, fine grain gravel, 20% Silt.	Varying amounts of gravel 5 to 10%.
30						10:36 at 33-feet. Production = 1.0 gpm. (Lots of sand and silt in water)

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: None

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 2 inches

Type: Schedule 80

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: 2-inch/Schedule 40 PVC Insta-pack

Slot size: 0.020"

SCREEN FILTER

Type: 10/20 silica sand.

Quantity used: 4 50-lb bags

SEAL

Type: 0.25" bentonite pellets CETCO

Quantity used: 3 5-gallon bucket

GROUT

Mix used: Volclay

Method of placement: Tremie pipe

Vol. in surface casing: 150 gallons

Vol. in well casing: 6 bags before casing pulled

DEVELOPMENT

Method Surge and block, with 1" Waterra pump

Time: 2 hours

Estimated purge volume: _____

Comments: Boring TD-43-feet. Sealed shoe with 2' bentonite pellets. Filled rat hole 41' to 35' with 10/20 sand. 1/4-inch bentonite seal from 21.5' to 16'.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER P-6 S

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/15/04 **COMPLETED** 9/15/04 **GROUND ELEVATION** _____ **WATER LEVELS** 23 feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641786 **EASTING** 372616

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					38.0	
40					**Silt (ML), Gray.**	
					43.0	
					Bottom of hole at 43.0 feet.	11:00 at 43-feet. TD - 43-feet

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

CH2MHILL

PROJECT NUMBER	WELL NUMBER P6B5 SHEET 1 OF 1

WELL DEVELOPMENT LOG

PROJECT : LOCATION :

DEVELOPMENT CONTRACTOR :

DEVELOPMENT METHOD AND EQUIPMENT USED :

START WATER LEVELS : 16.09 START : 1400 9-15-04 END : 9-16-04 LOGGER : D. Lacey

TD 38.21

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE:

TOTAL QUANTITY OF WATER DISCHARGED:

DISPOSITION OF DISCHARGE WATER:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Remarks (color, odor, sheen, sediment, etc.)	
1400	0						Pumping fm 37-37.5'	
1402	5	—	—	—	—	—	Brown, no odor, heavy sediment ~½" in bucket	
1405	10	—	—	—	—	—	Reddish brown, heavy sediment, ½" in bucket	
1407	15	—	—	—	—	—	" " " " Disc. sed. in bucket	
1408	20		990+	4.28	7.94	0.275		13.35
1409	25		990+	4.20	7.71	0.270		12.76
1410	30	19.18	990+	4.15	7.50	0.271		
1412	35		990+	4.07	7.26	0.271		12.84
1417	55		990+	4.37	6.87	0.269		13.14
1420	65		990+	4.35	6.77	0.269		13.43
1426	80		990+	4.40	6.66	0.267	Pumping fm 35-35.5'	13.68
1430	130	19.41	990+	4.25	6.61	0.267	Reddish brown w/sediment.	
1447	170		580	4.32	6.55	0.264	" "	
1500	220		506	3.98	6.53	0.265	Move to 33.5-34.'	
1525			300	4.2	6.43	0.266		
1536			560	4.42	6.47	0.263	Move to 32-32.5'	
1621			560	4.53	6.35	0.265		
1658			560	4.12	6.36	0.264	Move to 30.5-31	
1722			46	4.19	6.42	0.265	Remove surge @ 37-37.5	
1730	~~19.21~~	19.21	47	4.08	6.40	0.265	Slightly turbid, trace fine sand.	

TD = 38.21'

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-7D
PAGE 1 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AD

DATE STARTED 6/5/05 **COMPLETED** 6/8/05 **GROUND ELEVATION** 1294.42 feet **TOC ELEVATION** 1296.65 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641504.414 meters **EASTING** 370004.846 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser, Hagen, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.4 **Peat (PT)**	
					Silt to silty sand Brown, dry, subrounded, with moderate coarse sand, subrounded to subangular (70% silt). 3.0	
					Silty coarse gravel with minor sand Wet (water added), subrounded to subangular, well graded.	Drillers fabricated pin for rods. Added water.
5	GB				Sand ranges coarse to medium.	Added water.
					Dry to moist. 9.5	
10	GB				**Silty sand with gravel** Dark brown, subrounded, fine to coarse sand, ~70% silt, no cobbles.	
15	GB				Wet. Clay content increased with depth. No cobbles.	Easy drilling.
					19.0	
20	GB				**Silty sand** Brown, moist, with fine to medium sand with trace gravel, subrounded. 22.0	
					Well-graded sand with silt Brown, moist, subrounded to well rounded. 24.0	
25	GB				25.0 **Increased silt with depth, gravel subrounded to subangular.** 26.0	
					Well-graded sand with silt and gravel, dry, brown, subrounded to rounded.	
					Brown well-graded sand with silt and gravel, dry, subrounded to rounded. 29.0	
30					Well-graded sand with clay, silt, gravel dry.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.23 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 10 June/ 4 Sept, 2005
Purge Volume: 880 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 20 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 14.93 Date: 6/9/2005 Time: 0730

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7D
PAGE 2 OF 6

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AD
DATE STARTED 6/5/05 **COMPLETED** 6/8/05
GROUND ELEVATION 1294.42 feet **TOC ELEVATION** 1296.65 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641504.414 meters **EASTING** 370004.846 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser, Hagen, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB			Well-graded sand with clay, silt, gravel dry.	Hit bigger cobbles/rocks.
35	GB			35.7 Brown silty sand with trace gravel, dry, subangular. Silt content increasing. **Silt with sand** Brown, trace gravel, subangular, well graded.	Added water. Silt impacted in space between bit and shoe. Compressor problem, using one compressor not sufficient in silt. Added water. Silt interbedded with sand and gravel, distinct thin lenses.
40				Minor clay, increased gravel (moderate). 42.3 **Sand with silt and gravel** Brown, well graded, rounded to subrounded. 44.5	
45				**Sandy gravel** Well graded, subrounded. Increasing gravel content with depth. Sandy gravel, well graded, wet.	Interbedded gravel and silt, gravel lenses thicker than silt.
50	GB	40.9		51.8 **Silty sand** Poorly graded, subrounded to rounded, wet, fine to medium sand, trace coarse.	
55	GB			Silty sand, poorly sorted with silt, wet, trace coarse with silt lenses. 57.0	
			0.75	**Silt** 58.5	Added water.
60	GB			**Silty sand** Brown, poorly graded, fine- to medium-grain sand, trace coarse, wet.	Added water, heaving sands.
65				64.0 **Gravel** Subangular, well graded, wet.	
70	GB	41.1			
	GB		0.25		

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7D
PAGE 3 OF 6

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AD
DATE STARTED 6/5/05 **COMPLETED** 6/8/05
GROUND ELEVATION 1294.42 feet **TOC ELEVATION** 1296.65 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641504.414 meters **EASTING** 370004.846 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser, Hagen, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				75.5 **Silt with clay** Brown.	Added water to clean.
					77.0 Clay with silt (black).	Flushed with water. Filled casing with water. End of drilling June 5, 2005.
		70.9			78.0 **Silty gravel** Dark gray, gravel with fines and fine sand.	June 6, 2005. Pushed out water, drilled with one compressor. Added water.
80	GB					Added water.
					80.8 **Silt with sand and clay** Wet, trace gravel, intermittent gravel.	Added water.
			1/4		83.7	Added water.
					84.2 **Silt-silty sand** Brown, no clay content.	Added water.
85	GB				85.5 **Gravel** Poorly graded, little or no fines.	
					Silt with gravel Brown to light gray.	Added water.
	GB				87.1 **Silt with sand** Light gray.	
					Gravel No fines, very little silt, well-graded gravel, subangular.	
90	GB				Silt, fine to coarse sand and gravel.	Added water.
					91.4 **Silt** Dark gray, no gravel, with fine sand (subrounded), with clay.	Slow drilling.
						Added water.
95	GB				Dark gray silt with fine sand and clay, moist.	Added water. Slow drilling.
					96.8 **Sand with silt and gravel** Light gray, well-graded sand, subangular to subrounded, fine to coarse sand.	Added water.
100	GB				With thin silt lenses.	
					Well-graded sand with gravel, no silt, subangular, fine to coarse sand.	
105	GB		0.05		Same as above with minor silt.	
					Well-graded sand with silt and gravel, brown, subangular to subrounded, fine to coarse sand.	Added water.
						Added water.
110	GB				Same as above with increased sand fraction.	Added water.
		107.55				Added water.
115	GB				Well-graded sand with silt and minor gravel, brown, subangular, fine to coarse sand.	Added water. Drilling air ~150 psi.
			0.3		Well-graded sand with silt and minor gravel, light gray, subangular, fine to coarse sand.	
					Increased gravel content, subrounded to subangular sand.	Pump test air ~90 psi. Added water.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7D
PAGE 4 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AD
DATE STARTED 6/5/05 **COMPLETED** 6/8/05 **GROUND ELEVATION** 1294.42 feet **TOC ELEVATION** 1296.65 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641504.414 meters **EASTING** 370004.846 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser, Hagen, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				Well-graded sand with silt and gravel, light gray, subangular to subrounded. **Sand with silt and gravel** Light gray, well-graded sand, subangular to subrounded, fine to coarse sand.	Added water.
125	GB				Well-graded sand with silt and gravel, light gray, subangular to subrounded, fine to coarse sand.	
		122.3				Water level. Added water.
130	GB				Thin silt layer.	
						Added water.
135	GB				Well-graded sand with silt and gravel, light gray, subangular to subrounded, wet.	
						Added water.
140	GB				Same as above, light brown.	
			0.125			Added water.
145	GB		1		Well-graded sand with silt and gravel, light brown, subangular to subrounded, wet.	Added water.
		88.1				Water level. Added water. Slow drilling.
150	GB				150.0 Dry clay-silt layers, light brown. **Silt-clay** Light brown, dry, medium stiff.	Tough, slow drilling. Added water.
155	GB				Silty sand with clay and gravel, yellowish orange, subrounded gravel, subrounded to rounded sand (possibly influenced by added water), moist. Silty sand with silt and gravel, yellowish orange, subrounded to rounded, well graded, moist.	Added water.
160	GB				Less gravel (trace). Same as above with trace gravel.	Added soap to water. Added more water.
					164.8	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7D
PAGE 5 OF 6

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AD
DATE STARTED 6/5/05 **COMPLETED** 6/8/05
GROUND ELEVATION 1294.42 feet **TOC ELEVATION** 1296.65 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641504.414 meters **EASTING** 370004.846 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser, Hagen, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165	GB				**Possibly weathered bedrock** Fine to coarse sand and gravel, subangular and similar composition, quartz rich. Fine to coarse sand, trace gravel, similar mineraiogic composition (quartz rich, feldspar), subround to subangular. Weathered granitic bedrock.	
170						
175	GB				Weathered granitic bedrock, 0.1 to 5.0 mm fragments, gravel, similar composition, subrounded to subangular. Water turbid.	
					Making water fast.	Making water fast.
180	GB		4			
185	GB				Weathered granitic bedrock; more weathered than at 179 and 183 feet. Water turbid.	
	GB		5			Flush water down hole.
190	GB				Weathered granitic bedrock.	
						Added water.
195	GB				Weathered granitic bedrock, yellow-orange, subrounded to subangular pieces/grains, fine sand, pea-sized gravel. Weathered surface on pieces, iron staining.	
200			10			
205	GB				Artesian conditions/flowing at surface; resume drilling; water is clear; temporarily low turbidity. Same as above; some fragments have dark gray color; very fine grained. Weathered granitic bedrock (same as above), yellow-orange with dark gray faction, subrounded to subangular to angular (0.5 to 2 cm).	Drilling soft.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7D
PAGE 6 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AD
DATE STARTED 6/5/05 **COMPLETED** 6/8/05 **GROUND ELEVATION** 1294.42 feet **TOC ELEVATION** 1296.65 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641504.414 meters **EASTING** 370004.846 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser, Hagen, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
210	GB		10		Same as above, fragment of biotite observed, chalcopyrite observed in fragments. **Possibly weathered bedrock** Fine to coarse sand and gravel, subangular and similar composition, quartz rich. 213.0 Bottom of hole at 213.0 feet.	Casing pulled up with difficulty. Producing less water.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AD/P-05-7D
Date: 9/4/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	21.52	21.43
Total depth	~~200.0~~ TW	199.99	199.66
pH	—	7.67	7.63

Screen interval (btoPVC): 10
Top: 190.0
Bottom: 200.0
PVC stick-up height (above ground surface): 2.4

Development Observations X Polish ; Debris Surge Only X

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
~~Surge block on~~	SURGE Block off, START Pump @ 1605							
1625	185	21.52	4.3	86	0.13	42	5.08	Trace, Sand. WATER CLEAR
1630	"	—	—	—	—	—	—	STOP POLISH
1635	200.00	—	—	—	—	—	—	START Debris Surge
1649	"	—	4.0	142	0.13	69	4.25	WATER CLEAR, Trace Sand
1652	"	—	—	—	—	—	—	STOP Debris Surge
								END
Surge block off	START POLISH @ 1605							

WELL DEVELOPMENT LOG

Well ID: P-05-7D
Date: 9 JUNE 2005
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: HAGEN, KLIEFORTH, DIESER

Summary

	Installed (Well Log)	Start	End
Water level TOC	14.93	14.93	35.52
Total depth TOC	199.1		
~~pH~~ CONDUCTIVITY		0.204	
pH		6.17	

Screen interval (btoPVC):
Top: 189.1
Bottom: 199.1
PVC stick-up height (above ground surface): 2.1'

Development Observations

Time	Foot valve depth ~~(ft btoPVC)~~ bgs	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block ~~off~~ OFF								
1413	196							
1420	196	0.78 gpm =	19/77 sec	18	0.174	VERY	4.2	H_2O OPAQUE AFTER 10 MIN
								1/16" SEDS @ BOTTOM OF BUCKET
								FINE GR. SAND, SUBROUNDED
1444	196			~~29~~ 37				H_2O OPAQUE AFTER 5 MIN
								1/4 CUP SEDS @ BOTTOM.
1453	196		5/gpm	82				SAME AS ABOVE
1505	194		5/gpm		0.149		4.7	OPAQUE AFTER 3 MIN. 2 TABLESPOONS
								SEDS. FINE GR. WELL ROUNDED SAND
1513	194		5	182				LESS OPAQUE, 1-2 TABLESPOONS SAND
1523	194	4.48 gpm =	5gal/67sec	226				TRANSLUCENT AFTER 5 MIN. 1 TBS SEDS.
1534	192			275				TRANSLUCENT AFTER 5 MIN. 1-2 TBS SAND.
1547	192							TRANSLUCENT AFTER 6 MIN. 1 TBS SAND
1542	192							TRANSLUCENT AFTER 6 MIN. 1 TBS SAND
1616	190		2 gpm					
1630	190							NO FOAM. (FIRST TIME) SED = 3 TBL SPOONS
1643	190	2gpm	5gal/2:25	387				TRANSLUCENT 2 TBL SPOONS
1700	188		2gpm					
1718	188			437				2 TBL SPOONS
1720	196				0.140			FOAM OBSERVED
1733	196		3.4 gpm					3 TBL SPOONS
1736	END DEVELOP.							
Surge block off								

FOAM FROM DRILLING VERY EVIDENT IN H_2O.
FOAM WAS ADDED TO TROUGH DURING DRILLING (NOT DOWNCASING)

WELL DEVELOPMENT LOG

Well ID: P-05-07D
Date: 10 JUNE 2005

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: BOB KLIEFORTH, PAUL TAYLOR

Summary

	Installed (Well Log)	Start	End
Water level		4.97	
Total depth			
pH			

Screen interval (btoPVC):
Top: 189.1
Bottom: 199.1

PVC stick-up height (above ground surface): 2.1'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block ~~on~~ OFF								
1300	197		5 gpm					2 TBLSPOONS, MINOR FOAM
1319	197		0.75 gpm	55				CLEARING, BUT SLOWER FLOW RATE
1327	195		2.6					
1329	195		2.4	105				1 TABLESPOON, SLIGHTLY SILTY
1359	195		2.4	153				
1404	193		5					1.5 TABLESPOONS, SLIGHTLY SILTY
1422	193		0.8	205				
1428	191		5					
1439	191		5.5					1.0 TABLESPOONS, SLIGHTLY SILTY
1448	191			310				SLIGHTLY SILTY - CLEAR
1455	STOPPED DEVELOPMENT.							
	DRILLERS READY TO RESUME @ AF SITE							
	P-05-7D VASTLY IMPROVED FROM YESTERDAY							
	1 TABLESPOON FINE SAND & SILT IN BK PIEZOMETER							
Surge block off								

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

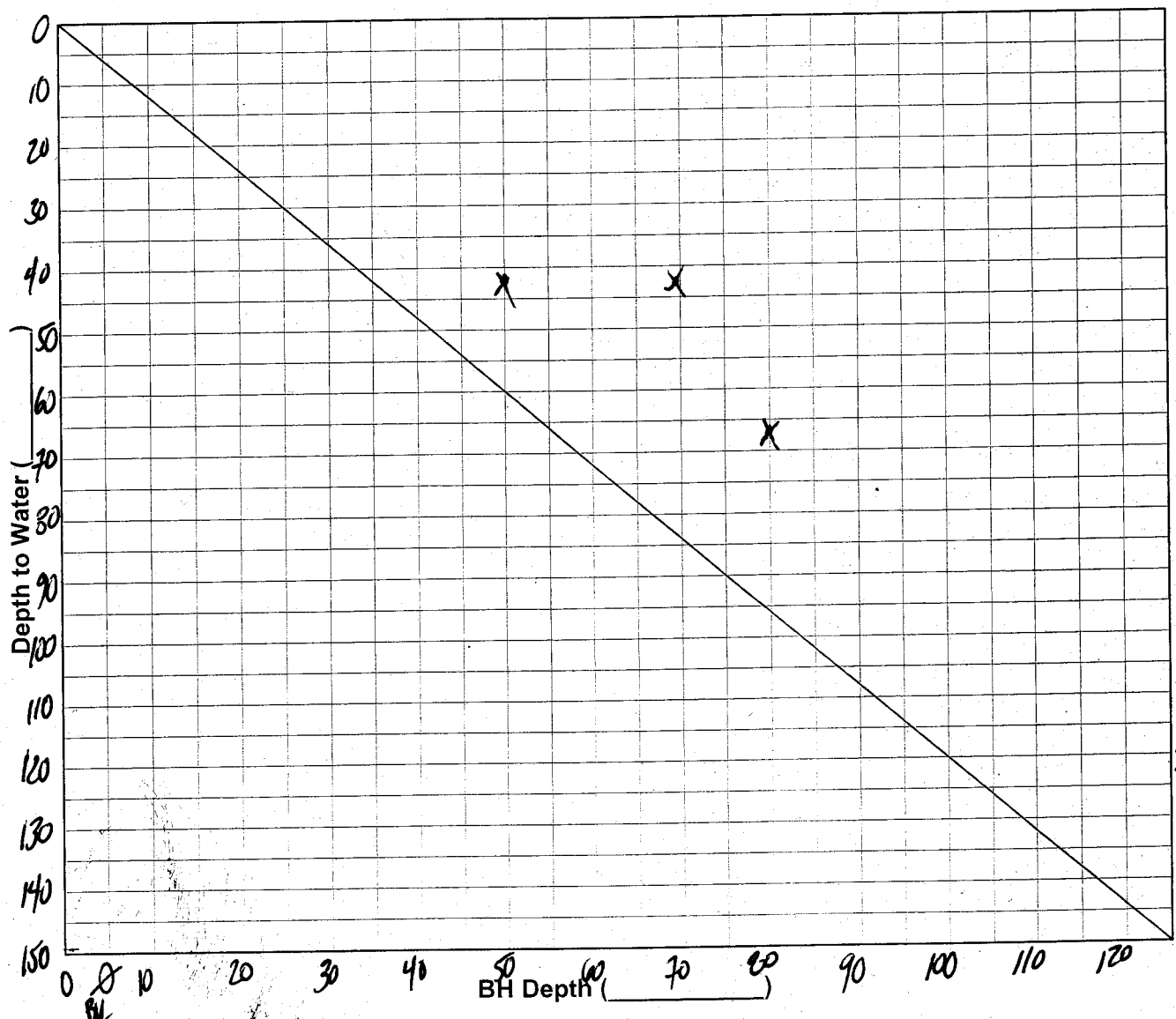
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: AD / P-05-07D
Name: KLOEFORTH, DIESER, HAGEN
Date start JUNE 05, 2005
Date finish JUNE 06, 2005

Water Level Measurements

Date	Time	Borehole Depth (BGS)	Water Depth (BGS)	Date	Time	Borehole Depth (BGS)	Water Depth (BGS)	Date	Time	Borehole Depth	Water Depth
JUNE 5	1627	48'	41.3'	JUNE 6	1119	113'	107.55'				
"	1631	48'	40.6'	"	1255	128'	122.3'				
"	1635	48'	40.9'	"	1258	128'	121.9'				
"	1738	68'	41.9'	"	1300	128'	121.85'				
JUNE 6	0730	78'	70.9'	"	1453	148'	88.1'				

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AD
DATE STARTED 6/8/05 **COMPLETED** 6/9/05
GROUND ELEVATION 1292.64 feet **TOC ELEVATION** 1294.92 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641497.901 meters **EASTING** 370011.47 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Rieser, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silt with gravel and sand** Brown, trace gravel, dry.	
5	GB				5.0 **Silt with gravel and sand** Brown, trace gravel, dry.	Drilling with one compressor.
10	GB				9.0 10.0 **Silt with sand and gravel** Brown, moderate fine to coarse sand, moist. 10.2 **Silty sand with gravel** **Silt with sand and gravel** Brown, fine to coarse sand, trace gravel, grace clay, moist.	
15	GB				15.0 **Silt with sand, clay and gravel** Brown, fine to coarse sand, trace clay, coarse gravel, moist.	
20	GB				19.8 **Silt with sand, clay and gravel** Same as above, moderate clay.	Vent. "Drilling slowing down." Added water.
25	GB				24.0 25.0 **Silt with sand and gravel** Brown, fine to coarse sand, subrounded to subangular, trace gravel, wet. **Silt with sand and gravel** Brown, fine to coarse sand, trace gravel, wet.	Added water. Water from rig infiltrates Tundra within 5 feet.
30					29.0	Added water. Added water.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.28 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 5 Sept., 2005
Purge Volume: 1578 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 20 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 32.25 Date: 6/9/2005 Time: 0740

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7S
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AD
DATE STARTED 6/8/05 **COMPLETED** 6/9/05
GROUND ELEVATION 1292.64 feet **TOC ELEVATION** 1294.92 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641497.901 meters **EASTING** 370011.47 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth, Rieser, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silty sand with gravel** Well-graded gravel, medium- to coarse-grained sand, subangular, wet.	
					31.5 **Silty sand with gravel** Well-graded gravel, medium- to coarse-grained sand, subangular to subrounded, wet.	Easier drilling.
					33.5 **Silty sand** Brown, fine to coarse, subrounded to subangular, wet.	Added water. Slow drilling.
35					35.0 **Sand with silt and gravel** Brown, well-graded sand, fine to coarse, subrounded to subangular, trace gravel, wet.	
					38.5 **Sand with silt** Dark gray, well-graded sand, fine to coarse, subrounded to subangular, wet.	
40					40.5 **Silty sand and gravel and silt** Brown, well-graded sand, subangular to subrounded.	Drier. Added water.
					43.3 **Silty sand and gravel** Brown, well-graded sand, subangular to subrounded, wet.	
45					45.0 **Gravel with sand and silt** Brown, well-graded gravel, fine to coarse, subangular, trace silt, wet.	Added water.
		42	1		48.8 **Silt with clay and sand** Dark gray, medium- to coarse-grained sand, subrounded to subangular, dry.	
50					50.3 **Silt with clay and sand** Bluish gray, fine-grained sand, subrounded, dry.	Added water.
					53.8 **Sand with silt and gravel** Brown, well-graded sand, fine to coarse, subrounded, trace gravel, wet.	Added water.
55					55.0 **Sand with silt and gravel** Brown, subrounded, wet.	
		48			59.5 **Gravel with sand and silt** Brown, well-graded sand, subangular, wet.	
60					63.3 **Sand with silt** Brown, poorly-graded, subrounded to subangular, fine- to medium-grained.	Added water.
					65.0 **Sand with silt and gravel** Subrounded to subangular, trace gravel.	Added water.
65					69.5 **Sand with gravel** Orange-brown, subangular to subrounded, wet.	
		42	2/3			Well making water at good rate.
70						

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-7S
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AD
DATE STARTED 6/8/05 **COMPLETED** 6/9/05 **GROUND ELEVATION** 1292.64 feet **TOC ELEVATION** 1294.92 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641497.901 meters **EASTING** 370011.47 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Rieser, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					75.8 76.5 **Silt with sand** Brown. **Sand with gravel and silt** Brown, well-graded sand, subangular to subrounded. 78.0 Bottom of hole at 77.8 feet.	Little water.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: AD/P-05-07S
Date: 9/5/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	35.20	35.20
Total depth	75.0	77.53	76.60
pH	—	6.23	5.96

Screen interval (btoPVC): 10'
Top: 67.53
Bottom: 77.53
PVC stick-up height (above ground surface): 2.2

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1708									
1736	77.48	35.20	3.9	109	0.07	E 3	5.18	Orange/Murky, 1 cup, Well graded sand & suspended SILT.	
1747	"	—	—	—	—	—	—	STOP Pump FOR DAY	
9/5/05 0905	"	—	—	—	—	—	—	START Pump @	
0922		—	4.0	177	0.09	1000	5.20	Orangish, Murky, 1/2 cup "	6.57 PH
0925	75.48	—	—	—	—	—	—	Move up 2 Ft, Restart Pump	
0948	"	—	4.0	269	0.08	519	4.95	Orange, Murky, 3 TBS SILT & Sand	
1009	"	—	4.0	353	"	293	5.06	" " 2 TBS "	PH. 5.85
1015	73.48	—	—	—	—	—	—	Move up. Restart Pump.	
1045	"	—	4.4	485	"	145	5.09	It orange, 2 TBS Fine Sand, SILT	PH 5.90
1112	"	—	4.0	577	"	120	5.04	" 1½ TBS. "	PH 5.93
1117	71.48	—	—	—	—	—	—	Move up. Restart Pump.	
1146	"	—	4.0	693	"	132	5.22	It Orange, Fine Sand & SILT 1½ TBS	PH 5.95
1208	"	—	4.0	781	"	99	5.08	" " 2 TSP	"
1219	69.48	—	—	—	—	—	—	Move up. Restart Pump.	
1249	"	—	4.1	904	"	299	5.23	It Orange, 1½ TBS	"
1312	"	—	4.0	996	"	191	5.05	" "	"
1320	67.48	—	—	—	—	—	—	Move up. Restart pump	PH 5.97
1340	"	—	4.0	1076	"	344	5.20	It orang, 1 TBS, Silt & Sand	
1417	"	—	4.2	1231	"	319	5.45	" "	PH 5.95
1422								STOP Pump.	
Surge block off START Polish @ 1427									
1440	62.48	—	4.0	1283	"	132	5.48	It orange, 2 tsp SILT	PH 5.98
1521	"	—	3.4	1354	"	109	5.36	" " 1½ tsp "	PH 5.96
1523	"	—	—	—	—	—	—	STOP Polish	
1525	77.53	—	—	—	—	—	—	START Debris Surge	
1616	"	—	4.0	1578	"	350	5.23		
1618	"	—	—	—	—	—	—	STOP Debris Surge	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

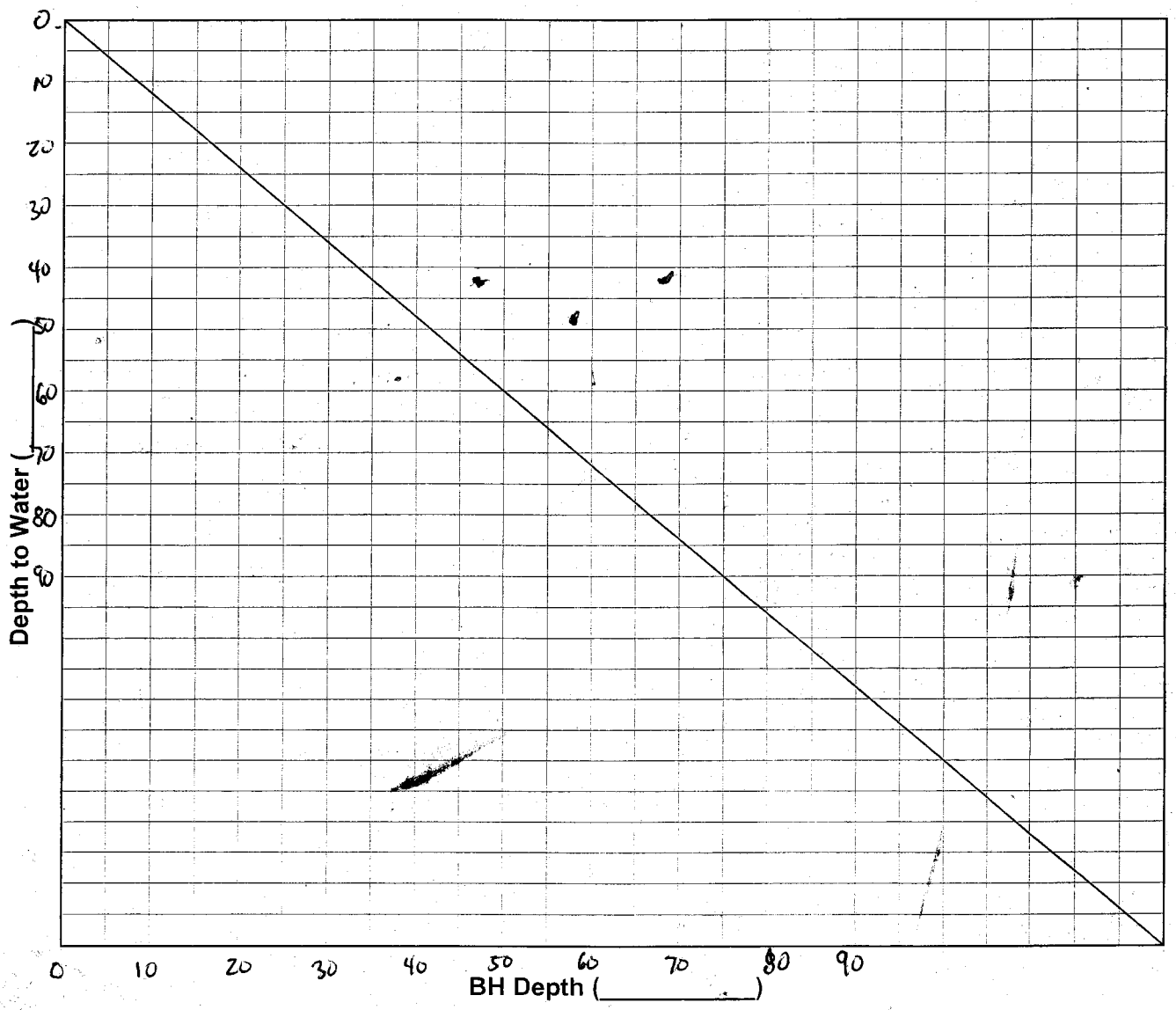
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: SITEAD, P-05-075
Name: KLICFORTH, HAGEN
Date start 8 JUNE 2005
Date finish 8 JUNE 2005

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
6/8	1505	48'	42' ↑								
	#1604	58'	48' —								
	1653	68	42' —								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-08

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AE

DATE STARTED 6/12/05 **COMPLETED** 6/12/05 **GROUND ELEVATION** 1322.82 feet **TOC ELEVATION** 1325.12 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6642229.7 meters **EASTING** 370295.471 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.4 **Peat/organics**	
					Silt with grave and well-graded silt Light to dark brown, dry.	
					4.5	
5	GB				**Silt with minor sand and gravel** Dark brown, well-graded sand, subrounded to subangular, moist. No recovery.	No recovery, no resistance, pushed right through. No resistance, pushed through without hammer.
						Slow drilling.
10	GB					Added water.
						Work of hydraulic fittings. Added water.
					Same as above. Frozen/semi-frozen (cold to touch).	
15	GB				15.0	Tough/slow drilling. Added water.
					Silt with minor sand Dark brown, well-graded sand, subrounded to subangular, cold to touch.	
					19.0	Pulled up 8', re-hammered.
20	GB				**Silt with sand** Dark brown, well-graded sand, subrounded, trace gravel, moist, cold to touch.	
						Added water.
					23.5	
25	GB				**Gravel with sand** Well-graded sand, wet. 25.0	
					Sand with silt and gravel Light brown, well-graded sand,subrounded to subangular, moist. 27.0	
					28.0 **Sand** Well graded.	
30					**Silt with sand** Orange, fine to medium-grain sand, subrounded, moist.	Slow drilling.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 6 Sept, 2005
Purge Volume: 339 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 20 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 17.6 Date: 6/13/05 Time: 0430

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-08
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AE
DATE STARTED 6/12/05 **COMPLETED** 6/12/05
GROUND ELEVATION 1322.82 feet **TOC ELEVATION** 1325.12 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642229.7 meters **EASTING** 370295.471 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				31.0 **Sand** Well-graded, angular to subangular.	
					33.8 **Sand with gravel** Well-graded, angular to subangular, moist to wet.	
35	GB				35.0 **Sand with silt** Orange-yellow, well-graded, subrounded, moist.	
40	GB				40.0 **Silt** Yellow-orange, subrounded to subangular sand grains, moist.	
					43.0 **Silt with gravel and sand** Yellow-orange, coarse to fine sand, angular to subrounded, wet.	
45	GB				45.0 **Silt with gravel and sand** Yellow-orange, angular to subrounded, wet.	Added water.
						Added water.
50	GB		0.5		49.8 **Silt with sand** Yellow-orange, well-graded sand, subangular, wet.	Added water.
55					54.8 55.0 **Silt with sand** Well graded.	
					56.2 **Silt with sand** Yellow-orange, well-graded sand, subangular to subrounded, wet.	
					Sand with gravel Yellow-orange, poorly-graded coarse sand, subangular to angular, wet.	
60	GB		1.5		59.8 **Sand with silt and gravel** Orange-yellow, well-graded sand, subangular, wet.	
		53.66			64.0 **Bedrock** Weathered, granitic matrix.	Worked on hydraulics for cable approximately 20 minutes. Doesn't feel competent.
65	GB		0.25			
70	GB		1.29		69.8 **Bedrock** Weathered, granitic matrix.	
		67.3			73.8 **Bedrock sulfides**	Hard drilling.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-08
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AE
DATE STARTED 6/12/05 **COMPLETED** 6/12/05 **GROUND ELEVATION** 1322.82 feet **TOC ELEVATION** 1325.12 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642229.7 meters **EASTING** 370295.471 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Bedrock sulfides**	
					77.7	
					Bottom of hole at 77.7 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AE/P-05-08
Date: 9/6/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	44.65	47.04
Total depth	73.1	74.35	73.45
pH	—	4.30	3.61

Screen interval (btoPVC): 10'
Top: 64.35
Bottom: 74.35
PVC stick-up height (above ground surface): 2.4

245
.02
243

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 0926									
1003	74.35	44.65	1.4	51.8	0.2	588	3.55	Milky Orange, Suspended Sed, 1Tsp Fine Sand ish CT	
1027	"	—	1.4	85.4	"	488	3.82	" "	
1032	72.35	—						—	
1100	"	—	1.4	124.6	"	240	3.83	Move up 2 ft, RESTART pump	
1135	"	—	1.4	173	"	62	3.84	LT Orange, Fine Sand, 1 Tsp	
1147	70.35	—						VERY light OR, TRACE Sand	PH. 3.64
1201	"	—	1.3	191	"	31	3.46	Move up, RESTART pump.	
1207	68.35	—						WATER CLAR, TRACE Sand.	PH. 3.59
1225	"	—	1.4	216	"	20	3.60	Move up, Restart Pump	
1233	66.35	—						WATER CLAR, TRACE Sand	
1253	"	—	1.1	238	"	81	3.95	Move up, RESTART pump	PH 3.61
1303	64.35	—						Slightly orange, VERY CLAR, TRACE Sand	PH 3.63
1321	"	—	0.6	252	"	105	3.88	Check FOOT VALVE, (OK) RESTART pump, Move ↑	
1324								Slightly orangish, " TRACE	PH 3.65
								Stop Pump	
Surge block off START POLISH @ 1331									
1400	59.35	—	0.6	269	"	50	4.29	WATER CLAR TRACE Sand.	PH 3.63
1404	"	—	—	—	—	—	—	STOP POLISH	
1407	74.3	—	—	—	—	—	—	START Debris Surge	
1427	"	—	1.0	316	"	33	3.28	LT Orange, 2 1/2 TBS Sand	PH 3.61
1450	"	—	1.0	339	"	22	3.56	WATER CLAR,	
1454								STOP Debris Surge	

2.34 2/4.68

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

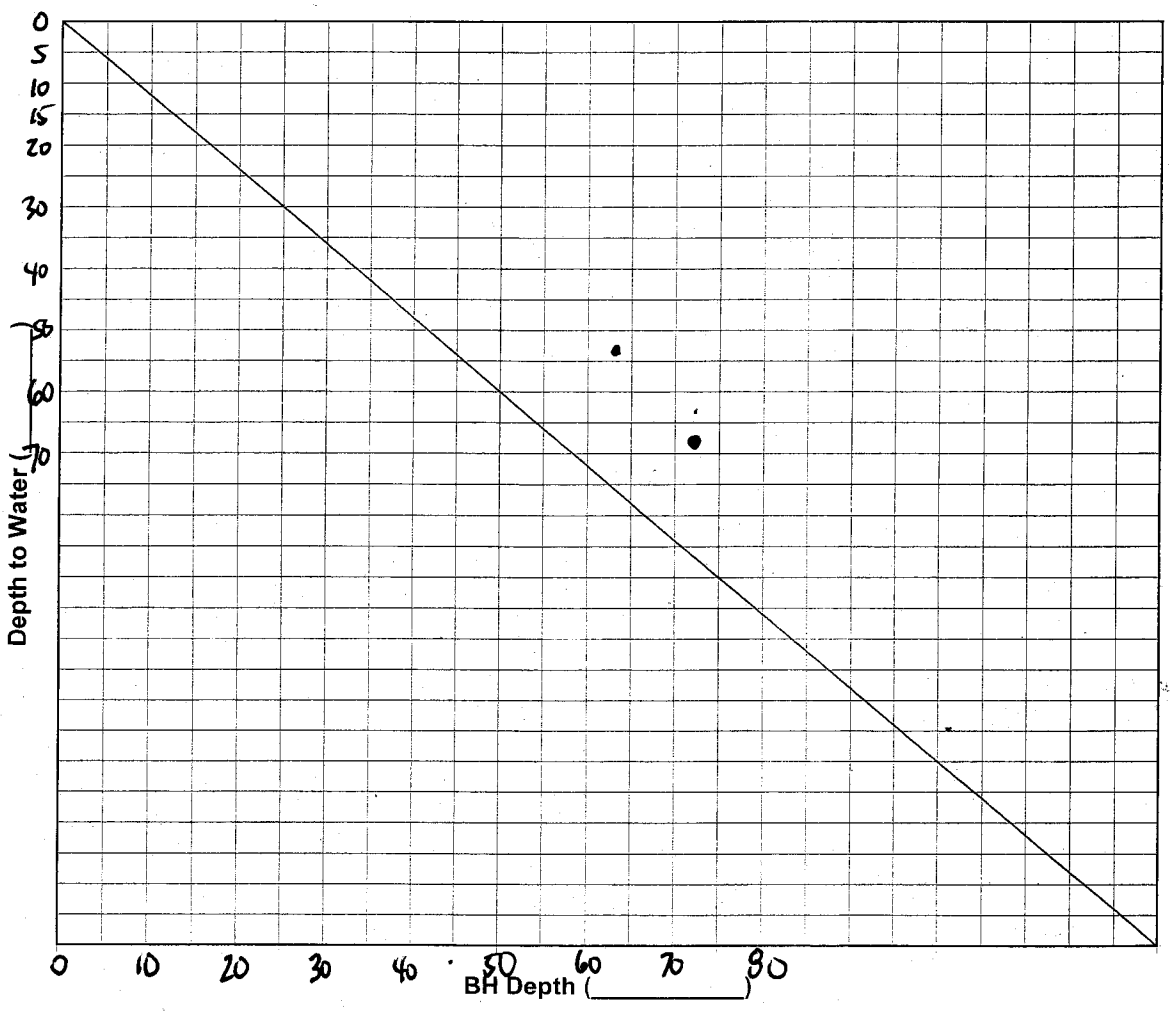
Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	AE / P-05-08
Name:	HAGEN
Date start	12 JUNE 2005
Date finish	12 JUNE 2005

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
12 JUN	2217	63	53.71								
"	2322	73	67.31								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-09D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AH

DATE STARTED 6/13/05 **COMPLETED** 6/14/05 **GROUND ELEVATION** 999.78 feet **TOC ELEVATION** 1002.18 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6642672.295 meters **EASTING** 372777.36 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen, Saganski,

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0 **Peat/organics, tundra**	
					Silt with clay Dark brown, dry.	
					4.0	
5	GB				5.0 **Silt with clay, sand and gravel** Dark brown, well-graded sand, trace gravel, dry to moist.	Cold to the touch.
					Silt with clay, sand and gravel Dark brown, minor well-graded sand, subrounded to subangular, trace gravel, dry to moist.	
					9.0	
10	GB				**Silt with clay, sand and gravel** Dark black, fine grained, subrounded, slight reaction with HCL.	
					14.0	
15	GB				15.0 **Silt with clay, sand and gravel** Same as above with moderate well-graded sand.	Relatively easy drilling, just coarse enough.
					17.0 **Silt with clay, sand and gravel** Dark brown, well-graded sand, trace gravel, dry to moist.	
					17.9 **Silt with clay, sand and gravel** Same as above with minor gravel-rich layer <6" thick.	
20	GB				**Silty sand with clay and gravel** Dark brown, well graded, moist.	
			0.25		Wet.	
					23.0	
					24.0 **Silty sand with clay and gravel** Same as above with higher silt/clay content.	Drilling slows down, added water the first time. Low recovery.
25	GB				25.0 **Silt with clay, sand and gravel** Dark brown, well-graded sand, trace gravel, wet.	Added water, slower drilling.
					Silt with clay, sand and gravel Dark brown, well-graded sand, trace gravel, wet.	Slow, added water.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.4 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 7 Sept, 2005
Purge Volume: 1339 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 25 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 52.69 Date: 6/14/05 Time: 1545, P-05-09S (1"pvc) and P-05-09D (2" pvc) are nested in same 6" well protector.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-09D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AH
DATE STARTED 6/13/05 **COMPLETED** 6/14/05 **GROUND ELEVATION** 999.78 feet **TOC ELEVATION** 1002.18 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642672.295 meters **EASTING** 372777.36 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen, Saganski,

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silt with clay, sand and gravel** Dark brown, well-graded sand, trace gravel, wet.	Possible natural water.
			0			Added water.
35					35.0 Color changes to gray. **Silt with clay, sand and gravel** Dark gray, fine to coarse sand, gravel subrounded to subangular. Gray.	Added water.
			0			Added water.
40					38.8 **Sand with silt and gravel** Gray, fine to coarse sand, wet (drilling water). (Heard a little gravel in cyclone.) 40.7	Drilling slightly easier. Added water.
					Silt with clay, sand and gravel Dark gray, fine to coarse sand, subrounded gravel.	Slow, added water.
45	GB				45.0	Added water. Very slow.
					Silt with clay, sand and gravel Dark gray, fine to coarse sand.	Slow drilling, added water.
50	GB				49.5 **Silt with clay, sand and gravel** Same as above with dry to moist silt conglomerations.	Added water, slow drilling.
					53.5	Worked on stabilizing, added water.
55	GB				**Silty sand with gravel** Dark gray, subrounded to subangular. 55.0 **Silt with sand and gravel** Dark gray, well-graded sand, subrounded to subangular gravel.	Slight improvement in drilling. Added water, slow drilling. Blew out all drilling water. Added water.
60	GB				61.5 **Sand with silt and gravel** Dark gray, well-graded sand, wet. 63.5	Added water. Fast drilling, no water added.
65	GB				**Silt with sand** Dark gray, dry. 65.0 **Silt with sand** Dark gray, well-graded sand, subrounded to subangular, some clay.	Added water, slow drilling. Added water, slow drilling. Added water.
70	GB				73.0 **Gravel with sand** Well-graded, subangular, wet. 74.5	Added water. Added water. Added water. Added water, very slow.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-09D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AH
DATE STARTED 6/13/05 **COMPLETED** 6/14/05 **GROUND ELEVATION** 999.78 feet **TOC ELEVATION** 1002.18 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642672.295 meters **EASTING** 372777.36 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen, Saganski,

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				75.0 **Gravel with sand**	Fast drilling.
		21.29	0.25		**Gravel with sand** Dark gray, well-graded, rounded to subangular, wet.	
80	GB				80.0 **Sand with gravel** Dark gray, well-graded, rounded to subangular, wet.	Fast drilling.
						Working on compressor.
85	GB		0.25			
		78.2				
90	GB					
95	GB				95.0 **Sand with gravel** Dark gray, well-graded sand, subrounded to subangular, wet.	Fast drilling.
			20.0		97.8 **Silt with sand** Dark gray, well-graded sand, dry to moist.	Added water, slow drilling.
100	GB	0			99.8 100.3 **Sand with gravel** Dark gray, well-graded sand, dry to moist.	Added water.
					Silt with sand Dark gray, well-graded sand, subrounded to rounded, dry. Increased coarse sands.	Added water, slow drilling. Added water.
105	GB				105.0 **Silt with sand** Dark gray, well-graded sand, subangular to rounded, moist.	Added water. Added water, slow drilling. Added water. Added water. Very slow. Turned on lights.
110	GB					Driller hit small lens of water. Added water.
115	GB				115.0 **Silt with sand** Dark gray, well-graded sand, subrounded to subangular, moist.	Added water. Added water. Added water, slow drilling.
					Silt with sand Dark gray, well-graded sand, rounded to subangular, dry to moist.	
					119.5	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-09D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AH
DATE STARTED 6/13/05 **COMPLETED** 6/14/05 **GROUND ELEVATION** 999.78 feet **TOC ELEVATION** 1002.18 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642672.295 meters **EASTING** 372777.36 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen, Saganski,

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Silt with gravel and sand** Dark gray, subrounded to angular gravel, round to subangular sand.	Added water. Added water.
					123.3	
			1		**Sand with silt** Well-graded sand, rounded to subangular, wet.	
125	GB		15		125.0 **Sand with silt** Well-graded sand.	
					126.5 **Silt with sand** Well-graded sand, subrounded to subangular, moist.	Added water, slow drilling. Added water, slow drilling. Added water.
130	GB					Added water, slow drilling. Added water. Added water. Added water.
135	GB				135.0	Added water.
					135.8 **Silt with sand** Dark gray, well-graded sand, rounded to subangular, moist.	Hard.
					137.0 **Bedrock** Dark gray, moderate reaction to HCL. **Siltstone** Calcareous.	Very hard.
140	GB		0.5			Hard drilling.
					142.0	

Bottom of hole at 142.0 feet.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

WELL DEVELOPMENT LOG

Well ID: AH/P-05-09D
Date: 9/6/05 / 9/7/05

Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	54.55	
Total depth	98.75	98.70	
pH	—	7.60	8.23

Screen interval (btoPVC): 15'
Top: 83.7
Bottom: 98.7
PVC stick-up height (above ground surface): 2.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1630									
1653	98.7	54.55	4.5	103	0.3	520	4.33	Greyish, Murky, 1/2 TBS Sand	
1717	"	"	4.4	164	0.3	274	4.10	Lighter Grey, Murky, 2TSP sand.	
1727	"	—	4.6	210	0.3	206	3.84	" " 1tsp	
1730	96.7	—						Move up. RESTART Pump	
9/6/05 1750	"	—	4.1	292	"	70	4.17	" 1/2 TSP.	PH 8.01
9/7/05 0913	94.7	—						RESTART pump. Move up 2FT.	
0935	"	—	4.3	386	0.5	85	4.18	light grey, Milkish, 2TSP Grey Sand	PH 6.86
0953	"	—	4.3		0.3	40	3.88	Slightly Grey, Clear, 1/4 tsp.	
0957	92.7	—						Move up. RESTART Pump	
1022	"	—	3.8	481	"	72	4.03	Hgrey Slightly Milky. 1 TSP Grey Sand	PH 7.95
1028	90.7	—						Move up. RESTART pump.	
1053	"	—	4.3	588	"	329	4.06	Grey Murky, 1 TBS	PH 8.09
1126	"	—	4.10	720	"	153	4.18	Grayish, Milky, 1TSP Sand	PH 8.18
1131	88.7	—						Move up. RESTART Pump.	
1203	"	—	4.3	857	"	174	4.73	Ltgrey Milky. ≤ 1tsp Sand.	
1209	86.7	—						Move up 2', RESTART Pump.	
1251	"	—	4.2	1033	"	114	4.71	" ≤ 1tsp Sand	PH 8.16
1257	84.7	—						Move up. RESTART Pump	
1330	"	—	4.6	1184	"	"	4.66	WATER CLEAR, TRACE Sand	PH 8.22
1335	83.7	—						Move up 1 FT, RESTART Pump	
1354	"	—	4.6	1271	"	3	4.66	WATER CLEAR, TRACE Sand	PH 8.23
1355								STOP Pump	
Surge block off START Polish @ 1401									
1410	78.7	—	3.8	1305	"	2	4.46	WATER CLEAR, TRACE Sand.	PH 8.20
1412	"	—						STOP POLISH	
1415	98.7	—						START Bubbs Surge	
1423	"	—	4.3	1339	"	24	4.32	VLtgrey, TRACE Sand.	PH 8.23
1425								STOP Bubbs Surge	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	AH/P-05-09
Name:	HAGEN
Date start	13 JUNE 2005
Date finish	

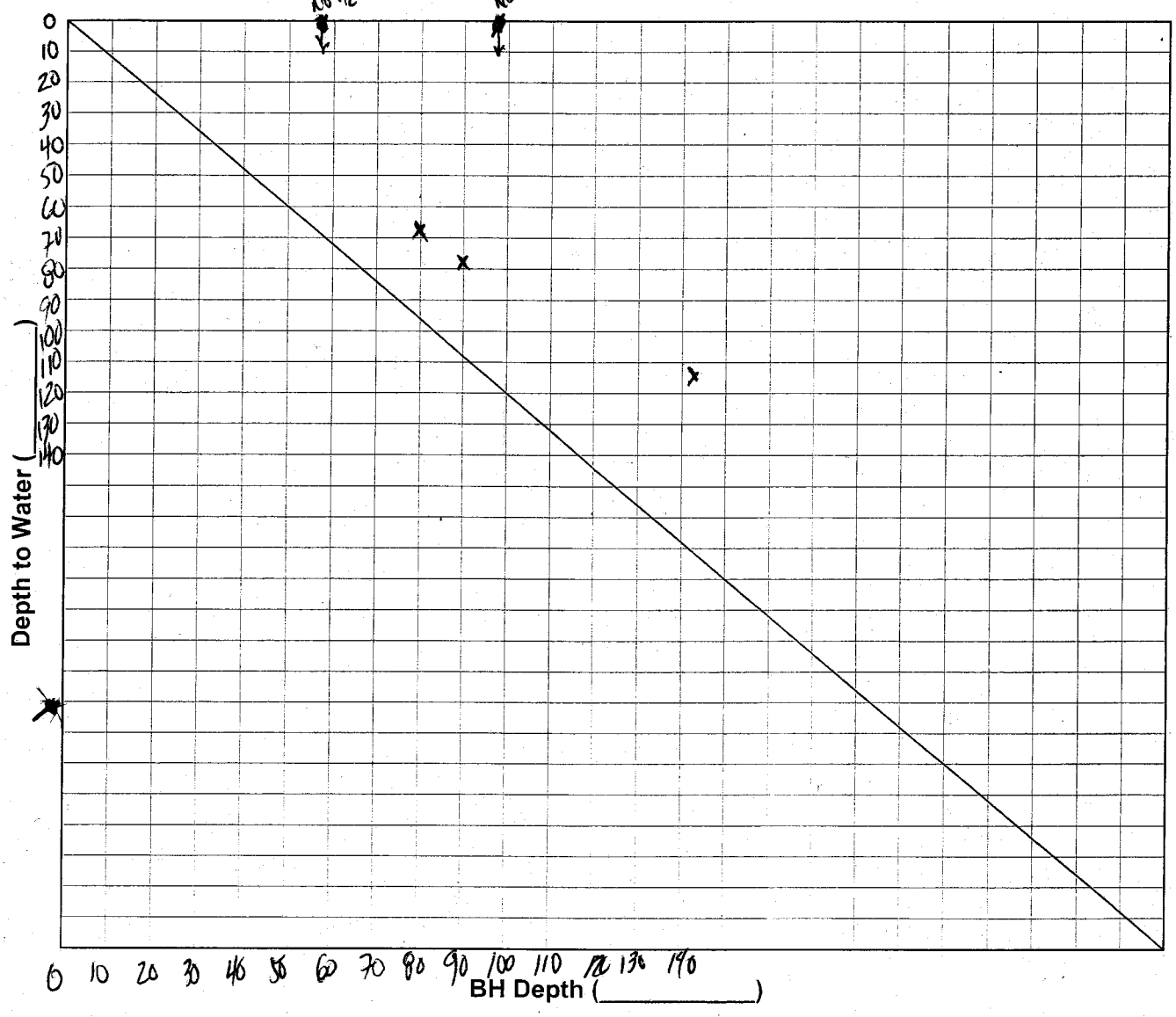
Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
13 JUNE	2125	78' hs	68.5 ↑	14 JUNE	0750	142'	113' ↑				
"	2208	88'	78.2 –								
"	2240	98	Ø								
"	1855	57.5'	Ø NO H2O WATER								

NO H_2O

NO H_2O

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-09S
PAGE 1 OF 1

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AH
DATE STARTED 6/13/05 **COMPLETED** 6/14/05 **GROUND ELEVATION** 999.78 feet **TOC ELEVATION** 1002.18 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642672.295 meters **EASTING** 372777.36 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Hagen, Sagansk

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION
0					1.0 **Peat/organics, tundra**
					Silt with clay Dark brown, dry.
					4.0
5	GB				5.0 **Silt with clay, sand and gravel** Dark brown, well-graded sand, trace gravel, dry to moist.
					Silt with clay, sand and gravel Dark brown, minor well-graded sand, subrounded to subangular, trace gravel, dry to moist.
					9.0
10	GB				**Silt with clay, sand and gravel** Dark black, fine grained, subrounded, slight reaction with hydrochloride.
					14.0
15	GB				15.0 **Silt with clay, sand and gravel** Same as above with moderate well-graded sand.
					17.0 **Silt with clay, sand and gravel** Dark brown, well-graded sand, trace gravel, dry to moist.
					17.9 **Silt with clay, sand and gravel** Same as above with minor gravel-rich layer <6" thick.
20	GB				**Silty sand with clay and gravel** Dark brown, well graded, moist.
					21.0 Wet.
					Bottom of hole at 21.0 feet.

WELL DIAGRAM: Cold to the touch. / Relatively easy drilling, just coarse enough.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 1 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: P-05-09S (1"pvc) and P-05-09D (2" pvc) are nested together in same boring and 6" steel well protector.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NESTED PIESOS P-05-09S&D PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-10D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site W
DATE STARTED 6/14/05 **COMPLETED** 6/16/05
GROUND ELEVATION 843.21 feet **TOC ELEVATION** 844.96 feet
DRILLING CONTRACTOR Foundex
NORTHING 6632659.683 meters **EASTING** 366838.214 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0 **Peat**	
					Sand with gravel and silt Brown, well-graded sand, subangular to rounded, loose, dry.	
5	GB				5.0 **Sand with gravel** Light brown, well-graded sand, rounded to subangular sand and gravel, dry.	
			Water in FM			
10	GB				10.0 **Gravel with sand and silt** Brown, well-graded gravel, coarse to medium-grained sand, rounded to subangular, wet.	
		6.35			12.0 **Sand with gravel** Subangular to subrounded sand, fine gravel, wet.	
15	GB				15.0 **Sand with gravel** Rounded to subangular, wet.	
			0.7			
20	GB				20.0 **Sand with gravel** Same as above, increased silt.	
		6.5			23.0 **Sand with gravel** Rounded to subangular.	
25	GB				25.0 **Sand with gravel** Brown to light brown, rounded to subangular, wet.	
			0.7			
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.7 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 16 June, 2005
Purge Volume: 986 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 6.5 Date: 6/14/05

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-10D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site W
DATE STARTED 6/14/05 **COMPLETED** 6/16/05
GROUND ELEVATION 843.21 feet **TOC ELEVATION** 844.96 feet
DRILLING CONTRACTOR Foundex
NORTHING 6632659.683 meters **EASTING** 366838.214 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB	12.9	1.5		**Sand with gravel** Same as above.	
					34.0	
35	GB				35.0 **Sand with gravel** Well-graded sand.	
					Sand with gravel Well-graded sand, rounded to subangular, wet. Decreased gravels.	
40	GB	12.9	1.5		40.0 **Sand with gravel** Well-graded sand, rounded to subangular, wet.	
45	GB				45.0 **Sand with gravel** Well-graded sand, wet.	
50	GB	20.4	10		50.0 **Sand with gravel** Well-graded sand, subrounded, wet.	
55	GB				55.0 **Sand with gravel** Well-graded sand, rounded to subrounded, wet.	
60	GB	6.1	20			
65	GB	50.5	4		65.0 **Sand with gravel** Well-graded sand, rounded to subrounded, wet.	"Big water." "Hammer won't fire."
70	GB	45.2			75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-10D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site W
DATE STARTED 6/14/05 **COMPLETED** 6/16/05 **GROUND ELEVATION** 843.21 feet **TOC ELEVATION** 844.96 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632659.683 meters **EASTING** 366838.214 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		5-10		**Sand with gravel** Well-graded sand, subangular to rounded, wet.	
80	GB				80.0 Decreased percentage of coarse-grained sand.	
	GB				**Sand with silt** Well-graded sand, subrounded, increased percentage of fines, wet.	Drilling slower.
85	GB		10		85.0 **Sand** Well-graded sand, rounded to subrounded, wet. Increased percentage of gravel.	Added water. Slower drilling. Heaving?
90	GB				90.0 91.0 **Sand** Well-graded sand.	Added water. Tripped rods-started at bottom at 87.5', approximately 2.5' heave.
95	GB				**Sand with gravel and silt** Well-graded sand, round to subrounded, subrounded to angular gravel, trace silt, wet. Decreased gravel, increased fine black sand. 95.0	Added water. Pulled back up to 92. Added water. Slow drilling. Added water.
100	GB				**Sand with gravel** Well-graded sand. No fine black sand. Decreased gravel. 100.0	Added water constantly to prevent heave. Pulled back to 97'. Added water.
105	GB				**Sand with gravel** Same as above. Increased gravel. Increased silt approximately 5 to 10%. Decreased gravel and coarse sand. 105.0	Water is added constantly.
110	GB		15		**Sand with gravel and silt** Well-graded sand, <10% silt. 110.0	Added water.
115	GB		12		**Sand with gravel and silt** Same as above. Slightly more silt. A little darker brown color. Decreased gravel, increased fine sand. 115.0	Possible heave. Rod not moving, water flowing up rod at 20 gpm 1455. Can't get hammer to fire.
	GB		7		116.5 **Sand with gravel** Well-graded sand, rounded to subangular, 15% gravel, wet. Increased silt. **Gravel with sand and silt** Subrounded to subangular, wet. 120.0	Water is very turbid, dark brown. Drilling rate slowing. Slow drilling.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-10D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site W
DATE STARTED 6/14/05 **COMPLETED** 6/16/05
GROUND ELEVATION 843.21 feet **TOC ELEVATION** 844.96 feet
DRILLING CONTRACTOR Foundex
NORTHING 6632659.683 meters **EASTING** 366838.214 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Gravel with sand and silt** Rounded to subangular, wet. Turbid water.	Hard drilling.
125	GB				125.0 Sand and gravel. **Sand with gravel** Well-graded sand, rounded to subangular, wet.	Slow drilling. Driller says there is a lot of water in the formation.
		6.5	5			
			20		129.0 **Sand with gravel and silt** Well-graded sand, fine gravel, trace silt, wet. Increasing coarse sand.	Added water. Pulled casing back 1'. Drilling stops.
130	GB					
			30-40		Color change to dark brown in silt component.	Added water.
			40-50		134.0 Color back to brown.	Water is flowing constantly, drilling is very slow.
135	GB				135.0 **Sand with gravel and silt** Well-graded sand, fine gravel, trace silt, wet.	Water slowing down.
	GB				137.0 **Sand with gravel and silt** Same as above.	
			35		138.0 **Bedrock** Black, angular fragments approximately 2-3 cm. Fractured bedrock with sand. Bottom of hole at 138.0 feet.	Hot lots of water. Driller notes that formation is hard.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

(SITE W)

Well ID: P-05-10D
Date: 8/4/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

		Installed (Well Log)	Start	End
Water level		~~12.75~~	12.68	12.75
Total depth	136.0	~~13.0~~	138.7	13.4
pH		~~7.07~~	6.68	7.07

Screen interval (btoPVC): 10'
Top: 126+2 => 128
Bottom: 136+2 -> 138
PVC stick-up height (above ground surface):
2 (1.77) FTOC

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
1400	136.0	12.68	5.75	0	0.11	474	5.30	START Purge @ 138.0 ft. 2 TBS.	
1412	"	—	4.13	49.56	0.10	105	5.45	Large to Medium Grain Sand, Brown/Grey/Black 1½ TSP.	
1428	"	—	4.34	119.0	0.10	22.1	5.83	" 1 TSP ~~Moved Surge Foot~~ ↑	
1435	136.0	—			~~0.10~~			Moved Surge ↓ PORT	
1450	"	—	4.34	166.74	0.10	0.01	5.55	≤ ½ TSP, WATER CLEAR	PH 6.88
1456	134.0	—	~~3.3~~				~~5~~	Moved Surge	
1510	"	—	3.3	201.34	0.10	18.8	5.34	WATER CLEAR, Medium/Fine Sand Brown Gravel, 1 TBS	PH 7.09
1532	"	—	5.0	316.34	0.10	12.3	4.97	" , 2 TSP.	PH 7.09
1551	"	—	5.0	411.34	0.10	5.15	5.0	" , 1 TSP	PH 7.10
1558	132.0	—						Moved Surge PORT	
1610	"	—	5.0	501.34	0.10	8.84	4.96	WATER CLEAR, ½ TSP	PH 7.07
1631	"	—	5.0	591.34	0.10	4.36	4.90	" 1 tsp., Stop Pumping (End of Day)	
8/5/05 0907	"	—						Resumed Pumping TO Double check Sediment	
0917	130.0	—						≤ 1 tsp Sediment, Moved Foot Valve	
0920	"	—						Resumed Pumping	
0925	"	—	5.0	616.34	0.12	7.98	5.25	Brown/mottled Sand, Medium Fine Sand 1 TBS	
0950	"	—	9.25	847.59	0.10	2.79	4.60	Flow Increase " 2 tsp.	
1009	"	—	4.90	940.69	0.10	3.04	4.60	Flow Resumed, 1 tsp	PH 7.07
1016	128.0	—						Moved Foot Valve.	
1019	"	—						Resumed Pumping	
1028	"	—	5.0	785.69	0.10	2.32	4.63	≤ ½ TSP.	
1037								STOP Purge	
Surge block off									
1044	130							START Polish	
1048								STOP Polish, TRACE Sand.	
1052	136.0							START Debris Surge	
1104								STOP Debris Surge, TRACE Sand ≤ ½ TSP.	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

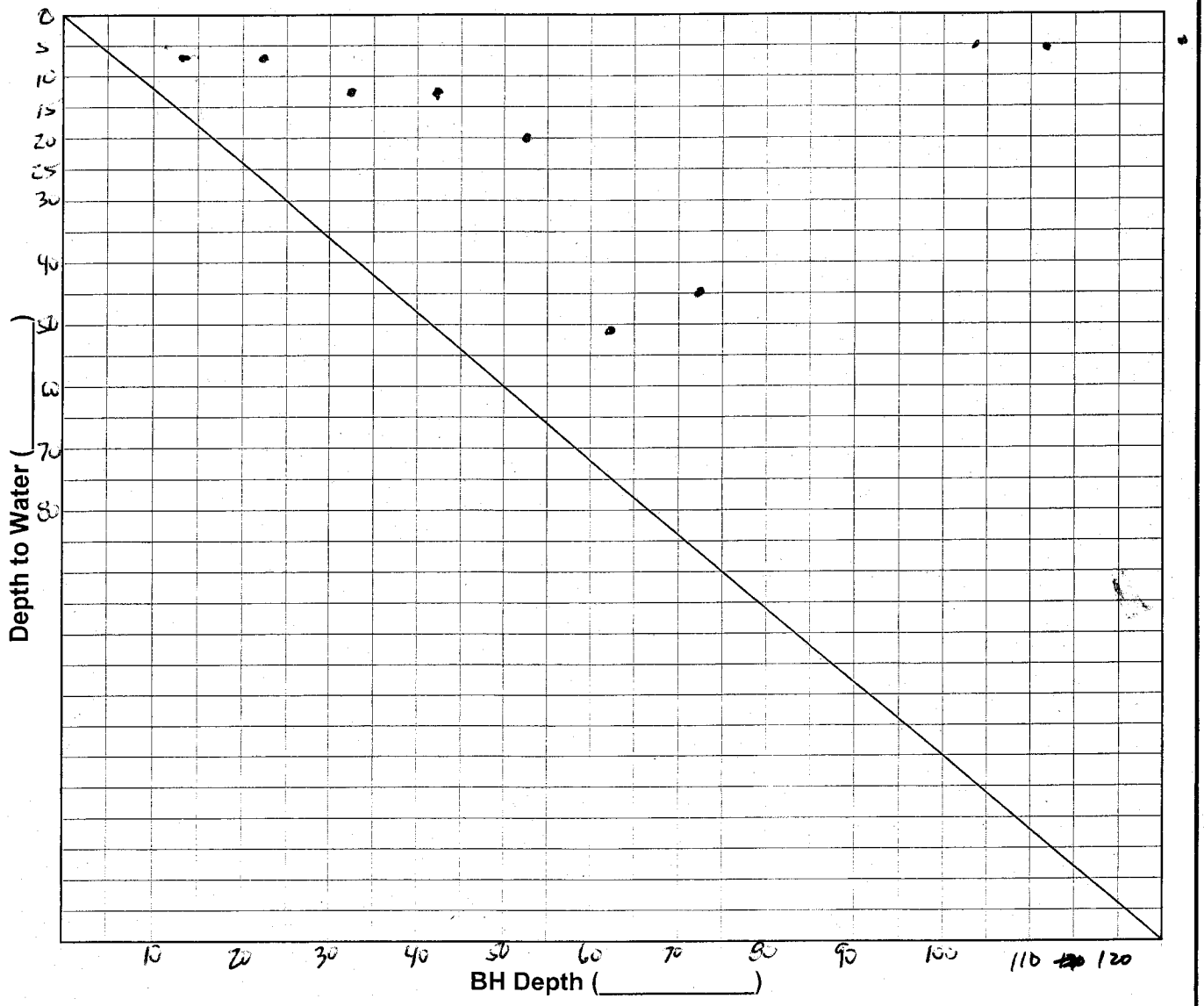
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: P-05-10
Name:
Date start 14 JUNE 05
Date finish 16 JUNE 05

Water Level Measurements

Date 2005	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
14 JUNE	2325	13	6.35	15 JUNE	0410	63	50.5 ↑	15 June	1234	104	~4' bgs
14 JUNE	2340	23	6.5	"	0453	73	45.2 ↑	"	1635	112	6.5' bgs
15 JUNE	2400	33	12.9	"				16 JUN	0200	128	6.5 bgs
15 JUNE	0026	43	12.9 ↑	"							
"	0054	53	20.4 ↑	"							

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-10S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site W
DATE STARTED 6/17/05 **COMPLETED** 6/17/05
GROUND ELEVATION 842.76 feet **TOC ELEVATION** 845.19 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632664.14 meters **EASTING** 366831.052 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat** No cuttings.	
					4.0	
5	GB				**Gravelly sand with silt** Brown, well-graded sand, moist.	
					9.0	Water coming into casing from formation.
10	GB				**Sandy gravel with silt** Brown, medium-coarse sand, wet.	
		6.5			13.0	
					14.0 **Gravel with sand** Coarse sand, wet.	
15	GB				15.0 **Gravel with sand** Same as above.	
					Gravel with sand Wet.	
					19.0	
20	GB				**Gravel with sand and silt** Brown, well-graded sand, wet.	
		7.0			23.0	
					24.0 **Gravel with sand and silt** Same as above.	
25	GB				**Gravel with sand and silt** Brown, well-graded sand, trace silt, wet.	
					29.5	Added water.

Bottom of hole at 29.5 feet.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.4 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 5 Aug., 2005
Purge Volume: 778 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 8.84 Date: 6/17/05 Time: 1310

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

(w)
Well ID: P-OS-10S
Date: 8/5/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		12.96	
Total depth	29.54	29.58	
pH		6.89	

Screen interval (btoPVC): 10'
Top: 19.6 + [illegible]
Bottom: 29.6 + [illegible]
PVC stick-up height (above ground surface): 2.08

2.55
.47
2.08
5.6
.208
.404

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
1154	29.6	12.96	4.06	∅	0.07	352	4.75	START PUMPING, 3/2 TBS,	
1215	"	—	4.06	85.26	0.07	201	4.50	Fine Sand & SILT, Brown/Grey Mottled 1TBS.	PH 6.60
1231	"	—	4.03	149.74	0.07	21.5	4.62	" 2TSP.	
1242	"	—	4.06	194.4	0.07	5.9	4.44	Brown Fine Sand 1 1/2 TSP TRACE SILT.	PH 6.37
1301	"	—	4.01	272.3	0.07	11.1	4.40	WATER CLEAR Brown Sand TRACE SILT 1TSP	6.44
1315	27.6	—	—	—	—	—	—	MOVED SURGE BLOCK	
1336	"	12.95	2.08	326.38	0.07	133	5.12	Flow Dropped, 4 TBS of Sediment, "	
1419	"	—	2.27	423.99	0.07	68.7	5.62	2 TBS,	
1449	"	—	1.25	461.49	0.07	77.5	5.20	2 TBS.	
1504	1509	"	1.25	480.24	0.07	57.8	5.95		
1510	25.6	12.96	—	—	—	—	—	MOVED CHECK VALVE,	
1517	"	—	3.70	506.14	0.07	61.6	4.84	Brown SAND & SILT, 1 1/2 TBS.	PH 6.49
1537	"	—	3.7	580.14	0.07	21.8	4.80	" 1 1/2 TSP	6.43
1600	"	—	3.6	662.94	0.07	20.1	4.82	= 1/2 TSP	
1608	23.6	—	—	—	0.07	—	—	RAISED CHECK VALVE	6.45
1619	"	—	1.50	679.44	0.07	34.5	—	" 2 TSP.	
1635	"	—	1.54	704.08	0.07	13.5	510	WATER CLEAR 1TSP	PH 6.27
1640	21.6	—	—	—	—	—	—	MOVED CHECK VALVE.	
1659	"	—	1.21	727.07	0.07	451	5.94	= 2 TBS " Brown Fine Sand & Silt.	6.48
1706	"	—	1.14	753.29	0.07	124	6.04	" 2 TSP	6.49
1740	"	—	1.12	768.97	0.07	43.9	7.09	1/2 TSP. STOP SURGE, MOVE VALVE	
1751	19.6	—	—	—	—	—	—	START SURGE 1753 (FLOW TEST) 1.19 gpm.	STOP Pumping End of Day
8/6/05 0808	"		—	—	—	—	—	RESTART Pumping	
0821	"		.71	778.2	0.07	45.5	5.14	TRACE Fine Sand, Flow Slowed, PH 6.58	@ 1800
Surge block off									
0838								START POLISH	
0843								STOP POLISH	
0846								START DEBRIS SURGE	
0850								STOP DEBIS SURGE.	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	R05-105
Name:	
Date start	17 June 2005
Date finish	17 June 2005

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
17 Jun 05	0955	13	6.5'								
"	1015	23	7'								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V

DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.42 feet **TOC ELEVATION** 848.77 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6632200.949 meters **EASTING** 368525.974 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Gravelly sand with silt** Brown, well-graded, moist.	
5	GB				5.0 **Gravelly sand with silt** Brown, well-graded, moist.	
10	GB				9.0 **Gravelly silt with sand** Brown, plastic silt, wet. Becomes gray with decreased gravel.	Added water.
15	GB				14.0 15.0 **Clayey silt with gravel and sand** Gray, wet. **Silt with gravel and sand** Plastic silt, trace sand, wet.	Added water.
20	GB				20.0 **Silt with gravel and sand** Same as above.	
25	GB				25.0 **Silt with gravel and sand** Gray brown, wet.	Added water.
30					29.0 **Clayey silt and gravel.** Trace gravel.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 11 Aug., 2005
Purge Volume: 1806 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 8.5 Date: 6/23/05 Time: 1730

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.42 feet **TOC ELEVATION** 848.77 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632200.949 meters **EASTING** 368525.974 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				31.0 **Clayey silt and gravel.** Trace gravel.	
					Sand with silt Brown, fine sand, some silt, wet.	Added water.
					34.0	
35	GB				35.0 **Sand with silt** Brown, fine sand, wet.	
					Sand with silt Brown, fine sand, wet.	Added water.
					38.0	
					39.0 **Clayey silt** Brown.	Added water.
40	GB				**Sand with silt** Brown, fine sand, wet.	
						Added water.
					44.0	Added water.
45	GB				45.0 **Sand with silt** Same as above.	
					Sand with silt Brown, fine sand, wet.	Added water.
					49.0	Adjusted rig to center rods in casing.
50	GB				**Gravelly sand with silt** Brown, fine sand, wet.	Added water.
					54.0	Sanded-in.
55	GB		17		**Gravelly sand with silt** Brown, fine to coarse sand, wet.	Added water.
					59.0	Added water.
60	GB				**Sand and gravel with silt** Brown, well-graded sand, wet.	
		25.7				Added water. Stuck in formation.
					64.5	Added water. Backed out casing 5', redrilled.
65	GB				65.0 **Sand and gravel with silt** Same as above, decreased gravel.	Added water.
					Sand and gravel with silt Brown, well-graded sand, wet.	Added water.
70					70.0	
					Sand and gravel Well-graded sand, angular to rounded, fine-grained gravel, wet. Turbid outflow.	
		41.9			Increased gravel.	Fixed rubber seal.
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.42 feet **TOC ELEVATION** 848.77 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632200.949 meters **EASTING** 368525.974 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		7	**Sand and gravel** Well-graded sand, rounded to subangular, wet. Turbid outflow (silt).	
80	GB			80.0 **Sand and gravel** Well-graded sand, rounded to subangular, wet. Turbid outflow (silt).	
85	GB	56.4	15	85.0 **Sand and gravel** Well-graded sand, subrounded to subangular, wet. Turbid outflow (silt).	Heaving sands.
90	GB			88.0 **Sand with gravel** Wet. Same silt. 90.0 **Sand with silt and gravel** Well-graded sand, fine gravel, subrounded to subangular, wet. Turbid outflow.	Driller said he hit water again. Said he lost water from 84' to 87'. Drilling slows. Added water. Added water. Added water.
95	GB	62.5		95.0 Fine- to medium-grained sand. **Sand with silt and gravel** Fine- to medium-grained sand, subrounded to rounded, trace gravel.	Heaving sands, added foam. Added water. Slow drilling. Added water.
100	GB			Increased coarse sand. Increased fine sand. 100.0 Increasing grain size.	Added foam, added water. Slow drilling. Load casing with water. Added water.
105	GB			101.0 **Sand** Fine- to medium-grained, poorly graded, rounded to subrounded, wet. Increased fine sand. **Sand with gravel and silt** Brown, well-graded sand, wet. 104.5 Decreasing gravel.	Added water. Added water. Lose drill shoe.
110	GB			**Sand with gravel and silt** Brown, well-graded sand, trace gravel, wet. Decreasing grain size. No gravel. 109.0 Increased gravel.	Added water. Added water. Stopped for maintenance on compressor.
115	GB			111.0 **Gravelly sand with silt** Brown, well-graded sand, wet. **Gravelly sand with silt** Brown, well-graded sand, wet. Decreasing gravel. 114.0 **Gravelly sand with silt** Brown, well-graded, wet.	Added water.
				Increasing gravel. 119.5	Added water. Added water.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.42 feet **TOC ELEVATION** 848.77 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632200.949 meters **EASTING** 368525.974 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB		12		120.0 **Gravelly sand with silt** Same as above.	
					Gravelly sand with silt Brown, well-graded sand, wet.	Drilling slowing.
						Added water.
125					125.0 **Gravelly sand with silt** Same as above.	Very slow drilling.
						Added water.
					Decreased gravel.	Drill rig cranked up to 180 psi.
130	GB				130.0 **Sand with gravel and silt** Brown, well-graded sand, wet.	
			30-40			Added water.
135	GB				135.0 **Sand with gravel and silt** Same as above.	
						Added water.
140	GB				140.0 **Sand with gravel and silt** Brown, well-graded sand, wet.	
						Added water.
145	GB				145.0 **Sand with gravel and silt** Same as above.	
			30-40			Added water.
150	GB				150.0 **Sand with gravel and silt** Brown, well-graded sand, wet. Increased silt.	Added water.
			20			
			30			
155	GB				155.0 **Sand with gravel and silt** Brown, well-graded sand, wet.	Added water.
					Increasing silt?	Driller says no water in formation. Added water. Drilling rate = 1 hr./5ft. to 158'.
160	GB				160.0 **Sand with gravel and silt** Same as above, increased silt.	
			35			

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.42 feet **TOC ELEVATION** 848.77 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632200.949 meters **EASTING** 368525.974 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
	GB			165.0 166.0	**Sand with gravel and silt** Brown, well-graded sand, wet. Bottom of hole at 162.0 feet.	Driller says we are in silty formation. Muddy outflow. Slow drilling. Slow drilling. Lots of water pressure.

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: V/P-05-111D
Date: 8/11/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: William Wimmer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		15.01	15.15
Total depth	165.22	166.40	166.25
pH		7.06	6.55

Screen interval (btoPVC): 15'
Top: 151.35
Bottom: 166.35
PVC stick-up height (above ground surface): 2.2

2.55 / 3

166 − 15 = 151

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump 1424.									
1437	166.35	15.01	.415	144.1	0.07	17.4	6.83	WATER CLEAR, medium Fine Sand ≤ 1 tsp.	
1448	164.35	— @ 48			0.07	9.65	7.02	Move up, RESTART Pump.	
1507	"	—	.48	352.3	0.07	9.65	7.02	CLEAR 1½ tsp	
1525	"	—	.415	550.2	0.07	9.21	6.39	CLEAR ≤ 1 tsp TRACE	PH. 6.89
1529	162.35	—						Move up, RESTART Pump.	
1538	"	—	12.5	662.8	0.07		6.29	" ≤ 1 tsp CLEAR.	
1543	160.35	—						Move up RESTART Pump	
1553	"	—	11.36	886.3	0.07	23.1	6.81	CLEAR ≤ 1 tsp, TRACE Sand	PH 6.80
1559	158.35	—						Moved up. RESTART Pump.	6
1610	"	—	11.11	897.3	0.06	30.5	6.34	CLEAR, Slightly cloudy, 1 tsp Sand	6.82
1617	156.35	—						move up. RESTART Pump.	
1634	"	—	11.11	1086.1	0.06	30.4	7.04	CLEAR, Same Soil Description, ≤ 1 tsp.	
1639	154.35	—						move up, RESTART Pump	PH 6.75
1656	"	—	10.63	1283.0	0.06	67.4	6.91	" WATER A little cloudy, 1 tbs.	
1709	"	—	11.11	1412.0	0.06	44.6	7.12	WATER CLEAR, ≤ 1 tsp	
1717	152.35	—						Move up, RESTART pump	PH 6.72
1735	"	—	11.11	1610.0	0.06	141.8	7.45	WATER CLEAR, ≤ 1 tsp	
1741	151.35	—						Move up, RESTART pump	
1745	"	—	10.0	1650.0	0.06	7.98	7.43	CLEAR Water, Fine & Medium Brown Sand	6'11" bs ≤ ½ tsp.
Surge block off START POLISH: 1753									
1802	146.35	—	11.11	1771.0	0.06	5.17	6.27	TRACE Sand, WATER CLEAR.	PH 6.60
1803	"	—						STOP POLISH.	
START Debris Surge 1808 ≤ 1812	166.35	—	8.92	1806.65	0.07	4.09	6.27	START Debris Surge, WATER CLEAR.	6.55
1813	"	—						STOP Debris Surge — TRACE Sand End TEST	

* Very HOT, Temp. Might NOT Reflect ACTUAL.

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

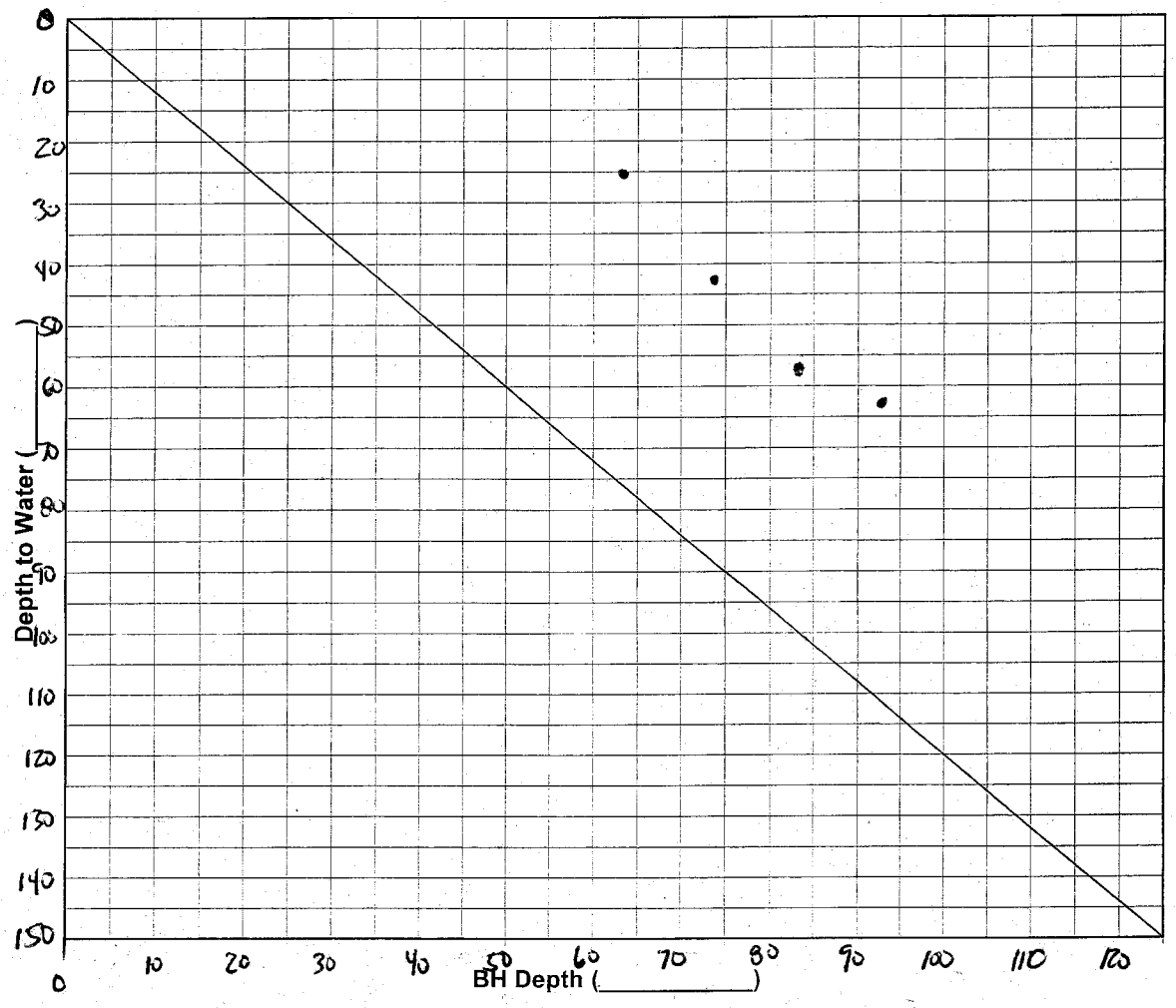
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: WP-05-11
Name:
Date start 19 JUNE 05
Date finish

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
19 JUNE	1705	63	25.7								
19 JUNE	1940	73	41.9								
11	2015	83	56.4								
11	2129	93	62.5								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05
GROUND ELEVATION 846.29 feet **TOC ELEVATION** 848.63 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632197.629 meters **EASTING** 368530.702 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					No recovery.	
					3.8	
5					4.8 **Gravel with sand and silt** Light brown, wet.	
					Gravel with sand and silt Light brown, moist.	
					9.0	
10	GB				10.0 **Gravel with sand and silt** Light brown, wet.	Added water. Driller says formation is dry.
					Silt and sand Moist.	
					12.0	
		8			13.0 **Silt with sand** Gray, plastic silt.	Increased pressure.
			0.2		**Silt with sand** Gray, plastic silt, wet.	
15	GB				15.0	
					Silt with sand Gray, plastic silt, trace gravel, wet.	
20						Added water. Added water.
						Added water to blow out casing for DTW.
			0.2			
25					25.0	
					Silt with sand and gravel Dark gray, plastic silt with sand, trace gravel.	Added water to blow out casing.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.34 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 17 Oct., 2005
Purge Volume: 1452 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments:

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.29 feet **TOC ELEVATION** 848.63 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632197.629 meters **EASTING** 368530.702 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB		0.2	**Silt with sand and gravel** Dark gray, plastic silt with sand, trace gravel.	
35	GB	35.2		35.0 **Silt with sand and gravel** Dark gray, plastic silt with sand, trace gravel. 36.0	Added water.
40				**Silt with sand and gravel** Same as above, slight increase in gravel. 40.0	
				Silt with sand and gravel Dark gray, plastic silt with fine gravel, subrounded. 43.0	
45				**Silt with sand and gravel** Same as above, dark gray silt. 45.0	Added water.
			4	**Silt with sand and gravel** Dark gray silt. 47.0	Added water. Added water. Soft drilling.
50				**Silt with sand and gravel** Same as above, increase in fine-grained sand. 50.0	Added water. Soft drilling.
				Silt with sand and gravel Same as above, dark gray silt with fine gravel and sand. 53.0	
55			4	**Silt with gravel and sand**	Added water. Stuck, heaving sands. Added water. Added water with foam.
60					Driller says no water.
65			15	64.0 **Gravel with silt and sand**	
				68.0 **Gravel with silt and sand**	
70	GB		18	70.0 **Sand with gravel and silt**	Added water.
				73.0 **Sand with gravel and silt** 75.0	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11M
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V
DATE STARTED 6/22/05 **COMPLETED** 6/23/05 **GROUND ELEVATION** 846.29 feet **TOC ELEVATION** 848.63 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632197.629 meters **EASTING** 368530.702 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75			20			
			17		**Sand with silt**	Added water.
		6			78.0	
					Bottom of hole at 78.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

DEVELOPMENT LOG P-05-11M

28

8/11/05 W. Wimer, P. Taylor

0730 MOBED TO SITE (Q)
Set up on P-05-11SD.
0805 Slung TOTE From SITE (O)
0830 HAD TO go BACK TO SITE (O) to retrieve pump.
0956 (W)
→ 0858

START Pump
STOP Pump
START Polish
STOP Polish
START Debris Surge
Stop Debris Surge

8/12/05 W. Wimer, P. Taylor

0740 MOBED TO SITE (V)
0813 Setup, CALIBRATED Equipment
P-05-11S (RENAMED P-05-11M)

	START	END
WL	15.47	
TD	77.81	
PH	7.28	

Screen Interval 10
PVC Stickup 2.3'
Top: 67.3
Bottom: 77.3
PVC Stickup 2.3'

START Pump: 0845

PH	Time	Depth	WL	Flow	PurgeV	cond	TDS	Temp
=1tsp	0903	77.3	15.47	4.34	78.12	0.04	380	6.04
7.34	0914	11	-	4.27	125	0.02	228	6.03
* WATER cloudy, 1 tsp of Silt & Sand. LT Brown.								
	0919	75.3						
							Move up, Restart	
PH 6.99	0944	11	-	4.0	225	0.02	102	6.59
* WATER Cloudy, ≤1 tsp Medium/F. Sand							TRACE SILT	
	0954	73.30						
							Move up, restart pump	
PH 6.99	1010	11	-	4.16	291	0.02	715	7.15
* WATER Cloudy, LT Gray/Brown in Color, 1 tbs Sand & Silt								
PH 7.12	1035	11	-	4.16	323	0.02	397	7.11
* WATER Gray/LT Brown, Medium/Fine sand & Silt, 2 tsp								
7.06	1054	11.0	-	4.16	402	0.02	227	7.35
	1058	71.3						
							Move up, Restart Pump	

cloudy water, 2 tsp sediment

8/12/05 W. Weimer, P. Taylor

Cont'd P-05-118

PH	TIME	DepTH	WL	FLOW (gpm)	PurgeV	Con	Turb	Temp
7.10	1132	71.3	–	4.16	526	0.02	721	8.13
7.21	1206	"	–	4.16	684	0.03	767	7.83
(1132)	Approx 2 TBS. Medium/Fine Sand + SILT, Water cloudy)							
	1216	69.3			Move up. Restart Pump			
	* Suspended Silt, WATER Murky Medium Brown, Fine/Medium Sand,							
7.09	1234	"	–	4.16	800	0.03	[E 3]	7.89
	~~1252~~ Medium/Dark Brown, & Fine sand + Abt of suspend silt-							8.56
7.17	1252	"	–	4.06	873	0.03	1000	8.56
+	Same Description As Above, Approx ½ cup							
7.27	1312	"	–	4.10	955	0.03	1000	8.46
	1317	67.3			Move up - Restart Pump			
7.31	1341	"	–	4.16	1054	0.03	[E 3]	8.47
*	" Same Description, Murky Silt & sand ≤ ½ cup.							
1.29	1406	"	–	4.06	1155	0.03	[E 3]	8.80
	1417				Stop Pump			
	Approx 4 TBS Sediment in bottom of Bucket, Murky lt Brown in color, Suspended Sediment, ~~Medium~~ Fine Sand, & ~~Fine~~ SILT.							
	1421				START Polish			
7.36	1441	62.3	–	4.16	1238	0.03	1000	9.26
	WATER looks murky, Fine Sand & SILT,							

8/12/05 W. Weimer P. Taylor

31

PH	TIME	DepTH	WL	FLOW	PurgeV	Con	Turb	Temp
7.23	1503	62.3	–	4.03	1306	0.03	1000	8.74
	" Same Description 2 TBS							
7.22	1517	"	–	4.16	1389	0.03	822	7.03
	WATER, Medium Brown & Murky, Fine Sand, SILT, Suspended							2nd
	1523				STOP Polish			
	1526				START Debis Surge			
7.33	1540	77.3	–	4.54	1452	0.03	119	9.10
	WATER, Cloudy Grey Lt clear NO SILT, Fine to medium Sand. Approx 1½ Tsp.							
	* ≤ ½ Teaspoon Stop Pump 1559.							
	DTW 1550				END TD 77.80			

* MOVED TO SITE (N)

TAG #'S
1. R05464
(BND) 2. REV07020 4
3. R05209
4. REV07024
5. REV07024 (bottle mix)
6. R0772

Site

Willow

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-11S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site V

DATE STARTED 9/10/05 **COMPLETED** 9/10/05 **GROUND ELEVATION** 846.05 feet **TOC ELEVATION** 847.89 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6632197.251 meters **EASTING** 368525.7 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	Air injection only.
	GB				3.0 Brown Silt, poorly graded Gravel, subrounded to subangular. 30% coarse to fine Sand, 20% brown Silt.	
5					6.0 well graded gravel with fine slightly silty sand.	Air injection only.
	GB				8.0	
					9.0 Poorley graded gravel, 20% subangluar gravel, 70% coarse to fine sand, 10% Silt, Damp.	
10					Gravely Silt, brown.	
					11.0 Gravely Silt, grading to ML.	Driller adding only.
15					15.0	
	GB				Silty gravel with minor sand, grey, wet.	Driller adding only.
20						
	GB				Silty Gravel, Angular to subangular clasts to 3/8" dia. minor sand, wet.	
					23.0	
					Bottom of hole at 23.0 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.85 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Oct., 2005
Purge Volume: 438 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 4 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 5.52 Date: 9/10/05 Time: 2245

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: V/P-05-11S
Date: 10/3/05 - 10/4/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		6.62	6.57
Total depth		22.68	21.61
pH		9.15	

Screen interval (btoPVC): 5'
Top: 17.6
Bottom: 22.6
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1526						Thick Grey Brown	
1610	22.68	6.62	1.5	66	0.06	[E 3]	5.80	11, 3/4 Gallon SILT, Fine Sand	
1640	11	—	0.9	111	0.06	11	5.10	11, 1 GALLON, SILT	PH 9.21
1650	20.6	—	—	—	—	—	—	MOVE UP. RESTART PUMP	
1655	11	—	—	—	—	—	—	STOP PUMP FOR DAY	
0905	18.6	—	—	—	—	—	—	RESTART PUMP @	
1002	11	—	0.7	150	0.09	11	5.15	NO Change In Appearance, 1/2 gallon	PH 9.10
1021	17.6	—	—	—	—	—	—	MOVE UP. RESTART PUMP	
1128	11	—	1.4	243	0.07	11	5.08	No Change In Color, 4 cups SILT.	PH 9.53
1138	11	—	—	—	—	—	—	STOP Pump.	
Surge block off		START Polish @ 1143							
1253	12.6	—	1.1	320	0.07	11	6.11	Slightly lighter But not much	
1257	11 22.6	—	—	—	—	—	—	STOP Polish / START Rubis Surge	
~~1358~~ 1302	22.6	—	2.2	438	0.06	11	6.07	11, 1/4	
1402	—	—	—	—	—	—	—	STOP Pump / END Rubis Surge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-12

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site P
DATE STARTED 6/23/05 **COMPLETED** 6/24/05
GROUND ELEVATION 869.95 feet **TOC ELEVATION** 872.23 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633319.142 meters **EASTING** 367622.407 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen, Klieforth, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silt with sand and gravel**	
5	GB				5.0 **Silt with sand and gravel** Dark brown, poorly-sorted sand, fine-grained gravel, dry.	
					8.0 **Silt with sand and gravel** Same as above, increasing sand.	
10	GB				10.0 **Silt with sand and gravel** Same as above, gravel and sand grains subrounded to subangular.	
					11.5 **Silt with sand and gravel** Same as above.	
15					15.0 **Silt with sand and gravel** Brown, well-graded sand, trace gravel, dry.	
20	GB				20.0 **Silt with sand and gravel** Same as above.	
					24.0	
25		28.3			25.0 **Sand with gravel** Well-graded sand, fine gravel, angular to rounded, dry.	
					26.0 **Sand with gravel** Well-graded sand, fine gravel, dry.	
					Sand with gravel Same as above, increase in moisture.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: N/A

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 24 June, 2005
Purge Volume: 1585 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 31.73 Date: 6/25/05 Time: 0610 * 45 feet of Casing left downhole, refer to drill notes

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-12

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site P
DATE STARTED 6/23/05 **COMPLETED** 6/24/05
GROUND ELEVATION 869.95 feet **TOC ELEVATION** 872.23 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633319.142 meters **EASTING** 367622.407 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen, Klieforth, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				31.0 **Gravel with sand** Well-graded sand, moist to wet.	Drills like gravel.
					Gravel with sand Same as above, increased sand.	
35	GB				35.0 36.0 **Gravel with sand and silt**	
					Gravel with sand and silt Brown, rounded to subangular, moist.	
40	GB				40.0 **Gravel with sand and silt** Brown, wet.	
45		28.35			45.0	Slow drilling. Hammer stops firing.
			15		46.0 **Gravel with sand and silt** Same as above.	
					Gravel with sand and silt Brown, muddy outflow, wet.	
50	GB				50.0 **Gravel with sand and silt** Well-graded gravel, angular to subrounded, muddy outflow, wet.	
55	GB					Heaving sands.
			12		56.0 **Sand with gravel** Well-graded sand.	
					Sand with gravel Well-graded sand, angular to subrounded, wet. 58.0	
60	GB				**Sand with gravel** Same as above. 60.0	Heaving sands. Add foam.
					Sand with gravel Same as above.	
65		51.2			65.0	
			10		**Gravel with sand** Well-graded sand, rounded to subrounded, wet.	
70	GB				70.0 **Sand with gravel** Well-graded sand, fine-grained gravel, subrounded to subangular, wet.	
			increasing			
		31.0			75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-12
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site P
DATE STARTED 6/23/05 **COMPLETED** 6/24/05 **GROUND ELEVATION** 869.95 feet **TOC ELEVATION** 872.23 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633319.142 meters **EASTING** 367622.407 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen, Klieforth, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		10		76.0 **Sand with gravel** Same as above, more rounded grains. **Sand with gravel and silt** Well-graded sand, fine-grained gravel, trace silt.	
80	GB		increased flow 20		80.0 81.0 **Sand with gravel** Well-grained sand. **Sand with gravel** Same as above, increased flow, increased silt.	Added water/foam.
85					85.0 86.0 **Sand with gravel** Same as above. 87.0 **Sand with gravel and silt** Well-grained sand. 88.0 **Sand with gravel and silt** Increased silt.	Added foam.
		18.9	20		**Sand with silt and gravel** Well-grained sand.	
90	GB				90.0 **Sand with silt and gravel** Brown, well-grained sand, wet.	Added water.
		28.0				Added water.
95	GB		18		95.0 Distinct sulfur odor (rotten eggs). **Sand with silt and gravel** Well-grained sand, odor diminishes.	Drill rate slows.
100	GB		increased flow 20 50		100.0 **Sand** Well-grained sand.	Heaving sands.
		61	60			High water pressure on the hammer. Drilling slows.
105	GB				105.0 **Sand** Same as above.	
110	GB		50		110.0 **Sand** Same as above.	
		70.2	50			
115					115.0 116.0 **Sand** Same as above. **Sand** Well-graded sand, rounded to subrounded.	
			20		120.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-12
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site P
DATE STARTED 6/23/05 **COMPLETED** 6/24/05
GROUND ELEVATION 869.95 feet **TOC ELEVATION** 872.23 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633319.142 meters **EASTING** 367622.407 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen, Klieforth, Saganski

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB		20		**Sand** Same as above.	Slow drilling. Added foam. Hard, slow drilling.
125	GB		30		125.0 **Sand with gravel** Well-graded sand, some (10%) gravel, rounded to subrounded. 128.0	Added foam.
130	GB				**Sand with gravel** Increased sand. 130.0 **Sand** Well-graded sand.	Added foam. Added foam.
135	GB		45		133.0 **Sand** Same as above. 135.0 136.0 **Sand** Same as above. **Sand with gravel** Well-graded sand, <10$ silt. 138.0	Added water. Added foam. Added foam.

Bottom of hole at 138.0 feet.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Page 1 of 2

WELL DEVELOPMENT LOG

(SITE P)

Well ID: P-05-12
Date: 8/6/05

Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

		Installed (Well Log)	Start	End
Water level		~~35.37~~	35.37	
Total depth	84.6	~~84.75~~	84.75	
pH			7.05	

Screen interval (btoPVC): 20'
Top: 62.6
Bottom: 82.6
PVC stick-up height (above ground surface): 2.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
0955	82.6	35.37	—	0				START Pump. PH 7.05	
0958	"	—	4.20	12.6	0.08	602	5.34	Brown, Fine/Medium Grain Sand & SILT ½ cup.	
1020	"	—	4.16	104.12	0.08	217	4.85	" TRACE SILT 1½ TBS.	PH 6.84
1046	"	—	3.78	200.32	0.08	485	5.37	More Sediment. ≥2 TBS	
1056	80.6	—						Moved Pump / STOP	
1103	"	—	4.42	213.26	0.08	302	5.25	RESTART Pump, " 1½ TBS.	PH 6.50
1134	"	—	4.62	356.48	0.08	138	5.48	" 1 tsp.	
1156	"	—	2.77	417.42	0.08	79.8	5.14	" ≤ ½ tsp.	PH 6.56
1200	76.6	—						Moved up, RESTART pump.	
1217	"	—	4.23	489.33	0.08	62.7	4.48	Brown Sand, Medium TO Fine grain, 1½ TBS	PH 6.26
1224	"	—	4.34	541.71	0.08	31.8	4.42	" 1½ TSP,	
1237	"	—	4.31	575.74	0.08	34.4	5.13	" ≤ ½ TSP	
1243	76.6	—						Moved up RESTART Pump	
1258	"	—	4.71	716.39	0.08	22.7	5.94	Brown Sand, Medium To Small grain ≥ 1½ tsp	
1307	"	—	4.16	683.83	0.08	14.5	5.53	> ¾ tsp	PH 6
1313	74.6	—						ABOVE Pump RESTART Pump.	
1328	"	—	4.46	730.73	0.08	16.2	6.02	≥ ½ tsp.	
1336	72.6	—	4.46	786.41	0.08	13.8	4.67	Moved up, RESTART Pump, ≤ 1 tsp.	
1340	"	—	4.46	786.41	0.08	13.8	4.67	≥ 1 tsp.	
1353	70.6	—						Moved up. RESTART Pump ≥ 1 tsp.	
1417	"	—	3.59	840.26	0.08	29.2	4.63	Brown Sand Fine Medium 2 TSP	6.57, PH
1448	68.6		4.34	935.74	0.08	7.91	5.57	" ½ TSP.	
1454								Moved up, RESTART Pump.	
1510			4.54	1008.38	0.09	14.8	4.62	Brown, Fine/Medium Sand & SILT, 1 TBS	
Surge block off									

Page 2 of 2

WELL DEVELOPMENT LOG (Site P)

Well ID: P-OS-12
Date: 8/6/05 - 8/7/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		35.37	
Total depth	84.6	84.75	
pH		7.05	

Screen interval (btoPVC): 20'
Top: 62.6
Bottom: 82.6
PVC stick-up height (above ground surface): 2.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
1529	68.6	—	4.27	1089.51	0.08	50.4	4.62	Brown Sand, Medium Fine, 1½ TSP,	PH 6.53
1545	"	—	4.23	1157.19	0.08	29.6	4.56	" 1 tsp	PH 6.62
1550	66.6	—	—	—	—	—	—	Move Up, START Pump.	
1610	"	—	2.5	1207.19	0.08	124	5.91	Water + Brown, Brown Sand Medium, 1½ TBS	PH 6.66
1627	"	—	1.17	1227.08	0.08	200	6.38	Flow Slowed, Check Ball Wont Thru,	PH 6.54
1651	"	—						RESTART Pump	
17.08	"	—	330	1266.18	0.08	140	4.41	Flow Resumed, Brown Medium/Fine Sand Sand, + silt. 1½	TBS.
1724	"	—	3.64	1317.14	0.08	53.4	4.39	" 3/4 TBS	PH 6.58
1731	64.6	—	—	—	—	—	—	Moved up, Restart pump	
1940	"	—						Stop Pump for End of day.	
8/7/05 0823	66	35.37	—	—	—	—	—	RESTART Pump	
0837	"	"	4.23	1380.59	0.10	57.3	4.31	Medium Brown Sand, Trace Silt, 1½ TSP.	PH 7.18
0854	"	—	4.16	1451.31	0.08	28.1	4.20	" 1½ TSP.	PH 7.05
0921	"	—	4.16	1563.63	0.08	27.6	4.38	" ≤ 1 TSP.	PH 6.90
0925	62.6	—	~~4.34~~	~~1585.33~~	0.08	11.8	4.21	Move up, RESTART Pump	
0930	"	—	4.34	1585.33	0.08	11.8	4.21	Trace Sand.	
0932								STOP Pump.	
Surge block off									
0942								START Polish	
1005								STOP Polish	
1010								START Debris Surge	
1034								STOP Debris Surge.	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

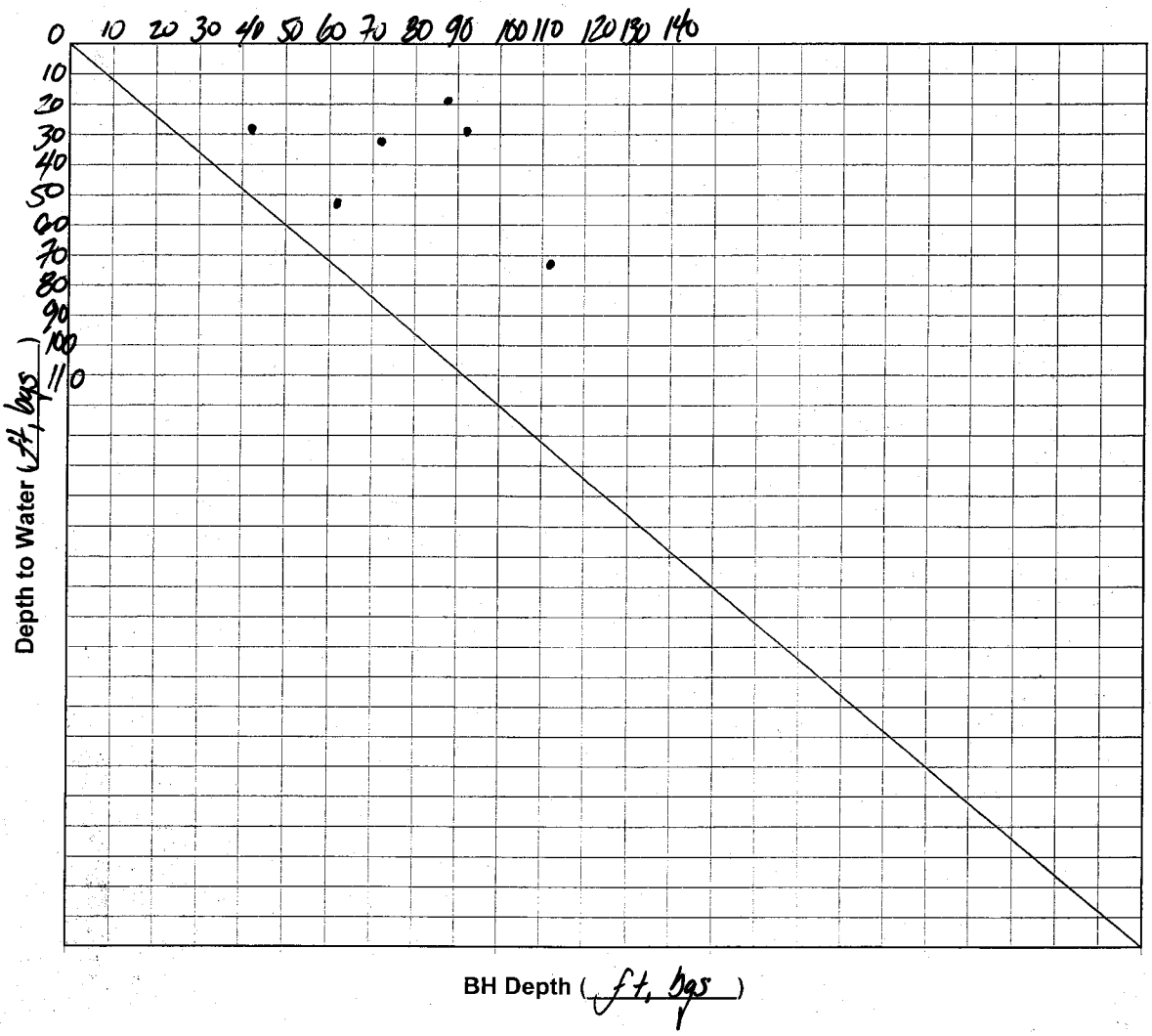
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: D-05-12
Name: ~~HIKEN~~, KLIEFORTH
Date start 6/23/05
Date finish

Water Level Measurements (ft, bgs) (ft, bgs)

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
6/23	2115	43	28.35	6/23	0215	93'	28 ↓				
6/23	2150	53	HEAVING					@95' BGS = SULFER ODOR			
6/23	2348	63	51.2'	6/23	0305	103'	61'				
6/23	0024	73	31.09 ↑	6/23	0409	113'	702' ↑				
6/23	0204	88	18.9-								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-13

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site M
DATE STARTED 6/25/05 **COMPLETED** 6/26/05
GROUND ELEVATION 879.58 feet **TOC ELEVATION** 881.81 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6634193.126 meters **EASTING** 368211.552 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Sandy silt with gravel** Moist.	
5	GB				5.0 **Sandy silt with gravel** Brown, moist.	
10	GB					
15	GB				15.0 **Sandy silt with gravel** Brown, moist.	
					17.0 **Sandy silt with gravel** Brown, moist.	
20	GB					
					23.0	
					24.0 **Silty sand** Brown, fine to medium, moist.	
25	GB				25.0 **Silt with sand and gravel** Brown, trace gravel, moist.	
					26.0 **Silty sand** Brown, fine to medium sand, moist.	
					27.0 **Silt with sand and gravel** Brown, moist.	
					27.8 **Silty sand and gravel** Brown, fine sand, trace gravel, moist.	
					28.0	
					29.0 **Sandy silt with gravel** Moist.	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.2 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 9 Aug., 2005
Purge Volume: 945 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 28.3 Date: 6/26/2005 Time: 1015

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-13
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site M

DATE STARTED 6/25/05 **COMPLETED** 6/26/05 **GROUND ELEVATION** 879.58 feet **TOC ELEVATION** 881.81 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6634193.126 meters **EASTING** 368211.552 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silty sand and gravel** Brown, fine to medium sand, some gravel, moist.	
					32.0 **Silty sand and gravel** Same as above, increased silt, decreased gravel.	
					34.0 **Silty gravel with sand** Brown, moist.	
35	GB				35.0 **Silty sand and gravel** Brown, moist.	
					39.0 **Silty gravel with sand** Brown, fine sand, wet.	
40	GB				41.0 **Silty gravel with sand** Same as above, becomes moist.	
					45.0 **Silty gravel with sand** Brown, fine- to medium-grained sand.	Added water. Both compressors running. Added water. Spoke to driller regarding limiting water added. Slow drilling.
45	GB				49.0 **Silty gravel with sand** Same as above, moist.	
50	GB		2			Added water/gel.
		43.80			54.0 **Silty gravel with sand** Same as above, decreasing gravel.	
55	GB				55.0 **Silty gravel** Brown, moist to wet.	Somewhat slow drilling.
					56.0 **Silty gravel** Same as above, increased gravel/sand.	
			5		58.0 **Sand with gravel and silt** Well-graded sand.	Mud prevents water flow, had to wait longer to let flow stabilize.
60	GB					Added mud.
		56.50			64.0	
65					65.0 **Sand with gravel and silt** Same as above, subrounded.	
			10		**Sand with gravel and silt** Well-graded sand,, subrounded, wet.	
70	GB				70.0 **Sand with gravel and silt** Same as above, minor silt.	
		24.0			Good water.	Foundex stabilizes.
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-13
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site M
DATE STARTED 6/25/05 **COMPLETED** 6/26/05
GROUND ELEVATION 879.58 feet **TOC ELEVATION** 881.81 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634193.126 meters **EASTING** 368211.552 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Saganski, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		2.5		75.8 **Sand with gravel and silt** Well-graded sand, minor silt.	
					Silt	
					78.0 **Sand with gravel and silt** Brown, well-graded sand, wet.	Added mud.
80	GB	64.25				
						Added mud.
85	GB		25		85.0 86.0 **Sand with gravel and silt** Brown, wet.	Added mud.
					Sand with gravel and silt Increased sand.	Color brown to dark brown.
					89.0	
90	GB				90.0 **Sand with gravel and silt** Same as above.	Added mud.
					91.5 **Sand** Well-sorted, fine to medium grained.	Added mud.
		57.1			92.0 **Sand with gravel and silt** Well-graded sand, wet.	Added mud.
					Sand with gravel and silt Well-sorted sand, wet.	Coming up fast, potential heaving sands.
95	GB				94.0 95.0 **Gravel with sand and silt** Well-graded gravel.	Added mud.
			4		**Gravel with sand and silt** Brown, well-graded gravel, fine to medium sand layers, wet.	Drilling slows, added mud.
					99.0	Added mud.
100	GB				**Sand with gravel and silt** Brown, well-graded sand, wet.	Added mud.
			20-50			Added mud. Break for lunch.
105	GB				105.0	Slow drilling.
					106.0 **Sand with gravel and silt** Brown, well-graded sand, subrounded, wet.	Added mud.
			45		**Sand with gravel and silt** Brown, well-graded sand, subrounded.	Added mud.
110	GB					Added mud.
						Slow drilling.
						Added mud.
115	GB					Added mud.
			40		117.0	
					Bottom of hole at 117.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P-05-13
Date: 8/9/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		31.77	
Total depth		116.6	
pH		6.67	

Screen interval (btoPVC): 10
Top: 106.0
Bottom: 116.0
PVC stick-up height (above ground surface): 2.05

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	(grain size, colour, quantity)
Surge block on								
0900	116.0	31.77		0				START Pump
0902	"	—	3.67	7.34	0.07	78.9	4.89	Brown, Medium to Fine Sand, Mixed with 15% SILT, 1 TBS
0915	"	—	3.57	53.75	0.07	29.0	4.60	" ≤ 1 tsp
0924	114.0	—						Move up, RESTART Pump
0944	"	—	4.03	134.39	0.07	82.4	4.09	same description, 1 3/4 TBS
1011	"	—	4.20	247.79	0.07	77.4	5.44	" 1 TBS.
1036	112.0	— (WL ~~4.20~~ ~~352.79~~)						Moved UP, 1 TBS. RESTART Pump
1052	"	—	4.06	312.75	0.07	158	5.12	Medium/Fine Sand Mixed w 15% Silt, 1 1/2 TBS.
1114	"	—	4.42	409.99	0.07	95.3	4.83	" ≥ 2 1/2 tsp
1138	"	—	4.27	502.47	0.07	109	5.21	" 3/4 TBS
1144	110.0	—						Move up. RESTART pump.
1205	"	—	4.62	609.49	0.07	39.5	4.91	" 3/4 TBS.
1228	"	—	3.96	700.57	0.07	37.2	5.65	" water lt Brown.
1236	108.0	—						Move up. RESTART pump.
1246	"	—	3.87	739.27	0.07	204	5.52	" 1 1/2 TBS.
1310	"	—	2.18	791.57	0.07	169	5.50	Medium to Fine Sand. 1/5 SILT, suspended sediment, 2 tsp.
1328	(	—						Flow Slowed. Stopped Pump, Pulled chain
1336		—						RESTART Pump.
1359	↓	—	4.67	899.0	0.07	351	4.96	< 1/2 Tsp.
1415	106.0							STOP Pump Move Up.
1425								RESTART pump
1435			4.54	944.45	0.07	7.10	5.0	TRACE Sand
1437								Stop Pump.
Surge block off								
1444								START POLISH
1448								STOP POLISH
1451								START DEBRIS Surge
1458								STOP DEBRIS Surge.

PH 6.99
PH 6.97
6.78
6.74
PH 6.79
6.79

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

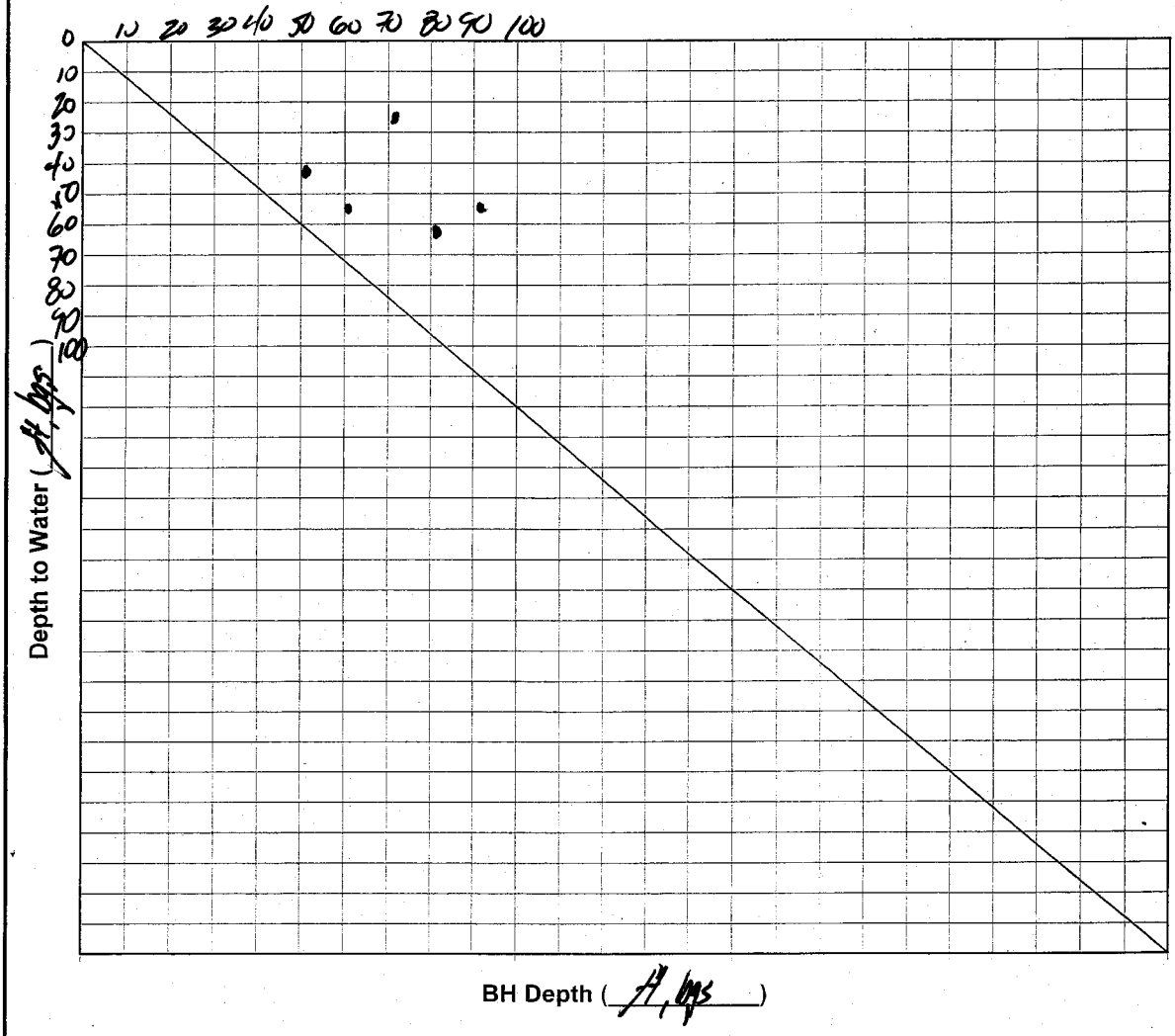
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: P-05-13
Name: Ruffner
Date start 6/25/05
Date finish 6/26/05

Water Level Measurements ft, bgs

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
6/25/05	1956	53	43.80'								
"	2034	63	56.50'								
"	2108	73	24.00'								
"	2202	85	64.25'								
"	2241	93	57.1'								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-14D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site K
DATE STARTED 6/26/05 **COMPLETED** 6/27/05
GROUND ELEVATION 886.72 feet **TOC ELEVATION** 888.91 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6634196.067 meters **EASTING** 369409.296 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Saganski, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Gravelly sand with silt** Brown, well-graded sand, moist.	
4.0						
5	GB				**Gravelly sand with silt** Brown, well-graded sand, moist.	
5.0					**Gravelly sand with silt** Brown, well-graded sand, moist.	
10	GB					
15	GB					
16.0					**Gravelly sand with silt** Brown, well-graded sand, moist.	
19.0					**Gravelly sand with silt** Brown, well-graded sand, moist.	
20	GB					
25	GB					
25.0						
26.0					**Gravelly sand with silt** Same as above, wet.	
					Gravelly sand with silt Brown, well-graded sand, brown, wet.	
29.0						
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.2 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 8 Aug., 2005
Purge Volume: 674 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 24.48 Date: 6/27/05 Time: 2040

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-14D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site K
DATE STARTED 6/26/05 **COMPLETED** 6/27/05
GROUND ELEVATION 886.72 feet **TOC ELEVATION** 888.91 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634196.067 meters **EASTING** 369409.296 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Saganski, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				31.0 **Gravelly sand with silt** Same as above, decreased gravel.	
					Gravelly sand with silt Same as above, decreased silt.	
					34.0	
35	GB				35.0 **Silty gravel with sand** Brown, well-graded sand, wet.	
					Silty sand with gravel Brown, well-graded sand, wet.	Added water.
						Drilling a little slower now.
40	GB					Added water.
					43.0	
					Silty sand with gravel Same as above, increased gravel.	Added water.
45	GB				45.0 **Silty sand with gravel** Brown, well-graded sand, wet.	
					48.0	Added water.
					Sandy gravel with silt	Added water/foam.
50	GB					
						Added water/foam.
55	GB				55.0	
					56.0 **Sandy gravel with silt** Same as above.	Added water/foam.
					Sandy gravel with silt Brown.	Added water/foam.
					59.0	
60	GB				**Sand with gravel and silt** Brown, well-graded sand, subangular to subrounded, wet.	
					63.0	
					64.0 **Sand with gravel and silt** Same as above, increase in gravel percent.	Added water/foam.
65	GB				65.0 **Sandy gravel with silt** Brown.	Doesn't feel like water.
					Sandy gravel with silt Brown.	
					67.0	
					Silty sand Brown, well sorted, fine grained, moist.	Added foam.
					69.0	
70	GB				**Sandy gravel with silt**	
					With silty sand interlayers.	SM interlayers causing slow drilling.
		52.5				Added foam.
					73.5	Added foam.
					Silty sand	
					75.0	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-14D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site K
DATE STARTED 6/26/05 **COMPLETED** 6/27/05
GROUND ELEVATION 886.72 feet **TOC ELEVATION** 888.91 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634196.067 meters **EASTING** 369409.296 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Saganski, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		0.5		**Silty sand with gravel** Minor gravel.	Driller thinks SM is making a little water.
					79.0	Added foam.
80	GB				**Silty gravel with sand** Well-graded sand.	
					81.0	
					Silty sand with gravel	Added foam.
85	GB				85.0	Added foam.
					Silty sand with gravel Brown, well-graded sand.	Added foam.
			3		87.5	
					Silty gravel with sand	Added foam.
90	GB					
					93.0	Added foam.
					Silty gravel with sand Same as above, too much fine-grained gravel.	
					94.3	
95	GB				95.0 **Silty sand with gravel** Brown to black.	
			50		**Silty gravel with sand** Brown.	Added foam.
			50			
					99.0	Added foam.
100	GB				**Silty gravel with sand** Same as above, well-graded sand.	
					105.0	
105	GB				106.0 **Silty gravel with sand** Same as above, well-graded sand.	Added foam, clear casing.
			10-15		**Sand with gravel** Well-graded sand.	
110	GB				110.5	
					Gravel with sand and silt Well-graded sand (less dense).	Water cleans fast.
			60			
115	GB				115.0	
					Gravel with sand and silt Well-graded sand.	
					118.0	
					Bottom of hole at 118.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

(Site K)

Well ID: P-05-14D
Date: 8/18/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		27.50	
Total depth		116.6	
pH		7.30	6.77

Screen interval (btoPVC): 10'
Top: ~~10~~ 106.0
Bottom: ~~120~~ 116.0
PVC stick-up height (above ground surface): 2.15
2.45 - .35

Development Observations

Surge block on

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
1323	116.0	~~27~~.50		0				START Pump	
1326	"	—	4.09	11.27	0.06	264	5.14	Brown, Medium to Fine Sand + TRACE SILT	1TBS
1341	"	—	4.27	76.32	0.06	82.7	5.26	" 1 tsp	
1346	114.0	—						Move up, Restart Pump	
1352	"	—	4.85	105.42	0.06	47.0	5.34	Same Description as Above, 1/2 TSP	PH 6.85
1358	"	—	5.0	130.42	0.06	23.5	5.79	" 1 tsp	PH 6.92
1403	112.0	—						Move up. Restart Pump.	
1412	"	—	5.0	175.42	0.06	65.1	5.45	Same Description, 1 TBS.	PH 6.84
1426	"	—	"	245.42	0.06	27.7	5.61	" 1 tsp	
1434	110.0	—						Moved up. Restart Pump	
1459	"	—	4.54	358.92	0.06	118	6.36	Brown, Fine to Medium Sand, some SILT, some pebbles	
1521	"	—	4.90	466.72	0.06	136	5.91	" 1 1/2 TBS	PH 6.92
1532	108.0	—						Moved up, Restart Pump.	
1552	"		4.76	561.92	0.06	165	5.13	Same Description as Above 1/2 TBS	PH 7.08
1613	"		4.62	656.94	0.06	110	5.25	" 1 1/2 TSP	PH 6.88
1634	106.0		5.0					STOP Pump, Move up, Restart.	1 tsp
1637	"		4.86	673.52	0.06	36.5	5.09	→ TRACE Fine to medium Sand	
1640								STOP Pump	PH 6.77

Surge block off

1647								START Polish	
1652								STOP Polish	
1655								START Reverse Surge	
1705								Stop Reverse Surge.	

(TRACE Sand!)

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	RC15-140
Name:	
Date start	
Date finish	

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
26 Jun	1750	43'	38'								
"	2025	73'	52.5'								

* FINE GRAINED SEDS @ DEPTH PREVENT DTW

Depth vs Depth During Drilling

* SEE FLOW TESTS INSTEAD

Depth to Water (_____)

BH Depth (_____)

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-14S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site K
DATE STARTED 6/27/05 **COMPLETED** 6/27/05
GROUND ELEVATION 886.66 feet **TOC ELEVATION** 888.89 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634203.395 meters **EASTING** 369403.407 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Sandy gravel with silt** Light brown, well-rounded clasts, 3/4" diameter or smaller. No water added.	
5					5.0 **Sandy gravel with silt** Well-rounded clasts, 1" diameter or smaller, dry.	
10						
15					15.0 **Sandy gravel with silt** Medium brown, 1.5"-diameter or smaller clasts, sub- to well-rounded, trace silt.	
20					19.0 **Sand with gravel** Medium brown, medium to coarse grained, moist.	
25					24.0 25.0 **Sand with gravel** Medium brown, medium to coarse grained, saturated. **Sand with trace gravel** Brown, medium to coarse grained, saturated.	
30					29.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.2 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 8 Aug., 2005
Purge Volume: 1070 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 17.76 Date: 6/27/2005 Time: 1846

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-14S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site K
DATE STARTED 6/27/05 **COMPLETED** 6/27/05 **GROUND ELEVATION** 886.66 feet **TOC ELEVATION** 888.89 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6634203.395 meters **EASTING** 369403.407 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravelly sandy silt** Brown, subrounded 2"-diameter clasts, medium to coarse sand, highly plastic silt.	Added water.
					34.0	
35					**Gravelly sandy silt** Same as above.	
					38.0	
					Bottom of hole at 38.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

SITE K

Well ID: P-OS-14S
Date: 8/7/05 - 8/8/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		19.26	19.92
Total depth		38.35	36.29
pH		7.77	7.60

Screen interval (btoPVC): 15'
Top: 23.3
Bottom: 38.3
PVC stick-up height (above ground surface): 2.2
2.5 - .3 =

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
1246	~~38.3~~ 38.3	~~36.35~~	3.33	∅				START Pump, Murky, Fine Sand & SILT	3½ cups.
1334	"	—	4.62	193.14	0.03	[E 3]	4.89	Silty, Fine Sand, suspended, ≥2 cups Fine SILT & sand	
1369	"	—						Moved up, RESTART Pump.	≥1½
1405	36.3	—	4.27	218.76	0.02	[E 3]	4.99	Dark Brown Fine Silt, sand, Water Murky, 2½ cups.	
1419	"	—	4.03	278.18	0.02	[E 3]	5.26	" ≥1½ cups.	PH 7.26
1446	"	—	3.64	360.74	0.02	[E 3]	6.35	" ≥1½ cups	
1505	39.3	—						Moved up, RESTART Pump	PH 7.54
1523	"	—	2.25	421.24	0.02	[E 3]	5.38	Dark Brown Silt & Fine Sand, ≥1½ cup.	
1603	"	—	3.28	552.44	0.02	[E 3]	6.16	" ≥1¼ cup.	PH 7.38
1612	32.3	20.46						STOP Pump, Move up.	
1630	"	—	3.31	612.02	0.02	[E 3]	6.47	Dark Brown Silt & Fine Sand. ≥2 cups	
1705	"	—	2.33	690.07	0.02	[E 3]	5.57	" 1½ cups.	
1712	30.3	—						REPLACED Check VALVE, Moved up, RESTART Pump.	
1738	"	—							
1753	"	—	1.93	719.02	0.02	[E 3]	6.43	2 cups Silt & Fine Sand D. Brown	
8/8/05 0800	"	~~20.46~~	1.62					RESTART Pump, Move up.	
0813	28.3		1.14	733.84	0.02	[E 3]	5.16	Move Fine Sand & less Silt, Still suspended Sediment	≥1 cup.
0834	"	20.13	1.40	746.44	0.02	838	6.11	Ended Pump for Hose, RESTART,	≤1 cup.
0848	"	—	1.09	761.72	0.02	1000	5.50		PH 6.95
0902	26.3	—						RESTART Pump. Move up. 4 TBS.	
0919	"	—	3.16	815.44	0.02	1000	5.73	Fine Sand & Silt, Brown, suspended Sediment,	≤4 TBS.
0943	"	—	2.47	873.04	0.02	1000	6.15	Half Sand & Silt " 3½ TBS	PH 7.49
0953	24.3	—	2.42	909.37				Move up. RESTART Pump.	
1020	"	—	2.04	944.05	0.02	778	6.12	Fine Sand & Silt. Suspended Sediment	≥2 TBS.
1042	~~Surge block on~~ "	—	2.03	988.71	0.02	632	6.43	"	≥2 TBS. PH 7.72
1047	23.3	—						Moved up, RESTART Pump.	PH 7.60
1052	"		1.54	996.41	0.02	504	5.93	Fine Sand & SILT, 1 TBS.	
1119	"	—	1.45	1035.56	0.02	474	5.98	"	
1141	"	—	1.53	1069.22	0.02	390	6.16	(Stop Pump @ 1145)	PH 7.60
Surge block off:	20.05								

* START POLISH @ 1158, Depth of 20.35
* STOP POLISH 1214
START Surge 1219
STOP Surge. 1257

4/6 5/5 3/5 4/3 4/3

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-15D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Q
DATE STARTED 6/28/05 **COMPLETED** 6/29/05
GROUND ELEVATION 864.30 feet **TOC ELEVATION** 866.44 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633210.584 meters **EASTING** 368973.493 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Sandy gravel with silt** Brown, sub- to well-rounded clasts, 1 3/4" diameter or smaller, dry. No water added.	
5	GB				5.0 **Sandy gravel with silt** Brown, sub- to well-rounded clasts, 1 1/4" diameter or smaller, dry.	
10	GB				9.0 **Sandy gravel with silt** Same as above.	
15	GB				14.0 **Gravel with sand** Brown, 1 1/2"-diameter clasts, sub to well rounded, dry.	
20	GB				16.0 **Gravel with sand** Same as above, grades into more silt, moist. 19.0 **Silt with sand and gravel** Brown, high plasticity, medium- to coarse-grained sand, 1/2"-diameter or smaller gravel clasts, moist.	
25					24.0 25.0 **Silt with trace gravel** Brown, saturated, highly plastic, <1/2"-diameter clasts, subrounded. **Silt with trace gravel** Brown, saturated, high plasticity, <1/2"-diameter clasts, subrounded.	Water blowing out. Added water, can't get cutting to blow out.
30					29.0 **Silt with trace gravel** Same as above.	Stopped adding water.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.1 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 11 Aug., 2005
Purge Volume: 892 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 8.09 Date: 6/26/05 Time: 2130

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-15D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site Q

DATE STARTED 6/28/05 **COMPLETED** 6/29/05 **GROUND ELEVATION** 864.30 feet **TOC ELEVATION** 866.44 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6633210.584 meters **EASTING** 368973.493 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silt with trace gravel** Same as above.	
	GB				34.0	Added water.
35	GB				35.0 **Sandy gravel** Brown, 1"-diameter or smaller clasts, subangular to subrounded, sand medium to coarse grained, saturated.	
					Sandy gravel Brown, clasts 1" diameter or smaller, subangular to subrounded, sand medium to coarse gravel, saturated.	Stopped adding water. Added water.
40	GB				39.0 **Sandy gravel** Same as above.	
	GB	37.6				Stopped adding water. Blowing hole clean. Mean water level 37.6 and rising. Problems. Added water.
45	GB				44.0 45.0 **Sandy gravel** Same as above.	
					Sandy gravel Brown, 1"-diameter or smaller clasts, subangular to subrounded, medium- to coarse-grained sand, saturated.	Adding water inside and outside rods. Added water.
50	GB				49.0 **Silty sandy gravel** Brown, 1"-diameter or smaller clasts, subangular to subrounded, medium- to coarse-grained sand, plastic silt, saturated.	Added water. Added water.
55	GB				54.0 55.0 **Gravelly sand** Gray, medium- to coarse-grained sand with <1/2"-diameter clasts, subangular to subrounded.	
					Gravelly sand Gray, medium to coarse sand with <1/2"-diameter clasts, subangular to subrounded.	Added water. Added polymer mud, flush hole. Added water outside hole. Added foam.
60	GB				59.0 **Sandy gravel** Gray, medium to coarse gravel, sand with 3/4"-diameter or smaller clasts, subangular to subrounded, saturated.	
					64.0	Added mud/foam and flush.
65					65.0 **Gravelly sand** Brown, medium- to coarse-grained sand with <1/2"-diameter clasts, subangular to subrounded, saturated.	Added foam.
					Gravelly sand Gray, medium- to coarse-grained sand with <1/2"-diameter clasts, subangular to subrounded, saturated.	Added foam. Flush hole.
70	GB				69.0 **Sandy gravel** Gray, medium- to coarse-grained sand with <3/4"-diameter clasts, subangular to subrounded, saturated.	
					74.0	Added foam.
					75.0 **Sandy gravel** Same as above.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-15D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Q
DATE STARTED 6/28/05 **COMPLETED** 6/29/05
GROUND ELEVATION 864.30 feet **TOC ELEVATION** 866.44 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633210.584 meters **EASTING** 368973.493 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sandy gravel** Brown, medium to coarse sand with <3/4"-diameter clasts, subangular to subrounded, saturated.	Added foam.
						Added foam. Flush.
					79.0	Added foam.
80	GB				**Sandy gravel** Same as above.	
						Added foam. Flush.
					84.0	
85					85.0 **Gravelly sand** Brown, medium- to coarse-grained sand with <1/2"-diameter clasts, subangular to subrounded, saturated.	Added foam. Added foam.
					Sandy gravel Brown, medium to coarse sand with <1/2"-diameter clasts, subangular to subrounded.	Added foam, flush hole. Added water outside rod.
					89.0	Added foam.
90	GB				**Gravelly silt with sand** Gray, high plasticity silt, <1/2"-diameter gravel clasts, medium- to coarse-grained sand.	
						Flushed and added foam. Stopped drilling for shift, resumed drilling (night shift).
					94.0	
95	GB				95.0 **Silt with sand** Brown, elastic silt, trace gravel, sand is medium to coarse, silt clasts are moist, not wet.	Added foam.
					Silt with sand Elastic silt, trace gravel, medium to coarse subrounded sand, silt is moist, not saturated.	Slow drilling.
						Added foam, almost jammed the rods. Drilling extremely slow, hammer jammed. One compressor is down.
100	GB					Very slow drilling.
						Added foam.
					104.0	Added water.
105	GB				105.0 **Silty sand with gravel** Brown, well graded, wet.	Very slow drilling.
					Silty sand with gravel Brown, well graded, wet.	
					Clearing casing of water.	Second compressor went down. It looked like we would have 1 gpm flow test, but compressor died before we could do it, resumed flow test. "Lots of fine sand."
					109.0	
110	GB				**Sand with silt and gravel** Brown, well-graded sand, subrounded to subangular, lots of fines, wet.	Added foam.
						Increased flow. Added foam.
						Added foam. "Less slow drilling." Stopped adding water/foam (turned off pump). Sands (fine) are messing with flow test. "We have only one compressor." "Slow, but steady drilling."
115	GB				115.0 **Sand with silt and gravel** Brown, well-graded sand, wet.	
					119.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-15D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site Q
DATE STARTED 6/28/05 **COMPLETED** 6/29/05 **GROUND ELEVATION** 864.30 feet **TOC ELEVATION** 866.44 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633210.584 meters **EASTING** 368973.493 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Sand with silt** Brown, poorly-graded sand, fine- to medium-grained, mostly rounded to subrounded, no gravel.	Added polymer mud. Added mud/foam. "Slow drilling." Added mud/foam. Worked on second compressor., trying to free hammer. Two compressors operating, added fud/foam. 20 minutes to advance 1 foot. Added mud/foam.
					123.0	
					Sand with gravel Brown, well-graded sand, subrounded, wet.	
125	GB				125.0	
					Sand with gravel Brown, well-graded sand, subrounded, wet.	
					126.7	
					Bottom of hole at 126.7 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: Q/P-05-15D
Date: 8/11/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wilmer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		10.72	10.70
Total depth	125.4	125.3	125.60
pH		7.35	6.84

Screen interval (btoPVC): 10'
Top: 115.7
Bottom: 125.7
PVC stick-up height (above ground surface): 2.05

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on Pump START: 0858									
0908	125.7	10.72	3.96	435.6	0.01	22.0	6.33	WATER CLEAR, Brown, Medium/Fine Sand, 1/2 tsp.	
0918	"	—	4.16	81.0	0.07	17.4	6.07	" 1 tsp	
0925	123.7	—							
0933	"	—	4.76	119.0	0.07	33.0	6.16	Move up, RESTART Pump. WATER CLEAR, Brown Fine/medium Sand 1 tsp	PH 6.75
0953	"	—	4.62	211.4	0.07	19.0	5.65	WATER CLEAR, " , 1 1/2 tsp	PH 6.70
1032	"	—	4.76	397.0	0.07	6.85	5.57	WATER CLEAR, " , ≥1/2 tsp.	PH 6.82
1036	121.7	—			0.07		6.35	Move up, RESTART pump	
1052	"	—	4.62	470.9	0.07	27.6	6.35	CLEAR, < 1 tsp	
1059	119.7	—						Move up, RESTART pump	
1118	"	—	4.20	550.7	0.07	34.2	7.19	CLEAR, Fine-Medium Brown Sand 1 tsp.	PH 6.82
1137	"	—	4.20	630.5	0.07	25.3	7.30	" < 1 tsp/TRACE	
1142	117.7	—						Move up, RESTART Pump	
1206	"	—	4.58	740.4	0.07	74.0	7.31	Same description, 1/2 tsp.	PH 6.84
1211	115.7	—						Move up, RESTART Pump	
1227	"	—	4.62	814.3	0.07	19.4	7.27	TRACE Sand, Clear WATER	
1231								STOP Pump.	
Surge block off 1237 - START POLISH									
1248		—	4.62	865.1	0.07	7.94	6.96	START pump POLISH/Clear water. TRACE Sand.	
1250		—						STOP POLISH.	
(START DeBris Surge 1253 / Sample Time 1259)		—	4.54	892.3	0.07	3.58	7.0	START DeBris Surge/CLEAR WATER, No Sand	PH 6.84
1305								STOP DeBris Surge / END of TEST	

HOT DAY → long TUBE (200 ft), Below Temp IS higher THAN ACTUAL.

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

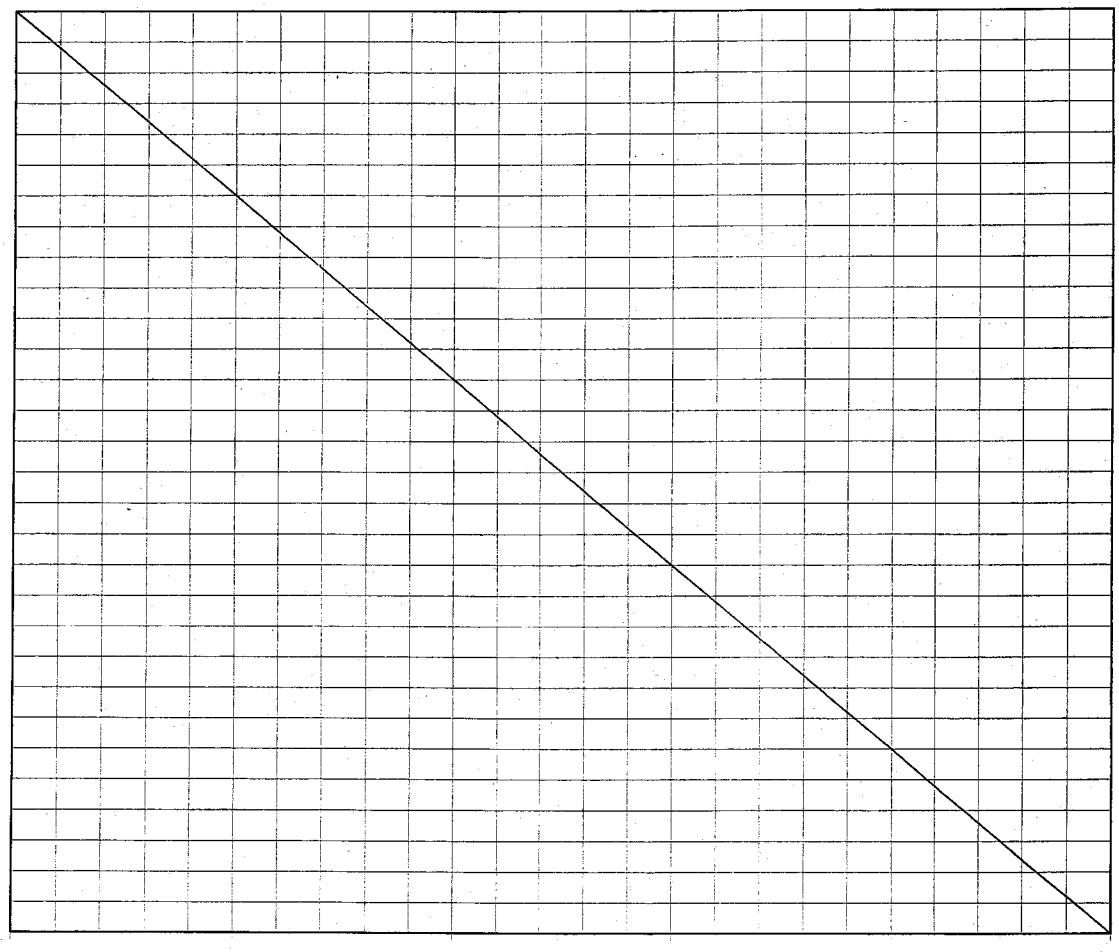
Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: P05-15
Name:
Date start 6/28/05
Date finish

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
6/28/05	1558	43'	37.6*								

* WL rising, concerned about sand heaving, meas WL

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-15S
PAGE 1 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Q
DATE STARTED 6/29/05 **COMPLETED** 6/30/05
GROUND ELEVATION 864.09 feet **TOC ELEVATION** 866.14 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633204.865 meters **EASTING** 368971.487 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Sandy gravel with silt** Brown, subrounded to rounded sand clasts, medium- to coarse-grained sand, trace silt, dry.	
5	GB				5.0 **Sandy gravel with silt** Brown, subrounded- to well-rounded clasts, medium- to coarse-grained sand, trace silt, dry.	
10	GB				9.0 **Sandy gravel with silt** Same as above, dry.	
15	GB				14.0 15.0 **Sandy gravel** Brown, subangular to subrounded clasts, <3/4" diameter, medium-grained sand, dry. **Sandy gravel** Brown, subangular to subrounded clasts, <3/4" diameter, medium-grained sand, dry.	Tube and cyclone clogged, drillers used dry bluey tube.
20	GB				19.0 **Clayey silt** Brown, high plasticity, moist. Cuttings dry.	
25	GB				24.0 25.0 **Clayey silt** Brown, high plasticity, moist. **Clayey silt** Brown, high plasticity, moist.	
30					29.0	Cyclone tube clogged, adding water to assist with unclogging.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.0 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: 10/20 silica sand
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 10 Aug., 2005
Purge Volume: 1348 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 16.68 Date: 6/30/05 Time: 0400

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-15S
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Q
DATE STARTED 6/29/05 **COMPLETED** 6/30/05
GROUND ELEVATION 864.09 feet **TOC ELEVATION** 866.14 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633204.865 meters **EASTING** 368971.487 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Clayey silt with gravel** Brown, angular to subangular, trace silt, saturated.	
					34.0	Added water.
35	GB				35.0 **Sandy gravel with silt** Brown, <3/4"-diameter clasts, subangular to subrounded, medium- to coarse-grained sand, trace silt.	Added water and foam.
					Sandy gravel with silt Brown, <3/4"-diameter clasts, subangular to subrounded, medium- to coarse-grained sand, trace silt.	
					39.0	Added water and foam.
40	GB				**Sandy gravel** Brown, <1"-diameter clasts, subangular to subrounded, medium- to coarse-grained sand, subrounded.	
					44.0	Added water and foam.
45	GB				**Sandy gravel** Brown, <1"-diameter clasts, subangular to subrounded, medium- to coarse-grained sand, subrounded.	Added water and foam.
					46.0 **Sandy gravel** Brown, <1"-diameter clasts, subangular to subrounded sand, medium to coarse grained, subrounded.	
					49.0	Added foam.
50	GB				**Gravelly sand with silt** Light brown, <1/2"-diameter clasts, angular to subangular, medium- to coarse-grained sand, trace silt.	
					54.0	Added foam.
55	GB				55.0 **Silty sand with gravel** Grayish brown, fine- to coarse-grained sand, <1"-diameter clasts, subrounded.	Added water and foam.
					Silty sand with gravel Grayish brown, fine- to coarse-grained sand, <1/2"-diameter clasts, subrounded.	
					59.0	Added water and foam.
60	GB				**Sandy silt** Brown sand, fine- to medium-grained.	
					64.0	
65	GB				65.0 **Sand with gravel** Brown, medium- to coarse-grained sand, subangular to subrounded, <1/4"-diameter gravel clasts, subangular to subrounded.	Added water and foam.
					Sand with gravel Brown, medium- to coarse-grained sand, subangular to subrounded, <1/4"-diameter gravel clasts, subangular to subrounded.	
					69.0	Added water and foam.
70	GB				**Sandy gravel** Brown, <1/2"-diameter clasts, subangular to subrounded, fine- to coarse-grained sand, subrounded.	
					74.0	
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-15S
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site Q
DATE STARTED 6/29/05 **COMPLETED** 6/30/05 **GROUND ELEVATION** 864.09 feet **TOC ELEVATION** 866.14 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633204.865 meters **EASTING** 368971.487 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		0.1		**Gravel with sand** Brown, well-graded gravel, subangular to subrounded, fine- to coarse-grained sand, minor silt, wet.	Added water.
					79.0 **Gravel with sand** Brown, well-graded gravel, subangular to subrounded, fine- to coarse-grained sand, minor silt, wet.	
80	GB				80.0 **Sand with gravel** Brown, well-graded sand, subangular to subrounded, wet.	Driller felt change.
					82.0 **Silt with sand and gravel** Gray.	
					83.0 **Silt with sand and gravel** Gray. Confirmed with visual sample.	
					Bottom of hole at 83.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: P-05-1SS
Date: 8/9/05 | 8/10/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wismer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		18.0	18.0
Total depth	79.9	79.8	79.8
pH		7.36	7.39

Screen interval (btoPVC): 10'
Top: 69.3
Bottom: 79.3
PVC stick-up height (above ground surface): 2.09
2.82
0.63
3.09

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on									
1619	79.3	18.0	WL	0	0.09		5.71	START Pump (sediment)	
1631	"	—	4.58	54.96	0.09	981.	5.71	SILT & Fn Sand suspended in water ≥ 5½ TBS	
1647	"	—	4.62	128.88	0.09	919	5.92	" 3TBS.	
1706	"	—	4.62	216.66	0.09	HBS	5.53	Move Fn Sand then SILT, silt suspended MOSTLY 70/30 2 TBS.	
1720	77.3	—					5.91	Move up, RESTART Pump.	
1730	"	—	5.0	266.66	0.09	686	5.91	Silt & Fn Sand, Brown, suspended sediment 50/50, 2½ TBS.	PH 7.86
1757	"	—	"	401.66	0.09	278	5.92	" 1½ TSP.	PH 7.38
1814	"	—	"	486.66	0.09	246	5.86	" Same	
1816								STOP Pump.	
8/10/05 0808	75.3	1800					4.71	RESTART Pump	
0831	"	—	4.34	586.48	0.09	595	4.71	Fn Sand & SILT suspended in water Brown, 2TBS.	PH 7.40
0848	"	—	4.54	663.66	0.09	408	4.45	" 2TBS	PH 7.34
0900	"	—	4.54	718.14	0.09	400	460	" ≥ 1½ NOT MUCH CHANGE.	
0904	73.3	—	WL 4.38		0.09	713	5.08	Move up, RESTART Pump.	PH 7.32.
0925	"	—	4.36	810.12	0.09	713	5.08	Silt & Fn Sand, 3TBS, suspended in water.	
0946	"	—	4.27	899.79	0.09	594	5.10	" 1½ TBS	PH 7.40
1001	71.3	—	WL 4.58		0.09		5.08	Moved up. RESTART Pump.	
1021	"	—	4.58	948.59	0.09	620	5.08	" SAME AS ABOVE, 2½ TBS	
1046	"	—	4.50	1058.09	0.09	413	5.20	Silt & Fn Sand suspended sediment, 1½ TBS.	
1051	69.3	—						moved up. RESTART Pump	PH 7.52
1118	"	—	5.0	1193.09	0.09	239	5.35	(Filled gas) Silt & Fn Sand, silt suspended ≥ 1½ TBS	PH 7.43
1135	"	—	5.0	1278.09	0.09	220	5.24	" ≥ 1 tsp	
1149	"	—	5.0	1348.09	0.09	189.	5.28	" Same Consumption ≥ 1 tsp	PH 7.39.
1151								STOP Pump	
Surge block off									
1200								START Surge. Polish	
1210								STOP Surge. STOP Polish	
1214								START Debris Surge	
1235								Stop Debris Surge/END	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site T

DATE STARTED 6/30/05 **COMPLETED** 7/1/05 **GROUND ELEVATION** 859.67 feet **TOC ELEVATION** 862.30 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6631188.363 meters **EASTING** 369440.393 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Tundra, organics** Few cobbles, mostly small, silty sand.	
					4.0	
5	GB				5.0 **Silty sand** Light brown, poorly graded, dry.	
					Silty sand Light brown, poorly graded, dry.	
					9.0	
10	GB				**Silty sand with gravel** Brown, subangular to subrounded, minor gravel, dry.	
					14.0	
15	GB				15.0 **Silty sand with gravel** Same as above, moderate gravel, moist.	
					Silty sand with gravel Brown, moist.	Relatively easy drilling.
						Added water. Moist soil.
					19.0	Added water.
20	GB				**Silt** Brown, minor sand.	
						Added water.
25	GB				25.0 **Silt** Brown, minor sand, soft, moist.	
						Added water. Low recovery, clogging in casing/lines. Compressed air pushes silt to side, not up casing, resulting in casing dropping fast/advancing fast.
					29.0	
30					**Silt** Brown, soft, trace sand and gravel, soft, moist.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.6 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: 10/20 silica sand
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 July, 2005
Purge Volume: 770 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 13 July 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 43.0 Date: 7/2/05 Time: 0420

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site T
DATE STARTED 6/30/05 **COMPLETED** 7/1/05 **GROUND ELEVATION** 859.67 feet **TOC ELEVATION** 862.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6631188.363 meters **EASTING** 369440.393 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silt** Brown, soft, trace sand and gravel, soft, moist.	Added water. Casing practically dropping.
						Added water.
						Added water.
35	GB					Added water.
					35.0 **Silt** Brown, soft, dry to moist.	Very low recovery. Air pushing soil to side, casing dropping fast.
40	GB					Added water.
					44.0	
45	GB				45.0 **Silty gravel with sand**	
					Silty gravel with sand Gray, well-graded gravel, subangular to subrounded, saturated.	
50	GB	22.70			50.0 **Silty gravel** Gray, wet.	
					54.0	
55	GB				**Silt** Gray, soft, moist.	Very low recovery. Low recovery.
						Added water. Added foam to water.
60	GB		0		59.0 **Silty gravel** Brown.	
					64.0	
65	GB				65.0 **Sand with silt and gravel** Brown, well-graded sand.	Added foam.
					Sand with silt and gravel Brown, well-graded sand, subangular to subrounded.	Added foam.
70	GB				69.0 70.0 **Silt**	Very low recovery.
					Silty sand Brown, fine.	Rain lets up a little.
					74.0 75.0 **Silty gravel and sand** Fine sand, wet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-16D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site T
DATE STARTED 6/30/05 **COMPLETED** 7/1/05
GROUND ELEVATION 859.67 feet **TOC ELEVATION** 862.30 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631188.363 meters **EASTING** 369440.393 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		0		**Silty gravel with sand** Fine sand.	Added foam.
			0		77.0 **Sand with gravel and silt** Well-graded sand, subangular, wet. Silt fraction may be underrepresented.	
80	GB		7.5			Added foam, cleared casing.
					84.0	
85	GB				85.0 **Sand with silt and gravel** Slightly more gravel. **Sand with silt and gravel** Brown, subangular to subrounded, minor silt.	Added foam.
					89.0	
90	GB		0		**Sand and silt** Fine to medium sand, poorly graded.	Added foam, cleared casing.
						Almost stuck.
95	GB				95.0 **Silty sand with gravel** Brown, trace gravel, predominately medium- to fine-grained, poorly graded, wet.	Added foam.
100	GB					Added foam.
					104.0	
105	GB				105.0 **Silty gravel** Gray, trace gravel, moist. **Silty gravel** Gray, trace gravel, moist.	Added foam.
					109.0	Added foam.
110	GB				**Silty sand with gravel** Gray, trace gravel, moist.	Added foam.
115	GB		4		115.0 **Silty gravel-silt with gravel** Gray, ratio difficult to distinguish.	Drilling relatively easy. Added foam, cleared casing.
					118.0 **Sand with gravel** Well-graded sand, subrounded to subangular.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site T
DATE STARTED 6/30/05 **COMPLETED** 7/1/05 **GROUND ELEVATION** 859.67 feet **TOC ELEVATION** 862.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6631188.363 meters **EASTING** 369440.393 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB		0		**Sand with gravel** Well-graded sand, subrounded to subangular.	Added foam, cleared casing.
125	GB		0		125.0 **Sand with gravel** Well-graded sand, subrounded to subangular.	Added foam, cleared casing. Added foam, cleared casing.
130	GB		3-7			Added foam. Added foam, cleared casing.
135	GB				135.0 **Sand and gravel with silt** Well-graded sand, subangular to subrounded.	Added foam, cleared casing. Added foam, cleared casing. Drilling slowing slightly.
140	GB				139.0 **Silt** Gray, trace coarse sand and gravel.	Added foam, cleared casing. Added foam. Drilling slows.
	GB				144.0 Bottom of hole at 144.0 feet.	Added foam.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P-05-16D
Date:

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Craig Soda / Willow Weimar / Mike Riesser

Summary

	Installed (Well Log)	Start	End
Water level		43.96	44.44
Total depth		137.35	~~138.15~~ 137.35
pH		6.91	9.15

Screen interval (btoPVC):
Top: ~~127.35~~ ~~127~~ (me) 127.35
Bottom: ~~137.35~~ ~~138~~ (me) 137.35

PVC stick-up height (above ground surface): 2.2 ft

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
11 July 2005 1444	137	43.96	3 1/3	0	—	—	—	start pumping
1449	"		"		0.205	>1000 (E3)	6.8	
1454	"		"		0.196	>1000 (E3)	5.8	formation water, ≈ 2 tsp. dark gray sand, milky
1505	"		"		0.191	>1000 (E3)	5.4	
1522	"		"		0.177	>1000 (E3)	5.3	
1530	135		0		—	—	—	raise foot valve, replace clamp
1540	"		3 1/3		—	—	—	resume pumping
1555	"		"	237	0.163	>1000 (E3)	6.8	
1557	"		0		—	—	—	out of fuel
1620	"		3 1/3		—	—	—	resume pumping
1643	"		"		0.155	>1000 (E3)	5.9	
1652	133		"		—	—	—	
1715	"		"		0.152	>1000 (E3)	5.5	1 tsp. dark brown fine sand in pail, silty bottom
1736	"		"		0.150	>1000 (E3)	5.8	
1738	131		"		—	—	—	raise foot valve
1743	"		0	514	—	—	—	low pump rate, pull tubing
1748	"		3 1/3		—	—	—	replace foot valve, continue pumping
1800	"		"		0.152	>1000 (E3)	5.1	
1818	"		"		0.148	>1000 (E3)	4.9	
1827	"		0	643	—	—	—	stop pumping
13 July 2005 0912	129		3 1/3		—	—	—	start pumping
0917	"		"		0.154	>1000	5.5	
0938			"		0.147	>1000	4.96	gray silt, fine sand, ≈ 1 tsp.
0948			"		0.147	>1000	4.83	
Surge block off			0950 - stop pump - vol. = 770 gal.					
polish 1000	123		3 1/3		—	—	—	start pump
1007	"		"		0.144	440	5.86	fine gray sand + silt, ≈ 1/2 tsp.
1015	"		"		0.149	595	5.12	fine gray sand + silt
1023	"		0		—	—	—	stop pumping, move valve to base of well to clear sediment, flush for 22 minutes @ 3 1/3 gpm

RESPONSE TEST

Date: 13 July 2005 Well ID: P-OS-16D

Project: Northern Dynasty Mines, Pebble Mine Site Ground Water Project #: 005.0189.05002, Task 5

Technician: Willow Clemens, Corey Scala, Mike Riesser

Depth to water (ft, bto port): (previous) 44.44 ft @ 10:56 - 13 July 2005
44.04 ft @ 12:56

Screened interval (bgs): 125.15' - 135.15'

WL meter: SI, 300-ft, s/n 24315

Transducer particulars

Brand	In-Situ	Installation depth	74 ft
Model	Mini Troll	Time of installation	1051
Serial number	598		
Pressure range	30psi		

Slug description: 20-ft length of 1" waterra tubing w. check valve blanked

Correlation of manual and transducer measurements confirmed on graph? Yes _____ No X

Manual water level readings and timing of slug insertion and removal - Manual readings not practical w. waterra tubing in casing

	Date	Time	DTW (ft, ____)
1	13 July 2005	10:56	44.44
2	13 July 2005	12:56	44.04
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

	Date	Time	DTW (ft, ____)
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			

- 2 cycles (2 in + 2 out) recorded
- Slug in + slug out times stored from transducer data file P-OS-16D.bin

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site T
DATE STARTED 7/1/05 **COMPLETED** 7/2/05
GROUND ELEVATION 862.14 feet **TOC ELEVATION** 864.59 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631186.294 meters **EASTING** 369446.124 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Tundra and organics** No cobbles.	
					4.0	
5	GB				5.0 **Silty sand** Brown, fine to medium grained, dry to moist.	
					Silty sand Brown, fine to medium grained, dry to moist.	Easy/fast drilling.
					9.0	
10	GB				**Silty sand** Brown, well-graded sand, trace gravel, moist.	
15	GB				15.0 **Silty sand** Brown, well-graded sand, moist.	Added foam, lines clogged.
					18.0	
20	GB				**Silt** Soft, coarse to fine sand, no gravel, dry. (We do not want to screen or sand pack in this.)	Added foam.
25	GB				25.0 **Silt** Brown to brown-gray, soft, wet (due to foam), very little sand inside of silt balls, dry.	Break for rain squall.
30						Added foam.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.45 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 July, 2005
Purge Volume: 460 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 13 July 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 41.85 Date: 7/2/05 Time: 0700

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site T
DATE STARTED 7/1/05 **COMPLETED** 7/2/05
GROUND ELEVATION 862.14 feet **TOC ELEVATION** 864.59 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631186.294 meters **EASTING** 369446.124 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silt** Brown to brown-gray, soft, wet (due to foam), very little sand inside of silt balls, dry.	Added foam.
35	GB				35.0 **Silt** Brown to brown-gray, trace fine to coarse sand, soft, dry.	Added foam. Added foam.
40	GB					Added foam. Added foam.
45	GB				44.0 **Silty gravel** Gray, increased coarse sand and glacial content. Gravel in cyclone.	Added foam.
50	GB	39.0			48.0 **Sandy gravel** Brown, rounded to subangular, minor to moderate silt, wet. Gravel in cyclone. Waited several minutes.	
55	GB				54.0 **Silty gravel** Light brown, wet.	Added a little foam.
60	GB					Added foam.
65	GB	26.7			64.0 65.0 **Silty sand** Brown, fine sand, wet. **Silty sand** Brown, fine sand and silty sand, minor gravel, wet. No gravel in cyclone.	
70	GB				69.0 **Silty sand** Same as above, brown, fine sand and silty sand, no gravel, wet. No gravel in cyclone. 75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16M
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site T
DATE STARTED 7/1/05 **COMPLETED** 7/2/05 **GROUND ELEVATION** 862.14 feet **TOC ELEVATION** 864.59 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6631186.294 meters **EASTING** 369446.124 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB	40.8			**Silty sand** Brown, fine sand, wet. Gravel in cyclone.	
					79.0	
80	GB				**Sand and gravel** Well graded sand, minor silt. Excellent screen interval.	
					84.0	
85	GB				**Sand with gravel and silt** Well graded sand.	Added foam. Increased silt
					88.0	
					Bottom of hole at 88.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

WELL DEVELOPMENT LOG

Well ID: P-05-16M
Date: 7/13/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: SCOLA, RIESER, WEIMER

Summary

	Installed (Well Log)	Start	End
Water level		42.88	42.91
Total depth		87.72	86.80
pH		9.41	9.20

Screen interval (btoPVC): 5 FT.
Top: 81.3 ft
Bottom: 86.3 ft
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on 85.8 (m)								
1225	~~87.7~~ (m)	42.88	3.3	0	0.082	[E3]	6.80	Silty, Very Fine Sand, Grey 2 1/2 TBS
1258	↓ 83.8	↓	3.3		0.081	[E3]	6.35	Silty, Very Fine Sand, Grey 2 1/2 TBS.
1315	~~85.2~~ (m)	42.90	3.3	231	0.080	[E3]	6.33	Silty, Vy Fine Sand, Grey, 4 TBS.
1335	↓ 81.8	↓	3.8		0.079	804	5.50	Silty, Very Fine Sand, Grey/Brown 2 TBS.
1357	~~83.2~~	42.92	3.8		0.079	234	6.20	Silty, Vy Fine Sand, Brown/Grey 1 TBS.
1415	↓	↓	3.8	459	0.081	151	5.52	Silty, Vy Fine Sand, Brown 1 TBS.
Surge block off								
	76.3	—	3.8		—	—	—	well polished
	85.8		3.3		—	—	—	well pumped to remove sediment at base

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

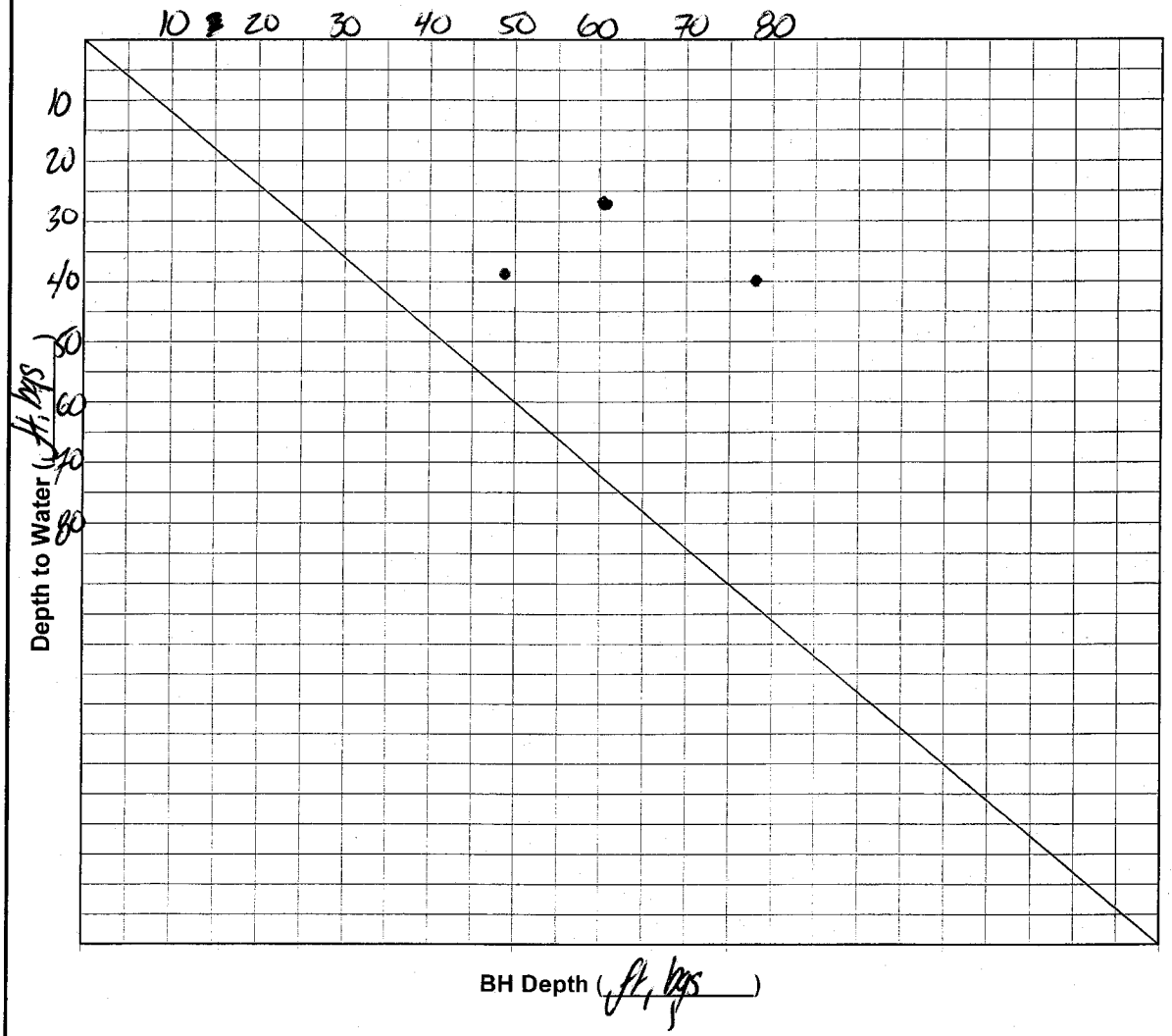
Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	P-05-16M
Name:	KRIEFORTH
Date start	1 JULY 2005
Date finish	2 JULY 2005

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
1 JULY	2222	48	39 ↓								
"	2304	63	26.7								
"	2337	78	40.8 ↑								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site T
DATE STARTED 7/3/05 **COMPLETED** 7/4/05
GROUND ELEVATION 858.14 feet **TOC ELEVATION** 860.31 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6631181.87 meters **EASTING** 369441.353 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Moss/Grass**	
					4.0	
5					5.0 **Silty gravelly sand** Light brown, fine- to medium-grained sand, <1/2"-diameter gravel clasts, subrounded.	Added water, cyclone tube clogged.
					Silty gravelly sand Light brown, fine- to medium-grained sand, <1/2"-diameter gravel clasts, subrounded.	Added water.
10					10.0 **Silty gravel** Light brown, <1/2"-diameter clasts, subrounded.	
15					15.0 **Silt with gravel** Light brown, highly plastic, trace gravel.	Added water.
20						Added water.
25						Added water.
30					30.0	Added water.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.2 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 July, 2005
Purge Volume: 544 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 July 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 23.75 Date: 7/4/05 Time: 0530

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site T
DATE STARTED 7/3/05 **COMPLETED** 7/4/05
GROUND ELEVATION 858.14 feet **TOC ELEVATION** 860.31 feet
DRILLING CONTRACTOR Foundex
NORTHING 6631181.87 meters **EASTING** 369441.353 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
35					**Silt with gravel** Brown, <1/2"-diameter clasts, subrounded to subangular, highly plastic silt.	Added water. Added water.
40					40.0	Added water.
45					**Gravel with sand** Brown, <3/4"-diameter clasts, subrounded. 45.0	Added water.
50					**Gravel with sand** Brown, <3/4"-diameter clasts, subrounded.	Added water.
55					55.0	Added water. Added water.
					Gravelly silt Brown. 58.0	
					Bottom of hole at 58.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P-05-165
Date: 7/13/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: SCOLA, RIESER, Weimer

Summary START TIME: 15:33

	Installed (Well Log)	Start	End
Water level		24.98'	25.55
Total depth		55.05'	54.11
pH		8.4	

Screen interval (btoPVC): 5'
Top: 50'
Bottom: 55'
PVC stick-up height (above ground surface): 2.2 ft

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on 15:33									
15:44	54.5	24.98	4.5		0.046	151	6.26	Brownish Grey, Silt & Fine Sand →	1½ Tsp.
16:05	"	"	"		0.045	590	5.27	Brownish Grey, Silt & Fin Sand →	½ Tsp.
16:18	52.5	25.3	"		0.051	[E 3]	5.80	Brownish Grey Silt & Fine Sand	3 TBS.
16:39	"	"	4.5		0.049	[E 3]	6.60	" "	1½ TBS.
16:59	50.5	25.55	4.5		0.044	184	5.50	" " ½ Tsp	
17:45	6		4.5	544	—	—	—	- end for the day	
Surge block off									
7/14/05 09:45	55	26.61	4.5					pump sediment off bottom	
0950	55	—	—					stop pumping, 0.5 tsp in bucket	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-16SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site T

DATE STARTED 7/3/05 **COMPLETED** 7/4/05 **GROUND ELEVATION** 858.27 feet **TOC ELEVATION** 860.89 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6631184.034 meters **EASTING** 369435.202 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0 **Grass/tundra**	
					Silt with sand Light brown, minor fine sand, moist.	
					4.0	
5	GB				5.0 **Silt and silty sand** Light brown, fine to medium grained, moist.	
					Silt and silty sand Light brown, fine to medium grained, moist.	
10	GB				11.0 Trace gravel.	
					12.0 **Silty sand with gravel** Light brown, medium grained, moist.	
					Sand with silt and gravel Light brown, well-grained sand, saturated.	
15	GB				15.0	
					Gravelly sand with silt Light brown, well-graded gravel, saturated.	
					17.0	
					18.0 **Silt with sand** Brown, soft, thin or fine sand, moist.	
					Bottom of hole at 18.0 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.6 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 14 July, 2005
Purge Volume: 298 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 30 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 13.23 Date: 7/4/05 Time: 0540

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

WELL DEVELOPMENT LOG

Well ID: P-05-16SS
Date: July 14, 2005

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Mike Riesar

Summary

	Installed (Well Log)	Start	End
Water level		13.64	13.70
Total depth		17.72	17.75
pH		7.92	7.16

Screen interval (btoPVC): ~~11~~ 13.2' to ~~16~~ 18.2' (MP)
Top: ~~11~~ 13.2' (MP)
Bottom: ~~16~~ 18.2' (MP)
PVC stick-up height (above ground surface): 2.2'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
10:20	17.5	13.64	2.9	—	—	—	—	start pumping
10:25	"	—	"	15	0.022	>1000 (E3)	4.96	6 tsp brown fine sand and silt
10:40	"	—	"	58	0.016	>1000 (E3)	4.93	2 " " " " " "
10:55	"	—	"	102	0.016	678	3.90	1½ " " " " " "
11:09	15.5	—	3.3	142	—	—	—	raise foot valve
11:24	"	—	"	192	0.018	255	4.18	1 tsp. of fine sand, brown
11:37	"	—	"	235	0.016	98.7	4.15	½ tsp of fine sand, faint H_2S odor
11:56	"	—	"	298	0.015	109	4.46	¼ tsp. of brown sand.
11:57								stop surging
Surge block off – insufficient water column for polishing above well screen								
11:57	17.5	—	2.9		—	—	—	start pumping to remove sediment from base
12:07	17.5	—	"		—	—	—	stop pump, water clear

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-17D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site U
DATE STARTED 7/4/05 **COMPLETED** 7/6/05
GROUND ELEVATION 908.95 feet **TOC ELEVATION** 911.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632157.504 meters **EASTING** 369459.427 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Moss, lichen**	
					4.0	
5					5.0 **Sandy gravel with silt** Brown, well-rounded clasts, trace silt.	
					Sandy gravel with silt Brown, well-rounded clasts, trace silt, dry.	
10						
15					15.0	
					Sandy gravel with silt Brown, subrounded to subangular clasts, trace silt, dry.	
20					20.0	
					Silty sand with gravel Dark brown, subrounded to subangular clasts, <1/2"-diameter, medium- to coarse-grained sand, dry.	
25					25.0	
					Silty sand with gravel Brown, well rounded clasts, <3/4"-diameter, medium- to coarse-grained sand, dry.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.4 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 10 July, 2005
Purge Volume: 303 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 11 July 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 96.82 Date: 7/7/2005 Time: 0600

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-17D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site U
DATE STARTED 7/4/05 **COMPLETED** 7/6/05 **GROUND ELEVATION** 908.95 feet **TOC ELEVATION** 911.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632157.504 meters **EASTING** 369459.427 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Sandy gravel** Grayish brown, fine- to coarse-grained gravel, <1/2"-diameter gravel clasts, subrounded, dry.	
35					35.0	
					36.0 **Gravel with sand** Grayish brown, <1"-diameter clasts, subrounded, medium-grained sand.	
					Gravel with sand Grayish brown, <1"-diameter clasts, subrounded, medium-grained sand, dry.	
40					40.0	
					Sand with gravel Fine to coarse sand, trace gravel.	Getting no return, added water. Tube clogged.
					44.0	Have circulation again. Lost circulation. Have some circulation.
45					45.0 **Sand with gravel** Grayish brown, medium- to coarse-grained sand, <1/2"-diameter gravel clasts, well to subrounded, dry.	No water added.
					Sand with gravel Grayish brown, medium- to coarse-grained sand, <1/2"-diameter gravel clasts, well to subrounded, dry.	
50					50.0	
					Gravelly sand Brown, medium to coarse grained, <1/2"-diameter clasts, well rounded, dry.	
55						No water added.
					59.0	Broke lead pipe. Pulled casing.
60	GB		Trace Flow		Cuttings are moist.	
					60.5 **Gravel** Well graded, moist, rounded to subangular, no silt.	Added water.
					62.5 **Silt** Stiff, dry.	Broke casing. Resumed drilling, Hear gravel in cyclone.
					Silt Light brown, stiff, dry.	Added water.
65	GB				64.0	Very slow drilling.
					65.0 **Silt with sand and gravel** Light brown (low recovery).	Added water.
					Silt with sand and gravel	Very slow drilling (5 feet in 15 minutes).
					69.0	Added water (a little at a time but often).
70	GB				70.0 **Silt**	Very little recovery Slow drilling.
					Silt with sand Coarse sand.	Added water and clear.
					73.0	Added water. Drilling is slightly easier.
					Silty gravel with sand Dry.	
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-17D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site U
DATE STARTED 7/4/05 **COMPLETED** 7/6/05 **GROUND ELEVATION** 908.95 feet **TOC ELEVATION** 911.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632157.504 meters **EASTING** 369459.427 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Silty gravel with sand**	Drilling is slightly easier, venting every 6". Added water (a little at a time but often).
					77.0 **Silt** Light brown, soft (presumed, very low recovery).	Down to one compressor (oil in chamber). Added water (a little at a time but often).
80	GB					"Very little resistance, no torque."
85	GB				85.0 **Silt** Light brown.	Attempted sample over 2-foot interval, silty water was only recovery. Added water often, but in small increments. Very soft, "no torque, very little resistance."
					89.0	No water added.
90	GB		Not measurable		**Silty sand** Light brown, fine grained, wet.	Added water and clear. No water out of cyclone on start-up.
95	GB				95.0 **Silty sand** Light brown, fine grained, wet.	No water added. No water added.
					99.0 Minor water at start-up (approximately 10 gals).	Added water and flush.
100	GB				**Silty sand** Fine grained, wet (low recovery).	No water added.
					Approximately 10 gallons at start-up.	Added water and flush.
105	GB				105.0 **Silty sand** Light brown, fine grained, poorly graded, wet, rapid dilatancy.	No water added.
					109.5	Added water and flush. No water.
110	GB				**Sand with silt** Brown, fine grained, poorly graded, minor medium grained, minor silt, moist, not saturated, rapid dilatancy.	Added water and flush.
					114.0	Added water (lots). Lines clogged.
115	GB				115.0 **Sand with silt** Same as above, holds a little more water (difficult to tell, we added a lot of water).	Stopped due to clogged casing/lines.
					Sand with silt Brown, fine to medium grained, moist to wet, rapid dilatancy.	No return, very little water returned. Added foam.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-17D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site U
DATE STARTED 7/4/05 **COMPLETED** 7/6/05 **GROUND ELEVATION** 908.95 feet **TOC ELEVATION** 911.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632157.504 meters **EASTING** 369459.427 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola, Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					**Sand with silt** Brown, fine to medium grained, moist to wet, rapid dilatancy.	Getting some return.
						Broke casing.
						Resumed.
						Added water downhole.
						Added foam.
125					125.0	Stuck.
					Sand with silt Brown, fine-grained, rapid dilatancy.	Unstuck.
					127.5	Added foam.
					Sand and gravel Well-graded sand, subrounded to subangular.	Added water down hole.
						No foam.
130	GB					Added foam (lots).
					134.0	
135	GB				**Sand and gravel** Same as above, subrounded.	
					135.5	Added foam (lots).
					Sand and silt No gravel.	
					137.0	
					Bottom of hole at 137.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: A-05-17D
Date: 10 July 2005
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Mike Riesse / Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		97.24	97.24
Total depth		139.40	
pH		4.15	5

Screen interval (btoPVC):
Top: 132
Bottom: 137
PVC stick-up height (above ground surface): 2.32'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1444	1396	97.24	2.5					
1454	1396		2.5	25	0.182	>1000	5.36	Brown fine sand + silt, ≈ 1/8" in bottom of pail
1522	1396		2.5		0.037	833	3.92	turbid water, 1 tsp sand settled in bottom of pail
1534	1374		2.5		0.035	>1000	3.82	≈ 4 tsp fine sand in pail, brown
1553	1374		2.5		0.036	310	4.04	2 tsp fine sand in pail, brown.
1603	1381		2.5		0.035	>1000	4.18	4 tsp fine sand in pail, brown, water very turbid
1613	1381	97.25	—		—	—	—	
1620-1630			—	240				re-set pump on well, well protector casing sinking
1635	1381		2.5		0.036	387	4.20	2 tsp. fine sand in pail, brown
1642	1380		2.5					lowered foot valve
1649	1380		2.5		0.036	215	4.04	Appox. 1 tsp fine sand in pail, brown
1655		97.24		303				remove surge block
Surge block off								
1704	1396							start pump avg, 1/2 tsp sand in pail
1708	1396		2.5		0.037	87	4.3	1/2 tsp in bottom of pail
1714	1296		2.5					
1716	1296		2.5		0.036	76	4.5	trace sand, clear water
1720			—					stopped

- well protector sank, not possible to close top of well protector

RESPONSE TEST

Date: 11 July 2005 Well ID: P-05-17D

Project: Northern Dynasty Mines, Pebble Mine Site Ground Water Project #: 005.0189.05002, Task 5

Technician: Mike Reser

Depth to water (ft, bto ~~port~~ PVC): (previous) 97.24 @ 16:55 10 July 05 Screened interval (bgs): 129.7' - 133.7'

97.29 @ 11:12 WL meter: 300 PSI, S/N 24315

Transducer particulars

Brand	In-Situ	Installation depth	125 ft
Model	Mini-Troll	Time of installation	11:20
Serial number	598		
Pressure range	30 psi		

Slug description: 20 ft. of 1-inch Western Tubing

Correlation of manual and transducer measurements confirmed on graph? (N/A) Yes ____ No X

- manual water level measurement not practical w/ Western tubing in place

Manual water level readings and timing of slug insertion and removal

	Date	Time	DTW (ft, ____)
1	11 July 2005	11:12	97.29
2	11 July 2005	11:51:30	97.31
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

	Date	Time	DTW (ft, ____)
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			

- 2 complete cycles, slug in/slug out

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-17S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site U
DATE STARTED 7/6/05 **COMPLETED** 7/7/05
GROUND ELEVATION 908.77 feet **TOC ELEVATION** 911.15 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632145.807 meters **EASTING** 369456.92 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Tundra and grass** **Silt** Brown, dry.	
					3.0 **Gravel with sand and silt** Brown, well to subrounded, minor silt.	
5	GB				5.0 **Gravel with sand and silt** Brown, well to subrounded, trace minor silt, dry.	Easy drilling.
10						
15					15.0 **Gravel with sand and silt** Brown to light brown, well to subrounded, trace minor silt, dry.	Easy drilling.
20						
25					24.0 25.0 **Silty sand with gravel** Brown, well graded, subangula to subrounded, dry. **Silty sand with gravel** Brown, well-graded sand, subangular to subrounded, dry.	Easy drilling.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.4 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 11 July, 2005
Purge Volume: 166 gallons

RESPONSE TEST
Response Method: N/A
Date: Insufficient Water

Comments: Static Water Depth is denoted by solid triangle (ftoc): 59.14 Date: 7/7/05 Time: 1806

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-17S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site U
DATE STARTED 7/6/05 **COMPLETED** 7/7/05
GROUND ELEVATION 908.77 feet **TOC ELEVATION** 911.15 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632145.807 meters **EASTING** 369456.92 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Silty sand with gravel** Brown, well-graded sand, subangular to subrounded, dry.	
					34.0	
35					35.0 **Gravel with sand** Brown, well-graded gravel, subangular to subrounded, trace silt, dry.	Easy drilling.
					Gravel with sand Brown, well-graded gravel, subangular to subrounded, trace silt, dry.	Approximately 3 minute stop.
					39.0	
40					**Gravel with sand** Same as above, less less gravel and more sand.	
					44.0	
45					45.0 **Gravel with sand** Brown, well-graded gravel, rounded to subrounded, trace silt, dry.	Easy drilling.
					Gravel with sand Brown, well-graded gravel, rounded to subrounded, trace silt, dry.	
50	GB				50.0	Broke casing. Resumed drilling.
					Sand with gravel Same as above, less gravel and more sand.	
55	GB				55.0 **Sand with gravel** Brown, well-graded sand, subangular to subrounded, trace silt, dry.	
					58.0 Very high gravel percent.	
					59.0 **Sand and gravel** Brown, well-graded sand, moist.	
60	GB				**Silt** Brown, trace grave, moist.	"Difficult to drill."
					62.5	Break to set up water. Added water, resumed.
					Bottom of hole at 62.5 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: A-05-17S
Date: 11 July 2005

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Mike Rieser

Summary

	Installed (Well Log)	Start	End
Water level		59.23	59.25
Total depth		61.2	61.2
pH		8.3	6.46

Screen interval (btoPVC): 5 ft
Top: 56 ft
Bottom: 61 ft
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
12:30	60.7	59.23	3 1/3	0	—	—	—	pump started
12:35	"		"		0.073	>1000	6.5	1/8" of dark brown silty sand in pail
12:41	"		"		0.056	578	5.5	—
12:50	"		"		0.146	439	6.1	3 tsp of dark brown silty sand
12:56	"		"		0.050	371	5.1	—
13:03	"		"		0.049	263	5.2	—
13:15	"		"		0.165	210	6.9	—
13:20	"	59.25		166				stop pumping, remove surge blocks
Surge block off			- insufficient water column to polish from above screen					
1330	60.7							start pump from base
1336					0.072	188	6.5	1/4 tsp dark brown sand
1339		59.24						stop pump

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S

DATE STARTED 7/7/05 **COMPLETED** 7/7/05 **GROUND ELEVATION** 925.0 feet **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 6632267 meters **EASTING** 370148 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Grass, tundra, gravel, cobbles**	Clogged with silt. Pulled up, worked with lead and hammer.
					4.0	
5	GB				5.0 **Sand with silt and gravel** Brown, well-graded sand, subangular to subrounded, dry.	
					Sand with silt and gravel Brown, well-graded sand, subangular to subrounded, dry.	
					9.0	
10	GB				**Gravel with sand and silt** Brown, well-graded gravel, subrounded, dry.	
					14.5	
15	GB				15.0 **Sand with gravel** Brown, fine- to medium-grained sand, minor gravel, dry.	
					17.0 **Sand with gravel** Brown, fine- to medium-grained sand, minor gravel, dry. Increase in gravel percent.	
20	GB				**Gravel with silt and sand** Brown, well-graded gravel, dry.	
					25.0	
25					**Gravel with silt and sand** Brown, well-graded gravel, dry.	
					29.0	Casing/rod keeps spinning.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: N/A
Type: N/A
Diameter: N/A

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

SCREEN FILTER
Type: N/A

SCREEN
Type: N/A
Slot Size: N/A

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Boring abandoned.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S

DATE STARTED 7/7/05 **COMPLETED** 7/7/05 **GROUND ELEVATION** 925.0 feet **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 6632267 meters **EASTING** 370148 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				31.0 **Sand with silt and gravel** Brown, well-graded sand, subangular to subrounded, trace gravel, dry.	Quick drilling.
					Sand with silt and gravel Same as above, increased gravel size - high percent of angular pieces. 34.0	Casing keeps spinning.
35	GB				35.0 **Sand and gravel** Well-graded sand, subangular to subrounded, dry.	
					Sand and gravel Well-graded sand, subangular to subrounded, dry. 39.0	Break for lunch.
40	GB				**Sand** Brown, fine, minor medium grained, dry. 42.0	Very low recovery, pushing sand to side instead of up casing. No torque.
					Sand Increasing grain size, medium to coarse sand. 44.0	
45	GB				45.0 **Sand** Brown, fine- to medium-grained sand, dry.	Low recovery.
					Sand Brown, fine- to medium-grained sand, dry. 47.5	
50	GB				**Sand and gravel** Brown, well-graded sand, subrounded, trace gravel, dry. 53.0	
55	GB				55.0 **Sand and gravel** Well-graded sand, subangular to subrounded, dry.	
					Sand and gravel Well-graded sand, subangular to subrounded, dry. 59.0 Coarse gravel.	"Driller having problems lifting the gravel. It comes up casing irregularly, some of it 1.5" diameter.
60	GB				**Silt with sand and gravel** Light brown, trace coarse sand and gravel, dry. Slightly moist, minor sand. 64.0	
65	GB				65.0 **Silt with sand and gravel** Brown, minor sand, moist.	Dramatic change, silt is at same depth as site P-05-17. It's much easier to drill through dry. Also, coarsest gravel was just above silt, same as P-05-17. Slow, deliberate drilling. Venting often and clearing lines with hammer.
					Silt with sand and gravel Brown, minor sand, trace gravel, moist. 69.0	
70	GB				**Silt with sand and gravel** Same as above. 75.0	

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S

DATE STARTED 7/7/05 **COMPLETED** 7/7/05 **GROUND ELEVATION** 925.0 feet **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 6632267 meters **EASTING** 370148 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Silt with sand and gravel** Brown, minor sand, trace gravel, moist.	Slow, cautious drilling. Venting often and banging on the lines with hammer. Torque extremely variable as clogs build and clear. Casing broke.
					77.5 Moist silt balls coming out of cyclone. Bottom of hole at 77.5 feet.	

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S

DATE STARTED 7/8/05 **COMPLETED** 7/8/05 **GROUND ELEVATION** 914.80 feet **TOC ELEVATION** 916.73 feet

DRILLING CONTRACTOR Foundex **NORTHING** 370163.797 meters **EASTING** 6632267.526 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Moss, lichen, gravel**	
					4.0	
5	GB				5.0 **Gravel** Brown, <1/2"-diameter clasts, subrounded to subangular.	
					Gravel Brown, <1/2"-diameter clasts, subrounded to subangular, dry.	
					9.0	
10	GB				**Sandy gravel** Brown, <1/2"-diameter clasts, subangular to subrounded, dry.	
					14.0	
15	GB				15.0 **Sand with gravel** Brown, fine to medium grained, dry.	
					Sand with gravel Fine to medium grained, dry.	
					19.0	
20	GB				**Gravel with sand** <3/4"-diameter clasts, subangular to subrounded, trace sand, dry.	
					24.0	
25	GB				25.0 **Sandy gravel** Brown, <1/2"-diameter clasts, subangular to subrounded, fine- to medium-grained sand, dry.	
					Sandy gravel Brown, <1/2"-diameter clasts, subangular to subrounded, fine- to medium-grained sand, dry.	
					29.0	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.9 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Sept., 2005
Purge Volume: N/A Insufficent Water

RESPONSE TEST
Response Method: N/A
Date: Insufficient Water

Comments:

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S
DATE STARTED 7/8/05 **COMPLETED** 7/8/05 **GROUND ELEVATION** 914.80 feet **TOC ELEVATION** 916.73 feet
DRILLING CONTRACTOR Foundex **NORTHING** 370163.797 meters **EASTING** 6632267.526 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Sandy gravel** Brown, <1/4"-diameter clasts, subangular to angular, pulverized cobbles, fine- to medium-grained sand, dry. Tons of gravel blowing out.	
35	GB				35.0 **Sandy gravel** Brown, <1/4"-diameter clasts, subangular to angular, pulverized cobbles, fine- to medium-grained sand, dry.	
40					39.0 **Gravelly sand-sandy gravel** Brown, <1/2"-diameter clasts, subangular to subrounded, fine- to medium-grained sand, dry.	
45					44.0 45.0 **Sandy gravel** Brown, <1/2"-diameter clasts, subangular to subrounded. **Sandy gravel** Brown, <1/2"-diameter clasts, subangular to subrounded.	
50	GB				49.0 **Gravelly sand-sandy gravel** Brown, <1/4"-diameter clasts, angular, coarse sand, dry.	
55	GB				55.0 **Gravelly sand-sandy gravel** Brown, <1/4"-diameter clasts, angular to subangular, dry.	"Tight." Rough drilling spot.
60	GB				61.0 **Sandy silt** Brown, fine-grained sand.	Broke steel at 1901 while ramming hole for cleanout. Hit silt.
65	GB				64.0 65.0 **Sandy silt** Brown, fine-grained sand, moist. **Sandy silt** Brown, fine-grained sand, moist.	Hit water. Cyclone tube getting clogged, drillers added water to flush silt out of tubes. Adding water as tube gets clogged.
70	GB				69.0 **Silty sand with gravel** Brown, trace gravel.	Drilling slowly. Added water.
					74.0 75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S
DATE STARTED 7/8/05 **COMPLETED** 7/8/05 **GROUND ELEVATION** 914.80 feet **TOC ELEVATION** 916.73 feet
DRILLING CONTRACTOR Foundex **NORTHING** 370163.797 meters **EASTING** 6632267.526 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
	GB				**Sandy silt with gravel** Brown, silt has slight plasticity, trace gravel, <3/4"-diameter clasts, subrounded to subangular.	Added water.
79.0					**Sandy silt with gravel** Brown, silt has slight plasticity, trace gravel, <3/4"-diameter clasts, subrounded to subangular.	Added water. Low return.
	GB				**Sandy silt** Brown, silt has some plasticity, fine- to coarse-grained sand.	Added water. Added water.
85.0						
	GB				**Sandy silt** Brown, silt has slight plasticity, fine- to coarse-grained sand.	Added water.
89.0						
	GB				**Silt with sand** Brown, medium- to high-plasticity sand, fine grained.	Added water.
94.0						Added foam.
95.0					**Silt with sand** Fine to coarse sand.	Broke rod at 1243.
	GB				**Silt with sand** Fine to coarse sand.	Resumed drilling trip #3. Added water/foam.
						Break for lunch. Added water/foam.
	GB					
103.0						
105.0					**Silt-silty sand** Increased sand fraction.	Added water/foam. Increased drill pace.
	GB				**Silt with sand and gravel** Coarse sand-gravel lenses, dry to moist.	Added water/foam. Drilling slowed again.
						Added water/foam.
	GB					
						Poor recovery.
	GB					Added water/foam.
119.0						Added foam.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-18
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site S
DATE STARTED 7/8/05 **COMPLETED** 7/8/05 **GROUND ELEVATION** 914.80 feet **TOC ELEVATION** 916.73 feet
DRILLING CONTRACTOR Foundex **NORTHING** 370163.797 meters **EASTING** 6632267.526 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
	GB				**Silt with sand and gravel** Same as above, well-graded sand and trace gravel.	Added foam.
					125.0 Bottom of hole at 73.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: SI P-05-18
Date: 9/4/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: PAUL TAYLOR & WILLOW WEIMER

Summary Only 3.28 FT WATER IN WELL.

	Installed (Well Log)	Start	End
Water level	—	61.08	60.91
Total depth	64.4	64.36	64.27
pH	—	7.72	8.72

Screen interval (btoPVC): 10
Top: 54.31
Bottom: 64.31
PVC stick-up height (above ground surface): ~~2.4~~ (est)

245 − .03 = 2.42

64.36 − 61.08 = 3.28

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 0934								
1006	64.31	61.08	0.9	248	0.06	[E 3]	5.24	Murky brown, 1/4 cup SILT/Fine Sand	
1024	"	—	0.9	522	0.04	"	4.99	"	PH 8.18
1037	63.31	—						Move up 1ST, RESTART Pump.	
1117	"	—	1.0	922	0.04	"	4.71	Murky lt brown 1/4 cup Silt/Fine Sand	PH 8.53
1141	"	—	1.1	1186	0.04	1000	5.43	"	PH 8.68
1150	62.31	—						Move up 1ST Restart Pump.	
1220	"	—	0.4	130	0.04	[E 3]	6.17	Murky brown, 1/2 cup SILT: Fine Sand	PH 8.65
1227	~~60.90~~	60.90						STOP Pump Check Foot Valve	
1232	"	—						RESTART Pump.	
1256	"	—	0.5	142	0.04	"	7.32	" 1/4 cup SILT: Sand	PH 8.71
1303								STOP Pump.	
								* FLOW SLOWED, CHECKED FOOT VALVE & IT WAS INTACT, MEASURED WATER LEVEL, NOT A BIG DROP. * RAISED UP, NO WATER * NO POLISH STEP	
Surge block off	START DEBRIS SURGE @ 1310								
1336	64.31	—	1.5	181	0.04	335	5.61	WATER LT Brown, Turbid, CLEARED, 1 TBS Fine Sand	SILT
1356	"	—	1.5	211	0.04	118	5.20	CLEAR, LT. BROWN, 1/4 Tsp Sand/SILT	8.73 PH 8.72
1402								STOP Debris Surge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-19M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site R
DATE STARTED 7/11/05 **COMPLETED** 7/12/05
GROUND ELEVATION 883.09 feet **TOC ELEVATION** 885.31 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632106.128 meters **EASTING** 371382.06 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Moss, lichen**	
	GB				4.0	
5	GB				5.0 **Silty sand and gravel** Brown, well-rounded clasts, medium- to coarse-grained sand, moist.	
					Silty sand and gravel Brown, well-rounded, <3/4"-diameter clasts, medium- to coarse-grained sand, moist.	
	GB					
10						
	GB				14.0	
15					15.0 **Silty sand and gravel**	
					Silty sand and gravel Brown.	
	GB				19.0	
20					**Silty sand and gravel** Same as above.	
	GB				24.0	
25					25.0 **Sand with gravel** Brown, medium- to coarse-grained sand, well rounded gravel, <1/2"-diameter clasts.	
					Sand with gravel Brown, medium- to coarse-grained sand, well rounded gravel, <1/2"-diameter clasts, dry.	Cyclone tube getting clogged.
	GB				29.0	Added water. Added water.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.2 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 24 Aug, 2005
Purge Volume: 1584 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments:

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-19M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site R
DATE STARTED 7/11/05 **COMPLETED** 7/12/05
GROUND ELEVATION 883.09 feet **TOC ELEVATION** 885.31 feet
DRILLING CONTRACTOR Foundex
NORTHING 6632106.128 meters **EASTING** 371382.06 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Silty sand with gravel** Brown, medium-grained sand, <1/2"-diameter clasts.	
	GB				34.0	
35					35.0 **Sand with silt** Brown, very fine-grained sand.	Soupy, runny.
					Sand with silt Brown, very fine-grained sand.	
	GB				39.0	
40					**Sand with silt** Same as above.	
	GB				44.0	
45					45.0 **Sand with silt and gravel** Brown, very fine sand, <1/2"-diameter clasts, subrounded, trace gravel.	Added water.
					46.0 **Sand with silt and gravel** Brown, very fine sand, <1/2"-diameter clasts, subrounded, trace gravel.	
	GB				**Sand with silt and gravel** Brown, very fine sand, <1/2"-diameter clasts, subrounded, trace gravel. 49.0	Not adding water.
50					**Sand** Brown, medium to coarse grained.	
	GB				54.0	Making some water.
55					55.0 **Sand and gravel** Coarse-grained sand, <1/2"-diameter clasts, subangular to angular.	Wet. Not adding water.
					Sand and gravel Coarse-grained sand, <1/2"-diameter clasts, subangular to angular.	
	GB				59.0	Added water.
60					**Gravelly sand** Brown, coarse-grained sand, <1/2"-diameter gravel clasts, subangular.	
	GB				64.0	
65					65.0 **Sand** Brown, fine to medium grained.	Added water.
					Sand Brown, fine to medium grained.	
	GB				69.0	Flushed hole, continued drilling.
70					**Sand** Brown, fine to medium grained.	
	GB				74.0	
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-19M
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site R
DATE STARTED 7/11/05 **COMPLETED** 7/12/05
GROUND ELEVATION 883.09 feet **TOC ELEVATION** 885.31 feet
DRILLING CONTRACTOR Foundex
NORTHING 6632106.128 meters **EASTING** 371382.06 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Scola, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Gravelly sand** Brown, medium- to coarse-grained sand, <3/4"-diameter clasts, subangular to subrounded.	Added water.
	GB				**Gravelly sand** Brown, medium- to coarse-grained sand, <3/4"-diameter clasts, subangular to subrounded. Grades with more medium gravel.	Flushed hole, continued drilling.
80					79.0 **Gravelly sand to sandy gravel** Brown, medium- to coarse-grained sand, <1/2"-diameter clasts, subangular to subrounded.	
	GB					Added foam.
85					84.0 85.0 **Gravelly sand to sandy gravel** Same as above.	Added foam.
	GB				**Gravelly sand to sandy gravel** Brown, medium- to coarse-grained sand, <1/2"-diameter clasts, subangular to subrounded.	Flushed hole, continued drilling.
90	GB				90.0 **Silt**	Shift change. Sample in bucket already. Added water.
95	GB				**Sand with silt and gravel** 94.5 Increased gravel. 95.0 **Silt with sand and gravel** Trace gravel. **Silt with sand** Fine-grained sand.	Heaving sand. Added water. Heaving sand. Can't tell if in water, can't check because of heaving sand.
100	GB				99.0 **Sand with silt** Fine-grained sand.	Added water. Added water. Added water. Added foam Heaving sand. Added foam. Added water.
105	GB				103.5 104.5 **Sand with silt and gravel** Fine-grained sand, gravels appear. 105.0 **Sand with gravel** Poorly-graded sand, trace gravel. **Sand with gravel and silt** Poorly graded, fine-grained sand, trace gravel.	Driller says there is water information. Added lots of water. Drilling rate increases. Heaving sand. Added water. Flooded hole. Added foam.
110	GB				109.5 **Sand with silt** Poorly graded, fine-grained sand.	Added foam. Heaving sand.
115	GB				112.5 **Sand with silt** Poorly graded, fine-grained sand. 114.5 115.0 **Sand with silt** Same as above. **Sand with silt and gravel** Poorly graded, fine-grained sand, trace gravel. 117.0 Increased silt. **Silt with sand** Fine-grained sand. 120.0	Added water. Flooded hole. Added foam. Drilling rate increases. "Lenses of gravel." Added water. Added water. Silt lens. Added water. Flooded hole. Fixed seal.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-19M
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site R
DATE STARTED 7/11/05 **COMPLETED** 7/12/05 **GROUND ELEVATION** 883.09 feet **TOC ELEVATION** 885.31 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632106.128 meters **EASTING** 371382.06 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Silt with sand** Fine-grained sand. Increased sands.	Added water and foam. Added water and foam. Added water. Heaving. Drilling slows.
124.5						
125	GB				**Silt with sand and gravel** Fine-grained sand, trace gravel.	Added water and foam. Added water and foam. Added water and foam.
125.0					**Silt with sand and gravel** Fine-grained sand, fine-grained gravel. Increasing fine sand.	Added water. Added water. Heaving sand. Flooded hole.
129.5						
130	GB				**Sand with silt and gravel** Fine-grained sand, trace gravel.	Added water. Added water. Heaving sand. Added water. Added water.
135	GB					Added water. Heaving sand.
135.0					**Sand with silt and gravel** Fine-grained sand, trace gravel. Increasing silt.	Added water. Added water. Added water. Added water. Flooded hole.
140	GB					Added water. Added water. Heaving.
140.0					**Silt with gravel** Trace gravel. Increasing sand.	Added water. Slow drilling. Added water. Flooded hole. Drilling rate slow.
143.5					Bottom of hole at 143.5 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: (R)/P-05-19M
Date: 8/23/05 - 8/24/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Sue Sequela

Summary

	Installed (Well Log)	Start	End
Water level		45.46	39.05
Total depth	86.0	83.90	82.35
pH		6.56	6.37

Screen interval (btoPVC): 10'
Top: 73.4
Bottom: 83.40
PVC stick-up height (above ground surface): 2.42

2.45
-0.03
2.42

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on START Pump @ 1209								
1209	83.4	45.46	3.7	11.0	0.06	711	4.9	Muddy, Dark Brown F-M sand, 5 ft
1230	"	—	3.8	79.8	0.05	137	5.1	≥ 1/2 cup F-M sand, lt Brown. PH 6.53
1300	"	—	3.4	161.8	0.05	203	4.98	" F-M sand 3/2 TBS. Surging Sed
1308	81.4	—						Stop Pump / Moved up
1314	"	—						Restart Pump PH 6.47
1344	"	—	3.8	293.8	0.05	72.9	4.95	1/2 cup F-M sand, Water lt brown. ↓
1410	"	—	2.1	330.1	0.05	91.5	5.15	PH 6.40
1419	79.4	—						Stop Move up, Restart Pump
1445	"	—	4.1	498.1	0.05	36.1	4.77	≥ 1/2 TBS PH 6.59
1520	"	—	4.1	599.6	0.05	41.6	5.17	Water Clearing F-M sand, ≥ 1/2 tsp PH 6.57
1525	77.4	—						Move up. Restart Pump
1541	"	—	3.8	660.4	0.05	30.7	4.99	Water clearing, lt Brown, F sand. 1 tsp.
1609	"	—	3.8	764.3	0.05	29.3	5.09	" = 1 TBS.
1626	"	—	3.8	850	0.05	41.3	5.32	^6.55
1631	75.4	—						Move up. Restart Pump
1653	"	—	3.9	915	0.05	30.2	5.14	PH 6.42
1655	"	—						Stop Pump
0953	"	—			0.06		15.14	Restart Pump. PH 6.68
1002	"	—	3.6	943	0.06	46.2	15.14	F-M to medium sand, water lt brown, ≥ 1/2 tsp.
1020	73.4	—						Move up. Restart Pump
1038	"	—	3.8	1011	0.05	18.7	4.92	" clear, F-M sand 1 TBS. PH 6.22
1054	"	—	3.7	1070	0.05	26.1	4.93	clear, F-M sand 3/4 TBS. PH 6.19
1118	"	—	3.4	1161	0.05	75.3	5.01	2 TBS F-M sand.
1122								Stop Pump 1
Surge block off START Polish @ 1129								
1151	68.4	—	4.2	1253	0.05	21.3	4.74	clear, 2 TBS. PH 6.38
1222	"	—	4.5	1392	0.05	89.5	4.76	More Sediment PH 6.37
1229/1238	82.9	—			0.05			START Rubbis Surge / Stop Pol 37
1325	"	—	4.0	1584	0.06	209	4.94	Sand Medium / F-M PH 6.39
1338								

STOP Rubbis Surge
END

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-19S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site R
DATE STARTED 7/24/05 **COMPLETED** 7/24/05
GROUND ELEVATION 883.42 feet **TOC ELEVATION** 885.41 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632098.486 meters **EASTING** 371391.345 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					Peat and Gravel at surface.	No water added.
4.0					**Sand**, medium brown, moist, trace gravel.	No water added.
10.0	GB				**Sand**, medium brown, moist.	
15.0	GB				**Sand**, well graded, grey, moist, trace gravel.	
20.0	GB				**Sand**,fine to medium, grey, moist.	
25.0	GB				**Sand**,fine to medium, grey, moist (est. 20%).	No water added.
27.0					**Gravel**, Subangular, up to 1/2" diameter clasts with Sand, well graded, moist.	
30.0						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.98 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 24 Aug, 2005
Purge Volume: 216 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: Insufficient Water

Comments: Static Water Depth is denoted by solid triangle (ftoc): 34.3 Date: 7/24/05 Time: 1730

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-19S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site R
DATE STARTED 7/24/05 **COMPLETED** 7/24/05 **GROUND ELEVATION** 883.42 feet **TOC ELEVATION** 885.41 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632098.486 meters **EASTING** 371391.345 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
35		34.3	1/4		**Sand**, Well graded, grey, moist with gravel (est. 20%), rounded clasts to 1/2" diameter.	Halt drilling to see if hole makes water. Wait 5 minutes. Lifted rods, hole dry.
					36.0 **Gravel**, Rounded to subangular, clasts to up to 3/8" diameter with well graded sand , moist.	
					38.0 Bottom of hole at 38.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: RP-05-19S
Date: 8/24/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Sue Sequela

Summary

	Installed (Well Log)	Start	End
Water level		37.74	37.73
Total depth	37.3	39.82	39.63
pH		6.58	6.64

Screen interval (btoPVC): 10'
Top: 29.8
Bottom: 39.8
PVC stick-up height (above ground surface): 1.98

39.82 − 37.74 = 2.08
2.40 − .42 = 1.98

Development Observations Only 2.08 water in well.

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump: 1409									
1432	39.3	37.74	2.1	48	0.04	342	7.26	lt Brown, Water, Silt + Fine/Medium Sand, 2 TBS.	
1508	"	—	2.1	123	0.04	85	7.44		
1516	36.3	37.75						Move up RESTART Pump.	
1521	"	—						Stop Pump, Measured water level, Sediment ABL	
1525	"	—						RESTART Pump.	
1532	39.8	—						Stop Pump, Move Down .5' (Flow Stopped)	
1537	"	—						RESTART Pump	
1541	"	—	2.0	131	0.04	550	7.38	, Brown water, 2 tsp Fine Sand/Silt.	PH 6.64
1610	"	—	2.0	189	0.04	46	7.02	WALL ~~Muddy~~, Suspended Sediment, A Brown, 1/8 tsp	PH 6.64
1612			~~2~~					STOP Pump,	
Surge block off START Redis Surge 1624									
1637	39.3	37.75	2.1	216	0.04	11	6.99	Water clear, 1/4 tsp	PH 6.62
1640								STOP Redis Surge	
								End —	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-20D
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Z
DATE STARTED 7/13/05 **COMPLETED** 7/15/05
GROUND ELEVATION 972.47 feet **TOC ELEVATION** 974.87 feet
DRILLING CONTRACTOR Foundex
NORTHING 6638708.861 meters **EASTING** 372403.071 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat** Pet, grass, roots, wet.	
4.0					Root zone.	
5	SS				**Sand with silt and gravel** Dark brown, well graded, wet.	Driller wets cathead with 24 oz. of water, rope damp. 24"-long spoon. Upper glacial outwash.
5.0					**Sand with silt and gravel** Dark brown, well graded, wet.	
8.0					**Sandy gravel** Light brown, well graded, wet.	24"-long spoon.
10	SS					Down pressure = 3,000 lbs.
12.0					**Sand** Light brown, well graded, angular to rounded, wet.	Lithology change, soft material, sand cuttings. Definitely water in the formation, mud thins.
15	SS					Smooth soft drilling, pressure build-up indicating silt of clay.
18.0					Interbedded gravels.	
19.5	ST SS				**Sandy silt with gravel** Olive gray.	Shelby tube easily advances but only able to advance shelby tube 6.5 inches. Recover from shelby tube = 2.0 inches.
20					**Sand with silt** Yellowish orange, plastic silt. Gravels.	Drilling soft.
21.5					**Sand and gravel**	Drilling dense, feels like cobbles.
23.0					**Gravel with silt and sand** Yellowish orange, well-graded gravel, wet.	Not as much water in formation.
25	SS					
25.0					**Silt with sand and gravel** Well graded.	
26.3					**Silt** Light brown, wet.	Mix new batch mud. 4,000 lbs. down pressure. Lithology change, smooth drilling. Fast drilling.
28.0						
30	SS					The hole caved from 30' to 20' bgs.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.40 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 10 Sept., 2005
Purge Volume: 1120 gallons

RESPONSE TEST
Response Method: N/A
Date: Flowing Well

Comments: Water Depth (ftoc): Flowing Date: 7/15/05

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-20D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Z
DATE STARTED 7/13/05 **COMPLETED** 7/15/05
GROUND ELEVATION 972.47 feet **TOC ELEVATION** 974.87 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6638708.861 meters **EASTING** 372403.071 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					30.5	(driller). Trip out, extend casing.
					31.5	Lithology change, drills like cobbles.
					33.0	Smooth, fast drilling.
					Silt Light brown, moist to wet.	Lithology change, drills like silt.
35	SS				35.0	
					Silt Light brown, wet.	Smooth drilling.
					37.5	
					38.0 **Sandy silt**	Lithology change, drills like gravel.
40	SS				**Sandy silt with sand** Olive gray, elastic silt, very stiff, moist.	Bouncy, drills like gravel.
					43.0	
	SS				**Sandy silt with sand and gravel** Light brown, hard, moist.	Drills like gravel.
45					45.0	5,000 lbs. down pressure.
					Silt with sand and gravel	Drills like gravel.
					48.0	2,500 lbs. pressure.
	SS				**Gravelly silt with sand** Olive gray, stiff.	Shift change, day shift on.
50						
55						
	SS					Refusal.
60					Extremely dense silt found on tricone bit after tripping out Glacial Till, gravel clasts angular.	
						Shift change, night shift on.
					63.0 Cuttings consist of fine to medium grains.	Bit pressure at max = 5,000 lbs. Good rotation and circulation. 4 3/4 button bit on.
	SS				63.5 **Bedrock** Reddish brown to gray, fine- to coarse-grained conglomerate.	125 blows = 1.5".
					Bottom of hole at 63.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: Z/P-05-20D
Date: 9/9/05 | 9/10/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	F	Flowing	Flowing
Total depth	63.0	—	65.34
pH	—	6.93	7.20

Screen interval (btoPVC): 10'
Top: 53.0
Bottom: 63.0
PVC stick-up height (above ground surface): 1.95

Development Observations UNABLE TO GET TD. Before pumping due to WL & Clarity.

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on			START Pump @ 1622						
1700	63.0	Flowing	4.3	163.4	0.05	422	5.08	Grey Brown, Sand & SILT 1½TBS	
1722	"	—	4.2	255	0.05	966	4.90	Reddish Brown. Silt & Sand, 2½TBS.	
1728	61.0	—						MOVE UP. RESTART Pump.	
1747	"	—	4.2	334	0.06	133	4.70	Cloudy Grey. 2Tsp Sand/SILT.	PH 7.06
1815	"	—	4.2	451				~~STOP Pump FOR DAY~~. Flow TEST	
9/9/05 1822			4.2	480				STOP Pump FOR DAY.	
9/10/05 0852	"	—						RESTART Pump	
0915	"	—	4.3	578	0.09	204	4.45	LT grey. Cloudy. ¼Tsp Sand.	PH 5.66
0919	59.0	—						MOVE up. RESTART Pump	
0943	"	—	4.4	683	0.05	63	4.15	Slightly Cloudy, TRACE Sand.	PH 6.16
0947	57.0	—						Move up. RESTART Pump.	
1009	"	—	4.4	779	0.06	166	6.57	Cloudy Grey TRACE Sand	PH 6.61
1013	55.0	—						MOVE Up. RESTART Pump.	
1026	"	—	4.2	833	0.05	101	3.87	H grey cloudy, TRACE Sand.	PH 6.83
1030	53.0	—						moved up. RESTART Pump.	
1043	"	—	4.2	887	0.05	115	3.89	LT Grey, TRACE Sand.	PH 6.89
1045	"	—						STOP Pump.	
Surge block off			START POLISH @ 1050						
1102	48.0	—	3.8	932	0.05	69	4.19	WATER CLEAR, NO Sand.	PH. 7.01
1104	"	—						~~STOP. Move~~ STOP POLISH	
1108	"	—						START Debris Surge	
1128	63.0	—	4.5	1022	0.06	94	4.74	LT Brown, cloudy. 2 Tsp Sand	PH 7.15
1149	"	—	4.7	1120	0.05	86	4.38	Slightly Cloudy (Grey) TRACE Sand	PH 7.20
1151								STOP Debris Surge / END	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-20S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site Z
DATE STARTED 7/15/05 **COMPLETED** 7/15/05
GROUND ELEVATION 972.95 feet **TOC ELEVATION** 975.28 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6638716.428 meters **EASTING** 372404.049 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Gravelly silt** Gray, angular clasts, medium plasticity.	
20	SS		8-13-15-			
25	SS		13-26-18-10		25.0 **Silty gravel** Brownish gray, <1/2"-diameter angular clasts. 26.5	Poor drilling.
30	ST		---		**Silt** Light brown, highly plastic. 30.0	

Bottom of hole at 30.0 feet.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 9 Sept., 2005
Purge Volume: 834 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments:

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: ZP-05-20S
Date: 9/19/05

Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	4.10	6.95
Total depth	26.5	28.9	28.95
pH	—	6.65	6.70

Screen interval (btoPVC): 5'
Top: 23.9
Bottom: 28.9
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump 1201								
1240	28.9	4.10	4.0	160	0.09	240	4.70	Orangish brown, Murky, 1 Tbs Sand & Silt	
1258	"	4.10	4.0	272	0.07	152	4.54	" " 1½ Tsp.	
1302	26.9	—						Move up 2', RESTART Pump	
1349	"	—	"	460	0.07	267	5.32	Grey, Cloudy/Murky. 1½ Tsp Sand	PH 6.96
1400	"	—	"	504	0.07	215	4.58	" " " ¼ Tsp.	PH 6.70
1404	24.9	—						Move up 2. RESTART Pump.	
1440	"	—	3.4	626	0.07	119	5.11	Grey Cloudy. 1½ Tsp.	PH 6.71
1502	"	—	"	700	0.07	121	5.43	" " , TRACE Sand	
1507	23.9	—						Move up 2, RESTART Pump.	
1518	"	—	3.7	740	0.07	80	5.13	WATER Tan/grayish, TRACE Sand	PH 6.72
1520								STOP Pump	
Surge block off	START POLISH @ 1525								
1535	18.9	—	3.2	772	0.07	86	5.43	WATER light Grey, TRACE Sand	PH 6.70
1538	"	—						STOP POLISH	
1542	28.9	—						START Debris Surge	
1558	"	—	3.9	834	0.07	71	5.08	Slightly Cloudy, TRACE Sand	
1600	"	—						Debris Surge STOP pump / END	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AA

DATE STARTED 7/16/05 **COMPLETED** 7/17/05 **GROUND ELEVATION** 964.73 feet **TOC ELEVATION** 967.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6638741.205 meters **EASTING** 371669.319 meters

DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Scola/Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	
5					5.0 **Peat, vegetation with silt** Light brown.	No split-spoon driven.
10	SS				11.0 **Gravelly cobbly sand** Light brown, fine- to medium-graded.	Drillers sink casing through 1st 10 feet very easily and rapidly. Feels like drilling in gravel.
15	SS				15.0 **Sandy gravel to gravelly sand** Brown, <2"-diameter, subangular, medium- to coarse-grained sand clasts.	
20	SS				20.0 **Silt** Gray, highly elastic.	
25	SS				21.9 **Gravelly sand to sandy silt** Gray. 25.0	
30					**Silt with gravel and sand** Grayish brown, medium stiff. 30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 8 Sept., 2005
Purge Volume: 2166 gallons

RESPONSE TEST
Response Method: N/A
Date: Flowing Well

Comments: Static Water Depth (ftoc): 12.21 Date: 7/19/05 Time: 0900

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AA
DATE STARTED 7/16/05 **COMPLETED** 7/17/05 **GROUND ELEVATION** 964.73 feet **TOC ELEVATION** 967.02 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6638741.205 meters **EASTING** 371669.319 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Scola/Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
	SS				**Silt** Gray, medium stiff, medium dense, medium plasticity.	
	ST				Attempted pushing a shelby tube ~ 10".	Drillers try to push shelby tube but can't beyond 10". Lift rig while pushing. Tubes comes up bent at the bottom.
35					Silt contains some gravel.	
	SS				35.0 **Silt with gravel** Gray, <3/4"-diameter angular clasts, stiff silt, medium dense.	
40					40.0	Drill bit (tri cone) has silty clay with gravel.
	SS				**Clayey silt** Gray, very stiff, dense.	
	ST					
45					45.0	
	ST				**Silt** Dark gray, plastic silt, stiff, moist.	Crew change. Shelby tube advance 8". Recovery.
					Silt with increased gravels.	Drills like gravel.
50					50.9 Out of gravel.	
					51.8 **Gravel** Gravel lense.	Fast drilling. Drills like gravel. Smooth drilling.
					Silt with sand and gravel Dark gray, fine to coarse sand, up to 4 cm gravel, stiff.	
	SS				55.0	
55					**Silt with sand and gravel** Dark gray, plastic, stiff.	
					56.8	Gravel lens.
					57.1 **Gravel** Gravel lense.	Losing mud.
					Silt with sand and gravel	Gravel lens. Losing mud.
					59.5	Smooth drilling.
60					60.0 **Gravel** Gravel lense.	Drills like gravel.
					Silt with sand and gravel	
					61.5	
					62.0 **Gravel** Gravel lense.	Gravel.
	ST				**Silt with sand and gravel** Dark gray, well-graded sand, very stiff to hard.	Tube extended 2".
65	SS				65.0	
					65.8 **Silt with sand and gravel** Dark gray, very stiff to hard, moist.	Driller adds mud. Losing mud and thinning.
					66.3 **Gravel** Gravelly, hard.	Drills like gravel, drilling rate slows.
					Silt with sand and gravel	Smooth drilling.
					68.4	Drills like silt.
					68.8 **Gravel**	Mud thinning.
70					69.8 **Silt with sand and gravel**	Slow drilling/bouncy.
					Gravel	
					71.5	
					Silt with gravel and sand Dark gray, hard, moist.	
	SS				75.0	Change from Mill tooth to button bit. Added mud.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AA

DATE STARTED 7/16/05 **COMPLETED** 7/17/05 **GROUND ELEVATION** 964.73 feet **TOC ELEVATION** 967.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6638741.205 meters **EASTING** 371669.319 meters

DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Scola/Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Silt with gravel and sand** Dark gray, hard, moist.	Drills like gravel, bouncy. Added mud. Lithology change? Not as bouncy.
					76.9 **Silt with gravel and sand** AS above, increased gravels.	Relatively smooth drilling, some crunchy zones.
80						Mud thinning.
					83.0	
	SS				**Gravel with sand**	3" recovery from spoon. Lithology change, possible bedrock - slow penetration, smooth drill rotation. Added fresh mud.
85					Possible 2'-diameter boulder.	Possible fractured bedrock, some drill chatter in the smooth drilling. No loss of drilling mud.
					88.0	
	SS				**Gravel with sand and silt** Well-graded gravel with small cobbles.	Drilling appears to act like gravels and cobbles. 18" split-spoon 04:50, 72 blows = 6".
90						Drilling appears to still be in silts, gravels and sands.
95						Slow drilling, feels like gravel.
					98.0	
	SS				**Gravelly sand to sandy gravel** Brown, <3/4"-diameter angular clasts.	Drove SPT 1 ft.
100						Slow drilling, feels like gravel.
105					105.0 **Sandy gravel** As above, <3/4"-diameter angular clasts, medium to coarse sand, subangular gravels.	Slow drilling.
	SS					
110						Drilling speeds a little, now drilling in sand vs. gravel?
115						Still slow drilling.
					118.0	
	SS				**Sandy gravel** Brown, <1/2"-diameter, medium- to coarse-grained, subangular to subrounded clasts.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-21D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AA
DATE STARTED 7/16/05 **COMPLETED** 7/17/05
GROUND ELEVATION 964.73 feet **TOC ELEVATION** 967.02 feet
DRILLING CONTRACTOR Foundex
NORTHING 6638741.205 meters **EASTING** 371669.319 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Scola/Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					**Sandy gravel** Brown, <1/2"-diameter, medium- to coarse-grained, subangular to subrounded clasts.	Strong smell/odor coming from rig battery. Rough drilling.
125						Rough drilling.
130	SS				129.5 **Gravel** Well-graded, subangular to subrounded, gravel.	M.S. in for C.S. Added fresh mud. Mud thinning.
135					135.0 **Gravel with sand** ~1/2"-diameter, medium- to coarse-grained, subangular to subrounded clasts.	Drilling like gravel. Crew change.
140	SS				138.0 **Gravel with sand** Brown, 1/2"-diameter, subangular to subrounded, also black igneous rock with pleocryst and weathered rock. Weathered rock chip coming up hole.	15" split-spoon, 50 blows = 2.5". Added mud to pit/loosing mud to hole. Drilling rig went smooth, possibly hit bedrock.
145	SS				139.5 143.0 144.0 **Gravel with sand** 1/4"- to 1/2"-diameter, subangular, subrounded, occasional small cobble. 145.0 **Sand and gravels** 146.0 **Sand** 147.0 **Sand** 148.0 **Sand** Occasional gravel at bottom of hole.	Drill went 1.5 feet of drilling in 15 min., then back to smooth drilling. Smooth and rough drilling, 1' in 10 min. penetration. Smooth and rough drilling, 1' in 7 min. penetration. SPT at 23:14, top foot soft from well cuttings settling, bottom foot is hard. Drilling into sands and gravels.
150					149.0 **Sandy silt** Light brown. **Sandy silt with pea gravel** Small pea gravel. 152.0	Fast penetration rate. Fast penetration rate. Fast penetration rate. Driller said pump pressure is fluctuating indicating some silts.
155	SS				153.0 **Gravel** 154.0 **Gravel with sand** 50% well-graded gravel, 50% coarse sand. 155.0 **Gravel** **Sand with gravel** Some gravel.	Drill rig is shifting up and down. 96 blows for 11 inches of penetration. 8" recovery of sample. Drill rig moving like we are in gravel. Driller mixed new batch of mud - removes cuttings of old mud from pit. Drilling is smooth, dark colored (black) chips in cuttings.
160	SS				161.0 162.0 **Sand with pea gravel** Small pea gravel in cutting. 163.0 **Gravel with sand** **Gravel with sand** Multicolored, well-graded gravel, coarse to fine sand.	Checked drill cutting with driller, mostly coarse, some with some chips from loose gravel. Some drill chatter from gravel. Cuttings contain a lot of pea gravel. Start SPT at 05:55, 50 blows in 2.5"

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AA
DATE STARTED 7/16/05 **COMPLETED** 7/17/05 **GROUND ELEVATION** 964.73 feet **TOC ELEVATION** 967.02 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6638741.205 meters **EASTING** 371669.319 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Scola/Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165					165.0 **Gravel with sand**	Driller continues additional blows 50=30 or 100 blows = 5.5". 4-inches of sample recovery. Drill chatter while drilling indicates we are still in gravel. Drills like gravel. Drilling rate slows. Drills like bedrock. Losing mud fast, ~20 gallons.
170					169.0 **Silt with sand and gravel** Darker.	
	SS				173.5	3" recovery = gravel.
					Bottom of hole at 173.5 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

WELL DEVELOPMENT LOG

Well ID: AA/P-05-21D
Date: 9/8/05 9/9/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary * Couldn't Measure TD & Water, Casing Totally Submerged.

	Installed (Well Log)	Start	End
Water level	—	Flowing	Flowing
Total depth	173.5	→ J	→ J
pH	—	6.88	7.59

(According To Well log.) Screen interval (btoPVC): 20'
→ Top: 153.0
Bottom: 173.0
PVC stick-up height (above ground surface): —

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1004									
1020	173.0	Flowing	4.4	70.4	0.2	1000	5.17	Brown, Murky, 1/4 cup Silt: Fine Sand.	
1044	"	"	4.9	266	0.1	646	5.58	" Sediment/Mud, 2 TBS, "	PH. 6.96
1117	"	"	5.0	431	0.1	240	5.36	LT Brown, 1½ Teaspoons, Sand Silt	
1126	171.0	"	—	—	—	—	—	Move up. Restart pump.	PH 6.51
1159	"	"	5.0	596	0.1	209	5.37	Milky Brown/gry, 1 TBS, Sand Silt	PH 6.26
1225	"	"	4.8	672	0.1	95	6.35	LT & CLAR, 1 TSP	PH 6.57
1235	169.0	"	—	—	—	—	—	Move up. Restart Pump	
1321	"	"	5.0	902	0.1	57	5.57	LT Brown/clar, 1 TSP Sand	PH 6.87
1327	167.0	"	5.0	—	—	—	—	Move up 2 ft, Restart pump	
1421	"	—	4.8	1161	0.1	155	5.86	LT Brown Milkyish, 1½ TSP.	PH 7.54
1426	165.0	—	—	—	—	—	—	Move up, 2 ft, Restart Pump	
1456	"	—	5.0	1311	0.1	54	5.46	WATER CLAR, TRACE Sand.	PH 7.63
1505	163.0	—	—	—	—	—	—	~~Stop~~ Move up, 2ft Restart Pump	
1519	"	—	5.0	1381	0.1	21	5.10	Wath. clar, TRACE Sand.	PH 7.35
1522	161.0	—	—	—	—	—	—	Move up, Restart pump.	
1543	"	—	5.0	1486	0.1	34	5.32	WATER CLAR, 1 TSP Sand	PH 7.36
1548	159.0	—	—	—	—	—	—	Move up 2, Restart Pump	
1609	"	—	5.0	1591	0.1	35	5.46	WATER CLAR, TRACE SAND	PH 7.02
1613	157.0	—	—	—	—	—	—	~~WATER CLAR~~ Move up 2' Restart Pump	
1638	"	—	5.0	1716	0.1	25	5.32	WATER CLAR. TRACE Sand	PH 7.50
1644	155.0	—	—	—	—	—	—	Move up 2', Restant Pump	
1707	"	—	5.0	1831	0.0	4	5.40	WATER CLAR, TRACE Sand	PH 7.66
1712	153.0	—	—	—	—	—	—	Move up 2', Restart Pump	
1728	"	—	5.0	1911	0.1	6	5.34	WATER CLAR. TRACE Sand	PH 7.56
Surge block off START Polish @ 1737								STOP Pump @ 1730	
1746	148.0	—	5.0	2001	0.1	5	5.32	WATER CLAR, TRACE Sand	PH 7.59
1752	173.0	—	—	—	—	—	—	STOP Polish, START Debris Surge	
1800	"	—	—	—	—	—	—	STOP Debris Surge FOR Rev.	
9/9/05 0950	"	—	—	—	—	—	—	RESTART Debris Surge	
1023	"	—	5.0	2166	—	—	—	STOP Debris Surge / WATER CLAR	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AA
DATE STARTED 7/19/05 **COMPLETED** 7/20/05
GROUND ELEVATION 964.10 feet **TOC ELEVATION** 966.26 feet
DRILLING CONTRACTOR Foundex
NORTHING 6638748.016 meters **EASTING** 371672.467 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	
10.5					**Gravel**	Added mud.
15.0					**Sand and Gravel**	
20.5					**Silt and Gravel**	Big boulder.
30.0						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.1 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 8 Sept., 2005
Purge Volume: 1155 gallons

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Water Depth (ftoc): Flowing 3.5gpm Date: 7/19/05

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21M
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AA
DATE STARTED 7/19/05 **COMPLETED** 7/20/05
GROUND ELEVATION 964.10 feet **TOC ELEVATION** 966.26 feet
DRILLING CONTRACTOR Foundex
NORTHING 6638748.016 meters **EASTING** 371672.467 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Silt**	Smooth drilling.
					34.8	
35					35.0 **Gravel**	
					Silt	
40						
45					45.0 **Silt with gravel**	
						Slow drilling.
50					51.1 **Gravel with sand**	Mud thinning. Added mud. Mud thinning.
55					55.0 **Gravel**	Drill chattering while drilling.
					58.0 **Silt with sand** Mainly silt.	Added 5 feet more surface casing, silt layer below surface casing swelling and sticking to bit when tripping. Drilling fairly fast, formation is sand and silt. Driller said there is a lot of pump pressure indicating we're in silt and he has to thin out drill mud with water.
60						
					64.0	
65					65.0 **Gravel**	
					Silt with sand Mainly silt.	
					68.0	
					69.0 **Gravel**	
70					70.0 **Silt with gravel** Some gravel.	
					71.0 **Silt with gravel** Some gravel.	
					71.5 **Gravel**	Lots of drill chatter followed by smooth silty layer.
					72.0 **Silt**	
					72.5 **Gravel**	Lots of drill chatter followed by smooth silty layer.
					73.0 **Silt with gravel**	Slow drilling.
					74.0 **Silt with gravel**	

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21M
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AA
DATE STARTED 7/19/05 **COMPLETED** 7/20/05
GROUND ELEVATION 964.10 feet **TOC ELEVATION** 966.26 feet
DRILLING CONTRACTOR Foundex
NORTHING 6638748.016 meters **EASTING** 371672.467 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Hagen/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					75.0 **Gravel**	Lot of drill chatter.
					Silt with gravel	Drill chatter then smooth drilling followed by drill chatter.
					78.0	Little drill chatter.
					Gravel with sand	Good drill chatter.
						Drill chatter.
80						Drill operates like in sand with some gravel.
						Drill chattering.
						Lot of drill chatter.
85						Lot of drill chatter.
						Lot of drill chatter.
					89.0	Drilled 1 foot more to 89 feet for 1 foot hole to set well point in it.
					Bottom of hole at 88.5 feet.	

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AA/P-05-21M
Date: 9/8/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wismer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	Flowing	
Total depth	88.5	~~89.75~~	
pH	—	7.23	

Screen interval (btoPVC): 10'
Top: 79.75
Bottom: 89.75
PVC stick-up height (above ground surface): —

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1250									
1330	89.75	Flowing	4.8	192	0.1	557	4.90	Lt Brown Milky, 2½ TBS Sand/SILT	
1349	"	—	4.6	279	0.1	352	4.59	" " 1½ TBS	PH 7.66
1353	87.7	—						MOVE UP, RESTART Pump	
1429	"	—	4.6	444	"	100	4.96	Gray Brown Milky, 1½ TBS Sand	PH 7.55
1447	"	—	4.6	526	"	99	4.85	Grayish, Cloudy 2½ TSP Sand	PH 7.83
1450	85.7	—						MOVE UP, RESTART Pump	
1515	"	—	4.6	641	"	103	~~4.60~~	LT Grey Cloudy/Milky 1 TSP Sand	PH 7.42
1527	83.7	—						MOVE UP 2 FT, RESTART Pump.	
1538	"	—	4.7	692	"	5	5.0	WATER CLEAR, Cloudy/ish 1 TSP Sand.	PH 7.30
~~1550~~	"	—	4.9	750	—	—	—	@ Stop Pump, Move UP, RESTART Pump 2 1 TSP Sand	Flow Test
1554	81.7	—						MOVE UP 2, RESTART Pump.	
1615	"	—	4.7	847	"	38	4.66	Slightly cloudy Grayish, 1 TSP Sand	PH 7.28
1620	79.7	—						MOVE UP 2', RESTART Pump	PH 7.59
1646	"	—	4.8	971	"	7	4.60	WATER CLEAR! TRACE Sand.	
1650	"	—						STOP Pump. ~~MOVE UP, RESTART~~ (END)	
~~1654~~									
Surge block off START Polish @ 1654									
1714	74.7	—	4.6	1063	"	4	4.81	WATER CLEAR, TRACE Sand	PH 7.67
1716	"	—						STOP Polish	
1719	89.75	—						START Debris Surge	
1739	"	—	4.6	1155	"	91	4.45	WATER Cloudy Grayish, 1½ TSP Sand	PH 7.67
1800	"	—						STOP Debris Surge / END	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-21S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AA

DATE STARTED 7/20/05 **COMPLETED** 7/20/05 **GROUND ELEVATION** 964.63 feet **TOC ELEVATION** 975.28 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6638754.286 meters **EASTING** 371674.57 meters

DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	
5						
	GB		---		7.0 **Gravel with peat and sand** Moist to wet.	
					9.0 **Gravel with peat and sand** As above, less gravel.	Smoother drilling.
10	ST	0	---		10.5 **Gravel with sand**	No recovery from tube, advanced 4". Added mud, drill rods clogged, resumed.
					13.0 **Gravel**	Slow drilling.
15					15.0 **Gravel with sand**	
					18.5 **Silt with sand** Brown, elastic.	
					19.5 Bottom of hole at 19.5 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.9 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 8 Sept., 2005
Purge Volume: 434 gallons

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Static Water Depth (ftoc): 0.6 Date: 7/20/05 Time:1640

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: AA/P-05-21S
Date: 9/7/05 - 9/8/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	2.45	1.75
Total depth	—	15.90	19.35
pH	—	6.82	6.36

Screen interval (btoPVC): 5[1]
Top: 10.9
Bottom: 15.9
PVC stick-up height (above ground surface): —

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1605								
1642	15.9	2.45	2.3	85.1	0.1	1000	5.20	Water Murky Orange Brown, 1/4 cup Sand, SIT.	
1704	"	—	2.3	135.7	0.09	515	4.73	3 TBS, suspended sediment & Medium Sand	PH 6.07
1708	13.9	—						Move Up 2FT, RESTART Pump	
1727	"	—	2.2	177	0.08	379	4.70	Orangish, Murky, suspended sed 1 TBS	PH 5.99
1755	"	—	2.2	238	0.08	116	4.97	Orangish Lighter, 1/2 tsp.	
1757	"	—						STOP Pump FOR DAY	
9/8/05 1007	"	—						RESTART Pump @	
1020	11.9	—						Move up, RESTART Pump.	
1048	"	—	2.2	299	0.09	174	4.61	Light Murky Brown, 1 Tsp Sand, S.IT	6.63 PH
1110	"	—	2.1	345	0.08	76	5.04	Water Clearer, 1/2 Tsp Sand	6.16 PH
1114	10.9	—						Move up .05, RESTART Pump.	
1128	"	—	2.1	374	0.08	57	5.0	Very LT Brown/clear, Trace Sand.	PH 6.38
1132	"	—						STOP Pump	
Surge block off	START Polish @ 1137								
1149	5.9	—	1.2	388	0.08	21	5.64	Water Clear, Trace Sand	PH 6.10
1152	"	—						STOP Polish	
1155	15.9	—						START Debris Surge	
1215	"	—	2.3	434	0.08	30	4.77	LT Brown/clearish, 1/2 Tsp Sand	PH 6.36
1218	"	—						STOP Debris Surge / END	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-22D
PAGE 1 OF 6

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AJ
DATE STARTED 7/21/05 **COMPLETED** 7/24/05
GROUND ELEVATION 994.14 feet **TOC ELEVATION** 996.08 feet
DRILLING CONTRACTOR Foundex
NORTHING 6637702.659 meters **EASTING** 371735.377 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	
					4.0	
5	SS	10	2-2-3-6		**Clay** Gray, stiff.	Clay in cuttings, cutting coming up in ribbons or belts.
	ST	18.5	---		8.0	Push shelby tube, driller said we are still in clay.
					Silt Brown, stiff, occasional gravel.	
10	ST	0	---			Pushed full 30 inches, Tube slightly crushed by rock sumping on outside of tube.
					13.0	
15	SS	0	8-10-11-13		**Silt** Brown (on outside of shelby tube).	Pushed 12", driller has full pressure unit 650 and it was very stiff, no recovery in tube so we drove SPT. No recovery in SPT. Drilling smooth and fast. Drill chatters.
					16.5	
					Gravel	
					18.0	
20	SS	10	7-12-11-11		**Clay** Gray, very stiff.	10" of recovery. Drilling very smooth, very fast.
					23.0	Drilling very smooth, very fast.
					24.0 **Silt** Dark brown, stiff.	Pushed 18" at 650 lbs., very stiff clay. 18" of recovery. Slight drill chatter. Drill chatter.
25	ST	18	---		**Gravel**	
					25.5	
					26.0 **Silt**	
					26.5 **Gravel**	
					27.5 **Silt**	
	ST	0	---		28.5 **Gravel**	Pushed shelby tube 10", stiff, no recovery, will drive SPT to collect
30	SS	16	20-16--		**Silty sand** Brown, very fine sand.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.94 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 3 Oct., 2005
Purge Volume: 2092 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth (ftoc): 12.49 Date: 7/23/05 Time: 1005

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-22D
PAGE 2 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AJ
DATE STARTED 7/21/05 **COMPLETED** 7/24/05 **GROUND ELEVATION** 994.14 feet **TOC ELEVATION** 996.08 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6637702.659 meters **EASTING** 371735.377 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						sampler. 16" of recovery in SPT.
					31.0 **Silty sand** Brown, very fine sand.	Driller notes change in pumping indicating change in lithology back to silts and clays.
					Silt or clay	Pushed shelby tube 15" (driller waits for tube sample to swell).
35					33.0 **Silt** Brown, stiff.	Silt is very sticky. Smooth fast drilling. Pump is making a lot of noise.
					38.0	24" recovery.
40	SS	24	2-2-6-6		**Clay** Gray, stiff, dense.	Pump surging due to clay digging drill bit. Natural clay is thickening the mud.
						Gray clay on drill bit.
45						Pushed 24". 24" recovery.
						Drilling is fast and smooth.
						Pump surging due to days.
50	ST	0	---			Pushed shelby tube. 29" push, no recovery, clay pulled out of tube down hole. Drilling is smooth and fast.
					53.0	
55	SS	24	5-6-5-8		**Clay** Gray, soft, plastic.	Perform SPT, 24" recovery of sample.
						Smooth drilling. Very thick mud.
60					60.5	
					61.5 **Sandy gravel** Subangular coarse sand grains.	Drills like gravel, bouncy, coarse gravel cuttings.
					Clay with sand and gravel Gray, trace gravel, stiff.	Smooth drilling.
	ST	0	---			Advance shelby 4", no recovery.
65	SS	24	12-8-12-16			24" SPT - 24" recovery.
						Smooth drilling using little to no down pressure.
					66.8	
					Clay with sand and gravel Increased gravel.	Slow drilling.
70					70.5	
					Clay with sand and gravel	Smoother.
	ST	0	---			Advance shelby 6", no recovery. 24" SPT, 22" recovery.
	SS	22	7-16-17-27		75.0	

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-22D
PAGE 3 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AJ
DATE STARTED 7/21/05 **COMPLETED** 7/24/05 **GROUND ELEVATION** 994.14 feet **TOC ELEVATION** 996.08 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6637702.659 meters **EASTING** 371735.377 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Clay with sand** Gray, trace sand, stiff.	Smooth drilling, using little amount of bit pressure.
						Smooth drilling.
80						Smooth drilling.
					82.5	
					83.0 **Sandy silt with clay**	Crunchy drilling.
	SS	22	13-9-11-14		**Clay with silt** Gray, medium to low plasticity, stiff.	24" SPT = 22" recovery.
85						Slow drilling.
						Smooth rotation.
					89.0	
90					**Silt with sand and gravel** Medium to coarse, angular sand clasts with silt.	Drilling mud appears a little thinner. Drilling bouncy.
					90.5 **Silt with sand** Light gray, poorly-graded, fine-grained sand clasts, moist.	Hard, slow advancement, good smooth rotation. Trip rods to change bit, resumed drilling.
	SS	16	21-46-47-50/4.5"			Slow drilling. 24" SPT = 16" recovery.
95					95.0	Hit something hard with spoon.
					Silt with sand Light gray, poorly-graded, fine-grained sand clasts, moist.	Smooth drilling.
					97.5	
					98.5 **Clay with silt** Light gray.	Materials on drill bit.
					Gravel Increased gravels.	Drilling like gravel.
100					100.5	
					Gravelly sand 50% gravel, 50% fine sand, dry.	Drilling smooths. Crew change. Drilling smooth but slow.
	SS	0	50/5"---			Perform SPT, 18" spoon, 50 blows = 5".
105						Drill chatter. Rig chatters. Slight rig chatter. Drill chatter.
110						Smooth drill. Drill chatter. Drill chatter.
					113.0	
	SS	0	50/5"---		**Gravelly sand** 1/4"-diameter pea gravel.	SPT 72 blows = 6", 50 blows = 5". 1" of sample recovery.
115					115.0 Possible cobbles.	Rock blocked split spoon.
					Gravel with sand and silt Small gravel, hard, dense.	Hard slow drilling, some drill chatter. Slow drilling, hard dense formation. Glacial Till. Cuttings appear to be a silty gravel. Mud is thickening and driller is

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-22D
PAGE 4 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AJ
DATE STARTED 7/21/05 **COMPLETED** 7/24/05 **GROUND ELEVATION** 994.14 feet **TOC ELEVATION** 996.08 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6637702.659 meters **EASTING** 371735.377 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					**Gravel with sand and silt** Small gravel, hard, dense.	constantly thinning, hard.
					123.0	Slow drilling/hard formation, occasional cobble.
	SS	12	58/6", 68/6"---		**Gravel, silt and sand** 40% well-graded gravel, 40% coarse to fine sand, 20% silt, stiff, dense, dry.	Drill movement and chatter. Hard slow drilling, Glacial Till.
125					125.0 **Gravel with silt and sand** Well-graded gravel, dense,	Inspecting cuttings on bit a coarse sand and silt (Glacial Till).
					126.5 dry.	SPT performed (06:15), 12" of recovery, good sample of formation.
					Silt Light gray, stiff, moist.	Drilling rate slow.
						Hard, slow drilling, occasional chatter.
130						Mud is thick.
						Slow drilling.
						Smooth, slow drilling.
						Thick mud.
	SS	8	47-50/3"--			18" split-spoon = 8" recovery for 9" advance.
135						
						Slow drilling.
						Thick mud.
						Using button bit.
						Slow chatter.
140						Drills like gravel.
						Drill action smoother.
					140.5 Sand grains in cuttings.	Rods hang up on trip out.
					142.5	Smooth slow drilling, rod turning at 30 to 40 rpm.
	SS	14	43-49-50/3"-		**Gravel with sand** Light brown, well-graded gravel, rounded to subrounded sand and gravel clasts, wet.	Dense till. 24" split-spoon advanced 15", 14" recovery.
145					145.0 **Gravel with sand** Increased gravels.	Drill mud thickening.
						Slow drilling.
						Increased drill chatter.
						Increased chatter, bouncing rig.
150						Mud appears to be thinning.
						Slow drilling, steady bouncing.
						Mud thick, added water.
					153.0 Sand cuttings.	
					153.1 **Silt** Gray.	Perform SPT at 18:20, 84 blows for 6", 50 blows for 4", 10" of recovery in sample. Crew change.
155	SS		84/6", 50/4"---		154.0 **Silty sand with gravel** Coarse to fine, some 1/4"- to 1"-diameter gravel, dense, dry.	Drilling smooth, slow.
					Gravel with sand and silt	
160						
					Gravel layers appear 6" thick.	Drill movement and chatter.
					163.0	Perform SPT.
	SS		50/5"---		163.5 **Silty sandy gravel** Gray, 50% pea gravel, 30% coarse	Added pipe, perform SPT at (23:25)
	SS		50-64--		to fine sand, 20% silt, very dense, stiff, damp to moist.	164 blows = 1 foot.

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-22D
PAGE 5 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AJ
DATE STARTED 7/21/05 **COMPLETED** 7/24/05 **GROUND ELEVATION** 994.14 feet **TOC ELEVATION** 996.08 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6637702.659 meters **EASTING** 371735.377 meters
DRILLING METHOD Mud Rotary/Tri Cone **EQUIPMENT** HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165					165.0 **Silty sandy gravel** 50% pea gravel, 30% coarse to fine sand, 20% silt, very dense, stiff, damp.	Smooth fast drilling.
					166.0 **Sand**	Drill movement, single drill chatter.
					168.0 **Gravel and sand**	Slight rig movement.
					169.0 **Gravel with sand** Small cobbles. Medium thinning, possible water.	Drill chatter and rig movement, lots of drill chatter and movement. Mud is thinning according to driller, possible water.
170					170.0 **Sand with gravel** Some gravel.	Slight rig movement. If this is a water zone it's a very thin layer.
					171.0 **Sand with gravel** Medium sand (0.8 to 0.2 meters), some gravel (cuttings).	Drill movement and slight chatter.
					172.0 **Sand with gravel** Coarse sand and small 0.19 to 0.8 meters pea gravels (cuttings).	Perform SPT. 170 blows for 10", 50 blows for 3.5", drive spoon for getting a good sample. A lot of rig chatter and movement.
	SS	0	50/3.5"---		173.0 **Sand with gravel** Coarse sand and gravel cuttings.	Drill chatter, drill movement.
175					**Gravel with sand** Well-graded gravel, coarse to fine sand, 50% 1/8"- to 1/2"-diameter gravel, very dense, damp to dry. Sample is very dense and dry with no indication of water. Gravelly cobbles. Occasional sand cobble.	Drill chatter and drill movement. Drill chatter and drill movement.
180						A lot of drill chatter. Drill chatter. Drill chatter.
	SS	0	50/3"---		183.0 **Sandy silty gravel** 50% 1/4"- to 1/2"-diameter well-graded, coarse gravel, 30% coarse to fine sand, 20% silt, dense, stiff, damp.	SPT performed, 170 blows = 9". Drill chatter.
185					185.5 **Gravel and sand** Well-graded gravel, subrounded to angular clasts, dense, moist.	Drill chatter. Crew change.
						Drill chatter.
190						Mud thinning. Smooth, slow rotation.
						Drill chatter.
	SS	9	50/3"---			Advance spoon a total of 10" for sample collection (120 blows).
195					195.0 Bottom 1" of sample is orange = oxidized. **Gravel with sand** Sand cuttings.	Increased chatter. Lost 40 gallons of drilling mud instantly. Slow drilling. Smooth slow rotation. Some drill chatter.
200					Sand cuttings.	Slow drilling. Gradually lost 10 gallons of drill mud. Slow rotation 20/m. Slight chatter. Gradually lost ~10g mud. Drilling smooth, advancing faster.
	SS	2	50/2.5"---		203.0 **Gravel with sand** Orange sands, >2" subrounded to subangular gravel, very dense.	113 blows for 6" = 2" recovery, 2" gravel fragment jammed in spoon. Mix new mud.
205						Driller lost more mud, ~ 50g gradually. Increased pump pressure (bit pressure), driller thinks may be in bedrock. No chatter. Pump spikes to 100.

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-22D
PAGE 6 OF 6

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AJ
DATE STARTED 7/21/05 **COMPLETED** 7/24/05
GROUND ELEVATION 994.14 feet **TOC ELEVATION** 996.08 feet
DRILLING CONTRACTOR Foundex
NORTHING 6637702.659 meters **EASTING** 371735.377 meters
DRILLING METHOD Mud Rotary/Tri Cone
EQUIPMENT HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6"	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
210					**Gravel with sand** Orange sands, >2" subrounded to subangular gravel, very dense. Sand cuttings.	Getting harder drilling. Rotation 40/m. No chatter. Smooth rotation. Pump spikes to 50.
					213.0 Only sand in cuttings.	
	SS		50/6", 64/6"---		**Sand** Dark rusty red, fine sand, occasional small gravel, dense, stiff, dry.	Drilling is smooth, just a little rig movement.
215					Sand cuttings.	Drilling smooth. Perform SPT (16:55).
					Sand cuttings.	Drilling is smooth. Drilling is smooth. Fast penetration rate.
					Medium sand cuttings.	Drilling is smooth. Fast penetration rate.
220						Drilling is smooth. Fast penetration rate.
					223.0	
	SS	0	26-42-64-		**Sand** Light tan, very fine, dense, stiff, dry.	Performed SPT at drive spoon 18".
225						Smooth drilling, little rig movement.
					Sand cuttings with silts.	Pump pressure indicates possible silts.
					229.5	Slowed down drilling rate due to gravel layer. Rig movement.
230					230.8 **Sand with gravel** Some gravel.	
					231.8 **Gravel**	Lot of drill chatter and movement, slow drilling.
					232.8 **Sand with gravel**	Slow drilling, little drill chatter.
					233.0 **Gravel**	Drill chatter and movement, little mud loss.
					233.5 **Sand** Light tan, medium, stiff, dense (upper 1" of sample).	Perform spt (22:00), 4" recovery of sample.
235					234.0 **Weathered bedrock?** Black rock chips, pieces of large cobble.	Change bit diameter to 4 1/4.
					237.0 **Bedrock**	Drill rate slowed down, slight drill chatter, smooth.
					Bottom of hole at 237.0 feet.	Drill rate slowed way down, still a little rig chatter, may be weathered bedrock. Bedrock smooth drilling, slow penetration rate, 1 hr./foot penetration. Bedrock.

MUD ROTARY WELLS PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AJ/P-05-22D
Date: 10/2/05 - 10/3/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		27.40	27.60
Total depth		225.5	232.15
pH		8.12	7.20

Screen interval (btoPVC): 10
Top: 215.5
Bottom: 225.5
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1232								
1314	225.0	27.40	4.4	184	0.1	E 3	3.75	WATER STARTED Thick Brown Muddy.	
1337	"	—	4.7	292	"	"	3.43	Still Thick Brown, 3 cups Silt & Fine Sand,	SILT & sand.
1347	223.0	—						Mud Brown, A lot of Suspended SEDIMENT, 1½ cups Z	PH 7.66
1435	"	—	4.7	517	0.1	1000	3.97	Move up, RESTART Pump.	
1501	"	—	4.5	634	0.1	1000	3.72	Mud Brown, Cloudy. 3 TBS Sand & Silt	PH 7.50
1505	221.0	—						" , 2 TBS Mud grain sand; 1 TBS SILT.	
1559	"	—	5.0	904	0.1	458	4.61	Move up. RESTART Pump.	
1605	219.0	—						LT Brown/Cloudy, Still Suspended sediment, 1 TBS	sand & SILT. PH 6.60
1630	"	—						MOVE UP. RESTART Pump.	
10/3/05 0918	"	—						STOP Pump FOR Day. RESTART Pump	
0940	"	—	4.4	1000	0.1	629	2.62	Mud Brown Suspended Sed. 2 TBS Mud Sand & SILT.	
1002	"	—	4.6	1101	0.1	277	2.81	LT Brown Cloudy. 1 TBS Sand & SILT.	PH 7.17
1007	217.0	—						MOVE UP. RESTART Pump	
1047	"	—	4.7	1289	0.1	470	3.52	LT Brown, Cloudy. 2½-3 TBS sand & SILT	PH 7.21
1106	"	—	4.7	1378	0.1	280	3.49	LT Brown, Cloudy. 1 TSP Sand & SILT.	PH 7.21
1111	215.0	—						MOVE UP. RESTART Pump	
1140	"	—	4.8	1597	0.1	238	3.64	LT Brown (lighter than Before) 1 TBS Sand	SILT. PH 7.23
1207	"	—	4.7		0.1	145	4.06	Very light in color. 3/4 TBS sand & light SILT.	
								MOVE UP. RESTART Pump.	
1209								STOP Pump	
Surge block off	Polish START @ 1216								
1235	217.0	—	4.7	1606	0.1	120	3.83	LT Brn/Tan color, Fine Sand, 1 TSP.	PH 7.20
1240 1242	" 225.0	—						STOP Polish / START Rebris Surge	
1317	225.0	—	5.0	1761	0.1	1000	3.74	Mud Brown, A lot of suspended sediment, 3/4 cup Silt	sand. PH 7.20
1353	"	—	8.9	2092	0.1	898	4.62		
1355	"	—						STOP Rebris Surge	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-23
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site J
DATE STARTED 7/26/05 **COMPLETED** 7/27/05
GROUND ELEVATION 953.42 feet **TOC ELEVATION** 955.01 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634354.789 meters **EASTING** 370681.294 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat and gravel**	
					4.0	
5	GB				**Silty sand** Brown, fine sand, slightly silty, occasional gravel, dry.	
					Cuttings.	
					9.0 Cuttings.	
10	GB				**Gravel with silt and sand** Brown, 40% well-graded gravel, 45% fine sand, 15% silt, dry.	
					14.0	
15	GB				**Gravel with silt and sand** Brown, 40% 1/4"- to 1/2"-diameter gravel, 45% fine sand, 15% silt, dry.	
					16.5 Cuttings.	
					Silt Brown.	Big chunks of brown silt.
					Cuttings.	
					18.8	
20	GB				**Gravel with sand and silt** Brown, 40% gravel, 45% coarse to fine sand, 15% silt, dry.	
					21.0	
					22.0 **Sand** Brown, coarse to fine, dry.	
					23.0 **Gravelly silty sand** Dry (cuttings).	Water dripping out of air hose at top of drill rod.
					24.0 **Gravel** Well-graded gravel.	No water flow out of cyclone.
25	GB				**Gravel** Well-graded gravel, <5% sand, wet.	Wet, but no flow out of cyclone.
					Gravel cuttings.	Injected a little water to clear silt of casing and air return.
					Gravel cuttings, good clean 1/8"- to 1/2"-diameter gravel, wet.	Blow water out of casing, it's approximately 2 gals. of groundwater, no real flow.
					Gravel cuttings, good clean gravel, very little fines, wet.	Sample. Loose fast drilling.
30					29.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.6 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 Aug., 2005
Purge Volume: 604 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 27.28 Date: 7/26/05 Time: 2300

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-23
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site J
DATE STARTED 7/26/05 **COMPLETED** 7/27/05
GROUND ELEVATION 953.42 feet **TOC ELEVATION** 955.01 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634354.789 meters **EASTING** 370681.294 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Gravel** Well-graded 1/4"- to 1"-diameter gravel, <15% fines, wet.	Loose ground, fast drilling.
					32.0 **Sand** Coarse sand cuttings.	
					34.0 **Gravel** Well-graded, coarse sand, <15% fines.	Blow out about 1 gal. of groundwater from casing.
35	GB				36.5 **Gravelly silty sand** Light brown to orange.	Loose ground, fast drilling.
					38.0	Driller injecting water. Loose ground, fast drilling.
					39.0 **Silty sand** Coarse to fine, subangular to subrounded, wet.	Some water, not enough for flow test.
40	GB				40.0 **Silty sand** Orange, coarse to fine, 40% coarse gravel, 40% fine sand, 20% silt, damp.	Inject water.
					40.5 **Silty sand** Light orange to brown (cuttings).	
					43.0 **Silty sand** Coarse to fine, angular, weathered rock chips.	
					44.0 **Gravel** Rusty weathered rock chips, angular, damp.	
45	GB				44.5 **Silt** Orangish brown, damp.	Inject water.
					46.0 **Gravel** Large, looks like weathered rock chips, very angular, possible large cobble.	Large rock chips of crushed gravel or cobbles.
					47.0 Rock chips.	Slow drilling.
					Weathered rock with silty clay Rust and gray color.	Slow drilling, possible bedrock.
					49.0 **Weathered rock** Rust colored limonite, gray rock chips, possible bedrock.	Rock is producing some water.
50	GB				Possible bedrock.	
					Bedrock Gray andesite with rust-colored stained limonite.	
	ST		1/8		53.0 Rock chips, andesite with rust stained limonite and pyrite.	
			1.5		54.0 **Bedrock** Gray colored andesite with limonite pyrite.	
55	GB				**Bedrock** Dark gray.	
			5		Gray andesite with pyrite.	
60			5		Bedrock.	
					Bedrock.	
					62.5	

Bottom of hole at 62.5 feet.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: JP-05-23
Date:

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Sue Segura

Summary

	Installed (Well Log)	Start	End
Water level		24.18	24.14
Total depth	60.2	60.2	60.15
pH		6.60	5.10

Screen interval (btoPVC): 10'
Top: 48.7
Bottom: 58.7
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on	START Pump 0935							Start Surge Swab
0948	58.7	24.18	4.2	541.6	0.08	117	4.20	Muddy Sand, Medium fine brown, some boulders, 2 TSP.
1004	"	—	4.3	123.4	0.08	56	4.05	" ≤ 1 TSP
1009	56.7	—						Move up, Restart Pump
1020	"	—	4.1	168	0.07	31	4.06	" water milky, ≤ 1 tsp Sand
1024	54.7	—						move up, Restart Pump
1039	"	—	5.0	243	0.08	33	4.05	milky, Medium brown Sand, ≤ 1 TSP
1051	"	—	5.0	303	0.08	17	3.89	Water clear, ≤ 1/4 tsp
1055	52.7	—						Move up, Restart pump
1111	"	—	3.5	359	0.08	24	4.39	Slightly milky, 1/4 TSP of Mixed Sand & fine brown
1119	"	—	3.7	388	0.08	17	4.08	Water Clear, ≤ 1 tsp
1125	50.7	—						Move up, Restart pump, Checked FOOT VALVE
1140	"	—	4.9	461	0.08	18	4.46	Water clear Sand Sediment, ≤ 1 tsp
1144	48.7	—						Move up, Restart Pump
1158	"	—	4.1	518	0.08	25	4.84	Water clear slightly Milky, trace sand
1201								Stop Pump
Surge block off	START Polish @ 1207							
1218	93.7	—	4.6	568	0.08	12	4.52	Water crystal Clear, TRACE Sand
1220	-	—						STOP Polish
1223	58.5	—						START Airlift Surge
1231	"	—	4.5	604	0.09	11	4.47	Water clear, 1/4 TSP
1233								Stop Airlift Surge

(* Bottom Depth By .2)

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-24D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AL
DATE STARTED 7/27/05 **COMPLETED** 7/28/05
GROUND ELEVATION 904.45 feet **TOC ELEVATION** 906.29 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633342.648 meters **EASTING** 371719.926 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Peat**	No water added.
					Gravel with sand Brown, subangular to rounded gravel, well-graded sand, dry.	
5	GB				4.5 **Gravel with sand** 1/4"-diameter, angular clasts, well sorted sand, dry.	No water added.
10	GB				10.0 **Gravel with sand** Brown, rounded to subrounded clasts, well-graded sand, dry.	
15	GB				15.0 **Gravel with sand** Brown, subrounded to subangular clasts, well-graded sand, dry.	No water added.
20	GB				20.0 **Gravel with sand** Same as above.	
25					Cuttings are wet, increased root fragments from coarser gravel or cobbles. 25.0 **Gravel with sand** Subangular to subrounded, high percent of fragments, poorly-sorted medium to coarse sand, saturated.	Minimal water added.
30					Significant water on rest of drill after water added. 30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.8 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 2 Sept., 2005
Purge Volume: 1452 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 19.7 Date: 7/28/05 Time: 0814

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-24D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AL
DATE STARTED 7/27/05 **COMPLETED** 7/28/05 **GROUND ELEVATION** 904.45 feet **TOC ELEVATION** 906.29 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633342.648 meters **EASTING** 371719.926 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Gravel with sand** Subangular to subrounded to 1/2"-diameter with significant fragments, poorly-graded coarse sand, saturated. Water level is at 22.1 ft. in casing, rising in casing rapidly after air shut off.	Occasional water added.
35	GB		1/8		35.0 **Gravel with sand** Brown, subangular to subrounded to 1/2"-diameter clasts, less fragments than above, silty well-graded sand, saturated. Water level at rod = 20.9 ft. bgs. Driller notes presence of silt layer.	Approximately 10 gallons total water added from top of hole to 38 feet. No water added.
40	GB				40.0 **Gravel with silty sand** Brown, majority is 0.25" or less in diameter, rounded to subrounded, well-graded silty sand, saturated.	
45	GB				45.0 **Gravel with sand** Subangular to subrounded to 1/2"-diameter, poorly graded medium to coarse sand, saturated.	No water added. High flow 45' to 45.5', little flow at 45.5 feet where flow test attempted.
50	GB				50.0 **Gravel with sand** Brown, subangular to subrounded 1/2"-diameter clasts, well-graded silty sand, saturated.	
55	GB				55.0 **Gravel with sand** Same as above.	
60	GB				60.0 **Gravel with sand** Same as above.	
65	GB				65.0 **Gravel with sand** Rounded to subrounded to 1/4"-diameter clasts, well-graded silty sand, saturated.	Heaving sand, water level not taken. Heaving sands jam bit, casing raised to clear rods, after sand cleared water was added to keep sand down. Foam added to rig water.
70	GB				69.0 70.0 Silt layer, slow drilling. **Sandy silt with clay** Gray, soft, photo of sample was washed on one site to remove soap.	
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-24D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AL
DATE STARTED 7/27/05 **COMPLETED** 7/28/05
GROUND ELEVATION 904.45 feet **TOC ELEVATION** 906.29 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633342.648 meters **EASTING** 371719.926 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Gravelly silt with sand** Gray, to 3/4"-diameter subangular clasts. Driller indicates that we went though a sand lens at 76.5 feet, back into silt at 77.0 feet.	Adding water and foam as needed.
						No water added.
80					80.0 **Gravelly silt with sand** Gray, to 1/2"-diameter subrounded clasts.	
85	GB				85.0 **Silt with sand** Gray, minor gravel, saturated.	Driller adds water with foam as necessary.
90	GB				Water level = 5.7 ft below ground surface, may be rig water hold in casing by silt at shoe. 90.0 **Gravelly silt** Gray, to 3/4"-diameter subangular gravel clasts, saturated.	
95	GB				95.0 **Silt** Gray, with trace sand, saturated.	Driller adds water with foam as necessary.
100	GB				100.0 **Silt** Gray, with trace gravel, saturated.	
					104.0	Injected water and foam to get silt out of hole.
105	GB				105.0 **Silt** Gray, stiff, with trace sand. **Silt** Gray.	Sample. Injected foam to remove silt cutting.
					109.0	Slow drilling, producing no water in cyclone.
110	GB				**Silt** Gray, stiff, dense, dry to damp.	Injecting foam to remove silt cuttings. Sample. Injected foam to remove silt cuttings.
					113.0	
					114.0 **Silt** Gray.	
115	GB				115.0 **Silt** Gray, stiff, dense, damp. **Silt** Gray silt in cuttings.	Sample. Slow drilling. Slow drilling in silt.
					118.0	
					Silt Red brown, stiff, dense.	Very slow drilling.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-24D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AL
DATE STARTED 7/27/05 **COMPLETED** 7/28/05
GROUND ELEVATION 904.45 feet **TOC ELEVATION** 906.29 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633342.648 meters **EASTING** 371719.926 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Rieser/Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					120.5 **Gravel** Well-graded, <15% fines (sample). Gravels, wet (cuttings)	Silt, slow drilling.
	GB		25		123.0 Gravels, wet (cuttings)	Formation is making some water. Driller not injecting foam.
					124.0 **Gravel** Well-graded, <15% fines in cuttings.	Flow test.
			12		124.5 **Gravel with sand and silt** (In cuttings.)	Formation making 25 gpm.
125					125.0 **Gravel** Well graded, 1/4"- to 1/2"-diameter, subrounded, <10% fines, wet.	Bit is stuck in ODEX because of gravels on top of bit.
					126.5 **Sand** Gray, coarse to fine (in cuttings), dense, wet.	Formation producing a lot of water.
					127.0 Sand in cuttings.	Slow drilling. Driller not getting cuttings up due to silt.
					128.0 Sand in cuttings, wet.	Slow drilling. Very dense sand, very slow penetration. Inject foam to get sand cuttings up. 15 min./ft. penetration rate.
					129.0 Sand in cuttings, wet.	Driller having difficulty getting through this end of sand, very dense.
130	GB				**Sand and pea gravel** Coarse, dense, wet (in cuttings).	Slow penetration rate.
					Sand and pea gravel Poorly graded 1/4"- to 1/2"-diameter gravel, coarse to fine sand, dense, wet. Sample.	Slow drilling, hard to get coarse sand cutting to top of hole.
					134.0 Gravel in cuttings.	Slow drilling.
135	GB				135.0 **Gravel** Poorly graded subrounded pea gravel, >15% fine sand, dense, wet.	Driller ups air flow from compressor to get sand and gravels to the surface.
					136.5 **Sand** Coarse sand (in cuttings).	Slow drilling.
					Gravel Poorly graded, coarse sand, <15% fines.	Slow drilling rate.
					138.0	Slow drilling, slow penetration.
			25		139.0 **Gravel** Poorly-graded pea gravel, coarse sand (cuttings).	Slow drilling. Injecting foam to get cuttings up hole.
140	GB				**Gravel** Well-graded 1/4"- to 1/2"-diameter gravel, <15% fines, coarse sand, dense, wet.	Slow penetration or rate. Dense - a lot of water.
					141.0	Still producing water from formation.
					142.0 **Gravel** Poorly graded, coarse sand. Large 1"-gravel in cuttings.	Slow penetration rate.
					Bottom of hole at 142.0 feet.	Very slow drilling. Formation producing a lot of water. Driller doesn't know how large gravel can get past bit.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AL/P-DS-24D
Date: 9/2/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wimmer, TREFIM WASSILLIE

Summary

	Installed (Well Log)	Start	End
Water level	21.57	22.82	22.75
Total depth	142.3	141.87	143.05 (SOFT)
pH	~~143.08~~	6.43	6.44

Screen interval (btoPVC): 10
Top: 131.82
Bottom: 141.82
PVC stick-up height (above ground surface): 1.7

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 0921									
0941	141.82	22.82	4.9	82	0.1	97	4.48	WATER Milky Medium grain Sand 1 TBS.	
0956	"	—	4.5	149.5	0.1	72	4.18	Slightly milky, " 1½ TSP	PH 6.43
1008	"	—	4.6	474	0.1	24	4.03	" " ½ TSP.	PH 6.45
1014	139.8	—	—	—	—	—	—	RESTART Pump. Move up	
1031	"	—	4.0	542	0.1	118	4.53	WATER lt Brown Slightly Milky, medium sand 1½ TBS	6.50
1050	"	—	3.9	616	0.1	56	4.77	" " 1½ TSP	
1107	"	—	3.9	682	0.1	41	4.44	WATER Slightly Milky, ½ TSP.	PH 6.49
1112	137.8	—	—	—	—	—	—	Move up RESTART Pump.	
1135	"	—	4.1	784	0.1	281	4.56	Milky Brown, suspended: Medium Sand 1½ TBS.	PH 6.48
1200	"	—	4.2	889	0.1	127	4.99	Slightly Milky, Medium Sand/Silt, 1½ TBS, 1 TSP	
1216	135.8	—	—	—	—	—	—	Move up. RESTART Pump	
1253	"	—	3.4	1014	0.1	159	5.18	lt Brown/Murky, Coarse/Medium Sand/Silt, 1½ TBS.	PH 6.51
1316	"	—	2.4	1069	0.1	82	5.68	Slightly Cloudy, Coarse/Medium Sand, 1 TSP	
1328	135.8	—	—	—	—	—	—	Move up. Restart pump (REPLACED Check Ball)	
1343	"	—	4.4	1135	0.1	70	5.48	WATER Cloudy/Milky, Medium Sand. 1½ TBS.	PH 6.47
1409	"	—	4.5	1252	0.1	13	5.12	WATER CLEAR, 1 TSP	6.44
1415	131.8	—	—	—	—	—	—	Move up. RESTART Pump	
1428	"	—	4.5	1310	0.1	7	4.73	WATER CLEAR, TRACE Sand.	
1431								STOP Pump.	
Surge block off START Polish @ 1438									
1450	126.8	—	4.0	1358	0.01	5	5.21	WATER CLEAR, TRACE SAND.	
1452	"	—	—	—	—	—	—	STOP Pump	
1456	141.82	—	—	—	—	—	—	START Polish Surge.	
1518	"	—	4.3	1452	0.01	6	4.96	WATER CLEAR, TRACE SAND	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-24S
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AL
DATE STARTED 7/28/05 **COMPLETED** 7/29/05
GROUND ELEVATION 904.17 feet **TOC ELEVATION** 906.17 feet
DRILLING CONTRACTOR Foundex
NORTHING 6633350.028 meters **EASTING** 371723.086 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat** **Silty sandy gravel** Brown, dry (cuttings).	
5					5.0 **Sand** Light tan, very fine, dry. 7.0	Sample collected 5' to 6'. Cuttings.
10	GB				**Gravel** Brown, well-graded gravel, fine sand. 10.0 **Gravel** Brown, well-graded gravel, coarse sand, >15% fines, dry. 14.0	Sample collected 10' to 11'. Fast drilling rate.
15	GB				15.0 **Gravel** Brown, well-graded 1/4"- to 1/2"- diameter gravel, coarse to fine sand, >15% fines, dry. **Gravel with sand** Well-graded 1/4"- to 1/2"- diameter gravel. 18.0 Cuttings.	Sample collected 14' to 15'.
20	GB				19.0 **Gravel** Well-graded gravel, coarse to fine sand, dry. **Gravel** Well-graded gravel, coarse to fine sand, >15% fines, dry. 23.0	Sample collected 19' to 20'. Fast drill rate.
25	GB				24.0 **Gravel with sand** Well-graded 1/4"- to 1/2"- diameter gravel, wet. 25.0 Cuttings. **Gravel** Well-graded 1/4"- to 1/2"- diameter gravel, fine sand, >15% fines, silt, wet. 28.0 **Gravel with sand and silt** Damp.	Water dripping out of air return and cyclone. Sample collected 24' to 25'.
30	GB				29.0 **Gravel with sand** Clean gravels, little or no fines, wet.	Wet, water flowing out of cyclone. Sample collected 29' to 30'.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.0 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 3 Sept., 2005
Purge Volume: 429 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 22.76 Date: 7/29/05 Time: 0600

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-24S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AL
DATE STARTED 7/28/05 **COMPLETED** 7/29/05 **GROUND ELEVATION** 904.17 feet **TOC ELEVATION** 906.17 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6633350.028 meters **EASTING** 371723.086 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
					31.5 **Gravel** Well-graded gravel, coarse sand, 15% fines, wet.	Cuttings.
					33.0 **Silty sandy gravel** Brown, damp, >15% fines.	
	GB				34.0 **Gravel with sand** Coarse sand, <15% fines, wet.	Sample collected 34' to 35'.
35					35.0 **Gravel** Well-graded gravel, <15% fines, wet.	Inject foam to get cutting out of hole.
					Gravel with sand Coarse sand.	
					37.0 **Gravel with sand and silt**	
					38.5	
					39.0 **Silt** Brown silt in cutting.	Silt layers in cutting, chunks of silt.
					Bottom of hole at 38.5 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

2.54
-0.64
1.90

WELL DEVELOPMENT LOG

Well ID: AL/P-05245
Date: 9/2/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Trefin, Wasasali

Summary

	Installed (Well Log)	Start	End
Water level	22.76	23.81	23.72
Total depth	40.17	39.93	39.95
pH		6.51	6.03

Screen interval (btoPVC): 5
Top: 34.88
Bottom: 39.88
PVC stick-up height (above ground surface): 1.90

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1548									
1605	39.88	23.81	3.8	64.6	0.06	175	5.80	Water Brown/orange, Murky, Suspended SILT 1½ Tsp Sand	
1621	"	—	3.8	124	0.06	72	5.80	Water lt orange Brown, Silt + Medium Sand, ½ Tsp	PH 6.09
1635	37.88	—	—	—	—	—	—	Move up, Restart Pump.	
1653	"	—	3.8	192	0.06	336	5.03	Many brown, Medium Sand & Silt, 2 TBS.	PH 5.99
1719	"	—	4.2	259	0.06	133	4.98	WATER lt Brown/orange, 1½ TBS.	PH 6.0
1730	"	—	4.6	309	0.06	84	4.77	lighter in color",	PH 5.97
1735	35.88	—	—	—	—	—	—	Move up, Restart Pump.	
1745	"	—	—	—	—	—	—	STOP pump For DAY	
9/3/05 0851	"	—	—	—	—	—	—	Restart Pump	
0915	35.88	—	0.31	316	0.02	52	4.86	WATER CLEAR, 1 tsp Medium Sand	PH 6.54
0923	34.88	—	—	—	—	—	—	MOVE UP. RESTART Pump checked FOOT	
0934	"	—	2.0	338	0.06	33	4.55	CLEAR WATER/Slightly Cloudy TRACE SAND, Ph 6.30	VALVE,
0939	"	—	—	—	—	—	—	STOP Pump	Its OK
Surge block off START Polish @ 0945									
0955	29.88	—	1.5	353	0.06	13	4.64	WATER CLEAR, TRACE Sand	PH 5.99
1000	"	—	—	—	—	—	—	STOP POLISH	
1006	39.88	—	—	—	—	—	—	START Debris Surge	
1025	"		4.0	429	0.06	8	4.56	WATER CLEAR / TRACE SAND	
1026	"	—	—	—	—	—	—	Stop Surge / END.	

1411
2
282

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-25

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 7/31/05 **COMPLETED** 8/1/05
GROUND ELEVATION 925.40 feet **TOC ELEVATION** 927.52 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6634389.914 meters **EASTING** 372510.061 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	
					4.0	
5	GB				5.0 **Sand with gravel** Brown, well-graded sand, minor silt, dry.	
					Sand with gravel Brown, well-graded sand, minor silt, dry.	
					9.0	
10	GB				**Sand with gravel** Brown, well-graded gravel, trace silt, dry.	
15	GB				15.0 **Sandy gravel** Brown, well-graded gravel and sand, trace silt, dry.	
					19.0	
20	GB				**Sand with gravel** Brown, well-graded sand, minor to trace gravel and silt, dry. Gravel in cyclone.	
					24.0	
25	GB				25.0 **Sandy gravel** Brown, well-graded gravel with sand, trace silt, dry.	
					Sandy gravel Brown, well-graded gravel with sand, trace silt, dry.	
					28.5	
30					29.5 **Rock and sand** White, silica-rich rock pieces, doesn't react to hydrogen chloride.	"White ash" = hard drilling.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.1 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 2 Aug., 2005
Purge Volume: 870 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 25 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 37.48 Date: 8/1/05 Time: 1030

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-25
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 7/31/05 **COMPLETED** 8/1/05
GROUND ELEVATION 925.40 feet **TOC ELEVATION** 927.52 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634389.914 meters **EASTING** 372510.061 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Sandy gravel** Brown, well-graded gravel, dry.	
					34.0	
35	GB				35.0 **Silt and fragments** Boulder fragments	
					Silt and fragments Boulder fragments, All pieces appear mineralogically equivalent	
					39.0	
40	GB				40.0 **Sandy gravel** Black, predominantly siltstone fragments, 0.5 mm- to 20 mm, subrounded to subangular, moist.	
					Weathered bedrock	
					43.0	
45	GB				**Weathered bedrock** Black, siltstone bedrock with brown silt, subrounded to subangular, weathered bedrock, minor iron-oxide stain, moist. 45.0	
					Weathered bedrock Black weathered siltstone bedrock, brown silt, minor iron-oxide stain, moist.	
		35.9				
					49.0	
50	GB		0.6		**Weathered bedrock** Black weathered siltstone bedrock, reacts slightly to hydrochloride, wet. One piece has crystalline calcite (2 mm x 2 mm).	Full air needed to push water.
			1.0			Full air needed to push water.
			6			Retracted bit, 50 psi air.
55					55.0	Shift change. Driller says bedrock getting denser, driller slower and cuttings smaller, dark gray to black consistency, freshly exposed surfaces.
			2.5		Black siltstone.	
60						
			1.5		62.0	Fracture zone @ 61' for approx. 0.5 foot, cutting brownish surface (weathered) large.
					Bottom of hole at 62.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P-05-25
Date: 8/2/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor, Bob Klingforth.

Summary

	Installed (Well Log)	Start (FTOC)	End
Water level		37.67	37.71
Total depth		64.39	64.45
pH		6.73	6.35

Screen interval (btoPVC): 10'
Top: 61.5 + 2 = 53.5 FTOC
Bottom: 61.5 + 2 = 63.5 FTOC
PVC stick-up height (above ground surface): 2.05

Development Observations Assume TD is 64.0.

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	Pumping started @ 11:50								
1150	63.5	37.67	-	0	0.20	[illegible] 37	6.80	DARK BROWN, SILTY Sand ≤ 1 cup Sediment	Ph 6.73
1209	"	-	2.29	43.57	0.13	312	5.89	Dark Brown, Silty Sand, Medium to Fine grain, 2 TBS.	
1225	"	-	4.34	113.13	0.11	106	5.23	" ≤ 1 TSP.	
1237	"	-	4.34	165.21	0.10	80.7	4.89	PH. 6.64. "	
1248	61.5	-	4.24	169.48	0.10	77.4	5.02	Brown / " 2 TSP.	
1300	"	-	4.23	220.24	0.10	39.1	5.49	≤ 1 TSP.	PH 6.56
1320	"	-	4.23	304.84	0.10	32.9	5.45	" ≤ 1 TSP	PH 6.63
1337	59.5	-	5.85	404.29	0.10	32.3	5.39	≤ 1/2 TSP.	PH 6.52
1348	"	-	5.85	468.64	0.10	26.2	5.38	≤ 1/2 TSP.	PH 6.51
1355	57.5	37.71	5.7	508.54	0.11	79.7	5.38	" ≤ 1/2 TSP	PH 6.71
1411	"	"	4.54	581.18	0.10	13.4	5.06	≤ 1/2 TSP.	PH 6.66
1425	55.5	"	4.35	642.04	0.10	32.8	4.77	" 2 TBS.	
1440	"	-	4.38	707.74	0.10	18.2	4.90	≤ 1 TSP	Ph 6.50
1455	[illegible] "		4.54	775.92	0.09	12.9	5.56	"	PH 6.50
1505	53.5	37.71	4.23	818.27	0.10	9.18	4.86	"	
1517	"	-	4.34	870.46	0.10	18.6	4.48	"	PH 6.35
								Stop Pumping @ 1522	
Surge block off									
1529	Resumed	Pumping @			5-6"	Above	Bottom of Well		
1539	63.9 Approx	-	4.23						
1557	[illegible] 45	Moved	Tubing To		5ft	Above	Top of Screen - START POLISH		
1608								Stopped Polish, No Sediment.	
1615								Moved Back to Bottom for Final	
1630								Stopped Pumping → End	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26D
PAGE 1 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/9/05 **COMPLETED** 8/9/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Tundra**	
					4.0	
5	GB				5.0 **Silty gravel** Brown, <3/4"-diameter, subrounded to well rounded clasts.	
					Silty gravel Brown, <3/4"-diameter, subrounded to well rounded clasts with sand.	Fast drilling, soft.
					9.0	
10	GB				**Silty gravel to gravelly silt** Brown, <3/4"-diameter, subrounded to well rounded clasts with sand.	
					14.0	
15	GB				15.0 **Silty gravel to gravelly silt** Same as above.	
					Silty gravel to gravelly silt Brown, <3/4"-diameter, subrounded to well rounded clasts.	
					18.0	
20	GB				19.0 **Silty gravel to gravelly silt** Same as above, more sand, less silt.	Dry.
					Sandy gravel to gravelly sand Brown, <3/4"-diameter, subrounded to well rounded clasts with silt.	
					24.0	Making trace water, muddy cuttings.
25	GB				25.0 **Silty gravel with sand** Brown, subrounded to well rounded <3/4"-diameter clasts.	Dry cuttings.
					Silty gravel with sand Brown, subrounded to well rounded <3/4"-diameter clasts.	Dry cuttings.
					29.0	Slower, harder drilling.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.8 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 Aug., 2005
Purge Volume: 380 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 137.81 Date: 0135 Time: 8/18/05

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-26D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N

DATE STARTED 8/9/05 **COMPLETED** 8/9/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silty sand with gravel** Brown, <1/2"-inch, angular to subrounded, fine-grained sand clasts.	Fresh exposed gravel clasts from pulverized boulders?
					34.0	
35					35.0 **Silty sand with gravel** Same as above.	Fresh exposed gravel clasts from pulverized cobbles?
					Silty sand with gravel Brown, <1/2"-inch, angular to subrounded, fine-grained sand clasts.	Fresh exposed gravel clasts from pulverized cobbles?
					39.0	
40	GB				**Silty sand with gravel** Same as above.	Dry cuttings.
						Lots of cobbles?
					43.0	
					44.0 **Silty sand with gravel** Same as above, more gravel and sand, less silt.	
45					45.0 **Sandy gravel to gravelly sand** Brown, ~2"-diameter, well rounded, fine- to medium-grained sand.	Dry cuttings.
					Sandy gravel to gravelly sand Brown, ~2"-diameter, well rounded, fine- to medium-grained sand.	
					49.0	
50					**Sandy gravel with silt** Brown, ~2"-diameter, subrounded to subangular, fine-grained sand.	
					54.0 Grades with more sand.	
55					55.0 **Sandy gravel to gravelly sand** Brown, ~1"-diameter, subangular to subrounded, fine- to medium-grained sand.	Dry.
					Sandy gravel to gravelly sand Brown, <1"-diameter, subangular to subrounded, fine- to medium-grained sand.	
					59.0	
60	GB				**Gravel with sand** Brownish gray, angular gravel clasts, trace sand, varying lithology all with fresh exposure.	
					64.0	
65					65.0 **Gravel with sand** Same as above.	
					Gravel with sand Brownish gray, 1"-diameter or smaller, angular gravel clasts, trace sand, varying lithology all with fresh exposure.	Dry.
					69.0	
70	GB				**Gravel** Gray, 1/2"-diameter, angular, mostly pea gravel clasts, all with fresh exposure.	Extremely dry and dusty.
					74.0	Dusty and dry.
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/9/05 **COMPLETED** 8/9/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Gravel** Gray, <1"-diameter, angular clasts with fresh exposure.	Dusty and dry.
					Gravel Gray, <1"-diameter, angular clasts with fresh exposure.	
80	GB					Dusty and dry.
					83.0	
					84.0 **Sand**	
85	GB				85.0 **Gravelly sand** Gray, <1/2"-diameter, medium-grained, angular clasts.	
					Gravelly sand Gray, <1/2"-diameter, medium-grained, angular clasts.	
					89.0	
90	GB				**Sand** Brown, medium- to coarse-grained, trace gravel.	Redrill, hit water at 91' bgs on 8/11/05
			1/4		94.0	Redrill
95	GB		1/4		95.0 **Sand** Brown, medium grained.	Redrill Started adding foam as cyclone tube is clogging.
					Sand Brown, medium grained.	
					98.5	
100	GB				**Gravel** Brown, ~1"-diameter or smaller, subangular to subrounded clasts. Started getting some dark-colored siltstone cuttings.	Very hard drilling. Added foam.
					104.0	Added foam.
105	GB				105.0 **Gravel** Brown, <1/2"-diameter, subangular to subrounded clasts, trace medium- to coarse-grained sand,	
					Gravel Brown, <1/2"-diameter, subangular to subrounded clasts, trace medium- to coarse-grained sand,	
110	GB				109.0 **Sandy gravel** Brown, <1/2"-inch diameter, subangular to subrounded clasts, medium- to coarse-grained sand.	
115					115.0 **Sandy gravel** Brown, <1/2"-inch diameter, subangular to subrounded clasts, medium- to coarse-grained sand.	Redrill, blow casing with air, no water in hole on 8/11/05.
					119.0	Added foam.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/9/05 **COMPLETED** 8/9/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Sandy gravel** Same as above, clasts up to 2"-diameter.	Added foam.
125	GB				125.0 **Sandy gravel** Brown, <3/4"-inch diameter, angular to subrounded clasts, medium- to coarse-grained sand.	Added foam.
130	GB					
135					135.0 **Sandy gravel** Brown, <3/4"-inch diameter, subangular to subrounded clasts, medium- to coarse-grained sand.	
140					139.0 **Sandy gravel** Same as above, pea-sized gravel.	Added foam.
145	GB		3/4		145.0 **Sandy gravel** Brown, subangular to subrounded pea-sized clasts, medium- to coarse-grained sand.	Redrill
150						Added foam.
155					155.0 **Sandy gravel** Brown, <1/2"-inch diameter, subangular to subrounded clasts, medium- to coarse-grained sand.	Added foam.
160	GB		10			Redrill, flow test 10 gpm at 16:10 on 8/11/05. Added foam.
						Redrill

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/9/05 **COMPLETED** 8/9/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165	GB		2.5-3.0		165.0 **Sandy gravel** Brown, <1/2"-inch diameter, subangular to subrounded clasts, medium- to coarse-grained sand.	
			2.5		169.0 **Sand** Brown, fine grained.	Redrill
170			2.5			
			5		174.0	Redrill
175			15		175.0 **Sand** Brown, fine-grained sand with silt.	Redrill
			8		**Sand** Brown, fine-grained sand with silt.	Redrill
					179.0 **Sandy silt to silty sand**	
180	GB				184.0	
	GB		15		185.0 **Gravelly sand to sandy gravel** Brown, 1/2"-diameter or smaller, subangular to subrounded gravel clasts, medium- to coarse-grained sand.	
			15		**Gravelly sand to sandy gravel** Brown, 1/2"-diameter or smaller, subangular to subrounded gravel clasts, medium- to coarse-grained sand.	Rechecked flow test, still 15 gpm. Water is very cold, icy cold. Broke lead on casing.
					190.0 Bottom of hole at 180.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: AN/P-05 ~~25D~~ 26D (MR)
Date: 8/13/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor.

Summary

	Installed (Well Log)	Start	End
Water level		137.84	
Total depth	181.0	182.45	
pH		6.83	

Screen interval (btoPVC): 15'
Top: 162.4
Bottom: 177.4
PVC stick-up height (above ground surface): 1.8

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump 0881									
0859	177.4	137.84	.59	10.6	0.10	[E 3]	6.82	DK Brown, Mocky, Muddy, Thick SILT/ ~~Fine Sand~~	2 cups
0940	"	—	.76	52.3	0.09	[E 3]	6.79	" SILT/Fine ○ ≥ 1½ cup	PH 7.81
0950	175.4	—	—	—	—	—	—	Move up. Restart Pump	
1010	"	—	1.66	87.16	0.08	[E 3]	6.12	"	
Pump Stopped Flowing. Pulled up & replaced check Ball.									
1050	175.4	—	—	—	0.0	[E 3]	—	Restart pump	
1101	"	—	1.1	121.56	0.09	[E 3]	7.38	" Same SILT AS Above, ~~1~~ ¾ cups	PH 7.03
1119	173.4	—	—	—	—	—	—	Move up. Restart pump.	
1144	"	—	.94	153	0.09	[E 3]	7.58	" 2½ cups.	PH. 7.0
1221	"	—	.625	176	0.09	[E 3]	10.43	Flow Slowed. Pulled Here, NOT TO FOOT VALVE	
1241	171.4	137.50	—	—	—	—	—	Restart pump. Move up 2 cups.	2 cups
1300	"	—	.49	186	0.08	[E 3]	10.78	Flow Still Trickle, 1½ cups Silt.	PH 7.1
1333	"	—	.55	204	0.08	[E 3]	9.75	Water Still Murky, Dark Brown.	PH 6.90
1354	169.4	—	—	—	—	—	—	Move up Restart Pump.	
1426	"	—	.71	226	0.08	162	9.93	Water A Bit Cloudy But Quite Itty! 2 tsp.	PH 6.90
1454	167.4	—	—	—	—	—	—	Move up. Restart Pump.	
1522	"	—	.5	240	0.08	319	10.30	Cloudy, Very Slow Flow. 1 TBS.	PH 7.07
1554	"	—	.5	256	008	92.2	11.82	SILT & Suspended Sitting, 2 tsp, Clear	PH 6.81
1611	165.4	—	—	—	—	—	—	Move up. Restart Pump.	
1624	"	—	1.55	276	0.08	814	7.41	Water Clear, Lt Brown. Grout Floating on top. 2 TBS Silt	6.93
1649	"	—	1.51	313	0.08	339	7.23	Cleaning up. 2 tsp. Fine Sand & Trace Silt	6.80
1700	163.4	—	1.62	—	—	—	7.07	Move Up., Restart Pump.	
1727	163.4	—	1.62	356	0.08	176	7.07	Grout Still Floating (Film) Water Cloudy (Grey) 1 tsp	PH 6.71
1738	162.4	—	—	—	—	—	—	Move up. Restart pump	
~~Surge Block off~~									
1748	"	—	160	372	0.08	96.5	6.74	Water Clear. Grout Film on top of Water ≤½	½ tsp. Medium Fine Sand 6.73 Trace Silt.
1757	"	—	—	—	—	—	—	END / Stop Pump	
1805	157.4	—	—	—	—	—	—	START POLISH	
1809	"	—	2.17	380	008	16.7	6.94	Water Clear. Medium to Fine Sand. Trace Silt ≤ 1 tsp.	PH 6.71
1814								Stop Polish	
1620								START Debris Purge	
06:45								STOP Debris Purge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N

DATE STARTED 8/15/05 **COMPLETED** 8/15/05 **GROUND ELEVATION** 1012.86 feet **TOC ELEVATION** 1015.65 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6635473.505 meters **EASTING** 370738.753 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Gravel and sand**	
					3.0 **Sand** Light brown, slightly silty, dry.	
5	GB				7.0	
					8.0 **Silty sand** Brown, <15% pea gravel, damp.	
	GB				**Silty sand** Cuttings easily ball-up, small amount of gravel in cuttings.	A lot of silt with fine sand, can ball-up cuttings due to silt content.
10					12.0	
					Silty sand with gravel Brown, >15% gravel, damp.	
	GB				15.0	
15					16.0 **Silty sand with gravel** Brown, <15% gravel, damp.	
					17.0 **Sand** Slightly silty, <15% gravel, damp.	
					Sand Brown, medium, slightly silt, <15% gravel, damp.	
	GB				19.0	
20					**Sand** Brown, medium, slightly silty, <15% gravel (cuttings).	
					22.0	
					Sand Poorly graded, >15% gravel, dry.	
	GB		1/8		24.0 Hit small amount of well-graded gravel, ~1/8 gpm.	
25					**Silty sand and gravel** Very silty, wet.	Cutting are clogging up pipe due to the amount of silt.
					26.5	
					27.0 **Sand** Medium sand and gravel.	
					28.0 **Sand** Brown, 70% medium sand, 30% 1/2"-diameter gravel, <15% fines, damp to dry.	
	GB		1/8-1/4		**Sand** Medium to fine, 10% to 15% silt, wet.	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.8 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: N/A Insufficent Water
Purge Volume: N/A Insufficent Water

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Static Water Depth is denoted by solid triangle (ftoc): 102.76 Date: 8/18/05 Time: 1:55

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site N
DATE STARTED 8/15/05 **COMPLETED** 8/15/05
GROUND ELEVATION 1012.86 feet **TOC ELEVATION** 1015.65 feet
DRILLING CONTRACTOR Foundex
NORTHING 6635473.505 meters **EASTING** 370738.753 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
					31.5 **Sand** Medium to fine, 10% to 15% silt, wet.	
					32.0 **Silt** Brown, fine sand, damp.	Injected foam to get silt out of ODEX pipe.
					33.0 **Silt** Brown, fine sand, <15% pea-sized gravel.	
	GB				**Silt** Brown, silt with sand and pea gravel.	Injected foam to clean out silt.
35						Injected foam.
	GB					
40						
	GB					
45						
					46.8	Drilled into a quartz boulder at 46.5' to 47'.
					48.0 **Sand or ash** Light gray, very fine (may be ash), dry.	
	GB				**Gravel and sand** Coarse sand, 15% fines, dry.	
50					52.0	
					Gravel and sand Well-graded gravel, coarse sand, <15% fines, dry. 54.0	Drilled into a 6"-thick cobble.
	GB				55.0 **Sand** Coarse, clean sand, no fines, dry (cuttings).	
55					**Sand** Coarse sand, no fines, loose formation, dry. 57.0	
					Sand Coarse sand, no fines, loose formation, dry.	Driller said air from rig is blowing into formation. Driller is getting some returns but loose formation is taking a lot of the air.
	GB				59.8	
60					**Gravel and sand** Dry (cuttings). 61.9	Driller contacted cone shack for more consumables, they did not send over what driller ordered.
					Sand 70% coarse sand, 30% 1/4"- to 1/2"-diameter gravel, <15% fines, dry. 64.0	
	GB				64.8 **Sand** Coarse, small-diameter gravel, dry.	
65					**Gravel** Clean, 1/2"-diameter, 3% sand or fines. 67.0	Injected foam to get 1/2"-diameter gravels up the hole, having some problems getting cuttings out with only one compressor working.
					Gravel 80% pooly-graded, 1/4"-diameter pea gravel, 20% coarse sand, <15% fines.	Injected foam to get gravel up.
	GB					Injected thick foam to get gravel cuttings up hole.
70					72.0	
					Gravel 80% pooly-graded, 1/4"-diameter pea gravel, 20% coarse sand, <15% fines. 74.0	
	GB					Injected thick foam to get pea gravel up the hole.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site N
DATE STARTED 8/15/05 **COMPLETED** 8/15/05
GROUND ELEVATION 1012.86 feet **TOC ELEVATION** 1015.65 feet
DRILLING CONTRACTOR Foundex
NORTHING 6635473.505 meters **EASTING** 370738.753 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Gravel** Well-graded, 1/2"- to 1/4"-diameter gravel, coarse sand, dry (cuttings).	
					77.0	
	GB				**Sandy gravel-gravelly sand** Brown, 1/2"-diameter, subrounded to subangular, medium- to coarse-grained sand clasts.	Added foam, both compressors now water.
80						
	GB					
85						
					87.0	
	GB				**Sandy gravel** Brown, 1/2"-diameter, subangular to subrounded, medium- to coarse-grained sand clasts.	
90						
	GB					Added foam.
95					95.0	
					Sandy gravel Brown, 1/2"-diameter, subangular to subrounded, medium- to coarse-grained sand clasts.	Making water.
	GB					
100						Making water.
	GB				102.6	
	GB				Bottom of hole at 102.6 feet.	Flushed hole.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: P-05-26M
Date:

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician:

Summary

	Installed (Well Log)	Start	End
Water level			
Total depth			
pH			

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
Surge block off								

LESS THAN 1' OF WATER IN PIEZOMETER...

NO DEVELOPMENT

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N

DATE STARTED 8/16/05 **COMPLETED** 8/16/05 **GROUND ELEVATION** 1011.66 feet **TOC ELEVATION** 1014.25 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6635466.971 meters **EASTING** 370744.105 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat**	
					Sand and gravel	Soil appears soft and drill stem and ODEX just pulled down with almost no hammering.
5					Started picking up gravels in soil. 7.0	
					Sand Brown, medium, some gravel, damp. 8.5	
	GB				**Gravel and sand** 1/2"-diameter gravel, <15% silt.	Show of water at top of casing, could be water from previous drilling at site.
10					11.5	
					Sand Brown, medium, little to no gravel, damp. 13.0	
	GB				14.0 **Gravel and sand** Poorly-graded gravel, dry (cuttings).	
15					15.0 **Sand** Brown, medium, dry (cuttings).	
					16.0 **Gravelly silty sand** Brown, 75% medium sand, 10% pea gravel, 15% silt, damp (cuttings).	Cuttings have more silt and starting to stick in pipe. Driller mixed up batch of foam. Driller injects foam.
					17.0 **Gravel and sand** 1/2"-diameter gravel, some silt.	
20					**Gravel and sand** 60% 1/2"-diameter, well-graded gravel, 40% medium sand, dry. 19.0	
					Gravel and sand Clean, 1/2"-diameter gravel, coarse to medium sand, little to no fines, dry. 21.0	
					22.0 **Gravel and sand** Clean, 1/2"-diameter, subrounded gravel, coarse to fine sand, 3% silt (cuttings). 23.0	
			1/8-1/4		**Gravel and sand** 50% 1/2"-diameter, subrounded, well-graded gravel, 47% coarse to fine sand, 3% silt, damp (cuttings). 24.0	Groundwater, very low flow
25					25.0 **Gravel and sand** Wet. 26.0	
					Silty sand and gravel Very silt sand, wet (cuttings). 27.0	
					Silty sand and gravel Very silt sand.	
					Sand Medium sand and gravel. 29.0	
30					**Sand** Medium sand and gravel, wet.	
					30.0 **Silt** Very silty sand and gravel, dry.	

Bottom of hole at 30.0 feet.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.6 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 17 Aug., 2005
Purge Volume: 1000 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 14 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 21.72 Date: 8/16/05

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-26S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/16/05 **COMPLETED** 8/16/05 **GROUND ELEVATION** 1011.66 feet **TOC ELEVATION** 1014.25 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635466.971 meters **EASTING** 370744.105 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
	GB					

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

P-05-265

Well ID: N/~~P-05-255~~ BK
Date: 8/17/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: C. Scala

Summary

	Installed (Well Log)	Start	End
Water level	21.72	21.79	
Total depth		~~21.79~~	
pH		↳ No pH meter avail. 32.75	

Screen interval (btoPVC):
Top: 19.5
Bottom: 29.5
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
2045		21.79						
2137	29 ft	21.82	2.5	~5	146.4	E3	6.8	Muddy Water br. 2 Tbl spoons
2200			2.75		53.0	E3	5.9	Muddy water br. 1 teaspoon
2233			2.0		49.3	1000	6.0	Cloudy water br. < ½ teaspoon
2301			2.0		49.3	1000	6.0	Milky
2305			Stop					
2308	27 ft		2.75		49.2	E3	5.5	Muddy Water br. ~1 Tbl spoon
2339			3.5		50.4	E3	6.6	Cloudy water < tsp
0009			2.75		34.9	242	6.6	Milky - Opaque trace sediment
0028			2.8		36.7	118	6.9	Opaque
0031			Stop					
0034	25 ft		3.25		36.6	408	6.3	Cloudy water Trace sed.
0113			2.5		27.0	27	7.1	Clear - can see bottom of bucket
0124			2.75		36.2	41.3	6.3	Clear " "
0141			2.75		24.5	43.0	6.4	Clear " "
0143			Stop					
0146	23 ft		2.33		45.7	>1000	5.1	Cloudy Water trace sed
0205			1.75		47.5	356	5.9	Cloudy water
0237			2.25		37.1	76.8	6.0	Opaque
0300			2.25		36.0	82.3	6.1	opaque
0326			2.25		41.1	562	5.7	Clear-Bb - opaque
0327			Stop					
0330	21 ft				~~45.8~~	~~577~~	~~7.8~~	Muddy ½ tsp
0400					45.8	577	7.8	Cloudy - Muddy ½ tsp
0421 * ~~Surge block off~~			1.75		45.2	828	6.4	Cloudy < ½ tsp
0504			0.75		48.7	262	6.2	Cloudy - opaque trace
0529		Stop	0.50		42.6	170	6.5	Opaque trace
0539	29.5	Pump Sediment			out of Piezo			2.5 gpm
0637		Stop						Milky trace sediment
0639		~~Stop~~ ~~pulsing~~	Can't pump as DTW ≈ top of screen.					

741 Stops pumping water. Check check valve, valve is fine, continue pumping

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BI
DATE STARTED 8/23/05 **COMPLETED** 8/23/05
GROUND ELEVATION 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex
NORTHING 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Organic silt	Driller welds lead ODEX casing to 2nd casing to try to prevent down hole break.
					2.0 **Organic silt (peat)** Moist.	
	GB				3.5 **Gravel, sand and silt** (Cuttings.)	
5						
					7.0 **Sand** 50% well-graded, medium sand with >15% gravel, 10% fine sand, 30% gravel, dry.	
	GB					Drilling dry, no injection of water.
10					10.5 **Sand** Coarse to medium sand, <10% fines, no gravel, dry.	
					12.0 **Sand** Brown, coarse to medium sand, <15% gravel, dry.	
	GB				13.0 **Gravel** Poorly-graded gravel, medium to fine sand, dry (cuttings).	
15					15.0 **Gravel** Poorly-graded gravel, medium to fine sand (cuttings).	
					17.0 **Sand**	
	GB					Drilling dry, no water injection.
20						
					22.0 **Sand** Coarse to medium sand, 10% pea gravel, <5% fines, dry.	
	GB					
25					26.0	
					27.0 **Gravel with sand** Well-graded gravel, coarse to medium sand, little fines, dry (cuttings).	
	GB				28.0 **Sand** Dark gray, 60% coarse sand, 20% medium sand, 20% gravel, damp. Water at 28 feet.	Driller injects water.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.7 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 27 Sept., 2005
Purge Volume: 1538 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 17 Oct 2005

Comments:

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site BI
DATE STARTED 8/23/05 **COMPLETED** 8/23/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
					32.0 **Gravel** Well-graded gravel, coarse sand, <10% silt, wet, water is very silty in cuttings (cuttings).	
	GB				**Gravel** Well-graded gravel, coarse sand, 15% fines, wet.	
35					35.0 **Gravel with sand** Coarse sand (cuttings).	
					37.0 **Gravel with sand** 50% 1/4"- to 1/2"-diameter, well-graded gravel, 50% coarse sand.	
	GB				39.0 **Sand** 70% coarse sand, 30% pea gravel, clean, no fines.	
40					40.5 **Gravel with sand** Well-graded gravel, coarse sand.	
					42.0 **Gravel with sand** 70% 1/2"- to 1/2"-diameter, well-graded gravel, 30% medium sand, little to no fines.	Injected water.
	GB				45.0 **Gravel and sand** Coarse sand (cuttings).	
45					45.9 **Gravel and sand** Well-graded gravel, medium sand, increasing >15% silt (cuttings).	
					47.0 **Gravel and sand** Well-graded gravel, medium sand, increasing >15% silt.	
	GB				49.9 **Silt** Gray, stiff, elastic, damp.	Sediments can be rolled into pencil-thick roll, some clay fraction in silt. Injected water.
50					51.0 **Silty gravel**	
					52.0 **Silty gravel** 40% pea gravel, 20% medium sand, 40% silt.	Injected water, silts broke down by water.
	GB				55.0 **Silty sand** Gray, very silty, very very fine sand, wet.	
55						
	GB					
60					60.5 **Silt** (Cuttings.)	
					62.0 **Silt** Dark gray, stiff, elastic, small sand, some clay, damp.	Sediment contains some sand and clay, can be rolled. Drill is slow due to silt.
	GB				64.0 **Gravel**	Intermixed small layers of pea gravel, then silt. Injected water.
65					64.3 **Silt**	
					65.0 **Gravel**	
					65.8 **Silt**	
					66.0 **Gravel and clayey silt** Alternating layers of pea gravel and clayey silts.	
	GB				67.0 **Silty sand and gravel** 75% very fine sand, very silty, gravelly sand, 25% silt, wet. Increasing silt.	While blowing sediments out of borehole, water started flowing out of medium piezometer. Water blows out of medium piezometer. Injected water.
70					73.0 **Silt and sand** Dark gray, coarse and angular sand.	Water blows out of medium piezometer.
	GB				75.0 Increased plastic silt, light gray color.	Injected water.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site BI
DATE STARTED 8/23/05 **COMPLETED** 8/23/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Silt and sand** Light gray, plastic silt, fine-grained sand. Decreased sand. Trace rounded ~2-3 cm gravels.	Added water continuously.
	GB				78.0 **Silt and sand** Light gray, stiff silt, fine-grained sand, moist to dry. Trace gravels.	Added water.
80						Added water.
					83.0 **Silt and sand** Light gray, fine-grained sand, trace gravel.	Added water.
85					85.0 **Silt and sand** Gray.	Added water.
	GB				88.0 **Silt with sand** Light brown.	Added water.
90					89.8 **Silt with sand** Light brown (very little recovery).	Faster drilling, very little recovery. Added water.
	GB					Added water.
95					95.0 **Silt with sand and gravel** Brown. Increased sand.	Added water. Water blows out of medium piezometer.
	GB				97.5 **Sand** Well-graded, subangular sand, >15% gravel. 98.8 **Silt with sand** Well-graded, subangular sand.	Water blows out of medium piezometer. Stopped drilling with water, no flow from cyclone. Added water.
100					103.0 **Silt with sand** Gray, well-graded, subangular gravel.	
	GB				105.0 **Silt with sand** Gray, fine- to medium-grained sand.	Added water.
105					108.0 **Silt with sand** Dry silt.	Added water.
	GB					Drilling slows.
110					113.0 **Silt** Gray, stiff, dry.	Added water. Added water.
					115.0 **Silt**	Added water.
115					118.0 **Silt** Gray, stiff, dry.	Added water. Added water.
	GB					Added water. Added water.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site BI
DATE STARTED 8/23/05 **COMPLETED** 8/23/05 **GROUND ELEVATION** 1012.44 feet **TOC ELEVATION** 1014.30 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635471.247 meters **EASTING** 370744.131 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					**Silt** Gray, stiff, dry.	Added water.
						Added water.
						Added water.
					123.0	
	GB				**Silt** Stiff, dry.	
125					125.0	
					Silt Brown, stiff.	Added water.
						Stopped drilling with water, no water in formation.
					128.0	Added water.
					Silt Brown, trace sand.	
130						Added water.
					131.0	
					Increased sand.	Added water.
					133.0	
					Sand with silt Brown, fine-grained sand.	
135					135.0 Increased coarse sand.	Added water.
					Sand Fine grained.	Heaving sand.
					Increased gravel.	Heaving sand, water blows from medium piezometer.
					138.0	Added water.
					Sand Brown, fine-grained sand, trace gravel.	
140					140.0	
					Sand Brown, fine-grained sand.	
					143.0	
					Sand Fine grained.	
145						Added water.
					Trace gravel.	Added water.
					148.0	
					Bottom of hole at 148.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: BI/P05-27D
Date: 9/26/05 - 9/27/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level	—	67.97	67.95
Total depth	—		146.45
pH	—	9.24	7.74

Screen interval (btoPVC): 10'
Top: 134.0
Bottom: 144.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on			START PUMP @ 1534						
1618	144.0	—	3.1	136	0.1	[E 3]	5.06	Thick D. Brown, Muddy, 1/4 GALLON! Fine Sand/SILT.	PH 9.24
9/27/05 0848	142.0	67.97	—	—	—	—	—	MOVE UP, RESTART Pump.	
0925	"	—	4.0	284	0.1	"	4.60	" , ~1/4 gallon, Fine sand SILT	
0949	"	—	4.1	382	0.1	"	4.70	" , 3 cups Fine sand SILT.	PH 9.03.
0952	140.0	—	4.1	—	—	—	—	MOVE up. RESTART Pump.	
1030	"	—	3.9	530	0.1	"	4.95	" , 2 1/2-3 cups Fine Sand SILT.	PH 9.27
1056	"	—	3.8	628	0.1	"	4.82	"	
1101	138.0	—	—	—	—	—	—	MOVE up. RESTART Pump.	
1135	"	—	4.0	764	0.1	"	5.03	"	PH 8.97
1206	"	—	4.2	876	0.1	"	5.40	"	PH 8.95
1213	136.0	—	—	—	—	—	—	MOVE up. RESTART Pump.	
1258	"	—	3.8	1047	0.1	"	5.56	"	PH 8.93.
1312	134.0	—	—	—	—	—	—	MOVE up. RESTART Pump.	
1356	"	—	4.0	1223	0.1	"	5.48		PH 8.92
1410 @								~~MOVE up RESTART pump.~~ @ STOP Pump.	
1410									
Surge block off			START POLISH @ 1427						
1452	129.0	—	3.9	1320	0.1	"	4.73	Thick MUDD, No change 3-4 cups.	PH. 8.36
1529	"	—	—	—	—	—	—	STOP POLISH	
1533	144.0	—	—	—	—	—	—	START Rebris Surge.	
1632	"	—	3.7	1538	0.1	"	4.70	"	

215.3

STOP Rebris Surge 1636/END

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BI
DATE STARTED 8/22/05 **COMPLETED** 8/22/05
GROUND ELEVATION 872.86 feet **TOC ELEVATION** 875.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632034.92 meters **EASTING** 370722.743 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silt** Organic-rich silt, wet.	Soft drilling, ODEX casing just pushed into 3' bgs. Sediments are probably old pond bottom.
					3.0	
5	GB				**Sandy gravel** Coarse to fine sand, ~10% to 13% silt, wet.	
					7.0	
10	GB				**Sandy gravel** Well-graded gravel, medium to fine sand, 10% to 13% silt, wet.	Easy drilling. Driller injected water to get silt-laden sediments out of air return pipe and up hole.
					12.0	
15	GB				**Sandy gravel** 30% poorly-graded gravel, 50% very fine sand, >15% fines, wet.	
					14.5	
					Gravel Clean, little sand and fines.	
					17.0	
20	GB				**Gravel** Well-graded gravel, little sand or silt, dry.	Driller had to inject water to get gravel out of pipe in hole.
					22.0	
25	GB				**Gravel** 80% poorly-graded, pea-size gravel, 10% fine sand, <15% fines, 10% silt.	
					25.0	
					Gravel Gravel with small amount of coarse to fine sand cuttings.	Injected water to get gravel up the hole, not getting good returns of cuttings.
					27.0	
30	GB				**Gravel** 70% poorly-graded pea gravel, 20% coarse to fine sand, 10% fine sand.	Injected water.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.5 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 27 Sept., 2005
Purge Volume: 439 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 28.98

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BI
DATE STARTED 8/22/05 **COMPLETED** 8/22/05
GROUND ELEVATION 872.86 feet **TOC ELEVATION** 875.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632034.92 meters **EASTING** 370722.743 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
					32.0 **Gravel** 70% poorly-graded pea gravel, 20% coarse to fine sand, 10% fine sand.	
	GB				**Gravel** 80% poorly-graded pea gravel, 15% coarse sand, 5% fine sand.	Water in formation, hard to tell flow due to air pressure from drill compressor holding back water.
35					37.0	
	GB				**Gravel** 80% poorly-graded, 1/4"-diameter pea gravel, 15% coarse to medium sand, 5% fine sand, wet.	
40					41.5	
					42.0 **Sand** Coarse to medium sand, some gravel.	
	GB				**Sand** 70% coarse sand, 30% poorly-graded, medium sand, 10% gravel.	
					44.0 **Sand** Brown, medium sand, some gravel.	
45			3		Getting more medium sand in cuttings.	
					47.0 **Sand** Brown, 80% medium to fine sand, 20% gravel, wet.	Injected water, slight heaving fine sands.
	GB					
50					50.0 **Sand** Medium sand, some gravel. Small silt lense in cuttings.	
					52.0 Starting to pick up more silt in cuttings.	Hit silt layer, hammer is not hitting as hard on bottom.
	GB				53.0 **Silt** Brown, stiff, elastic, damp.	
					Silt Brown, stiff, elastic, small amount of gravel.	
55					54.5 **Gravel** Poorly-graded.	
					56.5	
					57.0 **Gravel** Poorly-graded gravel with silt lense.	Driller rate sped up due to more gravel. Drill rate is indicating silt and gravel mix. Injected water.
	GB				**Gravel** Poorly-graded gravel with silt lense.	
60					59.5 **Silty Sand** Gray, very very fine sand, wet.	
					61.5	
					62.0 **Silt with sand** Gray, very fine sand with silt lense.	Silt balls in cutting sand is very very fine.
					63.0 **Silt with sand** Gray, very fine sand with silt lense.	Injected water to get cuttings up hole.
	GB				**Silt** Some gravel in silt.	
65					65.0 **Gravelly sand** Dry.	
					67.0	
					68.0 **Gravelly sand** Brown, <1/2"-diameter, medium- to coarse-grained, subrounded to subangular gravel.	Drill rods clogged.
	GB				69.0 **Gravelly sand** Same as above.	
70					**Silt** Gray, medium to high plasticity, trace gravel.	
					72.0	
	GB				**Silt** Highly plastic, trace gravel.	
					75.0	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27M
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site BI
DATE STARTED 8/22/05 **COMPLETED** 8/22/05 **GROUND ELEVATION** 872.86 feet **TOC ELEVATION** 875.36 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632034.92 meters **EASTING** 370722.743 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				Bottom of hole at 75.0 feet.	.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: BI/P-05-27M
Date: 9/15/05, 9/26-27
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Wimer, Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	28.96	28.02	[redacted]
Total depth	69.0		[redacted]
pH	—	9.64	10.07

Screen interval (btoPVC): 10
Top: 59.0
Bottom: 69.0
PVC stick-up height (above ground surface): —

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1109							START: Thick Grey Silt.	
1209	69.0	3002	1.9	114	0.31	[E3]	5.57	Murky Grey, 1 Cup Silt & Very Fine sand	
1215	67.0	—	—	—	—	—	—	Move up. Restart Pump.	
1302	"	—	0.5	119	0.1	"	5.81	Murky Thick Grey, 1 1/2 cups Silt	PH 10.37
1315	65.0	—	—	—	—	—	—	Move up. Restart Pump.	Fine sand
1343	"	—	0.9	133	0.1	"	6.12	Murky Grey, Thick 2 1/2 TBS Silt Very Fine Sand.	PH 10.33
1415	"	—	0.9	161	0.1	1000	5.50	" " SAME	PH 9.92
1431	63.0	—	—	—	—	—	—	Move up. Restart Pump.	
1508	"	—	1.1	201	0.1	654	6.06	Dark Grey, 1 TBS Silt & Fine Sand	10.12 PH
1534	"	—	1.1	229	0.1	550	5.83	Medium Grey (Still Thick) 1/2 Tsp Silt	PH 10.26
1543	61.0	—	—	—	—	—	—	Move up. Restart Pump.	
1628	"	—	0.9	269	0.1	943	5.95	Medium Brown, Alot of Suspended sediment 1 Tsp Silt Fine Sand	PH 9.55
1647	"	—	0.9	286	0.1	665	6.77	"	PH 10.08
1703	59.0	—	—	—	—	—	—	Move up. Restart Pump.	
1739	"	—	—	—	0.1	775	6.04		PH 10.22
1745	"	—	—	—	—	—	—	Stop Pump For Day.	
9/26/05 1534	"	—	—	—	—	—	—	Restart Pump.	
1556	"	—	1.1	312	0.1	1000	5.30	Medium Brown Alot of Suspended Sed.	1 TBS Silt
1623	"	—	1.1	339.9	0.1	752	5.01	" Trace Sand.	PH 8.42
1627								Stop Pump	
Surge block off	START Polish @ 1640.								
1700 0848	54.0	—	—	—	—	—	—	Stop Polish For Day / Re Start Polish	
9/27/05 0922	"	—	0.9	370	0.1	209	4.90	LT Grey/Brown. Trace Silt & Sand	PH 10.13
0936 0937	69.0	—	—	—	—	—	—	Stop Polish / Start Develop Surge	
1035	"	—	1.2	439	0.1	755	4.77	Muddy Brown, 2 TBS of Fine sand Silt.	PH 10.07

CORD #5 N5998375 W155. 19.379' STOP Rubris Surge @ 1039

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BI
DATE STARTED 8/21/05 **COMPLETED** 8/21/05
GROUND ELEVATION 873.61 feet **TOC ELEVATION** 875.88 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632034.75 meters **EASTING** 370718.799 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silty sand with gravel** Brown, fine to medium gravel with sand.	
4.0						
5	GB				**Gravelly sand to sandy gravel** Brown, medium gravelly sand, gravel clasts sub to well rounded.	Dry.
5.0					**Gravelly sand to sandy gravel** Brown, medium gravelly sand, gravel clasts sub to well rounded.	Dry.
8.0					**Sand with silt and gravel** Brown, fine gravel.	Feels soft.
10	GB					
14.0						
15	GB				**Sand with gravel** Brown, fine gravelly sand, <1/2"-diameter gravel clasts, sub to well rounded, dry.	Driller makes small break to see if we made water. Dry.
15.0						Dry.
16.0					**Gravel with sand** Brown, fine-grained sand, <1/2"-diameter gravel clasts, sub to well rounded.	
17.0					**Sandy gravel to gravelly sand** Brown, fine-grained sand, <3/4"-diameter clasts.	
19.0					**Sandy silt to silty sand with gravel** Brown, trace gravel.	Driller makes small break to see if we made water. Dry.
20	GB				**Gravelly sand** Brown, fine- to medium-grained sand, <3/4"-diameter gravel clasts, subrounded.	Dry.
25	GB					
25.0					**Gravelly sand** Brown, fine to medium grained, <3/4"-diameter clasts, subrounded to well rounded.	Dry.
30						Saturated.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.4 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 15 Sept., 2005
Purge Volume: 700 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 26.3

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-27S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site BI
DATE STARTED 8/21/05 **COMPLETED** 8/21/05 **GROUND ELEVATION** 873.61 feet **TOC ELEVATION** 875.88 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6632034.75 meters **EASTING** 370718.799 meters
DRILLING METHOD Air Percussion EQUIPMENT ODEX/HT700 **LOGGER** Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Gravelly sand** Brown, fine to medium grained, <3/4"-diameter clasts, subrounded to well rounded.	
					34.0	
35	GB				35.0 **Gravelly sand to sandy gravel** Brown, medium-grained sand, <2"-diameter clasts, subrounded.	
					Gravelly sand to sandy gravel Brown, medium-grained sand, <2"-diameter clasts, subrounded.	
					38.0	
					Bottom of hole at 38.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: BI/P-05-275
Date: 9/13/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	26.03	25.07	24.88
Total depth	37.70	37.74	37.63
pH	—	7.06	7.06

Screen interval (btoPVC): 5'
Top: 32.7
Bottom: 37.7
PVC stick-up height (above ground surface): 2.45

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1105							
1139	37.7	25.07	1.5	51	0.1	255	5.47	LT Brown/cloudy, 1 Tbs sand	SILT.
1201	"	—	1.9	92	0.06	134	5.32	LT Brown Tinge/cloudy 1½ Tsp	PH 6.21
1207	35.7	—	—	—	—	—	—	MOVE UP. RESTART Pump	
1231	"	—	2.1	140	0.06	69	5.25	LT Grayish Cloudy, 1 Tbs Med. sand	PH 8.90
1257	"	—	2.1	194	0.06	21	5.13	WATER CLEAR, ½ Tsp sand	PH 7.24
1308	"	—	2.1	217	0.06	104	4.96	WATER CLEAR. 1 Tsp sand.	
1313	33.7	—	—	—	—	—	—	MOVE up, RESTART Pump	
1350	"	—	1.5	272	0.06	60	5.11	LT Gry, Cloudy. 1½ Tsp sand	PH 8.90
1411	"	—	1.5	303	0.06	27	5.30	Gray sh Cloudy 1 Tsp Medium Sand.	PH 7.27
1426	32.7	—	—	—	—	—	—	MOVE UP. RESTART Pump.	
1503	"	—	1.4	326	0.06	208	5.38	WATER CLEAR, TRACE sand	PH 8.94
1508	"	—	—	—	—	—	—	STOP Pump	
Surge block off		START Polish @ 1517							
1545	27.7	—	0.8	3416	0.06	48	5.68	WATER Slightly Cloudy, TRACE Sand	PH 9.09
1552	"	—	—	—	—	—	—	STOP POLISH	
1555	22.7	—	—	—	—	—	—	START Debris Surge	
1622	"	—	2.0	402	0.06	14	5.39	WATER CLEAR, 1/4 Tsp Sand Medium grain Brown	PH 7.06
1625	"	—	STOP Debris Surge.						

WELL DEVELOPMENT LOG

Well ID: BI/P-05-27S
Date: ~~9/27/05~~ 9/27/05 - 9/28/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Jonathan Hobson.

Summary * Surging of The Top 5 ft of The Screen *

	Installed (Well Log)	Start	End
Water level			22.66
Total depth			57.65
pH		8.85	6.35

Screen interval (btoPVC): 45'
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		RESTART Pump 1410							
1440	7 ft	—	0.9	27	0.06	70	5.04	LT Brown, Milky/Cloudy, 1/2 Tbs Medium/Coarse Sand	PH 8.58
1543	11	—	1.1	96.3	0.06	29	5.08	LT Brown, " " , 1 Tsp Sand	PH 8.36
1549	9 ft	—							
1625	11	—	1.4	146	0.05	140	4.95	MOVE UP. RESTART pump.	
1645	11								
9/28/05 0848	11							STOP Pump FOR DAY	
0858	11	—	0.9	155	0.09	28	4.17	RESTART pump	
0905	10 ft	—						WATER Slightly Cloudy, Slightly Cloudy, TRACE Sand	PH 7.12
0927	11	—	1.4	171	0.05	21	4.24	MOVE UP RESTART Pump.	
0932								WATER CLEAR (Slightly Cloudy) Trace Sand	PH 6.50
								STOP Pump	
Surge block off		START Polish @ 0940, (2 ft Above Screen)							
1000	12 ft	—	0.9	189	0.05	7	4.78	WATER CLEAR.	PH 6.37
~~1004~~ 1004	~~"~~ .05	-							
1041	11	—	3.2	294	0.05	23	4.77	STOP Polish/START Pulsing Surge.	
1045								WATER CLEAR, Slightly Cloudy 1/2 Tsp Sand	PH 6.35
								STOP Pulsing Surge	

Mirage

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-28D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BG
DATE STARTED 8/25/05 **COMPLETED** 8/28/05
GROUND ELEVATION 1033.23 feet **TOC ELEVATION** 1035.23 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641107.969 meters **EASTING** 373974.35 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.3 **Peat**	
					Gravel Brown, poorly-graded gravel, silt and fine sand, damp.	
	GB				4.0	
5					5.0 **Gravel with silt** Fine sand, subangular gravel.	
					Gravel with silt Fine sand, damp.	
					7.0	
	GB				**Gravel with silt** 1/2"-diameter, subangular, well-graded gravel, coarse fine sand, damp.	
10					12.0	
	GB				**Gravel** 1/2"-diameter, subangular, well-graded gravel, coarse to fine sand, >15% fines, dry.	
15					17.0	
	GB				**Gravel** 1/2"-diameter, subangular, well-graded gravel, coarse to fine sand, <15% fines, dry.	
20					20.0	
					Sand Brown, medium to fine, some gravel, dry.	
					22.0	
	GB				23.0 **Sand** Brown, 85 medium to fine, 10% gravel, 5% silt,	
					23.5 dry.	
25					23.8 **Silt** Very silty, fine sand.	
					Sand Brown, dry.	
					25.5	
					25.8 **Sandy silt** Dark brown, dry.	
					26.0 **Sand**	
					27.5 **Gravel**	
	GB				27.8 **Gravel** Poorly-graded, dry.	
30					**Silt**	
					29.5 **Sand** Brown, dry.	

Alternating layers of silt and medium to fine sand.
Alternating layers of sandy silt or gravel, layers only 6" or less in thickness.

Alternating layers of sandy silt or gravel, 6" or less in thickness.
Drill is breaking up cobble into rock chips.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.0 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 14 Sept., 2005
Purge Volume: 2156 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 25 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 44.83 Date: 8/28/05 Time: 0200

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-28D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site BG
DATE STARTED 8/25/05 **COMPLETED** 8/28/05 **GROUND ELEVATION** 1033.23 feet **TOC ELEVATION** 1035.23 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641107.969 meters **EASTING** 373974.35 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					Small cobbles and sand, rock chip and sand cuttings, dry.	
					32.0 **Gravel** 1/2"-diameter, subangular, well-graded, subangular gravel, 50% of gravels with 5% fine sand, <5% little to no fines.	A lot of silt, but very dry and comes up in cutting resembling coarse sand. Silt slows penetration rate of drill.
	GB				33.0 **Sandy silt** Brown, some 1/4"-diameter gravel, dry.	
35					34.0 **Silt** Brown, (fine sand), some 1/4"-diameter gravel, dry (cuttings).	
					35.0 **Sandy silt** Brown, fine, 20% 1/4"-diameter gravel, 40% fine sand, 40% silt, dry.	
	GB				37.0 **Sandy silt** Fine, increasing gravel fraction, dry.	
40					39.0 **Gravel** Brown, 55% 1/4"- to 1/2"-diameter, well-graded gravel, 45% medium to fine sand, 5% fines, dry.	Injected small amount of water to get cutting out of borehole.
					39.5 40.0 **Sand** Light gray, <15% fines, dry.	
					42.0 **Sandy silt** Well graded.	
	GB	28.35			43.0 **Silty sand** Brown, fine sand, occasional gravel, dry.	Inject small amount of water.
45					**Silty sand** Brown, fine, occasional gravel, dry.	
					Gravel Well-graded, coarse to medium sand and silt, dry.	Inject small amount of water.
					45.5 **Silt** Brown, silt, occasional gravel.	
					47.0 **Gravel** 50% poorly-graded pea gravel, 30% silt,	
	GB				48.5 20% fine sand. **Silty sand** Very fine sand.	Possibly made a small amount of water. Injected small amount of water.
50					52.0	
					Silty gravel 60% well-graded gravel, 30% coarse to fine sand, 30% silt.	Injected small amount of water.
	GB					Injected a small amount of water.
55					57.0	
					58.0 **Silty gravel** Well-graded gravel, silt and very fine sand.	
	GB				**Sand** Coarse sand, clean pea gravel, no fines.	
60					62.0	
					63.0 **Sand** Coarse sand, <15% fines, wet.	
	GB				**Sand** Coarse sand, occasional 1/2"-diameter gravel, <15% fines, wet (cuttings).	
65					67.0	
					Sand Coarse to fine sand, <15% fines, wet.	
	GB				69.5	Injected small amount of water.
70					**Silt** Brown.	
					72.0 **Silt** Brown, stiff, elastic, small clay fraction, damp.	
	GB				73.5 74.0 **Gravel** Poorly-graded pea gravel, fine sand.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-28D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BG
DATE STARTED 8/25/05 **COMPLETED** 8/28/05
GROUND ELEVATION 1033.23 feet **TOC ELEVATION** 1035.23 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641107.969 meters **EASTING** 373974.35 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75				75.5 **Silt** Gray, pea gravel.	Driller notes penetration rate change.
				Gravel Well-graded, coarse to fine sand. 77.0	
				Sand 60% coarse sand, 30% medium to fine, 10% 1/2"-diameter gravel.	
80				82.0	Inject small amount of water.
	GB			**Sand** 80% medium to fine sand, 10% 1/4"-diameter gravel, 10% silt. 84.0	Injected small amount of water in casing.
85				85.0 **Gravel** Well-graded, 1/2"-diameter subrounded gravel, coarse sand, little to no fines.	
			1	**Gravel** Coarse to medium sand, <15% fines. 87.0	Formation producing ~1 gpm, no need to inject water.
	GB			**Sand** Coarse to medium sand, 20% 1/4"-diameter gravel, <15% fines. 89.0	
90				**Sand** Coarse sand, pea gravel, <15% fines.	
			1	92.0	No water injection, formation produces about ~1 gpm.
	GB		10	**Sand** Coarse to fine sand, 1/4"-diameter gravel, 80% coarse to medium sand, 10% fine sand.	Injected water to get downhole hammer to work.
95				95.0 **Sand** Coarse sand, some gravel. 97.0	
	GB			**Sand** 80% coarse sand, 10% medium sand, 10% 1/2"-diameter gravel.	
100				102.0	Injected water into casing.
	GB			**Gravel** 70% 1/4"-diameter subrounded gravel, 30% medium sand. 104.5	Injected water.
105				**Gravel** Well-graded, 3/4"-diameter gravel, medium sand. 107.0	Some drill chatter.
				Sand 60% coarse sand, 20% 1/4"-diameter, subrounded gravel.	
110				110.0	Injected water to get cutting up the hole.
				Sand Medium to fine, <15% silt, wet (cuttings).	Crew change.
				113.0	Injecting water.
	GB			**Sand** Angular to rounded, medium- to coarse-grains, <15% gravel.	
115				115.0	
			30	**Sand** Fine to coarse sand, rounded to angular grains, <15% silt, wet.	Hit big water, relatively clear coming out of the cyclone.
				118.0 Increased silts.	
	GB	85		118.5 **Sand and silt** Light brown, fine- to medium-grained sand, wet.	Added water.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-28D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BG
DATE STARTED 8/25/05 **COMPLETED** 8/28/05
GROUND ELEVATION 1033.23 feet **TOC ELEVATION** 1035.23 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641107.969 meters **EASTING** 373974.35 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					120.5 Increased silt, much less water.	Drilling slows.
					Sandy silt with gravel	Added water.
					Gravel with silt and sand Poorly-graded gravel.	Added water.
					123.0	
	GB				**Gravel with silt and sand** Well-graded gravel, round to angular clasts, wet.	Added water.
125					125.0 Increased sand.	Added water.
					Silty sand Light brown, <15% gravel, wet.	Added water.
					128.0	Added water.
					129.1 **Silty sand** Fine- to medium-grained sand, angular to subrounded clasts with silt, <15% gravel.	Sand heaved in at rod change.
130	GB		30		**Sand** Well graded, subrounded to subangular.	Added water. Added foam.
					133.0	
			30		**Sand with fines** Well-graded sand, subrounded to subangular grains.	Stopped using foam.
135					135.0	
					136.5 **Silty sand** Well-graded sand with silt and gravel, subrounded sand and gravel clasts, wet.	
					Sandy silt with gravel Gray, wet. Increased sands.	
	GB		25		Increased sands.	Added water.
140					Increased sands.	
					Increased sands.	
					143.0	
	GB				**Sand with silt** Poorly-graded, fine- to medium-grained sand, subrounded to rounded.	Added water.
145					145.0	
					146.0 **Silty sand** Fine- to medium-grained sand.	
			50-60		**Sand** Well graded sand.	Drilling slows. Lots of water.
					148.0 Increased sands.	
150					**Silty sand** Light brown, well-graded silty sand, <10% gravel.	
					Increased sands.	Added water.
					153.0	
					153.5 **Sand with silt and gravel** Well graded.	
155					**Sand** Well graded, subrounded sand, <15% gravel.	
					155.0 **Sand** Well graded, subrounded sand, <15% gravel.	
					158.0	Drilling rate slows.
	GB				**Sand** Well graded, <15% gravel.	
160			30-40			Slow drilling.
					162.0	
	GB				**Sand** Well-graded sand with gravel.	
					163.5 Increased fine-grained sand.	
					164.0 **Sand** Fine grained.	

Bottom of hole at 164.0 feet.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: BG/P-05/28D
Date: 9/13/05 - 9/14/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	40.26	~~43.~~ @ 38.88
Total depth	163.0	~~163.~~95	~~173.~~ @ 163.63
pH	—	8.44	8.47

Screen interval (btoPVC): 20'
Top: 143.9
Bottom: 163.9
PVC stick-up height (above ground surface):

Development Observations WATER looks like Soda, Very Bubbly. 163-155 ft

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on			START Pump @ 1700					START: Brownish In color.	
1722	163.9	40.26	4.4	96.8	0.1	28	5.08	WATER CLEAR, 1/4 Tsp Sand (grey)	
1731	161.9	—						Move up, RESTART Pump	
1747	"	—	4.7	172	0.09	23	4.13	WATER CLEAR 1/4 Tsp Sand (grey)	PH 8.57
9/13/05 1754	159.9	—						Move up, RESTART Pump	
9/14/05 1756	"	—						STOP Pump FOR DRY	
0851	"	—						RESTART Pump	
0922	"	—	4.6	314	0.09	24	4.43	WATER CLEAR, 1/4 Tsp Sand.	
0928	157.9	—						Move up, RESTART Pump	
0946	"	—	4.7	398	0.09	41	4.41	WATER Hgry, Grey Medium Sand 1 TBS	PH 8.18
1021	"	—	5.0	573	0.09	17	4.39	WATER CLEAR TRACE Sand	PH 8.62
1032	155.9	—						Move up, RESTART Pump.	
1058	"	—	4.6	697	0.09	65	5.10	WATER LT Brown/Grey SH/cloudy, 1/4 Tsp Sand.	
1105	153.9	—						Move up, RESTART Pump.	
1132	"	—	4.8	778	0.09	61	4.76	LT. Brown/cloudy, 1 Tsp Sand.	
1145	"	—	4.7	839	0.09	34	4.55	LT Brown/cloudy, 1 Tsp Grey Sand Medium to coarse	PH 8.57
1155	151.9	—						Move up, RESTART Pump (medium fine grain)	
1222	"	—	4.9	971	0.09	685	4.33	MUD/LT Brown, 3 TBS Sand/SILT	PH 8.56
1252	"	—	4.7	1112	0.09	342	4.29	" 1 TBS "	PH 8.61
1300	149.9	—						Move up, RESTART Pump	
1332	"	—	4.8	1265	0.09	332	4.26	Medium/LT Brown. 1/2 TBS Sand/Silt	PH 8.55
Broke 1402 1411	147.9	—	4.8	1399				Pump Broke . . . / Fix, Move up	RESTART
1452	"	—	4.5	1583	0.09	292	4.75	Medium Brown Murky, 1 TBS Silty Sand	PH 8.60
1506	"	—	4.6	1647	0.09	222	4.78	" , 1 Tsp	PH 8.51
1515	145.9	—						Move up, RESTART pump.	
1549	~~Surge block off~~ "	—	4.5	1800	0.09	66	5.77	LT Brown/cloudy 1 TBS Sand/Silt	PH 8.53
1614	"	—	4.4	1910	0.09	45	5.25	Very Light Brown, Cloudy, 1 Tsp Sand	PH 8.52
1620	143.9	—						RESTART Pump; Move Up.	
1653	"	—	4.3	2051	0.09	18	5.77	CLEAR WATER, TRACE Sand	PH 8.56
1655	"	—						Stop Pump	
1700	138.9	—						START Polish	
1723	"	—	4.6	2156	0.09	11	5.56	WATER CLEAR, TRACE Sand	PH 8.47
1726	"	—						STOP Polish.	

START Rubis Surge @ 1731 STOP Rubis Surge @ 1745

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-28S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BG
DATE STARTED 8/28/05 **COMPLETED** 8/28/05
GROUND ELEVATION 1033.70 feet **TOC ELEVATION** 1036.14 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641110.92 meters **EASTING** 373969.898 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.3 **Plants and roots**	Easy drilling, pushed casing 1/2 time.
	GB				**Gravel with sand and silt** 40% well-graded gravel, 40% medium sand, 20% silt, damp. 4.0	
5					5.0 **Silt** Brown, fine sand, no gravel.	
					Gravel with silt and sand Fine sand, dry (cuttings). 7.0	Just air injection.
	GB				**Sandy gravel** 50% coarse to fine sand, 40% small to 1/2"-diameter, subangular gravel, 50% silt, dry.	Drilling easy. No water injection. Drilling dry.
10					12.0	
	GB				**Gravel** 50% 1/4"- to 1/2"-diameter, subangular gravel, 30% medium sand, 20% silt, dry.	
15					17.0	Air injection only.
	GB				**Gravel** 50% 1/4"-diameter, poorly-graded, subangular gravel, 25% coarse to fine sand, 25% silt, dry.	Air injection only. Drilling is fast and easy.
20					22.0	
	GB				**Gravel** 50% coarse to fine sand, 30% 1/2"-diameter, poorly-graded, subangular gravel, 20% silt, dry. 24.5	
25					**Sand** Medium sand, <15% fines, dry (cuttings). 26.3	
					27.0 **Gravel and sand with silt**	Wet, close to water, sediments are damp.
	GB				**Gravel** 50% 1/4"-diameter, poorly-graded, subangular gravel, 25% coarse to fine sand, 25% silt, damp.	Air injection only. No water in sediments.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.44 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 14 Sept., 2005
Purge Volume: 1448 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 25 Sept 2005

Comments: Static Water Depth is denoted by solid triangle(ftoc): 46.35 Date: 8/28/05 Time:1815

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-28S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site BG
DATE STARTED 8/28/05 **COMPLETED** 8/28/05
GROUND ELEVATION 1033.70 feet **TOC ELEVATION** 1036.14 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641110.92 meters **EASTING** 373969.898 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					30.5 **Sand** Coarse sand, pea gravel (cuttings).	No water in sediments.
					32.0 **Sand** 85% coarse to medium sand, 10% 1/4"-diameter, subangular, pea gravel, 5% fines, dry.	Drilling slowed down due to silts.
	GB				33.5 **Gravel with sand and silt** Orange, 50% 1/2"-diameter, subangular gravel, 25% medium to fine sand, 25% silt, damp.	Injected small amount of water.
35					35.0 Increased silt.	Slow drilling.
					35.3 **Silt** Brown.	Injected small amount of water.
					36.0 **Gravel and silt**	
					37.0 **Gravel and silt** Well-graded grave with sand, 25% silt (cuttings).	Injected air only.
40					40.5 **Gravel and silt** 40% 1/4"- to 1/2"-diameter, well-graded gravel, 30% coarse to fine sand, 30% silt, damp.	
	GB				42.0 Increasing silt.	Injected small amount of water.
					44.0 **Gravel and silt** >30% silt.	
45					45.0 **Sandy silty gravel** 40% subangular pea gravel, 20% coarse to fine sand, 40% silt, damp.	Inject small amount of water.
					47.0 Increasing silt content.	
					47.5 **Sandy silt with gravel** Brown, 10% pea gravel.	
	GB				**Silt** Small amount of pea gravel.	
50					49.0 **Sandy silt** Brown, 60% silt, 30% fine sand, 10% pea gravel.	
					Gravel 50% poorly-graded gravel, 30% coarse sand, 20% silt.	
					52.0 Grading to less silty, mostly pea gravel.	
	GB				52.3 **Gravel** Pea gravel, medium sand, silt lenses (cuttings).	Alternating layers of sediments, layers only a few inches thick.
55					52.8 **Gravely with sand and silt** Poorly graded.	
					53.5 **Gravel** 1/4"-diameter, poorly-graded, subangular gravel.	
					55.0 **Gravely with sand and silt** Poorly graded.	Injected small amount of water.
					57.0 **Silt** Dark gray, some coarse to fine sand.	
	GB				**Silt** Dark gray, some coarse to fine sand.	
60					59.0 **Gravel** 50% 1/4"- to 1/2"-diameter, well-graded, subangular to subrounded gravel, 35% coarse to fine sand, 15% silt, wet.	Injected a small amount of water.
					62.0 **Sand** Coarse to medium sand, <15% fines (cuttings).	
	GB				**Silty sand** 80% very silty, medium to fine sand, 20% silt.	Fast, easy drilling.
65					67.0 **Silty sand** 85% medium to fine sand, 15% silt, wet.	
	GB					
70					72.0	
	GB				73.0 **Silt** Brown, some small gravels and medium sands.	Driller tags into silt layer and gets a small amount of silt cutting up hole. To avoid drilling into silt, we stop here and set well.
					Bottom of hole at 73.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: BG/P-05-28S
Date: 9/13/05 - 9/14/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	46.35	44.08	43.85
Total depth	75.36	75.82	73.65
pH	—	8.69	8.56

Screen interval (btoPVC): 10'
Top: 65.8
Bottom: 75.8
PVC stick-up height (above ground surface): —

Development Observations Colorado Sand In Purge Samples

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1702									
9/13/05 1702	75.8	44.08	4.2	47.2	0.07	[E 3]	5.23	Thick Brown Murky Water	
9/14/05 1750	"	—	—	—	—	—	—	Brown Murky, 2 cups Silt/Sand	
0851	"	—	—	—	—	—	—	Stop Pump for Day	
0911	"	—	—	—	—	—	—	Restart Pump	
0919	73.8	—	4.3	138.2	0.1	1000	5.11	Medium Brown, Sand/Silt/Medium / 1½ cups	
0951	"	—	—	—	—	—	—	Move up. Restart Pump	
1025	"	—	4.4	142.8	0.07	780	4.71	Water Medium Brown, 1 cup Sand/Silt	PH 8.33
1037	71.8	—	4.4	292.4	0.07	405	4.67	Water/Medium/LT Brown, Brown/Medium Sand 1/4 cup	PH 8.60
1106	"	—	—	—	—	—	—	Move up, Restart Pump	
1135	"	—	4.2	414	0.07	366	4.60	" 1/4 c.p Sand/Silt	
1141	69.8	—	4.4	541	0.07	277	4.59	Water Brown, Medium 1/2 cup Sand/Silt	PH 8.63
1217	"	—	—	—	—	—	—	Move up, Restart Pump	
1240	"	—	3.7	674	0.07	334	5.73	Medium/LT Brown/Cloudy, 1/4 cup Sand/Silt	PH 8.63
1250	67.8	—	3.3	749	0.07	342	5.25	" Same As Above	PH 8.63
1328	"	—	—	—	—	—	—	Restart Pump/Move up	
1351	"	—	3.4	878	0.07	154	5.70	LT Brown/Cloudy, 1/2 cup Sand/Silt	PH 8.65
1354	65.8	—	3.7	963	0.08	123	6.37	" " 1 cup Sand/Silt	PH 8.59
1420	"	—	—	—	—	—	—	Move up, Restart Pump	
1440	"	—	3.3	1048	0.08	113	6.73	Very LT Brown, Cloudy, Approx 1½ tsp Sand/Silt	PH 8.64
	"		3.3	1114	0.08	31	6.59	Light Brown, Cloudy, ¼ TSP Sand/Silt	PH 8.72
1443	"							Move up, Restart Pump	
								Stop Pump	
Surge block off START Polishe 1448									
1517	60.8	—	2.3	1180	0.07	25	6.18	Slightly cloudy, ½ tsp Sand	PH 8.60
1521	"	—	—	—	—	—	—	Stop Polish	
1529	75.8	—	—	—	—	—	—	Start Debris Surge	
1552	"	—	4.3	1278	0.08	160	5.59	LT Brown, Murky/cloudy, 2 TBS Sand	PH 8.56
1629	"	—	4.6	1448	0.08	97	5.63	Slight Silt	PH 8.56
1632								End Debris Surge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 9/11/05 **COMPLETED** 9/13/05
GROUND ELEVATION 999.09 feet **TOC ELEVATION** 1001.21 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641441.308 meters **EASTING** 372947.827 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Rieser, Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silt with gravel** Brown, trace sand, moist.	
5						Added water occasionally to flush out cuttings.
9.0						
10					**Silty sand with gravel** Brown, 3/8"-diameter, subrounded to subangular, gravel clasts, moist.	
14.0						
15					**Silt with clay and gravel** Brown, minor gravel, moist.	Driller is adding water.
19.0						
20					**Gravel** 3/8"-diameter, subrounded to subangular gravel, well-graded sandy silt, wet.	Stopped adding water.
24.0						
25					**Gravel** Subangular to angular gravel, well-graded sand and silt, wet.	
29.0						
30						Kelley says no consistent water produced

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.1 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 13 Sept., 2005
Purge Volume: 794 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 19 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 31.38 Date: 9/12/2005 Time: 2205

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D2
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 9/11/05 **COMPLETED** 9/13/05
GROUND ELEVATION 999.09 feet **TOC ELEVATION** 1001.21 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641441.308 meters **EASTING** 372947.827 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth, Rieser, Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						from well.
					Sand and gravel Well-graded sand with silt, subrounded to subangular gravel, moist.	
34.0						
35					**Sand and gravel** Well-graded sand with silt, trace gravel, wet.	
39.0						Driller injected good water.
40					**Sand and gravel** Well-graded sand with 1/2"-diameter, subangular, gravel clasts.	Pulled casing, hole was open to 35 feet.
44.0						
45					**Gravel with sand** Well-graded gravel with sand, very few fines, wet.	Heaving material.
47.0						
					Gravel with sand Same as above.	Added water.
						Heaving material.
50					No recovery (casing dropped).	Added water.
53.0						
					Silt with sand Grayish, no gravel.	
55						
55.0						
					Silt with sand Grayish, well-graded silty sand.	Added water.
						Heaving sand.
						Added water.
60						
60.0						
					Silt Gray, minor well-graded sand.	Drill off center.
						Added water.
						Added water.
65						
65.0						Slow drilling.
					Silt with sand Silt with minor, well-graded sand.	Added water.
66.5						
					Sand and gravel Gray, well-graded, fine to coarse sand, few fines.	Added water.
70						
						Added water.
75.0						

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AW

DATE STARTED 9/11/05 **COMPLETED** 9/13/05 **GROUND ELEVATION** 999.09 feet **TOC ELEVATION** 1001.21 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641441.308 meters **EASTING** 372947.827 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Rieser, Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sand and gravel** Well-graded sand transitioning to SW.	Added water.
						Added water.
80					80.0	Slow drilling.
					Weathered Bedrock Black, calcareous, mudstone/siltstone.	
			2			
85					85.0	
					Calcareous siltstone Black (fragments 1 mm to 1 cm).	
			2			Switched to rock bit.
90	GB					Added water.
						Added water.
95					95.0	
	GB				**Calcareous siltstone** Black (fragments 1 mm to 1 cm).	
			15			
100						
					104.0	
105					105.0 **Siltstone** Black.	
					Siltstone Black (fragments 1 mm to 1 cm).	
			20			
110	GB				110.0	
					Siltstone Black.	
			25			
115	GB				115.0	
					Siltstone Black.	
					119.0	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D2
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AW
DATE STARTED 9/11/05 **COMPLETED** 9/13/05 **GROUND ELEVATION** 999.09 feet **TOC ELEVATION** 1001.21 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641441.308 meters **EASTING** 372947.827 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth, Rieser, Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120			20			
			15-25		**TC Conglomerate** Greenish brown, fractured fragments, coarse to fine cuttings, coarse, rounded sand of various colors.	
					124.3 Bottom of hole at 124.3 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AW/P-05-2902
Date: 9/13/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Paul Taylor

Summary * No Well CASING *

	Installed (Well Log)	Start	End
Water level	31.38	30.05	
Total depth	125.7	125.18	
pH	—	7.33	7.99

Screen interval (btoPVC): 10'
Top: 115.7
Bottom: 125.7
PVC stick-up height (above ground surface): —

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1110								
1145	125.18	30.05	4.3	150	0.2	249	5.46	Thick Grey MUD (START)	
1155	123.1	—						Reddish Brown Tinge. ≤ 1/4 Tsp Sand	
1218	123.1	—	4.3	248	0.2	207	4.52	MOVE UP, RESTART Pump	
1224	121.1	—						LT. Reddish Brown, 1/4 Tsp Sand	PH 7.93
1245	"	—	4.3	338	0.2	91	4.79	MOVE UP. RESTART Pump.	
1252	119.1	—						LT. Grey ish, Cloudy, TRACE Sand	PH 7.98
1312	"	—	4.3	424	0.2	107	5.0	MOVE UP, RESTART Pump	
1320	117.1	—						Greyish/Brown, 1/4 Tsp Sand	PH 8.03
1344	"	—	4.3	527	0.2	37	5.35	MOVE UP - RESTART Pump.	
1349	115.1	—						WATER CLEAR (Very Slightly cloudy) TRACE Sand	PH 8.03
1413	"	—	4.3	630	0.2	45	5.45	MOVE UP - RESTART Pump	
1416	"	—						WATER CLEAR, TRACE Sand.	PH 8.01
								STOP Pump	
Surge block off	START Polish @ 1425								
1446	110.1	—	4.3	720	0.2	25	5.46	WATER CLEAR, TRACE Sand	
1448	"	—						STOP Polish	
1454	125.7	—						START Debris Surge	
1511	"	—	4.4	794	0.2	84	5.22	LT. Greyish Brown/cloudy/ 3/4 Tsp Sand	PH 7.99
1514	"	—						Stop Pump / End	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 8/28/05 **COMPLETED** 8/29/05
GROUND ELEVATION 1000.52 feet **TOC ELEVATION** 997.19 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641443.57 meters **EASTING** 372939.295 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat** Little recovery.	
					3.0 **Silt with sand** Light brown, root-zone, peat, wet.	
5	GB				5.0 **Silt with sand** Light brown, elastic, moist to wet.	
10					10.0 **Silt with sand and gravel** Light brown, elastic, angular sand and gravel clasts, trace gravel, moist.	Added water.
15	GB				15.0 **Silt with sand and gravel** Light brown, elastic, medium- to coarse-grained angular sand, trace gravel, moist.	Added water. Little recovery.
20	GB				20.0 **Silt with sand and gravel** Light brown, plastic, moist to wet. Increased gravel.	Added water. Added water. Little recovery.
25	GB				24.0 25.0 **Sand with gravel** Well-graded sand, subrounded to subangular gravel clasts, wet. **Sand with gravel** Well-graded sand.	Little recovery.
30					30.0	Very little recovery.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 3.33 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 12 Sept., 2005
Purge Volume: 790 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 19 Sept 2005

Comments: Static Water Depth is denoted by solid triangle(ftoc): 29.84 Date: 8/24/05 Time:2001

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 8/28/05 **COMPLETED** 8/29/05
GROUND ELEVATION 1000.52 feet **TOC ELEVATION** 997.19 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641443.57 meters **EASTING** 372939.295 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Sand with gravel** Well-graded sand, trace subrounded to subangular gravel, little to no fines.	
35	GB				35.0 **Sand with gravel** Well-graded sand, subangular to subrounded gravel clasts, little to no fines.	
					37.0 Increased pea gravel.	Lithology change.
					Gravel Poorly-graded, subrounded pea gravel.	
40	GB				40.0 **Gravel and sand** Poorly-sorted, subrounded pea gravel, <15% sand.	
					43.0 **Gravel** Well-graded, subrounded gravel clasts.	
45	GB				45.0	
					45.8 **Gravel** Well-graded, subrounded gravel clasts.	Lithology change.
					Sand and Gravel Well-graded sand, angular to subrounded gravel, wet. Water is dark brown. Increased sands.	
50					50.0	
					51.5 **Sand with gravel** Well-graded, angular to subangular sand, subrounded to rounded gravel clasts.	Added water.
					Sandy silt with gravel Light gray, angular to subangular.	Lithology change. Added water.
					53.5 Increased silts.	Lithology change.
55	GB				55.0 **Silt with sand** Light gray.	
					Silt with sand	Added water.
					Increased sand.	
60	GB				60.0 **Silt with sand** Light gray, angular to subangular sand clasts.	Added water.
65	GB				65.0 **Silt with sand** Light gray, angular to subangular sand clasts.	Added water.
					67.5 **Gravel with sand** Gray, well-graded, rounded to subrounded gravel clasts.	Lithology change.
70	GB				70.0 **Gravel with sand** Well-graded gravel.	Added water.
					71.5 **Sand with gravel** Well-graded sand. Increased sand.	Lithology change.
					75.0	Added water.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-29D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 8/28/05 **COMPLETED** 8/29/05
GROUND ELEVATION 1000.52 feet **TOC ELEVATION** 997.19 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641443.57 meters **EASTING** 372939.295 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB			**Sand with gravel** Light gray, well-graded sand.	
80	GB		30	80.0 **Sand with gravel** Well-graded sand.	
			30	84.0	
85				85.0 **Bedrock** Fractured black matrix, black siltstone, conglomerate.	Lithology change.
			2.5	**Bedrock** Fractured black matrix, black siltstone. 87.0	Crew change at 0915.
			1.3/4	88.0 **Bedrock** Black siltstone.	Driller wanted to change out bit to down-hole hammer because drill rate was slowing.
			15	89.0 **Bedrock** Black siltstone.	Slow penetration rate.
90			15	90.0 **Bedrock** Black siltstone.	Driller had some trouble with compression, had to use 100 psi for flow test, hole then produced a little more water at less psi.
			20		Penetration rate was fast with small diameter drill hammer.
			25		Driller said there was a lot of water and pressure on bit and was heaving, some trouble getting bit to operate properly.
95			30	95.0	Lots of water.
			30	**Bedrock**	
			25	99.0	
100			35	100.0 **Bedrock**	Penetration rate was fast and steady, hammer was hitting okay.
				Bedrock Black siltstone. 103.8	
105	GB		35	**Bedrock** Brownish black, fine-grained, almost sandy looking.	Flow test ~35 gpm, sample collected.
				107.0	
	GB		30	**Bedrock** Brownish black, fine-grained, sand grain material.	Flow test 5 gal = 10 sec 30 gpm.
110			30	109.5	Penetration rate slowed down. Flow rate 30 gpm.
			45	110.5 **Bedrock** Black to rusty brown, rock chips, cuttings.	Flow test ~45 gpm, 5 gal = 5 sec.
				111.5 **Bedrock** Rusty brown, fine-grained, rock chips.	
				112.0 **Bedrock** Black siltstone rock ships.	
				Bedrock Brownish green, very fine sand-sized cuttings.	Material may be TC conglomerate. Main size was coarse to fine sand.
115			45	115.0	Flow test 7 sec = 5 gal 45 gpm.
				Bedrock Brownish green, fine-grained cuttings, looks like TC conglomerate. 117.0	
			50	**Bedrock** Greenish brown, fine- to coarse-grained size cuttings, looks like TC conglomerate. 119.0	Flow test 6 sec = 5 gal 50 gpm.
					Drill rate was slightly faster than indicated by the drillers.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 8/28/05 **COMPLETED** 8/29/05
GROUND ELEVATION 1000.52 feet **TOC ELEVATION** 997.19 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641443.57 meters **EASTING** 372939.295 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120						
	GB		50		121.0 **Bedrock** Greenish brown, coarse- to fine-grained cuttings, looks like TC conglomerate.	Flow test 6 sec = 5 gal 50 gpm, sample collected.
			50		122.0 **Bedrock** Same as above.	Flow test 6 sec = 5 gal 50 gpm.
			50		**Bedrock** Brownish green, coarse- to fine-grained size cuttings, looks like TC conglomerate. 124.0	Sample collected. Flow test 6 sec = 5 gal 50 gpm.
					Bottom of hole at 124.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/31/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AW/P-05-29D
Date: 9/11/05 - 9/12/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	28.6	29.5
Total depth	127.40	127.8	126.9
pH	—	8.24	8.03

Screen interval (btoPVC): 1D
Top: 127.8
Bottom: 127.8
PVC stick-up height (above ground surface): 2.85

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on			Pump START @ 1714					WATER	
1740	127.8	28.6	4.3	311.8	0.2	34	5.65	Thick Murky Red Brown, 1TBS Silt	
9/11/05 1750	"	—	—	—	—	—	—	STOP Pump for DAY.	
9/12/05 0900	"	—	4.				—	RESTART Pump.	
0927	"	—	4.6	236	0.2	17	4.67	Very light Red Brown, TRACE Sand	
0935	125.8	—	—	—	—	—	—	Move up. RESTART Pump.	
0955	"	—	4.4	324	0.2	39	4.20	Light Red Brown. TRACE Sand	PH 7.75
1000	123.8	—	—	—	—	—	—	Move up. RESTART Pump	
1011	"	—	4.5	373	0.2	13	4.35	WATER CLEAR, Slightly Reddish	7.86 PH
1020	121.8	—	—	—	—	—	—	Move up. RESTART Pump	?NOSed.
1040	"	—	4.6	465	0.2	10	4.39	WATER CLEAR, TRACE sand.	PH 7.89
1046	119.8	—	—	—	—	—	—	Move up RESTART Pump.	
1100	"	—	4.6	557	0.2	9	4.87	WATER CLEAR, TRACE Sand.	
1112	117.8	—	—	—	—	—	—	Move up. RESTART pump.	
1130	"	—	4.8	643	0.2	7	4.56	WATER CLEAR. TRACE Sand.	PH 7.92
1135								STOP Pump	
Surge block off			START POLISH @ 1143						
1156	112.8	—	4.7	675	0.2	6	4.56	WATER CLEAR. NO Debris.	
1202	"	—	—	—	—	—	—	STOP POLISH @	
1400	127.8	—	—	—	—	—	—	START Debris Surge	
1425	"	—	4.6	790	0.2	13	4.95	WATER CLEAR - NO Debris	PH 8.03
1427	"	—	—	—	—	—	—	STOP Debris Surge	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-29M
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AW

DATE STARTED 9/14/05 **COMPLETED** 9/15/05 **GROUND ELEVATION** 1000.20 feet **TOC ELEVATION** 1002.58 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641445.956 meters **EASTING** 372952.407 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth/Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0 **Tundra**	
					Silt Brown, minor coarse sand, moist. No recovery.	
5					5.0 **Silt** Brown, minor coarse sand, moist.	
					9.0 **Silt** Brown, minor sand and gravel, moist.	
10					Possible boulder of gray aphanitic volcanic rock.	
						Slow drilling.
15					15.0 **Silt** Brown, minor sand and gravel, dry to moist.	
						Stopped before sand. Did not want to jam the hammer in heaving sands. Shift change.
20						
					24.0	
25					25.0 **Silt with sand** Brown, moist (few cuttings recovered).	Driller adding water.
					Gravel Angular to subrounded clasts to 2"-diameter, fine well-graded sand and silt, wet.	Driller adding water.
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.38 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 15 Sept., 2005
Purge Volume: 800 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 19 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 31.08 Date: 9/15/05 Time: 0258

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29M
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 9/14/05 **COMPLETED** 9/15/05
GROUND ELEVATION 1000.20 feet **TOC ELEVATION** 1002.58 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641445.956 meters **EASTING** 372952.407 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth/Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravel** Angular to subrounded clasts to 2"-diameter, fine well-graded sand and silt, wet.	
					34.0	
35					**Gravel** Subangular to subrounded clasts to 1/2"-diameter, trace well-graded sand, wet.	Driller adding water.
					39.0	
40					**Sand with silt** Brown, well-graded sand, wet.	
					44.0	
45					**Sand** Trace silt, wet.	Heaving sands Driller adding water.
50						
55						Driller adding water.
					59.0	
60					59.9 **Silt**	Water level at 39.2' bgs.
					Bottom of hole at 60.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

m (me)

Well ID: AW/P-05-29D
Date: 15 Sept 2005

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Mike Rieser / Johnathon - night shift

Summary

	Installed (Well Log)	Start	End
Water level	31.08	31.08	30.65
Total depth		57.1	59.2
pH		—	

Screen interval (btoPVC):
Top: 50 ft
Bottom: 60 ft
PVC stick-up height (above ground surface): 2.3 ft

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
0258	56.5	31.08	0.9	0	—	very turbid	—	1/2 cup fine sand & silt
0333	"	"	1.25		—	"	—	1 cup " ", minor silt
0346	54.5	30.78	1.4		—	"	—	1.5 cups " " " "
0432	52.5	30.75	2.4		—	"	—	1 " " " " "
0510	"	~~30~~	2.4		—	turbid	—	4 tsp. " " " " "
0517	50.5'	30.68	2.4		—	"	—	1/2 cup " " " "
0550	pump out working,				observe	25 min.		lost, re-set belt tension
0550 (with)	50.5'	—	—	—	—	turbid	—	
0625	50.5	30.67	2.4		—	"	—	2 tsp. " " " "
Surge block off								
0630	45.5	30.67	2.4		—	turbid	—	—
0700	"	—	"		—	slightly turbid		1/2 tsp. fine sand & minor silt
0705	57.5	—	"		—	very turbid		—
0823	STOP DEVELOPMENT							

Rotish
Sediments

clean up sediment on the bottom from 0705 to shift change. Stopped at 0815
Opened to feet from TOC.

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-29S
PAGE 1 OF 1

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 8/29/05 **COMPLETED** 8/30/05
GROUND ELEVATION 997.24 feet **TOC ELEVATION** 1000.56 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641449.106 meters **EASTING** 6641449.106 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**No recovery**	
5	GB				5.0 **Silt with sand** Light brown, moist.	No water added.
10	GB				10.0 **Silt with sand** Light brown, angular and medium to coarse sand grains.	No water added.
15	GB				15.0 **Silt** Light brown, plastic, <15% sand grains, moist.	No water added.
20	GB				18.8 **Sand with gravel** Well-graded, angular to subrounded gravel, some silt, moist. 22.0 **No recovery**	No water added. Soils clogging annular space. Added water.
25	GB				25.0 **Gravel with silt and sand** Poorly-graded, subrounded to rounded gravel, subangular to subrounded, fine- to coarse-grained sand. 28.0 Bottom of hole at 28.0 feet.	Driller remarks that we are not recovering soils because the formation is 'loose'. Air is jetting into formation. No water added to bring out soil samples. Stopped drilling for 30 min. to let water in.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 3.3 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: Dry
Purge Volume: N/A Insufficent Water

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Static Water Depth is denoted by solid triangle (ftoc): 29.25 Date: 8/30/05 Time: 0630

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P-05-295
Date:

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician:

Summary

	Installed (Well Log)	Start	End
Water level			
Total depth			
pH			

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
Surge block off								

LESS THAN 2' WATER IN PIEZO.
NOT DEVELOPED.

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-30D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AX
DATE STARTED 8/30/05 **COMPLETED** 8/31/05
GROUND ELEVATION 973.91 feet **TOC ELEVATION** 976.47 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643543.372 meters **EASTING** 372914.244 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.3 **Plants, plant roots, and peat**	
					Gravel with sand and silt Brown, 50% 1/4"- to 1/2"-diameter, subrounded, well-graded gravel, 30% fine sand, 20% silt, damp.	
5					5.0 **Gravel with sand and silt** Subangular gravel.	Drill rate slowed.
					7.0 **Silt** Brown, elastic, moist.	Injected water to get cuttings up hole.
10	GB				10.0 **Gravel with silty sand** Well-graded gravel.	
					12.0 **Gravel with silty sand** Well-graded, subangular gravel, dry.	Injected small amount of water.
15	GB				14.0 **Gravel with silty sand** Dry cuttings.	Injected small amount of water.
					15.0 **Gravel with silty sand** Same as above.	
					16.0 **Gravel with silty sand** Same as above.	
20	GB				17.0 **Gravel with silty sand** 35% poorly-graded gravel, 50% coarse to fine sand, 15% silt.	
					18.0 **Gravel with silty sand** Brown, 20% 1/4"- to 1/2"-diameter, subangular, poorly-graded gravel, 50% coarse to fine sand, 30% silt.	
25	GB				20.5 **Silt** Brown.	
					22.0 **Gravel with sandy silt** 30% 1/4"-diameter, subangular to subrounded, poorly-graded gravel, 40% coarse to fine sand, 30% silt.	Injected small amount of water.
30	GB				23.0 **Gravel with sand** 50% 1/2"-diameter, well-graded, subangular to subrounded gravel, 50% coarse sand, <15% fines.	
					25.0 Possible water (little if any). Sediments moist to dry.	
					26.5 **Gravel with sand and silt** Small cobbles with subangular gravel, coarse to fine sand, 20% silt, dry.	Not injecting water.
					27.5 **Sandy silt** Brown, elastic, damp.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.57 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 11 Sept., 2005
Purge Volume: 999 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 24 Sept 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 48.9 Date: 8/31/2005 Time: 0020

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-30D
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AX
DATE STARTED 8/30/05 **COMPLETED** 8/31/05
GROUND ELEVATION 973.91 feet **TOC ELEVATION** 976.47 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643543.372 meters **EASTING** 372914.244 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					Increased silts.	No indication of groundwater.
					32.0 **Gravel with sand and silt** Poorly-graded gravel, coarse sand, >30% silt.	Injected small amount of water.
	GB					No indication of groundwater.
35					35.0	Not injecting water.
					Gravel with silt >30% silt lenses.	Injecting water.
					37.0	Injected small amount of water.
	GB				**Gravel with sandy and silt** Brown, poorly-graded subangular gravel, >30% silt, damp.	
40					Cobbles grading into gravels with silt lenses.	Injected small amount of water.
					40.0 Increasing silts with coarse sand in silt, dry.	No indication of groundwater.
					40.5 **Gravel with silt** Poorly-graded gravel, <15% silt.	
					42.0 **Gravel with silt** Brown.	Injecting water.
	GB				**Gravel with sand and silt** Poorly-graded subangular gravel, 30% silt, dry.	Injecting water.
45					Increasing 14/"-diameter gravels with coarse sand, less silts.	
					45.0	Injected small amount of water.
					Gravel with sand and silt Poorly-graded subangular to subrounded gravels with sandy silt lenses, dry.	
					47.0	
					48.0 **Gravel with sand and silt** 40% 1/4"-diameter or less poorly-graded gravel, 30% coarse to fine sand, 40% brown silt lenses.	Injected small amount of water.
	GB				48.5 **Gravel with sand and silt** Pea gravel with coarse to fine sand, <15% silt.	
50					52.0 **Gravel with sand and silt** Pea gravel with brown sand, >30% silt.	
					53.0 **Sandy silt** Gray, 5% pea gravel, 15% coarse sand, 15% fine sand, 65% silt, dry.	
					54.0 **Silt with gravel** Gray, increasing pea gravel content.	
55					**Silt with gravel** Gray, increasing pea and coarse sands.	
					57.0	
					Silt with gravel Gray, 30% pea gravel, 30% coarse to fine sand, 40% silt, dry.	
	GB				59.0	
60					60.0 **Gravel with sand and silt** Gray, poorly-graded gravel, coarse to fine sand.	Formation is taking water.
			1/8		61.5 **Gravel with sand** Poorly-graded pea gravel, coarse sand, wet.	
					62.0 **Sand with gravel** Gray, very fine sand, some gravel, wet.	
	GB		1/8		**Gravel with sand and silt** Well-graded subangular to subrounded gravel, coarse to fine sand and silt, >15% fines.	
65					65.0	Injected water.
					67.0 **Gravel with silt** Gray, 10% gravel.	
					68.0 **Silt with sand** Gray, very silty fine sand, wet.	Hard to define flow, sediments are very silty. Driller injecting water to get cuttings up.
	GB				**Gravel with sand and silt** Pea gravel, coarse to fine sand, <15% silt, wet.	No real flow, appears 1/8 to 1/4 gpm.
70						Injecting water.
					72.0	
					72.5 **Possible bedrock** Black siltstone, rock chips.	Large cobble, drilled out of it.
	GB				**Sandy silt** Gray.	
					74.0	Formation opens to be wet but no real
					75.0 **Sand with silt** Medium sand, >15% silt.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-30D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AX
DATE STARTED 8/30/05 **COMPLETED** 8/31/05
GROUND ELEVATION 973.91 feet **TOC ELEVATION** 976.47 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643543.372 meters **EASTING** 372914.244 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Silty sand with gravel** Very silty medium sand, some gravel.	flow.
					77.0	
					78.0 **Sandy silt with gravel** Gray, 10% gravel, 40% fine sand, 50% silt, wet.	Collected sample.
	GB				**Silty sand and gravel** 20% pea gravel, 60% medium to fine sand, 20% silt.	Drilling is very hard. Torque, no drill chatter
80					80.0 Large cobbles.	Drilling is difficult, Torque.
					81.0 **Siltstone** Black, large cobbles.	Drilling returns to normal.
					81.5 **Sand and gravel** Medium sand.	Injecting small amounts of water.
					82.0 **Silt** Gray.	
					83.0 **Silt with sand** Gray, coarse sand.	
85					85.0 **Gravel with sand and silt** Poorly-graded subangular gravel, coarse sand.	Injected small amount of water.
					Gravel with silt	
					87.0 **Silt** Gray, stiff, dry.	Drill rate increased.
	GB					Crew change, lots of water flows out of cyclone when we begin.
90	GB				89.5 **Sand with silt** Gray, well-graded subangular to subrounded sand, <15% gravel, wet. Possible weathered bedrock.	Lithology change.
					93.0	
	GB		6		**Bedrock** Gray, fractured bedrock, siltstone.	No water added.
95					95.0	
	GB		6-8		**Possible bedrock** Light gray, angular to rounded siltstone and sandstone.	No water added.
			10			Drills like fractured bedrock.
100					100.0	
	GB				**Bedrock** Gray, fractured bedrock, siltstone/sandstone, light gray angular siltstone fragments.	
	GB		5-7			
105					105.0	
	GB				**Bedrock** Gray, siltstone, fine to coarse sand grains, gravels, wet.	"Feels fractured."
			5-7			Changed to 3 1/3" hammer and drill open hole.
110					110.0	
	GB		5-7		**Bedrock** Same as above.	
115					115.0	
	GB		3		Bottom of hole at 115.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AX/P-05-30D
Date: 9/11/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level		19.20	41.86
Total depth		108.04	108.37
pH		8.22	8.17

Screen interval (btoPVC): 10'
Top: 98.0
Bottom: 108.0
PVC stick-up height (above ground surface): 2.48

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1004							
1049	108.0	19.20	4.6	207	0.2	224	4.22	WATER grey cloudy, 2TBS Silt-Md Sand	
1104	"	—	4.6	276	0.2	167	3.38	" " 1TBS "	8.16 PH
1110	106.0	—	—	—	—	—	—	MOVE UP, RESTART Pump	
1143	"	—	4.4	412	0.2	38	3.61	LT grey, cloudy, 1TBS, Silt/Sand.	PH 8.17
1149	104.0	—	—	—	—	—	—	move up, RESTART Pump	
1205	"	—	4.3	480	0.2	36	3.30	Slightly cloudy, 1/2 TSP sand	PH 8.16
1215	"	—	4.3	523	0.2	44	3.36	" " 1/4 TSP Sand	
1218	102.0	—	—	—	—	—	—	move up, RESTART Pump.	
1240	"	—	4.3	617	0.2	105	3.62	Slightly cloudy, LT Gray, 1/2 TSP Sand	PH 8.15
1252	"	—	4.3	668	0.2	88	3.26	" " 1/4 TSP Sand	PH "
1259	100.0	—	—	—	—	—	—	MOVE UP, RESTART Pump	
1317	"	—	4.3	745	0.2	33	3.60	Slightly Cloudy, LT Gray, 1 1/2 TSP Sand	
1330	"	—	4.3	800	0.2	37	3.54	LT Slightly Gray, Cloudy, 1/4 TSP	PH 8.15
1335	98.0	—	—	—	—	—	—	move up, RESTART Pump	
1355	"	—	4.3	886	0.2	19	3.33	WATER CLEAR, TRACE Sand	8.15 PH
1356	"	—	—	—	—	—	—	STOP Pump.	
Surge block off		START Polish @ 1403							
1414	93.0	—	4.2	932	0.2	29	3.83	Slightly grayish cloudy, ≤ 1 TSP grey Sand	PH 8.17
1417	"	—	—	—	—	—	—	STOP. Polish	
1422	108.0	—	—	—	—	—	—	START ReBris Surge	
1438	"	—	4.2	999	0.2	17	4.31	Slightly cloudy, WATER CLEAR, TRACE Sand	PH 8.17
1441	STOP ReBris Surge/End.								

2.93 − 1.45 = 2.48

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-30S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AX
DATE STARTED 8/31/05 **COMPLETED** 8/31/05
GROUND ELEVATION 973.88 feet **TOC ELEVATION** 976.28 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643547.345 meters **EASTING** 372917.42 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.2 **Peat**	Air injection only.
					Gravel with sand and silt Well-graded gravel, fine sand, dry.	
					4.0	
5					5.0 **Silt** Brown, damp.	
					5.8 **Gravel with silt** Brown, damp to dry.	Air injection only.
					6.5 **Silt** Brown.	
					7.0 **Gravel with silt** Brown, damp to dry.	
					7.8 **Silt** Brown, damp to dry.	
					Silty sand with gravel Fine sand, small gravel, dry.	
10					9.3	
					10.0 **Silt with gravel** Brown, some gravel, damp to dry.	
					Silt Brown, damp to dry.	
					11.3	
					12.0 **Gravel with silt** Brown, dry.	
	GB				**Gravel with sand and silt** Brown, 40% well-graded subangular gravel, fine sand, 60% silt, dry. Increasing brown silt.	
15					15.0	
					16.0 **Silt** Brown, damp to dry.	Air injection only.
					17.0 **Gravel with silt** Brown, 60% well-graded gravel, 40% silt.	
	GB				**Gravel with sand and silt** 70% 1/4"- to 1/2"-diameter well-graded gravel, 20% fine sand, 10% silt, dry.	
20					19.0 **Gravelly silt** Brown, dry.	
					22.0	
	GB				**Gravel with sand and silt** 40% 1/4"- to 1/2"-diameter subangular gravel, 20% medium to fine sand, 40% silt, dry.	
25					25.0 **Gravel with sand and silt**	Air injection only.
					27.0	
	GB				**Gravel with sand and silt** 40% silt, 20% subangular gravel, 40% medium sand, small cobbles, dry.	
30					29.5	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.40 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 31 May, 2005
Purge Volume: 1114 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments:

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-30S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AX
DATE STARTED 8/31/05 **COMPLETED** 8/31/05 **GROUND ELEVATION** 973.88 feet **TOC ELEVATION** 976.28 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643547.345 meters **EASTING** 372917.42 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Silty gravel with sand and clay** Brown, some gravel, small clay fraction, damp.	Can roll silt into pencil strands. Air injection only.
					32.0 **Silt with gravel and clay** Brown, elastic, 10% gravel and small clay fraction, damp.	
35	GB				35.0	
					35.5 **Silt**	Air injection only.
					37.0 **Gravelly silt with sand** Brown, 60% subangular gravel, 20% medium sand, 20% silt.	
	GB				38.5 **Gravel with sand and silt** Brown, 40% 1/2"-diameter subangular gravel, 40% 20% medium sand, 40 percent silt, dry.	
40					**Silt with gravel** Brown, some small gravel, damp to dry.	
					42.0	
	GB				43.5 **Silt with gravel and sand** Brown, 10% small 1/4"-diameter gravel, 20% medium sand, 70% silt, dry.	
					Gravel with silt Brown, well-graded gravel.	
45					45.0 Increasing medium sand content, decreasing gravel, dry.	Air injection only.
					Gravel with silt	
					46.5 Increasing silt content, dry.	
					47.0 **Silt with gravel** Brown, 10% 1/4"-diameter gravel, dry.	
	GB				**Silt with gravel** Brown, 10% gravel, dry.	
50						
					51.5	
					53.0 **Gravel with silt and sand** 50% 1/4"- to 3/4"-diameter, well-graded, subangular gravel, 20% coarse to fine sand,	
	GB				53.5 30% silt, dry.	
55					55.0 **Gravel with silt and sand** Same as above.	Change in sediment, damp but not moist. No groundwater showing on cyclone or casing. Air injection only.
					Gravel with silt and sand Gray, very silty sand and gravel, damp.	
					57.0 **Silty gravel and sand** Gray, very silty gravel, medium sand, damp.	No groundwater showing on cyclone or casing. Inject small amount of water to get cutting up hole, they are sticking to casing and in air hose. Inject water.
	GB				**Silty gravel with sand** Gray, very silt gravel, medium sand, damp.	
60						
					62.0	
					62.9 **Gravelly silty sand** Small silt lenses, damp.	Possible groundwater. Let pipe stand and then blow out casing. Driller said water is cold.
	GB				63.0 **Silty sand** Gray.	
					Gravelly silty sand	
65					65.0	
					66.0 **Sandy silt** Gray.	
					67.0 **Sandy silt** Gray.	Inject water.
					68.0 **Sandy silt** Gray.	
	GB				**Gravelly sandy silt** 40% 1/4"-diameter gravel, 30% fine sand, 30% silt.	
70						
					72.0	
					73.0 **Sandy silt** Gray, damp to dry.	Inject water.
	GB				Bottom of hole at 73.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AX/P-05-30S
Date: 9/10/05 / 9/11/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Paul Taylor

Summary

	Installed (Well Log)	Start	End
Water level	—	29.27	30.67
Total depth	75.5	75.15	71.92
pH	—	7.76	7.33

Screen interval (btoPVC): 5'
Top: 70.1
Bottom: 75.1
PVC stick-up height (above ground surface): 2.32

2.90 − .58 = 2.32

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1251								
1336	75.1	29.27	3.2	144	0.2	E 3	4.30	DARK Grey, Murky, 2½ cups Thick Silt Sand	
1351	"	—	"	192	"	"	3.52	" " " 2 cups	PH
1356	73.1	—						RESTART Pump. Move up.	
1432	"	—	3.7	288	0.2	"	3.70	DARK Grey, Murky, 3 cups SILT	PH 8.23
1502	"	—	3.3	387	0.2	"	3.71	" " SAME Sand	
1507	71.1	—						Move up 2. RESTART Pump.	
1539	"	—	3.2	457	0.2	1000	3.77	Medium/Dark Grey 1½ cup.	PH 8.15
1606	"	—	3.2	543	0.2	997	3.58	" SAME	PH 8.13
1612	70.1	—						Move up, RESTART Pump	
1654	"	—	3.2	677	0.2	1000	4.29	Medium Grey Silt Sand, 1½ cups	PH 8.10
1712	"	—	3.2	722	0.2	1000	3.69	" " 1 cup	
1715								STOP Pump.	
1745									
Surge block off	START Polish @ 1721								
1745	65.1	—	3.7	810	0.2	52	4.30	WATER Hvy Grey (lots of) 2 TBSS Sand.	
1750 0902	"	—						STOP Polish / RESTART Polish	
0936	"	—	3.3	922	0.2	524	4.03	1/4 cup SILT & Sand, Murky Grey	PH 7.33
0941	"	—						STOP Polish 0941	
0950	75.1	—						START Debris Surge	
1020	"	—	3.2	1018	0.2	1000	4.24	2 cups Thick grey SILT & Sand	
1050	"	—	3.2	1114				STOP Debris Surge	

9/10/05 → 9/11/05

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-31D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AY

DATE STARTED 8/31/05 **COMPLETED** 8/31/05 **GROUND ELEVATION** 922.33 feet **TOC ELEVATION** 924.87 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6643092.315 meters **EASTING** 373484.407 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**No Recovery**	No water added.
					3.0	
					3.9 **Peat**	
5					5.0 **Silt** Light brown, moist.	
	GB				6.2 **Silt** Light brown, moist.	No water added.
					Sand with silt Brown, poorly-graded sand with silt, fine- to medium-grained sand, moist.	
					8.7	No water added.
10	GB				**Sand with gravel** Brown, well-graded sand, <15% gravel, subangular to subrounded, dry to moist.	
15					15.0	
	GB				16.2 **Sand with gravel** Well-graded sand, <15% gravel, subrounded to subangular, dry to moist.	No water added.
					Gravel and sand Well-graded gravel and sand, subrounded to subangular clasts, dry.	
20	GB				19.3	
					21.0 **Sand with silt and gravel** Light brown, well-graded sand, moist.	
					22.0 **Silt** Light brown.	Very little recovery.
					Sand with gravel Well-graded sand, >15% gravel, subangular, wet.	No water added.
					24.0	
25	GB				25.0 **Sand with silt and gravel** Well-graded sand, moist to wet.	No water added.
					26.0 **Sand with silt and gravel** Well-graded sand, subangular to subrounded sand and gravel, moist to wet.	
					27.5 **Silt with sand** Light brown, fine to medium sand grains, moist.	Injected slight amount of water.
30					**Silt** Brown, moist.	No water added.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.54 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 28 Sept., 2005
Purge Volume: 1143 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments: Static Water Depth is denoted by solid triangle(ftoc): 80.71 Date: 9/1/05 Time: 1815

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-31D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AY
DATE STARTED 8/31/05 **COMPLETED** 8/31/05 **GROUND ELEVATION** 922.33 feet **TOC ELEVATION** 924.87 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643092.315 meters **EASTING** 373484.407 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
	GB				30.5 Increased silt.	
					Gravel with silt and sand Gray, poorly-graded gravel, 31.9 subangular clasts, dry to slightly moist.	Injected water to clear hose.
					Silt with sand and gravel Gray.	No water added.
35					35.0	Added foam to bring up cuttings.
	GB				**Silt with sand** Light brown, fine to medium sand gravel.	Added foam continuously.
						Drillers leveled rig, added foam.
40					40.0	Added foam.
	GB				41.0 **Silt with sand** Light brown, fine to coarse angular sand grains.	No water added.
					Sand with silt Light brown, well-graded sand, moist to dry. 43.5	
					Decreased silt. 44.5 **Sand with silt** Well-graded sand.	
45					45.0 **Sand with silt** Well-graded sand.	
	GB				**Sand with silt** Light brown, well-graded sand, subrounded to rounded, dry to moist.	No water added.
						No water added.
50					49.5	No water at blow out.
	GB				**Silt with sand** Gray, fine-grained sand, rounded to subangular, dry.	
						No water added.
55					55.0 Increased coarse-grained sand.	
	GB				**Sand with silt** Poorly-graded sand, fine-grained sand, dry.	No water added.
						No water added.
60					60.0	
	GB				**Sand with silt** Poorly-graded sand, subrounded to subangular, dry.	
					63.0 Increased fines.	No water added.
					Silt with sand Light gray, dry.	
65					65.0	No water added.
	GB				**Silt with sand** Light gray, dry.	
					67.0 **Silt with sand** Light brown, increased fine-grained sand.	No water added.
70					70.0	
	GB				**Silt with sand** Light brown, dry.	
					75.0	No water added.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-31D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AY
DATE STARTED 8/31/05 **COMPLETED** 8/31/05
GROUND ELEVATION 922.33 feet **TOC ELEVATION** 924.87 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643092.315 meters **EASTING** 373484.407 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Silt with sand** Light gray, dry.	No water added.
79.8						
80	GB				**Silt with sand** Light gray, fine-grained sand, dry. Color changes to light brown. Increased sand.	
85.0						
85	GB				**Silty sand** Light brown, dry.	No water added.
90.0						
90	GB				**Silty sand** Light brown, fine- to coarse-grained sand, dry.	
94.0						No water added.
95	GB				**Silty sand** Dark brown.	No water added.
95.0						
96.5					**Silty sand** Dark brown, fine- to coarse-grained sand, subrounded, slightly moist.	
98.0					**Silty sand** Fine- to medium-grained sand.	
99.5					**Silty sand** Gray, fine-grained sand.	Crew change, driller cranks air valve and water flow out pipe.
100						
100.5					**Silty sand** Gray, coarse sand.	
101.0			1.5		**Gravel with silty sand** 1/2"-diameter gravels, fine sand.	
102.0					**Sand and gravel with silt** Gray, 65% coarse sand, 20% pea gravel, 15% silt.	
104.0			2		**Gravelly silty sand** Gray, 20% pea gravel, 60% coarse sand, 20% silt, wet.	
105						
105.0					**Gravel with sand and silt** Poorly-graded gravel, pea gravel and loose sand, <15% fines, wet.	No water added. Air injection only.
106.0						
107.0					**Gravel with sand and silt** Coarse sand and pea gravel with some silt, <15% fine weathered rock.	
108.0						
110	GB		5		**Sand with silt** Light brown, coarse sand with some silt, weathered rock.	
112.0					**Sand with silt** Coarse to fine sand, <15% fines, little to no pea gravel, wet.	
113.0					**Sand with gravel** Granular volcanic ash, easily crushed with 3% to 5% small subangular pea gravel.	
114.0	GB		2		**Sand with gravel** Light brown, coarse sand with 15% pea gravel, <15% fines, looks like welded volcanic ash, wet.	
115						
115.0			5		**Gravel and bedrock** Weathered bedrock to TC conglomerate.	
117.0					**TC Conglomerate or very weathered bedrock**	
118.0	GB		10		**TC Conglomerate or very weathered bedrock** Light tan to brown.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-31D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AY
DATE STARTED 8/31/05 **COMPLETED** 8/31/05
GROUND ELEVATION 922.33 feet **TOC ELEVATION** 924.87 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643092.315 meters **EASTING** 373484.407 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120					**TC Conglomerate or very weathered bedrock** Light tan to brown, 30% subangular gravel.	
					122.0 **TC Conglomerate**	
			5		**TC Conglomerate** Light gray to tan.	
			7			
125					125.0 **TC Conglomerate** Light tan to gray.	Formation looks like tan coarse grain size volcanic ash with 10% small pea size quartz gravel. Driller changes drill bit and we start open hole drilling.
					129.0 **TC Conglomerate** Light tan to gray.	
130			15			Inject foam. Drilling is normal, moderate penetration, no drill chatter.
					134.0	
135			30		135.0 **TC Conglomerate** Light tan to gray.	
					136.0 **TC Conglomerate** Light tan to gray.	
			60		**TC Conglomerate** Light tan to gray, 1/8"- to 1/4"-dark brown subangular quartz.	Drill rate is slowing down, formation is getting dense.
					139.0 **TC Conglomerate** Light tan to gray.	Drill penetration increased. Inject small amount of foam.
140	GB					
					142.0 **TC Conglomerate** Light tan to gray.	
			60		144.0	
145					145.0 **TC Conglomerate** Light tan to gray.	
	GB		60		**TC Conglomerate** Light tan to gray.	
					149.0 **TC Conglomerate** Light tan to gray.	
150	GB		45			
			45		152.0 **Siltstone bedrock** Brown to black.	
					154.0	
155			45		155.0 **TC Conglomerate** Light tan with greenish quartz, pea-size gravel.	
					Bottom of hole at 156.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AY/P-05-31D
Date: 9/28/05-9/29

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer, Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level	—	72.91	73.15
Total depth	149.3	149.0	148.50
pH	—	6.47	6.85

Screen interval (btoPVC): 10'
Top: 139.0
Bottom: 149.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1307						WATER Very light Brown orange but Very Small Sand SILT. 3 TBS Medium	
1340	149.0	72.91	3.2	105	0.3	[E 3]	2.30	[redacted] "Milky", A lot of Suspended	PH 6.47
1411	"	—	3.2	204	0.3	742	2.94	" , 1 TBS	PH 6.81
1420	147.0	—	—	—	—	—	—	MOVE UP, RESTART Pump.	
1452	"	—	2.5	284	0.3	319	3.50	" , 1/2 TSP Medium Grain Sand/SILT.	
1509	"	—	3.2	338	0.3	836	2.70	" SAME WATER Description, 1 TBS, "	
1512	145.0	—	—	—	—	—	—	MOVE UP. RESTART Pump	
1547	"	—	3.5	460	0.3	647	3.45	LT Brownish Orange, Milky, Suspended Sed, 1/2 TSP Medium grain sand/ SILT.	
1609	"	—	3.3	549	0.3	490	2.90	" , 3/4 TBS, PH 6.93.	
1615	143.0	—	—	—	—	—	—	MOVE UP. RESTART Pump.	
1648	"	—	3.5	664	0.3	256	3.14	" < 1 TBS Orange SILT Fine Sand.	PH 6.83
1710	"	—	—	—	—	—	—	STOP Pump FOR DAY	
9/29 0858	141.0	—	—	—	—	—	—	RESTART Pump. MOVE UP	
0929	"	—	3.4	769	0.8	167	2.42	WATER LT Orangish Brown/Milky, 1 TSP Med Sand/SILT.	PH 7.04
1001	"	—	3.5	881	0.3	128	2.29	LT Orangish Milky, TRACE Sand: SILT.	
1005	139.0	—	—	—	—	—	—	MOVE UP, RESTART Pump.	
1040	"	—	~~3.5~~	~~1003~~	~~0.3~~	~~44~~	~~2.36~~	WATER Slightly Orangish, Cloudy, TRACE Sed.	PH 8.86
1050	"	—	—	—	—	—	—	STOP Pump	
Surge block off		START	Polish @ 1053						
1112	134.0	—	3.2	1063	0.3	105	2.34	LT Orangish Brown/Milky/ish H. Trace Sed.	PH 6.87
1120/1123	"	—	—	—	—	—	—	STOP Polish/START Rubbish Surge	Ground Sed.
1147	149.0	—	3.2	1143	0.3	289	2.65	Med Brown Orangish Milky 1/2 TSP Sand	PH 6.85
1150								STOP Rubbish Surged	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-31S
PAGE 1 OF 1

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AY
DATE STARTED 9/1/05 **COMPLETED** 9/2/05
GROUND ELEVATION 922.35 feet **TOC ELEVATION** 924.04 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643097.901 meters **EASTING** 373488.784 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Peat**	No water added.
					3.0 **Silt with sand** Brown, moist.	
5	GB				5.0 **Silt with sand** Light brown, moist.	No water added.
					6.8 **Sand** Poorly graded, subangular, moist.	
					8.3 **Sand with gravel** Well graded sand, >15% gravel, subangular to subrounded, dry to moist.	No water added.
10	GB				12.0 **Sand with gravel** Same as above, decreased gravel.	
					14.0	
15	GB				15.0 **Sand with gravel** Same as above, fines.	No water added.
					Sand with gravel Well graded sand, <5% gravel, subrounded, dry to moist.	
					17.0 **Sand with gravel** Same as above, increased gravel (~20%), increased moisture.	No water added.
20	GB				20.0	
					21.0 **Sand with gravel** Same as above, moist to wet.	
					Sand with gravel Same as above, increased coarse sand, wet.	No water added.
25					24.8	
					25.0 **Silt with sand**	No water added.
					26.5 **Silt with sand** Brown, fine- to medium-grained sand.	
					27.0 **Silt with gravel and sand** Dark brown.	
					28.0 **Permafrost**	
					Bottom of hole at 28.0 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.69 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 28 Sept., 2005
Purge Volume: N/A

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Water Depth (ftoc): Dry Date: 8/2/05 Time: 0715

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: AY/P-05-31S
Date: 9/28/05 - 9/29

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer, Jonathan Hobson.

Summary

	Installed (Well Log)	Start	End
Water level	—	21.76	24.93
Total depth	26.35	26.50	26.47
pH	—	—	—

Screen interval (btoPVC): 5'
Top: 21.5
Bottom: 26.5
PVC stick-up height (above ground surface):

Development Observations Only 4.75' WATER In Well.

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on	START Pump @ 1305 → WATER Won't Pump out.							
1318	26.0	21.76	—	—	—	—	—	Stop Pump @, TAPED Surge Block
1324	"	—	—	—	—	—	—	(R. START Pump, (TAPED)
1422	24.0	—	—	—	—	—	—	Move up. RESTART Pump
1618	22.0	—	—	—	—	—	—	Move up. RSTART Pump
1710	"	—	—	—	—	—	—	STOP Pump For Day
9/29/05 0948	21.0	—	—	—	—	—	—	RESTART Pump; Move up 1ft.
1030								STOP Pump
Surge block off	START Debris Surge @ 1014.							
1038								STOP Debris Surge / End

* NOT ENOUGH WATER In Well TO pull out.

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-32D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AZ

DATE STARTED 9/2/05 **COMPLETED** 9/3/05 **GROUND ELEVATION** 890.53 feet **TOC ELEVATION** 892.53 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6642761.14 meters **EASTING** 373890.754 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Gravelly silty sand** Brown, 30% 1/2"-diameter gravel, 40% medium to fine sand, 30% silt	
5	GB				5.0 **Gravelly silty sand** Dry	Air injection only.
					7.0 **Gravelly silty sand** Brown, poorly graded, 20% 1/4"-diameter gravel, 50% medium to fine sand, 30% brown silt, dry	
10	GB				8.0 9.5 **Gravelly silty sand** Light gray to tan, dry	
					10.0 **Sand with gravel** Light gray, very fine sand, 10% gravel, dry	Slow penetration rate. Driller said material is hard to produce.
15	GB				12.0 **Sand with gravel** Light gray, very fine sand, some gravel	Air injection only. Sample collected. Sediment may be hardened mudstone or welded tuff.
					13.5 **Sand with gravel** Light gray, very fine sand (powder fine), 15% 1/4"-diameter gravel, 85% medium to very fine sand, dry	Air injection only.
					15.0 16.5 **Sand with gravel** Light brown, very fine sand, 15% small gravel, dry	Air injection only.
20	GB				17.0 **Gravel with sand and silt** Well-graded gravel with very fine sand and silt, dry	Very slow penetration rate, material is probably a mudstone that is pulverized by drill hammer.
					Sand with gravel Light tan, very fine sand, 15% gravel, dry (mudstone)	Slow penetration rate. Material is very hard.
					21.5 **Sand with gravel** Light gray, very fine sand, 15% 1/4"-diameter gravel, dry (mud stone)	Air injection only.
25	GB				22.0 **Sand** Light tan (mudstone)	Air injection only.
					Sand Light tan, very fine sand, 15% coarse sand, dry	
					25.0 **Sand with gravel** Light tan, very fine sand, 15% 1/4"-diameter gravel, dry (mudstone on molded tuff)	Air injection only.
30					29.0	Driller changes out bit and we start open hole drilling. 4"-diameter open hole bit.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.00 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 29 Sept., 2005
Purge Volume: 889 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 48.6 Date: 9/3/05 Time: 0515

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-32D
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AZ

DATE STARTED 9/2/05 **COMPLETED** 9/3/05 **GROUND ELEVATION** 890.53 feet **TOC ELEVATION** 892.53 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6642761.14 meters **EASTING** 373890.754 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Sand with gravel** Light tan, very fine sand, 15% 1/4"-diameter or less gravel, dry (mudstone)	Air injection only. Air injection only, open hole drilling.
					34.0	
35					35.0 **Sand** Light gray, fine sand, 15% coarse sand, dry (mudstone)	Air injection only, open hole drilling, slow penetration rate.
					Sand Light tan, very fine sand, 15% coarse sand, dry (mudstone or limestone)	Drill hammer is pulverizing rock sediment, may be mudstone or limestone.
					39.0	
40	GB				**Sand** Light tan, very fine sand, 15% coarse sand, dry (mudstone or limestone)	
					44.0	
45					45.0 **Sand** Light tan, very fine sand, 15% coarse sand, dry	
					Sand Light gray, fine sand, 15% coarse sand, dry	Air injection only, open hole drilling.
					49.0	
50	GB				**Sand** Light tan, very fine sand, 15% coarse sand, dry (mudstone or limestone)	1 foot per minute penetration rate, air injection only.
					54.0	
55					55.0 **Sand** Light tan, very fine sand, 15% coarse sand, dry (mudstone or limestone)	Air injection only, open hole drilling.
					Sand Light tan, very fine sand, 15% coarse sand, dry	3 minutes per foot penetration rate.
					59.0	
60	GB				**Sand** Light tan, very fine sand, 15% coarse sand, dry	Collected sample. Air injection only, open hole drilling.
					61.5	
					Sand and silt Light tan, coarse sand with very fine sand and silt, damp (mudstone)	Drill hammer breaks up formation, could be mudstone. Formation is damp, but no show of water.
					63.0 **Sand** Light tan, coarse sand, dry (mudstone)	Air injection only.
65					64.0 **Sand** Light tan, fine sand, 15% coarse sand, dry	
	GB				65.0 **Sand** Light tan, very fine sand, 15% coarse sand, dry (mudstone)	Air injection only, open hole drilling, 4"-diameter drill bit.
					68.5	3 minutes per foot penetration rate.
					69.0 **Sand** Light gray, very fine sand with coarse sand	
70					**Sand** Light gray, very fine sand, 15% coarse sand, dry (mudstone)	Air injection only, open hole drilling, 4"-diameter drill bit.
						Water encountered when drilling resumed (with crew change water came up). No water added.
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-32D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AZ
DATE STARTED 9/2/05 **COMPLETED** 9/3/05 **GROUND ELEVATION** 890.53 feet **TOC ELEVATION** 892.53 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642761.14 meters **EASTING** 373890.754 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sand** Light tan, well-graded sand, siltstone fragments with well-graded sand	Bit gummed up. No water added, little to no recovery. Drill rate slows. Transitions to bedrock. No sample collected. Driller says he hit bedrock.
80					80.0 **Bedrock**	
			8-10		83.0	
	GB				**Bedrock** Gray, sand grains, angular fragments (mudstone)	
85			8-10		85.0	
			8-10		**Bedrock** Gray conglomerate, sand grains and angular fragments (mudstone)	Feels more competent.
	GB				88.0 **Bedrock** Same as above	
90			10			
	GB				93.0 **Bedrock** Same as above	
95					95.0	
			10-15		**Bedrock** Gray conglomerate, sand grains (mudstone)	No water added. Hammer not firing due to water.
	GB					
100					101.0	
					Bottom of hole at 101.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AZ/P-05-32D
Date: 9/29/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level	418.6	41.73	41.91
Total depth	101.5	102.35	102.2
pH	—	7.96	8.25

Screen interval (btoPVC): 15'
Top: 88.0
Bottom: 102.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1308							Water Thick Medium Brown Orange/Milky	
1329	102.0	41.73	4.6	96.6	0.07	581	3.90	LT Orange SH Brown Milky, 1½ Tsp of Medium grain Sand & IT	
1353	"	—	4.9	214	0.06	178	3.40	LT Orange, Milky, 0½ Tsp Mud Sand. SLT.	
1358	100.0	—	—	—	—	—	—	Move up. Restart Pump.	
1411	"	—	4.7	275	0.06	123	3.12	LT Orange SH Grey Brown, < 1 tsp mud Sand in SLT.	PH 8.10
1415	98.0	—	—	—	—	—	—	Move up. Restart Pump.	
1433	"	—	4.8	385	0.06	77	3.25	Slightly Colored/Cloudy < 1½ Tsp Sand in SLT	PH 8.19
1438	96.0	—	—	—	—	—	—	Move up. Restart Pump.	
1450	"	—	4.7	441	0.06	54	3.18	Water Cloudy but No Color, < ½ Tsp Sand.	PH 8.20
1454	94.0	—	—	—	—	—	—	Move up. Restart Pump	
1509	"	—	4.7	511	0.06	77	3.41	Slightly colored, < ½ Tsp Sand.	PH 8.19
1514	92.0	—	—	—	—	—	—	Move up. Restart Pump.	
1532	"	—	4.7	642	0.06	46	3.32	Slightly Grey In colour, Cloudy. Trace Sand.	PH 8.25
1538	90.0	—	—	—	—	—	—	Move up. Restart pump.	
1549	"	—	4.7	693	0.06	22	3.41	Water Clear, Trace Sand	PH 8.17
1554	88.0	—	—	—	—	—	—	Move up. Restart pump.	
1605	"	—	4.7	744	0.06	34	3.25	Slightly Cloudy. Trace Sand	PH 8.23
1611	88.0	—	—	—	—	—	—	Move up. Restart pump	
1620	"	—	4.7	786	0.06	24	3.26	Slightly Cloudy. Trace Sand	PH 8.26
1622	"	—	—	—	—	—	—	Stop Pump @	
Surge block off	START Polish @ 1628								
1638	82.0	—	4.7	833	0.06	14	3.17	Water Clear. No Sand.	PH 8.25
1639 1641	" 102.0	—	—	—	—	—	—	Stop Polish/Start Decb. 3 Surge.	
1653	102.0	—	4.7	889	0.06	29	3.24	Slightly Cloudy. Trace Sand.	
1655	"	—						Stop Pump @	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-33D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AV
DATE STARTED 9/3/05 **COMPLETED** 9/3/05
GROUND ELEVATION 840.18 feet **TOC ELEVATION** 842.08 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642870.379 meters **EASTING** 374366.93 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat**	Air injection only.
					2.0 **Gravel with sandy silt**	
					3.0 **Gravel with sandy silt** Brown,50% well-graded gravel, 30% medium to fine sand, 20% silt, damp.	
	GB				**Silt** Brown, elastic, damp.	
5						Air injection only.
					7.0 **Silt** Brown, elastic, 5% small gravel, damp.	
	GB				9.0	
10					10.0 **Silt** Brown, 5% to 8% gravel.	
					Silty gravel Brown, 50% 1/2"-diameter gravel, 20% medium to fine sand, 30% silt, damp. 12.0	
	GB				**Gravelly silt** Brown, 70% silt, 20% medium to fine sand, 10% 1/2"-diameter gravel, damp. 13.5	
15					14.5 **Gravelly silt** Brown, 40% silt, 40% 1/4"- to 1/2"-diameter gravel, 20% medium sand. 15.3	
					Gravelly silt Dark brown, 30% gravel, dry.	Air injection only.
			1/8		**Gravel** Dark brown, well-graded gravel, 10% medium to fine sand, 10% silt, dry. Large cobble, getting rock chips with small amount of silt, dry.	Driller said hammer and rotary are working smooth. Penetration 3 min./foot. Air injection only. Water showed. Injected small amount of water.
20					20.0 Large cobbles with 5% to 10% dark brown silt.	
					Sandy gravel with silt Well-graded gravel, coarse to fine sand and silt, wet. 22.0	
	GB				**Sandy gravel with silt** Dark brown, 40% well-graded gravel, 40% silt, 20% coarse to fine sand, wet.	Air injection only.
25			1/8		25.0	Air injection only.
					Sandy gravel with silt Dark brown, well-graded gravel, small cobbles, wet. 26.5	
					27.0 **Sandy gravel with silt** Poorly-graded gravel.	Injected small amount of water.
					28.0 **Sandy gravel with silt** Dark brown, 50% well-graded pea gravel, 30% silt, 20% coarse to fine sand, wet.	
	GB		1/8		**Gravel with silt** Dark brown, well-graded gravel.	Injected small amount of water.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 1.09 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 30 Sept., 2005
Purge Volume: 1249 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 4.85 Date: 9/4/05 Time: 0720

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-33D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AV
DATE STARTED 9/3/05 **COMPLETED** 9/3/05 **GROUND ELEVATION** 840.18 feet **TOC ELEVATION** 842.08 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642870.379 meters **EASTING** 374366.93 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
					31.3 **Gravel with silt** Dark brown, well-graded gravel.	Injected small amount of water.
					32.0 **Silt** Dark gray, 5% to 10% small gravel, dry.	
					33.0 **Silt** Dark gray, 5% to 10% small gravel, dry to damp.	
					Gravel with silt Dark brown, 40% well-graded gravel, 30% coarse to fine sand, 30% silt.	
35			1/4		35.0 **Gravel with silt** Dark brown.	Injected small amount of water.
					37.0 **Sandy gravel with silt** Dark gray, 40% poorly-graded pea gravel, 40% silt, 20% coarse to fine sand.	Crew change.
						No water.
40	GB		1		40.0 **Sandy gravel with silt** Dark gray, poorly-graded gravel.	
					41.8 **Gravel** Well-graded, silt and sand.	
					43.8 **Silt with sand and gravel**	
45	GB				45.0 **Silt with sand and gravel** Dark gray, <20% gravel.	Added water.
						Dense, slow drilling.
						Added water.
						Added water.
					49.5	Injected water.
50	GB				50.5 **Gravel-bedrock** Poorly-graded gravel, weathered bedrock.	Injected water.
					Bedrock Light gray, conglomerate-tuff.	
						Injected water.
55	GB				55.0 **Bedrock** Gray, conglomerate-tuff.	
			1/4			Added water.
						Open hole, 3 7/8" hammer.
60	GB				60.0 **Bedrock** Same as above.	Drill rate slows.
			1/2		More competent.	Added water.
			1/4			Added water.
					64.0	Added water.
65	GB				65.0 **Bedrock** Same as above, cuttings more pulverized.	
					Bottom of hole at 65.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: AW/P-05-33D
Date: 9/30/05 / 10/1/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level	4.85	4.37	5.23
Total depth	50.0	46.42	46.55
pH	—	6.32	7.64

Screen interval (btoPVC): 10
Top: 36.4
Bottom: 46.4
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1120							WATER Thick Muddy, Brown/Grey In Color	
1152	46.4	4.37	44	140	0.5	1000	3.48	WATER A bit light In Color, 2 TBS Fine sand & SILT	
1216	"	—	4.3	243	0.5	807	3.04	" " 1 TSP	
1220	44.4	—	—	—	—	—	—	Move up. RESTART Pump	
1249	"	—	4.2	364	0.5	462	3.32	LT Grey Brown, Cloudy, Medium/Fine sand & SILT 1/2	TBS. PH 7.72
1310	"	—	4.4	456	0.5	338	3.14	" " " 1 TSP	
1321	42.4	—	—	—	—	—	—	Move up. RESTART Pump	
1344	"	—	4.3	554	0.5	405	2.95	Dull LT grey brown, 1 TBS Very Fine sand & Silt	PH 7.66
1421	"	—	4.3	756	0.5	168	3.15	" " 1 1/2 TSP Very Fine sand & SILT	PH 7.64
1430	40.4	—	—	—	—	—	—	MOVE UP. RESTART pump	
1452	"	—	4.3	850	0.5	228	3.30	LT Grey Cloudy. 1 TBS Very Fine sand Dull LT Grey In color.	
1527	"	—	4.1	993	0.5	140	3.21	LT Grey Cloudy, 1 TSP, "	PH 7.62
1531	38.4	—	—	—	—	—	—	MOVE UP. RESTART Pump.	
1556	"	—	4.0	1093	0.5	120	3.06	LT grey cloudy. 1 TSP Sand	PH 7.66
1600	36.4	—	—	—	—	—	—	Move Up. RESTART Pump	
1611	"	—	3.9	1135	0.5	88	3.11	LT grey In color / cloudy, TRACE Sand SILT	PH 7.64
1614	"	—	—	—	—	—	—	Stop Pump	
Surge block off	START Polish @ 1619								
1635	31.4	—	3.7	1194	0.5	76	3.23	WATER LT Grey/Cloudy, 1/4 TSP of Sand	PH 6.62
1637 1640	31.4 46.4	—	—	—	—	—	—	STOP Polish / START Rebound Surge	
1653	46.4	—	4.3	1249	0.5	147	3.03	LT grey cloudy, 1 1/2 tsp Sand	PH 7.64
10/1/05 0846	"	—	8.9		0.4	9.99	1.71	RESTART Rebound Surge /	PH 7.64
0912								STOP Rebound Surge, 1 tsp Very Fine Sand	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-34D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AU
DATE STARTED 9/4/05 **COMPLETED** 9/4/05
GROUND ELEVATION 853.88 feet **TOC ELEVATION** 855.88 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643193.565 meters **EASTING** 373940.111 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Peat	Air injection only.
					3.0 **Peat**	Driller said he saw water.
5						Air injection only.
					7.0 **Gravel with sand and silt** Poorly-graded gravel, coarse to fine sand and silt, 30% pea gravel, 50% coarse to fine sand, 20% silt, wet.	
	GB					
10					10.0 **Silt with gravel** Gray, 5% small gravel, elastic, damp to dry.	
					13.0	
					14.0 **Silt with sand** 5% to 10% coarse sand, elastic, damp to dry.	Injected small amount of water.
15					15.0 **Gravel with sand and silt** Well-graded gravel with sand and silt, 30% 1/2"-diameter gravel, 40% coarse to fine sand, 30% silt.	Injected small amount of water.
					17.0 **Gravel with sand and silt** Well-graded gravel, coarse to fine sand, gray silt.	
20			1/4		20.0 **Gravel with sand and silt** Poorly-graded gravel, subangular to subrounded, coarse to fine sand, gray silt, 30% 1/4"-diameter gravel, 40% coarse to fine sand, 30% gray silt.	Air injection only.
					22.0 **Gravel with sand and silt** Well-graded subangular gravel, medium to fine sand and silt, 40% gravel, 40% sand, 20% silt.	Injected small amount of water.
25					25.0 **Gravel with sand and silt** Poorly-graded subangular gravel, coarse sand and gray silt, 40% 1/4"-diameter gravel, 45% coarse sand, 15% gray silt, damp.	Injected small amount of water.
					27.0 **Gravel with sand and silt** Poorly-graded subangular gravel, coarse sand and gray silt, damp.	Difficult to tell water content in formation with injection of water which hydrates the silt.
	GB					Injected small amount of water.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.00 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 1 Oct., 2005
Purge Volume: 430 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 16 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 11.85 Date: 9/5/2005 Time: 0045

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-34D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AU
DATE STARTED 9/4/05 **COMPLETED** 9/4/05 **GROUND ELEVATION** 853.88 feet **TOC ELEVATION** 855.88 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643193.565 meters **EASTING** 373940.111 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30				30.5 **Gravel with sand and silt** Poorly-graded subangular gravel, coarse to medium sand and gray silt, 40% 1/4"-diameter pea gravel, 45% coarse to medium sand, 20% gray silt, damp to wet.	
				32.0 **Silt with gravel** Gray silt, 5% small gravel, elastic, damp to dry.	
35				35.0 **Silt with sand** Gray silt, 5% coarse sand, elastic, damp to dry.	Injected small amount of water.
				36.5 **Gravel with sand and silt** Poorly-graded subangular gravel, 1/4"-diameter clasts with sand and <15% silt, damp to dry.	
	GB			37.0 **Silt** Gray, elastic, damp to dry.	
40				40.0 **Silt with gravel** Gray silt, 10% 1/4"- to 1/2"-diameter subangular gravel, damp to dry.	
				40.5 **Silt with gravel** Gray silt, 10% gravel.	
	GB			42.0 **Silt with gravel** Poorly-graded gravel, 40% pea gravel, 20% coarse sand, 40% gray silt.	
45				43.0 **Silt with gravel and sand** Light tan silt, 10% pea gravel, coarse sand.	
				44.0 **Silt with gravel** Light tan.	
				45.0 **Silt with gravel** Light tan silt, 10% pea gravel.	No water. Penetration rate and drill action nominal to fast.
				46.0 **Silt with gravel** Light tan silt, 10% pea gravel, dry.	
			3	47.0 **Weathered rock** Light tan to gray, maybe top of conglomerate.	Water blows out top of casing.
50				50.0 **Weathered rock** Light tan to gray, conglomerate.	
				Weathered conglomerate Tan (mudstone).	
			0	53.0 **Gravel with sand and silt** Light tan, pea gravel with coarse sand and silt, silt has a clay friction (may be fault grange or mudstone).	Formation dropping off to no water content, appears to be the same as formation that contained water. Formation has silt with clay fraction that may be from water in the hole. Injected small amount of water to get cutting up hole.
55				55.0 **Conglomerate or mudstone** Light tan, 15% silt, coarse sand, small gravel.	
	GB			57.0 **Conglomerate or mudstone** Light tan, small (5% to 10%) fraction of silty clay.	Drill penetration rate slowing with hammer action. Formation is getting harder.
				58.0 **Conglomerate or mudstone** Light tan, some sand, small gravel, 15% silt.	
60			1	59.0 **Conglomerate** Light tan, wet.	Injected small amount of water.
			6	62.0 **Conglomerate** Light tan.	
				64.0 **Conglomerate** Light tan.	Driller pulled rod and bit to change to 4" bit to drill open hole.
65				65.0 **Conglomerate or mudstone** Light tan.	Injected small amount of water.
			5	69.0	Injected small amount of water to clean hole.
70			7	**Conglomerate or mudstone** Light tan.	Injected small amount of water.
				74.0 **Conglomerate or mudstone** Light tan.	
				75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-34D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AU
DATE STARTED 9/4/05 **COMPLETED** 9/4/05 **GROUND ELEVATION** 853.88 feet **TOC ELEVATION** 855.88 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643193.565 meters **EASTING** 373940.111 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle, Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75			16		**Conglomerate or mudstone** Light tan.	
					79.0	
80	GB		42		**Conglomerate or mudstone** Light tan.	
			60			
					84.0	
85			50		85.0 **Conglomerate** Tan to dark reddish brown.	
			60		**Conglomerate** Dark brown.	
					86.5 **Conglomerate** Light gray.	
					89.0	
90			60		**Conglomerate** Light gray to tan.	
					94.0	Crew change.
95	GB		60		95.0 **Bedrock conglomerate** Light gray.	
					Bottom of hole at 95.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AV/P-05-34D
Date: 10/1/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Jonathan Hobson.

Summary

	Installed (Well Log)	Start	End
Water level	/	5.75	5.8
Total depth	/	95.5	95.8
pH	/	7.64	7.47

Screen interval (btoPVC): 1D
Top: 85.5
Bottom: 95.5
PVC stick-up height (above ground surface): —

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1026							
1036	95.5	5.75	8.4	84	0.3	335	1.42	WATER STARTED, Medium Brown	
1042	93.5	—	—	—	—	—	—	WATER CLEAR, Very Slightly cloudy TRACE Fine Sand	
1051	"	—	5.0	129	0.3	19.6	1.30	MOVE UP. RESTART Pump	
1055	91.5	—	—	—	—	—	—	WATER CLEAR, TRACE Sand	PH 7.52
1107	"	—	4.8	186	0.3	12.1	1.31	MOVE UP. RESTART Pump.	
1111	89.5	—	—	—	—	—	—	WATER CLEAR, TRACE Sand.	PH 7.49
1121	"	—	4.6	232	0.3	6.9	1.31	Move up. RESTART Pump.	
1126	87.5	—	—	—	—	—	—	WATER CLEAR, TRACE Sand	PH 7.54
1141	"	—	4.8	304	0.3	10	1.49	MOVE UP. RESTART Pump.	
1145	85.5	—	—	—	—	—	—	WATER CLEAR, TRACE Sand	PH 7.50
1152	"	—	4.8	337	0.3	6	1.27	MOVE UP. RESTART Pump.	
1156	"	—	—	—	—	—	—	WATER CLEAR, TRACE Sand	7.53
								STOP Pump.	
Surge block off		START Polish @ 1200							
1210	80.5	—	5.0	387	0.3	7	1.38	WATER CLEAR, No Sand.	PH 7.46
1212 / 1215	80.5 / 96.5	—	—	—	—	—	—	STOP Polish / START Rebris Surge.	
1224	95.5	—	4.9	430	0.3	5	1.44	WATER CLEAR. TRACE Sand.	PH 7.47
1227	"	—	—	—	—	—	—	STOP Pump/End Rebris Surge	

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-35D
PAGE 1 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AT

DATE STARTED 9/5/05 **COMPLETED** 9/5/05 **GROUND ELEVATION** 936.74 feet **TOC ELEVATION** 938.76 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6643852.309 meters **EASTING** 373355.927 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.3 **Peat** Plant roots, stems.	Air injection only.
					2.0 **Silty sand** Light tan, medium sand.	
	GB				**Silty sand** Light tan, medium sand, slightly silty, dry.	
5					4.5 5.0 **Silt** Light brown, some gravel.	Injected small amount of water.
					Silt Light brown, elastic, 5% subangular gravel, damp. 7.0	
					8.0 **Silt** Light brown, elastic, damp.	
	GB				**Silt** Light brown, elastic, 5% small gravel, damp.	Very slow drill rate in this silt, drill hammer is working.
10					10.0 11.0 **Silt** Increasing gravel content.	
					12.0 **Silt** Increasing gravel content.	Inject small amount of water.
	GB				**Gravelly silt** Brown, 60% silt, 40% poorly graded pea gravel, dry.	No significant amount of water in this formation.
15					15.0	
					Gravelly silt Brown, poorly-graded pea gravel. 17.0	Inject small amount of water.
	GB				**Gravelly silt** Brown, poorly-graded, subangular pea gravel.	Drill rate is moderate to slow 3 min./foot.
20					20.0	
					Silty sand Brown, medium sand. 22.0	Drill rate increased to fast penetration rate. Inject small amount of water.
					Silty sand Brown, 60% medium sand, 40% silt.	No or very limited free standing water encountered.
25					25.0	
					Silty sand Brown. 26.5	Inject small amount of water.
					Siltstone rock chips Black siltstone, brown silt, small cobbles. 28.5	Drill action indicates we are in cobbles or large gravel.
	GB				29.0 **Gravel** Well-graded, 1/2"-diameter subangular to well rounded. 30.0	Drill cuttings are probably from small cobbles.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.02 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4"coated tablets

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 1 Oct., 2005
Purge Volume: 439 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 24.74 Date: 9/6/05 Time: 0730

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-35D
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AT
DATE STARTED 9/5/05 **COMPLETED** 9/5/05
GROUND ELEVATION 936.74 feet **TOC ELEVATION** 938.76 feet
DRILLING CONTRACTOR Foundex
NORTHING 6643852.309 meters **EASTING** 373355.927 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					31.0 **Silt** Gray, 5% pea gravel, dry.	Inject small amount of water.
					32.0 **Silt** Gray, 10% pea gravel, dry.	
					33.0 **Silt** Gray, dry.	
	GB				34.0 **Silt** Gray, 10% pea gravel, 10% coarse sand, stiff, dry.	No water in this gravel.
35					35.0 **Gravel** Cobbles or large gravel, dry.	
					Silt Dark gray.	Inject small amount of water.
					37.0 **Gravel with silt** Gray, 50% poorly-graded pea gravel, 35% coarse to medium sand, 25% silt.	
	GB				**Gravel with sand** Gray, 40% 1/4"-diameter well-graded, subangular gravel, 40% coarse to medium sand, 40% silt, dry.	
40					42.0	
					Gravel with sand Gray, 40% well-graded 1/4"- to 1/2"-diameter subangular gravel, 40% coarse to medium sand, 20% silt, dry.	
45					45.0	
					Gravel with silt Gray, dry.	Inject small amount of water.
					47.0	Injected water hydrates silt, but no water flow appears with cuttings.
	GB				**Gravel with silt** Gray, 40% poorly-graded, subangular to subrounded pea gravel, 30% coarse to fine sand, 30% silt, dry.	
50					49.0 **Gravel with silt** Gray, small gravel, stiff, dry.	Air injection only.
					51.5	
					52.0 **Gravel** Well-graded, subangular gravel, dry.	Small show of water, but no measurable flow.
	GB				53.0 **Gravel** 50% well-graded subangular gravel, 40% coarse to medium sand, 10% silt, dry.	Inject small amount of water.
					54.0 **Gravel with silt** Gray to light tan, 20% silt.	
55					55.0 **Gravel with silt** Subangular to rounded gravel, increasing silt and fine sand.	
					56.5 **Gravel with silt** 50% fine sand, 30% silt, 20% gravel.	
					Weathered rock Light gray, conglomerate.	
			1		59.0	Crew change. Water out of hole at rod/crew change.
60	GB				**Bedrock** Light gray, competent, conglomerate.	
					62.0	
			1/4		**Bedrock** Light tan, conglomerate.	Inject small amount of water. Trip out 6-inch hammer, trip in 4-inch hammer, drill open hole. Added water.
65					65.0	
	GB		1/4		**Bedrock** Light gray, conglomerate.	Hard slow drilling, driller says no water. Injected water. Injected water.
70						Injected water.
	GB				**Bedrock** Light gray, competent, conglomerate, cuttings are pulverized.	
					74.0	
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-35D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AT
DATE STARTED 9/5/05 **COMPLETED** 9/5/05 **GROUND ELEVATION** 936.74 feet **TOC ELEVATION** 938.76 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6643852.309 meters **EASTING** 373355.927 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		1/4		**Bedrock** Light gray, conglomerate, competent, cuttings very pulverized. Bottom of hole at 75.0 feet.	.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AT/P-05-35D
Date: 10/1/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer ; Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		22.05	25.33
Total depth		59.2	59.20
pH		8.06	7.88

Screen interval (btoPVC): 5
Top: 54.2
Bottom: 59.2
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on START Pump @ 1326									
1400	59.2	22.05	1.5	51	0.3	1000	2.36	STARTed Thick & BROWN, MUDDY	
1428	"	—	1.5	93	0.3	428	2.51	WATER, Mud Brown, Medium/Fat, suspended Sed.	3 TBS.
1433	57.2	—	—	—	—	—	—	(Bucket Dumped)	
1512	"	—	1.4	147	0.3	632	2.15	MOVE UP. RESTART PUMP	
1533	"	—	1.2	172	0.3	405	1.87	Mud Brown/LT, Suspended Sed. + Fine/Med Sand 2TBS	PH 8.11
1542	55.2	—	—	—	—	—	—	MED BROWN, " 1 1/2 TBS.	PH 8.10
1630	"	—	1.2	229	0.3	152	2.10	MOVE UP. RESTART PUMP.	
1644	"	—	0.9	241	0.3	140	1.86	LT Brown/Grey, Cloudy. 1/2 Tsp Fine Sand: SILT.	
1651	54.2	—	—	—	—	—	—	" "	PH 8.13
1657	"	—	—	—	—	—	—	MOVE UP. RESTART PUMP.	
0954								STOP PUMP FOR DAY/WATER Clear Trace Sand.	
10/2/05 Surge block off		START Polish @ 0926							
0954	49.2	—	3.7	344	0.4	30	2.38	WATER Slightly Cloudy, Trace Sand	PH 6.92
0958 1000	" 59.2	—	—	—	—	—	—	STOP Polish / START Rebuild Surge.	
1025	59.2	—	3.8	439	0.29	39	2.12	Slightly Cloudy. 1/4 Tsp Sand.	PH 7.88
1032								STOP Rebuild Surge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05 **GROUND ELEVATION** 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat**	Air injection only.
					2.0 **Silty sand** Light brown, medium to fine sand, damp.	
	GB				3.0 **Silty sand** Light brown, 50% silt, 50% medium to fine sand, damp.	
					4.0 **Silty gravel** Poorly-graded gravel, medium to coarse sand, dry.	
5					5.0 **Silty sand** Coarse to medium sand, 15% silt, damp.	Air injection only.
					7.0 **Silty gravel** Poorly graded.	
	GB				**Silty sand** Brown, 75% medium to fine sand, 15% silt, 10% gravel, damp.	
10					9.0	
					10.5 **Sandy gravel** Poorly-graded, subangular gravel, coarse to medium sand, dry to damp.	
					12.0 **Gravel and sand** Dry.	
	GB				**Gravel and sand** 50% well-graded, 1/4"- to 1/2"-diameter subangular gravel, 40% coarse to fine sand, 10% silt, dry.	
15					15.0	Air injection only.
					17.0 **Gravel with sand** Well-graded gravel, coarse to fine sand, damp to dry.	
	GB				19.0 **Gravel with sand** 45% well-graded, 1/4"- to 1/2"-diameter gravel, 45% coarse to fine sand, 10% silt.	
20					20.0 **Sand** Light brown, coarse to medium sand, 10% gravel, dry.	
					22.0 **Gravel and sand** Well-graded, subangular gravel, coarse to medium sand, dry.	
	GB		1/8		23.0 **Sand** Coarse to medium sand, 10% subangular to subrounded gravel, <15% fines, damp to wet.	First show of water. No significant flow.
					24.0 **Sand** Coarse to medium sand, increasing gravel.	
25					**Gravel** Well-graded, subangular gravel, coarse to medium sand, increasing silt.	Air injection only.
					26.5	
	GB				**Gravel with silt and sand** Brown, 45% well-graded gravel, 40% coarse to medium sand, 15% silt, damp.	
30					29.0	Flow out of cyclone at drill break. Flow immediately stops drilling air injection.
					Gravel Poorly-graded pea gravel, wet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.30 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Oct., 2005
Purge Volume: 294 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 113.0 Date: 9/6/05 Time:0215

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-36D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05
GROUND ELEVATION 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30			1/2			
					32.0 **Gravel** Poorly-graded pea gravel, wet.	
					33.0 **Gravel** 80% subangular to subrounded, poorly-graded gravel, 20% medium sand, <15% fines, wet.	Inject small amount of water.
35					35.0 **Gravel** Well-graded, subangular to subrounded gravel, coarse to medium sand.	Inject small amount of water.
					Silt Gray, elastic, dry.	
					38.0 **Silt** Gray, elastic, 5% coarse sand and small gravel, dry.	
40						
					42.0 **Silt** Gray, elastic, 5% to 10% coarse sand, small gravel.	
45					45.0 **Silt** Gray, 5% to 10% silt, dry.	Inject small amount of water.
					47.0 **Silt** Gray, elastic, 5% to 10% coarse sand and small gravel, dry.	
50						
					52.0 **Silt** Gray, elastic, 15% subangular to subrounded gravel, dry.	
55					55.0 **Silt** Gray, 15% coarse sand and gravel.	Inject small amount of water.
					56.5 57.0 **Gravel with sand and silt** Poorly-graded gravel, coarse sand.	
					58.0 **Gravelly silt** Gray, 75% silt, 15% 1/4"- to 1/2"-diameter subrounded gravel, 10% coarse to medium sand.	
60					**Silt** Gray, gravel and coarse sand.	
					62.0 **Silt** Gray, elastic, 10% to 5% coarse sand, dry.	
					63.5 64.5 **Gravel with sand** 70% coarse sand, 30% poorly-graded pea gravel.	
65					65.0 **Sand** Coarse to fine sand (probably wet).	Inject small amount of water.
					Sand Coarse to fine sand.	
					67.0 **Sand with gravel** 70% coarse to medium sand, 30% 1/4"-diameter subangular to subrounded pea gravel, wet (maybe).	Heaving sands. Inject small amount of water.
70					70.0 **Sand with gravel** Coarse to medium sand, 20% gravel.	
					72.0 **Sand** Medium to fine sand.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05 **GROUND ELEVATION** 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sand** Medium to fine sand.	
					77.0 **Sand** 80% coarse sand, 20% pea gravel.	
					78.5 **Gravel with sand** Well-graded gravel, <20% coarse subrounded sand, wet.	
80	GB				80.5 **Sand and gravel** Well-graded sand.	Added foam.
						Added foam. Filled casing with water.
85	GB				85.0 **Sand and gravel** Well-graded sand.	
					86.5 **Sand with silt and gravel** Well-graded sand.	Added foam.
					88.5 Increased silt.	Added foam.
90	GB				90.0 **Silt with sand**	
					Silt with sand and gravel Light brown, moist.	Added water/foam.
					94.5	
95	GB				95.0 **Silt with gravel** Black, angular.	Driller says bedrock.
					96.0 **Silt with gravel** Black.	Driller says bedrock.
					96.5 **Silt with sand and gravel**	
			1/8		**Silt with gravel** Black. Boulder.	Waited 10 min., let hole stabilize.
100	GB				99.5 **Silt with gravel and cobbles** Light brown.	Change out rods, drilled with 4" bit open hole. Added water. Added water/foam. Added water/lots of foam.
105	GB				105.0 **Silt with sand and gravel** Light brown, stiff.	Added foam.
					108.0 **Gravel with silt and sand** Subangular to angular.	Added water.
110	GB					
						Added water.
115	GB				115.0 **Gravel with silt and sand** Tan, subangular to angular gravel, coarse, rounded to subangular sand grains.	Added water. Driller says it drills like clay. Added water. Added water/foam.
					119.5	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05
GROUND ELEVATION 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Silt with sand and gravel** Black, angular to subrounded grains, stiff silt.	Applying lots of water/foam. Gauge is bouncing.
					124.5	Added water/foam. "Drilling like clay."
125	GB				125.0 **Bedrock** Gray, conglomerate.	Added water/lots of foam.
			<1		**Bedrock** Gray, conglomerate.	
130	GB					Added water/foam.
135	GB		3/4		135.0 **Bedrock** Gray, conglomerate.	No water added.
			3/4			No water added.
140			6			
			6-8			Changed from 6" to 4" hammer, drilled open hole.
145			8-10		145.0 **Bedrock** Gray, conglomerate.	
150			8-10			
			8-10		151.0 Bottom of hole at 151.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AG/P-05-36D
Date: 10/4/05 - 10/5/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimin & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		19.96	22.20
Total depth		150.2	150.5
pH		6.39	7.35

Screen interval (btoPVC): 10'
Top: 140.2
Bottom: 150.2
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1608							
1620	150.2	19.96	—				—	PUMPED DRY	
10/5/05 0924	11	—	—				—	RESTART Pump	
0936	11	—	2.4	19.2	0.5	873	4.01	Medium Grey, Cloudy, Med to Fine Sediment, Sand, RTBS	
1002	11	—	0.9	42	0.4	205	4.43	Slightly LT in color, 1 TSP sand	PH 7.24
1030	148.2	—	—				—	MOVE UP, RESTART Pump	
1111	11	—	1.4	99	0.4	73	4.92	LT Grey, Cloudy, 1 TSP Fine Black Sand	PH 7.40
1137	11	—	1.1	127	0.4	36	4.68	Slightly LT Grey, Cloudy, 1 TSP Fine Sand	PH 7.60
1146	146.2	—	—				—	MOVE UP, RESTART Pump.	
1218	11	—	1.1	162	0.4	17	4.77	WATER CLEAR, 1/4 TSP Black Fine Sand	
1226	144.2	—	—				—	Move up, RESTART Pump.	
1232	11	—	—				—	Pump Dry @ 1232	
1356	11	20.53	—				—	Resume pumping	
1400	11	—	3.5	176	0.4	38	4.86	Slightly LT Grey Cloudy, 1/4 TSP Fine Sand	pH 7.31
1407	142.2	—	—				—	MOVE UP, RESTART Pump.	
1411	11	—	2.1	247	0.4	24	4.99	WATER Colorless, CLEAR, Trace Sand	
1446	140.2	—	—				—	MOVE UP, RESTART Pump	
1502	11	—	1.9	277	0.4	27	5.01	Slity Cloudy.	
1505	11	—	—				—	STOP Pump.	
Surge block off		START Polish @ 1514							
1523	135.2	@ 0.7	0.7	283	0.4	41	5.03	Slightly cloudy very light grey silt, Trace sand	
1527/1552	11/150.2	—	—				—	STOP Polish, START Pulsing Surge	
1543	150.2	—	1.4	294	0.5	410	5.20		
1551	11	—	—				—	STOP Pulsing Surge/END.	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05
GROUND ELEVATION 1012.17 feet **TOC ELEVATION** 1015.27 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642156.83 meters **EASTING** 372684.909 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**No recovery**	No water added.
					4.0	
5					5.0 **Sand, silt and gravel** Brown, poorly-graded sand, dry.	
					Sand, silt and gravel Poorly-graded sand, subrounded gravel clasts, dry to moist.	
					8.5	
10	GB				**Sand with silt and gravel** Brown, well-graded sand, subrounded gravel, moist.	
					11.5	
					Gravel with silt and sand Light brown, well-graded, subrounded gravel clasts, moist.	
15	GB				15.0	
					Sand with silt and gravel Light brown, well-graded sand, <20% subrounded gravel, moist.	
					17.0 Increased gravel.	
					Gravel with silt and sand Brown, well-graded, subangular gravel, moist.	
20	GB				Decreased silt.	
					21.8	
					Gravel with sand Well-graded, subrounded to subangular gravel, wet.	
25	GB				25.0	
					Gravel Well-graded, subangular to subrounded, wet.	
			1		27.0 Increasing silt.	
			1		**Gravel with sand** Well-graded gravel, wet.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 3.10 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 5 Oct., 2005
Purge Volume: 1071 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 23.22 Date: 9/8/05 Time: 1805

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36M
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05 **GROUND ELEVATION** 1012.17 feet **TOC ELEVATION** 1015.27 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642156.83 meters **EASTING** 372684.909 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB		1		**Gravel with sand** Brown, well-graded, subangular to subrounded gravel, wet.	No water added.
35	GB				35.0 **Gravel with sand** Well-graded gravel, wet. 35.5 **Silt with sand** Light brown. 36.8 **Clay with silt** Greenish gray. 38.0 **Clay with silt** Greenish gray.	Injected water. Added foam. Injected water/foam.
40	GB				40.0 **Clay with silt** Greenish gray, trace sand. Trace gravel. 43.5	Injected water/foam. Cuttings very foamy. Added water.
45	GB				45.0 **Silt with sand and gravel** Greenish gray. **Silt with sand and gravel** Gray, plastic, trace gravel.	Added water/foam. Added water/foam.
50	GB				50.0 **Silt with sand and gravel** Gray, medium plasticity. 51.8 52.8 **Silt with sand and gravel** Gray.	Added water/foam.
55	GB				55.0 **Silt with sand and gravel** Increased coarse-grained, angular sand.	Added water/foam. Added water/foam.
60	GB				60.3 **Silty sand** Gray, coarse, subangular sand. 61.5 **Silty sand and gravel** Well-graded, subrounded gravel.	Drill advancing much faster. Added water. Added water. Sands heaving severe.
65	GB				65.0 **Gravel with sand** Well-graded gravel, subrounded sand.	Add water/foam. Heaving sands. Added water/foam. Added water/foam.
70	GB				70.0 **Sand with gravel** Well-graded sand, <15% subrounded gravel. 73.0 **Sand**	Drill in heaving sand.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36M
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05 **GROUND ELEVATION** 1012.17 feet **TOC ELEVATION** 1015.27 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642156.83 meters **EASTING** 372684.909 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sand**	Injected foam/water.
					77.0 **Sand** Gray, medium to fine, wet.	Driller cleaned casing and got heave under control. Heave is back in casing, even when water was added to casing to control heave. Injected foam and water.
80	GB				80.0 **Sand** Coarse.	
					82.0 **Sand** Coarse, little to no fines.	Fines may have been washed out of sample by water used to control heaving sand. Inject foam and water.
	GB				85.5	
85					86.5 **Sand with gravel** Medium to fine sand, 5% to 10% 1/2"-diameter gravel.	Injected moderate amount of foam and water.
					87.5 **Gravel with sand** Well-graded gravel, coarse to medium sand, little to no fines.	
	GB				89.0 **Sand** Coarse to medium sand, 10% to 20% gravel, little to no fines.	
90					90.5 **Silty gravel** Rock chips are black siltstone, maybe a large cobble. Gray, 20% gravel.	Sand heave 8' into casing, installed piezometer, removed piezometer and drilled deeper.
	GB				Bottom of hole at 90.8 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: AG/P-05-36M
Date: 10/5/05 - 10/6/05

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Jonathan Hobson

Summary

	Installed (Well Log)	Start	End
Water level		22.30	22.03
Total depth		93.45	94.03
pH		8.33	8.35

Screen interval (btoPVC): 10
Top: 83.4
Bottom: 93.4
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Pump @ 1622								
1650	93.4	22.30	4.3	120	0.2	343	4.74	Grey cloudy, 2 1/2 TBS Mud/Fine Sand.	
1700	"	—	—	—	—	—	—	STOP Pump FOR DAY	
10/6/05 0942	"	—	—	—	—	—	—	RESTART Pump	
1007	"	—	4.5	232	0.3	144	3.95	Med Grey. cloudy, 1 1/2 Tsp Coarse/Fine Sand. SLT.	PH 8.36
1015	91.4	—	—	—	—	—	—	Move up. RESTART Pump.	
1029	"	—	4.1	289	0.3	72	4.26	Med Grey cloudy. 3/4 TBS Coarse-Fine Sand	PH 8.42
1049	"	—	3.8	365	0.3	38	4.42	LT Grey cloudy, 2 Tsp, " Sand Dark grey/black	PH 8.40
1112	"	—	3.8	452	0.3	30	4.34	" " , 1 Tsp, " "	PH 8.38
1119	89.4	—	—	—	—	—	—	Move up. RESTART Pump.	
1144	"	—	4.3	559	0.3	33	4.39	LT Grey cloudy, 1 Tsp Sand	
1152	87.4	—	—	—	—	—	—	Move up, RESTART Pump.	
1211	"	—	4.4	642	0.3	32	4.35	LT grey Slightly Cloudy, 1 Tsp Sand	PH 8.42
1217	85.4	—	—	—	—	—	—	Move up. RESTART Pump.	
1233	"	—	4.6	711	0.3	12	4.52	WATER CLEAR, 1/4 Tsp Coarse/Med Sand.	
1238	83.4	—	—	—	—	—	—	Move up. RESTART Pump	
1253	"	—	4.5	778	0.3	5	4.36	WATER CLEAR, TRACE Sand.	
1255	"	—	—	—	—	—	—	STOP Pump	
Surge block off	START POLISH @ 1300								
1312	78.4	—	4.4	830	0.3	6	4.44	WATER CLEAR, TRACE Sand.	
1314/1320	"/93.4	—	—	—	—	—	—	STOP POLISH / START Rebris Surge	
1355	93.4	—	4.2	977	0.3	460	4.84	Med Grey/cloudy. 2 1/2 TBS Sand SLT.	PH 8.35
1417	"	—	4.3	1071	0.3	327	4.54		
1420	End Rebris Surge								

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05 **GROUND ELEVATION** 1011.81 feet **TOC ELEVATION** 1014.38 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642166.108 meters **EASTING** 372679.8 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Peat**	Air injection only.
	GB				**Gravel with sand and silt** 40% 1/2"-diameter well-graded gravel, 40% medium to fine sand, 20% silt.	
5					5.0	
					6.0 **Sand** Brown, coarse, <15% fines, dry.	Air injection only.
					Sand Brown, coarse to medium sand, 15% 1/2"-diameter subangular to subrounded gravel, <15% silt or fines, dry.	
	GB				8.0	
					9.0 **Gravel with sand and silt** Well-graded gravel with small cobbles, medium sand, <15% fines, dry.	
10					**Gravel with sand and silt** Well-graded gravel and small cobbles, coarse to medium sand, <15% fines, dry.	
					12.0	
	GB				**Gravel with sand and silt** Well-graded gravel, coarse to medium sand, <15% fines, dry.	
15					15.0	
					Gravel with sand and silt Brown, well-graded subangular to subrounded gravel, coarse to medium sand, <15% fines, dry.	Air injection only.
					17.0	
	GB				**Sand with gravel** Brown, 80% coarse to medium sand, 20% poorly-graded gravel, <15% fines, dry.	
20					20.0	
					Gravel with sand 50% well-graded, subangular to subrounded gravel, coarse to medium sand, dry.	
					22.0	
	GB				**Sand with gravel** Brown, 80% coarse to medium sand, 20% 1/2"-diameter subangular to subrounded gravel, <15% silt, damp.	Show of water at 23' bgs, water drilling out of casing. Air injection only. Injected small amount of water.
25					25.0	
					26.0 **Sand with gravel** Brown, coarse to medium sand, 20% subangular to subrounded small gravel, damp.	
					27.0 **Silty gravel** Brown, 50% well-graded, 1/2"-diameter subangular gravel, 30% coarse to medium sand, 20% silt.	
	GB				29.5 **Gravel with sand** 60% well-graded, 1/4"- to	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.57 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Oct., 2005
Purge Volume: 932 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 22.51 Date: 9/7/05 Time: 1815

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

P-05-36S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05 **GROUND ELEVATION** 1011.81 feet **TOC ELEVATION** 1014.38 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6642166.108 meters **EASTING** 372679.8 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30				31.0	1/2"-diameter subangular to subrounded gravel, 40% well-graded, coarse to medium sand, <15% fines.	
				33.0	**Gravel and sand** Brown, well-graded gravel, coarse to medium sand, 15% silt.	
				34.0	**Gravel and sand** Brown, coarse to medium sand, 15% silt.	Injected water to clean up hole and casing.
				35.0	**Sand** Light gray, fine, small clay lenses.	
					Silt Gray, elastic, dry.	
					Bottom of hole at 34.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

WELL DEVELOPMENT LOG

Well ID: AG/P-05-36S
Date: 10/4/05 - 10/5/05
Project: Pebble Mine Site Ground Water Program
Project #: 005.0189.05002 Task 5
Technician: Willow Weimer, Jonathan Hobson.

Summary

	Installed (Well Log)	Start	End
Water level		21.19	21.27
Total depth		36.0	36.0
pH		7.03	6.94

Screen interval (btoPVC): 10
Top: 26.0
Bottom: 36.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on		START Pump @ 1604, Very Orange, Rusty looking.							
1642	36.0	21.19	3.7	140.6	061	96	4.25	LIGHTER 1½ Tsp Fine Sand.	
1700	—	—	—	—	—	—	—		
10/5/05 0918	"	—	—	—	—	—	—	Stop Pump For Day	
0933	"	—	3.7	196	0.2	65	4.22	RESTART PUMP. LT Orange, ¼ Tsp Fine Sand	PH 5.69
0957	34.0	—	—	—	—	—	—	Move up. RESTART Pump	
0958	"	—	3.5	248	0.1	196	4.05	Move up. RESTART Pump	
1024	34.0	—	3.5	339	0.1	63	4.0	Rust Orang in color, 2 Tsp Md/Fine (Black) Sand	PH 6.58
1046	"	—	3.5	416	0.1	15	4.17	Move up. RESTART Pump 1', 1½ Tsp. Very Orange, TRACE SAND	PH 5.73
1050	32.0	—	—	—	—	—	—		
1128	"	—	3.1	533	0.1	30	4.25	move up. RESTART Pump	
1135	30.0	—	—	—	—	—	—	LT Orange, ¼ Tsp of Sand	
1212	"	—	2.0	607	0.1	75	4.43	Move up, RESTART Pump	
1235	"	—	1.5	641	0.1	105	4.33	Md Orange. 1 Tbs. Sand, Suspended Fine	PH 7.37
1243	28.0	—	—	—	—	—	—	" , 1½ Tsp Sand. "	
1320	"	—	2.3	726	0.1	159	4.60	Move up, RESTART Pump	
1343	"	—	2.1	774	0.1	89	5.66	Md Orange, Cloudy, ½ Tsp. Fine Brown sand	PH 5.70
1352	26.0	—	—	—	—	—	—	Med Dk Orange, TRACE Sand	PH 5.61
1427	"	—	2.2	851	0.1	73	4.78	Move up, RESTART Pump	
1430	"	—	—	—	—	—	—	LT Orange, cloudy TRACE Sand	
								STOP Pump	
Surge block off		START Polish @ 1438						2 FT ABOVE screen	
1450	24.0	—	1.9	873	0.1	29	4.45	Slightly cloudy Colorless WATER Sand.	PH 6.94
1459 1459	" 36.0	—	—	—	—	—	—	STOP Polish / START Rubber Surge	
1516	36.0	—	3.5	932	0.1	10	4.53	Slightly Very orangish BUT CLEAR, Trace Sand	
1519	"	—	—	—	—	—	—	STOP Pump / END Rubber Surge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37D
PAGE 1 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/19/06 **COMPLETED** 7/19/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163540.2 **EASTING** 1409443.9
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					GP **Gravel** with silty sand, brown, fine to medium gravel, fine to coarse sand, silt, moist.	
5	GB					
10	GB				10.0 CL **Clay** with silt and gravel, brown, gravel medium sized, moist.	
15	GB				15.0 GP **Gravel** Brown, fine to coarse gravel with medium to coarse sand, trace silt, moist.	
20	GB				20.0 SM **Silty Sand** Brown, fine to medium sand, wet to saturated.	Hit Ground water, brown mud being discharged.
25	GB				25.0 ML **Silt** brown, with trace fine sand and trace fine gravel, moist.	
30	GB				ML **Sandy Silt** Yellowish brown, Fine to coarse sand, moist. 30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: N/A
Type: N/A
Diameter: N/A

SURFACE SEAL
Mix Used: N/A

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: N/A

SCREEN
Type: N/A
Slot Size: N/A

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Well abandoned

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/19/06 **COMPLETED** 7/19/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163540.2 **EASTING** 1409443.9
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB			GP **Gravel** Yellowish orange, fine to coarse, medium to coarse sand and trace silt, moist.	With 100 cfm water flow was a trickle. Once air was supplied to new rod, a significant amount of water was discharged in a large blast. After drilling resumed water began to flow.
35	GB	10.8	15.0	35.0 **Bedrock** Yellowish orange, possible granite dicrite, saturated.	
40	GB			**Bedrock** Yellowish orange, some fines in balls, possibly from shallower zones, saturated.	
45	GB		11.25	**Bedrock** Yellowish orange, saturated.	1301 took a picture of water flowing out of discharge
50	GB		13.5	**Bedrock** Yellowish orange, possible conglomerate, saturated.	
55	GB		12.0	**Bedrock** Yellowish orange, possible conglomerate, saturated.	
60	GB			**Bedrock** Light grey, possible Diorite.	
65	GB		3.0	63.0 CL-ML **Silty Clay** Light grey, fine to coarse sand.	
			0	65.0 **Bedrock** Siltstone and rock flower matrix, saturated.	Water changed to a grey color.
70	GB		9.4	**Bedrock** Sandy silt texture, possible siltstone and rock flower, saturated.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/19/06 **COMPLETED** 7/19/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163540.2 **EASTING** 1409443.9
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB		12.8		**Bedrock** Siltstone and rock flower matrix, saturated.	
					Bedrock Dark grey, Siltstone, trace rock flower, saturated.	
			15			
80	GB				**Bedrock** Dark grey, Sandstone, poorly cemented, saturated.	
85	GB				**Bedrock** Dark grey, Sandstone, poorly cemented, saturated.	
			1.4			
			3.4			Water color changed to brown.
			9.0			During drilling water color returned to grey color.
90	GB				**Bedrock** Dark grey, Sandstone, fine grained, saturated.	
95	GB				**Bedrock** Light grey, Conglomerate, saturated.	
			1.8-18.75			
100	GB				**Bedrock** Light grey, Conglomerate, saturated.	
			26.25			
105	GB				**Bedrock** Light grey, Conglomerate, saturated.	
110	GB				**Bedrock** Light grey, Conglomerate, saturated. Doesnt fizz with HCL.	
		14.2	13.5			
115	GB				**Bedrock** Light grey, Conglomerate, saturated. Doesnt fizz with HCL.	The driller noted that drilling became harder.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/19/06 **COMPLETED** 7/19/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163540.2 **EASTING** 1409443.9
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Bedrock** Siltstone and rock flower matrix, saturated. **Bedrock** Light grey, Conglomerate, saturated.	
			15.0			With the pressure and flow water pushed out of the bucket.
125	GB				**Bedrock** Light brown and light grey, Conglomerate, saturated.	
			15.0			
130	GB				**Bedrock** Light brown, Conglomerate, saturated.	
			75.0			Flow estimated by the driller.
135	GB				**Bedrock** Greenish grey, Conglomerate, saturated.	
			75.0			Flow estimated by the driller.
140	GB				**Bedrock** Light grey to Light brown, Conglomerate, possibly altered, visible crystals, saturated.	
			75.0			Flow estimated by the driller. Too much pressure to gauge with the bucket.
145	GB				**Bedrock** Light grey, Conglomerate, saturated.	
	GB				**Bedrock** Light grey, Conglomerate with rock flower, saturated.	
150	GB				**Bedrock** Light grey, Conglomerate with rock flower, saturated.	
			75.0			Flow estimated by the driller.
		10.2				
155	GB				**Bedrock** Light grey, Conglomerate with rock flower, saturated.	
			75.0			Flow estimated by the driller.
160	GB				**Bedrock** Light grey, Rock flower with conglomerate, probably from drilling action, saturated.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/19/06 **COMPLETED** 7/19/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163540.2 **EASTING** 1409443.9
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165	GB				**Bedrock** Siltstone and rock flower matrix, saturated.	
	GB		0		**Bedrock** Light grey, Rock flower probably from drilling action, trace conglomerate or coarse grained material, saturated.	No more water, very little coming out. Added 25 gallons of foam and water. Back into water.
170	GB				**Bedrock** Rockflower, trace coarse grained material, very soft. **Bedrock** Light grey, rock flower probably from drilling action, with fine to medium gravel, saturated.	
			60.0			Flow estimated by the driller.
175	GB				**Bedrock** Light grey to Dark grey, Conglomerate, saturated.	
			60.0			Flow estimated by the driller.
180	GB				**Bedrock** Light grey, Conglomerate, trace rock flower, light grey, saturated.	
			60.0			Flow estimated by the driller.
185	GB				**Bedrock** Greenish grey, Conglomerate, saturated.	Driller added about 20 gallons of water and foam.
			60.0			Flow estimated by the driller. Driller added about 10 gallons of water and foam.
190	GB				**Bedrock** Dark grey, Conglomerate, saturated.	
			60			Driller added about 20 gallons of water and foam.
195	GB				**Bedrock** Dark grey, Conglomerate, saturated.	Water flow slowed down but driller will allow flow test @ 200ft.
200	GB		7.5		200.0 **Bedrock** Light grey, Conglomerate, saturated. Bottom of hole at 200.0 feet.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

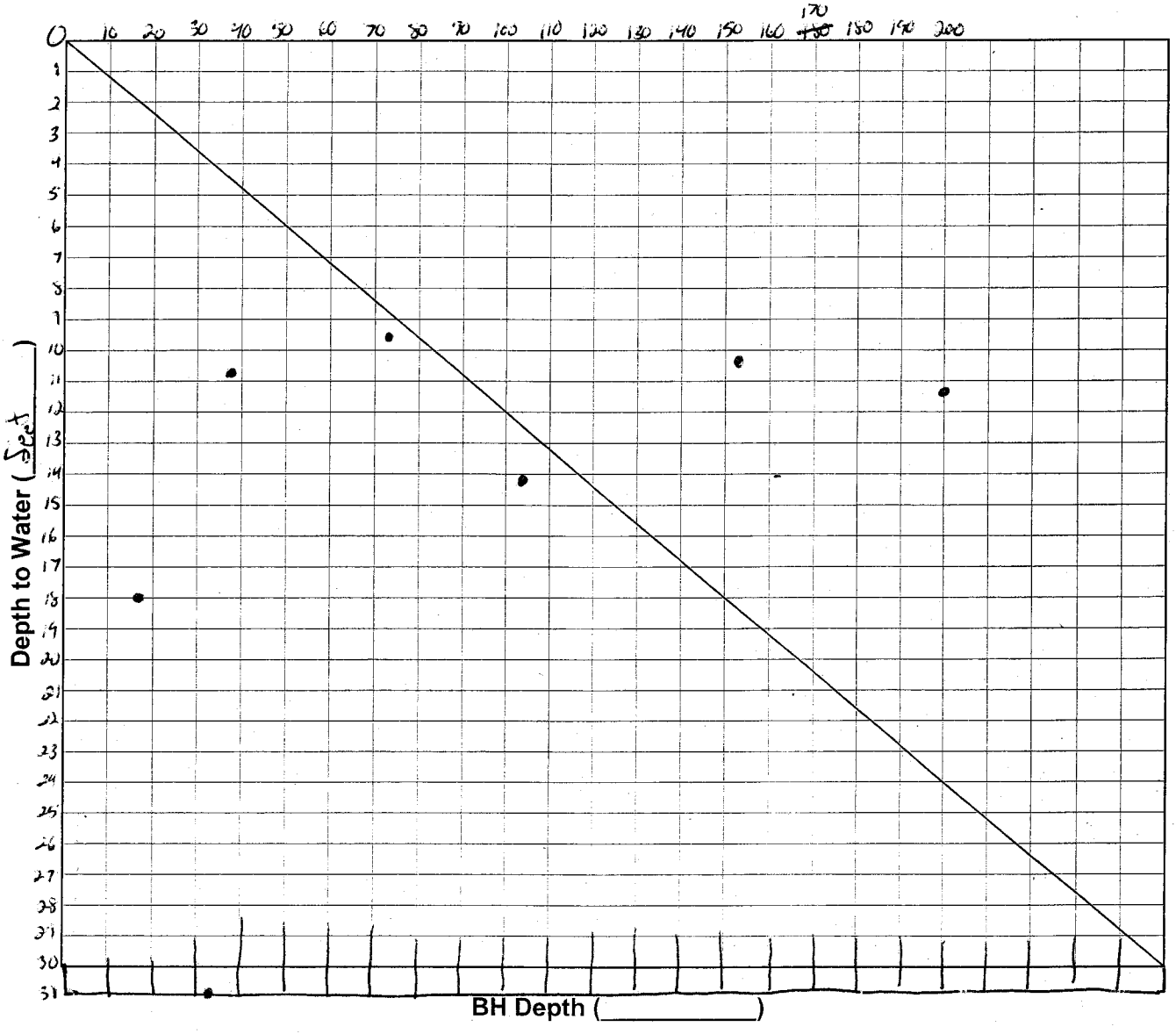
Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.05002 Task 5
Hole ID:	P-06-370
Name:	Beau Johnson
Date start	17 July 06
Date finish	

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-17-06	1021	18	18	7-18-06	1506	153	10.2				
7-17-06	1058	31	31	~~7-18-06~~ B3							
7-17-06	1128	38	10.8	7-19-06	0930	200	11.3				
7-17-06	1451	73	9.6								
7-18-06	1128	113	14.2								

Depth vs Depth During Drilling



WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

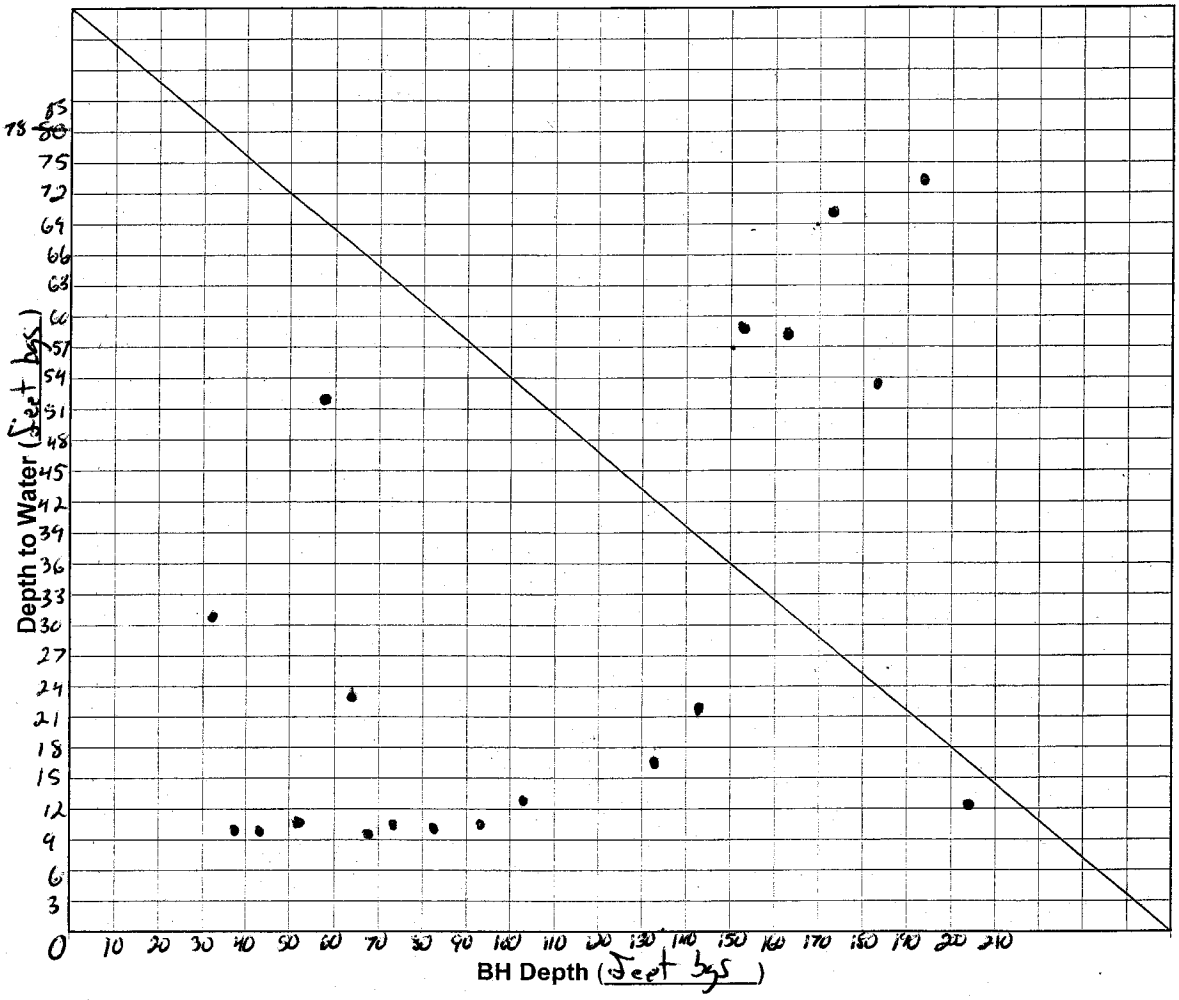
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: P-06-370
Name:
Date start ~~7-21-06 BS~~ 7-20-06
Date finish ~~7-22-06 BS~~ 7-21-06

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-20-06	1714	31	31	7-21-06	1004	63	23.1	7-21-06	1213	103	13.3
"	1731	38	10.8	"	1014	68	9.8	"	1456	133	17.6
"	1804	43	10.2	"	1024	73	11.7	"	1528	143	22.3
7-21-06	0921	53	11.1	"	1107	83	10.3	"	1552	153	56.1
"	0932	58	52.0	"	1149	93	11.8	"	1647	163	55.6
								"	1717	173	70.9
								"	1748	183	53.8
								"	1813	193	73.7
								7-21-06	0800	205	12.4

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37DA

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/20/06 **COMPLETED** 7/21/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** _____ **EASTING** _____
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0	GB				ML **Silt** Dark brown, with fine to medium gravel with fine to medium sand, moist.	
5	GB				ML **Silt** Dark brown, with fine to medium sand, moist.	
10	GB	▼			ML **Silt** Dark brown, with trace fine to medium sand, moist.	
	GB				ML **Silt** with Sand, Light brown, fine to medium sand, trace fine to medium gravel, moist.	
15	GB				ML **Silt** with Sand, Light brown, fine to medium sand, trace fine to medium gravel, light brown, very moist.	
20	GB				ML **Silt** with Sand, Light brown, fine to medium sand, trace fine to medium gravel, very moist.	
	GB				ML **Silt** with Sand. Light brown, fine to medium sand, trace fine to medium gravel, light brown, very moist.	
25	GB				ML **Silt** with Gravel, Light brown, fine to coarse gravel, medium to coarse sand, moist.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.8
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: Celco 1/4" coated tablets

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/7/06
Purge Volume: 359.0 Gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/15/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 7/22/06 Time: 0800

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37DA
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/20/06 **COMPLETED** 7/21/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** _____ **EASTING** _____
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB		9.5		GM **Silty Gravel with Sand** Yellowish orange, fine to coarse gravel, medium to coarse sand, moist.	First water. Water is yellowish orange.
35	GB				35.0 GP **Gravel with Sand** Yellowish orange, fine to coarse gravel, medium to coarse sand, trace silt, saturated.	
	GB	10.8	13.3		GP **Gravel** Yellowish orange, fine to coarse gravel, medium to coarse sand trace silt, saturated.	
40	GB				40.0 **Conglomerate** Yellowish orange, saturated.	
		10.2	22.5			
45	GB				**Conglomerate** Yellowish orange, saturated.	
			15.0			
50	GB				**Conglomerate** Yellowish orange, saturated.	
		11.1	17.5			
55	GB		0		Rock flower with**Conglomerate** Yellowish orange, saturated.	No water.
		52.0				Hit water again.
60	GB				**Conglomerate** Yellowish orange, with trace rock flower, saturated.	
		23.1	8.1			
65	GB				**Conglomerate** Yellowish orange, with trace rock flower, saturated.	
		9.8	9.5			
70	GB				**Conglomerate** Yellowish orange, saturated.	
		11.7	17.1			
			0			No water.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37DA
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/20/06 **COMPLETED** 7/21/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** _____ **EASTING** _____
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB	75.5		**Conglomerate** Yellowish orange, saturated. Rock flower with Conglomerate, Light grey, very moist.	Water is back.
			12.8		
80	GB			**Conglomerate** Dark grey with trace rock flower, saturated.	
		10.3	10.9		
85	GB			**Conglomerate** Dark grey, saturated.	
			15.0		
90	GB			Rock flower with Conglomerate, Light grey, saturated.	
	GB			**Conglomerate** Yellowish orange, saturated.	
		11.8	22.5		Water flow is high. Water is pushed out of the bucket. Flow is based on driller estimates.
95	GB			**Conglomerate** Yellowish orange, saturated.	
100	GB			**Conglomerate** Light grey to Yellowish orange, saturated.	
		13.3	20		Flow is based on driller estimates.
105	GB			**Conglomerate** Yellowish orange to Dark grey, saturated.	
			30		Water level meter broke. Having one shipped out with other equipment. Flow is based on driller estimates.
110	GB			**Conglomerate** Yellowish orange to Light grey, saturated.	
			30		Flow is based on driller estimates.
115	GB			**Conglomerate** Light grey to dark grey with trace rock flower, saturated.	
			0		No water

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37DA
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/20/06 **COMPLETED** 7/21/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** _____ **EASTING** _____
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Conglomerate** Yellowish orange, saturated. Rock Flower, Light grey with trace conglomerate, very moist.	Water.
	GB		5			
125	GB				Rock Flower, Light grey with trace conglomerate, saturated.	
			6.25			
130	GB		< 1.5		**Conglomerate** Light grey, trace rock flower.	Low flow less than 1.5 gpm. Had to add water with foam. Added Approximately 10.85 gallons of foam or water. Water level meter replaced. Back into water.
		17.6	12.0			
135	GB				**Conglomerate** Dark to light grey, saturated.	
			15.0			
140	GB				**Conglomerate** Dark to light grey, saturated.	Added 10 gallons of water and foam. Began taking pictures and bagging cuttings at 140 feet bgs. added 40 gallons of foam and water.
		22.3				
145	GB				**Conglomerate** Light to dark grey, saturated.	
			6.4			
150	GB				**Conglomerate** Light to dark grey, trace rock flower, saturated.	
		56.1	9.0			Added 10 gallons of water and foam.
155	GB				**Conglomerate** Dark to greenish grey, saturated.	Added 10 gallons of water and foam. Added 10 gallons of water and foam.
			18.0			
160	GB				**Conglomerate** Dark to light grey, trace rock flower, saturated.	Added 5 gallons of foam.
		55.6	22.5			

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37DA
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/20/06 **COMPLETED** 7/21/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** _____ **EASTING** _____
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165	GB				**Conglomerate** Yellowish orange, saturated.	
					Conglomerate Dark to light grey, saturated.	Added 5 gallons of water and foam.
			18.0			
170	GB				**Conglomerate** Light grey, trace rock flower, saturated.	
		70.9				
175	GB				**Conglomerate** Light to dark grey and greenish grey, trace rock flower, saturated.	Added 10 gallons of water and foam.
			45			Flow is based on driller estimates.
			55			Added 10 gallons of water and foam.
180	GB				**Conglomerate** Greenish to dark grey, saturated.	Flow is based on driller estimates.
		53.8	55			Flow is based on driller estimates.
185	GB				**Conglomerate** Light grey with rock flower, saturated.	Added 10 gallons of water and foam.
			55			Flow is based on driller estimates.
190	GB				Rock Flower, Light grey, trace conglomerate, saturated.	
			55			Flow is based on driller estimates.
		73.7				Added 10 gallons of water and foam.
195	GB				**Conglomerate** Light grey, with rock flower, saturated.	
			55			Flow is based on driller estimates.
200	GB				200.0 **Conglomerate** Light to dark grey, saturated.	Added 10 gallons of water and foam.
			55			Flow is based on driller estimates.
205	GB				205.0 Bottom of hole at 205.0 feet.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P-06-37D-A
Date: 7/26/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Deannie Andree

Summary

	Installed (Well Log)	Start	End
Water level		9.7	
Total depth	200.7	~~197.3~~	
pH		7.58	

Screen interval (btoPVC): 180-200
Top: 180
Bottom: 200
PVC stick-up height (above ground surface): 2.8'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond µS/cm ~~(mS/cm)~~	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
08:45	199	22.4	3		303	737	6.6	silt, fine sand, light gray
						~~755~~	~~6.4~~	TDS
09:00	199	25.3	3		312	455	6.9	Silt, light grey, teaspoon
09:15	199	24.3	3		328	265	6.0	
0930	199	24.6	3		326	182	6.8	
0940	197	21.6	3		324	925	7.2	Silt, fine sand, light grey
0955	197	22.4	3		333	188	7.0	
1015	197	22.8	3		338	117	7.0	
1030	197	24.5	3		329	98.3	6.5	
1040	195	23.9	3.25		338	930	5.9	silt, fine sand, light grey, tsp
1055	195	24.8	3.25		334	165	7.2	
1110	195	25.6	3.25		320	212	7.9	Silt, fine sand, light grey, tsp
1120	193	23.9	3.50		336	515	6.4	Silt, fine sand, light grey, tsp
1135	193	29.0	3.50		339	90.9	7.2	
1150	193	25.0	3.50		331	42.4	7.1	
1200	191	17.0	2.50		319	116	9.0	
[illegible]	[illegible]	[illegible]	2.50	[illegible]	[illegible]	[illegible]	[illegible]	ran out of gas
1310 [illegible]	191	21.2	3		300	189	10.1	silt, fine sand, light gray, tsp
1325	191	21.4	3		305	65.6	10.3	
1330	189	21.9	3		310	198	10.3	Silt, fine sand, light gray, TDS
1340	189	22.1	3		313	64.8	10.4	
1350	189	22.5	3		319	66.2	9.6	
Surge block off								
1400	187	20.2	2.5		327	313	9.0	
1410	187	20.3	2.5		310	74.0	10.5	
1420	187	20.9	2.5		331	68.2	9.0	

WELL DEVELOPMENT LOG

Well ID: P-06-37D-A
Date: 7/26/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Deannie Andree

Summary

	Installed (Well Log)	Start	End
Water level		9.7	
Total depth		200.7	
pH		7.58	

Screen interval (btoPVC): 180-200
Top: 180
Bottom: 200
PVC stick-up height (above ground surface): 2.8'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1430	185	19.9			321	393	9.8	
1440	185							Quit - rig move
1450	185							
Surge block off								

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/23/06 **COMPLETED** 7/25/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163524.3 **EASTING** 1409436.3
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
5	GB				ML **Silt** Light brown, trace fine to coarse gravel, moist.	
	GB	▼			ML **Silt** Trace fine to coarse gravel, light brown, moist.	
10	GB				ML **Silt** Light brown, trace fine to coarse gravel, trace fine to medium sand, moist.	
	GB				ML **Silt** Light brown, trace fine to coarse gravel, trace fine to coarse sand, moist.	
15	GB				ML **Silt** Light brown, trace fine to coarse gravel, trace fine to coarse sand, moist.	
20						first water.
			12.0			No water.
25	GB				ML **Silt** Light brown, trace fine to coarse gravel, trace fine to coarse sand, very moist.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.98
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/8/06
Purge Volume: 1421 Gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/15/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 7/25/06 Time: 1610

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37M
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/23/06 **COMPLETED** 7/25/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163524.3 **EASTING** 1409436.3
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB			GP **Gravel** Light brown with Silt, trace fine to coarse sand, very moist.	Driller wanted me to wait to measure DTW due to material down hole.
35	GB			35.0 GM **Gravel with Silt** light brown, fine to coarse gravel, silt, trace fine to coarse sand, very moist.	
40	GB			40.0 **Conglomerate** Yellowish orange, very moist.	Added 5 gallons of foam and water.
45	GB			**Conglomerate** Yellowish orange, very moist.	
50	GB			**Conglomerate** Yellowish orange, very moist.	
55	GB		10.5	**Conglomerate** Yellowish orange, saturated.	Back in water. @12:15 hydrolic hose blows on the compressor. small leak obtained. @ 12:50 Resumed drilling, unable to advance casing because the hammer is plugged. @ 14:34 Drilling resumes.
60	GB			**Conglomerate** Yellowish orange, saturated.	
65	GB			**Conglomerate** Yellowish orange, trace rock flower, saturated.	Low water flow. water flow increasing.
70	GB	8.5	9	**Conglomerate** Yellowish orange, saturated.	
			7.5		

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/23/06 **COMPLETED** 7/25/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163524.3 **EASTING** 1409436.3
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Conglomerate** Yellowish orange, very moist.	
					Conglomerate Light grey, saturated.	
			25.7			
80					**Conglomerate** Light grey, saturated.	
			30			
85	GB				**Conglomerate** Light brown, saturated.	
		17.6	24			No water.
90	GB				**Conglomerate** Dark grey, trace rock flower, very saturated.	
95	GB				**Conglomerate** and rock flower, dark grey, very moist.	Back in water.
						No water.
100	GB				100.0 **Rock flower** Dark grey, with trace conglomerate, very moist.	Added 10 gallons of foam and water. Added 20 gallons of foam and water. Back in water.
			1.5			
105	GB				**Rock flower** Light grey, trace conglomerate, saturated.	Added 10 gallons of foam and water. Back in water.
		82.7	4.0			
110	GB				110.0 **Conglomerate** Light grey, saturated.	No water.
115	GB				**Conglomerate** with Rock flower, dark grey, saturated.	Low water flow.
					120.0	Added 10 gallons of foam and water.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37M
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/23/06 **COMPLETED** 7/25/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163524.3 **EASTING** 1409436.3
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Rock flower** Light grey, conglomerate, saturated.	Added 10 gallons of foam and water.
						No water.
						Added 5 gallons of foam and water.
						Added 10 gallons of foam and water.
125						Still no water.
	GB				**Rock flower** Dark grey, with trace conglomerate, saturated.	
						Added 10 gallons of foam and water.
130					130.0	Added 10 gallons of foam and water.
	GB				**Rock flower** Light grey, with trace conglomerate, saturated.	
						No water coming up with cuttings.
135						
	GB				**Conglomerate** and rock flower, light grey, saturated.	Added 10 gallons of foam and water.
						In water.
140					140.0	
	GB	0.6	61.58		**Conglomerate** Light grey, saturated. Bottom of hole at 140.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

WELL DEVELOPMENT LOG

Well ID: C/P-06-37M
Date: 9/7/06, 9/8/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow W

Summary

	Installed (Well Log)	Start	End
Water level		9.31	
Total depth		91.9	
pH		6.37	

Screen interval (btoPVC): 15 FT
Top: 75
Bottom: 90
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	PH
Surge block on START 1258									
1350	85.5	9.31	3.5	182	0.223	OR	4.5	WATER Milky LT Brown, sand mixed w/ silt Fine to Med Sand,	
1357	83.5	—	—	—	—	—	—	START & MOVE UP Pump	
1421	83.5	—	3.8	273.2	0.210	834	4.39	Milky LT Brown, sand. Fine to SILT	6.99
1456	"	—	3.7	402.7	0.207	491	4.03	" , " , 1½ TBS.	
1519	81.5	—	—	—	—	—	—	MOVE Pump UP, START.	
1553	"	—	3.8	531	0.214	692	4.01	Milky, Grayish White/LT Brown FINE Sand, 2 TBS.	
1604	"	—	3.6	595	0.207	380	4.35	" , Fine Sand, 1 TBS	6.81
1622	79.5	—	—	—	—	—	—	RAISE Pump 2', START	
1641	"	—	3.6	653	0.213	601	4.44	Milky LT Gray, 2 TBS.	6.63
9/8/06 0945	79.5	—	—	—	—	—	—	RESTART PUMP	
1003	"	—	3.9	723	0.225	365	4.34	Milky White, Sand Fine-Mid Grained, 1½ TBS	PH 7.06
1025	77.5	—	—	—	—	—	—	RAISED Pump 2', START,	6.80
1044	"	—	3.9	812	0.201	4.67	4.01	Milky LT grayish white, Fine to medium, 3/4 TBS	
1140	"	—	3.9	1077	0.201	342	4.06	" , Fine to Med Sand, 1 TBS	PH 6.68
1144	75.5	—	—	—	—	—	—	RAISE Pump 2', START	
1204	"	—	4.0	1157	0.199	247	4.21	Milky White/LT Grayish, " , 3/4 TBS	PH 6.59
1223	"	—	4.0	1233	0.199	81.8	4.05	" " , ½ TSP	
1227	75.0	—	—	—	—	—	—	RAISE Pump ½ FT, START	
1239	"	—	4.0	1281	0.200	109	4.09	Milky, LT grayish white, ½ TSP	
Surge block off 1247 START POLISH.									
1257	70.0	—	4.0	1285	0.206	62.2	4.36	Milky LT Grey, NO SAND	
1309	85.5	—	—	—	—	—	—	STOP POLISH, START DEBRIS SURGE	
1323	"	—	4.0	1341	0.199	175	4.06	Milky [illegible] T.NT, 3/4 TBS, Fine to Mid Sand	
1343	"	—	4.0	1421	0.199	263	4.32	" , 1 TSP	PH 6.85
1348								Stop Purge	

WATER MANAGEMENT CONSULTANTS

SLR Alaska

DRILLING WATER LEVEL MEASUREMENTS

Water Level Meter

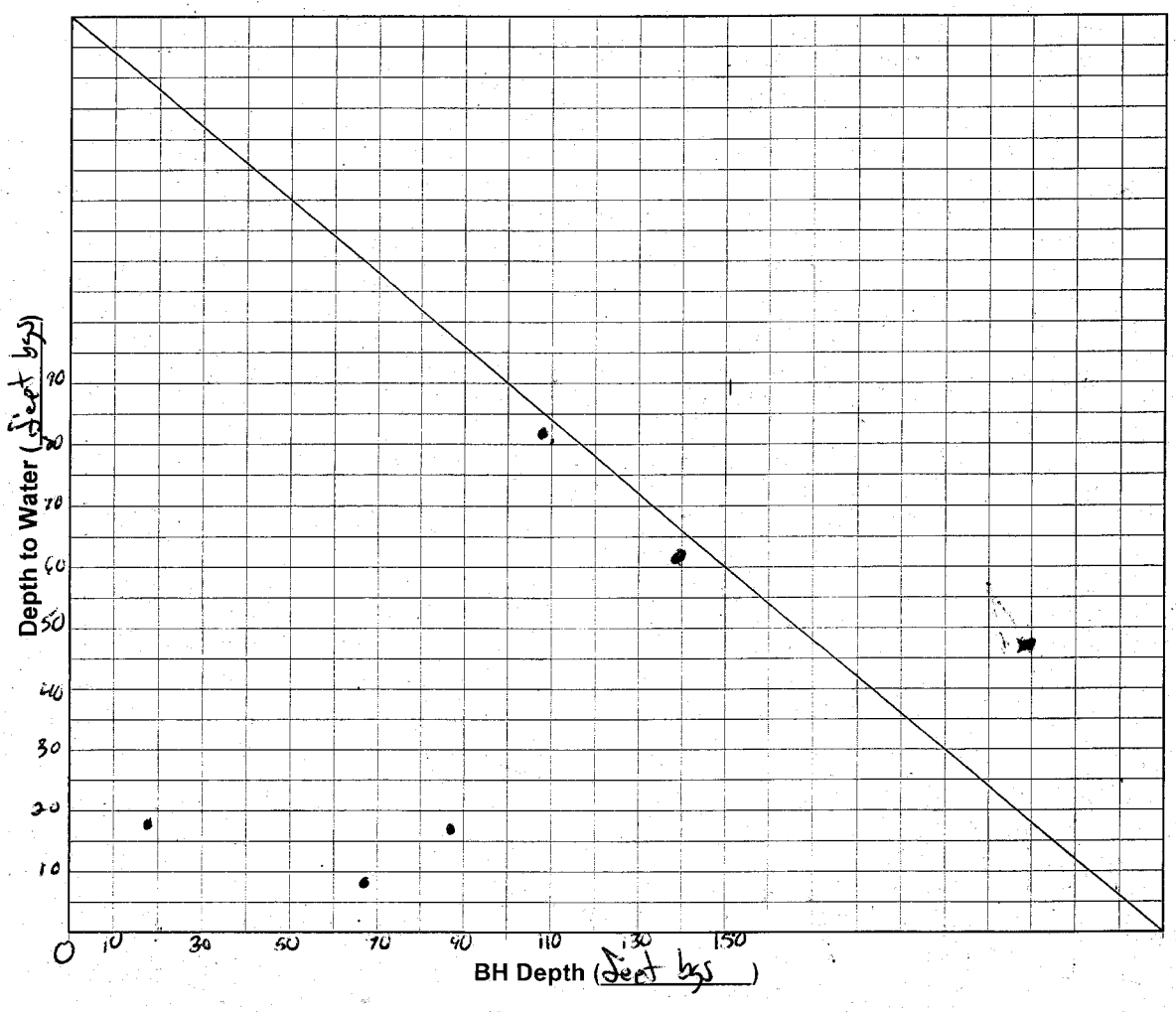
Make: Slope Indicator
Model: Slope Indicator
Cutoff: None
Units: Decimal Feet
Res:

Project: Pebble Mine Site GW
Project #: 005.0189.05002 Task 5
Hole ID: P-06-37m
~~Name:~~
Date start 7-23-06
Date finish 7-25-06

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-24-06	0900	19	19								
7-24-06	1326	68	8.5								
7-24-06	1705	88	17.6								
7-25-06	0826	108	82.7								
7-25-06	1030	140	61.6								

Depth vs Depth During Drilling



Pebble Project

NORTHERN DYNASTY MINES INC.

P-06-37S
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C

DATE STARTED 7/26/06 **COMPLETED** 7/26/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 2163508.2 **EASTING** 1409431.3

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0	GB				ML **Silt** Dark brown, trace fine to coarse sand, moist.	
5	GB				ML **Silt** Dark brown, trace fine to coarse gravel, Trace fine to coarse sand, moist.	
10	GB				ML **Silt** Dark brown, trace fine to coarse gravel, Trace fine to coarse sand, moist.	
15	GB				ML **Silt** Dark brown, trace fine to coarse gravel, Trace fine to coarse sand, moist.	
	GB				ML **Silt** and Gravel, Light brown, trace fine to coarse sand, moist.	
20	GB	▼			20.0	First water @ 0921
	GB				GP **Gravel** Light brown, fine to coarse gravel, trace silt, saturated. 23.0	
25	GB				GW **Gravel** Light brown, fine to coarse gravel, medium to coarse sand, saturated. 25.0	
	GB				SM **Silty Sand** Light brown, Fine to coarse sand, silt, trace fine to coarse gravel, saturated. 28.0	No more water.
	GB				**Conglomerate** with Rock flower, yellowish orange, moist. 30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.97
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/7/06
Purge Volume: 601.0 Gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/15/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 7/26/06 Time: 0959

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-37S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site C
DATE STARTED 7/26/06 **COMPLETED** 7/26/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2163508.2 **EASTING** 1409431.3
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
	GB	23.3			**Conglomerate** with Rock flower, Light grey, moist. Bottom of hole at 29.0 feet.	.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

WELL DEVELOPMENT LOG

Well ID: C/P-06-37S
Date: 9/6/06 - 9/7/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Terry Wassale

Summary

	Installed (Well Log)	Start	End
Water level		13.7	
Total depth		28.03	
pH		6.38	6.30

Screen interval (btoPVC): 5'
Top: 23.0
Bottom: 28.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity NTU	Temp (deg C)	Sediment (grain size, colour, quantity)	PH
Surge block on									
16.07								START	
1608	27.5	13.7	1.74	5.22	0.133	61.0	7.35	Chocolate Brown, Medium to coarse grained sand, 4 cups	
1627	"	—	5	100.22	0.124	630	4.43	Brown, Medium to Coarse Sand, 3/4 cups.	
1654	"	—	3.7	335.1	0.122	224	4.35	LT Brown, " , 2½ TBS.	PH = 6.48
17.07	25.5	—						Move up 2 FT, START	
17.14	"	—	3.76	344.8	0.120	679	4.30	START @ Brown, Fine to coarse Sand, 3/4 cup	
17.42	"	—						STOP Pump - End of Day	
0935	"	—						RESTART Pump.	
0948	25.5	—	1.6	345.6	0.125	225	4.35	Medium Brown, Medium Coarse Sand, 2TBS.	4.48
1005	"	—	2.2	403	0.122	229	3.94	" , 1½ TBS.	
1011	23.5	—						Move Pump up, START.	
1021	"	—	1.9	427	0.122	74.1	4.41	WATER Tgray, 1½ Tsp. Medium/Fine Sand	PH. 6.48
1039	"	—	1.9	446	0.122	116.7	4.27	START / Move up ½ FT. / WATER Light TRACE Sand.	
1045	23.0	—						START Move up ½ FT,	
1052	"		1.9	469	0.122	32.6	4.31	WATER CLEAR, NO Sand.	
Surge block off	START POLISH @ 1100								
1106	1800	—	1.6	478	0.120	20.9	4.42	WATER CLEAR, NO Sand.	
1129	27.5							START DEBRIS SURGE.	
1156	"	—	2.1	543	0.122	45.1	4.75	LT Brown, Sand, Medium to Fine, 2 TBS.	6.39
1226	"	—	2.1	601	0.123	28.6	4.61		

DRILLING WATER LEVEL MEASUREMENTS

SLR Alaska

Water Level Meter

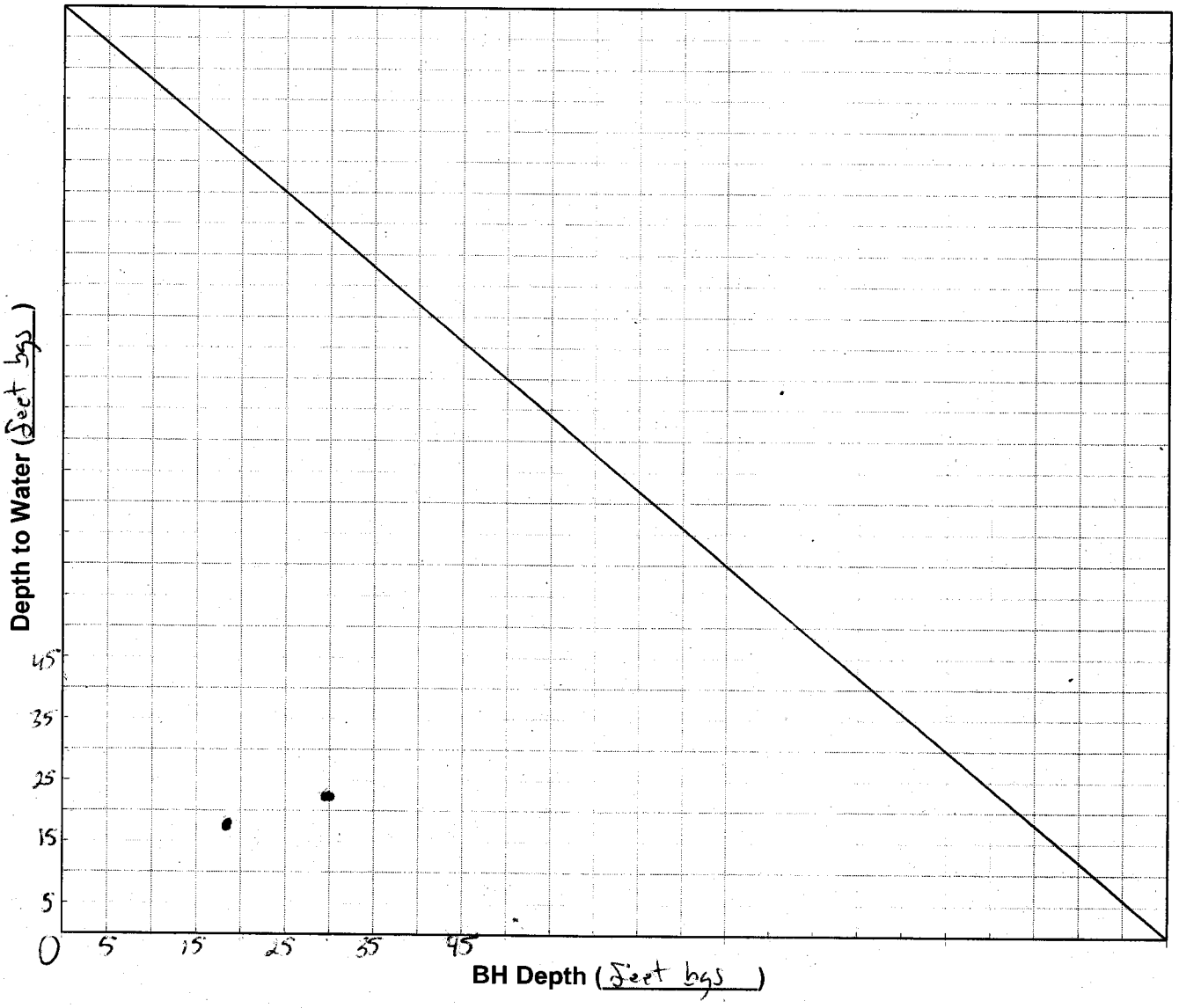
Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.06002 Task 7
Hole ID:	P-06-375
Name:	
Date start	7-26-06
Date finish	7-26-06

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-26-06	0971	19	19								
7-26-06	0959	30	23.3								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G

DATE STARTED 7/28/06 **COMPLETED** 7/29/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166680.4 **EASTING** 1406578

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0	GB				GP **Gravel** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
5	GB				GP **Gravel** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
10	GB				GP **Gravel** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
	GB				GP **Gravel** Light brown, coarse sand, trace silt, moist.	
15	GB				GP **Gravel** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
20	GB				20.0 SP **Sand with Gravel** Light brown, Fine to coarse sand, Fine to coarse gravel, Trace silt.	
25	GB				25.0 GP **Gravel with Sand** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.97
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: Celco 1/4" coated tablets

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/14/06
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 7/28/06 Time: 1644

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/28/06 **COMPLETED** 7/29/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166680.4 **EASTING** 1406578
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				SP **Sand with Gravel** Light brown, Fine to coarse sand, Fine to coarse gravel, Trace silt, moist.	
					33.0	Added 5 gallons of foam and water.
	GB				GP **Gravel** Light brown, Fine to coarse gravel, Trace coarse sand, Trace silt, moist.	
35	GB				GP **Sand with Gravel** Fine to coarse sand, Fine to coarse gravel, Trace silt, Light brown.	
40	GB				GP **Sand with Gravel** Light brown with sand, Fine to coarse sand, Fine to coarse gravel, Trace silt, moist.	
45					45.0	
	GB				GP **Gravel** Light brown, Fine to coarse gravel, medium to coarse sand, Trace silt, moist.	Added 5 gallons of foam and water.
	GB				**Rock flower** Light brown, possible trace conglomerate or gravel.	
	GB				48.0	
50	GB				GP **Gravel with Sand** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
					GP **Gravel with Sand** Light brown, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	
55	GB	▼			GP **Gravel** Light grey, Fine to coarse gravel, Fine to coarse sand, Trace silt, moist.	Added 10 gallons of foam and water.
					57.0	Added 10 gallons of foam and water.
	GB				**Conglomerate** Light to dark grey, moist.	
60	GB				**Conglomerate** Light grey to greenish grey, moist.	Added 10 gallons of foam and water.
						Added 10 gallons of foam and water.
65	GB				**Conglomerate** with rock flower, Light to dark grey, moist.	Driller noted that the drilling became a bit harder. Driller added 10 gallons of foam.
					68.0	
	GB				**Gravel with Silt** Light brown, Fine to coarse gravel, Fine to coarse sand, Silt, Moist.	Added 5 gallons of foam and water.
70					70.0	
	GB				**Conglomerate** with rock flower, Light grey, moist.	Added 10 gallons of foam and water.
	GB				**Conglomerate** Dark grey, very moist.	Added 10 gallons of foam and water.
						Added 20 gallons of foam and water.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/28/06 **COMPLETED** 7/29/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166680.4 **EASTING** 1406578
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Conglomerate** with rock flower, Light grey, moist.	Added 10 gallons of foam and water.
					Conglomerate Dark grey, with rock flower and silt, very moist.	Added 10 gallons of foam and water.
80	GB					Added 10 gallons of foam and water.
					Conglomerate Dark grey, with rock flower and silt, very moist.	
85	GB				85.0	Added 10 gallons of foam and water.
					Rock Flower and Silt Dark grey, with trace conglomerate, very moist.	First water.
90	GB				90.0	Added 10 gallons of foam and water.
					Conglomerate Greenish grey, with rock flower and silt, saturated.	Added 10 gallons of foam and water.
		78.6	0			No water flowing, DTW possibly from foam and water.
95	GB					Added 10 gallons of foam and water.
					Conglomerate Light grey to yellowish orange, with trace rock flower and silt, saturated.	When water was cleared before drilling, very little came out. DTW is suspect.
					Conglomerate light brown to yellowish orange, with trace rock flower and silt, saturated.	Added 10 gallons of foam and water.
100	GB					Added 10 gallons of foam and water. Flowing water.
		78.5				Added 10 gallons of foam.
						Added 10 gallons of foam.
105	GB				**Conglomerate** Light brown, with trace rock flower and silt, saturated.	Added 10 gallons of foam and water. Low water flow.
110	GB				**Conglomerate** Dark brown, with trace rock flower and silt, saturated.	Added 10 gallons of foam and water.
		105.6				
115	GB				**Conglomerate** Light to dark grey, with trace rock flower and silt, saturated.	Added 10 gallons of foam and water. Added 5 gallons of foam and water.
		0				No water in hole at start up (0815 7/28/06), none came up.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/28/06 **COMPLETED** 7/29/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166680.4 **EASTING** 1406578
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Conglomerate** Greenish grey, with rock flower and silt, saturated.	Added 10 gallons of foam and water. Formation water visible in cuttings.
					Conglomerate Dark grey, with trace rock flower and silt, saturated.	Low flow. Added 10 gallons of foam and water.
125	GB				**Conglomerate** Dark to greenish grey, saturated.	Low flow. Added 10 gallons of foam and water.
130	GB				**Conglomerate** Dark to greenish grey, saturated.	Added 5 gallons of foam and water. low flow Added 10 gallons of foam and water and hit good water flow.
135	GB				**Conglomerate** Light to dark grey, saturated.	
			2.50			Driller wanted me to wait to do DTW.
140	GB				**Conglomerate** Light grey, with rock flower and silt, saturated.	
	GB	86.19	2.50		**Lithified sedimentary Rock** medium grey with Pyrite, fine grained.	Doesnt fizz with HCL.
145	GB				**Lithified sedimentary Rock** medium grey with Pyrite, fine grained.	Doesnt fizz with HCL.
	GB	78.3	3.0		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated.	Switched to an open hole. Resume drilling with an open hole @ 1324
150	GB				**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated.	
155	GB		10.0		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated.	
160	GB	63.4	3.0-5.0		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated.	Water level meter almost got stuck, will wait to get a final DTW.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/28/06 **COMPLETED** 7/29/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166680.4 **EASTING** 1406578
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Beau Johnson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165	GB		9.0		**Conglomerate** Greenish grey, with rock flower and silt, saturated.	
					Lithified sedimentary Rock Light grey with Pyrite, fine grained, saturated.	
170	GB		4.5		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated.	
175	GB		8.0		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated.	
180	GB		11.0		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, saturated. Cuttings also included a fine grained, black volcanic or sedimentary rock.	
185	GB		10.0		**Lithified sedimentary Rock** Light grey with Pyrite, fine grained, light grey, saturated.	
190	GB		6.0		**Lithified sedimentary Rock** Light to dark grey with trace pyrite, fine grained, saturated.	
195	GB	56.8	5.5		**Lithified sedimentary Rock** Light to dark grey with trace pyrite, fine grained, saturated.	
200	GB		5.5		200.0 **Lithified sedimentary Rock** Light to dark grey with trace pyrite, fine grained, saturated. Bottom of hole at 200.0 feet.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: P|06|38D
Date: 9|13|06 - 9|14|06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Terry Wassali

Summary

	~~Installed (Well Log)~~	Start	End
Water level	Flowing		Flowing
Total depth	179.0		180.0
pH	6.74		7.28

Screen interval (btoPVC): 15 ft
Top: 164.0
Bottom: 179.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	PH
Surge block on START Pump @ 1103									
1111	178.5	Flowing	119		0.274	OR	6.36	Milky White LT Brown Tinge,	6.76
↓	↓	↓	—		—	—	—	Sediment, Grout (white Mixed w Med.	
↓	↓	↓	—		—	—	—	To Fine Sand, 1 1/2 cups.	
1200	"	—	102		0.628	OR	6.05	Milky White/LT Brown, 2 Cups, "	7.49
1206	176.5	—	—		—	—	—	RAISE Pump 2', START	
1235	"	—	103		0.601	933	5.99	", 2 cups Grout & Coarse to Fine Sand	7.75
1302	"	—	103		0.369	OR	5.93	", 1/2 cup	
1308	174.5	—	103		—	—	—	RAISE Pump 2', START	
1343	"	—	55		0.296	779	5.81	Milky White, Sand & grout "	7.31
1407	"	—	55		0.254	443	5.65	Milky White, Sand Coarse to Fine,	
1419	172.5	—	—		—	—	—	RAISE Pump 2', START	
1445	"	—	55		0.235	306	6.04	", ", 2 tsp Grout & Sand.	
1504	"	—	55		0.223	227	5.91	" ", 1 TSP "	
1516	170.5	—	—		—	—	—	RAISE Pump 2', START	
1536	"	—	55		0.212	191	5.88	", 1 1/2 TSP	
1554	"	—	54		0.207	189	5.81	", 1 TSP	
1600	168.5	—	—		—	—	—	RAISE Pump 2', START	
1619	"	—	54		0.211	265	5.80	", 1 TBS, "	6.99
1647	"	—	54		0.201	232	6.08	1 TSP	
1657	166.5	—	—		—	—	—	RAISE Pump, START	
1720	←						→	STOP Pump / End of DAY	
9/14/06 0935	←						→	RESTART	
1007	"	—	60		0.204	249	5.16	Milky White, Sand & Grout ", 1 1/2 TSP	
1004	164.0	—	—		—	—	—	RESTART, RAISE Pump 1.5'	
~~Surge block off~~									
1039	"	—	54		0.177	236	5.25	", 2 TSP	6.97
1109	"	—	59		0.171	209	5.47	"	
Surge block off 1121	159.0	—	—		—	—	—	END Purge / START Polish	
1149	"	—	103		0.168	133	5.66	Still Milky But less, 1/2 Bp Sand & Grout.	7.20
1207	"	—	103		0.166	95.6	5.46	", 1/2 TSP Sand & Grout.	
End Purge @ 1315 1213	178.5	—	—		—	—	—	STOP Polish / START Pushing Surge	7.14
1234	"	—	53		0.167	205	5.62	", 1/2 TBS, Sand & Grout	7.16
1313	"	—	55		0.164	204	5.53	", 1 TSP	

DRILLING WATER LEVEL MEASUREMENTS

SLR Alaska

Water Level Meter

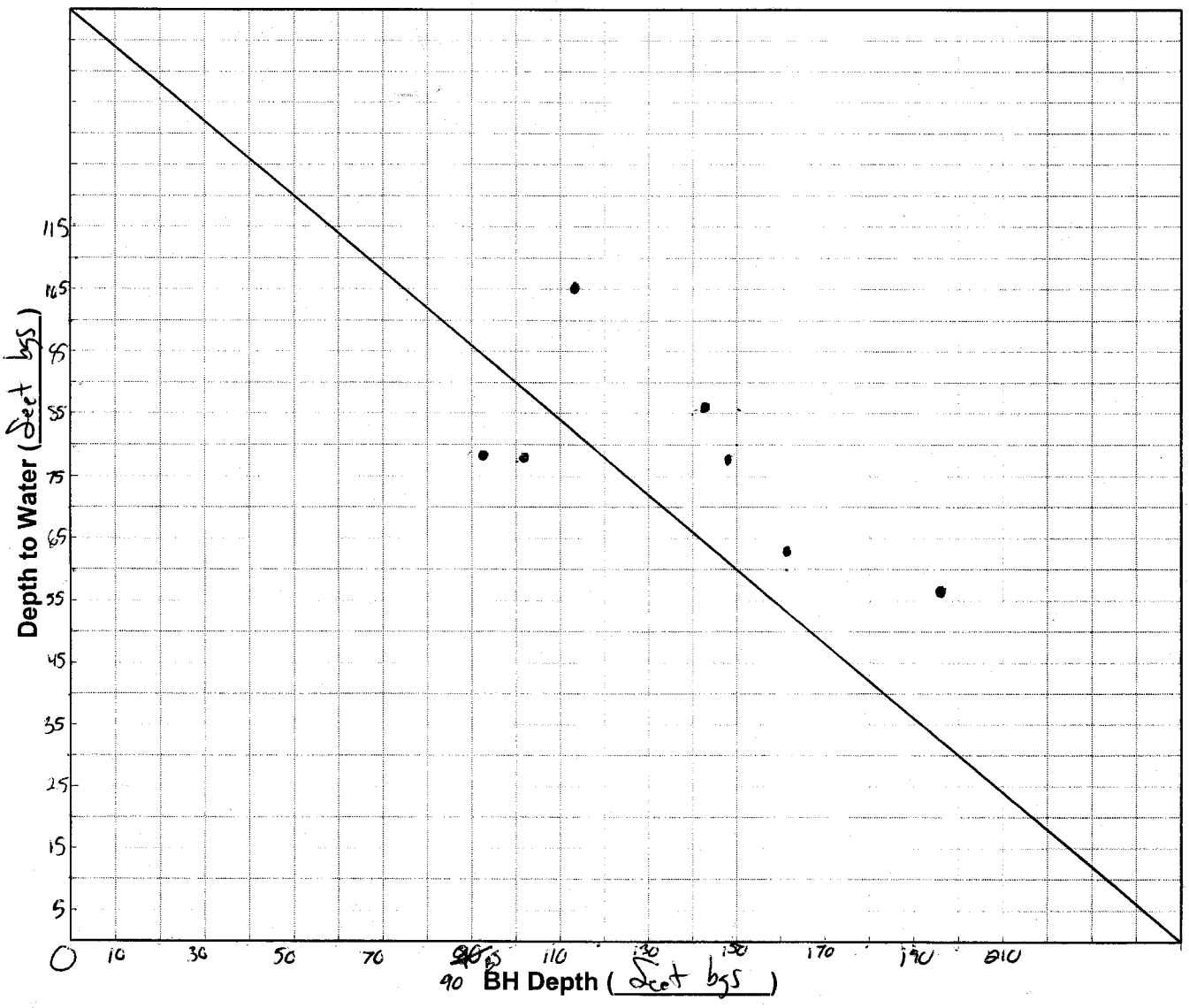
Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

Project:	Pebble Mine Site GW
Project #:	005.0189.06002 Task 7
Hole ID:	P-06-38D
Name:	—
Date start	7-27-06
Date finish	7-28-06

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-27-06	1508	93	78.6	7-28-06	1410	160	63.4				
7-27-06	1621	102	78.5	7-28-06	1644	195	56.8				
7-27-06	1757	113	105.6								
7-28-06	1048	143	86.2								
7-28-06	1150	148	78.3								

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/30/06 **COMPLETED** 7/30/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166691.1 **EASTING** 1406562
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					GW **Well Graded gravel** Brown medium, with very silty sand. 85% gravel, 15% Silty medium sand,Dry.	
5	GB					
10	GB				GW **Well Graded gravel** Brown, with very silty fine to medium sand. 85% gravel, 15% Sands and silts, Dry.	
15	GB				15.0 GM **Well Graded gravel** Brown, with very silty coarse to medium sand, 50% subrounded to subangular gravel, 50% medium to coarse sand, Dry.	
20	GB				20.0 GW **Well Graded gravel** Brown,with silty medium to coarse sand, 75% subangular to subrounded gravel, 25%, medium to coarse sand, Dry.	
25	GB				25.0 GM **Poorly Graded gravel** Brown with fine to medium sand. 40% 1/4-1/2" in diameter subangular gravel, 60% fine to medium silty sand, dry.	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 3.0
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: Celco 1/4" coated tablets

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/6/06
Purge Volume: Well purged dry.

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/15/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 7/30/06 Time: 1845, Well development was unsuccessful due to silt content and lack of recharge.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/30/06 **COMPLETED** 7/30/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166691.1 **EASTING** 1406562
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				GM **Poorly Graded gravel** Brown with fine to medium sand. 40% 1/4-1/2" in diameter subangular gravel, 60% fine to medium silty sand, dry.	
35	GB				GM **Poorly Graded gravel** Brown with slightly silty medium to coarse sand. 40% 1/4" diameter sub angular gravel, 60% medium to coarse sand, Dry. 35.0	Check for water is casing. No water indicated on WL meter. Add 10 gallons of foam to get beck pressure needed to get cuttings up the casing.
40	GB				GW **Well Graded gravel** Brown with medium to coarse sand, 70% 1/4-1/2" in diameter subangular gravel, 30% medium to coarse slightly silty sand, dry. 40.0	
45	GB				GM **Poorly Graded gravel**with slightly silty medium to coarse sand, 70% 1/4" diameter subangular to subrounded gravel, 15% medium to coarse slightly silty sand. Brown, Dry. 45.0	
50	GB				GP **Poorly Graded gravel** Brown with medium to coarse sand. 80% 1/4" diameter subangular to subrounded gravel, 15% medium to coarse slightly silty sand, dry. 49.0	
55	GB	▼			ML **Silt**LIght grey, Dry. 50.0 ML **Silt** LIght grey, Dry. 51.0 GM **Gravel** (drill cuttings) 56.0	Gravel and coarse sand mixed with silt layer. Gravel and sand probably cuttings from above formation. Driller says he is back into gravel. No water in casing.
60	GB				SM-GM **Gravel and silt** Grey, poorly graded Gravel with grey fine to medium sand, 30% 1/4" diameter gravel, 50% fine sand, 20% Silt. Very silty fine sand, Dry. 60.0	Add 10 gallons of foam. Add 20 gallons of foam.
65	GB				ML-SM **Sandy Silt** Grey, mixed with Occasional gravel. 10% subangular gravel, 90% grey sandy silt, dry. 63.0	
					Conglomerate Grey multicolored Angular rock fragments with dandy silt, Dry. 68.0 Bottom of hole at 68.0 feet.	Driller indicates that we are in harder and more competent rock. Still in conglomerate. Let hole sit for 1/2 hour and check water level indicator. WL meter shows possible water at 65.5 ft but its very muddy in casing. Driller will clean out casing and 1300-1310 Let well sit after the casing was cleaned. Blow casing and produce only a fine mist of water for a few seconds. Well is mostly dry. Maybe

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-38M
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site G
DATE STARTED 7/30/06 **COMPLETED** 7/30/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2166691.1 **EASTING** 1406562
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
						able to get a peiso measurement of H20 if left standing. After pulling drill stem ground water was noted and measured at 66.5 ft bgs.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: GP-06-38M
Date: 9/6/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Terry Wasali.

Summary Well Completion Diagram says Well is named P-06 38M.

	Installed (Well Log)	Start	End
Water level		33.37	
Total depth		69.9	
pH			

Screen interval (btoPVC): 10 ft
Top: 59.9
Bottom: 69.9
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1242	68.9	33.37	START					
1246	"	—			0.137	92.3	6.01	Brown,
1250		67.34						→ WATER Stopped Pumping → WL Not Recharging Enough to pull out.
								Shut Pump off
								Recharge = .15 ft per minute.
1304	"	65.54						Restart & Slower Pumping Rate
1309	"	—						Turned Down, Stopped Pumping
1321		67.6						Turned Down, Wont Pull WATER.
1322								Turned Down. Very Slow.
								Purged Dry
Surge block off								

66.60
66.45
0.15

Pebble Project

NORTHERN DYNASTY MINES INC.

P-06-39D
PAGE 1 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site D

DATE STARTED 8/1/06 **COMPLETED** 8/1/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 2160791.8 **EASTING** 1412116.9

DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
5	GB				GM **Sandy Silt** Brown, 30% 1/2" diameter gravel, 70% coarse sandy silt, Damp.	
10	GB				GM **Sandy silt** Brown, with Gravel, 30% 1/4-1/2" diameter gravel, and 70% coarse sandy silt, Damp.	
15	GB	▼			GM **Sandy silt** Brown, with Gravel, 10% 1/4" diameter gravel, 90% fine sandy silt, Damp.	Refuel rig. Drill break.
20	GB				20.0 ML **Silt** Tan with coarse sand and small gravel. 10% coarse sand, 90% Sandy silt, Damp.	
25	GB				24.0 Large cobbles on rocky small bolder. Rock chips from cobbles with coarse silty sand, dry. Rocky cobble.	Hit small cobbles @ 24' bgs. Slow drilling, a lot of drill chatter.
30					Starting to get more silt in drill cuttings. 30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.49
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/9/06
Purge Volume: 1309.0 Gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/16/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 8/1/06 Time: 1845

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-39D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site D
DATE STARTED 8/1/06 **COMPLETED** 8/1/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160791.8 **EASTING** 1412116.9
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB		6.0		GW-GM **Well graded gravel** Reddish brown with sandy and silt.	Hit water
			4.0			
35	GB				GW-GM **Well graded gravel** Reddish brown with sandy and silt.	
			1/4		37.0 ML **Silt**Light grayish tan.	
			3.0		39.0 ML **Silt**Grey.	
40	GB				40.0 GW **Well graded gravel**	
			7.0		**Conglomerate** light greyvery friable.	
			1.5		**Conglomerate** Grey with light grey and reddish quartz pebble inclusions.	
45	GB	42.33	7.0		**Conglomerate** Grey with light grey and reddish quartz pebble inclusions.	
			1/2		**Conglomerate** Grey	Let casing sit for 10 minutes and then check flow.
50	GB		12.0		**Conglomerate** Grey with reddish quartz pebble inclusions, friable, soft rock.	
			5.0			
55	GB		15.0		**Conglomerate** Grey with reddish quartz pebble inclusions, friable, soft rock.	
			10.0		**Conglomerate** Grey with reddish quartz pebble inclusions.	
60	GB		9.48		**Conglomerate** Grey with reddish quartz pebble inclusions	Resume drilling 8/1/06, measure ground water level in casing before drilling.
			12.0			
65					**Conglomerate** Grey with reddish quartz pebble inclusions	
		43.71			**Conglomerate** Grey (drill cuttings).	Add rod
70	GB		10		**Conglomerate** Grey with reddish quartz pebble inclusions, friable, soft, wet.	
			12.0			

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-39D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site D
DATE STARTED 8/1/06 **COMPLETED** 8/1/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160791.8 **EASTING** 1412116.9
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75			12.0	**Conglomerate** light greyvery friable.	
				Conglomerate Grey with reddish quartz pebble inclusions, friable, soft, wet.	
		21.40		**Conglomerate** Grey with reddish quartz pebble inclusions	Water is recharging fast in casing.
80			18.0	**Conglomerate** Grey with reddish quartz pebble inclusions, friable, soft, wet.	
			12.0		
85				**Conglomerate** Grey with reddish quartz pebble inclusions, friable, soft, porous, wet.	
				Conglomerate Grey drill cuttings.	
			16.0		
90	GB	51.75		**Conglomerate** Grey with reddish quartz pebble inclusions and light blue inclusions, friable, soft, porous, wet.	
			18.0		
95				**Conglomerate** Grey with reddish quartz pebble inclusions and light blue inclusions, friable, soft, porous, wet.	
			20	**Conglomerate** Grey with reddish quartz pebble inclusions	
100	GB		30	**Conglomerate** Grey with reddish quartz pebble inclusions and green inclusions, friable, soft, porous, wet.	
			30		Add rod.
105	GB		30	**Conglomerate** Grey with reddish brown quartz pebble inclusions and green inclusions, soft, porous, wet.	
				Conglomerate Grey with reddish brown quartz pebble inclusions and green inclusions.	
110	GB		30	**Conglomerate** Grey with reddish brown quartz pebble inclusions and greenish matrix inclusions, soft, porous, wet.	
				112.5 Bottom of hole at 112.5 feet.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: DIP-06-39D
Date: 9/8/06 - 9/9/06
Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: WILLOW WEIMER & TERRY WASALE

Summary

	Installed (Well Log)	Start	End
Water level		1545	
Total depth		114.1	
pH		6.89	6.80

Screen interval (btoPVC): 20
Top: 94.0
Bottom: 114.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, colour, quantity)	PH
Surge block on START PURGE @ 1544									
1555	113.5	15.45	4.5	40.5	0.475	612	3.86	WATER, BROWN, Fine Sand/SILT, 2 TSP	
1610	"	—	4.8	112.5	0.485	329	3.98	LT BROWN, "	
1650	"	—	—	—	—	—	→	STOP PUMP / End of Day	
9/9/06 0907	"	—	—	—	—	—	→	RESTART PUMP	
0914	"	—	—	—	—	—	→	RAISE PUMP / START	
0946	111.5	—	4.4	260	0.481	99.6	3.12	WATER, MILKY/SILTY, TRACE SAND.	7.33
0953	109.5	—	—	—	—	—	—	RAISE PUMP / START.	
1017	109.5	—	4.7	343	0.481	79.8	3.64	MILKY, TRACE SAND	7.16
1023	107.5	—	—	—	—	—	—	RAISE PUMP 2', START	
1041	"	—	4.5	464	0.477	76.6	4.00	MILKY, LT GRY, TRACE SAND	6.95
1045	105.5	—	—	—	—	—	—	RAISE PUMP 2', START	
1109	"	—	4.5	572	0.471	75.1	4.44	MILKY LT GRY, TRACE SAND.	
1112	103.5	—	—	—	—	—	—	RAISE PUMP 2", START	
1138	"	—	4.5	689	0.469	64.9	4.30	"	6.98
1143	101.5	—	—	—	—	—	—	RAISE PUMP 2', START	
1213	"	—	4.4	812	0.464	49.0	4.11	"	6.93
1217	99.5	—	—	—	—	—	—	RAISE PUMP 2', START	
1236	"	—	4.4	895	0.463	63.0	4.54	"	6.82
1241	97.5	—	—	—	—	—	—	RAISE PUMP 2", START	
1300	"	—	4.4	978	0.458	47.2	4.56	"	6.81
1305	95.5	—	—	—	—	—	—	RAISE PUMP 2', START	
1324	"	—	4.5	1081	0.458	34.6	4.09	"	6.64
1335	94.0	—	—	—	—	—	—	RAISE PUMP 1'1/2', START	
1350	"	—	4.2	1144	0.460	22.3	4.16		
Surge block off START POLISH @ 1357									
1408	89.0	—	4.4	1192	0.451	46.0	5.37	MILKISH, NO/TRACE SAND.	6.62
1414	113.5	—	4.4	—	—	—	—	START DEBRIS SURGE	
1440	"	—	4.5	1309	0.444	44.2	4.52	CLEAR, TRACE SAND.	
1442								END DURGE	

DRILLING WATER LEVEL MEASUREMENTS

SLR Alaska

Water Level Meter

Make:	Slope Indicator
Model:	Slope Indicator
Cutoff:	None
Units:	Decimal Feet
Res:	

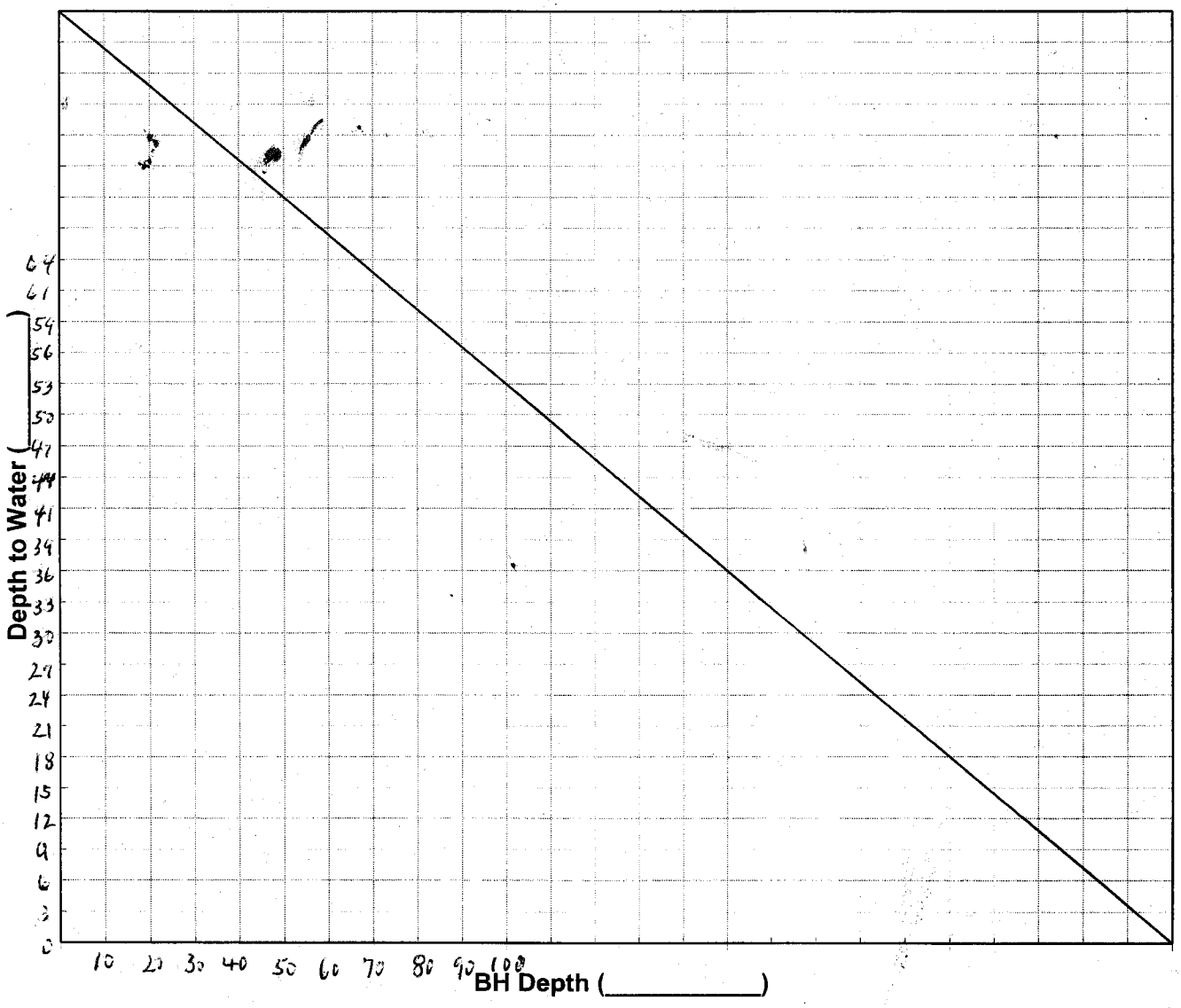
Project:	Pebble Mine Site GW
Project #:	005.0189.06002 Task 7
Hole ID:	
Name:	
Date start	
Date finish	

Water Level Measurements

Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth	Date	Time	Borehole Depth	Water Depth
7-31-06	17:27	45	42.33								
8-1-06	08:30	58'	9.48								

12 hrs

Depth vs Depth During Drilling



Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-39S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site D
DATE STARTED 8/2/06 **COMPLETED** 8/2/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160809.7 **EASTING** 1412125.4
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					GM **Gravely sandy silt**Brown.	
5	GB				GM **Gravely sandy silt**Brown, damp.	
					GM **Gravely sandy silt**Brown, damp.	
10	GB	▼			GM **Gravely sandy silt** brown, 20% gravel, 40% coarse to medium sand, 40% silt, damp.	
15	GB				GM **Gravely sandy silt** brown, 20% gravel, 40% coarse to medium sand, 40% silt, damp.	
					GM **Gravely sandy silt**Brown.	
					19.0	
20	GB				GW **Well graded gravel** brown with silt, Damp. 20.0	
					Small cobbles. 21.0	Small cobble zone, some drill chatter.
25	GB				GW **Well graded gravel** brown with silt, 70% subangular gravel, 10% coarse sand, 20% silt.	
					GW **Well graded gravel** with silt.	
					GW **Well graded gravel** with little to no silt.	First water, no measurable flow at 27 bgs. Rock got stuck behind drill bit and casing locked. Pull string and redrill hole.
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.5
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/9/06
Purge Volume: 158.1

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/16/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 8/2/06 Time:

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-39S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site D
DATE STARTED 8/2/06 **COMPLETED** 8/2/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160809.7 **EASTING** 1412125.4
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB		1/4		GW **Well graded gravel** 1/4"- 1/2" diameter gravel and coarse sand, 10% silt. Wet.	
35	GB		<1/4 0	35.0 36.0	SP **Sand** Grey, very coarse to small angular gravel, damp.	No flow/Dry.
					SP **Sand** Grey, Very coarse to 1/8" angular gravel, dry. Bottom of hole at 35.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

WELL DEVELOPMENT LOG

Well ID: DIP-06-39S
Date: 9/8/06 9/9/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.06002 Task 5
Technician: Willow Weimer & Terry Wasalli

Summary

	Installed (Well Log)	Start	End
Water level		17.2	
Total depth		35.7	
pH		7.0	

Screen interval (btoPVC): 5 FT
Top: 30
Bottom: 35
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on START Purge @ 1541								
1548	34.0	7.2	1.2	18.5	0.401	1000	4.97	Thick Brown Mud like WATER, 3½ cups Fine sand + SILT.
1608	"	32.5	—	—	—	—	→	WATER Drew Down, Slowed Pump.
1650	"	—	—	—	—	—	—	STOP Pump / End of Day.
9/9/06 0907	"	—	—	—	—	—	→	START Pump
0933	"	—	0.9	31.9	0.424	1136.4	4.93	DARK Brown, Alot of Suspend Sediment 1 cup 7.61 Fine Sand + SILT.
0946	32.0	—	—	—	—	—	—	RAISE Pump 2', START
0957	"	—	0.9	41.8	0.409	818	4.06	MEDium Brown, Alot of Suspended Sediment, 1½ cups Fine Sand + SILT
1048	"	—	0.9	87.7	0.406	704	4.53	" , 1 TBS Fine Sand + SILT
1054	30.0	—	—	—	—	—	—	RAISE PUMP, START
1115	"	—	0.7	99.6	0.402	514	5.03	Medium Brown, Suspended Sed, 1 TBS, " 6.97
1157	"	—	0.7	129	0.404	465	5.80	" " , 1½ TSP.
								~~BAIL~~ @ END Purge.
Surge block off START Polish @ 1210								
1244	25.0	—	0.1	132	0.405	77.8	5.0	Slightly Milky Appearance, NO Sand
1254	34.5	—	—	—	—	—	—	Stop Polish, START Debris Surge
1323	"	—	0.9	158.1	0.406	55.9	6.0	"
1332	"	—	—	—	—	—	—	END Purge

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site E
DATE STARTED 8/11/06 **COMPLETED** 8/12/06
GROUND ELEVATION **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158571.9 **EASTING** 1412908.1
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					PT **Peat** and organic matter, plant roots.	
					4.0	
5	GB				CL **Clay** Grey.	
					CL **Clay** Grey, Elastic, stiff, damp.	
10	GB				CL **Clay**, Grey, with occasion gravel, Elastic, stiff, damp.	
					13.0	
15	GB				GM Gravely, grey clay.	
					GM **Gravely silty clay** Grey, Elastic, damp.	
					18.0	
20	GB				GW-GM **Well graded gravel and silt.**	
					20.0 GW-GM increasing gravel content with silt.	
					GM **Gravely Silt** with coarse sand and clay fraction Elastic, damp.	
					GM **Gravely Silt** dark grey with increasing gravel. 50% gravel, 50%.	
25					25.0	
					26.0 GW-GM **Well graded gravel to very Silty Gravel.** 70% gravel, 30% Silt.	
					GM **Silty Gravel** coarse grained. 50% gravel, 50% Silt.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 4.5
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Well is Artsian and is plugged with pressure plug.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site E
DATE STARTED 8/11/06 **COMPLETED** 8/12/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158571.9 **EASTING** 1412908.1
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				GW-GM **Well graded Gravel with Silt**60% Gravel, 40% Silt. GW-GM Damp to dry.	
35					GW-GM **Well graded Gravel with Silt**60% Gravel, 40% Silt.	
40	GB				40.0 **Conglomerate** Fractured, Grey with greenish quartz and reddish brown inclusions. Contains more dark larger clasts due to fractures.	Harder drilling. Sample feels very fractured.
45	GB				**Conglomerate** Fractured, Grey with greenish quartz and reddish brown inclusions.	Not open hole yet we will play it safe.
50	GB				**Conglomerate** Light brown with reddish brown inclusions.	
55	GB		1.0		**Conglomerate** Light brown, tan, with reddish brown inclusions.	Faster drilling, John said he hit the same type of material at 60 bgs on 40M. John said he will go another 10' before going open hole. He wants to make sure its not float we are drilling into.
			10.0		**Conglomerate** Light brown, tan, with reddish brown inclusions.	Fractured ? open hole drilling from here.
60	GB		20.0			Injecting water.
65	GB				**Conglomerate** Light brown, tan, with reddish brown inclusions.	Injecting water.
					Conglomerate Light brown, tan, with reddish brown inclusions. Inclusions are 1/4" in diameter and well rounded.	Injecting water.
70	GB					Injecting water.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site E
DATE STARTED 8/11/06 **COMPLETED** 8/12/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158571.9 **EASTING** 1412908.1
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB				**Conglomerate** Fractured, Grey with greenish quartz and reddish brown inclusions.	Injecting water.
					Conglomerate Light brown, tan, with reddish brown inclusions. Inclusions are 1/4" in diameter and well rounded.	Injecting water.
80	GB				**Conglomerate** Light brown, tan, with reddish brown inclusions. Inclusions are 1/4" in diameter and well rounded.	
85	GB				**Conglomerate** Light brown, tan, with reddish brown inclusions. Inclusions are 1/4" in diameter and well rounded.	Injecting water.
90	GB		30.0		**Conglomerate** Light brown, tan, with reddish brown inclusions. Inclusions are 1/4" in diameter and well rounded.	Injecting water.
95					**Conglomerate** Light brown, tan, with reddish brown inclusions. Inclusions are 1/4" in diameter and well rounded.	Injecting water, no return on sample. Injecting water.
100						Injecting water, no return on sample.
105			30.0			Injecting water, no return on sample.
					Conglomerate Light brown, tan, with reddish brown inclusions.	
110	GB				**Conglomerate** Grey with greenish quartz inclusions. **Conglomerate** Light brown, tan, with reddish brown inclusions.	Injecting water. Injecting water.
115						No return on sample.
					Conglomerate Grey with reddish brown inclusions and greenish quartz inclusions.	Injecting water.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site E
DATE STARTED 8/11/06 **COMPLETED** 8/12/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158571.9 **EASTING** 1412908.1
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Conglomerate** Fractured, Grey with greenish quartz and reddish brown inclusions.	
					Conglomerate Light brown, tan, with reddish brown inclusions.	
125	GB					
					Conglomerate Light brown, tan, with reddish brown inclusions.	Injecting water.
130	GB		35.0			
						Injecting water.
135	GB					Injecting water.
					Conglomerate Light brown, tan, with reddish brown inclusions.	
					Conglomerate Grey with reddish brown inclusions and greenish quartz inclusions.	
140	GB					
					Conglomerate Light brown, tan, with reddish brown inclusions.	
145	GB		60.0		145.0 Bottom of hole at 145.0 feet.	Let casing stand for 1 hour. Well was Artesian at 4 gpm in 5" casing. Set well after talking with WMC. Well was not Artesian at time of cal. It started after.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

No well development at P-06-40D. Flowing well. Plugged after drilling.

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site E
DATE STARTED 8/3/06 **COMPLETED** 8/3/06
GROUND ELEVATION **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158592.8 **EASTING** 1412942.1
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle/ Mike Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					PT **Peat**	
5	GB				5.0 GM **Sand and Silt** Grey, 40% coarse to medium Sand, 60% Silt, Wet.	
10	GB				10.0 GM/ML **Silt with coarse to medium Sand** Grey, 70% Silt, 30% coarse sand, soft, damp.	
15	GB				GM/ML **Silt with coarse to medium Sand** Grey, 70% Silt, 30% coarse sand, damp.	
20	GB				18.0 GM **Gravely Silt** Grey, Gravel is 1/2" in diameter Subangular to angular, Silt is slightly elastic, stiff, damp to dry. 20.0 GM/ML **Gravely Silt** Dark grey, Silt is damp to dry, Stiff, slightly elastic, 20% 1/2" diameter gravel. 10% coarse to medium Sand. 70% Silt. 22.0 GM **Gravely Silt** Dark grey, dry.	A lot of Gravel mixed with dry Silt.
25	GB				GM **Gravely Silt** Dark grey, dry.	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: ?
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Well is Artsian and is plugged with 10ft downhole plug.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site E
DATE STARTED 8/3/06 **COMPLETED** 8/3/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158592.8 **EASTING** 1412942.1
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle/ Mike Rieser

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB			GM **Gravely Silt** Dark grey, dry.	
				GM **Silty Gravel** 70% gravel, 30% Silt, Dry.	
35	GB			35.0	
				GW-GM **Well graded Gravel** Dark grey, with Silt, 85% Gravel, 15% Silt, Dry.	
40				GW-GM **Well graded Gravel to silty Gravel.** 80% 1/4" to 1/2" Subangular to angular groove, 20% Silt, Dry.	
45	GB		1/8	46.0 GW-GM **Well graded Gravel to silty Gravel.** Dark grey, 80% 1/4" to 1/2" Subangular to angular groove, 20% Silt.	No measurable flow.
				SP **Poorly graded sand** Coarse Sand to angular Pea gravel.	
50			1/8	50.0 SM-GM **Silty Gravel** Silty very coarse angular sand to Silty angular gravel.	
55	GB			55.0 GW **Well graded Gravel** Angular, with coarse sand, wet.	
			2.0	GW **Well graded gravel** with coarse sand.	
60	GB			GW **Well graded gravel** Brown with well graded Sand, few fines, Saturated.	
				62.0 63.0 GW/SW **Well graded gravel and Sand** Brown, Few fines, Saturated.	
	GB	2.2	8.0	Bottom of hole at 63.0 feet.	@2130, well is flowing, 2gpm, seems to be accelerating.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

No well development at P-06-40M. Flowing well. Plugged after drilling.

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-40S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site E
DATE STARTED 8/4/06 **COMPLETED** 8/4/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2158584.7 **EASTING** 1412926.2
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					PT **Peat**	
5	GB				PT **Peat** Dark brown to black with silty fine Sand with Organics.	
					8.0 ML **Silt**Dark grey, damp.	
10	GB				10.0 GM/ML **Gravely Silt** Dark grey, 30% 1/4" diameter gravel, 70% Silt, damp.	
15	GB				15.0 GM **Gravely Silt** Dark grey, 50% 1/8" to 1/4" angular gravel, 50% Silt, damp.	At depths 16-18 ft bgs, there is a potential ground water zone. No flowing water in cyclone, only damp Silt.
					17.0 GM **Gravely Silt** Dark grey, Starting to grade.	
					SM-GM **Silty Sand with Gravel** 60% very coarse angular Sand, 10% Gravel, 30% Silt. Damp.	
20	GB				19.0 20.0 GW-GM **Well graded gravel with Silt** Dark Grey, Dry, Gravel content increasing in amount and size. Gravel 1/2" in diameter.	No flowing water only damp silty Gravel.
					GW-GM **Well graded gravel with Silt** 50% clayey Silt, 50% 1/4" to 1/2" angular gravel, Dry. Bottom of hole at 20.0 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.5
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/6/06

Comments: Well collapsed at 9ft No measurable water in well following completion. Date: 8/4/06 Time: 1100 Well development was unsuccessful due to silt content and lack of recharge.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

WELL DEVELOPMENT LOG

Well ID: E-P-0640S
Date: 9/6/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Terry Wasaii

Summary P-0640M is plugged w/ Downhole, P-0640D is flowing, capped with Passive Plug.

	Installed (Well Log)	Start	End
Water level		1.07	19.0
Total depth		21.3	
pH			

Screen interval (btoPVC): 5 ft
Top: 16.3
Bottom: 21.3
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on								
1445	20.8	@TOC						START
1509	20.17	19.0						Pumped Dry, Attempted to slow Pumping to allow Recharge, still wouldn't pull water.
								PUMPED DRY
Surge block off								

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F
DATE STARTED 8/6/06 **COMPLETED** 8/9/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160961.1 **EASTING** 1420117.8
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					PT **Peat**	
5	GB				5.0 GP **Poorly graded Gravel** Pea Gravel with coarse sand. 90% Gravel, 10% Silt. Wet. 7.0	
10	GB				GM **Silty Gravel** with coarse to medium Sand. 60% subangular gravel, 30%Silt, 10% Sand, Reddish brown, Wet. 13.0	
15	GB				16.0 ML/CL **Clayey Silt with some Gravel** dark grey, Silt is stiff, slightly elastic, damp to dry. CL/ML **Clayey Silt** Dark grey, damp.	
20	GB				20.0 ML/CL **Clayey Silt with some Gravel** Dark grey, damp.	
25	GB				25.0 CL/ML **Clayey Silt** Dark grey, damp.	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.6
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: Celco 1/4" coated tablets

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/11/06
Purge Volume:

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/16/06

Comments: Static Water Depth is denoted by solid triangle (ftoc): Date: 8/2/06 Water level taken after well completion.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site F
DATE STARTED 8/6/06 **COMPLETED** 8/9/06
GROUND ELEVATION **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex
NORTHING 2160961.1 **EASTING** 1420117.8
DRILLING METHOD Air Percussion
EQUIPMENT Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB	20.28			CL/ML **Clayey Silt** Dark grey, damp.	
					32.0 CL/ML **Clayey Silt** dark grey, with increasing gravel, damp.	First show of water in hole.
					GM Increasing Gravel content in dark grey clayey silt.	Let casing stand for 10 minutes before taking water level.
35	GB		1/8		GM Gravel increasing in angularity, 1/4" to 1/2" diameter gravel.	
					GM **Gravely Silt** dark grey, 50% Gravel, 50% Silt, Wet.	
					GM **Silty Gravel** Dark grey.	
					39.0 SM **Silty Sand** Fine, wet.	Bit starting to clog.
40	GB		0		SM **Silty Sand** Grey, Very silty medium Sand with occasional small Gravel, 60% Sand, 40% grey Silt, wet.	No measurable flow. Add water to clean up casing of silty sand.
					44.0 SP-GP **Sand with gravel** , multicolored coarse grained Sand with Gravel 1/4" to 1/2", Grey.	
45	GB		6.0		SP-GP **Sand with gravel** Grey, coarse grained Sand with Gravel 1/4", 85% coarse to medium Sand, 15% gravel with very little fines, multicolored.	
			16.0		SP-GP **Sand with gravel** Coarse to medium grained Sand with 10 to 20% gravel, wet.	Water clear.
50	GB				50.0 GW **Well graded Gravel** Subangular gravel with little to no fines, sand coarse grained, Wet.	Water level in casing is 1.5 ft above ground surface.
			20.0		54.0 **Conglomerate** , Grey, Weathered, looks similar to very coarse angular Sand.	
55	GB		20.0		**Conglomerate** Grey, Terrciary conglomerate.	
			12.0		**Conglomerate** Grey.	
60	GB		24.0		**Conglomerate** Grey with reddish brown and light blue quartz pebble inclusions.	
			24.0			
65	GB		30.0		**Conglomerate** Grey with reddish brown quartz pebble inclusions, Wet.	Start open hole drilling with 3 7/8" down hole hammer, resume drilling.
			30.0			
70	GB	5.11			**Conglomerate** Grey with reddish brown quartz pebble inclusions, Wet.	Water is climbing in casing at 1 inch every 25 seconds.
			35.0			

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F
DATE STARTED 8/6/06 **COMPLETED** 8/9/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160961.1 **EASTING** 1420117.8
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75	GB			**Conglomerate** , Grey, Weathered, looks similar to very coarse angular Sand.	
				Conglomerate Grey with reddish brown and light blue quartz pebble inclusions.	
80	GB			**Conglomerate** Grey.	
			36.0		
85		7.5		**Conglomerate** Grey with reddish brown quartz pebble inclusions, Wet.	Compressor goes down due to a bad solenoid. ground water is slowly rising.
		2.25			
90	GB			**Conglomerate** with light blue quartz pebble inclusions.	
			21.0		
95	GB			**Conglomerate** Grey with red and light blue quartz pebble inclusions.	
			36.0		
100	GB			**Conglomerate** Grey with reddish brown quartz pebble inclusions, Wet.	
			30.0		
105	GB			**Conglomerate** Grey with reddish brown quartz pebble inclusions, Wet.	Getting some grey clay with sample, This may be some old clay stuck in return hose that has broken free. Will monitor cuttings.
			30.0		
110	GB			**Conglomerate** Grey, with bluish green quartz pebble inclusions, some grey clay showing in cuttings, Wet.	
			24.0		
115				**Conglomerate** Grey, with bluish green and reddish brown quartz pebble inclusions.	
					Add foam to get cutting up the hole.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F
DATE STARTED 8/6/06 **COMPLETED** 8/9/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160961.1 **EASTING** 1420117.8
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB	5.95	18.0		**Conglomerate** , Grey, Weathered, looks similar to very coarse angular Sand. **Conglomerate** Grey, with bluish green and reddish brown quartz pebble inclusions.	
125					**Conglomerate** Grey with bluish green and reddish brown quartz pebble inclusions.	
130					**Conglomerate**	Continue drilling.
135			20.0		**Conglomerate** Grey with bluish green and reddish brown quartz pebble inclusions.	
140	GB				**Conglomerate** Grey with bluish green and reddish brown quartz pebble inclusions, occasional Calcite clasts.	
145	GB				**Conglomerate** Grey with bluish green and reddish brown quartz pebble inclusions, occasional Calcite clasts.	
150	GB		20.0		**Conglomerate** Grey with silty clat seams. bluish green and reddish brown quartz pebble inclusions, occasional Calcite clasts.	
155	GB				**Conglomerate**with silty clat seams. Grey with bluish green and reddish brown quartz pebble inclusions, occasional Calcite clasts. **Conglomerate**Grey with occasional silty clay seams/balls. bluish green and reddish brown quartz pebble inclusions, Clay is Blue-Grey.	
160	GB		20.0		**Conglomerate**Grey with bluish green and reddish brown quartz pebble inclusions, Clay is Blue-Grey.	
			20.0			

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

P-06-41D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F

DATE STARTED 8/6/06 **COMPLETED** 8/9/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 2160961.1 **EASTING** 1420117.8

DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165	GB				**Conglomerate** , Grey, Weathered, looks similar to very coarse angular Sand. **Conglomerate**Grey with bluish green and reddish brown quartz pebble inclusions, Clay is Blue-Grey.	
170	GB		20.0		**Conglomerate** Grey with 3/4" diameter white soft pebbles, bluish green and reddish brown quartz pebble inclusions.	Driller not convinced that he is blowing out all the water that is being produced, out of hole.
175	GB				**Conglomerate** Grey with 3/4" diameter white soft pebbles, bluish green and reddish brown quartz pebble inclusions.	
180	GB				**Conglomerate** Grey with 3/4" diameter white soft pebbles, bluish green and reddish brown quartz pebble inclusions.	
185	GB				**Conglomerate** Grey with 3/4" diameter white soft pebbles, bluish green and reddish brown quartz pebble inclusions.	
190	GB				**Conglomerate** Grey with 3/4" diameter white soft pebbles, bluish green and reddish brown quartz pebble inclusions.	
195	GB				**Conglomerate** Bedrock, Black with jet black rock chips and rock flower.	
197.0						
200	GB				200.5 **Bedrock** Black rock Chips.	
					Bottom of hole at 200.0 feet.	

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: F/P-06-41D
Date: 9/10/06 - 9/11/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Wimer & Terry Wassall

Summary

	Installed (Well Log)	Start	End
Water level		.2	
Total depth		198	
pH		7.79	8.26

Screen interval (btoPVC): 20
Top: 178
Bottom: 198
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, colour, quantity)
Surge block on	START Pump @ 1248							WATER, DARK GREY @ START.
1344	197.5	.2	0.7	30.2	0.463	1104	5.72	Dark Grey Thick, 3 cups SILT
1354	195.5							RAISED Pump 2', START
1305	"							Switched Pumps
1423	"							RESTART
1525	"	—	0.6	74	0.459	740	5.90	GREY, 2 cups SILT
1539	193.5	—						Raised Pump 2', START
1600	"	—	0.6	86.6	0.453	547	6.49	Grey, Coarse to Med/Fine Sand, 2 TSP
1636	"	—	0.9	119	0.454	490	7.29	" 1 TSP 9.06
9/11/06 0930	191.5	—	0.9					RAISE Pump 2', START
1000	"	—	404		0.515	648	5.76	Grey, Slightly Milky, 1TBS of Coarse to Fine Sand 2 TSP.
1021	"	—	549		0.504	756	5.05	", 1 TSP, Pump Slowed BACK TO 193.5
1035	"	—						RESTARTED 191.5...
1054	"	—	545		0.496	713	5.5	Milky Grey, < 1 TSP Sand 8.49
1115	189.5	—						RAISED Pump 2', START
1150	"	—	512		0.493	520	5.45	Milky Grey, 2 TSP, Coarse to Fine Sand 15 IT.
1219	"	—	523		0.493	519	5.47	", 1 1/2 TSP, A lot of Suspended 8.79
1230	187.5	—						RAISE pump 2', START
1305	"	—	505		0.495	521	6.59	", A lot of Suspended SIT, 2 TSP of, Mid to Fine 8.57
1346	"	—	443		0.494	449	6.52	" ; 1 TSP 8.44
1400	185.5	—						RAISE Pump 2' START
1423	"	—	452		0.489	407	6.52	Milky LT Grey TRACE Sand
1447	183.5	—						RAISED Pump 2', START
1500	"	181.0						RAN OUT OF WATER STOP / RESTART Slower Pump
1509	"	—	545		0.489	312	6.68	Milky Grey, < 1 TSP Sand Mid TO Fine 8.36
1523 1550 Surge Stop	181.5							RAISE Pump 2', START
1649	"		411		0.489	382	711	Milky LT Grey, < 1 TSP Fine Sand 8.48
1600	79.5	—						RAISE Pump 2' START
1612	"	—	627		0.488	390	7.07	" , TRACE Silt & Sand. 8.26
1623	78.0	—						RAISE Pump 2', START
1634	"	—	612		0.486	319	705	"
1645								End Purge, PULL TUBE

WELL DEVELOPMENT LOG

Well ID: FIP-06-41D
Date: 9/12/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5
Technician: Willow Weimer & Terry Wasali

Summary

	Installed (Well Log)	Start	End
Water level			
Total depth			
pH			

Screen interval (btoPVC): 20'
Top: 178
Bottom: 198
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity	Temp (deg C)	Sediment (grain size, colour, quantity)	PH#
Surge block ~~on~~ OFF. START Polish @ 1045									
1100	173	0.3	1.4	21	0.502	710	7.0	DARK TO Med Grey, ALOT of Suspended SEDIMENT IN WATER, SAND IS Medium To Fine, DARK Grey BLACK IN COLOR, 1 TBS of sand.	7.81
1130	"	—	1.6	69	0.474	459	5.97	", 1 TSP Sand	
1138	—	—	—	—	—	—	—	STOP Polish	
1143	197.5	—	—	—	—	—	—	START Debris Surge	
1209	"	—	~~2.0~~	~~19~~	0.476	6.89	6.0	", 2 1/2 TBS, Sand "	8.22
1231	"	—	1.5	148	0.473	671	5.93	", 2 TBS	7.95
1258	"	—	1.1	177	0.473	707	5.60	", 1 1/2 TBS.	8.09
Surge block off									

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F
DATE STARTED 8/9/06 **COMPLETED** 8/9/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160971.2 **EASTING** 1420135.7
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					PT **Peat** Organic matter with plant roots.	
5					5.0 GM **Silty Gravel** Reddish brown, damp to wet.	No sample.
10					GM **Silty Gravel** Reddish brown.	No sample. Inject water to get cuttings out of pipe.
15	GB				GM **Silty Gravel** Reddish brown, damp to wet. GM **Silty Gravel** Dark grey.	
20	GB				GM **Silty Gravel** Dark grey. 20% pea gravel, damp.	
25	GB				23.0 CL-ML **Clayey Silt** Dark grey, Damp. CL-ML **Clayey Silt** Dark grey, Damp.	
30					28.0 GM **Silty Gravel** Dark grey with clay.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: 2.5
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/10/06
Purge Volume: 392.4

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/16/06

Comments: Static Water level is Above ground surface at time of instalation. FTOC: 2.05

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F
DATE STARTED 8/9/06 **COMPLETED** 8/9/06 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160971.2 **EASTING** 1420135.7
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				GM **Silty Gravel** Dark grey with clay.	
					GM **Clayey Silt** Dark grey with gravel, 20% pea gravel, 80% clayey Silt, Damp.	
					GM **Clayey Silt** Dark grey with pea gravel.	
35			0		GM Increasing Gravel in dark grey clay Silt.	
					GM **Clayey Silt** Dark grey with gravel, 30% pea gravel, 70% clayey Silt, Damp.	First show of water, no measurable flow.
			1/2		38.0	
40					GW **Well graded Gravel** 10% Silt, wet.	
					GW **Well graded Gravel** and coarse sand, 70% Gravel, 20% coarse sand, 10% Silt, wet.	
45					45.0	
			1/4		SP **Silty Sand**Very silty medium sand, Wet. 46.0	Hard to drill.
					SM **Silty Sand**, grey, wet.	
50					50.0	
	GB				**Conglomerate** Grey with reddish brown and greenish quartz pebble inclusions.	Harder drilling.
55	GB					
			3-4		**Conglomerate** Grey with reddish brown and greenish quartz pebble inclusions.	
					Conglomerate Grey with reddish brown and greenish quartz pebble inclusions. Some weathered ?????? in white?	
60					61.0	
					ML/CL **Silty Clay** Grey, dry.	Dry.
					63.0	driller add water.
	GB				ML/CL **Silty Clay** mixed with conglomerate. Grey, Bottom of hole at 63.0 feet.	driller add water.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: FIP-06-41M
Date: 9/9/06 - 9/10/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: Willow Weimer & Terry Wasalt

Summary

	Installed (Well Log)	Start	End
Water level		.25	
Total depth		64.2	
pH		8.15	7.80

Screen interval (btoPVC): 10 ft
Top: 54.2
Bottom: 64.2
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, colour, quantity)	PH
Surge block on START Purge @ 1617								WATER Milky LT Grey	
1641	63.7	.25	2.1	50.4	0.471	764	4.58		
4/10/06 0902	"	—	—	—	—	—	—	RESTART Pump.	
0919	"	—	1.6	72.6	0.043	416	3.41		7.57
0926	61.7	—	—	—	—	—	—	RAISE Pump 2', START	
0947	"	—	1.4	107	0.445	489	3.82	Milky, Slight LT Brown, S/T: Mud to Fine Sand 2 TBS	
1018	"	—	2.0	149	0.439	213	4.35	" , (Suspended S.M), 1 TBS	7.72
1025	59.7	—	—	—	—	—	—	RAISE Pump 2ft, START	
1052	"	—	1.4	186.8	0.434	47.6	4.34	Milky, " , 1/2 TSP	
1059	57.7	—	—	—	—	—	—	RAISE pump 2ft, START	
1122	"	—	0.9	207.8	0.438	67.6	5.08	"	7.98
1137	55.7	—	—	—	—	—	—	RAISE Pump 2FT, START	
1207	"	—	1.1	240.0	0.458	426	5.06	Milky Grey, COARSE to Fine Sand 1/2 TBS	8.39
1224	"	—	1.1	260.9	0.451	564	6.08	" , 1/2 TSP	
1236	54.2	—	—	—	—	—	—	RAISE Pump 1.5 FT, START	
1310	"	—	1.5	308	0.449	392	6.17	Milky Grey, 1/2 TSP	
								STOP Pump	
Surge block off START Polish @ 1314									
1332	49.2	—	1.4	327.6	0.447	480	6.05	Milky Grey, 1/2 TSP COARSE to Sand	7.91
1338	63.7	—	—	—	—	—	—	STOP Polish/START Debris Surge	7.90
1405	"	—	2.4	392.4	0.443	98.5	5.44	Milky GREY/White, 1 TSP "	
1415								STOP Purge	

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F

DATE STARTED 8/10/06 **COMPLETED** 8/10/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet

DRILLING CONTRACTOR Foundex **NORTHING** 2160982.5 **EASTING** 1420151.3

DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					PT **Peat**	
					4.0	
5					GM Gravely silty layer.	
10					10.0	
					GP-GM **Well graded gravel** Reddish brown, damp to wet.	
15	GB				15.0	
					GW **Well graded gravel** reddish brown, with silt. 85% gravel, 15% Silt, wet.	
20					20.0	
					GM **Silt with Gravel** dark grey, 20% pea gravel, 80% Silt with clay fraction, Damp.	
25	GB				GM **Silt with Gravel** dark grey, 20% pea gravel, 80% Silt with clay fraction, Damp.	
30					29.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 4 inch

WELL CASING
Stickup: ?
Type: Schedule 40 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aqua Guard
Method of Placement: Tremie

PLUG
Type: Celco 1/4" coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.010 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump w/ 1" diameter tubing (with and without surge block)
Date: 9/10/06
Purge Volume: 661.5

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 9/16/06

Comments:

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

P-06-41S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site F
DATE STARTED 8/10/06 **COMPLETED** 8/10/06 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** 2160982.5 **EASTING** 1420151.3
DRILLING METHOD Air Percussion **EQUIPMENT** Semco/2800 **LOGGER** Jim Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				CL/ML **Silty Clay** dark grey, Silt with 10% coarse sand to gravel with clay fraction, 90% silt, damp.	
35	GB				35.0 GM-ML **Silty Gravel** Grey, 15% pea gravel, 85% silt with clay fraction, Damp. 36.0 GM **Silty Gravel** Grey, 50% coarse sand and Pea gravel, 50% Silt, Damp.	
40					40.0 ML **Silt** Grey, with clay fraction, damp. 42.0 SM **Silty Sand** Grey, with gravel. 43.0 Bottom of hole at 41.5 feet.	Heaving Sands. Heaving while setting sand pack around 5ft screen of piezometer.

NORTHERN DYNASTY PEBBLE 2006.GPJ PEBBLE2.GPJ 1/25/07

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

WELL DEVELOPMENT LOG

Well ID: F/P-06-41S
Date: 9/9/06 - 9/10/06

Project: Pebble Mine Site Ground Water Program Project #: 005.0189.05002 Task 5

Technician: WILLOW WEIMER & JERRY WADALI

Summary

	Installed (Well Log)	Start	End
Water level		1.0	
Total depth		43.1	
pH		7.6	8.47

Screen interval (btoPVC): 5 FT
Top: 38.1
Bottom: 43.1
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, colour, quantity)	
Surge block on	START Purge @ 1615							WATER DARK to Medium Grey.	PH
1636	42.6	1.0	3.6	75.6	0.449	712	5.23		
9/10/06 0859	"	—						RESTART PUMP	
0915	"	—	4.0	139.6	0.454	465	3.54		
0923	40.6	—						MOVE PUMP ↑ 2ft, START	
0942	"	—	3.5	206	0.419	405	4.02	Grey & Milky, like, Fine Sand to Mud & SILT, Sus	3 TBS. Eroded Sediment 7.90
1013	"	—	3.5	314	0.426	228	4.23	LT Grey, Milky, 2 TBS Suspended Sed.	
1023	38.6	—						RAISED Pump 2FT, START	
1048	"	—	2.4	374	0.429	51.3	4.41	LT Grey & Milky, 1 TSP mud to fine sand.	
1057	38.1	—						RAISE pump ½ FT, START	
1111	"	—	3.7	425	0.429	60.7	4.32	TRACE Sand, WATER CLEAR.	8.04
1114								STOP	
Surge block off	START Polish @ 1119								
11.27	33.1	—	3.7	450	0.423	0.423	4.50	M. Vis LT grey Medium/Fine Sand ½ TSP	7.75
11.34	43.1	—						STOP Polish / START Rebuild Surge	
12.04	"	—	3.9	567	0.430	156	4.80	Medium Grey, Slightly Milky, 1 TBS Sand.	
1231	"	—	3.5	661.5	0.432	134	4.73	" & 1 TSP	8.47

1234. End Purge

THE pebble PARTNERSHIP

P-07-42D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42D

DATE STARTED 8/25/07 **COMPLETED** 8/26/07 **GROUND ELEVATION** 1160.05 feet **TOC ELEVATION** 1161.95 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171817.5 feet **EASTING** 1404363.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0	
					ML **Sandy Silt** reddish brown, fine to coarse grained sand, silt balls, organic soil with roots, moist	
					3.0	
					4.0	
5	GB				ML **Sandy Silt with Gravel** reddish brown, fine subangular to subrounded gravel, silt balls 5.0	
					Boulder or Cobble Layer	
					7.0	
					GM **Gravel with Sand and Silt** fine subangular to subrounded gravel, fine to coarse grained sand, silt balls 8.0	
					9.0	
10	GB				GP **Gravel** subangular gravel, clasts up to 1/2"; medium to coarse grained sand, no silt balls, <5% silt, dry 10.0	
					11.0	More sand present, 11-12 feet
					GP **Gravel** subangular gravel, clasts up to 1/2"; medium to coarse grained sand, no silt balls, dry 12.0	
					GM **Gravel** subangular gravel, clasts up to 1/2"; medium to coarse grained sand, >5% silt, dry to moist	
					14.0	
15	GB				GP **Sandy Gravel** well graded poorly sorted sand, <5% silt 15.0	
					SW **Gravelly Sand** fine subangular gravel, well graded fine to coarse grained sand, dry 16.0	
					SW **Gravelly Sand** fine subangular gravel, well graded fine to coarse grained sand, silt balls, dry 17.0	
					SM **Silty Sand** fine gravel, silt balls, dry 18.0	
					GP **Sandy Gravel** predominantly fine gravel, fine to coarse grained sand, dry 19.0	
20					SW **Sand** fine gravel, well graded poorly sorted fine to 20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 1.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Pel Plug Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/23/07
Purge Volume: 1186 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/27/07 at 930 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-42D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42D

DATE STARTED 8/25/07 **COMPLETED** 8/26/07 **GROUND ELEVATION** 1160.05 feet **TOC ELEVATION** 1161.95 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171817.5 feet **EASTING** 1404363.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				coarse grained sand, <5% silt, dry	
					21.0 SM **Silty Sand** fine gravel, well graded poorly sorted fine to coarse grained sand, dry	
					22.0 GM **Gravel with Silty Sand** predominantly fine subangular to subrounded gravel, well graded fine to coarse grained sand, dry	
					23.0	
					24.0 ML **Sandy Silt**	
25	GB				GM **Gravel with Sandy Silt** fine subangular to subrounded gravel, moist	
					25.0 GM **Gravel with Sandy Silt** brown, subangular gravel, clasts <1/2", moist	
					26.0	
					27.0 ML **Sandy Silt** brown, trace gravel, moist	
					GM **Gravel with Silty Sand** subangular to subrounded gravel, clasts up to 3/8", moist	
					28.0	
					29.0 SM **Silty Sand with Gravel** subangular gravel, clasts <1/2", moist	
30	GB				30.0 GM **Sandy Gravel** reddish brown, clasts <1/2", poorly graded sand, moist	Gravel up to 1/2", 30-31 feet
					GM **Silty Gravel** reddish brown, subangular to subrounded gravel, moist	Gravel up to 3/4", 31-32 feet
					32.0	
					GM **Sandy Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", moist	
					33.0	
					SM **Gravelly Sand** brown, subangular to subrounded gravel, clasts up to 1/2"; fine grained sand, moist	
35	GB				35.0	
					GM **Sandy Gravel** brown, subrounded gravel, clasts up to 1 1/4", moist	
					36.0	
					GM **Sandy Gravel** angular to subangular gravel, clasts up to 1 1/2"; well graded sand, wet	Water encountered, 37 feet
						Adding water while drilling, 38-39 feet
						Gravel up to 3/4", 38-41 feet
40	GB	▼				
		41.9			41.0	
					SW **Sand** well graded fine grained sand, wet	
					42.0	
					GW **Sandy Gravel** subangular to subrounded gravel, clasts up to 1/4"; well graded sand, wet	
					43.0	
					GM **Gravel with Sand and Silt** subangular to subrounded gravel, clasts up to 3/4", wet	
					44.0	
45	GB				GP **Sandy Gravel** subangular to subrounded gravel, clasts up to 3/4"; coarse grained sand, trace silt, wet	
					45.0	
			No Flow		46.0 GM **Gravel and Sand with Silt** subangular to subrounded gravel, clasts up to 1 1/4"; well graded sand, wet	
			0.25			Gravel up to 1 1/2", 47-49 feet
					GP **Gravel and Sand** subangular to subrounded gravel, clasts up to 1 1/4"; well graded coarse grained sand, wet	
					49.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-42D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42D

DATE STARTED 8/25/07 **COMPLETED** 8/26/07 **GROUND ELEVATION** 1160.05 feet **TOC ELEVATION** 1161.95 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171817.5 feet **EASTING** 1404363.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	48.7			51.0 GP **Sandy Gravel** subrounded gravel, clasts up to 3/4"; well graded sand, trace silt, wet	
					GM **Sandy Gravel with Silt** subrounded gravel, clasts up to 3/4"; well graded sand, wet	
55	GB				55.0	
					56.0	Adding water while drilling, 56-57 feet
					57.0 GP **Gravel with Sand and Silt** yellowish brown, subangular to subrounded gravel, well graded fine to coarse grained sand, wet	Material is very similar aside from silt and water content, 56-65 feet
					58.0 GW **Sandy Gravel** brown, subangular to subrounded gravel, well graded sand, <5% silt, wet	
					59.0 GW **Sandy Gravel** brown, subangular to subrounded gravel, medium to coarse grained sand, <5% silt, wet	
60	GB				GW **Sandy Gravel** brown, subangular to subrounded gravel, fine to coarse grained sand, trace silt, wet	
		51.8	0.8		62.5	
					63.0 SW **Gravelly Sand** well graded sand, little silt, moist	
					64.0 GW **Sandy Gravel** yellowish brown to brown, subangular to subrounded gravel, clasts up to 1/2"; medium to coarse grained sand, moist	
65	GB				65.0 GP **Gravel with Sand and Silt** yellowish brown to brown, subangular to subrounded gravel, fine to coarse grained sand, wet	
					66.5	
					67.0 GM **Gravel with Sand and Silt** yellowish brown, wet	More silt present, 66.5-67 feet
					68.0	
					69.0 GM **Gravel with Sand and Silt** yellowish brown, wet	
70	GB				70.0 GP **Gravel with Silty Sand** yellowish brown, well graded sand, wet	Adding water while drilling, 69-72 feet
					SM **Silty Sand with Gravel** yellowish brown, wet	
		69.3	0.3		72.0	
					GM **Gravel with Sandy Silt** yellowish brown, subrounded to rounded gravel, clasts up to 1/2", moist to wet	
					74.0	Adding water while drilling, 73.5-76 feet
75	GB				SW **Gravelly Sand** brown, fine to coarse grained sand, trace silt, wet	
		62.2	1.5		77.0	
					GP **Gravel with Sand and Silt** yellowish brown to brown, subangular to subrounded gravel, clasts up to 1/2"; well graded sand, wet	Slightly more silt present, 78-86 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-42D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42D

DATE STARTED 8/25/07 **COMPLETED** 8/26/07 **GROUND ELEVATION** 1160.05 feet **TOC ELEVATION** 1161.95 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171817.5 feet **EASTING** 1404363.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB				GP **Gravel with Sand and Silt** yellowish brown to brown, subangular to subrounded gravel, clasts up to 1/2"; well graded sand, wet	
		67.4	1.1			Adding water while drilling, 83 feet
85	GB				86.0 GM **Gravel with Silty Sand** yellowish brown, subangular to subrounded gravel, clasts up to 1/2"; medium to coarse grained sand, wet	Higher silt content, 87-90 feet Adding water while drilling, 87-91 feet
90	GB				90.0 GM **Gravel with Silty Sand** yellowish brown, clasts <1/2"; well graded sand, wet	
		50.3	0.4		92.0 GP **Sandy Gravel** brown, subrounded gravel, clasts up to 3/4"; well graded sand, 5-10% silt, wet	
					93.0 GM **Gravel with Sandy Silt** yellowish brown, subangular to subrounded gravel, clasts up to 5/8", wet	Adding water while drilling, 93-98 feet
95	GB				96.0 GM **Sandy Gravel with Silt** yellowish brown, subangular to subrounded gravel, clasts up to 5/8", wet	
			0.5		97.0 GM **Sandy Gravel** subangular to subrounded gravel, clasts up to 5/8"; medium to coarse grained sand, wet	
100	GB				100.0 ML **Silt** light brown to yellowish brown, trace sand, wet	Adding water while drilling, 99-112 feet
		50.11			104.0 GP **Sandy Gravel** subangular to subrounded gravel, coarse grained sand, trace silt, wet	
105	GB					

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-42D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42D

DATE STARTED 8/25/07 **COMPLETED** 8/26/07 **GROUND ELEVATION** 1160.05 feet **TOC ELEVATION** 1161.95 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171817.5 feet **EASTING** 1404363.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB				110.0 SW **Gravelly Sand** well graded sand, 5-10% silt, wet	
					111.0 SM **Gravelly Sand** clasts up to 1/2", medium grained sand, 10% silt, wet	
		35.04	15		112.0 GW **Sandy Gravel** subangular to subrounded gravel, clasts <1/2"; well graded sand, trace silt, wet	Adding water while drilling, 113-115 feet
					114.0 **Bedrock (Basalt)** black, of clasts are fractured, fine grained	
115	GB		0.8		115.0	Adding water while drilling, 116-126 feet
		69.9	3		117.0 **Bedrock (Basalt)** dark gray, wet	
			7.5			
120	GB					
			1			
			5.5			
125	GB		14			Second flow test 8GPM, 125 feet
		83.2			126.0 Bottom of hole at 126.0 feet.	Confirmed bedrock is basalt

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: D-07-42D
Date: 10-23-07
Project: 2007 WELL DEVELOPMENT Project #: 005.0189.07007
Technician: TRYSTAN HERRIOTT

Summary

	Installed (Well Log)	Start	End
Water level	—	35.7	39.2
Total depth	121	123.90	123.5
pH		8.07	7.91

Screen interval (btoPVC): 10'
Top: 113.90
Bottom: 123.90
PVC stick-up height (above ground surface): 1.9'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH								
Surge block on	START AT 1245 → DEEP DARKER COLORED WATER							
8.07 1300	123.40	—	2.75	41	288	466	2.44	2 TBSP V.F.G. SAND & SILT
9.08 1332	"	—	3.5	153	196	582	2.12	1 TSP GRAY-BRN V.F.G. SAND & SILT
1348	121.40	—	—	—	—	—	—	MOVED UP 2 FT → WATER SLIGHTLY CLOUDY
8.37 1358	"	—	3.5	244	165	398	2.36	CLOUDY, LIGHT BRN, 1 TSP V.F.G. SAND & SILT
8.21 1433	"	—	3.75	375	145	223	2.29	" " ½ TSP V.F.G. SAND & SILT
1438	119.40	—	—	—	—	—	—	MOVED UP 2 FT → WATER SLIGHTLY CLOUDY
8.35 1449	"	—	3.75	435	138	186	2.53	CLOUDY, LIGHT BRN, 2 TSP V.F.G. SAND & SILT
8.42 1519	"	—	3.75	548	133	133	2.23	" " ½ TSP " "
1528	117.40	—	—	—	—	—	—	MOVED UP 2 FT → WATER SLIGHTLY CLOUDY
8.39 1538	"	—	3.5	615	135	192	2.59	SLIGHTLY CLOUDY, ½ TSP V.F.G. SAND & SILT
8.73 1553	"	—	3.5	668	130	128	2.69	" "
1600	115.40	—	—	—	—	—	—	MOVED UP 2 FT → CLEAR OUT OF HOSE
1609	"	STOP PURGE FOR DAY → START B-24 AT 1015						
10-24-07 1032	"	—	3.5	728	157	113	2.21	SLIGHTLY CLOUDY → ½ TSP V.F.G. SAND & SILT
8.35 1048	"	—	3.5	784	165	146	2.18	" " ½ TSP " "
		STOP AT 1100						
				824				
Surge block off	START DEBRIS EDGE AT 1107							
8.05 1123	123.40	—	3.0	874	132	351	1.76	CLOUDY, 2 TSP V.F.G. SAND & SILT
8.00 1155	"	—	3.5	986	127	215	2.46	" " 1 TSP " "
1215	108.90	—	—	—	—	—	—	MOVED UP FOR POLISH
8.06 1225	"	—	3.5	1091	133	126	2.45	CLOUDY, ¾ TSP V.F.G. SAND & SILT
1232	"	AIR DISABLED - SURGE STOPPED						
1240	"	AIR FIXED - SURGE RESUMED.						
1245			1.75					
7.91 1320	"	—	1.5	1186	127	15.12	2.42	TRACE OF SEDIMENT

THE pebble PARTNERSHIP

P-07-42S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42S

DATE STARTED 8/27/07 **COMPLETED** 8/27/07 **GROUND ELEVATION** 1160.48 feet **TOC ELEVATION** 1162.78 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171795.2 feet **EASTING** 1404364.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 ML **Sandy Silt with Gravel** brown, moist	
					3.0	No recovery, 3-4 feet
					4.0 SM **Sandy Silt with Gravel** brown, dry to moist	
5						More gravel present, 6-8 feet
					8.0 GM **Gravel with Sandy Silt** brown, subangular to subrouned gravel, well graded sand, dry	
10					11.0	
					12.0 GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, well graded fine to coarse grained sand, dry	
					GP **Sandy Gravel** brown, subangular to rounded gravel, well graded fine to coarse grained sand, trace silt, dry	Gravel more rounded, 13-14 feet
					14.0	
15					15.0 GM **Gravel with Sandy Silt** brown, dry	
					17.0	
					18.0 SW **Gravelly Sand** brown, well graded sand, trace silt, dry	
					19.0 GP **Sandy Gravel** brown, subrounded to rounded gravel, trace silt, dry	
20					20.0 GP **Gravel and Sand** brown, subangular to	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Pellets

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/23/07
Purge Volume: 586 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/28/07 at 820 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-42S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42S

DATE STARTED 8/27/07 **COMPLETED** 8/27/07 **GROUND ELEVATION** 1160.48 feet **TOC ELEVATION** 1162.78 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171795.2 feet **EASTING** 1404364.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					subrounded gravel, trace silt, dry	
					21.0 GM **Gravel with Silt and Sand** brown, dry	
					GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, some silt, dry	
					23.0 GP **Sandy Gravel** brown, subangular to subrounded gravel, well graded sand, trace silt, dry	
25					25.0 GP **Sandy Gravel** brown, trace silt, dry	
30	GB					
					32.0 GM **Gravel with Silty Sand** yellowish brown, subrounded gravel, moist	
					33.0 GP **Gravel with Sand and Silt** brown to yellowish brown, subrounded gravel, trace to some silt, moist	
35	GB	▼			34.0 SP **Gravelly Sand** brown, well graded poorly sorted sand, moist	
					35.0 SW **Gravelly Sand** reddish brown, subrounded gravel, clasts up to 1/2"; well graded sand, trace silt, moist	
					37.5 38.0 GW **Sandy Gravel** clasts up to 1/4", moist	
40	GB				GP **Sandy Gravel** reddish brown, subrounded gravel, clasts up to 1/2", moist	
					41.0 GP **Gravel** subangular to subrounded gravel, trace poorly sorted sand, moist	
					42.0 GM **Gravel** reddish brown, subrounded gravel, clasts up to 5/8"; trace silt, moist	
45	GB				44.0 GM **Sandy Gravel** reddish brown, subrounded gravel, clasts up to 5/8"; coarse grained sand, trace silt, moist	
					45.0 GM **Gravel** reddish brown, subrounded gravel, clasts up to 5/8"; 10% silt, moist	
					46.0 GP **Sandy Gravel** subangular to subrounded gravel, clasts up to 5/8"; coarse grained sand, moist	
					47.0 GP **Gravel** yellowish brown, subangular gravel, clasts <1/2"; trace silt, wet	Water encountered, 48.5 feet Adding water while drilling, 49-52 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-42S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-42S

DATE STARTED 8/27/07 **COMPLETED** 8/27/07 **GROUND ELEVATION** 1160.48 feet **TOC ELEVATION** 1162.78 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171795.2 feet **EASTING** 1404364.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	49			GP **Gravel** yellowish brown, subangular gravel, clasts <1/2"; trace silt, wet	Water level rising
					52.0 Bottom of hole at 52.5 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-425
Date: 10-23-07
Project: 2007 WELL DEVELOPMENT Project #: 005.018.09.07052
Technician: TETSTAN WEEDING

Summary

	Installed (Well Log)	Start	End
Water level	34.8	29.61	30.62
Total depth	50	53.76	53.24
pH		9.04	8.34

Screen interval (btoPVC): 10'
Top: 43.26
Bottom: 53.26
PVC stick-up height (above ground surface): ~ 1-8

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on	START AT 1327 → WATER IS CARMEL IN COLOR								
1349	52.76	—	1.5	21	129	398	1.76	CARMEL COLORED, ½ TSP RED SILT	9.04
1421	"	—	2.25	111	129	654	1.86	" " "	8.62
1431	50.76	—	—	—	—	—	—	MOVED → 2 FT → WATER CARMEL COLOR	
1441	"	—	1.25	136	129	356	1.98	CARMEL COLORED, ½ TSP V.F.G. SAND + SILT	8.50
1511	"	—	2.25	204	129	566	1.98	"	8.63
1524	48.76	—	—	—	—	—	—	MOVED → 2 FT → WATER CARMEL COLOR	
1533	"	—	1.5	237	129	603	2.20	CARMEL COLORED 1 TSP RED, BRN V.F.G. SAND + SILT	8.53
1606	"	—	1.75	295	132	269	2.00	" ", ½ TSP"	8.42
1609	"	STOP	PURGE FOR DAY						
1006	46.76	—	—	—	—	—	—	MOVED → 2 FT → WATER CARMEL COLOR	10-24-07
1029	"	—	1.0	318	139	246	2.73	LIGHT CARMEL COLORED, ¼ TSP V.F.G. SAND + SILT	8.46
1052	"	—	1.25	347	133	258	1.75	" ", ⅛"	8.77
1058	44.76	—	—	—	—	—	—	MOVED → 2 FT → WATER CARMEL COLOR	
1111	"	—	1.0	366	132	544	1.63	LIGHT CARMEL IN COLOR, ½ TSP V.F.G. SAND + SILT	7.64
1140	"	—	1.25	402	130	151	1.79	" ", TRACE OF SEDIMENT	8.38
		STOP	AT	1148					
				412					
Surge block off	START DEBRIS SURGE AT 1152								
1202	52.76	—	2.5	437	146	410	1.99	LIGHT CARMEL COLOR, 1 TSP RED SILT	8.30
1258	"	—	1.5	521	134	76.2	2.19	" ", TRACE OF RED SILT	8.59
1305	38.26	—	—	—	—	—	—	MOVED → FOR POLISH	
1315	"	—	1.25	544	139	580	2.12	CLEAR, TRACE OF SEDIMENT	7.75
1343	"	—	1.50	586	135	13.50	2.65		8.34

THE pebble PARTNERSHIP

P-07-43D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43D

DATE STARTED 8/28/07 **COMPLETED** 8/29/07 **GROUND ELEVATION** 1195.58 feet **TOC ELEVATION** 1198.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171790.4 feet **EASTING** 1408689.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					ML **Sandy Silt** dark brown, roots, moist	
					1.0 ML **Sandy Silt** dark brown, trace roots, moist	
					3.0 ML **Silt with Sand and Gravel** dark brown, moist	
5	GB				5.0 ML **Silt with Sand and Gravel** dark brown, subrounded gravel, trace clay, moist	
					7.0 SW **Sand and Gravel** brown, fine to coarse subangular to subrounded gravel, fine to coarse grained sand, trace silt, moist	
					8.0 9.0 SW **Gravelly Sand** brown, fine subangular to subrounded gravel, fine to coarse grained sand, moist	
10	GB				10.0 GP **Sandy Gravel** brown, fine to coarse subangular gravel, clasts up to 3/4"; fine to coarse grained well graded sand, trace silt, moist	
					11.0 12.0 GM **Gravel with Silt and Sand** brown, fine subrounded gravel, well graded sand, moist	
					13.0 GM **Gravel and Sand with Silt** brown, fine to coarse subrounded gravel, silt coated, clasts up to 3/4"; well graded sand, moist	
15	GB				16.0 GP **Gravel and Sand** brown, fine subrounded gravel, silt coated; well graded sand, trace silt, moist	
20					20.0	Difficult drilling, sounds like grinding on boulder or cobble; Grayer cuttings, 19-20

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Pel Plug Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Not Developed - Insufficient Water
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/31/07 at 758 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43D

DATE STARTED 8/28/07 **COMPLETED** 8/29/07 **GROUND ELEVATION** 1195.58 feet **TOC ELEVATION** 1198.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171790.4 feet **EASTING** 1408689.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				21.0 GM **Gravel with Silt and Sand** grayish brown, fine angular to subangular gravel, well graded fine to coarse grained sand, dry to moist	feet
					22.0 GM **Gravel with Silt and Sand** brown, fine to coarse subangular to subrounded gravel, clasts up to 3/4"; well graded sand, dry to moist	
					24.0 SM **Sand with Silt and Gravel** brown, fine subangular gravel, predominantly medium grained sand, moist	
25	GB				GP **Sandy Gravel** grayish brown, fine subangular to subrounded gravel, well graded sand, trace silt, moist	
					26.0 GP **Sandy Gravel** brown, fine subrounded gravel, silt coated; well graded sand, trace silt, moist	
					27.0 GP **Gravel with Silty Sand** brown, subangular to subrounded gravel, silt coated; well graded sand, moist	
30	GB				31.0 GP **Sandy Gravel** brown, fine subangular gravel, clasts up to 1/2"; well graded sand, trace silt, dry	
					32.0 GM **Gravel with Sand and Silt** brown, fine subangular gravel, clasts up to 1/4"; well graded sand, moist	
					33.0 GP **Sandy Gravel** brown, fine predominantly subrounded gravel, clasts up to 1/2"; well graded sand, trace silt, moist	
35	GB	▼			34.0 SP **Gravelly Sand** brown, fine to coarse subrounded gravel, silt coated, clasts up to 3/4"; medium to coarse grained sand, trace silt, moist	
					35.0 GW **Gravel with Silty Sand** brown, fine to coarse subrounded gravel, silt coated, clasts up to 3/4"; well graded sand, moist	
40	GB				41.0 GW **Gravel with Silty Sand** reddish brown, subrounded gravel, clasts up to 1 1/4"; medium grained sand, moist	Less silt and sand present, 41-42 feet
					42.0 GM **Gravel** yellowish brown, subangular to subrounded gravel, clasts up to 1 1/4"; trace silt, wet	Water encountered, 42 feet
					43.0 ML **Silt** yellowish brown, trace gravel, little sand, wet	Adding water while drilling, 43.5-57 feet
45	GB	22.12			44.0 GM **Silty Gravel** clasts up to 3/4", wet	
					45.0 GM **Silty Gravel** yellowish brown, subangular to subrounded gravel, clasts up to 1 1/4", wet	
					49.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43D

DATE STARTED 8/28/07 **COMPLETED** 8/29/07 **GROUND ELEVATION** 1195.58 feet **TOC ELEVATION** 1198.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171790.4 feet **EASTING** 1408689.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	45.85	0.4		GM **Silty Gravel** yellowish brown, clasts up to 1/2", wet	
		49.15			52.0 GM **Silty Gravel** yellowish brown, subangular gravel, clasts up to 1/2", wet	Multiple DTW measurements taken, DTW=45.85 at 5:51pm on 8/28/07, DTW=49.15 at 7:48am on 8/29/07; Flow test 8/29/07
55	GB				54.0 ML **Gravelly Silt** yellowish brown, subangular gravel, clasts up to 1/2"; trace sand, wet	
					57.0 GM **Silty Gravel** yellowish brown, subangular gravel, clasts up to 1/2"; trace sand, wet	
60	GB				59.0 GW **Gravel** subangular to subrounded gravel, clasts up to 3/4"; trace silt, wet	
		55	2.75		61.0 SP **Gravelly Sand** subrounded gravel, clasts up to 3/4"; medium grained sand, trace silt, clean, wet	Hit water bearing formation, 62 feet
					63.0 GP **Sandy Gravel** subangular to subrouned gravel, clasts up to 1"; medium grained sand, clean, wet	
65	GB				65.0 GP **Sandy Gravel** subangular gravel, clasts up to 1/2"; medium grained sand, trace silt, clean, wet	Adding water while drilling, 65-133 feet
		62.1			66.0 GM **Sandy Gravel with Silt** subangular to subrounded gravel, clasts up to 1/2"; medium to coarse grained sand, wet	
					67.0 GM **Sand and Gravel with Silt** subrounded gravel, clasts up to 1/2"; medium to coarse grained sand, wet	
70	GB				68.0 GP **Sandy Gravel** subrounded to subangular gravel, clasts up to 1/2"; medium to coarse grained sand, trace silt, wet	
		66.9			69.0 GM **Silty Gravel** subrounded to subangular gravel, clasts up to 3/4"; trace coarse grained sand, wet	
			1.5		73.0 GM **Silty Gravel** yellowish brown, subrounded gravel, clasts up to 1 1/4", wet	
75	GB				76.0 GM **Silty Gravel** gray, fine subangular gravel, trace fine grained sand, wet	
		53			78.0 ML **Gravelly Silt** gray, fine subangular gravel, trace fine grained sand, wet	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43D

DATE STARTED 8/28/07 **COMPLETED** 8/29/07 **GROUND ELEVATION** 1195.58 feet **TOC ELEVATION** 1198.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171790.4 feet **EASTING** 1408689.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB				ML **Gravelly Silt** gray, fine subangular gravel, trace fine grained sand, wet	
		79.19	0.75		82.0	Faster drilling, less dense, 81-82 feet
					GM **Gravel** gray, fine subangular gravel, trace sand, some silt, wet	
					83.0 ML **Sandy Silt** gray, trace gravel, fine to coarse grained sand, wet	
					84.0 ML **Sandy Silt** gray, some fine gravel, fine to coarse grained sand, wet	
85	GB				85.0 GM **Gravel with Sandy Silt** gray, fine subangular to subrounded gravel, predominantly coarse grained sand, wet	
		82.98			86.0 GP **Gravel** gray, fine subangular to subrounded gravel, trace sand, trace silt, wet	
					87.0 GM **Gravel** gray, fine subangular to subrounded gravel, trace sand, some silt, wet	
					88.0 ML **Sandy Silt with Gravel** gray, some fine subangular to subrounded gravel, fine to coarse grained sand, wet	
90	GB				89.0 SM **Silty Sand and Gravel** gray, fine subangular to subrounded gravel, fine to coarse grained sand, wet	
		89.81	1.6		90.0 ML **Silt** gray, trace fine gravel, some fine to coarse grained sand, wet	Slower drilling, dense formation, 91-96 feet
					92.0 ML **Silt** gray, wet	
95	GB					
		93.92				
100	GB				100.0 ML **Silt** gray, trace coarse grained sand, wet	Faster drilling, less dense, 101-102 feet
		97.61				Slower drilling, dense formation, 102-103 feet
						Faster drilling, less dense, 103-115 feet
105	GB				105.0 ML **Silt** gray, trace fine to coarse grained sand, wet	
		103.87				

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43D

DATE STARTED 8/28/07 **COMPLETED** 8/29/07 **GROUND ELEVATION** 1195.58 feet **TOC ELEVATION** 1198.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171790.4 feet **EASTING** 1408689.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB				ML **Silt** gray, trace fine to coarse grained sand, wet	
					111.0 ML **Silt** gray, trace fine subangular to subrounded gravel, some fine to coarse grained sand, wet	
115	GB				115.0 ML **Silt** gray, trace fine subangular gravel, trace fine to coarse grained sand, wet	
					118.0 ML **Silt with Gravel and Sand** gray, some fine subangular gravel, some fine to coarse grained sand, wet	Increasing gravel and sand content, 117-118 feet
120	GB					
		118.2			121.0 **Bedrock** weathered	
125	GB					
		101.83	1.0		126.0 **Bedrock**	
			<0.25			
130	GB		0.8			
		122.77	0.75		133.0	
					Bottom of hole at 133.6 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-43D
Date: 10-23-07
Project: 2007 WELL DEVELOPMENT Project #: 605.0189.07002
Technician: TRISTAN WHEELOCK

Summary WELL NOT DEVELOPED DUE TO POOR RECHARGE.

	Installed (Well Log)	Start	End
Water level	36.2'	29.10	
Total depth	133'7"	137.07	
pH			

Screen interval (btoPVC): 5
Top: 132.07
Bottom: 137.07
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on	START AT 1058 → CHOC. MILK COLORED WATER, THICK CONSISTENCY							
1105	136.9	—	FLOW	STOPPED	!			
1110	"	CHANGED	FOOT VALVE - STILL NO WATER					
1115	WATER	LEVEL =	132'	BTOC				
Surge block off								

pH

THE pebble PARTNERSHIP

P-07-43M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43M

DATE STARTED 8/30/07 **COMPLETED** 8/30/07 **GROUND ELEVATION** 1195.48 feet **TOC ELEVATION** 1198.08 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171783.4 feet **EASTING** 1408706.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Boulder or Cobble** gray, pulverized boulder just below ground surface	In between two large boulders, lifted drill rod and looked at subsurface boulders at ~6" and 8"
					ML **Sandy Silt** brown, trace angular gravel, 100% of clasts are fractured; fine to medium grained sand, dry	
5					5.0	
					6.0 ML **Sandy Silt** brown, some predominantly angular gravel, 100% of clasts are fractured; fine to medium grained sand, dry to moist	
					7.0 ML **Sandy Silt and Gravel** brown, some fine to coarse angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry to moist	
					8.0	
10					SW **Gravelly Sand** brown, angular to subrounded gravel, 30-40% of clasts are fractured; well graded fine to coarse grained sand, trace silt, dry	
					10.0	
					11.0 GP **Sandy Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured; well graded fine to coarse grained sand, dry	More subrounded gravel present, 11-17 feet
					12.0	
					GP **Sandy Gravel** brown, angular to subrounded gravel, silt coated, 30% of clasts are fractured; fine to coarse grained sand, trace silt, dry	
15					GP **Sandy Gravel** brown, angular to subrounded gravel silt coated, <10% of clasts are fractured; well graded fine to coarse grained sand, trace silt, dry	Moisture content increased to moist, 15-18 feet
					GP **Sandy Gravel** brown, subrounded gravel, silt coated; well graded fine to coarse grained sand, trace silt, dry	
					17.0	Water encountered, 17 feet
					GP **Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured; trace silt, wet	
					19.0	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/21/07
Purge Volume: 1228 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/31/07 at 1000 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43M

DATE STARTED 8/30/07 **COMPLETED** 8/30/07 **GROUND ELEVATION** 1195.48 feet **TOC ELEVATION** 1198.08 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171783.4 feet **EASTING** 1408706.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				GP **Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured; trace fine to coarse grained sand, trace silt, wet	
		21.1			22.0 GP **Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured; trace sand, trace silt, wet	Adding water while drilling, 23-25 feet
25	GB				24.0 GM **Silty Gravel** yellowish brown, subangular to subrounded gravel, <10% of clasts are fractured; trace sand, wet	More silt present, 23-24 feet
					27.0 GP **Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured; trace sand, trace silt, wet	
					28.0 ML **Gravelly Silt** yellowish brown, subangular to subrounded gravel, <10% of clasts are fractured, wet	Silt is gray when broken apart, 28-29 feet
30	GB	▼			29.0 GP **Gravel** gray, subangular to subrounded gravel, <10% of clasts are fractured; trace sand, trace silt, wet	Adding water while drilling, 28-61 feet
		27			32.0 GM **Silty Gravel** yellowish brown, subangular to subrounded gravel, 10-20% of clasts are fractured; trace sand, wet	DTW questionable, silt still in well
					33.0 GM **Gravel** yellowish brown, trace sand, some silt, wet	Color change to yellowish brown, 32-33 feet
35	GB				34.0 GM **Gravel** yellowish brown, subangular gravel, <10% of clasts are fractured; some fine to coarse grained sand, some silt, wet	
					35.0 GM **Silty Gravel** brown, subangular gravel, <10% of clasts are fractured; trace sand, wet	
40					36.0	
		39.34			41.0 GP **Gravel** subangular gravel, clasts up to 1 1/4"; trace silt, wet	
					42.0 GM **Silty Gravel** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1 1/4"; trace sand, wet	
45	GB					
		23.7	0.75		48.0 GM **Silty Gravel** subangular gravel, clasts up to 3/4", wet	
					49.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43M

DATE STARTED 8/30/07 **COMPLETED** 8/30/07 **GROUND ELEVATION** 1195.48 feet **TOC ELEVATION** 1198.08 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171783.4 feet **EASTING** 1408706.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	44.95	1.0		GP **Sandy Gravel** subangular gravel, clasts up to 3/4"; medium to coarse grained sand, trace silt, wet	
					51.0 GP **Gravel** subangular gravel, clasts up to 5/8"; trace silt, wet	
					53.0 GM **Silty Gravel** subangular gravel, clasts up to 5/8", wet	
55	GB	42.33				
					59.0 GP **Gravel** subangular gravel, clasts up to 1/2"; trace sand, trace silt	
60	GB				60.0 SP **Sand** some gravel, coarse grained sand, trace silt, wet	Lots of water, 60 feet
		30.79	10		61.0 GP **Gravel** subangular gravel, 10% of clasts are fractured, clasts up to 1/2"; trace coarse grained sand, wet	Lots of water, 62-63 feet
					63.0 GP **Gravel** subangular gravel, clasts up to 1/2"; some coarse grained sand, trace silt, wet	
65	GB	36.41			65.0 SP **Sand and Gravel** subangular gravel, clasts up to 1/2"; coarse grained sand, wet	
			0.25		66.0 SP **Sand and Gravel** subangular gravel, clasts up to 1/2"; coarse grained sand, trace silt, wet	
					68.0 SP **Sand and Gravel** subangular gravel, 10% of clasts are fractured, clasts up to 1"; coarse grained sand, trace silt, wet	
70	GB		0.25		70.0 GP **Gravel** subangular gravel, clasts <1/2"; trace coarse grained sand, trace silt, wet	
		26.91			72.0 Bottom of hole at 72.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

4-26-10
43 m (mR)

Well ID: P-07-~~37~~ ~~MW~~
Date: 10-21-07

Project: 2007 WELL DEVELOPMENT Project #: 005.0189.07002
Technician: TETRA TECH

Summary PURGE WATER CONSISTENTLY CLOUDY/MILKY THROUGHOUT DEVELOPMENT WITH CLEAR WATER SOLELY OBSERVED DURING POLISH

	Installed (Well Log)	Start	End
Water level	30.01	26.71	27.87
Total depth	~~70.0~~	~~74.0~~	74.0
pH		6.79	7.02

Screen interval (btoPVC): 9'
Top: 63.0
Bottom: 74.0
PVC stick-up height (above ground surface): 2.27'

Development Observations

pH	Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
	Surge block on START @ 1115								BRN-RED MUDDY WATER
	1127	73.5	—	4.0	48	—	—	—	V.F.G. SAND, GRAY-BRN, 1 TBSP
6.79	1137	"	—	4.5	93	147	412	352	"
6.16	1217	"	—	4.0	253	132	167	2.38	V.F.G. SAND, GRAY-BRN, <1/4 TSP WATER IS CLEAR
	1227	71.5	—						MOVED UP 2 FT → RED-BRN, SILTY WATER
6.89	1237	"	—	3.75	328	133	193	2.46	V.F.G. SAND TO SILT, 1 TSP
6.98	1317	"	—	4.0	488	129	71.3	2.92	TRACE OF SED. IN BUCKET WATER IS MILKY
	1322	69.5	—						MOVED UP 2 FT → GRAY-BRN SILTY WATER
7.01	1332	"	—	3.75	526	129	265	2.87	V.F.G. SAND GRAY-BRN, <1/4 TSP WATER IS MILKY
7.01	1402	"	—	4.0	646	126	150	2.44	V.F.G. SAND TO SILT <1/4 TSP WATER IS MILKY
	1417	67.5	—						MOVED UP 2 FT → GRAY-BRN SILTY WATER
7.02	1427	"	—	4.0	766	124	170	2.46	V.F.G. SAND TO SILT RED-BRN, <1/2 TSP
7.01	1452	"	—	4.0	806	124	133	2.32	" " <1 TSP
	1457	65.5	—						MOVED UP 2 FT → WATER IS CLEAR
6.93	1507	"	—	3.25	855	124	91.3	2.25	V.F.G. SAND TO SILT, <1/8 TSP WATER IS MILKY
6.93	1532	"	—	3.0	936	123	93.5	2.18	" " TRACE OF SED.
		STOP @ 1537							*WATER REMAINS SLIGHTLY
					945				CLOUDY/MILKY, ALTHOUGH
									SEDIMENT THAT SETTLES IS
									REDUCED TO A FRACTION
									OF A TEASPOON.*
	Surge block off START @ 1543 (DEBRIS SURGE)								
pH 6.96	1553	73.5	—	4.5	990	124	50.1	2.30	WATER CLOUDY IN BUCKET, TRACE SEDIMENT
*6.96	1613	"	—	4.5	1080	123	50.3	2.35	" "
	1620	~~58.0~~	—						MOVED UP FOR POLISH
7.01	1630	"	—	4.0	1146	123	14.12	2.35	WATER CLOUDY IN BUCKET, BUT MORE CLEAR THAN PREV. OBSVD.
7.02	1650 * START POLISH	"	—	4.0	1228	123	10.98	2.33	WATER CRYSTAL CLEAR IN BUCKET.

THE pebble PARTNERSHIP

P-07-43S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43S

DATE STARTED 8/31/07 **COMPLETED** 8/31/07 **GROUND ELEVATION** 1194.35 feet **TOC ELEVATION** 1197.65 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171767.8 feet **EASTING** 1408701.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-3 feet
					3.0	
					ML **Silt** brown, trace subrounded gravel, trace sand, wet	
					4.0	
5					SM **Sandy Silt** brown, trace gravel, moist	
					5.0	
					Boulder or Cobble gray, fine to coarse angular fragments, 100% of clasts are fractured, dry	
					6.0	
					ML **Silt** brown, trace angular to subrounded gravel, 30% of clasts are fractured, moist	
					7.0	
					Boulder or Cobble gray, fine to coarse angular fragments, 100% of clasts are fractured, dry	
					8.0	
					GP **Gravel** brown, angular to subrounded gravel, 40% of clasts are fractured, silt coated; some predominantly coarse grained sand, trace silt, dry	
10					9.0	
					GP **Sandy Gravel** brown, angular to subrounded gravel, 20% of clasts are fractured, silt coated; well graded fine to coarse grained sand, trace silt, dry	
					13.0	
					SW **Sand** some subrounded gravel, <10% of clasts are fractured; well graded fine to coarse grained sand, trace silt, dry	
15	GB	▼			15.0	
					16.0	
					SP **Sand** brown, some fine subrounded gravel, <10% of clasts are fractured; predominantly coarse sand, trace silt, dry	
					17.0	Hit water, 17.5 feet
					GP **Gravel** brown, predominantly fine subangular to subrounded gravel, <10% of clasts are fractured; trace sand, trace silt, wet	
					19.0	
20					GM **Gravel** brown, predominantly fine subangular to 20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Pel Plug Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/22/07
Purge Volume: 510 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/31/07 at 931 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-43S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-43S

DATE STARTED 8/31/07 **COMPLETED** 8/31/07 **GROUND ELEVATION** 1194.35 feet **TOC ELEVATION** 1197.65 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171767.8 feet **EASTING** 1408701.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				subrounded gravel, <10% of clasts are fractured; some fine to coarse grained sand, some silt, wet	Adding water while drilling, 20-30 feet
		20.63			GM **Silty Gravel** brown, fine subangular gravel, <10% of clasts are fractured; some fine to coarse grained sand, wet	
					23.0 GM **Silty Gravel** gray, predominantly fine subangular gravel, <10% of clasts are fractured; some fine to coarse grained sand, silt balls, wet	
25	GB				26.0 GM **Gravel** gray, fine subangular gravel, <10% of clasts are fractured; some fine to coarse grained sand, some silt, wet	
		25.22			27.0 GP **Sandy Gravel** gray, fine subangular gravel, <10% of clasts are fractured; predominantly coarse grained sand, some silt, wet	
30	GB				28.0 SM **Silty Sand** light brown, fine subangular to subrounded gravel, <10% of clasts are fractured; fine to coarse grained sand, wet	
					30.0 32.0 Bottom of hole at 32.0 feet.	Drove casing an additional two feet to aid in tripping rods

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-435
Date: 10-22-07
Project: 2007 WELL DEVELOPMENT Project #: 005-0189.07002
Technician: TRYSTAN HERRIOTT

Summary

	Installed (Well Log)	Start	End
Water level	15.43	11.91	12.32
Total depth	291.10	33.01	32.96
pH		6.34	6.37

Screen interval (btoPVC): 9'
Top: 24.01
Bottom: 33.01
PVC stick-up height (above ground surface): 2.50

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on	START AT 1048 → MOCHA COLORED, THICK WATER								
1100	32.51	—	1.75	21	—	—	—	"	
1125	"	—	1.25	52	83	285	1.48	LIGHT MOCHA COLORED, >1 TBSP RED-BRN SILT	6.34
1155	"	—	1.75	105	72	341	1.49	" , >> TBSP RED-BRN SILT	5.73
1205	30.51	—	—	—	—	—	—	MOVED UP 2FT → LARGE REMAINS MOCHA COLORED.	
1215	"	—	1.0	125	72	455	1.63	LIGHT MOCHA COLORED, >1 TSP RED-BRN SILT	5.94
1245	"	—	1.25	163	73	688	1.25	" , ≤1/4 TSP RED-BRN SILT	6.02
1255	28.51	—	—	—	—	—	—	MOVED UP 2FT → WATER REMAINS MOCHA COLORED.	*
1305	"	—	1.25	188	73	580	1.59	LIGHT MOCHA COLORED, ≤1 TSP RED-BRN SILT	6.25
1335	"	—	1.12	222	73	493	1.55	" , < 1/2 TSP " "	6.16
1345	26.51	—	—	—	—	—	—	MOVED UP 2FT → LIGHT MOCHA COLORED	
1355	"	—	1.25	247	72	787	2.65	LIGHT MOCHA COLORED, < 1/2 TSP V.F.G. SAND + SILT	6.45
1425	"	—	1.25	285	72	642	3.76	"	6.49
1435	24.51	—	—	—	—	—	—	MOVED UP 2FT → STOPPED PUMP FOR 5 MIN TO REPAIR ARM	
1450	"	—	2.25	330	72	764	3.82	CLOUDY RED-BRN COLOR, 1 TSP V.F.G SAND + SILT	6.43
1520	"	—	1.50	375	75	467	3.78	" , < 1/4 TSP	6.45
	STOP AT 1530			390					
Surge block off	START AT 1536 (DEBRIS SURGE)								pH
1546	32.51	—	1.5	405	72	724	2.51	CLOUDY RED-BRN COLOR, < 1/4 TSP RED-BRN SILT	6.28
1606	"	—	1.5	435	72	751	2.47	"	6.26
1616	19.01	—	—	—	—	—	—	MOVED UP FOR POLISH	
1626	"	—	1.5	465	71	275	2.38	SLIGHTLY CLOUDY, TRACE OF SILT IN BUCKET	6.35
1636	"	—	1.5	510	72	139	2.30	" NO SEDIMENT IN BUCKET	6.37

* CHANGED FOOT VALVE: FLOW REMAINS THE SAME @ 1.25 GPM.

THE pebble PARTNERSHIP

P-07-44D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-44D

DATE STARTED 9/1/07 **COMPLETED** 9/2/07 **GROUND ELEVATION** 1483.28 feet **TOC ELEVATION** 1485.82 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2174231.9 feet **EASTING** 1411817.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0	No recovery, 0-1 feet
					Topsoil organic soil and roots 2.0	
					ML **Silt** brown, trace gravel, moist 3.0	
					GM **Silty Gravel** dark gray, subangular to subrounded gravel, moist 4.0	
5	GB				ML **Silt** dark gray, trace gravel, moist 6.0	
					ML **Silt** grayish brown, trace gravel, trace sand, dry to moist 7.0	
					ML **Silt** brown, trace gravel, moist	Adding water while drilling, 8-12 feet
10						
					13.0	Moisture content increased to wet, 12-13 feet
		13.5			ML **Silt** yellowish brown, trace gravel, some sand, wet 14.0	
15	GB				ML **Sandy Silt** yellowish brown, trace gravel, wet	Adding water while drilling, 15-93 feet
		9.6			16.0	
					ML **Gravelly Silt** brown, subangular gravel, clasts up to 3/4"; trace sand, wet 17.0	
					ML **Gravelly Silt** grayish brown, subangular gravel, clasts up to 1/4", wet 18.0	
					GM **Gravel** fine gravel, clasts up to 1/4"; trace coarse grained sand, some silt, wet 19.0	
20					GP **Gravel** predominantly fine gravel, trace coarse 20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Pel Plug Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/2/07 at 240 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-44D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-44D

DATE STARTED 9/1/07 **COMPLETED** 9/2/07 **GROUND ELEVATION** 1483.28 feet **TOC ELEVATION** 1485.82 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2174231.9 feet **EASTING** 1411817.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB	11.95			gravel, clasts up to 3/4"; trace silt, wet	
					21.0 GM **Gravel** yellowish brown, fine gravel, clasts up to 1/2"; some silt, wet	
					22.0 ML **Gravelly Silt** yellowish brown, fine gravel, clasts up to 1/2", wet	
					GM **Silty Gravel** yellowish brown, fine subangular gravel, clasts up to 1/2", wet	
25	GB	21.65	0.2			
					29.0	
30	GB	26.87			GM **Silty Gravel** yellowish brown, fine subangular gravel, clasts up to 1/2"; trace sand, wet	
					30.0 ML **Gravelly Silt** yellowish brown, subangular gravel, clasts up to 1/2", wet	
					31.0 GM **Silt and Gravel** gray, fine subangular gravel, clasts up to 1/2"	
					32.0 GM **Silt and Gravel** gray, fine subangular gravel, clasts up to 1/2"; trace coarse grained sand	
					34.0	
35	GB	30.91	0.1		GM **Silty Gravel** fine subangular gravel, clasts up to 1/2", wet	
					39.0	
40	GB	36.93			GM **Gravel** fine gravel, trace coarse grained sand, some silt, wet	
					41.0	
					ML **Gravelly Silt** fine subangular gravel, clasts up to 1/2", wet	
					42.0 ML **Silt** some fine gravel, trace coarse grained sand, wet	
					43.0 GM **Gravel and Silt** fine subangular gravel, clasts <1/2", wet	
					44.0	
45	GB	46.2			ML **Silt** some fine subangular gravel, clasts <1/2", wet	
					45.0 ML **Silt** yellowish brown, wet	
					46.0 ML **Gravelly Silt** subangular gravel, clasts <1/2", wet	
					47.0 ML **Silt** trace fine gravel, wet	
					48.0 ML **Gravelly Silt** fine subangular gravel, clasts <1/2"; trace coarse grained sand	
					49.0	
					50.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-44D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-44D

DATE STARTED 9/1/07 **COMPLETED** 9/2/07 **GROUND ELEVATION** 1483.28 feet **TOC ELEVATION** 1485.82 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2174231.9 feet **EASTING** 1411817.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	45.53			GP **Gravel** fine subangular gravel, clasts <1/2"; trace coarse grained sand	Slow drilling, 50.5-51.5 feet
					51.0 GM **Gravel** fine subangular gravel, clasts <1/2"; some silt, wet	Fast drilling, 51.5-53.5 feet
					52.0 SM **Silty Sand and Gravel** coarse grained sand, wet	
					GP **Gravel** fine gravel, trace coarse grained sand, trace silt, wet	
					54.0 GP **Gravel** fine subangular gravel, clasts up to 1/2"; some coarse grained sand, trace silt, wet	
55	GB	48.9	0.25			More silt present, 55-57 feet
					57.0 SM **Sand** some gravel, coarse grained sand, some silt, wet	
					58.0 GM **Silty Gravel** subangular gravel, clasts <1/2"; some coarse grained sand, wet	
		55.21			59.0 SP **Sand and Gravel** fine subangular gravel, clasts <1/2"; coarse grained sand, trace silt, wet	
60	GB				60.0 SM **Silty Sand** some gravel, coarse grained sand, wet	
					63.0 ML **Gravelly Silt** subangular gravel, clasts <1/2"; some coarse grained sand, wet	
		59.91			64.0 GM **Silty Gravel** subangular gravel, clasts <1/2"; trace coarse grained sand, wet	
65	GB				65.0 ML **Gravelly Silt** subangular gravel, clasts <1/2", wet	
					67.0 GP **Gravel** fine subangular gravel, clasts <1/2"; trace coarse grained sand, wet	
		61	0.2		69.0 SP **Sand and Gravel** predominantly fine gravel, trace coarse gravel, clasts up to 1/2"; coarse grained sand	
70	GB				70.0 SP **Sand and Gravel** predominantly fine gravel, trace coarse gravel, clasts up to 1/2"; coarse grained sand, some silt	Slow drilling, 70-71 feet
					73.0 ML **Silt** brown, trace gravel, wet	
		71.55			74.0 ML **Sandy Silt** coarse grained sand, wet	
75	GB					
					78.0 SM **Silty Sand** coarse grained sand, wet	
		75.95			79.0 **Bedrock** pulverized	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-44D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-44D

DATE STARTED 9/1/07 **COMPLETED** 9/2/07 **GROUND ELEVATION** 1483.28 feet **TOC ELEVATION** 1485.82 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2174231.9 feet **EASTING** 1411817.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB		0.1		**Bedrock** pulverized	
			0.25			
85	GB		0.0			
90					93.0	
					Bottom of hole at 93.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-44D
Date: 6-12-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level			
Total depth		84.95	
pH			

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								

THE pebble PARTNERSHIP

P-07-44S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-44S

DATE STARTED 9/2/07 **COMPLETED** 9/2/07 **GROUND ELEVATION** 1483.67 feet **TOC ELEVATION** 1486.17 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2174242 feet **EASTING** 1411807.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 ML **Silt** brown, some gravel, wet	Adding water while drilling, 2-4 feet
					4.0 ML **Gravelly Silt** brown, subangular gravel, <10% of clasts are fractured, wet	
5					5.0 GM **Silty Gravel** brown, subangular gravel, <10% of clasts are fractured, wet	Adding water while drilling, 5-22 feet
					6.0 ML **Silt** brown, trace gravel, wet	
					7.0 GM **Silty Gravel** brown, fine subangular gravel, <10% of clasts are fractured; trace sand, wet	
					8.0 ML **Gravelly Silt** brown, angular to subangular gravel, 50% of clasts are fractured, clasts up to 1/2", wet	
					9.0 ML **Silt** gray, trace gravel, wet	
10	GB				11.0 GM **Silty Gravel** gray to brown, predominantly fine angular to subangular gravel, 50% fracured; trace sand, wet	
					12.0 ML **Silt** gray, trace gravel, wet	
					13.0 GM **Silty Gravel** gray, predominantly fine angular to subangular gravel, 50% of clasts are fractured; trace sand, wet	Difficult drilling, 14-17 feet
15	GB				14.0 GW **Gravel** dark gray to black, angular fine gravel, 100% of clasts are fractured, clasts up to 3/4", wet	Boulder; similar composition to bedrock, 14-17 feet
					17.0 GM **Silty Gravel** gray, predominantly fine angular gravel, 100% of clasts are fractured; trace sand, wet	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Pel Plug Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Not Developed - Insufficient Water
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/3/07 at 1245 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-44S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-44S

DATE STARTED 9/2/07 **COMPLETED** 9/2/07 **GROUND ELEVATION** 1483.67 feet **TOC ELEVATION** 1486.17 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2174242 feet **EASTING** 1411807.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB	22.3			21.0 GM **Gravel** gray, fine angular to subangular gravel, most clasts are fractured; some predominantly coarse grained sand, some silt, wet	Slightly less silt, 20-21 feet
25					25.0 ML **Gravelly Silt** gray, predominantly fine angular gravel, 100% of clasts are fractured, moist 27.0 Bottom of hole at 27.0 feet.	Relatively free of silt, 24.5 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

No well development at P-07-44S. Well Dry.

THE pebble PARTNERSHIP

P-07-45D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-45D

DATE STARTED 9/3/07 **COMPLETED** 9/4/07 **GROUND ELEVATION** 1316.82 feet **TOC ELEVATION** 1319.48 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169420.4 feet **EASTING** 1418782.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-6 feet
5						
					6.0 ML **Silt** light brown, trace fine gravel, trace sand, wet	
					7.0 ML **Silt** light brown to yellowish brown, some fine to coarse grained sand, wet	
					8.0 ML **Silt** light brown to yellowish brown, trace gravel, some fine to coarse grained sand, wet	Adding water while drilling, 7-21 feet
10	GB				10.0 ML **Silt** light brown to yellowish brown, trace gravel, trace sand, wet	
					11.0	
					12.0 GM **Gravel** brown, angular to subangular gravel, 100% of clasts are fractured, clasts up to 3/4"; trace sand, some silt, wet	
					14.0	
15	GB				15.0 ML **Gravelly Silt** light brown to yellowish brown, angular to subangular gravel, 100% of clasts are fractured; some fine to coarse grained sand	
					16.0	
		Dry			17.0 GM **Gravel** brown, angular gravel, 100% of clasts are fractured, clasts up to 1/2"; some fine to coarse grained sand, some silt, wet	
					ML **Gravelly Silt** brown, subangular gravel, most clasts are fractured, clasts up to 1/4"; trace sand, wet	
					19.0	
20					20.0 GM **Gravel** brown, angular, 100% of clasts are fractured; some fine to coarse grained sand, some silt,	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 9/27/07
Purge Volume: 771 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/4/07 at 1222 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-45D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-45D

DATE STARTED 9/3/07 **COMPLETED** 9/4/07 **GROUND ELEVATION** 1316.82 feet **TOC ELEVATION** 1319.48 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169420.4 feet **EASTING** 1418782.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				wet GP **Gravel** gray to black, angular gravel, 100% of clasts are fractured; trace sand, trace silt, wet	Some water production, not adding water, 21 feet
		22.0			22.0 **Bedrock** dark gray to black, 100% of clasts are fractured, dry	DTW may be suspect, no water immediately above or below, 22 feet Fragments up to 1/4", 22-23 feet Approximate bedrock contact at 23 feet (completely pulverized), drive to 32 feet to verify and determine if there is any water Fragments up to 1/2", 23-24 feet Fragments up to 3/4", 24-27 feet
25	GB					
		Dry			27.0 **Bedrock** dark gray to black, 100% of clasts are fractured (pulverized), clasts up to 1/4", dry	Adding water while drilling, 28-29 feet
30	GB					
		Dry				Move to open hole drilling, 32 feet
		Dry				
35	GB					Adding water while drilling, 36-45 feet
40						
45	GB	Dry	0.6		45.0 **Bedrock** dark gray to black, 100% of clasts are fractured (pulverized), clasts up to 1/4", wet	Driller believes he hit a fracture; possible ground water at 45.5 feet Adding water while drilling, 48-49 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-45D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-45D

DATE STARTED 9/3/07 **COMPLETED** 9/4/07 **GROUND ELEVATION** 1316.82 feet **TOC ELEVATION** 1319.48 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169420.4 feet **EASTING** 1418782.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	32.2	1.25		**Bedrock** dark gray to black, 100% of clasts are fractured (pulverized), clasts up to 1/4", wet	
			2.1			
			1.25			
55	GB		1.1			
			2.5			
60	GB		2.5		60.0 Bottom of hole at 60.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-45D
Date: 9/27/07
Project: 2007 PEBBLE WELL Development Project #: 005.0189.07002
Technician: WILLOW WEIMER & RAMONA BATCHELDER

Summary

	Installed (Well Log)	Start	End
Water level	36.05	30.63	32.76
Total depth	60.0	62.95	62.98
pH	—	7.54	7.56

Screen interval (btoPVC): 15 ft
Top: 47.95
Bottom: 62.95
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	
	Surge block on START: 1734 Slug Medium Brown WATER.								
1739	61.95	—	3.75	18.75	394	326	2.80	light Brown, Cloudy, 1 TBS of Fine Sand.	PH
1804	"	—	4.0	118.75	361	46.2	2.05	WATER Cloudy, 1/4 tsp Fine Sand.	7.55
1814	59.95	—						MOVE upT 2 ft, START.	
1826	"	—	4.0	166.75	359	26.41	2.09	Milky/Cloudy Lt gry WATER, TRACE Sand.	7.73
1832	57.95	—						MOVE ↑ 2 ft, START	
1842	"	—	3.75	204.25	358	24.6	2.12	Cloudy, Lt gray WATER, TRACE Sand	7.68
1847	55.95	—						MOVED ↑ 2 ft, START	
1910	"	—	3.75	290.5	359	28.9	2.61	"	7.68
0940	53.95	—						RAISE Pump 2 ft ↑, START	STOP @ 1915
1011	"	—	2.25	360.25	380	17.42	2.73	WATER CLEAR, TRACE Sediment.	9/28/07 PH 6.94
1015	51.95	—						RAISE Pump ↑ 2 ft, START.	PH 7.43
1037	"	—	3.5	437.75	374	11.92	2.23	WATER CLEAR, TRACE Sediment	
1042	49.95	—						RAISE Pump ↑ 2 ft, START	
1100	"	—	1.75	464.75	373	4.74	2.24	WATER CLEAR, TRACE Sediment	PH 7.50
1105	47.95	—						RAISE Pump ↑ 2 ft, START.	
1120	"	—	2.75	510.0	372	6.57	2.24	WATER CLEAR, TRACE Sediment.	PH 7.56
1125	"	—						STOP Purge	
	Surge block off 1131 START POLISH.								
1219	42.95	—	2.25	613.5	374	0.73	2.56	WATER CLEAR, NO Sediment	
1221/1227	61.95	—						STOP POLISH / START DEBRIS Surge.	
1309	"	—	3.75	771.0	372	5.69	2.38	~~STOP~~ WATER CLEAR,	
1311	—	—						STOP DEBRIS Surge	

THE pebble PARTNERSHIP

P-07-46D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-46D

DATE STARTED 9/4/07 **COMPLETED** 9/5/07 **GROUND ELEVATION** 966.80 feet **TOC ELEVATION** 969.30 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2163586.3 feet **EASTING** 1419003.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 ML **Sandy Silt** brown, fine to coarse grained sand, roots, moist	
					ML **Sandy Silt** brown, trace gravel, fine to coarse grained sand, roots, moist	
					4.0	
5	GB				5.0 ML **Sandy Silt** brown, fine to coarse grained sand, moist	
					6.0 ML **Silt** brown, trace sand, moist	
					7.0 ML **Silt** brown, trace gravel, trace sand, moist	
					8.0 ML **Sandy Silt** brown, trace fine angular gravel, 100% of clasts are fractured; fine to coarse grained sand, moist	Adding water while drilling, 8-44 feet
					ML **Gravelly Silt** brown, angular fine gravel, 100% of clasts are fractured; trace sand, wet	
10	GB				10.0 ML **Silt** brown, trace gravel, wet	
					12.0 ML **Gravelly Silt** brown, subangular gravel, <50% of clasts are fractured; trace sand, wet	
					14.0 ML **Silt** brown, trace gravel, trace sand, wet	
15	GB				15.0 ML **Silt** gray, trace gravel, trace sand, wet	
					16.0 ML **Gravelly Silt** brown to gray, fine angular to subangular gravel, mostly fractured, clasts up to 3/8"; trace sand, wet	
					17.0 ML **Gravelly Silt** gray, angular to subangular gravel, mostly fractured; trace sand, wet	
					18.0 GM **Silty Gravel** gray, angular to subangular gravel, mostly fractured, clasts up to 1/2"; trace sand, wet	
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4" Bentonite Pellets

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 9/27/07
Purge Volume: 202.5 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/5/07 at 200 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-46D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-46D

DATE STARTED 9/4/07 **COMPLETED** 9/5/07 **GROUND ELEVATION** 966.80 feet **TOC ELEVATION** 969.30 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2163586.3 feet **EASTING** 1419003.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB					
		21.0			21.0 GM **Silty Gravel** gray, angular to subangular gravel, mostly fractured; some fine to coarse grained sand, wet	
					22.0	
					23.0 ML **Gravelly Silt** gray, angular to subangular gravel, mostly fractured; trace sand, wet	
					GM **Silty Gravel** gray, angular to subangular gravel, mostly fractured; some fine to coarse grained sand, wet	
25	GB				25.0	
					26.0 GM **Gravel** gray, subangular gravel, clasts up to 1 1/4", mostly fractured; some silt, wet	
					27.0 ML **Silt** gray, some fine subangular gravel, clasts <1/2"	
					28.0	
					ML **Gravelly Silt** gray, subangular gravel, clasts up to 3/4", wet	
30	GB				31.0	
					Bedrock fractured, clasts <1/2", wet	
35	GB				35.0	
					Bedrock fractured, clasts up to 1/2", weathered, wet	
					36.0	
					Bedrock dark gray to black with trace white, trace clasts up to 1/2", 90% of clasts <1/16", weathered, wet	
					38.0	
					Bedrock gray with some black and white, angular clasts up to 1/2", weathered, wet	
40	GB				40.0	
					Bedrock gray with some black and white, finer clasts are mostly <1/16", wet	
		34.3				Water level is suspect, 41 feet
		27	2.2			Move to open hole drilling, 42.5 feet
			2.25		43.0	
					Bedrock gray, clasts up to 3/8", wet	
45	GB				45.0	
					Bedrock dark gray, angular clasts up to 3/8", wet	
			1.3			Adding water while drilling, 46-52 feet
			1.25			

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-46D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-46D

DATE STARTED 9/4/07 **COMPLETED** 9/5/07 **GROUND ELEVATION** 966.80 feet **TOC ELEVATION** 969.30 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2163586.3 feet **EASTING** 1419003.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB		2.3		**Bedrock** dark gray, angular clasts up to 3/8", wet	
			2.0		52.0 Bottom of hole at 52.0 feet.	No indication of significant ground water flow intercepted while drilling

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-46D
Date: 9/27/07

Project: 2007 Pebble Well Development Project #: 005.0189.07002
Technician: Willow Weimer & Ramona Batchelder

Summary

	Installed (Well Log)	Start	End
Water level		11.92	19.0
Total depth		45.9	45.
pH		6.80	7.37

Screen interval (btoPVC): 5 ft
Top: 40.9
Bottom: 45.9
PVC stick-up height (above ground surface): 3.0

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
PH	Surge block on START: 1349 MILKY WHT/BROWN.							
6.80 1357	44.9	~~40~~	~~50~~ 2	~~16~~	~~583~~ 715		3.03	>1/2 Tsp, fine grained Sand: GROUT
1413	"	—	2	48	570	334	2.0	>1/4 Tsp, ", WATER MILKY
7.25 1431	"	—	2.5	103	570	167	1.8	"
1438	42.9	—						Moved pump ↑ 2ft, START
1453	"	—	2	133	571	51.7	2.65	>1/4 Tsp. Slightly Cloudy, FINE Sand grit
1505	40.9	—						Moved pump ↑ 1½ ft, START.
7.34 1519	"	—	1.25	150.5	577	50.4	2.43	CLEAR WATER TRACE SEDIMENT.
1522	"	—						STOP Purge.
Surge block off START Polish @ 1530								
1543	36.4	—	1.5	170	574	27.3	3.02	WATER CLEAR, TRACE SEDIMENT.
1556	—	—						STOP POLISH
1549	44.9	—						START DEBRIS Surge.
PH 7.37 1612	"	—	2.5	202.5	584	39.0	2.67	WATER CLOUDY, TRACE SEDIMENT
1617	—	—						STOP DEBRIS Surge.

THE pebble PARTNERSHIP

P-07-47D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-47D

DATE STARTED 9/5/07 **COMPLETED** 9/12/07 **GROUND ELEVATION** 920.85 feet **TOC ELEVATION** 923.35 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158453.3 feet **EASTING** 1418171.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					ML **Silt** brown, trace rounded gravel, clasts up to 1/2"; trace fine grained sand, trace fibrous organics, wet	Trace cuttings, 0-2 feet
					2.0	
					SM **Silty Sand and Gravel** dry to moist	Transition zone, 2-4 feet
					4.0	
5	GB				SM **Silty Sand and Gravel** brown, angular to subrounded gravel, clasts up to 1 1/4"; fine grained sand, dry to moist	
					7.0	
					ML **Gravelly Silt** brown, wet	Water coming out of top of casing, 7 feet
		Dry			8.0	
					GM **Silty Gravel**	Adding water while drilling, 8-8.5 feet
					9.0	
10					SM **Sand and Silt** brown to gray, some gravel, dry to moist	
	GB				10.0	
					SM **Sand and Silt** brown to gray (olive), some fine subangular gravel; well graded fine to coarse grained sand, moist	
					12.0	
					ML **Silt** pale gray, some fine angular to subangular gravel; some fine grained sand, dry to moist	Adding water while drilling, 12.5-17 feet
15	GB					
						Occasional moist cluster indicated sample not saturated in situ
					18.0	
20					**Bedrock** dark gray to black, fractured, clasts up to 3/4", most clasts <1/2", trace quartz and pyrite, covered with light gray dust	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 40 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# grout, 200# cement, 25 gal H2O

GROUT
Type: Volclay Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/12/07 at 1230 PM; 8" casing installed, 0-20 feet; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-47D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-47D

DATE STARTED 9/5/07 **COMPLETED** 9/12/07 **GROUND ELEVATION** 920.85 feet **TOC ELEVATION** 923.35 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158453.3 feet **EASTING** 1418171.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB	19	0.0		**Bedrock** dark gray to black, fractured, clasts up to 3/4", most clasts <1/2", trace quartz and pyrite, covered with light gray dust	Adding water while drilling, 21-21.5 feet
					22.0 **Bedrock** gray, angular, fractured, clasts up to 1", trace quartz, covered with light gray dust, dry	
		Dry				
25	GB	Dry	0.0		25.0 **Bedrock** light gray, fractured, clasts up to 1", trace quartz, covered with dust, dry	Adding water while drilling, 26.3-43 feet
			0.05			Trace amber colored translucent material observed, 27 feet
30	GB	28.7	0.0			DTW reading may be to top of hammer, 31 feet
35	GB	15.4	<0.05			DTW reading may be from drill water, 36.6 feet
			0.05			
40	GB	41.1	0.2			Less rock dust below 40 feet
			0.1			Move to open hole drilling, 41.8 feet
45	GB		0.1		45.0 **Bedrock** light gray, fractured, trace to some quartz, trace dust, wet	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-47D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-47D

DATE STARTED 9/5/07 **COMPLETED** 9/12/07 **GROUND ELEVATION** 920.85 feet **TOC ELEVATION** 923.35 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158453.3 feet **EASTING** 1418171.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB	38.8	<<0.05		**Bedrock** light gray, fractured, trace to some quartz, trace dust, wet	Adding water while drilling, 50-52 feet
					52.0 **Bedrock** dark gray, fractured, clasts up to 1", trace quartz, wet	
			<<0.05			Adding water while drilling, 53-54 feet
55	GB	35	<<0.05			DTW measurment may be suspect, 55 feet
			<<0.05			Adding water while drilling, 55-57.5 feet
			<<0.05			More white minerals present, possible calcite, 59 feet
60	GB					Attempted DTW measurement, probe catching on casing shoe at 40 feet, 60 feet
			<<0.05			Adding water while drilling, 62-63 feet
					64.0 **Bedrock** dark gray, trace quartz and pyrite, wet	
65	GB		<<0.05		65.0	
			0.25		**Bedrock** dark gray, trace quartz, wet	
						Adding water while drilling, 67-68 feet
			0.1			Softer ground, 69-70.5 feet
70			0.15		70.5	Trace recovery, 70-71 feet
	GB				**Bedrock** 50% light gray and 50% dark gray with trace white, dust, wet	
			0.5			Adding water while drilling, 74-76 feet
75			0.25			More rock dust present, 75-80 feet
			1.25			
	GB					
			1.25		80.0	Adding water while drilling, 79.5 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-47D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-47D

DATE STARTED 9/5/07 **COMPLETED** 9/12/07 **GROUND ELEVATION** 920.85 feet **TOC ELEVATION** 923.35 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158453.3 feet **EASTING** 1418171.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			1.5		Bottom of hole at 80.0 feet.	.

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-47D
Date: 6-12-08 - 6-13-08
Project: Pebble
Project #: 005.0189.08002
Technician: C. Comer

Summary

	Installed (Well Log)	Start	End
Water level	3.53	~~4.55~~ 4.54	47.9
Total depth	~~79.5~~ 79.7	82.9	83.8
pH		11.62	7.61

Screen interval (btoPVC): 5
Top: 77.9
Bottom: 82.9
PVC stick-up height (above ground surface): 28" = 2.3'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1508 - START - 1' off Bottom									
1518	81.9	4.54	0.5	5	1.305	837	3.00	fine Sand-silt, med. gray, cloudy, Trace	11.62
1553	↓		0.75	31.25	0.645	262	3.20	V-med gray-cloudy, very trace fine sed.	7.08
1558	79.9	—					→	Move 2' ↑ - START	
1618	↓		0.75	46.25	0.404	73	3.05	fine sand, lt. gray-clear, trace	7.41
1622	77.9	—					—	Move 2' ↑ - START	-
6-12-08 1652	↓		0.50	61.25				off-site	-
6-13-08 819	77.9	—					—	on-site - Restart	-
855	↓		0.50	79.25	0.440	175	3.13	fine clay (possibly drilling material) Clear - sl. cloudy, Trace	7.10
Surge block off									
908	72.9	49.9	—	—	—	—	—	Move 5' above Screen - START	
Polish 922	↓		0.50	86.25	0.400	68	3.14	Clear, no sed.	7.59
926	81.9	—						Move 1' off bottom - START	
Debris 941	↓		0.25	90	0.396	120	2.93	Clear, no sed.	7.61

NOTES: No Monument

THE pebble PARTNERSHIP

P-07-48D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-48D

DATE STARTED 9/12/07 **COMPLETED** 9/13/07 **GROUND ELEVATION** 1048.91 feet **TOC ELEVATION** 1051.74 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2172841.4 feet **EASTING** 1380043.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-3 feet
					3.0 ML **Gravelly Silt** brown with trace gray, weathered clasts, moist	
5	GB				5.0	No recovery, 5-6 feet
					6.0 GM **Gravel and Silt** black, coarse angular gravel, brown silt, moist	
					7.0 GM **Gravel and Silt** black, coarse angular gravel, platy, elongated, clasts up to 1/2"; some coarse grained sand, brown silt, moist	Adding water while drilling, 8-12 feet
					9.0	
10	GB	Dry			10.0 GM **Silty Gravel** dark gray, coarse angular gravel, brown silt coated, clasts up to 1 1/4"; trace coarse grained sand	Gravel may be fractured cobble, 10-13 feet
					13.0 GM **Silty Gravel** dark gray, fine to coarse angular to subangular gravel, brown silt, wet	Adding water while drilling, 13-14 feet
15	GB				15.0 GM **Silty Gravel** multicolored, fine to coarse subrounded gravel, clasts up to 1/2"; some coarse grained sand, wet	Possible fluvial deposit
		10.6			17.0 GW **Gravel** well graded angular to subrounded gravel, 30% of clasts are fractured; some coarse grained sand, trace silt, wet	Increased hardness, 17-25 feet; DTW may be mud reading; Adding water while drilling, 17-22 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 40 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aquaguard Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/13/07 at 350 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-48D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-48D

DATE STARTED 9/12/07 **COMPLETED** 9/13/07 **GROUND ELEVATION** 1048.91 feet **TOC ELEVATION** 1051.74 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2172841.4 feet **EASTING** 1380043.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				GW **Gravel** well graded angular to subrounded gravel, 30% of clasts are fractured; some coarse grained sand, trace silt, wet	
		Dry	0.0		22.0 GW **Gravel** well graded gravel, trace fine sand, some silt	
					24.0 **Bedrock** yellowish brown to gray, fine to coarse angular clasts, 60% coarse and dust coated, iron precipitate, weathered, dry	
25	GB				25.0 **Bedrock** yellowish brown, 70% pulverized, gray dust, dry to moist	Fast drilling, 25-28 feet
					28.0 **Bedrock** gray and orangey brown, angular sand to gravel sized clasts, coated in dust, dry to moist	Transition to orangey brown, 27 feet
30	GB		0.0		32.0 **Bedrock** gray, coarse angular to subrounded clasts, 50% of clasts are fractured, weathered, dry	Increased hardness, 33-34.5 feet More small clasts present, 33-34.5 feet
35	GB	▼			34.5 **Bedrock** yellowish brown, 25% fine to coarse grained sand sized angular to subangular clasts, 75% <1/16", weathered, dry to moist	
					38.0 **Bedrock** yellowish brown, fine to coarse angular clasts, trace fines, moist	
40	GB		0.0		39.0 **Bedrock** fine angular clasts, coarse grained sand sized clasts, dust coated, moist to damp	More sand sized particles present, 39-42 feet
		Dry			42.0 **Bedrock** gray with yellowish brown precipitate, fine angular to subrounded gravel sized clasts, some medium to coarse grained sand sized particles, moist	Probe catching at 20.6 feet, no sign of water, DTW assumed, 42 feet
45	GB		0.0		46.0	
					47.0 **Bedrock** fine angular gravel sized clasts, moist	Attempted DTW measurement, probe catching at 11 feet Fines building up in casing, samples may be biased coarse, 47 feet
					49.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-48D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-48D

DATE STARTED 9/12/07 **COMPLETED** 9/13/07 **GROUND ELEVATION** 1048.91 feet **TOC ELEVATION** 1051.74 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2172841.4 feet **EASTING** 1380043.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB		0.0		**Bedrock** yellowish brown, trace gravel sized clasts, medium to coarse grained sand sized clasts, silty, moist	
			0.3		52.0 **Bedrock** light yellowish brown, fine to coarse angular gravel sized clasts, some fine to medium grained sand sized particles, wet	Water noted in hole after 30 minutes, 52 feet
55	GB				54.0 **Bedrock** gray with orange, fine angular gravel sized clasts, rusty fractured faces, wet	Increased hardness associated with more competant bedrock, 54 feet
		43.4	0.13			Very hard, 57-58 feet
			0.40		59.0 **Bedrock** gray with orange, gravel sized clasts, clasts up to 3/4", rusty fractured faces, wet	Slightly faster drilling, 58-59 feet
60	GB		0.30			
		35			62.0 Bottom of hole at 62.0 feet.	Changing water levels over time, DTW=35 at 4:50am, DTW=36.9 at 8:50am, DTW=35.7 at 1:30pm

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-48 D
Date: 6/9/08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level		30.2	30.94
Total depth	57.1 + 2.5' = 59.6	60.21	60.2
pH	~~Bgs~~	7.75	8.78

Screen interval (btoPVC): 10
Top: 50.21
Bottom: 60.21
PVC stick-up height (above ground surface): 2.5'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity * (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1242 = START									7.75
1254	59.21	30.20	4.5	54	0.057	485	3.55	fn-m Sand, lt. tan, ≈ 1 Tbsp	6.04
1312	59.21		3	108	0.016	707	3.00	fn-m Sand, lt tan ≈ 1 Tbsp	5.87
1327	59.21		3.5	126.5	0.014	467	3.10	fn-m sand, lt tan < 1 Tbsp	
1335	~~57.21~~							Move ↑ 2' - START	5.76
1357	↓		1.25	154	0.014	467	3.83	fn-m sand, lt. tan, Trace	
1405	55.21							move ↑ 2' - START	5.76
1417	↓		1.75	175	0.013	351	3.54	fn-m Sand, lt tan, ≈ 1 tsp	5.51
1438	↓		1.50	206.5	0.013	116	3.53	fn Sand lt tan-clear, < 1 tsp	
1443	53.21							Move ↑ 2' - START	5.78
1457	↓		1.25	224	0.013	163	3.51	fn Sand, lt tan-clear < 1 tsp	
1503	~~51.21~~							Move ↑ 2' - START	5.80
1515	* ↓		1.50	242	0.013	197	3.60	fn Sand, lt-tan, ≈ 1 tsp	
1522	49.21					~~159~~	→	~~clear~~,	5.73
1532			1.25	254.5	0.014	139	4.00	clear, trace sand	
Surge block off									
polish 1543	45.21							Move ↑ 4' - START	5.78
1555	↓		2.0	278.5	0.013	56.6	4.14	clear, v. trace sand	
Debris 1609								Move 1' from bottom - START	5.78
1625			3.0		0.013	79.3	3.77		

* - meter not calibrated correctly - base on visual
- Bottom 3.5" off from start

THE pebble PARTNERSHIP

P-07-48S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-48S

DATE STARTED 9/13/07 **COMPLETED** 9/13/07 **GROUND ELEVATION** 1049.21 feet **TOC ELEVATION** 1051.51 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2172825.7 feet **EASTING** 1380029.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Tundra/Topsoil** dark brown, vegetated carpet layer, sand, silt, amorphous organics, trace rootlets	No recovery, 0-4 feet; description based on surficial soils
1.0						
4.0					GM **Silty Gravel** multicolored, fine angular gravel, dark brown silt, wet	Trace recovery, 4-5 feet
5	GB					
5.0					GM **Silty Gravel** multicolored, predominantly coarse angular to subangular gravel (75%), silt coated; some fine to coarse grained sand, damp to wet	
10	GB					More silt and less sand, 9-13 feet
13.0					GW **Sandy Gravel** angular to subangular gravel, fine to coarse grained sand, some silt, moist	30% angular gravel, 13-14 feet 70% subangular to angular gravel, 14-15 feet
15	GB	Dry				
15.0					GM **Sandy Gravel** multicolored, predominantly coarse angular to rounded gravel (60%), some fragmented, clasts up to 1 1/4"; fine to coarse grained sand, some brown silt, moist	
18.0					GM **Silty Gravel** multicolored, angular to subrounded gravel, clasts up to 1"; some fine to coarse grained sand, brown silt, moist to damp	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.3'
Type: Schedule 40 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Cetco 1/4" Bentonite Pellets

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/14/07 at 530 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-48S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-48S

DATE STARTED 9/13/07 **COMPLETED** 9/13/07 **GROUND ELEVATION** 1049.21 feet **TOC ELEVATION** 1051.51 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2172825.7 feet **EASTING** 1380029.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB	Dry			GM **Silty Gravel** multicolored, angular to subrounded gravel, clasts up to 1"; some fine to coarse grained sand, brown silt, moist to damp	
					23.0	
					GW **Gravel** light brown to gray, possible boulder, dusty, dry	
					24.0 **Bedrock** medium gray with some orange clasts, oxidized powder, traces of quartz/basalt, weathered, dry	
25	GB	Dry				
					28.0 **Bedrock** light gray with 15% yellow oxidized, dry to moist	
30	GB					
		31.3			31.9 Bottom of hole at 31.9 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-BB-48s
Date: 6-9-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Krone

Summary Insufficient water to develop.

	Installed (Well Log)	Start	End
Water level		26.19	
Total depth	22.08	28.98	
pH			

Screen interval (btoPVC):
Top:
Bottom:
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
Surge block off								

THE pebble PARTNERSHIP

P-07-49D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-49D

DATE STARTED 9/14/07 **COMPLETED** 9/14/07 **GROUND ELEVATION** 1118.01 feet **TOC ELEVATION** 1120.57 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2167007.4 feet **EASTING** 1384394.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					ML **Sandy Silt** dark brown, fine to medium grained sand, some roots, moist	
2.0						No recovery, 2-3 feet
3.0					GM **Gravel and Silt** dark brown, fine to medium rounded gravel, moist	Very fast drilling, 3-4 feet
5	GB					
5.0					GM **Gravel and Silt** light gray, medium to coarse angular to subrounded gravel; dark brown silt, moist	
6.0					GM **Silty Gravel** dark gray, medium to coarse angular to subangular gravel; dark brown silt	
7.0					GM **Silty Gravel** gray, fine to medium gravel; dark brown silt	
8.0					GM **Silty Gravel** gray, medium to coarse angular gravel; dark brown silt	
9.0						Fast drilling; no recovery, 9-10 feet
10						
10.0					GP **Gravel** gray, fine to coarse poorly graded angular gravel; trace silt	
11.0	GB				GP **Sandy Gravel** gray, fine to coarse poorly graded angular gravel, dry	
13.0					SW **Gravelly Sand** light brown, medium to coarse grained sand, dry	
15						Very fast drilling, 15-17 feet
16.0					SP **Sand** light brown, some subrounded gravel, medium to coarse grained sand, dry	
17.0	GB				GP **Sandy Gravel** light gray fragments, light brown medium to coarse grained sand	
19.5					**Bedrock** light gray, of clasts are fractured	Drilling slower and harder; lots of rock dust, 19-21 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 40 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Aquaguard Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/15/07 at 125 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-49D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-49D

DATE STARTED 9/14/07 **COMPLETED** 9/14/07 **GROUND ELEVATION** 1118.01 feet **TOC ELEVATION** 1120.57 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2167007.4 feet **EASTING** 1384394.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				**Bedrock** light gray, of clasts are fractured	
25	GB	▼				Slightly moist, 24-26 feet Dry, 26-30 feet Move to open hole drilling, 28 feet
30	GB					Slightly moist, 30-31 feet Dry, 31-45 feet
35						
40	GB					
45	GB					Slightly moist, 45-46 feet Dry, 46-50 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-49D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-49D

DATE STARTED 9/14/07 **COMPLETED** 9/14/07 **GROUND ELEVATION** 1118.01 feet **TOC ELEVATION** 1120.57 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2167007.4 feet **EASTING** 1384394.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB				**Bedrock** light gray, of clasts are fractured	Slightly moist, 50-55 feet
55						Moist, 55-100 feet
60	GB					
65	GB					
70	GB					
75	GB					

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-49D

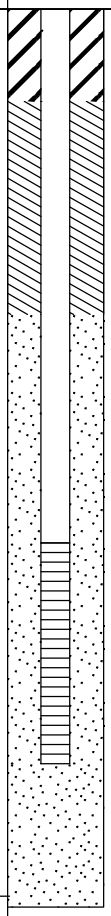
PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-49D

DATE STARTED 9/14/07 **COMPLETED** 9/14/07 **GROUND ELEVATION** 1118.01 feet **TOC ELEVATION** 1120.57 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2167007.4 feet **EASTING** 1384394.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson, L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB				**Bedrock** light gray, of clasts are fractured	
85	GB					
90	GB					
95	GB					
100	GB				100.0	
105						



2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-49D
Date: 6-12-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level	26.50	23.26	
Total depth bgs	97.0	101.25	
pH			

Screen interval (btoPVC): 5'
Top: 96.25
Bottom: 101.25
PVC stick-up height (above ground surface): 27.5" = 2.3'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	
Surge block on 9/5 - START - 1' off bottom									
930	100.25	23.26	0.25	375	0.336	89	5.93	fine sand, clear, trace — recharge	7.07
935	98.25							~~Recharge~~ Move ↑ 2' - START	
940 - 10:30	↓							~~clear, trace sand - no sample~~	
1038	↓		low					Recharge - clear, trace sand, no sample	
1100	96.25	90'	X low					Move ↑ 2' - START	
1113	↓		low		0.127	119	9.75	likely residual in tubing	7.18
1120	↓				0.113	128	10.26	clear-lt. tan, trace sand	7.15
tag		93'							
Surge block off - no polish, no water above screen = slow recharge									
1130		93.0'						Move ↑ from bottom - start - recharge	
1200		95.3'						start - recharge	
1230								start - recharge	

Insufficient water - will not develop

THE pebble PARTNERSHIP

P-07-49S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-49S

DATE STARTED 9/15/07 **COMPLETED** 9/15/07 **GROUND ELEVATION** 1115.61 feet **TOC ELEVATION** 1118.27 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2167025.6 feet **EASTING** 1384409.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					GP **Sandy Gravel with Silt** medium to dark brown, fine to medium grained sand, some silt, occasional boulder, trace rootlets, moist	No recovery, 0-5 feet; descriptions based on soil in sump
					3.0	
5					5.0	Adding water while drilling, 4-7 feet
					GW **Gravel** dark brown, angular to subangular gravel, clasts up to 3/4", wet	Trace cuttings, 5-8 feet
		Dry				Casing clogging with fines portion, descriptions may be biased coarse, 6-10 feet
					8.0	
	GB				GW **Gravel** brown, rounded gravel, clasts up to 1 1/4", wet	
					9.0	No recovery, 9-10 feet
10					10.0	
					GW **Gravel** brown, fine gravel, clasts up to 1 1/4", wet	
					11.0	
		Dry			SP **Gravelly Sand** multicolored, 30% angular to subrounded gravel; medium to coarse grained sand	
					13.0	Occasional cobble, 13-15 feet
					GW **Sandy Gravel** brown, angular to rounded gravel, silt coated; medium to coarse grained sand, trace silt, damp	
15	GB				15.0	
					SM **Silty Sand and Gravel** brown, angular to rounded gravel, damp	
					16.0	
			0.0		SM **Sand and Gravel with Silt** brown, angular to rounded gravel, damp	DTW measurement attempted, probe catching at 11 feet, 17 feet
					17.0	
					SW **Sand and Gravel** multicolored, angular to rounded gravel, some silt, moist	
						Transition to weathered bedrock, 19-20 feet
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 40 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 40 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Not Developed - Insufficient Water
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Piezometer is dry; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-49S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-49S

DATE STARTED 9/15/07 **COMPLETED** 9/15/07 **GROUND ELEVATION** 1115.61 feet **TOC ELEVATION** 1118.27 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2167025.6 feet **EASTING** 1384409.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				**Bedrock** dark gray, weathered, dry to moist	
					22.0	
					Bottom of hole at 22.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

No well development at P-07-49S. Well Dry.

THE pebble PARTNERSHIP

P-07-50D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50D

DATE STARTED 10/16/07 **COMPLETED** 10/22/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1060.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171915.1 feet **EASTING** 1379658.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SW **Gravelly Sand** brown, subangular to subrounded gravel, well graded sand, dry	
					4.0	
5	GB				GP **Sandy Gravel** poorly graded gravel, angular fragments (possibly cobble), dry	
					5.0 GP **Sandy Gravel** poorly graded gravel, dry	
					9.0	More sand present, 8-9 feet
10	GB				11.0 SW **Gravelly Sand** brown, subangular to subrounded gravel, well graded sand, dry	Well annular space is a combination of bentonite grout, native material, and bentonite chips, 10-141.1 feet
15	GB				17.5	No recovery, 17.5-18.5 feet
					18.5 GP **Sandy Gravel** poorly graded gravel, clasts predominantly 1/2", dry	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: Aquaguard Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/24/07
Purge Volume: 955 gallons

RESPONSE TEST
Response Method: 1" Waterra Tube
Date: 10/23/2007

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 10/23/07 at 325 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50D

DATE STARTED 10/16/07 **COMPLETED** 10/22/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1060.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171915.1 feet **EASTING** 1379658.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				21.0	
					21.5 SW **Sand** well graded sand	
					GP **Sandy Gravel** poorly graded gravel, clasts predominantly 1/2", dry	Sand fraction increases in quick intervals, possible interbedding, 23-25 feet
25	GB				25.0	
					GP **Sandy Gravel** poorly graded gravel, 15% of clasts are fractured, clasts predominantly 1/2", dry 26.0	
					28.0	
					GP **Sandy Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry	
30	GB				30.0	
					GP **Sandy Gravel** brown, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry 31.0	
		Dry			32.0	
					GP **Sandy Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry 33.0	
					SW **Sand** brown, trace fine gravel, well graded fine to coarse grained sand, dry	
35	GB				35.0 SW **Sand** brown, 10% fine gravel, well graded fine to coarse grained sand, dry	
					36.0	
					GP **Sandy Gravel** brown, predominantly angular to subangular gravel, 90% of clasts are fractured, clasts up to 5/8"; well graded fine to coarse grained sand, dry 37.0	Very little recovery, hose clogged, 37-38 feet
		Dry			38.0	
					GP **Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; some well graded sand, dry	
40	GB				GP **Sandy Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 5/8"; well graded sand, dry 40.0	
					GP **Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/2", most <1"; some well graded sand, dry 42.0	
		Dry			43.0 SP **Gravelly Sand** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"; predominantly medium to coarse grained sand, wet 44.0	
45	GB				45.0 GP **Gravel** gray, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"; some well graded sand, dry	Producing a lot of dust while drilling, 45-58 feet
					GP **Gravel** gray, angular to subrounded gravel, 80% of clasts are fractured, clasts up to 1"; trace sand, dry	Clasts up to 1 1/4", 45-47 feet
		Dry			GW **Gravel** gray, angular to subangular gravel, 90% of clasts are fractured; some sand sized fragments, dry	Clasts up to 1", 47-48 feet
						Clasts up to 1 1/4", 48-49 feet
						Clasts up to 3/4", 49-51 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50D

DATE STARTED 10/16/07 **COMPLETED** 10/22/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1060.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171915.1 feet **EASTING** 1379658.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB			GW **Gravel** gray, angular to subangular gravel, 90% of clasts are fractured; some sand sized fragments, dry	Clasts up to 1", 51-52 feet
		Dry			Clasts up to 3/4", 52-53 feet
55	GB				Clasts up to 3/4", 52.5-53.5 feet Very little recovery, hose clogged, 52.5 feet Clasts up to 1 1/4", 53-55 feet
					Clasts up to 1", 55-56 feet
				56.0	
		Dry		GP **Sandy Gravel** brown, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry	Pulled out suspected broken casing, resumed advancing down same hole, 56.5 feet
				58.0	Started adding water while drilling (redrill, see 72.5')
				SW **Gravelly Sand** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; well graded sand, dry	
60	GB			59.0 60.0 SW **Sand and Gravel** dark brown, predominantly rounded gravel, silt coated, <10% of clasts are fractured, clasts up to 1"; well graded sand, trace silt, dry	
				61.0	No recovery, 61-62 feet
				62.0 SW **Sand** dark brown, some subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4"; well graded, well sorted fine to coarse grained sand, moist	
		63		63.0	Very little recovery, 63-65 feet
				SP **Sand and Gravel** dark brown, predominantly rounded gravel, <10% of clasts are fractured, clasts up to 3/4"; fine to predominantly coarse grained sand, moist	
65	GB			65.0	No recovery, 65-66 feet
				66.0 SP **Sand** brown, trace fine gravel, predominantly coarse grained sand, moist	Encountered water, 66-67 feet
				GP **Gravel** dark gray, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 3/4"; trace coarse grained sand, no fines, wet	Very little recovery, 67-68 feet
		61.35		69.0	
				GP **Sandy Gravel** dark gray, subangular to subrounded gravel, <30% of clasts are fractured, clasts up to 3/4"; predominantly coarse grained sand, wet	Discharge water is brown, 69-86 feet
70	GB				Descriptions may be biased coarse
	GB	61.36			Hammer jammed, pulled out all casing, 72.5 feet; re-drilled same hole Adding water while drilling, 73-86 feet
75	GB			75.0	
			<0.125	GP **Sandy Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; brown predominantly coarse grained sand, wet	DTW not measured due to potential heaving sands
				76.0 77.0 SP **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; brown predominantly coarse grained sand, wet	More fine to medium grained sand present, 77-87 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50D

DATE STARTED 10/16/07 **COMPLETED** 10/22/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1060.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171915.1 feet **EASTING** 1379658.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB		2.25		SP **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; brown fine to predominantly coarse grained sand, wet	Grab sample photographed but accidentally discarded, 80 feet Increasing fine and medium sand, 82-85 feet
85	GB		Trace Flow		86.0 89.0	Flow noted only when drilling, 87 feet Adding water while drilling, 88-89 feet
90	GB		0.5		GP **Gravel** green, poorly graded subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; trace coarse grained sand, wet 92.0 93.0 GW **Gravel** multicolored, well graded subrounded gravel, 20% of clasts are fractured, clasts up to 1"; some sand, wet	Adding water while drilling, 93-95 feet
95	GB		<1		95.0 GW **Sandy Gravel** multicolored, well graded subrounded gravel, <20% of clasts are fractured, clasts up to 1", wet	More sand present, 98-99 feet
100	GB		2.5			Adding water while drilling, 99-108 feet
			0.5		102.0 SW **Sand and Gravel** multicolored, subangular to subrounded gravel, <10% of clasts are fractured; well graded sand, wet 104.0	
105	GB		Trace Flow		105.0 SW **Sand and Gravel** multicolored, subangular to subrounded gravel, <10% of clasts are fractured; well graded sand, wet	
			0.2		108.0 GW **Gravel** multicolored, well graded subangular to subrounded gravel, <10% of clasts are fractured; some sand, wet	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50D

DATE STARTED 10/16/07 **COMPLETED** 10/22/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1060.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171915.1 feet **EASTING** 1379658.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB				110.0 SW **Sand and Gravel** multicolored, well graded gravel, <10% of clasts are fractured; well graded sand, wet	
			0.5			
115	GB		0.7		115.0 SW **Sand and Gravel** multicolored, well graded gravel, <15% of clasts are fractured, clasts up to 1"; well graded sand, wet	Adding water while drilling, 115-116 feet Discharge water is brown, descriptions may be biased coarse, 115 feet
			Trace Flow			
120	GB					Adding water while drilling, 119-120 feet
						Adding water while drilling, 122-124 feet
			<0.2		123.0 SP **Sand** multicolored, some subangular to subrounded gravel, clasts up to 3/4"; medium to coarse grained sand, wet	
125	GB					Adding water while drilling, 125-126 feet
					127.0	Slower drilling, 127-128 feet
			No Flow		128.0 GP **Sandy Gravel** 129.0	Adding water while drilling, 128-131.5 feet
130	GB				SW **Sand** multicolored, some subangular to subrounded gravel, <5% of clasts are fractured, clasts up to 3/4"; well graded sand, wet	
			1.1			
						Adding water while drilling, 133-134 feet
					134.0	
135	GB				135.0 SW **Gravelly Sand** multicolored, subangular to subrounded gravel, <5% of clasts are fractured, clasts up to 1"; well graded sand, wet	Adding water while drilling, 135-144 feet Discharge water is brown, descriptions may be biased coarse, 135 feet
			3.5		SW **Gravelly Sand** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; well graded sand, wet	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50D

DATE STARTED 10/16/07 **COMPLETED** 10/22/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1060.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171915.1 feet **EASTING** 1379658.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140	GB		0.5		SW **Gravelly Sand** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; well graded sand, wet	
145	GB		60			More gravel present, up to 1/2", 143-144 feet Slower drilling, 144-145 feet No water added, discharge water is brown, descriptions may be biased coarse, 145-154 feet
150	GB		1.5		150.0 SW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; well graded sand, wet	
			60		154.0 **Bedrock** white matrix, some tan and black clasts, fractured, soft, weathered	Sustained high flow, 153.5-161 feet
155	GB		50			Discharge water is milky white to clear, 155-160 feet
			55			
			60			Discharge water changes color, 159-161 feet Some iron staining on fragments, 159-161 feet
160	GB		60		161.0 Bottom of hole at 162.0 feet.	Bottom of hole soft, difficult total depth reading, between 161 and 162 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-SCD
Date: 10-24-07
Project: 2007 WELL DEVELOPMENT Project #: 005-0189.07002
Technician: TRISTAN HERRON

Summary

	Installed (Well Log)	Start	End
Water level		64.9	64.25
Total depth	162	164.73	164.86
pH		7.57	6.93

Screen interval (btoPVC): 10'
Top: 154.73
Bottom: 164.73
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
24 Surge block on	START PURGE AT 1524 → WATER MOCHA COLORED							
7.57 1535	164.23	—	3.5	39	79	164	3.64	WATER SLIGHTLY CLOUDY, BRN, 1/2 TSP V.F.G SAND.
7.40 1550	"	—	3.5	102.75	77	165.10	3.87	" " 1/4 TSP"
1605	162.23	—						MOVED UP 2 FT → WATER MILKY
7.19 1615	"	—	3.5	173	77	34.5	4.13	WATER SLIGHTLY CLOUDY, TRACE SEDIMENT
7.15 1630	"	—	3.5	226	79	28.2	4.01	"
		START PUMP		261	DAY AT	1640		
MOVED UP 2FT → 10-25: START AT 1021 → WATER SLIGHTLY CLOUDY								
7.68 1031	160.23	—	3.5	294	93	19.34	4.57	SLIGHTLY CLOUDY, TRACE V.F.G. SAND
6.73 1051	"	—	3.5	364	77	18.36	3.81	" " NO TRACE SED.
1100	158.23	—						MOVED UP 2FT → WATER APPEARS CLEAR AT THIS DEPTH
6.81 1110	"	—	3.25	426	75	33.3	3.61	SLIGHTLY CLOUDY, TRACE V.F.G SAND.
6.74 1130	"	—	3.25	491	74	17.79	3.46	" "
1137	156.33	—						MOVED UP 2FT → WATER CLEAR AT THIS DEPTH
6.82 1152	"	—	3.5	568	76	12.61	3.47	SLIGHTLY CLOUDY, TRACE V.F.G. SAND
6.86 1212	"	—	3.5	638	75	5.39	3.74	CLEAR, NO SEDIMENT
		START PUMP		667	STOP AT	1220		
24 Surge block off	START DEPTH SURGE AT 1228							
6.91 1243	164.23	—	3.5	702	74	21.2	3.13	SLIGHTLY CLOUDY
6.91 1258	"	—	3.5	772	74	19.29	3.62	" "
1309	149.73	—						MOVED UP FOR POLISH
6.94 1319	"	—	3.5	846	74	7.06	3.32	CLEAR
6.93 1350	"	—	3.5	955	74	6.21	3.43	CLEAR.

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SP **Sand** brown, gravel, medium to coarse grained sand, trace silt, dry	
					2.0 GP **Gravel** brown, trace silt, dry	
					3.0 GP **Sandy Gravel** brown, subrounded gravel, trace silt, dry	
5	GB				5.0	No recovery, 5-7 feet
					7.0 GP **Sandy Gravel** light brown to gray, medium subangular gravel, dry	
10	GB				9.0 GP **Sandy Gravel** light brown, medium to coarse subangular gravel, some possible dark gray quartz crystals, dry	
					12.0 GP **Gravel and Sand** brown, fine to coarse angular to subangular gravel, dry	
15	GB				15.0 GP **Sandy Gravel** brown to gray, angular to subangular gravel, sand, dry	
					17.0 SP **Gravelly Sand** brown, fine gravel, coarse grained sand, dry	
20					18.0 GP **Gravel** light to dark gray, coarse subangular to subrounded gravel, clasts up to 1"; some brown sand, dry	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Aquaguard Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/19/07
Purge Volume: 856 gallons

RESPONSE TEST
Response Method: 1" Waterra Tube
Date: 10/21/2007

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/22/07 at 749 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				21.0 GP **Gravel and Sand** brown, medium angular to subrounded gravel, medium to coarse grained sand, dry	More coarse gravel present, 23-25 feet
25	GB				25.0 GP **Sandy Gravel** light gray, fine to medium angular to subrounded gravel, crystalline; brown sand, dry	
					26.0 GP **Gravel and Sand** gray, fine to coarse angular to subrounded gravel, brown sand, dry	
					27.0 GP **Gravel** brown, angular to subrounded gravel, some sand, dry	
					29.0 GP **Gravel and Sand** brown, fine to coarse angular to subrounded gravel, dry	
30	GB					
35	GB				35.0 GP **Gravel** brown, angular to subangular gravel, trace sand, dry	
					36.0	No recovery, 36-37 feet
					37.0 SP **Sand** brown, trace fine gravel, dry	Very little recovery, sample may be biased fine, 37-38 feet
					38.0 GP **Gravel** brown, some sand, dry	
					39.0 GP **Gravel** brown, fine to coarse angular to subrounded gravel, some sand, dry	
40	GB				40.0 GP **Sandy Gravel** light to dark gray, angular to subrounded gravel, brown sand, dry	
					43.0 GP **Gravel** light to dark gray, crystalline gravel, some sand, dry	
45	GB				45.0 GP **Gravel** gray, fine to coarse angular to subrounded gravel, some sand, dry	Gravel becoming more angular, 46-47 feet
					47.0 GP **Gravel** gray, predominantly angular to subrounded gravel, trace coarse grained sand, dry	Harder drilling, lots of dust being created, 46-48 feet
					48.0	No recovery, 48-49 feet
					49.0	
					50.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB				GP **Gravel** gray, fine to medium angular gravel, 95% of clasts are fractured, dry	No recovery, 50-51 feet
					GW **Gravel** 100% of clasts are fractured, dry	
55	GB					
					59.0	
					GP **Sandy Gravel** brown, subrounded gravel, silt coated, dry	
60	GB				60.0 GW **Gravel** 100% of clasts are fractured, dry	
					63.0	
					GP **Gravel** 70% subrounded gravel, silt coated, moist	
65	GB				65.0	
					GP **Gravel** angular to rounded gravel, 99% silt coated, moist	
					66.0	
					GW **Gravel** angular to rounded gravel (40%), most clasts are fractured, silt coated, dry	
					67.0	
					GW **Gravel** 100% of clasts are fractured, wet	
70	GB				70.0	
					GP **Gravel** medium to coarse subangular to subrounded gravel, silt coated, wet	
					71.0	
		68	1.5		GP **Gravel** fine to medium subrounded to rounded gravel, silt coated, wet	Multiple flow tests, Flow=1.5 GPM at 4:50 pm, Flow=1 GPM at 5:10 pm Casing broke at 172 feet during drilling and upon removal of casing, the hole collapsed to 20 feet; the hole was re-drilled to 72 feet in order to install P-07-50S; below 72 feet is native material
					72.0	
					GP **Gravel and Sand** subangular to subrounded gravel	
					74.0	
					GP **Gravel** poorly graded fine to coarse gravel	
75	GB				75.0	
					GP **Gravel** poorly graded fine to coarse subangular to rounded gravel	
					76.0	
					GP **Sandy Gravel** fine to medium subangular to rounded gravel, coarse grained sand	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB				GP **Sandy Gravel** fine to medium subangular to rounded gravel, coarse grained sand	
					82.0 GP **Gravel** poorly graded predominantly subrounded gravel, some coarse grained sand	Adding water while drilling, 83-88 feet
					84.0 GP **Gravel and Sand** subangular to rounded gravel, coarse grained sand	
85	GB				85.0 GW **Gravel and Sand** multicolored, predominantly fine subrounded gravel, clasts up to 1 1/4"; medium to predominantly coarse grained sand, trace silt, wet	Slower drilling, 86-87 feet DTW measurement attempted, probe caught at 56 feet, no water detected, 87 feet More angular clasts present, possible cobble, 87-89 feet
					89.0 SP **Sand and Gravel** fine to coarse angular to rounded gravel, predominantly medium to coarse grained sand	
90	GB		0.03		90.0 SW **Sand and Gravel** multicolored, fine to coarse angular to rounded gravel, fine to coarse grained sand, brown matrix, wet	Adding water while drilling, 92-93 feet; Clasts up to 1", mostly rounded, 93-94 feet
					94.0 SW **Gravelly Sand** brown, predominantly fine subangular to rounded gravel, fine to coarse grained sand, trace silt, wet	
95	GB		Trace Flow		95.0 SW **Sand and Gravel** brown, fine to coarse angular to rounded gravel, fine to coarse grained sand, trace silt, wet	
		65.5				
			<0.05			More sand present, 99-100 feet
100	GB					Increased caking and fines, 101-102 feet
			Trace to No Flow			DTW measurment attempted, clogged at 37 feet, 102 feet Descriptions may be biased coarse, 103-110 feet
					103.0 GP **Gravel and Sand** fine rounded gravel, coarse grained sand	
105	GB				105.0 GW **Gravel and Sand** multicolored, fine to coarse angular to rounded gravel, fine to coarse grained sand, trace brown silt, wet	Adding water while drilling, 105-106 feet Water muddy, 106-107 feet Increased fine to medium sand, 106.5-107 feet
			0.05			
		89.4				Trace fine to medium sand, 109-110 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB		Trace to No Flow		GW **Gravel and Sand** multicolored, fine to coarse angular to rounded gravel, fine to coarse grained sand, trace brown silt, wet	Grab sample taken at 111 feet more representative than the sample from 110 feet
	GB	88.9				More silt present, 113-115 feet
115	GB		Trace to No Flow		115.0	
			Trace to No Flow		GM **Gravel and Sand** multicolored, fine to coarse angular to rounded gravel, 25% of clasts are fractured, clasts up to 1 1/4"; fine to coarse grained sand, some brown silt, wet	
		82.7	Trace to No Flow			
120	GB				121.0	Very little recovery, 120-122 feet
			0.75		SM **Sand** brown, some gravel, fine to medium grained sand, some silt	
		67.4			122.0	Multiple DTW measurements taken, DTW=68' at 12:15am, DTW=67.4' at 1:06 am, DTW may be more representative than earlier due to faster recharge
					GW **Gravel and Sand** multicolored, fine to coarse angular to rounded gravel, 25% of clasts are fractured, clasts up to 1 1/4"; fine to coarse grained sand, some brown silt, wet	
					123.0	
					124.0	
125	GB		1.3		125.0 SM **Sand** brown, some gravel, fine to medium grained sand, some silt	Inconsistent flow, 125 feet
			0.0		GW **Gravel and Sand** multicolored, fine to coarse angular to rounded gravel, 25% of clasts are fractured, clasts up to 1 1/4"; fine to coarse grained sand, some brown silt, wet	
		77.6			SP **Gravelly Sand** multicolored, predominantly fine rounded to coarse angular gravel, brown fine to medium grained sand, trace silt, wet	Flow test results from 9/18/07
130	GB		0.4		131.0	
		122.2			SW **Gravelly Sand** fine to coarse gravel, 50% of clasts are fractured; fine to coarse grained sand, trace silt, wet	
			<0.05			
135	GB				135.0	
			0.15		SW **Gravelly Sand** coarse subangular to rounded gravel, 50% of clasts are fractured, clasts up to 2 1/2"; fine to coarse grained sand, trace brown silt, wet	
					137.0	
		72.9			SP **Gravelly Sand** angular to rounded gravel, 40% of clasts are fractured; fine to coarse grained sand	Rig down: casing broke around 3:30am on 9/17/07, had to pull all casing out; New casing installation began at 5:05 pm on 9/17/07, resumed logging at 2:30am on 9/18/07
			<0.05			

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140	GB				SP **Gravelly Sand** angular to rounded gravel, 40% of clasts are fractured; fine to coarse grained sand	Water level rising, 138 feet
					141.0 SP **Gravelly Sand** subangular to rounded gravel, 20% of clasts are fractured; fine to coarse grained sand	
		111.95	Trace Flow			Water level rising slowly, 142 feet
					143.0	Adding water while drilling, 143-144 feet
			0.25			
145	GB		4.6			
					146.0	Adding water while drilling, 146-147 feet
			Trace Flow		SP **Gravelly Sand** angular to rounded gravel, 30% of clasts are fractured; fine to coarse grained sand	DTW measurement attempted, probe caught at 120 feet, 147 feet
					149.0	Adding water while drilling, 149-150 feet
150	GB		1.7			
					151.0	Adding water while drilling, 151-152 feet
		66.2	69		**Bedrock** white, weathered	
155	GB				155.0 **Bedrock** white, 100% of clasts are fractured	
					156.0	
		68.35	60		157.0 **Bedrock** predominently soft yellow clasts; trace black hard clasts; some quartz crystalline aggregates	
160	GB					
		62.0	43		162.0 **Bedrock** predominently soft yellowish white clasts; trace black hard clasts	
					164.0 **Bedrock** predominently soft yellow clasts; trace black hard clasts	
165	GB					
		67.8	43			

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50S

DATE STARTED 9/16/07 **COMPLETED** 9/18/07 **GROUND ELEVATION** 1056.73 feet **TOC ELEVATION** 1059.23 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171909.9 feet **EASTING** 1379684.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford, E. Robson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170	GB	78	1.5		**Bedrock** predominently soft yellow clasts; trace black hard clasts	Casing broke, pulled out casing; hole collapsed to 20 feet
					172.0 Bottom of hole at 172.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-50S
Date: 10/19/07
Project: PEBBLE Well Development Project #: 005.0189.07002
Technician: RAMONA BATCHELDER

Summary * BOB Pre Developed 300 gallons *

	Installed (Well Log)	Start	End
Water level BTOC		62.70	
Total depth BTOC		72.50	
pH		7.78	6.69

Screen interval (btoPVC): 10'
Top: 60
Bottom: 70
PVC stick-up height (above ground surface): 2'6

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH Surge block on START AT 1109								
1120	69'	—	3.0	33	—	—	—	1 teaspoon, dk brown fine to medium sand
1150	69'	—	3.0	123	—	—	—	<1 teaspoon, " " " "
7.78 1243	67'	—	2.75	268.75	.056	40.2	3.15	1/4 tsp " " "
6.91 1311	67'	—	2.75	345.75	.043	22.7	3.06	1/8 tsp " " " "
6.80 1345	65'	/	2.5	423.75	.042	38.6	2.88	same as above
6.82 1417	65'	/	2.5	510.75	.041	20.8	2.71	little to no sand dk brown fine
6.69 1512	63'	/	2.0	630.75	.041	85.7	2.87	1/4 tsp fine dk brown sand
6.78 1542	63'	/	2.25	688.25	.041	54.8	2.95	little to no sand (fine)
1643	69'	—	3.75					
Surge block off @ 1615								
6.80 1643	69.5'	/	2.75	856	.042	30.8	3.11	little to no fine sand
6.69 1716	69.5'	/	2.75		.041	28.7	2.9	little to none

Note * We didn't do a polish ... there wasn't enough water in well.
End water Level & TD could not be taken without water Level meter

THE pebble PARTNERSHIP

P-07-50SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50SS

DATE STARTED 9/20/07 **COMPLETED** 9/20/07 **GROUND ELEVATION** 1057.12 feet **TOC ELEVATION** 1059.87 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171931.4 feet **EASTING** 1379683.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-3 feet
						Adding water while drilling, 1-8 feet
						Cobble or boulder, 1.5-2 feet
					3.0	
					GP **Gravel** angular to subangular gravel, most clasts are fractured, clasts up to 1/2"; some coarse grained sand, wet	
5					5.0	
					GP **Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2"; some coarse grained sand, trace silt, wet	Increasing sand content, 6-11 feet
		Dry			8.0	
					GP **Sandy Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2"; predominantly coarse grained sand, trace silt, dry	
10					10.0	
					GP **Sandy Gravel** brown, subrounded gravel, silt coated, <10% of clasts are fractured, clasts up to 1/2"; fine to coarse grained sand, trace silt, dry	
					11.0	
					12.0	
		Dry			SP **Gravelly Sand** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry	Silt coating on gravel, 13-15 feet
					GP **Sandy Gravel** gray, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry	
15					15.0	
					SP **Gravelly Sand** grayish brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2"; fine to coarse grained sand, trace silt, dry	More angular gravel present, up to 3/4", 16-17 feet
					18.0	
		Dry			GP **Gravel** fine subrounded and coarse predominantly angular gravel, 100% of clasts are fractured, dry	Lots of dust, 18-19 feet
					19.0	
20					GP **Gravel** brown, angular to subrounded gravel, 30% 20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Pel Plug Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Native Material and Bentonite Pellets

DEVELOPMENT
Method: Not Developed - Insufficient Water
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Piezometer is dry; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50SS

DATE STARTED 9/20/07 **COMPLETED** 9/20/07 **GROUND ELEVATION** 1057.12 feet **TOC ELEVATION** 1059.87 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171931.4 feet **EASTING** 1379683.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					of clasts are fractured; some fine to coarse grained sand, trace silt, dry	
					GP **Sandy Gravel** fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2"; fine to coarse grained sand, trace silt, dry	
		Dry			22.0	
					SP **Gravelly Sand** predominantly fine subrounded gravel, <10% of clasts are fractured; fine to coarse grained sand, trace silt, dry	
25					23.0	
					GP **Gravel** subangular to subrounded gravel, 70% of clasts are fractured, clasts up to 3/4"; some fine to coarse grained sand, trace silt, dry	
					25.0	
					SP **Gravelly Sand** subrounded gravel, <10% of clasts are fractured, clasts up to 1/2"; predominantly medium to coarse grained sand, trace silt, dry to moist	
		Dry			28.0	
					GP **Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2"; some medium to predominantly coarse grained sand, trace silt, dry	
30					31.0	
					GP **Sandy Gravel** brown, subangular to subrounded gravel, <15% of clasts are fractured, clasts up to 5/8"; fine to coarse grained sand, trace silt, dry	
					32.0	
		Dry			GP **Gravel** brown, subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 5/8"; some predominantly medium to coarse grained sand, trace silt, dry	
					33.0	
					34.0	No recovery, 34-36 feet
35					SP **Gravelly Sand** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts <1/2"; fine to coarse grained sand, trace silt, dry	
					36.0	Casing broke at 116 feet during drilling and upon removal of casing, the hole collapsed to 52 feet; the hole was backfilled with native material to 36.2 feet in order to install P-07-50SS at the target depth
					GP **Gravel** grayish brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; some fine to coarse grained sand, trace silt, dry	
		Dry			38.0	Clasts up to 1/2", 38-39 feet
					GP **Sandy Gravel** subangular to subrounded gravel, <30% of clasts are fractured; fine to coarse grained sand, trace silt, dry	Clasts up to 3/4", 39-41 feet
40					41.0	
					GP **Sandy Gravel** brown, subangular to predominantly rounded gravel, silt coated, <10% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, trace silt, dry	
					42.0	
		Dry			43.0	
					GP **Sandy Gravel** gray, fine to coarse angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry	
45					45.0	
					GP **Gravel** gray, angular to subangular gravel, most clasts are fractured, clasts up to 3/4"; some fine to coarse grained sand, dry	
					GP **Gravel** gray, angular to subrounded gravel, most clasts are fractured, clasts up to 3/4"; some fine to coarse grained sand, dry	
		Dry			49.0	No recovery; Lots of gray dust, 49-50 feet
					50.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50SS

DATE STARTED 9/20/07 **COMPLETED** 9/20/07 **GROUND ELEVATION** 1057.12 feet **TOC ELEVATION** 1059.87 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171931.4 feet **EASTING** 1379683.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						
					51.0 GP **Gravel** gray, fine to coarse predominantly angular gravel, 100% of clasts are fractured, clasts up to 3/4"; trace sand, dry	
		Dry			GP **Gravel** fine to coarse predominantly angular gravel, 100% of clasts are fractured, clasts up to 3/4"; some fine to coarse grained sand, dry	
55						
					57.0	Increasing sand content, 57-60 feet
		Dry			58.0 GP **Sandy Gravel** fine subrounded and coarse angular to subrounded gravel, 60% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, dry	
60					GP **Sandy Gravel** fine subrounded to coarse angular to subrounded gravel, 60% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, trace silt, dry to moist	
		61.6				
					64.0 GP **Sandy Gravel** predominantly fine gravel, fine to coarse grained sand, moist	Very little recovery, 64-66 feet
65					66.0	
					67.0 GP **Sandy Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand, trace silt, moist	
		Dry			68.0 GP **Gravel** brown, predominantly subrounded gravel, <10% of clasts are fractured, clasts up to 3/4"; some fine to coarse grained sand, trace silt, dry	
70					GP **Sandy Gravel** subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2"; predominantly medium to coarse grained sand, moist to wet	Encountered water, 71-72 feet
		65.5	0.3		73.0	No recovery, 73-74 feet
					74.0	
75					75.0 GP **Sandy Gravel** subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2"; predominantly medium to coarse grained sand, wet	Clasts up to 1/2", 75-77 feet
					GP **Gravel** subangular to subrounded gravel, 30% of clasts are fractured; some predominantly coarse grained sand, wet	Clasts up to 3/4", 77-79 feet
		64.8				Clasts up to 1/2", 79-80 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50SS

DATE STARTED 9/20/07 **COMPLETED** 9/20/07 **GROUND ELEVATION** 1057.12 feet **TOC ELEVATION** 1059.87 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171931.4 feet **EASTING** 1379683.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
					81.0	Clasts up to 3/4", 80-81 feet
					SP **Sand and Gravel** subangular to subrounded gravel, 15% of clasts are fractured, clasts up to 3/4"; coarse grained sand, wet	More fine grained sand present, 82-84 feet
					84.0	
85					GP **Gravel** subangular to subrounded gravel, 20% of clasts are fractured, clasts up to 1/2"; some coarse grained sand	
					86.0	
					SP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured; coarse grained sand	
		67.2			87.0	Water level rising, 87 feet
					88.0	
					SP **Sand and Gravel** subangular to subrounded gravel, <10% of clasts are fractured; medium to coarse grained sand	
					89.0	
90					90.0	
					SW **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured; some white angular fragmented pieces, fine to coarse grained sand	
		65.22				Water level falling, 92 feet Increasing fines, 92-94 feet
					94.0	
					SP **Sand and Gravel** subangular to subrounded gravel, 20% of clasts are fractured; coarse grained sand	
95					95.0	
					SP **Sand and Gravel** subangular to predominantly subrounded gravel, <10% of clasts are fractured; medium to coarse grained sand	
					98.0	
					SW **Sand and Gravel** subangular to subrounded gravel, <10% of clasts are fractured; fine to coarse grained sand	
100						
					102.0	
		65.46			SW **Sand and Gravel** subangular to subrounded gravel, 15% of clasts are fractured; fine to coarse grained sand	Water level rising, 102 feet
					104.0	
					SW **Sand and Gravel** subangular to predominantly subrounded gravel, 15% of clasts are fractured; fine to coarse grained sand, trace silt	
105						Decreasing fines, 105-107 feet
					107.0	
					SP **Sand and Gravel** subangular to subrounded gravel, <10% of clasts are fractured; fine to medium grained sand	
					109.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-50SS

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-50SS

DATE STARTED 9/20/07 **COMPLETED** 9/20/07 **GROUND ELEVATION** 1057.12 feet **TOC ELEVATION** 1059.87 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171931.4 feet **EASTING** 1379683.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB	76.42			110.0 SW **Sand and Gravel** subangular to subrounded gravel, 20% of clasts are fractured, clasts up to 3/4"; fine to coarse grained sand	More fines present, 111-112 feet
					112.0 SW **Sand and Gravel** subangular to subrounded gravel, 30% of clasts are fractured; fine to coarse grained sand	Water level rising, 112 feet
					114.0 SP **Sand and Gravel** angular to subrounded gravel, 20%-25% of clasts are fractured; medium to coarse grained sand	
115					115.0 SW **Sand and Gravel** predominatly subrounded gravel, 20% of clasts are fractured; fine to coarse grained sand	
					117.0 SW **Sand and Gravel** predominatly subrounded gravel, 20% of clasts are fractured, some >2"; fine to coarse grained sand	
					Bottom of hole at 117.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

No well development at P-07-50SS. Well Dry.

THE pebble PARTNERSHIP

P-07-51D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-51D

DATE STARTED 9/26/07 **COMPLETED** 9/27/07 **GROUND ELEVATION** 1617.09 feet **TOC ELEVATION** 1619.17 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2162375.1 feet **EASTING** 1372609.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Boulder** brown, coarse grained sand	Boulder near surface, kicked drill out of alignment, able to straighten No recovery, 0-9 feet
1.0						
5						
9.0					SP **Sand and Gravel** brown, subrounded gravel, 15% of clasts are fractured, clasts up to 3/4"; coarse grained sand, moist	Little recovery, 9-11 feet
10	GB					
11.0					SP **Gravelly Sand** brown, subrounded gravel, 10% of clasts are fractured, clasts up to 3/4"; medium to coarse grained sand, moist to wet	Water level falling; Adding water while drilling, 12 feet
		7.52				
13.5					**Bedrock** weathered	Adding water while drilling, 14 feet
15	GB		0.25			
		9.45				Water level rising Move to open hole drilling, 17 feet
			0.5			
20						
20.0						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.08'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Aquaguard Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Native Material, Sand, and Bentonite Pellets

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/28/07 at 340 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-51D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-51D

DATE STARTED 9/26/07 **COMPLETED** 9/27/07 **GROUND ELEVATION** 1617.09 feet **TOC ELEVATION** 1619.17 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2162375.1 feet **EASTING** 1372609.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB		1		**Bedrock** slightly weathered	
			0.65			
25	GB				25.0 **Bedrock**	
			0.5			Very fractured, hammer keeps dropping
			1			
30	GB		0.8		30.0 **Bedrock** grayish black, fractured, wet	Clasts up to 1/4", 30-32 feet
			0.75			Clasts up to 1/2", 32-33 feet
						Clasts up to 3/8", 33-35 feet
			1.25			
35	GB					Clasts up to 1/2", 35-50 feet
			1			In order to install P-07-51D at the target depth, the hole was backfilled with native material to 67 feet, sand from 67 feet to 54.4 feet, and a bentonite seal from 54.4 feet to 50.4 feet to seal the lower portion of the hole off from the piezometer
			1.5			
40	GB		1.75			
			1.75			
			2			
45	GB					
			1.5			
			1.75			Clasts up to 3/8", 49-54 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-51D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-51D

DATE STARTED 9/26/07 **COMPLETED** 9/27/07 **GROUND ELEVATION** 1617.09 feet **TOC ELEVATION** 1619.17 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2162375.1 feet **EASTING** 1372609.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB		1.4		**Bedrock** grayish black, fractured, wet	Adding water while drilling, 51-85 feet
			1			
			1.75			Clasts up to 1/2", 54-55 feet
55	GB					Clasts up to 3/8", 55-56 feet
			2			Flow rate may be biased high, 56 feet Clasts up to 1/2", 56-62 feet
			1.5			
60	GB		0.75			
			1.8			Clasts up to 3/8", 62-65 feet
			0.75			
65	GB					Clasts up to 1/2", 65-68 feet
			0.8			
			2			Clasts up to 3/8", 68-69 feet
						Clasts up to 1/2", 69-71 feet
70	GB		0.9			
						Clasts up to 3/8", 71-73 feet
			2.25			
			2.8			Clastsup to 1/2", 73-74 feet
						Clasts up to 3/4", 74-75 feet
75	GB		2.25		75.0	Water changed from gray to brown, 74 feet
					Bedrock grayish black with small reddish orange and yellowish tan clasts, fractured, wet	Clasts up to 3/8", 75-78 feet
			1.75			Water changed from brown to gray, 76 feet
					78.0	
					Bedrock grayish black, fractured, clasts up to 3/8", wet	
			1.9		79.0	
					80.0	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-51D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-51D

DATE STARTED 9/26/07 **COMPLETED** 9/27/07 **GROUND ELEVATION** 1617.09 feet **TOC ELEVATION** 1619.17 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2162375.1 feet **EASTING** 1372609.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB		1.2		**Bedrock** grayish black with small reddish orange and yellowish tan clasts, fractured, clasts up to 3/8", wet	Clasts up to 3/8", 80-82 feet
			2		**Bedrock** grayish black, fractured, wet	Clasts up to 1/4", 82-84 feet
85	GB		1	85.0		Clasts up to 3/8", 84-85 feet
					Bottom of hole at 85.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-51D
Date: 6-10-08
Project: Pebble
Project #: 005.0189.08002
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level	5.13	9.14	
Total depth	46.18 + 1.25 =	47.86	
pH	48.43	6.95	7.34

Screen interval (btoPVC): 10'
Top: 37.86
Bottom: 47.86
PVC stick-up height (above ground surface): 27" = 2.25'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 928 - START								1' off bottom	
1000	46.86	9.14	.75	24	0.221	E-3*	4.92	SILT-fn sand, Dark gray, 1 Tbsp + Suspended	6.95
1018	↓		0.25	28.5	0.184	85	4.38	Trace silt, Clear to lt. gray	6.68
1024	44.86							Move ↑ 2' - START	–
1049	↓		0.25	34.75	0.175	63	4.49	Trace silt, Clear to lt. gray	6.75
1055	42.86							Move ↑ 2' - START	–
1121	↓		0.25	41.25	0.170	86	5.16	Trace silt, clear to v. lt gray	6.59
1129	40.86							Move ↑ 2' - START	–
1219	↓		0.25	53.75	0.171	358	6.67	fn sand, lt. brown, 1 tsp	6.72
~~1237~~	38.86							Move ↑ 2' - START	–
1315	↓		0.25	63.25				wait for recharge - WL at 37.9'	–
1406	↓							WL at 16'	–
1428	↓		~~2.0~~		~~0.168~~	~~223~~	~~3.45~~	Restart	6.66
1430	↓		2.0	67.25	0.168	223	3.45	SILT, gmed gray, ~1 TBSP	
1450	36.86							Move ↑ 2' - START – Switched to Electric	
1515	↓		0.5	85	0.246	86	6.33	med. gray, trace sed.	6.74
1640	46.86							Recharge	
1650	46.86							Restart	
1658	↓		1	109.5	0.225	~~1000~~ 1346	4.48	trace sand, lt. gray - cloudy	7.35
1714	↓		0.25	113.5		278			
1719	↓		0.25	114.75	0.190	116	5.57	trace sand, clear	7.34
Surge block off									
~~1526~~	32.86							Moved 5' above screen	
1540			0.25	88.5				- Recharge	
1556	1606 ↓		1	96.5	0.178	308*	8.49**	Restart - trace fines, lt-gray - clear	7.42
1607	46.86					(134)		Move 1' from bottom - START	
1620			0.25	101.5				Recharge	

Debris ↑ Debris

* = Sample too cloudy for measurement -
** = likely residual from turbidity, came up clear after sample collected. 2nd Turbidity measurement taken

THE pebble PARTNERSHIP

P-07-51S

PAGE 1 OF 1

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-51S

DATE STARTED 9/28/07 **COMPLETED** 9/28/07 **GROUND ELEVATION** 1617.78 feet **TOC ELEVATION** 1620.28 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2162387.2 feet **EASTING** 1372627.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-8 feet
5						
8.0					SM **Silty Sand and Gravel** brown, subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", moist	
10	GB					
10.0					SP **Sand and Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4"; predominantly fine to medium grained sand, dry	
11.0						Adding water while drilling, 10-18 feet
		9.77	0.75		**Bedrock** dark grayish black, fractured, clasts up to 1/2", weathered	
14.0						
15	GB				**Bedrock** dark grayish black with some colored clasts, fractured clasts up to 1/2", weathered	Clasts up to 1/2", 15-16 feet
15.0					**Bedrock** dark graish black with some colored clasts, wet	Clasts up to 3/4", 16-20 feet
		8.76	3.5			
20	GB					
20.0						

Bottom of hole at 20.0 feet.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/28/07 at 353 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-51S
Date: 6-10-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Krane

Summary

	Installed (Well Log)	Start	End
Water level	3.94	7.77	8.50
Total depth	22.7 +2.6 =	22.9	22.7
pH	25.3	6.86	6.66

Screen interval (btoPVC): 10'
Top: 12.9
Bottom: 22.9
PVC stick-up height (above ground surface): 31" = 2.6'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	
Surge block on 931 – START								1' off Bottom	
1005	21.9	7.77	2.0	68	0.067	774	2.12	fine Sand, Med brown, ≤ 1 tbsp	6.86
1025	↓		1.75	103	0.064	85	1.95	fine sand, lt. brown, ≈ ½ Tbsp	6.73
1030	~~19.9~~							Move ↑ 2' – START	–
1058	↓		2.0	159	0.064	86	2.03	fine Sand, lt-brown-clear, 1 tsp	6.66
1102	17.9							Move ↑ 2' – START	–
1130	↓		1.75	208	0.065	86	2.04	fine sand, lt brown – clear, 1 tsp	6.81
1137	15.9							Move ↑ 2' – START	
1223	↓		0.75	242.5	0.068	~~885~~	2.82	fine sand, lt brown, ≈ 1.5 Tbsp + suspended	6.62
1243	13.9							Move ↑ 2' – START	–
1334	↓		1.75	331.75	0.070	1000	2.57	fine sand, M. brown, ≤ 1 Tbsp	6.41
1338	11.9							Move ↑ 2' – START	
1353	↓		1.0	346.75	0.064	61	2.89	V. trace sand, clear	6.26
~~1353~~									
Surge block off									
1403	10.9							Move 2' above screen – to stay in water	
1411	↓		0.75	352.75	0.062	19	2.96	Clear no sed.	6.36
1416	21.9							Move 1' from bottom – START	
1434	↓				0.067	86	2.12	fine sand, clear to lt. tan, < 1 tsp.	6.66

THE pebble PARTNERSHIP

P-07-52D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-52D

DATE STARTED 9/28/07 **COMPLETED** 9/29/07 **GROUND ELEVATION** 1856.73 feet **TOC ELEVATION** 1859.36 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153681.7 feet **EASTING** 1367487.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SP **Sand and Gravel** brown, subrounded gravel, clasts up to 3/4"; medium to coarse grained sand, wet	No recovery 0-7 feet; Cuttings described from outside casing
1.0						
						Few cobbles, 3-5 feet
5						
7.0					SW **Sand** brown, coarse grained sand	Very little recovery, 7-8 feet
8.0		5			SP **Sand and Gravel** brown, wet	Hole blocked at 5 feet, 8 feet
9.0					SP **Sand and Gravel** brown, subrounded gravel, clasts up to 1/2"; coarse grained sand, wet	Little recovery, hose to cyclone may have been blocked by cuttings from shallower depths, sample may not be representative, 10 feet
10	GB					
10.0					SP **Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2"; coarse grained sand, wet	
12.0					SP **Gravelly Sand** brown, subrounded gravel, 10% of clasts are fractured; medium to coarse grained sand, moist	Adding water while drilling, 12-13 feet
13.0		11.15			GP **Sandy Gravel** brown, subangular to subrounded gravel, 20-25% of clasts are fractured, clasts up to 3/4"; coarse grained sand, moist to wet	
15	GB					
15.7					**Bedrock (Monzonite)** gray to black, clasts up to 1/2", weathered	Drilling slowed due to bedrock, 15.7 feet Clasts up to 1/2", 16-18 feet
16.0					**Bedrock (Monzonite)** white to gray, weathered	
		15.42 ▼				Water level falling, 18 feet Clasts up to 3/4", 18-19 feet Adding water while drilling, 18.5-19 feet Clasts up to 1", 19-20 feet
19.0			0.4		**Bedrock (Monzonite)** grayish white and reddish white, wet	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: Aquaguard Bentonite Grout
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/29/07 at 1231 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-52D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-52D

DATE STARTED 9/28/07 **COMPLETED** 9/29/07 **GROUND ELEVATION** 1856.73 feet **TOC ELEVATION** 1859.36 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153681.7 feet **EASTING** 1367487.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB	14.55	0.75		**Bedrock (Monzonite)** grayish white and reddish white, wet	Clasts up to 3/4" from 20-23 feet
			0.7			Move to open hole drilling, 22.4 feet
			2.7			Clasts up to 1/2", 23-25 feet
					24.0	Multiple flow tests, Flow=0.7 GPM at 1:47 am, Flow=2.7 GPM at 2:56
25	GB		2.6		**Bedrock (Monzonite)** white to gray	Clasts up to 1/4", 25-34 feet
			3.75			
			1.4			Clasts mostly 1/8", resemble coarse sand
30	GB		1.25			
			0.9			
					34.0	
35	GB		3.0		**Bedrock (Monzonite)** reddish white to brown, clasts up to 1/4"	Brown discharge water (changed from gray), 35-41 feet
					35.0	
			3.5		**Bedrock (Monzonite)** white to grayish black, clasts up to 1/4"	
			3.5		39.0	
40	GB		3.0		**Bedrock (Monzonite)** grayish white, reddish white, and black, clasts up to 1/4"	Gray discharge water, 41-49 feet
			2.25			
45	GB		3.5			
			3.4			
			3.6			Brown discharge water, increase in rust colored clasts, 49-50 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-52D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-52D

DATE STARTED 9/28/07 **COMPLETED** 9/29/07 **GROUND ELEVATION** 1856.73 feet **TOC ELEVATION** 1859.36 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153681.7 feet **EASTING** 1367487.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, K. Bilyj

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB		4.0		**Bedrock (Monzonite)** grayish white, reddish white, and black, clasts up to 1/4"	Gray discharge water, 50-54 feet
			4.0			
55	GB		4.2			Brown discharge water, increase in rust colored clasts, 54-55 feet Gray discharge water, 55-58.5 feet
			5.5			
60	GB		4.5		59.5 Bottom of hole at 60.0 feet.	Brown discharge water, increase in rust colored clasts, 58.5-59 feet Gray discharge water, 59-59.5 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-52D
Date: 6-11-08
Project #: 005.0189.08002

Project: Pebble
Technician: C Kramer

Summary

	Installed (Well Log)	Start	End
Water level	18.27	18.93	19.51
Total depth	63.10	63.33	63.34
pH		6.91	6.68

Screen interval (btoPVC): 10'
Top: 53.33
Bottom: 63.33
PVC stick-up height (above ground surface): 30" ≈ 2.5'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment discharge (grain size, color, quantity)	pH
Surge block on 838 - START									
858	62.33	18.93	3.5	70	0.199	401	3.04	fine Sand, Med. brown, ≥ 1 tsp	6.91
909	60.33	—						Move ↑ 2' - START	—
929	↓		1.0	90	0.086	145	3.24	Trace fine Sand, lt. brown	6.90
934	58.33	—						Move ↑ 2' - START	—
944	↓		1.25	102.5	0.083	59	2.94	trace fine sand, lt. brown to clear	6.72
948	56.33	—						Move ↑ 2' - START	—
1003	↓		3.5	155	0.084	118	2.93	fine Sand, lt brown, ≥ 1 tsp	6.70
1008	54.33	—						Move ↑ 2' - START	—
1023	↓		3.5	207.5	0.083	60	2.91	fine sand, lt. brown - clear, ≈ 1 tsp	6.68
1027	52.33	—					→	Move ↑ 2' - START	—
1049	↓		1.0	229.5	0.084	132	3.27	fine sand, lt. brown, trace	6.67
1059	↓		1.0	239.5	0.085	108	3.40	fine sand, lt. brown - clear, trace	6.74
Surge block off									
1108	48.33	—					→	Move 5' above screen	—
1127	↓		1.0	258.5	0.085	50	3.5	Clear, very trace sand	6.70
1132	62.33	—						Move 1' above bottom	—
1143	↓		2.0	280.5	0.083	25	3.12	Clear	6.68

Polish

Debris

THE pebble PARTNERSHIP

P-07-52S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-52S

DATE STARTED 9/29/07 **COMPLETED** 9/29/07 **GROUND ELEVATION** 1856.20 feet **TOC ELEVATION** 1858.78 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153676.4 feet **EASTING** 1367475.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-7 feet
7.0					GP **Sandy Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2"; predominantly coarse grained sand, trace silt, wet	
11.0					SP **Gravel and Sand** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; predominantly coarse grained sand, some silt, wet	Adding water while drilling, 11-12 feet
12.0		10.39			SP **Gravel and Sand** brown, subangular gravel, 30% of clasts are fractured, clasts up to 3/4"; predominantly coarse grained sand, trace silt, wet	
14.0					SP **Sand and Gravel** brown, angular to subrounded gravel, clasts up to 3/4"; predominantly coarse grained sand, trace silt, moist	Adding water while drilling, 15-17 feet
16.0		11.59	0.6		**Bedrock (Monzonite)** white with black elongated crystals, some iron staining, fractured, clasts up to 3/4", weathered, wet	Move to open hole drilling, 17 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 25# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: To be Completed in 2008
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/29/07 at 537 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-52S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-52S

DATE STARTED 9/29/07 **COMPLETED** 9/29/07 **GROUND ELEVATION** 1856.20 feet **TOC ELEVATION** 1858.78 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153676.4 feet **EASTING** 1367475.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB		2.25		21.0	Into more competent bedrock, 20 feet
					Bedrock (Monzonite) white with black elongated crystals, some iron staining, mostly fractured (pulverized), clasts up to 3/4"; trace black, brown, and tan subrounded clasts, wet	
25	GB		3.5			Completely pulverized, no clasts greater than 1/4", 26-28 feet
					28.0	
					Bottom of hole at 28.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

SLR

Well ID: P-07-52S
Date: 6-11-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level	18.43	19.40	19.38
Total depth Bgs →	31.0	30.8	30.9
pH		6.46	6.10

Screen interval (btoPVC): 10'
Top: 20.8
Bottom: 30.8
PVC stick-up height (above ground surface): 30.5" = 2.54'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1204 - START - 1' off bottom									
1221	29.8	19.4	1.0	17	0.040	700	2.31	fine sand, Mod-lt brown, ≈ 1 tsp, -trace	6.46
1237	↓		1.0	33	0.039	237	2.09	fine sand, Mod- lt. brown, trace	6.17
1241	27.8							Move ↑ 2' - START	-
1256	↓		1.25	51.75	0.039	76	1.94	Lt. brown, very trace sand	6.03
1300	25.8							move ↑ 2' - START	-
1316	↓		1.0	67.75	0.038	25	2.41	Clear, very trace sand	6.08
1320	23.8							Move ↑ 2' - START	-
1345	↓		1.0	92.75	0.039	82	2.12	Lt. brown, very trace sand	5.96
1349	21.8							Move ↑ 2' - START	-
1413	↓		1.0	128.75	0.039	435	2.02	Lt. brown, very trace sand	6.03
1429	↓		1.0	144.75	0.039	216	2.12	Lt. brown, very trace sand	6.06
1433	19.8							Move ↑ 2' - START - minimal flow	
1440	↓		0.50	148.25	0.041	83	2.71	Lt. brown/Lt. gray/clear, very trace sand	6.13
Surge block off									
polish								- No polish, ∴ water not above screen	
1448	29.8							- Move 1' from bottom	
Odonis 1528	↓		1.25	173.25	0.040	37	2.04	Clear	6.10

THE pebble PARTNERSHIP

P-07-53D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53D

DATE STARTED 10/23/07 **COMPLETED** 10/25/07 **GROUND ELEVATION** 1057.31 feet **TOC ELEVATION** 1059.56 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171900.7 feet **EASTING** 1379645 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
						No recovery, 0-3 feet, partially due to ice in discharge hose
					3.0	
					SP **Sand** brown, fine grained sand, dry	Very little recovery, 3-4 feet
					4.0	
5	GB				GP **Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; some well graded sand, dry	
					5.0	Very little recovery, may be biased fine, 5-6 feet
					SW **Sand** brown, well graded sand, dry	
					6.0	No recovery, 6-7 feet
					7.0	
					SW **Gravelly Sand** brown, angular to subangular gravel, 1/4-1/2"; well graded sand, dry	
10	GB					
					11.0	
					GW **Sandy Gravel** brown, clasts up to 1/2", poorly graded sand, dry	
					13.0	
					GW **Sandy Gravel** brown, angular to subangular gravel, clasts up to 1/2"; poorly graded sand, dry	
15	GB				15.0	
					GW **Gravel** brown, 25% of clasts are fractured, clasts up to 1/2"; well graded sand, dry	Gravel clogging discharge hose, throughout drilling
					18.0	
					GW **Sandy Gravel** brown, 70% gravel, 30% of clasts are fractured, clasts up to 1/2"; 30% well graded sand, dry	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/27/07
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 10/27/07 at 1210 AM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53D

DATE STARTED 10/23/07 **COMPLETED** 10/25/07 **GROUND ELEVATION** 1057.31 feet **TOC ELEVATION** 1059.56 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171900.7 feet **EASTING** 1379645 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				21.0 GW **Gravel** angular to subangular gravel (90%), 40% of clasts are fractured; little sand, dry	Clasts up to 3/4", 21-23 feet
					24.0 SW **Gravelly Sand** brown, well graded fine to coarse grained sand (60%), dry	Little recovery, 23-24 feet Clasts up to 1", 23-24 feet Clasts up to 3/4", 24-25 feet
25	GB					Clasts up to 1/8", 25-26 feet Clasts up to 1/4", 26-28 feet
					28.0 GW **Gravel** angular to subangular gravel, clasts up to 1/2"; some sand, dry	Little recovery, 28-29 feet
30	GB				32.0 GP **Gravel** angular to subangular, clasts up to 1/2"; some fine to coarse grained sand, dry	
35	GB				36.0	Clasts up to 3/4", 35-36 feet
					37.0 SW **Gravelly Sand** brown, clasts up to 1/8", well graded sand, dry	Low recovery, 38-39 feet
40	GB					
					43.0 GP **Gravel** fine angular to subangular gravel, 30% of clasts are fractured, dry	Low recovery, 42-43 feet
45	GB				44.0 GP **Sandy Gravel** fine angular to subangular gravel, 30% of clasts are fractured, fine to coarse grained sand dry	
					45.0 GP **Sandy Gravel** angular to subangular gravel, 30% of clasts are fractured, clasts up to 1/4"; fine to coarse grained sand, dry	
					46.0 GP **Gravel and Sand** fine angular to subangular gravel, fine to coarse grained sand, dry	Low recovery, 46-47 feet Native material used as backfill from 46 to 141.3 feet due to the high permeability in this area (750 gallons of grout installed in annual space of nearby piezometer with no return at surface)

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53D

DATE STARTED 10/23/07 **COMPLETED** 10/25/07 **GROUND ELEVATION** 1057.31 feet **TOC ELEVATION** 1059.56 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171900.7 feet **EASTING** 1379645 fee

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB				51.0	No recovery, 51-52 feet
					52.0 SW **Gravelly Sand** brown, fine gravel, well graded sand, dry	
					54.0 GW **Gravel** fine angular to subangular gravel, 40% of clasts are fractured, clasts up to 1/2"; some fine to coarse grained sand, dry	
55	GB					Clasts up to 3/4", 56-58 feet
60	GB				61.0	No recovery, 61-64 feet
		▼				No DTW measurements due to potential for heaving sands based on proximity to HH-07-N/P-07-50D Adding water while drilling, 62-151 feet
					64.0 GW **Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; some predominantly coarse grained sand, wet	
65	GB				65.0	Discharged water is brown and very turbid, may be losing fines, 65-151 feet Water encountered, between 66 and 70 feet
					66.0 GP **Gravel and Sand** brown, angular to subangular gravel, 90% of clasts are fractured, clasts up to 3/4"; predominantly coarse grained sand, wet	
					67.0 GP **Gravel and Sand** brown, angular to subangular gravel, 90% of clasts are fractured, clasts up to 3/4"; well graded sand, wet	
70	GB		<0.125		GP **Sandy Gravel** brown, angular to subangular gravel, 90% of clasts are fractured, clasts up to 1 1/4"; fine to predominantly coarse grained sand, wet	Clasts up to 1/2", 70-72 feet
					72.0 GP **Gravel and Sand** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"; fine to predominantly coarse grained sand, wet	
75	GB		<0.125		75.0 SW **Gravelly Sand** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2"; well graded sand, wet	
					77.0 GP **Gravel and Sand** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; fine to predominantly coarse sand, wet	
					79.0	Clasts up to 1", 79-80 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53D

DATE STARTED 10/23/07 **COMPLETED** 10/25/07 **GROUND ELEVATION** 1057.31 feet **TOC ELEVATION** 1059.56 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171900.7 feet **EASTING** 1379645 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB		2.25		GP **Gravel** brown, angular to subrounded gravel, 70% of clasts are fractured; some predominantly coarse grained sand, wet	Clasts up to 1 1/4", 80-82 feet Flow not constant, most of volume in last 15 seconds of test at 80 feet
					82.0	
					SP **Sand and Gravel** brown, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 1"; predominantly coarse grained sand, wet	
					83.0	
					SW **Gravelly Sand** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2"; well graded sand, wet	
85	GB				85.0	
			0.25		SP **Gravelly Sand** brown, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 1"; fine to predominantly coarse grained sand, wet	
					86.0	
					SP **Sand and Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; fine to predominantly coarse grained sand, wet	
					89.0	
90	GB				SP **Gravelly Sand** brown, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 1"; fine to predominantly coarse grained sand, wet	
					90.0	
			0.5		SP **Sand and Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; fine to predominantly coarse grained sand, wet	Clasts up to 1/2", 93-94 feet
95	GB				95.0	
			0.6		GP **Sandy Gravel** angular to subangular gravel, 40-50% of clasts are fractured, clasts up to 1"; fine to predominantly coarse grained sand, wet	
100	GB					
			0.25		101.0	
					GP **Gravel and Sand** angular to subangular gravel, 40-50% of clasts are fractured, clasts up to 1"; fine to predominantly coarse grained sand, wet	More coarse grained sand present, 103-106 feet
105	GB				105.0	
			<0.125		GW **Gravel and Sand** angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"; predominantly coarse grained sand	Clasts up to 1/2", 107-108 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53D

DATE STARTED 10/23/07 **COMPLETED** 10/25/07 **GROUND ELEVATION** 1057.31 feet **TOC ELEVATION** 1059.56 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171900.7 feet **EASTING** 1379645 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB		0.25		110.0 GP **Gravel** coarse subangular gravel, clasts up to 1 1/4"; trace predominantly coarse grained sand	
					112.0 GP **Gravel** coarse subangular gravel, clasts up to 1"; some predominantly coarse grained sand	Clasts up to 1", 113-116 feet
115	GB		0.125		115.0 GP **Gravel** fine subangular gravel, 40% of clasts are fractured, clasts up to 1/2"; trace predominantly coarse sand, wet	
					119.0 SP **Sand** brown, coarse grained sand, wet	More coarse grained sand present, 118-119 feet Low recovery, 118-120
120	GB				121.0	
			5		122.0 SP **Sand** brown, trace fine gravel, predominantly coarse grained sand, wet	
					124.0 GP **Gravel** fine angular to subangular gravel, 10% of clasts are fractured, clasts up to 1/4"; some predominantly coarse grained sand, wet	
125	GB				126.0 GP **Gravel** angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2"; some sand, wet	
					129.0 GP **Gravel and Sand** angular to subangular gravel, clasts up to 1/2"; fine to predominantly coarse grained sand, some silt, wet	
130	GB				131.0 GP **Gravel** fine angular to subrounded gravel, clasts up to 1/4"; trace predominantly coarse grained sand, wet	
			<0.0625		133.0 GP **Gravel** angular to subrounded gravel, clasts up to 1/2"; some predominantly coarse grained sand, wet	
135	GB				136.0 SP **Sand** brown, some clasts up to 1/8", predominantly coarse grained sand, wet	More sand present, 135-136 feet
					138.0 GP **Gravel and Sand** brown, angular to subrounded gravel, 40% of clasts are fractured, clasts up to 1/2"; coarse grained sand, wet	Sand is multicolored, 138-150 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53D

DATE STARTED 10/23/07 **COMPLETED** 10/25/07 **GROUND ELEVATION** 1057.31 feet **TOC ELEVATION** 1059.56 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171900.7 feet **EASTING** 1379645 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140	GB		No Flow		GP **Gravel and Sand** brown, angular to subrounded gravel, 40% of clasts are fractured, clasts up to 1/2"; coarse grained sand, wet	
145	GB		1.5		145.0 GP **Gravel and Sand** brown, 30% of clasts are fractured, clasts up to 1/2"; coarse grained sand, wet	Less sand present, 146-149 feet
150	GB		50		150.0 GP **Gravel** angular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2"; trace weathered bedrock, wet 151.0 **Bedrock** white matrix with tan and black grains, soft, weathered, wet	
155	GB		55		155.0 **Bedrock** white matrix with tan and black grains, wet	
160	GB		55		159.0 **Bedrock** light gray matrix with tan and black grains, wet 161.0 Bottom of hole at 162.8 feet.	Presence of bedrock accompanied by distinct change in color of discharge water from brown to milky white

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

No well development at P-07-53D. Well Dry.

THE pebble PARTNERSHIP

P-07-53S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53S

DATE STARTED 10/26/07 **COMPLETED** 10/26/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1059.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171885.9 feet **EASTING** 1379651.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					GP **Gravel** gray, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 5/8"; some coarse grained sand, roots, moist	
					2.0	
					GP **Sand and Gravel** brownish gray, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; medium to predominantly coarse grained sand, moist	
					3.0	
					4.0	
5					SW **Sand and Gravel** brown, subrounded to rounded gravel, silt coated, <10% of clasts are fractured, clasts up to 1"; poorly sorted fine to coarse grained sand, trace silt, moist	Clasts up to 1/2", 5-6 feet Samples biased coarse, fine sand sticking to and accumulating in bottom of bucket, 5-25 feet Greater moisture content, 6-7 feet
					6.0	
					SW **Gravelly Sand** brown, subangular to rounded gravel, <10% of clasts are fractured, clasts up to 3/4"; well graded sand, moist	
					9.0	
10					SP **Sand and Gravel** brown, subangular to rounded gravel, silt coated, 30% of clasts are fractured, clasts up to 3/4"; predominantly medium to coarse grained sand, trace silt, dry to moist	
					GP **Sand and Gravel** brown, angular to subrounded gravel, silt coated, 50% of clasts are fractured, clasts up to 1"; well graded sand, trace silt, dry	Percentage of fractured clasts decreases to 30%, 11-13 feet
					14.0	
15					GP **Gravel** gray to brown, angular to subangular gravel, 90% of clasts are fractured, clasts up to 1"; some well graded sand, dry	
					15.0	
					GP **Sand and Gravel** gray to brown, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 1"; well graded poorly sorted sand, dry	
					18.0	
20					SW **Sand** brown, trace fine gravel, well graded well sorted sand, dry	
					19.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

SCREEN FILTER
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Native Material

DEVELOPMENT
Method: Waterra Pump (w/ and w/out surge block)
Date: 10/30/07
Purge Volume: 638.75 gallons

RESPONSE TEST
Response Method: N/A
Date: To be Completed in 2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 10/27/07 at 1222 PM; Location in State Plane Coordinates, Zone 5, NAD 83 datum

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53S

DATE STARTED 10/26/07 **COMPLETED** 10/26/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1059.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171885.9 feet **EASTING** 1379651.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GP **Sand and Gravel** gray to brown, angular to subrounded gravel, silt coated, 30%-50% of clasts are fractured, clasts up to 1"; well graded poorly sorted sand, dry	
22.0					SW **Sand** brown, trace fine gravel, well graded well sorted sand, dry	
23.0					SW **Gravelly Sand** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 5/8"; well graded well sorted sand, dry	
24.0					SW **Sand** brown, trace fine gravel, well graded well sorted sand, dry	
25					GP **Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"; some well graded sand, dry	
25.0					GP **Sand and Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; well graded poorly sorted sand, dry	
26.0					SW **Sand and Gravel** brown and gray, fine gravel, dry	
28.0					GP **Sand and Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; well graded poorly sorted sand, dry	Very little recovery, 28-29 feet
29.0					SW **Gravelly Sand** brown, angular to subangular gravel, 70% of clasts are fractured, clasts up to 3/4"; well graded well sorted sand, dry	
30					SW **Sand** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 5/8"; well graded sorted sand, dry	
30.0					GP **Sand and Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4"; well graded poorly sorted sand, dry	
31.0					SW **Sand** brown, some subangular to subrounded gravel, clasts up to 3/4"; well graded well sorted sand, dry	No recovery, 37-38 feet
32.0					SW **Sand** brown, trace fine gravel, well graded well sorted sand, dry	
34.0					GP **Sand and Gravel** brown, angular to subrounded, 30% of clasts are fractured, clasts up to 3/4"; well graded well sorted sand, dry	No recovery, 40-41 feet
35					SW **Sand** brown, trace fine gravel, well graded well sorted sand, dry	
35.0					GP **Sandy Gravel** brown, angular to subrounded, 30% of clasts are fractured, clasts up to 1/2"; well graded sand, dry	
36.0					GP **Gravel** gray, angular to subangular gravel, 90% of clasts are fractured, clasts up to 5/8"; some well graded sand, dry	
37.0					GP **Sand and Gravel** brown, angular to subrounded, 30% of clasts are fractured, clasts up to 3/4"; well graded well sorted sand; dry	
38.0					GP **Gravel** gray, angular to subrounded gravel, 60% of clasts are fractured, clasts up to 1/2"; some well graded sand, dry	Native material used as backfill from 39 feet to 51 feet due to the high permeability in this area (750 gallons of grout installed in annual space of nearby piezometer with no return at surface)
40						
40.0						
41.0						
42.0						
43.0						
44.0						
45						
45.0						
48.0						
49.0						

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53S

DATE STARTED 10/26/07 **COMPLETED** 10/26/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1059.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171885.9 feet **EASTING** 1379651.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB					
					51.0 GP **Gravel** gray, angular to subangular gravel, 90% of clasts are fractured, clasts up to 1"; some well graded sand, dry	
					GP **Sand and Gravel** gray, angular to subrounded gravel, 80% of clasts are fractured, clasts up to 1"; well graded sand, dry	Clasts up to 1/2", 53-54 feet
					53.0 GP **Gravel** gray, angular to subangular gravel, 90% of clasts are fractured, clasts up to 1"; some well graded sand, dry	Clasts up to 1", 54-57 feet
55	GB				SP **Sand and Gravel** gray, angular to subrounded gravel, 80% of clasts are fractured, clasts up to 1/2"; well graded sand, dry	
					GP **Gravel** gray, angular to subangular gravel, 90% of clasts are fractured; some well graded sand, dry	Clasts up to 1/2", 57-59 feet
					59.0 SW **Sand** brown, little gravel, fractured, clasts up to 1/8"; predominantly fine to coarse grained sand, dry	Little recovery, 59-61 feet
60	GB				61.0 GP **Gravel** brown, angular to subangular gravel, 80% of clasts are fractured, clasts up to 1/2"; some fine to coarse gained sand, dry	
		▼			62.0	No recovery, 62-64 feet
					64.0	Adding water while drilling, 63-65 feet
65	GB				65.0 GP **Gravel** subangular gravel, 75% of clasts are fractured, clasts up to 1/2"; little coarse grained sand, moist	
					66.0 GP **Gravel** subangular gravel, 75% of clasts are fractured, clasts up to 1/2"; some sand	No recovery, 66-67
					67.0 GP **Gravel** subangular gravel, 75% of clasts are fractured, clasts up to 1/2"; some sand, wet	
			Trace Flow		69.0	Water encountered, 68 feet
70	GB				70.0 SP **Sand** brown, fine angular gravel, most clasts are fractured, clasts up to 1/8"; coarse grained sand, wet	Adding water while drilling, 69-70 feet More sand present, 69-70 feet
					71.0 GP **Gravel** angular to subrounded gravel, 50% of clasts are fractured; some predominantly coarse grained sand, wet	No recovery, 70-71 feet
						Clasts up to 3/4", 71-75 feet
75	GB					Adding water while drilling, 73-74 feet In order to install piezometer at targeted depth native material was used to backfill the hole to 73.2 feet Clasts up to 1 1/4", less sand present, 75-81 feet

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

THE pebble PARTNERSHIP

P-07-53S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-07-53S

DATE STARTED 10/26/07 **COMPLETED** 10/26/07 **GROUND ELEVATION** 1057.38 feet **TOC ELEVATION** 1059.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171885.9 feet **EASTING** 1379651.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB				GP **Gravel** angular to subrounded gravel, 50% of clasts are fractured; some predominantly coarse grained sand, wet	
					82.0 Bottom of hole at 82.0 feet.	

2007 PEBBLE LOGS 2007 PEBBLE.GPJ PEBBLE2.GPJ 3/19/08

WELL DEVELOPMENT LOG

Well ID: P-07-535
Date: 10/30/07
Project: 2007 Well Development
Project #: 005.0189.07002
Technician: Ramona Batcheldor

Summary

	Installed (Well Log)	Start	End
Water level	63.69'	66.65'	63.74'
Total depth	82'7"	76.95'	76.58'
pH	—	7.42	6.80

Screen interval (btoPVC): 9'8"
Top: 62'6"
Bottom: 72'10"
PVC stick-up height (above ground surface): 2'6"

Development Observations

pH	Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
	Surge block on Start @ 1106								
7.42	1127	72'4"	—	1.5	31.5	106	43.1	3.55	Cloudy 1 tsp. fine drk. Brown Sand
6.88	1152	72'4"	—	1.5	69	52	34.16	3.62	Slightly Cloudy 1/4 tsp. fine sand
—	1203	—	—	—	—	—	moved ↑2'		Restart @ 1206
6.89	1219	70'4"	—	1.25	99	52	119	3.59	Drk. Cloudy 2 tsp. fine drk. brwn sand
6.75	1243	70'4"	—	1.25	129	50	28.6	3.48	tan translucent 1 tsp. fine sand
—	1252	—	—	—	—	—	moved ↑2'		Restart @ 1259
6.91	1309	68'4"	—	1.25	152.75	50	642	3.47	Chocolate Brwn 1 1/2 Tbl. fine sand
6.92	1334	68'4"	—	1.25	184	51	314	3.52	light Chocolate Brwn 1 tsp. fine sand
6.90	1357	68'4"	—	1.25	212.75	49	23.9	3.51	tan translucent 1/2 tsp. fine sand
—	1405	—	—	—	—	—	moved ↑2'		Restart @ 1409
6.91	1419	66'4"	—	1.5	239.75	51	198	3.70	light Chocolate Brwn 1/2 tsp. fine Sand
6.99	1448	66'4"	—	1.25	276	52	102	3.34	translucent lightly Cloudy 1 tsp. fine sand
7.0	1510	66'4"	—	1.25	303.5	51	101	3.4	light-tan-translucent 3/4 tsp. fine sand
7.0	1529	66'4"	—	1.25	327.25	52	35.8	3.44	light-tan-translucent 1/4 tsp. fine sand
—	1535	64'4"	—	—	—	—	moved ↑2'		Restart @ 1541
6.82	1552	64'4"	—	1.25	356	51	328	3.37	Chocolate Brwn 1 Tbl. fine drk. Brwn. Sand
6.98	1620	64'4"	—	1.25	391	51	181	3.31	light Chocolate Brwn 1/2 tsp. fine drk Brwn Sand
7.01	1635	64'4"	—	1.25	409.75	51	136	3.29	" " " "
—	1642	—	—	—	—	—	—	—	Shut down for day
10/31/07	1057	64'4"	—	—	—	—	—	—	Start pump
—	1124	64'4"	—	—	—	—	shut down to refuel		Restart @ 1134
7.11	1143	64'4"	—	1.5	474.25	65	22	2.97	Clear 1/4 tsp. fine sand
—	1149	—	—	—	—	—	moved ↓		to debris Surge
—	—	—	—	—	—	—	—	—	—
	Surge block off Start debris @ 1208								
6.79	1220	72'4"	—	3.5	537.25	54	12.27	3.13	clear w/ trace of fine sand
6.80	1249	72'4"	—	3.5	638.75	60	11.03	3.09	" " " "
—	1250	—	—	—	—	—	moved ↑ to Polish		Restart @ 1310
—	1315	56'6"	—	—	—	—	shut down - no water - well complete		

THE pebble PARTNERSHIP

P-08-54D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54D

DATE STARTED 4/18/08 **COMPLETED** 4/21/08 **GROUND ELEVATION** 1071.4 feet **TOC ELEVATION** 1074.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155638.4 feet **EASTING** 1401547.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** dark brown, woody debris, moist	Re-drilled using mud rotary in order to install 8" conductor casing, 0-20 feet
			no flow			
5	GB					
			no flow		7.0	
					SP **Sand and Organic Soil** brown, trace fine gravel, poorly graded, well sorted coarse grained sand, moist	
					9.0	
10	GB				GP **Gravel with Sand** brown, angular to subangular gravel, 25% of clasts are fractured, clasts up to 3/4", poorly graded, well sorted coarse grained sand, trace silt, wet	
			no flow		12.0	
					GP **Gravel with Sand** brown, angular to subangular gravel, <10% of clasts are fractured, clasts up to 3/4", poorly graded, well sorted coarse grained sand, moist	
					14.0	
15	GB				GM **Silty Gravel with Sand** brown, subangular gravel, <10% of clasts are fractured, clasts up to 1/2", well graded, well sorted medium to coarse grained sand, silt, wet	Discharge water brown; losing fines, 14-20 feet Sample washed, 15 feet
					15.0	
			no flow		ML **Silt and Gravel** brown, subangular gravel, <10% of clasts are fractured, clasts up to 1/2", trace coarse grained sand, brown non-plastic silt, wet	
					18.0	
					GM **Silty Gravel** brown, subangular gravel, <10% of clasts are fractured, clasts up to 3/4", trace coarse grained sand, brown non-plastic silt, wet	
20	GB				20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 5 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is flowing)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is flowing)

Comments: Piezometer is flowing (artesian); Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-54D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54D

DATE STARTED 4/18/08 **COMPLETED** 4/21/08 **GROUND ELEVATION** 1071.4 feet **TOC ELEVATION** 1074.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155638.4 feet **EASTING** 1401547.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						No recovery, 20-22 feet
					22.0	
					GP **Gravel with Sand** brown to gray, subangular to subrounded gravel, clasts up to 3/4", trace silt	Adding water while drilling, 22-46 feet
					24.0	
25	GB				GP **Sandy Gravel** multicolored, subangular to subrounded gravel, clasts up to 1", trace silt	Discharge water brown, 24-26 feet
					25.0	No recovery, 25-26 feet
					26.0	
					GP **Sandy Gravel** multicolored, subangular to subrounded gravel, clasts up to 1", trace silt	Discharge water gray, 26-37 feet
					28.0	
					SP **Sand and Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2"	
					29.0	Silt balls, 29-34 feet
30	GB				SM **Sand and Silty Gravel** multicolored, angular to subrounded gravel, clasts up to 1/2", coarse grained sand, gray silt	Sample washed, 30 feet
					32.0	
					ML **Gravelly Silt** angular to subrounded gravel, clasts up to 1/2"	
					34.0	No recovery, 34-35 feet
35					35.0	
	GB				ML **Gravelly Silt** multicolored, gravel, clasts up to 1/4"	Silt is gray, 35-37 feet Silt balls, 35-39 feet
						Silt is brown, 37-39 feet
						Discharge water is brown, 37-46 feet
					39.0	
40	GB				GW **Sandy Gravel** multicolored, angular to subangular gravel, clasts up to 3/4", fine to coarse grained sand, gray silt	
					42.0	
					GW **Sandy Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", medium to coarse grained sand	
					43.0	
					SW **Gravelly Sand** multicolored, subangular to subrounded gravel, fine to coarse grained sand	
					44.0	
45	GB				GW **Sandy Gravel** multicolored, angular to subangular gravel, clasts up to 1", fine to coarse grained sand	
					46.0	Clasts up to 1 1/4", 46-50 feet
					SP **Sand with Gravel** orangey brown, angular gravel, most of the clasts are fractured	Encountered water, 46 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-54D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54D

DATE STARTED 4/18/08 **COMPLETED** 4/21/08 **GROUND ELEVATION** 1071.4 feet **TOC ELEVATION** 1074.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155638.4 feet **EASTING** 1401547.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50	GB				51.0	Clasts up to 3/8", 50-51 feet
					GW **Sandy Gravel** orangey brown, angular gravel, most of the clasts are fractured, clasts up to 3/4"	Discharge water is brown; losing fines, 52-65 feet
55	GB					
60	GB				64.0	
65	GB				SP **Gravelly Sand** light brown, subangular gravel, 25% of clasts are fractured, clasts up to 1/2", well graded, poorly sorted medium to coarse grained sand, wet	
70	GB				71.0	
					GW **Sandy Gravel** tannish white, gravel, most of the clasts are fractured, clasts up to 3/4", coarse grained sand	
75	GB				76.0	
					77.0 GW **Sandy Gravel** brown to gray, subangular gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	No recovery, 77-80 feet
	GB				80.0	Discharge water is almost clear, 77 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-54D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54D

DATE STARTED 4/18/08 **COMPLETED** 4/21/08 **GROUND ELEVATION** 1071.4 feet **TOC ELEVATION** 1074.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155638.4 feet **EASTING** 1401547.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			14		GW **Sandy Gravel** grayish brown, subangular gravel, 25% of clasts are fractured, clasts up to 1/2"	Discharge water is dark gray, 80-81 feet
					82.0	DTW was rising when measured; drilling depth 81 feet
					SW **Sand with Gravel** subangular gravel, 35% of clasts are fractured, clasts up to 1/4", well graded, well sorted medium to coarse grained sand	Discharge water is brown, 81-82 feet
85	GB					
						DTW was rising when measured; drilling depth 86 feet
					88.0	
					GP **Gravel** gravel, clasts up to 1/2"	
					89.0	
90	GB				SW **Sand with Gravel** brown to gray, subangular gravel, 25% of clasts are fractured, clasts up to 1/4", well graded, well sorted fine to coarse grained sand, wet	
					93.0	Slow drilling, 92-93 feet
95					**Bedrock (Tertiary Basalt)** bluish gray to black, crystalline, weak to moderately magnetic, small olivine grains (less than 1mm)	
						Very slow drilling, 97 feet
100			22			
						Moved to open hole hammer, 102 feet
105			40			
			36			
			38			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-54D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54D

DATE STARTED 4/18/08 **COMPLETED** 4/21/08 **GROUND ELEVATION** 1071.4 feet **TOC ELEVATION** 1074.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155638.4 feet **EASTING** 1401547.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110						
			38		**Bedrock (Tertiary Basalt)** bluish gray to black, crystalline, weak to moderately magnetic, small olivine grains (less than 1mm)	
			38			
					114.7	
					Bottom of hole at 114.7 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-54D. Flowing well. Plugged after drilling.

THE pebble PARTNERSHIP

P-08-54S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54S

DATE STARTED 4/16/08 **COMPLETED** 4/17/08 **GROUND ELEVATION** 1071.3 feet **TOC ELEVATION** N/R feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155637.2 feet **EASTING** 1401527.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-8 feet
						Water in borehole, 1.15 feet
5						
			no flow		8.0	
10	GB				GW **Gravel** brown, angular to subangular gravel, <10% of clasts are fractured, clasts up to 3/4", wet	
					11.0	No recovery, 11-13.5 feet
			no flow		13.5	
15					GW **Gravel** brown, angular to subangular gravel, <10% of clasts are fractured, clasts up to 3/4", wet	Clasts up to 3/4", 13.5-16 feet
					17.0	Clasts up to 1/2", 16-17 feet
					SM **Silty Sand** brown, trace gravel, clasts up to 1/4", well graded, poorly sorted sand, wet	Discharge water brown, 17-18.5 feet
			no flow		18.5	No recovery, 18.5-20 feet
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: N/R
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: N/R

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is flowing)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is flowing)

Comments: Piezometer is flowing (artesian); Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-54S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-54S

DATE STARTED 4/16/08 **COMPLETED** 4/17/08 **GROUND ELEVATION** 1071.3 feet **TOC ELEVATION** N/R feet

DRILLING CONTRACTOR Foundex **NORTHING** 2155637.2 feet **EASTING** 1401527.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Gravel with Silt** brown, subangular gravel, <10% of clasts are fractured, clasts up to 1/2", wet	
		9.12	no flow			
25					25.0 GM **Silty Gravel** brown, subangular gravel, clasts up to 1/2", wet	
			no flow		28.5	
					29.0	No recovery, 28.5-29 feet Adding water while drilling, 29-45 feet
30	GB				30.0 GP **Gravel with Sand** brown, angular to subangular gravel, clasts up to 1/2", poorly graded, well sorted coarse grained sand, wet	Sample washed (fines lost), 30 feet No recovery, 30-32 feet
					32.0	
					GM **Gravel with Silt** brown, angular to subangular gravel, clasts up to 1/2", wet 33.0	No recovery, 33-34 feet
					34.0	
35	GB				GM **Gravel and Silt** brown, angular to subangular gravel, clasts up to 1/2", wet 35.0	Sample washed (fines lost), 35 feet
					GM **Silt and Gravel with Sand** brown, angular to subangular gravel, clasts up to 1/4", coarse grained sand, non-plastic brown silt, wet	
40	GB					Sample washed (fines lost), 40 feet
					43.5	
					44.0	No recovery, 43.5-44 feet
45	GB				GP **Gravel with Sand** angular to subangular gravel, <10% of clasts are fractured, clasts up to 3/4", poorly graded, well sorted coarse grained sand, wet	Sample washed, 45 feet
			0.5			
			14		47.0	
					Bottom of hole at 47.0 feet.	DTW was rising when measured; drilling depth 47 feet Boring terminated in order to control artesian flow; no 8" conductor casing had been installed prior to drilling, total depth = 47 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-54S. Flowing well. Plugged after drilling.

THE pebble PARTNERSHIP

P-08-55D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55D

DATE STARTED 4/22/08 **COMPLETED** 4/25/08 **GROUND ELEVATION** 989.8 feet **TOC ELEVATION** 992.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152842.25 feet **EASTING** 1403812.43 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** brown, organic, woody	Re-drilled using mud rotary in order to install 8" conductor casing, 0-20 feet
5	GB	▼				
					5.0 **Topsoil** gray, some subangular gravel, clasts up to 1/2", brown silt	Discharge water is brown, 6-16 feet
					7.0 GM **Gravel and Silt** gray, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", some coarse grained sand	
10	GB				9.0 ML **Gravelly Silt** gray, subangular gravel, clasts up to 3/8" 10.0	No recovery, 10-15 feet
15					15.0	
	GB				ML **Silt** gray, trace subrounded gravel, clasts up to 3/4" 16.0	No recovery, 16-21 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 250# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/17/2008
Purge Volume: 1316 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/2/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 4/25/08 at 200 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-55D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55D

DATE STARTED 4/22/08 **COMPLETED** 4/25/08 **GROUND ELEVATION** 989.8 feet **TOC ELEVATION** 992.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152842.25 feet **EASTING** 1403812.43 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	
					ML **Silt with Sand** multicolored, medium to coarse grained sand, gray silt, wet	Adding water while drilling; discharge water is gray, 21-36 feet Silt balls, 21-37 feet
					23.0	
					ML **Silt** gray, trace gravel, clasts up to 3/4", trace medium to coarse grained sand, wet	
25	GB					
						Little recovery, 26-27 feet
					27.0	
					ML **Silt with Gravel and Sand** multicolored, subrounded gravel, clasts up to 1/2", well graded sand, gray silt	
					29.0	
30	GB				ML **Sandy Silt with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, gray silt	
35	GB				35.0	
					ML **Gravelly Silt and Sand** multicolored, subangular to subrounded gravel, clasts up to 1", coarse grained sand, gray silt	
					36.0	
					ML **Silt** multicolored, trace coarse grained sand, gray silt	
					37.0	
					ML **Sandy Silt with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, gray silt	
					38.0	
					GM **Silty Gravel with Sand** angular gravel, 50% of clasts are fractured	
					39.0	Discharge water is gray, 39-40 feet Encountered water, 39.5 feet
40	GB				SW **Gravelly Sand** multicolored, angular to subrounded gravel, clasts up to 1", well graded sand, trace silt	
			1			DTW was rising when measured; drilling depth 42 feet
					43.0	
					GW **Gravel and Sand** multicolored, angular to subrounded gravel, clasts up to 1", well graded sand, trace silt	
45	GB				45.0	Discharge water is gray, 45-46 feet
					SW **Sand and Gravel** multicolored, subangular to subrounded gravel, clasts up to 1", well graded sand, trace gray silt	
					46.0	Discharge water is brown, 46-52 feet 25% of clasts are fractured; clasts up to 1", 46-51 feet
					GW **Sandy Gravel** multicolored, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", well graded sand, silt coated	
			6			DTW was rising when measured; drilling depth 48 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-55D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55D

DATE STARTED 4/22/08 **COMPLETED** 4/25/08 **GROUND ELEVATION** 989.8 feet **TOC ELEVATION** 992.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152842.25 feet **EASTING** 1403812.43 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			10.5		GW **Sandy Gravel** multicolored, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", well graded sand, silt coated	<10% of clasts are fractured; clasts up to 3/4", 51-52 feet
					52.0 GW **Gravel with Sand** black and brown, angular to subrounded gravel, 25% of clasts are fractured, fine to coarse grained sand, trace silt	DTW was rising when measured; drilling depth 52 feet
					54.0	Discharge water is brownish gray, 52-55 feet
55	GB				SW **Gravelly Sand** dark brown, subangular gravel, clasts up to 1/2", some silt	
					56.0 GW **Sandy Gravel** black and brown, subangular to subrounded gravel, clasts up to 1", fine to coarse grained sand, trace silt	Discharge water is brown, 55-82 feet
					57.0 GW **Sand and Gravel** multicolored, silt coated subangular to subrounded gravel, clasts up to 1", fine to coarse grained sand, brown silt	DTW was rising when measured; drilling depth 57 feet
60	GB					
			21		62.0 GW **Gravel with Sand** multicolored, angular to subrounded gravel, clasts up to 1 1/4", fine to coarse grained sand, some partially oxidized clasts	DTW was rising when measured; drilling depth 62 feet
					63.0 GW **Sandy Gravel** subangular to subrounded gravel, clasts up to 1", well graded fine to coarse grained sand, some oxidized clasts	
65	GB					
					67.0 GW **Sand and Gravel** grayish white, subangular to subrounded gravel, clasts up to 3/4", well graded sand, some oxidized clasts	
			1.5			More clasts are oxidized, 69-70 feet
70	GB					Less clasts are oxidized; clasts are silt coated, 70-72 feet
			23.3		72.0 GP **Gravel with Sand** multicolored, silt coated subangular to rounded gravel, clasts up to 1", medium to coarse grained sand, brown silt	
					74.0 GP **Gravel and Sand** multicolored, subangular gravel, clasts up to 3/4", fine to coarse grained sand, some oxidized clasts	
75	GB					
			1		77.0 GW **Gravel and Sand** white and brown, silt coated subangular gravel, clasts up to 1", well graded sand	
	GB				80.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-55D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55D

DATE STARTED 4/22/08 **COMPLETED** 4/25/08 **GROUND ELEVATION** 989.8 feet **TOC ELEVATION** 992.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152842.25 feet **EASTING** 1403812.43 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					GW **Sandy Gravel** white and brown, silt coated subangular gravel, clasts up to 1", well graded sand	
					81.0 GW **Gravel and Sand** white and brown, silt coated subangular gravel, clasts up to 1", well graded sand	
			1		82.0 SW **Gravelly Sand** grayish white, angular to subangular gravel, clasts up to 1 1/4", well graded, poorly sorted sand, trace silt, oxidized	Discharge water is grayish brown, 82-85 feet
85	GB					Discharge water is orangy brown, 85-91 feet
					86.0 GW **Gravel and Sand** grayish white, angular to subangular gravel, clasts up to 1 1/4", well graded, poorly sorted sand, trace silt, oxidized	
					87.0 **Bedrock** light to very dark brown, oxidized	
					89.0 **Bedrock** light to dark brown, bluish gray crystalline with oxidized clasts	
90	GB		75			Slow drilling, 90-91 feet
			13			Discharge water is more clear, 91-95 feet
95	GB		10			
			21		96.0 **Bedrock** bluish gray, crystalline	Discharge water is grayish brown, 96-97 feet
		3.19				Moved to open hole hammer, 97.5 feet
			30			
100			32			
			32			
			36			
105			36			Discharge water is milky white, 106.5-115 feet
			48			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-55D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55D

DATE STARTED 4/22/08 **COMPLETED** 4/25/08 **GROUND ELEVATION** 989.8 feet **TOC ELEVATION** 992.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152842.25 feet **EASTING** 1403812.43 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			54		**Bedrock** bluish gray, crystalline	
			54			
			54			
115					115.0	
					115.3	Not logged, 115-115.3 feet
					Bottom of hole at 115.3 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-55 ~~S~~ D
Date: 6/16/08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer / V. Webb / Mike Canti

Summary

	Installed (Well Log)	Start	End
Water level	3.35	0.69	1.95
Total depth	115.3	117.98	117.30
pH		6.66	8.56

Screen interval (btoPVC): ~~107~~ 10'
Top: ~~107~~ 107.98
Bottom: ~~117~~ 117.98
PVC stick-up height (above ground surface): 2.41

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1134 - START - 1' off bottom									
1202	116.98	0.69	3.5	98	.167	1000*	5.09	fine sand-silt, milky, ≈ ½ tbsp	
1225	↓	—	4.25	195.75	0.166	655	4.26	fine sd-silt, milky, ~ ½ Tsp	6.66
1233	114.98	—						Move ↑ 2' - START	–
1305	114.98	—	3.0	291.75	0.163	606	4.25	fine sd-silt, milky ~ ½ Tsp	6.69
1315	112.98	—	3.0	321.75				Move ↑ 2' - START	–
1342	—	—						~~Pump~~ ~~Recharge~~ Stop - replace foot va	
1405	112.98	—						Restart	–
1430	112.98	—	2.5	354.25	0.167	420	4.92	fine sd, silt, milky ~ ½ tsp	6.62
1448	110.98	—						Move ~~up~~ 2' - START	–
1510	↓		2.5	409.25				-STOP - out of gas	–
1539	↓	—						START	–
1610	↓		4.0	533.25	0.172	171	4.65	fine sd-silt, milky, trace	6.78
1645	108.98	—						Move ↑ 2' - START	–
1712	↓	—	4.0	641.25	0.190	202	4.97	fine sd-silt, milky, trace	6.90
6/17/08 1221	108.98	.78						start	
1315	↓	—	3.0	779.25	0.189	437	6.37	fine sd-silt, milky, trace	8.73 recheck
1330	STOP	- Surge block / foot valve fell off							
1345	START								
1400	108.98	—	1.5	846.75	0.201	620	5.98	fine sd-silt, milky, trace	7.11
1410	106.98	—						Move ↑ 2' - START	~~6.83~~
1455	↓	—	4.25	1038.0	0.135	620	5.13	fine sd, silt, milky, trace	6.82
Surge block off 1535 - START - 5' off top of screen									
dlisl 1535	102.98	—						Move 5' above screen - START	
1615	↓	—	2.25	1128.0	0.276	620	5.75	fine sd, silt, milky, trace	6.98
chris 1630	116.98	—						Move 1' above bottom - START	–
1720	116.98	—	3.75	1315.5	.141	287	5.00	fine sd, silt, milky, trace	8.56

* over turbidimeter limit

THE pebble PARTNERSHIP

P-08-55S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55S

DATE STARTED 4/26/08 **COMPLETED** 4/28/08 **GROUND ELEVATION** 989.7 feet **TOC ELEVATION** 993.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152825.3 feet **EASTING** 1403811 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** mixed with ice	Re-drilled using mud rotary in order to install 8" conductor casing, 0-20 feet
		▼			3.0	
					Topsoil brown, frozen, some ice	
					4.0	
5					**Topsoil** brown, trace subrounded gravel, clasts up to 1/2", silt	
					5.0	
					ML **Silt** brown, trace subrounded gravel, clasts up to 1/2"	
					8.0	
					ML **Silt and Gravel** brown, subrounded gravel, clasts up to 1/2", wet	
10	GB					
					13.0	
					ML **Silt** brown, trace subrounded gravel, clasts up to 3/8", moist	
15	GB					
					18.0	
					ML **Silt** gray, trace gravel, clasts <1/4"	Adding water while drilling; discharge water is gray, 18-23 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 250# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/17/2008
Purge Volume: 1381 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/2/2008

Comments: Static Water Level not measured; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-55S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55S

DATE STARTED 4/26/08 **COMPLETED** 4/28/08 **GROUND ELEVATION** 989.7 feet **TOC ELEVATION** 993.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152825.3 feet **EASTING** 1403811 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt** gray, trace gravel, clasts <1/4"	
					23.0	
					ML **Silt with Sand** brown, medium to coarse grained sand, wet	Adding water while drilling, 23-39 feet
					24.0	
25	GB				ML **Silt** trace coarse subangular gravel, clasts up to 3/8", wet	No recovery, 25-28 feet
					25.0	
					28.0	
					Boulder or Cobble gray, subangular to subrounded fragments, fragements up to 3/8", pulverized rock, wet	Slow drilling, 28-30 feet
30	GB				31.0	
					ML **Silt and Gravel** gray, fine gravel, clasts up to 1/4", trace coarse grained sand, wet	
					33.0	
					ML **Silt with Gravel** grayish brown, fine subangular gravel, clasts <1/4", wet	
35	GB				36.0	
					ML **Gravelly Silt** grayish brown, fine gravel, clasts <1/4", wet	
					37.0	
					GP **Gravel and Silt** grayish brown, fine gravel, clasts up to 1/4", wet	
					38.0	
					GP **Gravel** fine subangular to subrounded gravel, clasts up to 3/8", trace silt, wet	
40	GB				39.0	More fine gravel than rest of unit, 39-40 feet
					GW **Sand and Gravel** subangular gravel, medium to coarse grained sand	Encountered water, 39.5 feet
						More coarse gravel than rest of unit, 40-42 feet
					42.0	
					GW **Gravel and Sand** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, well graded sand	Discharge water is gray, 42-46 feet
						Clasts up to 1", 42-43 feet
						Clasts up to 1 1/2", 43-47 feet
45	GB					
		12.85			47.0	
					GW **Sandy Gravel** multicolored, <10% of clasts are fractured, clasts up to 1 1/2", well graded sand	Subangular to subrounded gravel, 47-51 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-55S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-55S

DATE STARTED 4/26/08 **COMPLETED** 4/28/08 **GROUND ELEVATION** 989.7 feet **TOC ELEVATION** 993.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2152825.3 feet **EASTING** 1403811 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50		35.84			GW **Sandy Gravel** multicolored, <10% of clasts are fractured, clasts up to 1 1/2", well graded sand	Subangular to rounded gravel, 51-56 feet
55	GB		10.5			Discharge water is gray, 55-57 feet
		10.16	10		56.0 GW **Sand and Gravel** multicolored, subangular to rounded gravel, <10% of clasts are fractured, clasts up to 1 1/2", well graded sand	Discharge water is brown, 57-58 feet
					57.0 SW **Gravelly Sand** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", well graded sand	
60	GB				58.0 GW **Sand and Gravel** multicolored, angular to subrounded gravel, clasts up to 1 1/2", fine to coarse grained sand, wet	
					60.0 GW **Sandy Gravel** multicolored, angular to subrounded gravel, clasts up to 1 1/2", fine to coarse grained sand, wet	DTW was rising when measured; drilling depth 62 feet
					61.0 SW **Gravelly Sand** multicolored, subangular to subrounded gravel, clasts up to 3/4", well graded brown sand, wet	Cuttings are multicolored, 62-66 feet
65	GB				62.0 SW **Sand and Gravel** angular to subrounded gravel, clasts up to 1", well graded sand, oxidized	
					67.0	Cuttings are grayish white, 66-67 feet
					67.4	Not logged, 67-67.4 feet
					Bottom of hole at 67.4 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-55~~8~~5
Date: 6-15-08
Project: Pebble
Project #: 005.0189.08002
Technician: C. Kramer / V. Webb

Summary

	Installed (Well Log)	Start	End
Water level	~~[illegible]~~ NA	0.56	
Total depth	65.2~~[illegible]~~	69.66	
pH		7.04	7.20

Artesian

Screen interval (btoPVC): ~~[illegible]~~ 20'
Top: ~~[illegible]~~
Bottom: ~~[illegible]~~ 69.66

PVC stick-up height (above ground surface): 2.98

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	
Surge block on 1301 - START 1' off bottom									7.04
1321	68.66	0.56	2.25	45	0.207	1000*	4.39	silty, med brown H_2O ; 1 Tbsp	-
1344	↓	—	2.25	96.75	0.206	435	4.17	SILT, Med. brown, < 1 tsp	6.99
1351	66.66							Move ↑ 2' - START	-
1410	↓	—	2.50	144.25	0.204	435	4.44	SILT, light brown, < 1 tsp	7.02
1431	↓	—	2.75	207	0.204	514	4.41	SILT, light brown < 1 Tsp	7.01
1435	64.66							Move ↑ 2' - START	-
1455 ~~[illegible]~~	↓	—	2.75	257	0.204	395	4.96	SILT, light brown, ~ 1/2 Tsp	7.00
1520	↓	—	2.50	319.5	0.206	142	4.60	fine Sand/SILT, lt-med brown ≈ 1 Tsp	7.06
1525	62.66							Move ↑ 2' - START	-
1600	↓	-	2.0	389.5	0.206	50	4.75	trace sed, lt. gray	7.18
1606	60.66							Move ↑ 2' - START	-
1629	↓	-	2.75	429.75	0.206	116	4.65	SILT, lt. brown, trace	7.20
6-15-08 1651	↓	-	1.75	468.25	0.207	39	4.52	fn-sand lt. gray, trace	7.08
1655	58.66	—	~~[illegible]~~	477				Move ↑ 2' - START = off-site 1700	-
6-16-08 1027	58.66	0.61						Restart - on-site	-
1107	↓	—	2.25	567	0.228	88	4.88	fine Sand, med-gray-lt.brown, 2 tsp	7.14
1115	56.66							Move ↑ 2' - START	-
1205	↓	—	2.00	667	0.215	199	4.30	fine Sand-silt, Med-gray-lt.brown, 2 tsp	6.93
~~[illegible]~~								Move ↑ 2' - START	-
1230	↓	—	1.75	710.75	0.215	99	3.92	fine sand, silt, med-gray-lt-brown, 2 tsp	6.88
1236	54.66							Move ↑ 2' - START	-
1300	54.66	—	1.50	746.75	0.214	99	4.30	fine sand, silt, med-gray/light brown, ~ 1 tsp	7.06
1326	52.66							Move ↑ 2' - START	-
1406	↓		2.0	786.75	0.207	642	4.82	fine Sand-silt, med-gray-lt.brown ≈ 1 Tsp	6.97
1426 ~~[illegible]~~	↓		2.0	826.75	0.211	74	4.85	fine sd-silt, med-gray, lt.brown ~ 1 Tsp	7.01
1431	50.66							Move ↑ 2' - START	-
1515	↓	—	2.5	936.75	0.213	115	4.88	fine Sand, silt, lt. gray, ~ Tsp	6.89
1521	48.66							Move ↑ 2' - START	-
1607	↓	-	2.0	1028.75	0.219	67	4.79	fine Sand, lt. gray, trace	7.07

* - too high for turbidity meter

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-~~S~~SS-S

Date: 6-16-08

Project: Pebble

Project #: 005.0189.08002

Technician: C. Kramer/V. Webb

Summary

	Installed (Well Log)	Start (ARTESIAN)	End
Water level	N/A	0.56	1.70
Total depth	65.2	69.66	69.66
pH		7.04	7.20

Screen interval (btoPVC): ~~65~~ 20'

Top: ~~87.7~~ ~~59.66~~ 49.66

Bottom: ~~92.9~~ 69.66

PVC stick-up height (above ground surface): 2.98'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
	On Page 1							
Surge block off								
1637	44.66	—	2.0					Move 5' above screen
1715			2.0	1104.75				off-site
1227	44.66	.75	—					Start
1251	1	~~2.75~~	2.75	1110.75	.193	101	5.90	fine sd, lite gray, trace
1345	1	—	2.50	1245.75	0.175	23	5.00	
1350	68.66	—						Move 1' off bottom, re-initial KSI
1356	68.66	—						START
1450	—	—	2.50	~~1245~~ 1380.75	0.179	620	4.41	
1455		—						STOP

6/ Debris

7.87

7.84

8.20

THE pebble PARTNERSHIP

P-08-56D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56D

DATE STARTED 5/5/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.3 feet **TOC ELEVATION** 989.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150855.6 feet **EASTING** 1402964.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Organic Matter** rotting wood	Re-drilled using mud rotary in order to install 8" conductor casing, 0-20 feet
					2.0	No recovery, 2-6 feet
5						
					6.0	
					ML **Organic Matter** dark gray, trace angular gravel, most of the clasts are fractured, clasts up to 1/2", wet 7.0	Very little recovery, 6-12 feet
					ML **Silt with Sand** dark brown, trace gravel, fine grained sand, organic matter, wet	
10	GB					
					12.0	
					GP **Sand and Gravel** fine subangular to subrounded gravel, <10% of clasts are fractured, poorly sorted coarse grained sand	Discharge water is dark brown, 12-15 feet Clasts up to 1/4", 12-14 feet
15	GB					Clasts up to 1/2"; trace silt, 14-16 feet
					16.0	
		▼			GP **Sand and Gravel** fine gravel, <10% of clasts are fractured, clasts up to 1/4", poorly sorted coarse grained sand, trace silt, clean, wet 17.0	Discharge water is clearer, 16-17 feet Discharge water is brown, 17-19 feet
					GM **Silty Sand and Gravel** fine gravel, clasts <1/4", poorly sorted coarse grained sand, wet 19.0	
20	GB				GM **Silty Sand and Gravel** subangular gravel, 20% of clasts are fractured, clasts up to 1/4", poorly sorted 20.0	Added water while drilling; discharge water is brown, 19-20 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: N/R

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/19/2008
Purge Volume: 1265 gallons

RESPONSE TEST
Equipment: 48" Slug
Date: 6/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/8/08 at 135 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56D

DATE STARTED 5/5/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.3 feet **TOC ELEVATION** 989.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150855.6 feet **EASTING** 1402964.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					sand, wet	No recovery, 20-23 feet
					23.0 ML **Silt** brown, trace subangular gravel, clasts <1/4", wet	
25	GB					Brown discharge, 24-25 feet Added water while drilling; discharge water is brown; lots of fines, 25-32 feet Trace medium grained sand, 26-27 feet
					27.0 ML **Silt with Gravel** subangular gravel, 25% of clasts are fractured, clasts up to 1/4", trace coarse grained sand, wet	
					29.0	
30	GB				30.0 ML **Silt and Sand** trace subangular gravel, clasts <1/4", medium grained sand, wet	
					ML **Sandy Silt** trace subangular gravel, clasts up to 1/4", medium grained sand, wet	
					32.0	
35	GB				ML **Silt, Sand, and Gravel** fine gravel, clasts up to 1/4", poorly sorted medium grained sand, wet	Added water while drilling; discharge water is gray; losing fines, 32-67 feet
40	GB					
45	GB					
	GB				49.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56D

DATE STARTED 5/5/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.3 feet **TOC ELEVATION** 989.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150855.6 feet **EASTING** 1402964.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SM **Silty Sand and Gravel** subangular gravel, 10% of clasts are fractured, clasts up to 1/4", poorly sorted medium to coarse grained sand, wet	
					52.0 GM **Silty Gravel** gray, angular to subangular gravel, 30% fractured, clasts up to 1", some coarse grained sand, wet	
					53.0 SM **Silty Sand and Gravel** gray, angular to subangular gravel, 30% fractured, clasts up to 1", some coarse grained sand, wet	Slow drilling, 54-56 feet
55	GB				54.0 **Boulder or Cobble** black, angular, fractured, wet	
					55.0 GM **Silty Sand and Gravel** gray, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	Subangular gravel; clasts up to 3/4", 56-59 feet
					56.0 ML **Gravelly Silt with Sand** gray, <10% of clasts are fractured, coarse grained sand, trace clay, wet	
60	GB					Subangular to subrounded gravel; clasts up to 1", 59-60 feet Subangular gravel; clasts up to 3/4", 60-63 feet Less gravel than rest of unit, 60-62 feet
					63.0 GM **Silty Gravel with Sand** gray, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", well graded, poorly sorted sand, wet	
65					65.0 GM **Silty Gravel** gray, angular gravel, most of the clasts are fractured, clasts up to 3/4", trace sand, wet	
					67.0 GW **Gravel and Sand** multicolored, coarse grained sand, wet	Encountered water, 67 feet Adding water while drilling, 67-73 feet Discharge water is brown; lots of fines, 67-110 feet
			0.5		69.0 SW **Gravelly Sand** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 5/8", well graded sand, wet	Subangular to subrounded gravel; <10% of clasts are fractured; clasts up to 5/8", 67-69 feet Angular to subrounded gravel; 30% of clasts are fractured; clasts up to 1", 68-69 feet
70	GB				72.0 GW **Sandy Gravel** multicolored, angular to subrounded gravel, 30% fractured, clasts up to 3/4", coarse grained sand, wet	
					73.0 SM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", well graded sand, wet	
75	GB		<0.125		75.0 GW **Sandy Gravel** multicolored, angular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", well graded sand, wet	Adding water while drilling, 75-92 feet
					77.0 SP **Sand and Gravel** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	
	GB				80.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56D

DATE STARTED 5/5/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.3 feet **TOC ELEVATION** 989.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150855.6 feet **EASTING** 1402964.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			<0.125		GW **Sandy Gravel** brown, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", coarse grained sand, wet	
					82.0	
					SP **Sand and Gravel** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	
					83.0	
					ML **Sandy Silt and Gravel** brown, fine subangular gravel, wet	
85	GB				85.0	Subangular gravel, 85-87 feet
					SM **Silty Sand and Gravel** brown, clasts up to 1", coarse grained sand, wet	Subangular to subrounded gravel, 87-89 feet
					89.0	
90	GB		<0.125		SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", well graded sand, brown silt, wet	
					90.0	
					GP **Gravel with Silty Sand** multicolored, subangular to subrounded gravel, clasts up to 3/4", wet	Cuttings are brown, 91-94 feet
					91.0	
					SM **Gravelly Sand with Silt** subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", well graded sand, brown silt, wet	Cuttings are multicolored, 94-95 feet
95	GB		0.5			Cutting are brown, 95-97 feet
					97.0	
					SM **Silty Sand** multicolored, some fine gravel, well graded sand, wet	
100	GB		0.75			Clasts up to 3/8", 100-101 feet
					102.0	Coarse sand, 102-103 feet
					GW **Sand and Gravel** multicolored, angular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", coarse grained sand, wet	Well graded sand, 103-107 feet
105	GB					
					107.0	
					GW **Sand and Gravel** multicolored, most of the clasts are fractured, well sorted sand, wet	Clasts up to 1/2"; some orange staining, 108-111 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56D

DATE STARTED 5/5/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.3 feet **TOC ELEVATION** 989.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150855.6 feet **EASTING** 1402964.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			0.75			Discharge water is orangey brown, 110-115 feet
					111.0 GW **Sand and Gravel** multicolored, most of the clasts are fractured, clasts up to 3/4", well graded sand, trace silt, wet	Clasts up to 3/4", 111-112 feet
					112.0 GW **Sand and Gravel** multicolored, angular to subrounded gravel, clasts up to 3/4", well graded sand, trace silt, wet	
115	GB					Discharge water is brown, 115-117 feet
						Traces of weathered bedrock, 115-119 feet
						Discharge water is orangey brown, 117-122 feet
					119.0 **Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** dark brown to red, strong iron oxidation staining, weathered, fractured	
120	GB					Slow drilling, 120-122 feet
						Moved to open hole hammer, 122 feet
			12			Discharge water is orange, 123-131 feet
125	GB		11			
			11			
130	GB		12			
			11			Discharge water is light gray, 131-133 feet
			11			Discharge water is orange, 133-134 feet
135	GB		15		135.0 **Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** off white to dark red, fine grained anhedral groundmass of quartz and feldspars, weak iron oxidation staining	Discharge water is brown, 134-135 feet
						Discharge water is light gray, 135-140 feet
			15			
	GB		15			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56D
PAGE 6 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56D

DATE STARTED 5/5/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.3 feet **TOC ELEVATION** 989.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150855.6 feet **EASTING** 1402964.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					140.0	Not logged, 140-141.2 feet
					141.2 Bottom of hole at 141.2 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-56D
Date: 6-15-08
Project: Pebble
Project #: 005.0189.08002
Technician: ~~C Kramer~~ V Webb/M Jenti

Summary

	Installed (Well Log)	Start	End
Water level FTOC	16.65	8.50	8.32
Total depth FTOC	~~141.20~~	142.89	142.99
pH	12.50	6.73	6.41

Screen interval (btoPVC): 10' 12
(FTOC) Top: ~~132.89~~ 132.5
Bottom: ~~142.89~~ 142.5
PVC stick-up height (above ground surface): ~~3.48~~ 2.5

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1055 - START 1' off bottom									
1137	141.89	5 —	3.25	136.5	.246	40	5.87	very lite gray, fine sands, < ½ Tsp	6.73
1148	139.89	5						move 2' above screen - START	
1224	1	—	3.75	271.50	.239	41	6.28	Very lite gray/brn, fine sands, < ½ Tsp	
1238	~~137.89~~	5						move 2' above screen - START	
1315	1	—	3.75	410.25	.245	26	6.36	Very lite brown, fine sds, < ¼ Tsp	6.8
1340	135.89	5						move 2' above screen - START	
1425	1	—	4.25	601.50	.244	20	6.00	Very lite brown, fine sands, < ¼ Tsp	6.66
1435	133.89	5						Move 2' above screen - START	
1510	1	—	~~3.25~~	715.25	.242	11	6.53	clear, fine sds, less th ¼ Tsp	
1520	131.~~89~~	5						Move 2' above screen - START	
1558	1	—	3.50	848.25	.251	11	6.32	clear, fine sds, less than ¼ Tsp	6.72
Surge block off 5'									
Polish 1625	~~127.89~~	—						Move 4' from screen - start polish	
1655	1	—	4.0	968.25	.240	28	6.03	lite brown, fine sds, < ¼ Tsp	6.73
6/19/08 0800	127.~~89~~	5.10	3.75	1080.75	.522	28	4.62	lite brown, fine sands, < ¼ Tsp	6.52
Debris 0827	141.~~45~~	5 —						Move 1' off bottom - START	
0913	1	—	4.0	1267.5	.263	55	~~4.72~~	clear, trace sands, < ¼ Tsp	6.41

THE pebble PARTNERSHIP

P-08-56M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56M

DATE STARTED 4/30/08 **COMPLETED** 5/4/08 **GROUND ELEVATION** 987.1 feet **TOC ELEVATION** 989.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150835.8 feet **EASTING** 1402957.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. Loomis, S. O' Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil** snow and ice mixed with soil	Re-drilled using mud rotary in order to install 8" conductor casing, 0-20 feet Little recovery, 1-3 feet
					Topsoil mixed with ice, some organic matter	
					3.0 **Organic Soil** dark brown, moist	
					4.0 **Silt with Organic Soil** dark brown, moist	
5	GB					
					6.0 **Organic Soil and Silt** brown, moist	
					8.0 ML **Silt** dark brown, wet	Adding water while drilling, 8-12 feet
10	GB					
					13.0 SP **Sand and Gravel** subangular gravel, <10% of clasts are fractured, clasts up to 3/4", poorly sorted medium to coarse grained sand	Fine gravel, 13-18 feet
15	GB	▼				
					19.0	Fine to coarse gravel; cuttings are wet, 18-19 feet
20	GB				20.0 GM **Silty Sand and Gravel** fine gravel, clasts up to 5/8", medium to coarse grained sand, wet	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.4'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/18/2008
Purge Volume: 1135 gallons

RESPONSE TEST
Equipment: 48" Slug
Date: 6/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/5/08 at 1030 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56M
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56M

DATE STARTED 4/30/08 **COMPLETED** 5/4/08 **GROUND ELEVATION** 987.1 feet **TOC ELEVATION** 989.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150835.8 feet **EASTING** 1402957.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. Loomis, S. O' Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						No recovery, 20-22 feet
					22.0	
					ML **Silt with Gravel and Sand** gray, fine subrounded to rounded gravel, coarse grained sand, wet	Adding water while drilling; discharge water is gray, 22-36 feet Silt balls, 22-24 feet
					23.0	
						No recovery, 23-25 feet
25					25.0	
	GB				ML **Silt with Gravel and Sand** gray, fine subrounded to rounded gravel, coarse grained sand, wet	Silt balls, 25-26 feet
					26.0	
						No recovery, 26-27 feet Losing lots of fines, 26-36 feet
					27.0	
					ML **Sandy Silt** gray, trace fine gravel, fine to coarse grained sand	
					28.0	
					ML **Sandy Silt with Gravel** gray, fine subangular to rounded gravel, clasts up to 1/2", fine to coarse grained sand	
					29.0	No recovery, 29-32 feet
30	GB					
					32.0	
					ML **Silt with Sand** gray, fine grained sand	
					34.0	
					ML **Silt with Sand and Gravel** fine subangular to rounded gravel, clasts up to 1/2", fine grained sand	
35	GB				35.0	
					ML **Silt with Sand** trace fine subangular to rounded gravel, clasts up to 1/2", fine grained sand	
					36.0	No recovery, 36-38 feet
					38.0	
					ML **Gravel and Silt** multicolored, angular to subrounded gravel, clasts up to 3/4", gray silt	
					39.0	Silt balls, 39-41 feet
40	GB				ML **Silt with Gravel** gray, fine gravel	
					40.0	
					ML **Gravelly Silt** black, clasts up to 1", gray silt	
					41.0	No recovery, 41-42 feet
					42.0	
					ML **Silt with Gravel and Sand** multicolored, fine angular to subangular gravel, fine to coarse grained sand, gray silt	
45	GB					Adding water while drilling; discharge water is gray, 45-46 feet
					48.0	
					ML **Gravelly Silt with Sand** multicolored, subangular gravel, clasts up to 1/2", coarse grained sand, gray silt	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56M

DATE STARTED 4/30/08 **COMPLETED** 5/4/08 **GROUND ELEVATION** 987.1 feet **TOC ELEVATION** 989.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150835.8 feet **EASTING** 1402957.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. Loomis, S. O' Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					51.0	
					ML **Silt and Gravel with Sand** multicolored, subangular gravel, clasts up to 1/2", coarse grained sand, gray silt	Slow drilling, 52-54 feet
					52.0	
					GM **Silty Gravel with Sand** angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand	10% of clasts are fractured, 54-59 feet
					53.0	
					54.0	
55	GB				GP **Gravel** black, gravel, most of the clasts are fractured, clasts up to 3/4", wet	Adding water while drilling, 55-72 feet
					SM **Silty Sand and Gravel** fine gravel, 10% of clasts are fractured, clasts up to 3/8", medium to coarse grained sand, wet	More silt than rest of unit, 55-59 feet
60	GB					<10% of clasts are fractured, 59-72 feet
65	GB					
		57.55	no flow			
70	GB					
					72.0	
					GP **Sand and Gravel** fine subangular gravel, clasts up to 3/8", coarse grained sand, trace silt, wet	Encountered water, 72 feet
					74.0	
75	GB				GP **Sand and Gravel** fine subangular gravel, clasts up to 3/8", medium to coarse grained sand, wet	Trace silt, 75-76 feet
		46.02	0.3		76.0	
	GB				GP **Sand and Gravel** fine subangular gravel, 10% of clasts are fractured, clasts up to 3/8", coarse grained sand, trace silt	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56M

DATE STARTED 4/30/08 **COMPLETED** 5/4/08 **GROUND ELEVATION** 987.1 feet **TOC ELEVATION** 989.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150835.8 feet **EASTING** 1402957.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. Loomis, S. O' Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			0.6		GP **Sand and Gravel** fine subangular gravel, 10% of clasts are fractured, clasts up to 3/8", coarse grained sand, trace silt	Adding water while drilling, 81-82 feet
					82.0 GP **Sand and Gravel** subangular gravel, 10% of clasts are fractured, clasts up to 3/8", medium to coarse grained sand, trace silt	Fine gravel, 82-87 feet
85	GB					Adding water while drilling, 86-89 feet
						Fine to coarse gravel, 87-91 feet
90	GB					Slow drilling, 90-91 feet
			2.75		91.0 GP **Sand and Gravel** multicolored, subangular to subrounded gravel, coarse grained sand, trace silt, wet	Discharge water is dark brown; slow drilling, 91-100 feet Clasts up to 1/2", 91-92 feet 30% of clasts are fractured; clasts up to 3/4", 92-94 feet
95	GB				94.0 95.0 GP **Sand and Gravel** multicolored, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", well graded sand, wet	Angular to subrounded gravel; 15% of clasts are fractured, 95-98 feet
			0.5		GP **Sand and Gravel** multicolored, clasts up to 1", well graded, poorly sorted sand, wet	Subangular to subrounded gravel; <10% of clasts are fractured, 98-99 feet Angular to subrounded gravel; 15% of clasts are fractured, 99-100 feet
100	GB				100.0	
					Bottom of hole at 100.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-56M
Date: 6-18-08
Project #: 005.0189.08002
Project: Pebble
Technician: ~~C. Kramer~~ V Webb / M Jantz

Summary

	Installed (Well Log)	Start	End
Water level FTOC	16.04	6.87	13.90
Total depth FTOC	100.0	99.09	100.23
pH	N/A		7.03

Screen interval (btoPVC): ~~98~~ 90' 100' LKZ
(FTOC) Top: ~~85.2~~ ~~89.9~~ 90.1
Bottom: ~~95~~ ~~99.9~~ 100.1
PVC stick-up height (above ground surface):
~~30.68"~~ = 2.56'
2.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 0950 - START 1' off bottom									
1045	~~98.09~~ 99.1	—	3.50	192.50	.555	170	5.32	fine sands, milky/lite brown tint, trace	6.97
1100	1	—	3.50	245.0	.475	170	4.74	fine sands, milky/lite brown tint, trace	6.97
1105	~~98.09~~ 99.1							move 2' above screen - START	
1152	~~96.09~~ 97.1	—	3.0	386	.426	27	5.11	clear, fine sands, trace	6.62
1156	~~94.09~~ 95.1							move 2' above screen - START	
1228	1	—	3.25	490	.423	26	4.72	clear, fine sands, trace	6.88
1244	~~92.09~~ 93.1							move 2' above screen - START	
1319	1	—	3.25	603.75	.355	32	4.87	lite lite grey, fine sands, < 1/2 Tsp	6.82
1330	~~90.09~~ 91.1	—						move 2' above screen - START	
1415	1	—	3.25	750	.369	17	5.58	lite lite grey, fine sands, < 1/2 Tsp	6.98
1421	~~88.09~~ 89.1							move 2' above screen - START	
1522	1	—	3.25	948.25	.357	11	5.60	lite lite grey, fine sands, < 1/4 Tsp	6.85
Surge block off									
1535	~~84.09~~ 85.1							move 4' above screen, no surge	
1600	1	—	3.25	1029.50	.328	14	5.66	lite lite grey, fine sands, < 1/4 Tsp	
1605	~~98.09~~ 99.1							move ~~bot~~ above screen - START DEBRIS	
1650	~~98.09~~ 99.1	—	2.50	1134.50	.327	11	5.64	clear, trace sands	7.03

LKZ
Polish
debris

THE pebble PARTNERSHIP

P-08-56S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56S

DATE STARTED 5/8/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.37 feet **TOC ELEVATION** 989.97 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150851 feet **EASTING** 1402937.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** orangey brown, wet	
					2.0 **Topsoil** dark brown, wet	
					3.0	No recovery, 3-4 feet
					4.0 SM **Silty Sand** very dark brown, trace gravel, organic matter, wet	
5		▼			6.0	No recovery, 6-7 feet
					7.0 SM **Silty Sand** very dark brown, trace gravel, organic matter, wet	
					8.0	No recovery, 8-12 feet
10						
					12.0 ML **Gravelly Silt** very dark brown, fine gravel, wet	Very little recovery, 13-14 feet
					14.0 ML **Gravelly Silt** very dark gray, some clay, wet	
15	GB				16.0	More gravel than rest of unit, 15-16 feet
					GP **Sand and Gravel** dark gray, subangular to subrounded gravel, clasts up to 3/4", coarse grained sand, wet	Encountered water, 17 feet
			0.5		19.0	Discharge water is light gray, 18-20 feet
20	GB				20.0 ML **Gravelly Silt** gray, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/2", wet	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 50# cement, 2 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Monument needs repair)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Monument needs repair)

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/8/08 at 140 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-56S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-56S

DATE STARTED 5/8/08 **COMPLETED** 5/8/08 **GROUND ELEVATION** 987.37 feet **TOC ELEVATION** 989.97 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2150851 feet **EASTING** 1402937.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					20.5 ML **Silt** gray, some clay, wet Bottom of hole at 20.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-56S. Monument needs repair prior to development.

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** dark, fine gravel, mostly fractured, clasts <1/4", some silt, moist	Re-drilled using mud rotary in order to install 8" conductor casing; during advancement hit boulder or cobble (15-17 feet), 0-20 feet
					4.0	
5	GB				ML **Silt** brown, dry	Less gravel and more silt than rest of unit, 3-4 feet Trace gravel, 4-6 feet
					7.0	
					ML **Silt and Gravel** subrounded gravel, trace medium grained sand, dry	10% of clasts are fractured; clasts <1/4", 7-8 feet <10% of clasts are fractured; clasts up to 1/4", 8-9 feet
					9.0	
10	GB				ML **Silt with Gravel** brown, subangular gravel, <10% of clasts are fractured, clasts up to 1/2", trace sand, dry to moist	
					10.0	
					ML **Silt with Gravel** brown, subrounded gravel, <10% of clasts are fractured, clasts <1/4", dry to moist	Slow drilling, 12-14 feet
					13.0	Adding water while drilling, 13-148 feet
					ML **Silt and Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/4", moist	
15	GB				14.0	
					GM **Gravel with Silt** most of the clasts are fractured, clasts up to 1/4", trace coarse grained sand, wet	
					15.0	
					GM **Silty Sand and Gravel** subangular gravel, <10% of clasts are fractured, clasts <1/4", coarse grained sand, wet	
					19.0	
20	GB				GM **Silty Sand and Gravel** subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", 20.0	Lots of fines, 19-20 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 5/19/2008
Purge Volume: 359 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/15/08 at 1207 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D
PAGE 2 OF 9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					coarse grained sand, wet	Discharge water is brown; losing fines; descriptions may be biased coarse, 20-35 feet
					21.0 GM **Silty Gravel with Sand** gray, subangular gravel, most of the clasts are fractured, clasts up to 5/8", wet	
					ML **Gravelly Silt with Clay** black, angular gravel, most of the clasts are fractured, clasts up to 1/2", brown silt, wet	
					23.0	
					24.0 GM **Gravel with Sandy Silt** gray, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 1", well graded sand, brown silt, wet	
25	GB				GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1", well graded sand, trace clay, moist to wet	
						More sand than rest of unit, 27-28 feet
					28.0 ML **Gravelly Silt** brown, angular gravel, most of the clasts are fractured, clasts up to 1", trace sand, trace clay, wet	
30	GB					
					31.0	
		▼			32.0 GM **Silty Sand and Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", well graded sand, trace clay, wet	
					ML **Silt with Gravel** brown, wet	
					34.0	
35	GB				ML **Silt with Gravel** brown, subangular to rounded gravel, 25% of clasts are fractured, clasts up to 1 1/4", wet	
					36.0	
					GM **Gravel with Silt** subangular gravel, clasts <1/4"	
						More silt than rest of unit, 38-39 feet
					39.0	
40	GB				GP **Gravel** subangular gravel, clasts <1/4", trace silt	
					40.0 GP **Gravel** 30% of clasts are fractured, clasts up to 1/2"	
					42.0	
					GP **Gravel with Sand** 30% of clasts are fractured, clasts up to 1/2", coarse grained sand	
					43.0	
					SW **Sand with Gravel** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
45	GB					Discharge water is brown; losing fines; descriptions may be biased coarse, 45-65 feet
					48.0 GP **Gravel with Sand** brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GP **Gravel with Sand** brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
					53.0	
55	GB				SP **Sand with Gravel** brown, subangular gravel, 25% of clasts are fractured, clasts up to 1/2", fine to medium grained sand, wet	
					58.0	
			<1		GW **Sand and Gravel** brown, angular to subangular gravel, 60% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	Encountered water, 58 feet
60	GB				59.0	
					SP **Gravelly Sand** brown, subrounded gravel, 15% of clasts are fractured, clasts up to 3/4", fine to medium grained sand, trace silt	
					61.0	
					GM **Silty Gravel** subrounded gravel, 20% of clasts are fractured, clasts up to 1", gray silt, wet	
			1		63.0	Silt balls, 63-64 feet
65	GB				ML **Silt** gray, trace subrounded gravel, clasts up to 1/4", wet	Descriptions may be biased coarse, 65-113 feet Slow drilling, 66-71 feet
			1.5			
70	GB				71.0	
					GW **Gravel** subangular to subrounded gravel, clasts up to 3/4", trace silt	
					72.0	
			1.5		SW **Sand with Gravel** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
75	GB				73.0	
					SW **Gravelly Sand** brown, subangular gravel, 20% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
			2		79.0	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D
PAGE 4 OF 9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
			2		SW **Sand with Gravel** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	
85	GB					
			0.5		88.0 SW **Sand** brown, trace subangular gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
90	GB				91.0 SW **Sand** brown, trace subangular gravel, 10% of clasts are fractured, clasts up to 1/2", fine to medium grained sand, wet	
			<1		93.0 GM **Silty Sand and Gravel** subangular gravel, 50% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
95	GB					
			<1			
100	GB					
			<1			
105	GB				105.0 SW **Sand with Gravel** subangular to subrounded gravel, 20% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand	
			<1		108.0 SP **Sand** brown, fine grained sand, wet	
	GB				109.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					SW **Gravelly Sand** brown, angular to subangular gravel, 25% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, wet	
			1.5		113.0 SW **Sand** brown, trace gravel, 75% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, wet	
115	GB				114.0 SW **Sand with Gravel** brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, wet	No flow tests due to heaving sands, 115-127 feet
120	GB				119.0 SW **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", well graded, poorly sorted fine to coarse grained sand, wet	
125	GB				122.0 SM **Sand with Gravel and Silt** brown, subangular to subrounded gravel, clasts up to 1/2", well graded, poorly sorted fine to coarse grained sand, gray silt, wet	
					123.0 SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", well graded, poorly sorted fine to coarse grained sand, gray silt, wet	
					124.0 ML **Silt** gray, trace subangular gravel, 50% of clasts are fractured, clasts up to 1/4", wet	
					127.0 ML **Silt with Gravel and Sand** gray, fine angular to subangular gravel, clasts up to 1/4", fine grained sand, wet	
			3		128.0 GM **Silty Gravel** subangular to subrounded gravel, 100% of clasts are fractured, clasts up to 3/4"	
130	GB				129.0 GW **Gravel** subangular to subrounded gravel, 100% of clasts are fractured, clasts up to 3/4", trace silt	
			4		133.0 ML **Silt** gray, trace coarse grained sand, wet	
135	GB				134.0 ML **Silt with Gravel and Sand** brown, subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", well graded fine to coarse grained sand, wet	No flow tests due to heaving sands, 135-174 feet
			no flow		138.0 GP **Gravel with Sand** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", coarse grained sand	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					GP **Gravel with Sand** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", coarse grained sand	
					143.0	
					GW **Sand and Gravel** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", well graded sand, wet	Slow drilling, 143-144 feet Discharge water is brown; losing fines; descriptions may be biased coarse, 143-161 feet
					144.0	
145	GB				145.0	
					SW **Sand with Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", well graded, well sorted sand, wet	Low recovery, 146-149 feet
					147.0	
					SP **Sand** brown, trace gravel, fine grained sand, wet	
			4.5		GW **Sand and Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/8", fine grained sand, wet	
					149.0	
150	GB				SP **Sand** brown, fine grained sand, wet	Trace gravel, 149-150 feet
					151.0	
						No recovery, 151-152 feet
					152.0	
					SP **Sand** brown, trace gravel, fine grained sand, wet	
			<0.125			
					154.0	
155	GB				SW **Gravelly Sand** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/8", fine to coarse grained sand, wet	
					155.0	
					SP **Sand** brown, fine grained sand, wet	Trace gravel, 156-157 feet
			<0.125			Trace gravel, 158-160 feet
160	GB				160.0	
					SP **Gravelly Sand** multicolored, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 5/8", coarse grained sand, wet	Discharge water is gray; losing fines; descriptions may be biased coarse, 161-167 feet
					161.0	
					GW **Gravel with Sand** multicolored, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", coarse grained sand, wet	
			4		163.0	
					GM **Silty Gravel** black and green, angular to subangular gravel, most of the clasts are fractured, clasts up to 3/4", gray silt, wet	Adding water while drilling, 164-165 feet
					164.0	
165	GB				165.0	
					GW **Sand and Gravel** gray, angular to subangular gravel, most of the clasts are fractured, clasts up to 1 1/4", well graded sand, wet	
					167.0	
					GW **Sand and Gravel** multicolored, subangular to rounded gravel, <10% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	30% of clasts are fractured; clasts up to 1",167-169 feet Discharge water is brown; losing fines; descriptions may be biased coarse, 167-174 feet
			0.5		SW **Gravelly Sand** multicolored, angular to rounded gravel, fine to coarse grained sand, wet	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170					170.0	
			3		SW **Sand with Gravel** multicolored, angular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", well graded sand, wet	<10% of clasts are fractured; clasts up to 3/4", 169-170 feet Slow drilling; poorly sorted 170-172 feet Well sorted, 172-174 feet
		51.39	15		174.0 GP **Gravel** multicolored, clasts <1/4", wet	Logged via cuttings, 174-176 feet Advanced via mud rotary, 174-242 feet
175					176.0	No recovery, 176-179 feet
					179.0	
180	SS				SP **Sand with Gravel and Silt** most of the clasts are fractured, clasts up to 1", poorly graded medium to coarse grained sand, brown silt 180.0	Conduct SPT; blow counts: 47-67-45 (3"), 179-181 feet No recovery, 180-186 feet
						No SPT; grinding on boulder or cobble, 183-185 feet
185						Drilling behavior indicative of gravel, 185-186 feet
					186.0 **Boulder or Cobble** dark green 187.0	Very slow drilling, 186-187 feet Logged via cuttings, 186-189 feet
					GP **Gravel** multicolored 189.0	Drilling speed faster than above, 187-189 feet
190	SS				GM **Silty Sand and Gravel** gray, subrounded gravel, clasts up to 1", wet 190.0	Conduct SPT; blow counts: 46-50+, 189-191 feet No recovery, 190-192 feet
					192.0 GW **Sand and Gravel** multicolored, wet 194.0	Logged via cuttings, 192-194 feet
195	SS				ML **Gravelly Silt** gray, subrounded gravel, clasts up to 5/8", trace sand, trace clay, moist 195.0	Conduct SPT; blow counts: 16-50+, 194-196 feet Logged via cuttings, 195-198 feet
					GM **Silty Sand and Gravel** multicolored, clasts up to 3/8", wet 198.0	
					Boulder or Cobble black 199.0	Slow drilling, 198-199 feet
						Conduct SPT; blow counts: 40-50+,

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
200	SS				200.0 ML **Gravelly Silt** gray, subrounded gravel, clasts up to 3/4", trace sand, trace clay, moist	199-201 feet Logged via cuttings, 200-203 feet
					GM **Silty Sand and Gravel** multicolored, clasts up to 1/4", wet	
					203.0	No recovery, 203-204 feet
					204.0	Conduct SPT; blow counts: 50+, 204-206 feet
205	SS				205.0 ML **Silt and Gravel with Clay** gray, angular gravel, fractured, trace sand, moist to wet	No recovery, 205-206 feet
					206.0	Logged via cuttings, 206-212 feet
					ML **Gravelly Silt**	
210						Conduct SPT; blow counts: 50 (4"); no recovery, 209-211 feet
					211.0	
					ML **Sandy Silt**	
					212.0	No recovery, 212-214 feet
					214.0	
215	SS				SM **Silty Sand** brown to gray, poorly graded, well sorted medium to coarse grained sand, moist 215.0	Conduct SPT; blow counts: 50 (3"), 214-216 feet Logged via cuttings, 215-219 feet
					ML **Sandy Silt**	
					219.0	
220	SS				SM **Silty Sand with Gravel** brown to gray, rounded gravel, clasts up to 3/4", poorly graded, well sorted medium to coarse grained sand, moist 220.0	Conduct SPT; blow counts: 50 (3"), 219-221 feet Slow drilling, 220-224 feet Logged via cuttings, 220-225 feet
					Bedrock (Tertiary Rhyolite) off white to gray, finely flow banded rhyolite	
225	SS					Conduct SPT; blow counts: 50 (3"), 225-227 feet Logged via cuttings, 226-242 feet
	GB					Competent bedrock encountered, 227 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-57D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-57D

DATE STARTED 5/8/08 **COMPLETED** 5/14/08 **GROUND ELEVATION** 1033 feet **TOC ELEVATION** 1035.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.22 feet **EASTING** 1410049.79 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
230					**Bedrock (Tertiary Rhyolite)** off white to gray, finely flow banded rhyolite	
235	GB					
240					242.0 Bottom of hole at 242.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-57D
Date: 5/8/08 - 5/9/08
Project: Pebble - ODEX Drilling
Project #: 005.0189.08002
Technician: Shannon Loomis / Chris Lee

Summary

	Installed (Well Log)	Start	End
Water level		52.68	51.78
Total depth		242.5	
pH		7.11	—

Screen interval (btoPVC): 231.8 - 241.7'
Top:
Bottom:
PVC stick-up height (above ground surface): 2.75'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
~~Surge block on~~	Start 1220pm							
112 pm	244.4	—	.5	43.5	—	—	—	milky water, ~ 1 Tbsp / 5 gal, brown, fine
230 pm	244.4	—	.5	70.5	—	—	—	milky, ~ 1 tsp / 5 gal, brown fine
237 pm	244.4	—	.5	84.5	.187	108	6.73	milky, brown fine seds
305 pm	242.4	—	.5	88	.130	205	6.86	milky, brown fine seds
	stop	355pm to drill,	restart 503pm					
515 pm	242.4	—	.5	129	—	298	—	milky, brown fine seds
556 pm	242.4	—	.5	149.5	—	60.8	—	almost clear
616 pm	240.4	—	.5	159.5	—	53.7	—	almost clear
913 pm	240.4	—	.5	248	—	33.6	—	
	stop for recharge 915pm,		restart 945pm					
945pm	238.4	—	.3	256	—	908	—	
950pm	238.4	—	.3	257.5	—	323	—	water brown, sus
1020pm	238.4	—	.3	266.5	—	66.7	—	almost clear
1145pm	238.4	—	.3	292	—	51.8	—	
	stop	for recharge	1200AM,	restart 130AM				
130AM	236.4	—	.3	303.5	—	951	—	
150AM	236.4	—	.3	309.5	—	164	—	semi clear, still some suspended solids
227AM	236.4	—	.3	320.6	—	105	—	
300AM	236.4	—	.3	330.5	—	28.9	—	
320AM	238.9	—	.3	339	—	420	—	stopped & started air
325AM	234.9	—	.25	340.3	—	265	—	nearly clear
400AM	234.9	—	.25	349	—	16.98	—	
440AM	234.9	—	.25	359	—	16.89	—	
Surge block off								

* Development method = air lift → WL measurements couldn't be taken during development
* YSI malfunction 330pm, turbidity readings only afterwards
* See 2008 ODEX Rig 2 Logbook #1 for drilling details

THE pebble PARTNERSHIP

P-08-58D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58D

DATE STARTED 5/24/08 **COMPLETED** 5/24/08 **GROUND ELEVATION** 1015.1 feet **TOC ELEVATION** 1017.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151637.4 feet **EASTING** 1408967.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil**	
					3.0	
					ML **Silt** brown, moist	
					4.0	
5					ML **Silt and Gravel** brown, angular to subrounded gravel, clasts up to 1", dry to moist	Silt balls, 5-7 feet
					7.0	
					ML **Gravel and Silt** brown, silt coated subangular to subrounded gravel, clasts up to 1"	Cuttings are dry, 7-9 feet
10						Cuttings are moist, 9-12 feet
					12.0	
					GW **Sandy Gravel** silt coated angular to subrounded gravel, clasts up to 1/2", well graded, brown silt, moist to wet	
					14.0	25% of clasts are fractured, 14-15 feet
15					GM **Silty Gravel** multicolored, silt coated angular to subangular gravel, clasts up to 1 1/4", brown silt, moist	50% of clasts are fractured, 15-17 feet
					17.0	
					GP **Gravel and Sand** multicolored, fine silt coated subrounded gravel, coarse grained sand, brown silt, wet	Encountered water, 17 feet Discharge water is brown and silty, 17-19 feet
					19.0	
20					GM **Gravelly Silt** multicolored, subangular to subrounded gravel, clasts up to 1/2", brown silt 20.0	Adding water while drilling; discharge water is brown and silty, 19-25 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 100# bentonite

GROUT
Type: Volclay
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/14/2008
Purge Volume: 811 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/3/2008

Comments: Static Water Level not measured; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-58D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58D

DATE STARTED 5/24/08 **COMPLETED** 5/24/08 **GROUND ELEVATION** 1015.1 feet **TOC ELEVATION** 1017.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151637.4 feet **EASTING** 1408967.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", brown silt	Silt balls, 19-24 feet Slow drilling, 20-21 feet
					23.0	
					ML **Silt with Gravel and Sand** multicolored, subangular to subrounded gravel, clasts up to 1/2", brown silt	
					24.0	
25					**Bedrock (Tertiary Rhyolite)** white, fractured, weathered	Encountered water, 25 feet Discharge water is light brown, 25-28 feet
		7.18	22			
			<0.25			
30					30.0	
					Bedrock (Tertiary Rhyolite) white to light gray, finely flow banded rhyolite	
			20			Moved to open hole hammer, 32 feet
35					35.0	
					Bedrock (Tertiary Rhyolite) light gray, weakly oxidized, finely flow banded rhyolite, fractured	
			20			
40			30			Slow drilling, 42-43 feet
45			35		45.0	
					Bedrock (Tertiary Rhyolite) light gray to off white, fractured	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-58D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58D

DATE STARTED 5/24/08 **COMPLETED** 5/24/08 **GROUND ELEVATION** 1015.1 feet **TOC ELEVATION** 1017.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151637.4 feet **EASTING** 1408967.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			40		**Bedrock (Tertiary Rhyolite)** light gray to off white, fractured	
55			60		55.0 **Bedrock (Tertiary Rhyolite)** dark pink to tan, weakly oxidized rhyolite, low specific gravity, fractured	Slow drilling, 55-56 feet
			60+			
60						
65	GB		60			
70	GB		60+		70.0 **Bedrock (Tertiary Rhyolite)** dark pink to tan, weakly oxidized, finely flow banded rhyolite, fractured to pulverized	
75	GB		60+			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-58D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58D

DATE STARTED 5/24/08 **COMPLETED** 5/24/08 **GROUND ELEVATION** 1015.1 feet **TOC ELEVATION** 1017.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151637.4 feet **EASTING** 1408967.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			60+		**Bedrock (Tertiary Rhyolite)** dark pink to tan, weakly oxidized, finely flow banded rhyolite, fractured to pulverized	
85	GB					
90	GB		60+			Discharge water is milky white, 90-99 feet
95	GB		60+			
100	GB					Discharge water is clearer; rock is harder in this interval, 99-100 feet
105	GB	4.34	60+		105.0 105.3 Bottom of hole at 105.3 feet.	Rock is soft in this interval, 103-104 feet; Not logged, 105-105.3 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-58D
Date: 6-13-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level	N/A	17.74	18.05
Total depth	105'	109.28	108.79
pH		7.63	7.25

Screen interval (btoPVC): 9.8'
Top: ~~95.1~~ 99.48
Bottom: ~~104.9~~ 109.28
PVC stick-up height (above ground surface): 32" - 2.67'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1138 - START - 1' off bottom									
1145	108.28	17.74	2.5	17.5	0.228	1000*	4.20	fine Sand, cloudy - Med. gray, ≈ 1 TSP	7.63
1218	↓		2.75	90.75	0.076	175	4.18	fine sand, H. gray - clear, trace	7.57
1221	106.28	—	—	—	—	—	—	Move ↑ 2' - START	—
1236	↓		2.0	120.75	0.067	181	4.68	fine Sand, cloudy - H. gray, < 1 tsp	7.08
1248	↓		1.5	138.75	0.063	89	5.00	Very trace fine sand, lt. gray - clear	7.04
1252	104.28	—	—	—	—	—	—	Move ↑ 2' - START	—
1319	↓		2.25	199.5	0.061	40	4.54	fine sand, lt gray - clear, trace	7.01
1325	102.28	—	—	—	—	—	—	Move ↑ 2' - START	—
1343	↓		2.25	240	0.064	44	4.54	lt gray - clear, no sed.	6.96
1347	100.28	—	—	—	—	—	—	Move ↑ 2' - START	—
1417	↓		2.5	315	0.070	70	4.66	lt-gray - clear trace fine sand	6.95
1422	98.28	←	—	—	—	—	—	Move ↑ 2' - START	—
1442	↓		2.75	370	0.065	48	4.75	lt-gray - clear, no sed.	6.93
Surge block off									
1452	94.45	—	—	—	—	—	—	Move 5' above screen	
Polish 1534	↓		2.5	415	0.059	51	~~8.95~~ 4.95	lt gray - clear, No sed.	6.93
1650	↓		3.5	709	0.055	53	4.78	cloudy, no sed	7.03
1701	108.28	—	—	—	—	—	—	Move 1' off bottom	
Rebuild 1730	—			810.5				Off site	
6/14/08 1215	—							On-site RESTART	7.25
1245	→		17.93	3.0	~~810.5~~ 0.113	38	4.49	- very trace sand, lt gray-clear	

THE pebble PARTNERSHIP

P-08-58M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58M

DATE STARTED 5/23/08 **COMPLETED** 5/23/08 **GROUND ELEVATION** 1013 feet **TOC ELEVATION** 1015.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151635.3 feet **EASTING** 1408925.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil**	
					2.0 GW **Gravel and Sand** silt coated subangular gravel, clasts up to 1/2", coarse grained sand, brown silt, dry	
					ML **Sandy Silt with Gravel** brown, fine grained sand, brown silt, dry	
					3.5	
					4.0 **Boulder or Cobble**	Boulder, 3.5 feet
5	GB				ML **Gravel and Silt** brown, gravel, 75% of clasts are fractured, clasts up to 1", brown silt, dry	
					5.0	
					6.0 **Boulder or Cobble** gray, fractured	
		▼			GW **Gravel** gray, 75% of clasts are fractured, clasts up to 1", dry	
					7.0	Silt balls, 7-9 feet
					ML **Gravel and Silt** gray, silt coated subangular to subrounded gravel, clasts up to 1 1/2", brown silt, moist	
					9.0	
10	GB				ML **Gravelly Silt** brown, subangular to subrounded gravel, clasts up to 1/2", brown silt, dry to moist	
					11.0	
					GW **Sand and Gravel** brown, silt coated subangular gravel, clasts up to 1", well graded, brown silt, moist to wet	
					13.0	
					GW **Sandy Gravel** angular to subangular gravel, coarse grained sand	Encountered shallow water, 13 feet Discharge water is brown; losing fines, 13-16 feet Clasts up to 1", 13-15 feet
15	GB					Clasts up to 1 1/4", 16-17 feet
		13.31	0.25			Clasts up to 1", 17-19 feet
					19.0	
20	GB				SP **Sand and Gravel with Silt** brown, silt coated fine gravel, coarse grained sand, wet	
					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: N/R

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/15/2008
Purge Volume: 344 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/3/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/24/08 at 750 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-58M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58M

DATE STARTED 5/23/08 **COMPLETED** 5/23/08 **GROUND ELEVATION** 1013 feet **TOC ELEVATION** 1015.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151635.3 feet **EASTING** 1408925.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GW **Gravel with Sand and Silt** brown, silt coated subrounded to rounded gravel, clasts up to 1 1/4", wet	Not producing water, 20 feet
					22.0	
			0.25		GW **Gravel** angular to subangular gravel, clasts up to 1 1/4", trace sand, trace silt, wet	Encountered water, 23 feet
					23.0	
					GW **Gravel with Sand** angular to subangular gravel, clasts up to 3/4", well graded	Trace silt, 24-25 feet
25	GB				25.0	
					ML **Silt and Gravel with Sand** brown, subangular gravel, clasts up to 1", wet	Adding water while drilling; discharge water is brown and silty, 25-27 feet
					26.0	
					SW **Sand and Gravel** multicolored, subangular to subrounded gravel, clasts up to 3/4", well graded	
					27.0	Adding water while drilling; discharge water is light brown, 27-30 feet
			1		SW **Sand and Gravel** white, subangular to subrounded gravel, clasts up to 3/4", well graded	
					28.0	
					Bedrock (Tertiary Rhyolite) white, fractured	Fragments up to 3/4", 29-30 feet
30	GB		20		30.0	Slow drilling, 30 feet
					Bedrock (Tertiary Rhyolite) white to light gray, fractured, weakly oxidized	
					32.0	Larger clasts (up to 2"), 32-35 feet
			40		**Bedrock (Tertiary Rhyolite)** light gray, finely flow banded rhyolite	Moved to open hole hammer, 33 feet
35	GB					
			40			
40	GB		35 to 40			
			60			
					44.0	
45	GB		60		**Bedrock (Tertiary Rhyolite)** light gray to off white, fractured	Very little recovery, 45-50 feet
			60			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-58M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-58M

DATE STARTED 5/23/08 **COMPLETED** 5/23/08 **GROUND ELEVATION** 1013 feet **TOC ELEVATION** 1015.7 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2151635.3 feet **EASTING** 1408925.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			60		51.0 **Bedrock (Tertiary Rhyolite)** dark pink to tan, weakly oxidized	
			60			
55	GB		60			
			60			
			60			
60	GB		60		60.0 Bottom of hole at 60.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-58M
Date: 6-14-08
Project: Pebble
Project #: 005.0189.08002
Technician: C. Kramer / V. Webb

Summary

	Installed (Well Log)	Start	End
Water level	6.30	8.06	8.13
Total depth	60/45' screen depth	47.60	47.54
pH		6.78	6.61

Screen interval (btoPVC): 9.8'
Top: 37.8
Bottom: 47.60
PVC stick-up height (above ground surface): 2.8'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 13:06 - START									
1322	46.60	8.06	1.5	24	0.038	290	4.96	trace very fine sand, milky H2O	6.78
1346	46.60	8.06	.75	~~35~~ 72	0.034	45	4.49	trace very fine sd, slightly milky H2O	
1350	44.60							Move ↑ 2' - START	
1422	↓	8.06	.75	~~84~~ 66	0.036	148	5.08	trace v. fn sand, sl. milky	6.45
1430	↓		.75	79.5	0.036	#97	5.73	sl. milky - clear, no sed.	6.68
1445	42.60		~~.75~~					Move ↑ 2' - START	
1505	↓		.75	88.5	0.043	279	5.51	Sl. milky - clear, trace fine sand	6.51
1532	↓		.75	108.75	0.042	122	5.83	" "	6.68
1541	40.60							Move ↑ 2' - START	
1615	↓		.75	134.25	0.043	~11	5.77	trace fine sand, slightly milky	6.69
1630	↓		1.00	149.25	0.040	214	5.90	trace fine sd, slightly milky	6.67
1640	38.60							Move ↑ 2' - START	—
1700	↓		1.00	169.25	0.042	378	5.71	trace fine sd, slightly milky	6.90
1725	↓		1.00	194.25	0.040	218	5.82		6.78
6-14-08 1730	36.60							Move up 2↑ - START	
1748			1.00	212.25				off-site - STOP	
849	36.60	8.14						Restart	
6-15-08 917	↓		1.00	240.25	0.052	360	4.23	trace fine sd, sl milky H2O	8.38
1035	↓		.75		0.041	208	4.52	(my)	7.03
Surge block off									
924	32.6							Move 5' above screen - START	
1033	↓		.75	292	0.041	208	4.52	trace fine sd, slightly milky	
1037	46.60							Move 1' off bottom	
1107	46.60		1.75	344.25	0.034	36	4.10	Sl milky, trace fine sand	6.61

THE pebble PARTNERSHIP

P-08-59D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-59D

DATE STARTED 5/25/08 **COMPLETED** 5/26/08 **GROUND ELEVATION** 1535.2 feet **TOC ELEVATION** 1537.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2149006.1 feet **EASTING** 1396198.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Organic Soil and Silt** some gravel, most of the clasts are fractured, clasts up to 1/4"	
					2.0 ML **Silt and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/4"	
					3.0 ML **Silt and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", trace organic matter	
5	GB				ML **Silt** trace angular to subangular gravel, 50% of clasts are fractured, clasts up to 1/2"	
					6.0 SP **Sand** brown, trace subrounded to rounded gravel, clasts up to 1/4", medium grained sand, trace silt, moist	
					8.0 GP **Sand and Gravel** brown, subrounded gravel, clasts up to 1", medium grained sand, moist	Little recovery, 9-10 feet
10						
					12.0 ML **Sandy Silt** brown, trace subangular gravel, 25% of clasts are fractured, moist	Adding water while drilling, 13-16 feet
					13.0 ML **Silt and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", wet	
15	GB				14.0 GM **Silty Gravel** subangular gravel, 75% of clasts are fractured, clasts up to 3/4"	
					15.0 ML **Silt and Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 3/4", wet	Slow drilling, 16-17 feet
					16.0 GM **Gravel with Silt** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2"	Adding water while drilling, 17-28 feet
					17.0 ML **Silt and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, wet	
20	GB				18.0 SM **Silty Sand and Gravel** subangular to subrounded	
					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 100# bentonite

GROUT
Type: Volclay
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/25/2008
Purge Volume: 2230 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/27/2008 at 920 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-59D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-59D

DATE STARTED 5/25/08 **COMPLETED** 5/26/08 **GROUND ELEVATION** 1535.2 feet **TOC ELEVATION** 1537.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2149006.1 feet **EASTING** 1396198.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					gravel, 50% of clasts are fractured, medium to coarse grained sand	
					21.0 GP **Sand and Gravel** fine subangular gravel, 25% of clasts are fractured, clasts up to 1/4", coarse grained sand	
					GM **Sand and Gravel with Silt** fine subangular gravel, clasts up to 1/4", medium to coarse grained sand, wet	
25	GB				26.0 SP **Sand with Gravel** fine subrounded gravel, 50% of clasts are fractured, clasts up to 1/4", medium grained sand, trace silt	
					28.0 GP **Sand and Gravel** fine subangular gravel, <10% of clasts are fractured, clasts up to 1/4", coarse grained sand, trace silt	
30	GB				30.0 SM **Silty Sand and Gravel** fine subangular gravel, 10% of clasts are fractured, clasts up to 1/4", coarse grained sand	Trace coarse gravel, 29-30 feet
					31.0 GP **Sand and Gravel** fine gravel, 10% of clasts are fractured, clasts <1/4", coarse grained sand, trace silt	
					32.0 SP **Gravelly Sand** fine subangular gravel, coarse grained sand, trace silt	
35	GB				33.0 GP **Sand and Gravel** subrounded gravel, clasts up to 1/2", coarse grained sand, trace silt	No water in hole, 33 feet
					34.0 SM **Silty Sand and Gravel** subrounded gravel, clasts up to 1/2", coarse grained sand, wet	Adding water while drilling, 36-37 feet
					39.0 GM **Sand and Gravel with Silt** fine subangular to subrounded gravel, clasts up to 1/2", coarse grained sand	No water in hole, 38 feet Adding water while drilling, 38-39 feet
40	GB				41.0 GP **Sand and Gravel** fine subangular to subrounded gravel, clasts up to 1/2", coarse grained sand, trace silt	Adding water while drilling, 41-47 feet
45	GB					
	GB					Encountered water, 48 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-59D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-59D

DATE STARTED 5/25/08 **COMPLETED** 5/26/08 **GROUND ELEVATION** 1535.2 feet **TOC ELEVATION** 1537.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2149006.1 feet **EASTING** 1396198.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GP **Sand and Gravel** fine subangular to subrounded gravel, clasts up to 1/2", coarse grained sand, trace silt	Adding water while drilling, 51-53 feet
			0.25		52.0	
					ML **Sandy Silt and Gravel** fine subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4", medium grained sand	Adding water while drilling; discharge water is brown, 53-55 feet
					53.0	
55	GB				ML **Silt** light brown, non-plastic, wet	
					55.0	
					ML **Silt** light brown, trace fine gravel, most of the clasts are fractured, clasts up to 1/4", trace sand, non-plastic, wet	Drilling speed increased, 56.5 feet Discharge water is brown, 57-61 feet
					56.0	
					57.0	
					ML **Silt, Sand, and Gravel** dark tan angular gravel, 100% of clasts are fractured, clasts up to 1/2", coarse grained sand	
					58.0	
					GW **Sandy Gravel with Silt** brown, angular to subangular gravel, clasts up to 3/4", well graded, wet	
					59.0	
60	GB				GW **Sandy Gravel** brown, angular to subangular gravel, clasts up to 3/4", trace silt, wet	
					60.0	
			<0.25		GW **Sandy Gravel with Silt** brown, angular to subangular gravel, clasts up to 3/4", well graded, wet	Adding water while drilling; discharge water is brown, 61-62 feet Discharge water is brown, 62-64 feet
					Bedrock (Tertiary Basalt) black to dark red-tan, moderately magnetic basalt, moderate iron staining	
		▼				
65	GB					
			<0.25			
70	GB					
			<0.25			
75	GB					Discharge water is brown and silty, 77-78 feet
			<0.25			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-59D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-59D

DATE STARTED 5/25/08 **COMPLETED** 5/26/08 **GROUND ELEVATION** 1535.2 feet **TOC ELEVATION** 1537.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2149006.1 feet **EASTING** 1396198.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					**Bedrock (Tertiary Basalt)** black to dark red-tan, moderately magnetic basalt, moderate iron staining	
			10			
85	GB				85.0	
					Bedrock (Cretaceous Kaskanak Batholith - Granodiorite) plutonic textures, quartz, magnetite with hematite rimming, chlorite, plagioclase, and finely disseminated pyrite grains	
			30			
90	GB		15			
						Adding water while drilling, 92-93 feet
95	GB		20			
100			20 to 25			
			25			
105			20 to 25		105.0	Pulverized rock, 104-105 feet
					105.1 Bottom of hole at 105.1 feet.	Not logged, 105-105.1 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-59D
Date: 6/24/08 & 6/25/08
Project: Pebble
Project #: 005.0189.08002
Technician: L. Crawford / J. Parker

Summary ~~bgs~~ FTOC FTOC FTOC

	Installed (Well Log)	Start	End
Water level	64.28	55.0	55.78
Total depth	104.7	104.45	104.82
pH			

6/25 @ 0940 (FTOC)

Screen interval (btoPVC): 19.7
Top: 85.0
Bottom: 104.7

PVC stick-up height (above ground surface): 2.66

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 0855 – START (1' off bottom of screen)									6.20
0925	103.7	55.0	5	150	0.304	0	3.71	lt brown, ~1/8 tsp fine sand	↓
0940	101.7	—						Move ↑ 2' – START	
1012	↓	—	5	310	0.283	0	3.59	v. lt brown, trace sand	5.88
1019	99.7	—						Move ↑ 2' – START	
1105	↓	—	4.75	519	0.284	0	3.60	clear, no sediment	5.80
1112	97.7	—						Move ↑ 2' – START	
1145	↓	—	4.75	~~156.75~~ 675.75	0.282	0	3.81	clear, trace sediment	5.76
1154	95.7	—						Move ↑ 2' – START	
1234	↓	—	4.75	856.25	0.282	0	3.45	clear, no sediment	5.69
1240	93.7	—						Move ↑ 2' – START	
1318	↓	—	5	1046.25	0.281	0	3.59	clear, no sediment	5.65
1324	91.7	—						Move ↑ 2' – START	
1356	↓	—	4.75	1198	0.280	0	4.01	clear, no sediment	5.62
1402	89.7	—						Move ↑ 2' – START	
1437	↓	—	5	1373	0.281	0	3.93	clear, no sediment	5.68
1440	87.7	—						Move ↑ 2' – START	
1522	↓	—	5	1583	0.285	3	3.73	clear, no sed	5.68
1525	85.5	—						Move ↑ 2' – START	
1557	↓	—	4.75	1735	0.282	0	3.42	clear, no sed	5.64
1600	83.5	—						Move ↑ 2' – START	
1635	↓		4.75	1901	0.280	0	3.87		5.65
Surge block off									
POLISH 1645	79.5	—							
1655	↓	STOP							
6/25/08 0755		START POLISH AGAIN							
0830	↓	—	4.5	2059	0.329	0	5.20	clear, no sediment	5.77
DEBRIS 0855	103.7	—						Move 1' off bottom – START	
0931	↓	—	4.75	2230	0.316	0	3.63	clear, no sediment	5.38

THE pebble PARTNERSHIP

P-08-59S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-59S

DATE STARTED 5/26/08 **COMPLETED** 5/27/08 **GROUND ELEVATION** 1533.7 feet **TOC ELEVATION** 1536.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2149026 feet **EASTING** 1396218.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, T. Herriott

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Organic Soil and Silt** subangular gravel, clasts up to 1 1/4"	
					2.0	
					GM **Silty Gravel** angular to subangular gravel, trace organic material	
					3.0	
					SM **Silty Sand** trace angular to subangular gravel	
5					6.0	
					GW **Sandy Gravel** subangular to subrounded gravel, 25% of clasts are fractured, trace silt	
					7.0	Adding water while drilling, 7-14 feet
					ML **Silt with Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured	
					9.0	
10					GW **Gravel with Sand** multicolored, gravel, most of the clasts are fractured, coarse grained sand	
					11.0	
					GW **Gravel with Sand** multicolored, gravel, most of the clasts are fractured, clasts up to 3/4", coarse grained sand, trace silt	
					13.0	Encountered boulder, 12.5 feet
					14.0 GW **Sand and Gravel** multicolored, gravel, most of the clasts are fractured, clasts up to 5/8", coarse grained sand	
15					15.0 GW **Gravel with Sand** subangular gravel, 50% of clasts are fractured, clasts up to 3/4", coarse grained sand	Adding water while drilling, 15-29 feet
					GW **Sandy Gravel** subangular gravel, 50% of clasts are fractured, clasts up to 1 1/4", trace silt	
					18.0	
20					GW **Gravel with Sand** most of the clasts are fractured, clasts up to 1 1/4", coarse grained sand, trace silt	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 200# quik gel

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/25/2008
Purge Volume: 494 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/28/2008 at 340 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-59S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-59S

DATE STARTED 5/26/08 **COMPLETED** 5/27/08 **GROUND ELEVATION** 1533.7 feet **TOC ELEVATION** 1536.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2149026 feet **EASTING** 1396218.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, T. Herriott

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	
					SP **Sand with Gravel** brown, subangular gravel, most of the clasts are fractured, coarse grained sand	
					22.0	
					GW **Sandy Gravel** subangular gravel, most of the clasts are fractured, clasts up to 3/4", trace silt	
					23.0	
25					GW **Gravel with Sand** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 5/8", trace silt	
					27.0	
					GW **Gravel with Sand** subangular gravel, 50% of clasts are fractured, clasts up to 1 1/4", coarse grained sand, trace silt	
30		▼			30.0	
					GW **Gravel** subangular gravel, most of the clasts are fractured, clasts up to 1 1/2", trace sand, trace silt, wet	
					32.0	
					GW **Gravel** multicolored, subangular gravel, most of the clasts are fractured, clasts up to 1 1/4", wet	
35					37.0	
					GW **Gravel** subangular gravel, clasts up to 1 1/4", trace sand, wet	Most of the clasts are fractured, 37-39 feet Some water in hole, 38 feet 75% of clasts are fractured, 39-41 feet
40					41.0	
					ML **Silt with Gravel** brown, subangular gravel, trace sand, wet	
					42.0	Broke through silt layer; sand and gravel unit below is producing water, 42 feet
					GW **Gravel and Sand** subangular to subrounded gravel, trace silt, wet	
					43.0	
					SW **Sand with Gravel** subangular to subrounded gravel, trace silt, wet	
45					45.0	
					SP **Sand** brown, trace subangular to subrounded gravel, coarse grained sand, trace silt, wet	
			30		47.0	Not logged, 47-47.7 feet
					47.7	
					Bottom of hole at 47.7 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-595
Date: 6/25/08
Project: Pebble
Project #: 005.0189.08002
Technician: L Crawford / J. Parker

Summary

	Installed (Well Log)	Start	End
Water level FTOC	30.1	28.06	20.03
Total depth FTOC	50.1	49.90	49.95
pH			

Screen interval (btoPVC): 4'
(FTOC) Top: 46.1
Bottom: 50.1
PVC stick-up height (above ground surface): 2.6

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 0956 - start (1' off bottom of screen)									
1027	49.1	28.06	3.0	93	0.072	94	4.62	v. light brown; tsp fine sand	5.58
1036	47.1	—						move ↑ 2' start	
1106	"	—	2.75	181	0.058	96	4.57	v. light brown;	5.69
1115	45.1	—						move ↑ 2' start	
1145	"	—	2.5	256	0.056	96	4.84	clear; no seds	5.66
1156	43.1	—						~~move ↑ 4' start polish~~	
~~1228~~							4		
Surge block off									pH
Polish 1156	43.1	—						move ↑ 4' start polish	
1228	"	~~stop~~	2.75	344	0.057	96	4.91	clear; no seds	5.65
DEBRIS 1233	49.1	—						move ↑ 1' off bottom start	
1307	"	—	3.0	494	0.058	0	4.65	clear no seds	5.61

THE pebble PARTNERSHIP

P-08-60D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-60D

DATE STARTED 5/27/08 **COMPLETED** 5/28/08 **GROUND ELEVATION** 1411.8 feet **TOC ELEVATION** 1413.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2144623.1 feet **EASTING** 1397111 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Organic Soil with Gravel** moist to wet	
					2.0 ML **Silt and Gravel** dark brown, angular to subangular gravel, clasts up to 1/2", some organic material, wet	Cuttings are moist, 2-3 feet
					ML **Gravelly Silt** brown, subangular to subrounded gravel, clasts up to 3/4"	Cuttings are dry, 3-6 feet
5	GB					
					6.0	
					7.0 ML **Gravel and Silt** multicolored, angular gravel, 75% of clasts are fractured, clasts up to 1", some coarse grained sand, brown silt	Adding water while drilling; silt balls (up to 1"), 6-7 feet
					SM **Silt and Sand with Gravel** brown, subrounded gravel, clasts up to 1/2", fine grained sand, dry to moist	
					9.0	
10	GB	▼			GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, well graded, dry to moist	Clasts up to 1"; silt coated gravel, 9-10 feet Clasts up to 3/4", 10-13 feet
						25% of clasts are fractured, 12-13 feet
					13.0	
					14.0 SW **Gravelly Sand** brown, clasts up to 1", well graded sand, moist	
15	GB				GM **Silty Gravel with Sand** brown, silt coated subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", dry to moist	
					16.0	
					ML **Silt with Gravel and Sand** brown, gravel, clasts up to 1", well graded sand	Adding water while drilling; discharge water is brown; silt balls (up to 2"), 16-22 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 1.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 5 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/28/2008
Purge Volume: 815 gallons

RESPONSE TEST
Equipment: 48" Slug
Date: 6/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/28/08 at 330 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-60D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-60D

DATE STARTED 5/27/08 **COMPLETED** 5/28/08 **GROUND ELEVATION** 1411.8 feet **TOC ELEVATION** 1413.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2144623.1 feet **EASTING** 1397111 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt with Gravel and Sand** brown, gravel, clasts up to 1", well graded sand	
					22.0 ML **Silt and Gravel with Sand** multicolored, subangular to subrounded gravel, clasts up to 3/4", well graded sand, brown silt	
25	GB					Adding water while drilling; discharge water is brown, 25-27 feet
					27.0 GW **Sandy Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded	Encountered water, 27 feet
					29.0	Discharge water is brown, 28-30 feet
30	GB				GP **Sandy Gravel with Silt** multicolored, subangular gravel, clasts up to 1/2", poorly graded coarse grained sand, brown silt	Silt balls, 29-30 feet
					30.0	Adding water while drilling; discharge water is brown, 30-32 feet
					31.0 GP **Sandy Gravel and Silt** multicolored, subangular gravel, clasts up to 1/2", poorly graded coarse grained sand, brown silt	
					32.0	Discharge water is brown, 32-34 feet
					ML **Silt with Gravel and Sand** brown, clasts up to 1/2", well graded sand	
					34.0 SW **Gravelly Sand** multicolored, silt coated subangular to subrounded gravel, clasts up to 1", well graded sand, trace brown silt	
35	GB					Adding water while drilling; discharge water is brown, 34-37 feet
						Silt balls, 34-45 feet
					36.0 ML **Gravelly Silt with Sand** brown, subrounded gravel, fine grained sand	
					GP **Gravel** mostly black, most of the clasts are fractured, clasts up to 1 1/2", brown silt, wet	Discharge water is brown, 37-51 feet
					39.0	
40	GB				GP **Gravel** mostly black, coarse rounded gravel, clasts up to 1", brown silt, wet	
					42.0	
					GP **Gravel with Sand** mostly black, coarse rounded gravel, clasts up to 1", well graded sand, wet	
					44.0	
45	GB				SW **Gravelly Sand** multicolored, fine subangular to subrounded gravel, well graded sand, silt	
					45.0 SW **Sand with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1", well graded sand	Soil descriptions biased coarse; adding lots of water while drilling, 46-49 feet
					49.0	
	GB				50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-60D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-60D

DATE STARTED 5/27/08 **COMPLETED** 5/28/08 **GROUND ELEVATION** 1411.8 feet **TOC ELEVATION** 1413.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2144623.1 feet **EASTING** 1397111 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SW **Sand with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded sand, wet	
					Bedrock (Tertiary Basalt) black to dark green, fine grained groundmass, pyrite bearing, strongly magnetic basalt	Drilling rate slowed, 53 feet
55	GB		2			Discharge water is dark gray, 55-57 feet
			2			Moved to open hole hammer, 56 feet
						No recovery, 57-58 feet
						Discharge water is milky gray, 58-64 feet
60	GB		1			
			1			
65	GB		1			Discharge water is milky gray, 65 feet
			1.5			
			0.5			
70			0.125			
			1			No recovery, 72-73 feet Discharge water is brown; accompanied by a slight increase in flow rate, 72-73 feet
75	GB		4.5			Discharge water is gray, 73-78 feet
			5			
						Discharge water is light gray, 78-79 feet
	GB		5			Discharge water is milky, 79-80 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-60D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-60D

DATE STARTED 5/27/08 **COMPLETED** 5/28/08 **GROUND ELEVATION** 1411.8 feet **TOC ELEVATION** 1413.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2144623.1 feet **EASTING** 1397111 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			2		**Bedrock (Tertiary Basalt)** black to dark green, fine grained groundmass, pyrite bearing, strongly magnetic basalt	Discharge water is light gray, 80-83 feet
					84.0 Bottom of hole at 84.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-60D
Date: 6/27/08 & 6/28/08
Project: Pebble
Project #: 005.0189.08002
Technician: L. Cranford / M. Jantz

Summary

	Installed (Well Log)	Start	End (6/28/08 @ 1255)
Water level FTOC	9.45	9.79	12.08
Total depth FTOC	78.60	78.40	78.57
pH			

Screen interval (btoPVC): 19.6
Top: 59.0
Bottom: 78.6
(FTOC)
PVC stick-up height (above ground surface): 1.8'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1235 = START (1' off bottom)									
1308	77.6	—	3.5	115.5	0.181	70	4.52	lt. brown, ~ 1 tsp fine sand	7.10
1328	75.6	—						Move ↑ 2" - START	
1400	↓	—	2.5	195.5	0.162	72	4.76	lt. brown ~ 1 tsp fine sand	7.39
1410	73.6	—						Move ↑ 2' - START	
1439	↓	—	2.5	268	0.159	14	4.77	clear, trace sediment	6.80
1445	71.6	—						Move ↑ 2' - START	
1513	↓	—	2.25	331	0.160	399	5.12	Brown, 1 tsp fine sand	6.80
1522	69.6	—						Move ↑ 2' - START	
1555	↓	—	1.5	380.5	0.179	585	5.21	Brown, <1 tsp sand	6.79
1558	67.6	—						Move ↑ 2' - START	
1627	↓	—	2.25	436.75	0.158	14	4.71	clear, trace sand	6.76
1630	65.6	—						Move ↑ 2' - START	
1650	—	—	STOP 476.75						
6/28/08 0835	65.6	—	START						
0915	↓	—	1.5	536.75	0.217	48	4.08	clear (v. lt. brown), trace sed.	6.65
0920	63.6	—						Move ↑ 2' - START	
0950	↓	—	2	596.75	0.181	19	3.97	v. lt. grey, trace sed	6.40
0953	61.6	—						Move ↑ 2' - START	
1025	↓	—	1.5	644.75	0.176	23	4.18	v. lt. grey, trace sed	6.62
1037	59.6	—						Move ↑ 2' - START	
1100	↓	—	1.0	667.75	0.180	40	4.39	v. lt. grey, trace sed	7.01
1103	57.6	—						Move ↑ 2' - START	
1126	↓	—	1.5	702.25	0.188	252	4.62	lt. brown, <1 tsp fine sand	7.13
Surge block off									
POLISH 1135	53.6	—						Move ↑ 4' - START	
1205	↓	—	1.25	739.75	0.189	82	4.56	lt. brown, trace sed	7.29
DEBRIS 1208	77.6	—						Move to start (1' off bottom)	
1238	↓	—	2.5	814.75	0.179	28	4.37	clear, trace sed	7.14

THE pebble PARTNERSHIP

P-08-60S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-60S

DATE STARTED 5/28/08 **COMPLETED** 5/28/08 **GROUND ELEVATION** 1413.5 feet **TOC ELEVATION** 1416.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2144603.6 feet **EASTING** 1397092.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil and Gravel** 1.0	
					GM **Silt and Gravel** dark brown, subangular gravel, clasts up to 1", wet 2.0	
					ML **Silt with Gravel and Sand** grayish brown, fine subangular gravel, coarse grained sand, wet 4.0	
5					5.0	No recovery, 4-5 feet
					ML **Silt with Gravel and Sand** medium brown, fine subangular gravel, coarse grained sand, wet 7.0	
		▼			ML **Silt with Gravel and Sand** medium brown, fine subangular gravel, fine to coarse grained sand, wet 8.0	
10					ML **Silt with Gravel and Sand** angular to subrounded gravel, <10% of clasts are fractured, well graded sand, brown silt, moist 13.0	
					ML **Silt** brown, trace fine grained sand, moist 15.0	
15					ML **Silt** brown, moist 18.0	
					ML **Silt** brown, trace silt coated subangular gravel, clasts up to 1", moist 20.0	Adding water while drilling; discharge water is brown, 19-22 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 5 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/28/2008
Purge Volume: 405 gallons

RESPONSE TEST
Equipment: 48" Slug
Date: 6/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/29/08 at 1030 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-60S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-60S

DATE STARTED 5/28/08 **COMPLETED** 5/28/08 **GROUND ELEVATION** 1413.5 feet **TOC ELEVATION** 1416.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2144603.6 feet **EASTING** 1397092.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
					21.0 GM **Silt and Gravel** black angular gravel, most of the clasts are fractured, clasts up to 1", black, white/oxidized fine grained sand, brown silt	
					22.0 GM **Silt and Gravel** multicolored, angular to subrounded gravel, clasts up to 1", well graded, brown silt	Discharge water is brown, 23-24 feet
			0.25		GM **Sand and Gravel with Silt** multicolored, angular to rounded gravel, 10% of clasts are fractured, well graded sand, brown silt	
25					25.0 SW **Gravelly Sand** multicolored, angular to rounded gravel, 10% of clasts are fractured, well graded sand, trace brown silt	
			<0.125			
			15			Discharge water is brown: losing fines, 27-31 feet
			4			
30						More fines than rest of unit, 30-31 feet
			2		31.0	
					32.0 SM **Sandy Silt with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded sand	Silt balls, 32-36 feet
			no flow		SM **Sand with Silt** multicolored, subangular to subrounded gravel, clasts up to 3/4", well graded sand	
35			trace flow		36.0	
					Bottom of hole at 36.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-60S
Date: 6/27/08 & 6/28/08
Project: Pebble
Project #: 005.0189.08002
Technician: L. Crawford / M. Jarti

Summary

	Installed (Well Log)	Start	End
Water level FTOC	8.19	7.41	10.85 @ 1010 6/28/08 (FTOC)
Total depth FTOC	32.80	32.60	32.60
pH			

Screen interval (btoPVC): 6'
Top: 26.8'
Bottom: 32.8'
PVC stick-up height (above ground surface): 2.8'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1335 = START (1' off bottom)									
1413	31.8	—	1.75	66.5	0.095	1000*	4.24	brown, turbid, 1½ Tbsp sediment	7.00
1448	↓	—	2.25	145.25	0.097	731	4.32	brown, 1 Tbsp sediment	6.86
1454	29.8	—						Move ↑ 2' - START	
1525	↓		2.0	207.250	0.095	314	4.20	brown, 1 Tbsp sediment	6.88
1530	27.8	—						Move ↑ 2' - START	
1600	↓	—	1.50	252.25	0.097	175	4.79	lt brown, <tsp sediment	6.74
1606	25.8	—						Move ↑ 2' - START	
1627	↓	—	1.50	297.25	0.103	83	4.44	lt. grey, trace sediment	6.75
VSL ~~1640~~	~~21.8~~	—							
DEBRIS 0927	31.8	—						Move to start (1' off bottom)	
1002	↓	—	2.50	492.75	0.111	11	3.13	clear, no sediment	6.74
Surge block off									
POLISH 1640	21.8	—						Move ↑ 4' - START	
1650		— STOP 30725						↓	
~~DEBRIS~~ 0835	21.8	— START							
6/28/08 0924	↓	—	2.0	405.250	0.114	9	3.79	clear, no sediment	6.13

* NTU over range of turbidimeter

THE pebble PARTNERSHIP

P-08-61D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61D

DATE STARTED 5/29/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 976 feet **TOC ELEVATION** 978.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136355.8 feet **EASTING** 1391891.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil** dark brown, silt, organic matter, moist to wet	
					SM **Sand with Silt** brown, fine grained sand	Cuttings are moist, 1-3 feet
					4.0	Cuttings are dry, 3-4 feet
5	GB				SM **Sand with Silt and Gravel** brown, fine grained sand, dry	
					6.0 GM **Gravelly Sand with Silt** multicolored, angular to subrounded gravel, 75% of clasts are fractured, fine to coarse grained sand, brown silt	Adding water while drilling; discharge water is brown, 7-21 feet
					8.0 GM **Sand and Gravel with Silt** multicolored, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 1", well graded, brown silt	
10	GB				10.0 GW **Sandy Gravel** multicolored, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 1 1/4", coarse grained sand	
15	GB					
20	GB					Little recovery, 19-20 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/7/2008
Purge Volume: 213 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/3/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/30/08 at 1131 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-61D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61D

DATE STARTED 5/29/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 976 feet **TOC ELEVATION** 978.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136355.8 feet **EASTING** 1391891.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	No recovery, 21-22 feet
					22.0	Adding water while drilling; discharge water is brown, 22-23 feet
25	GB				GW **Sandy Gravel** multicolored, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 1 1/4", coarse grained sand	Less fractured than above, 24-25 feet
						Adding water while drilling; discharge water is brown, 25-61 feet
30	GB					
35	GB					
40	GB					Slow drilling, 39-40 feet
45	GB					
					47.0	No recovery, 47-49 feet
	GB				49.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-61D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61D

DATE STARTED 5/29/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 976 feet **TOC ELEVATION** 978.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136355.8 feet **EASTING** 1391891.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						
					51.0 GW **Sandy Gravel** multicolored, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", well graded sand	
					52.0 SW **Sand** multicolored, well graded sand, trace fines	
					53.0 GW **Gravel** subangular to subrounded gravel, clasts up to 1 1/2", trace sand	
					GW **Sandy Gravel** subangular to subrounded gravel, clasts up to 1 1/2", coarse grained sand	
55	GB					
					57.0	No recovery, 57-58 feet
					58.0	More sand than above, 58-59 feet
					59.0 GW **Sandy Gravel** subangular to subrounded gravel, clasts up to 1 1/2", coarse grained sand, trace fines	Well graded sand, 59-60 feet
60	GB				GW **Sandy Gravel** multicolored, subangular to subrounded gravel, 10% of clasts are fractured, trace fines	Coarse grained sand, 60-61 feet
					62.0	More sand than above; well graded sand, 61-62 feet
			trace flow		GW **Sandy Gravel** coarse grained sand, moist	Encountered water; discharge water is brown, 63 feet
					64.0	Adding water while drilling, 63-65 feet
65	GB				65.0 GW **Sandy Gravel** subangular gravel, clasts up to 1/2", fines	
					66.0 GW **Sandy Gravel**	Adding water while drilling; discharge water is brown, 65-72 feet
					67.0 SW **Sand with Gravel** multicolored, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", well graded sand	
		▼			GW **Gravel with Sand** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", coarse grained sand	
70	GB					More sand than above, 70-71 feet
					71.0	
					72.0 GW **Sand with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded sand	Slow drilling; discharge water is gray, 72-73 feet
					Bedrock (Tertiary Mudstone) black, very fine grained mudstone, fractured, weathered	Adding water while drilling, 73-74 feet
75	GB					
						Adding water while drilling, 76-77 feet
			0.25			Moved to open hole hammer, 77 feet
						Discharge water is milky gray, 77-80 feet
			3			No recovery, 77-82 feet
	GB				80.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-61D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61D

DATE STARTED 5/29/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 976 feet **TOC ELEVATION** 978.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136355.8 feet **EASTING** 1391891.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			4		**Bedrock (Tertiary Basalt)** dark green, weakly magnetic basalt clasts	Discharge water is brown to gray, 80-81 feet
			3			
85	GB		3			
			3.25			Adding water while drilling; flow is periodically stopping; could be sucking the formation dry, 86-87 feet
			3			
90			3.5			
			1			
95			3			
			trace flow		97.0	
					Bottom of hole at 97.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-61D
Date: 6-7-08
Project #: 005.0189.08002

Project: Pebble
Technician: C. Kramer

Summary WELL DEVELOPMENT

	Installed (Well Log)	Start	End
Water level	68.66	72.53	72.82
Total depth	88.4	91.27	92.3
pH		7.45	7.80

Screen interval (btoPVC): 10'
Top: ~~78.4~~ 81.2
Bottom: ~~88.4~~ = 91.2
PVC stick-up height (above ground surface):
2.8' = 91.2

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (cumulative) (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on START: ~~12 of 5 gpm~~ 1222									~~7.45~~
1225	90.2	72.53	1.25	3.75	0.317	118	6.29	fn-vfn sand, med brown, ½ cup	7.45
1243	90.2		1.50	11.25	0.099	324	5.09	fn-med sand, med brown, 2.5 tbsp	7.71
1238 restarted 1255	90.2		1.75	55.0	0.080	170	5.24	med sand, bl. brown, 1 tsp.	7.09
1317	88.2	—						Move ↑ 2ft. / START	
1325	88.2		1.00	63.0	0.082	147	5.08	medium lt. brown, 1 tbsp	6.93
1350	88.2		1.5	100.5	0.088	114	6.03	lt. gray/brown < 1 tbsp	7.02
1358	~~86~~ 86.2	—						Move ↑ 2ft / start	
1414	86.2		1.0	116.5	0.083	48.2	6.13	Ch. gray < ½ tsp	7.02
1430	84.2	—						Move ↑ 2ft / START	
1450	84.2		1.25	141.5	0.076	118	6.77	very lt brown < ½ tsp	7.01
1505	84.2		1.25	160.25	0.078	90.5	6.53	lt. gray trace sand	6.86
1609	82.2	—						Move ↑ 2 ft / START	
* 1630	82.2		0.75	176	0.031	166	— *	lt. gray trace sand	6.91
1643	80.2	—						Move ↑ 2 ft / START	
* 1655	80.2		1.0	188	0.040	92.9	44.65	lt gray-clear trace sand	7.06
Surge block off									
1609	75.2	—						Move ↑ 5 feet / START POLISH	
* 1620	75.2		0.25	190.75	0.040	98.6	71.26	Clear trace sand	7.72
1628	90.2	—						Move 1 ft from Bottom / START	
1657	90.2		0.75	212.5	0.095		7.18 V.	lt brown, trace sand	7.80

* YSI meter temperature not functioning - reading 66 °C

THE pebble PARTNERSHIP

P-08-61S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61S

DATE STARTED 5/30/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 978.2 feet **TOC ELEVATION** 981.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136406.6 feet **EASTING** 1391885.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Organic Soil** dark brown, roots, moist	
					2.0 SP **Gravelly Sand** brown, gravel, most of the clasts are fractured, clasts up to 3/8", well graded fine to coarse grained sand, dry	50% of clasts are fractured; clasts up to 3/4", 2-3 feet
					GW **Sandy Gravel** brown, angular to subrounded gravel, well graded fine to coarse grained sand, dry	50% of clasts are fractured; clasts up to 1"; trace silt, 3-5 feet
5						30% of clasts are fractured; clasts up to 1 1/2"; 5-6 feet
					6.0	
					7.0 SP **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1", fine to medium grained sand, moist	
					8.0 SP **Sand** brown, trace gravel, moist	
					9.0 SP **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1", fine to medium grained sand, moist	
10					10.0 SM **Silty Sand** brown, trace gravel, well graded sand, moist	
					12.0 SP **Sand** brown, subangular to subrounded gravel, clasts up to 1", fine to medium grained sand, trace silt, moist	No recovery, 12-13 feet
					13.0 SM **Sand and Gravel** brown, fine angular gravel, coarse grained sand, trace silt, moist	
15					15.0 SW **Gravelly Sand** brown, subrounded gravel, clasts up to 1", fine to medium grained sand, trace silt, moist	
					19.0 GP **Gravel and Sand** brown, angular to subangular gravel, 30% of clasts are fractured, clasts up to 1/2",	
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/8/2008
Purge Volume: 185 gallons

RESPONSE TEST
Equipment: N/A
Date: N/A

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/31/08 at 220 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-61S
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61S

DATE STARTED 5/30/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 978.2 feet **TOC ELEVATION** 981.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136406.6 feet **EASTING** 1391885.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					poorly graded fine to coarse grained sand, moist	
					SW **Gravelly Sand** brown, subrounded gravel, clasts up to 1", fine to medium grained sand, trace silt, moist	
					22.0 GP **Gravel and Sand** brown, angular to subangular gravel, 30% of clasts are fractured, clasts up to 1/2", poorly graded fine to coarse grained sand, moist	
25					25.0 SW **Sand** brown, fine angular gravel, fine to coarse grained sand, dry to moist	
					26.0 GW **Gravel and Sand** brown, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 1"	
					27.0 SW **Gravelly Sand** brown, subrounded gravel, clasts up to 1", fine to medium grained sand, trace silt, moist	
					28.0 SP **Sand and Gravel** brown, fine gravel, most of the clasts are fractured, clasts <1/4", poorly graded fine to coarse grained sand, moist	
30					32.0 GW **Sandy Gravel** brown, fine gravel, most of the clasts are fractured, clasts up to 1/2", poorly graded fine to coarse grained sand, moist	
					34.0 SP **Sand and Gravel** brown, fine gravel, most of the clasts are fractured, clasts <1/4", poorly graded fine to coarse grained sand, moist	
35					35.0 GW **Gravel and Sand** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, moist	
					36.0 GW **Gravel and Sand** brown, fine angular gravel, fine to coarse grained sand, mostly dry	
					38.0 GW **Gravel with Sand** brown, angular to subangular gravel, 70% of clasts are fractured, clasts up to 3/4", moist	
40					39.0 SW **Gravelly Sand** brown, fine angular gravel, fine to coarse grained sand, moist	50% of clasts are fractured, 41-42 feet
					41.0 GW **Gravel and Sand** brown, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, trace silt, moist	25% of clasts are fractured, 42-43 feet
					43.0 SW **Sand** brown, trace fine gravel, well graded fine to medium grained sand, moist	
45					47.0 GM **Gravel and Sand with Silt** brown, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, trace iron staining, moist	
					48.0 SW **Sand** brown, trace fine gravel, fine to medium	Little recovery, 49-50 feet
					49.0	
					50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-61S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-61S

DATE STARTED 5/30/08 **COMPLETED** 5/30/08 **GROUND ELEVATION** 978.2 feet **TOC ELEVATION** 981.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136406.6 feet **EASTING** 1391885.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					grained sand, moist	
					SW **Sand** brown, trace fine gravel, fine to medium grained sand, moist	Clasts up to 3/8", 51-52 feet
					52.0 SW **Sand with Gravel** brown, fine gravel, well graded sand, trace silt, moist	
					53.0 GW **Gravel and Sand** brown, subrounded to rounded gravel, clasts up to 5/8", well graded sand, moist	
55					SW **Gravelly Sand** brown, subrounded to rounded gravel, clasts up to 3/4", trace silt, moist	
					55.0 SW **Sand** brown, trace gravel, trace silt, moist	
					56.0 GW **Sand and Gravel** brown, subrounded to rounded gravel, clasts up to 3/4", trace silt, moist	
					57.0 SW **Sand** brown, trace gravel, trace silt, moist	
					58.0 SW **Sand with Gravel** brown, fine gravel, most of the clasts are fractured, clasts <1/4", trace silt, moist	
					59.0 GW **Sand and Gravel** brown, fine gravel, most of the clasts are fractured, clasts <1/4", trace silt, moist	
60					60.0 SW **Sand with Gravel** brown, fine gravel, most of the clasts are fractured, clasts <1/4", trace silt, moist	Very little recovery , 62-64 feet
					64.0 GW **Sandy Gravel** brown, subrounded to rounded gravel, clasts up to 3/4", well graded sand, moist	
65					65.0 GW **Gravel and Sand** brown, subrounded to rounded gravel, clasts up to 3/4", well graded sand, moist	Angular to subrounded gravel, 66-67 feet
					67.0 GW **Sand and Gravel** brown, subrounded to rounded gravel, 30% of clasts are fractured, clasts up to 5/8", well graded sand, moist	Subrounded to rounded gravel, 67-69 feet
		▼			69.0 **Boulder or Cobble** light gray, fractured, dry	
70					71.0	Not logged, 71-71.2 feet
					71.2 Bottom of hole at 71.2 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-61S
Date: 6/7/08 → 6/8/08
Project: Pebble
Project #: 005.0189.08002
Technician: C. Kramer

Summary

	Installed (Well Log)	Start	End
Water level FTOC	68.96	69.15	69.44
Total depth FTOC	71.2 ~~bgs~~ 74.1 ~~TopPVC~~	73.75	74.7
pH	~~73.9~~	7.4	~~7.29~~

Screen interval (btoPVC): 20'
(FTOC) Top: ~~53.75'~~ 54.1
Bottom: ~~73.75'~~ 74.1
PVC stick-up height (above ground surface): ~~2.7'~~ 2.9

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1725 : START									
6/8/07 1755	~~73.25~~ 74.1	~~73.6~~ 69.15	0.30	9	0.067	693	6.7	6" from bottom	7.4
1830	~~73.25~~ 74.1	~~73.6~~	0.30	19.5				Left site	
6/9/07 757	~~73.25~~ 74.1	69.11						On-site - START	
827	~~73.25~~ 74.1		0.5	34.5	0.388	661	5.16	fn-m/SILT, m. brown, ± tsp + suspended	7.1
850	~~73.25~~ 74.1		0.5	46	0.090	595	4.53	fn sand/SILT, m-lt. brown, 1 tsp + suspended	7.19
902	~~73.75~~ 74.1	74.1						Move ↑ 6"	
943	~~73.75~~ 74.1		0.75	76	0.060	768	5.19	SILT, m. brown, 1 tsp + suspended	7.06
1023	~~73.75~~ 74.1		0.50	96	0.061	592	5.65	fn/silt Lt brown, <1 tsp + suspended	7.27
1048	~~73.75~~ 74.1		0.375	105.4	0.059	399	5.32	" " "	7.01
1100	~~73.25~~ 74.1		0.375	116.7				Ran for ½ hr, moved up 6" - NO sample - see field notes	
1140	~~71.75~~ 74.1	~~72.6~~						START	
1230	~~71.75~~ 74.1		0.50	141.7	0.062	442	6.33		7.09
1240	~~70.75~~ 74.1	~~71.6~~						Move ↑ 1' - START	
1300	~~70.75~~ 74.1		0.375	149.2	0.060	278	6.65	fn sand/SILT, med. Brown, 1 tsp + suspended	7.11
1325	~~70.75~~ 74.1		0.25	155.5	0.060	226	6.81	" "	7.08
1330	~~69.75~~ 74.1	~~70.6~~						No flow / above water	
Surge block off - Bottom 4" higher than start									
1345	~~73.0~~ 74.1	~~73.6~~						6" from bottom / START	
1405	~~73.0~~ 74.1		0.5	175.5	0.061	270	5.79	Trace sand/SILT V. lt brown to clear	7.41
1430	~~73.0~~ 74.1		0.375	184.9	0.061	95.2	6.59	clear, trace sand	7.29

- No polish - only 4' water in 20' screen

THE pebble PARTNERSHIP

P-08-62D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					GP **Sand and Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2", well graded, trace brown silt, dry	
					3.0	
					SW **Sand with Gravel**	
					4.0	
5					SW **Sand with Gravel** clasts up to 1/2", well graded sand, trace silt	
					5.0	
					SW **Sand** trace gravel, trace silt	
					6.0	
					SW **Sand with Gravel** clasts up to 1/4", well graded, poorly sorted sand, trace silt	
					8.0	
					SW **Sand** trace gravel, trace silt	
					9.0	
10					SW **Sand with Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", well graded, poorly sorted sand, trace silt, dry	
					11.0	
					11.5 SM **Silty Sand** brown, trace gravel, dry	
					12.0	
					GM **Silty Gravel with Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1"	Adding water while drilling, 12-14 feet
					13.0	
					ML **Gravelly Silt with Sand** fine grained sand	
					ML **Silt with Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1"	
15	GB		no flow		15.0	
					ML **Silt with Gravel** trace sand	
					17.0	More gravel than rest of unit; subangular gravel; clasts up to 1/4", 16-17 feet Possible trace flow at 17 feet Adding water while drilling, 17-22 feet More gravel and sand than rest of unit, 18-20 feet
			trace flow		GM **Silty Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2"	
20	GB				20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 150# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: Anticipated completion in 2009
Purge Volume: N/A

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/8/08 at 740 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 2 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
					21.0 GM **Sandy Gravel with Silt** subangular to subrounded gravel, 50% of clasts are fractured, well graded sand	
					22.0 SW **Sand with Gravel**	Adding water and foam while drilling; discharge water is brown, 22-33 feet
					SP **Gravelly Sand** multicolored, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2", coarse grained sand	
25	GB					
					26.0	Losing fines, 26-27 feet
					27.0 SP **Gravelly Sand** multicolored, subangular to subrounded gravel, clasts up to 1/2", coarse grained sand	No recovery, 27-29 feet
					29.0	
30	GB				GW **Sandy Gravel** multicolored, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", fine to coarse grained sand	
		▼				
					34.0	
35					SW **Sand** multicolored, trace gravel, well graded sand	Adding water and foam while drilling; discharge water is brown, 35-36 feet
					38.0	
					SW **Sand** trace gravel, poorly sorted fine to coarse grained sand	Little recovery; losing most of fines in discharge, 38-43 feet
40	GB				40.0	
					SP **Sand** fine grained sand	
					43.0	No recovery, 43-44 feet
					44.0	
45	GB				SP **Sand** brown, fine grained sand	Adding water and foam while drilling; discharge water is brown, 45-46 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SP **Sand** brown, fine grained sand	
					53.0	
					SW **Sand** brown, well graded sand	
55	GB					Adding water and foam while drilling, 55-60 feet
					57.0	
					SP **Sand** brown, fine grained sand	
60	GB					
					64.0	
65	GB				SW **Sand** trace gravel, well graded sand	
					66.0	No recovery, 66-67 feet
					67.0	
					SP **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", wet	Discharge water is dark brown, 67-75 feet Adding water and foam while drilling; losing fines, 67-107 feet
					69.0	
70	GB				GP **Sandy Gravel** brown, subangular gravel, 70% of clasts are fractured, clasts up to 5/8", wet	
75	GB		no flow			Fine grained sand, 74-75 feet
			2			Fine to coarse grained sand, 75-78 feet Discharge water is brown, 75-94 feet
					78.0	
					GW **Gravel with Sand** multicolored, subangular to rounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, wet	
					79.0	No recovery, 79-81 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					81.0	
			trace flow		GW **Sand and Gravel** multicolored, subangular to rounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, wet	No recovery, 82-83 feet
					82.0	
					83.0	
					GW **Sand and Gravel** multicolored, subangular to rounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, wet	
85	GB					
					86.0	
			trace to no flow		SW **Sand with Gravel** multicolored, fine gravel, well graded fine to coarse grained sand, wet	
					87.0	
					SW **Gravelly Sand** multicolored, subangular gravel, clasts up to 1/2", poorly sorted fine to coarse grained sand, wet	
					89.0	
90	GB				SP **Sand** brown, trace gravel, fine grained sand, wet	
					90.0	
					SW **Gravelly Sand** multicolored, subangular gravel, clasts up to 1/2", poorly sorted fine to coarse grained sand, wet	
					91.0	
			0.5		92.0 SP **Sand** brown, trace gravel, fine grained sand, wet	
					SW **Gravelly Sand** multicolored, subangular gravel, clasts up to 1/2", poorly sorted fine to medium grained sand, wet	
					94.0	Discharge water is gray, 94-103 feet
95	GB				GW **Sand and Gravel** multicolored, subangular to rounded gravel, 50% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	Trace gravel, 95-99 feet
					95.0	
			4		SP **Sand** gray, fine grained sand, wet	Flow tests in this interval may be biased low, 95-135 feet
						Very little recovery, 98-102 feet
100			15			Trace gravel, 100-101 feet
			3		102.0	Clasts up to 1/2", 102-103 feet
					GP **Sandy Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, well graded sand, wet	Clasts up to 3/4", 103-104 feet
					104.0	Discharge water is brown, 103-138 feet
105	GB				GP **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", well graded sand, wet	Losing fines, 105-115 feet
			6			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 5 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					GP **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", well graded sand, wet	
			1.5			
115	GB					Adding water and foam while drilling, 115-117 feet More sand than rest of unit, 116-121 feet
120	GB		15			Less water production than above, 120-123 feet More gravel than previous 5-foot interval, 121-123 feet
					123.0	
					GW **Gravel with Sand** multicolored, subangular to subrounded gravel, <30% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	
125	GB				124.0	
					GP **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", well graded sand, wet	
					125.0	
					GW **Gravel with Sand** multicolored, subangular to subrounded gravel, <30% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	Clasts up to 1/2", 126-129 feet
					126.0	
					GW **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, well graded sand, wet	
130	GB		3			Adding water and foam while drilling; clasts up to 3/4", 129-130 feet Clasts up to 1", 130-131 feet Clasts up to 1/2", 131-133 feet Clasts up to 1", 133-134 feet
135	GB		1.75			Clasts up to 3/4", 134-135 feet Adding water and foam while drilling, 134-138 feet Clasts up to 1/2", 135-138 feet More sand than rest of unit, 137-138 feet
					138.0	
					GP **Sand and Gravel** most of the clasts are fractured, clasts up to 1/2"	Losing mud into the formation, 138-140 feet Logged via cuttings; biased coarse, 138-149 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					GP **Sand and Gravel** most of the clasts are fractured, clasts up to 1/2"	Advanced via mud rotary, 138-307 feet No SPT; grinding on boulder or cobble, 139-141 feet
					142.0 GP **Gravel** subangular to subrounded gravel, most of the clasts are fractured, clasts up to 1/4"	
145	GB					
					147.0 GP **Gravel** most of the clasts are fractured, clasts <1/4"	
					149.0 GW **Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/2", trace sand	Conduct SPT; blow counts: 6-7-6; likely sluff, 149-151 feet Logged via cuttings; biased coarse, 150-151 feet
150	SS				150.0 GP **Gravel** fine gravel, most of the clasts are fractured, clasts up to 1/4"	Losing mud into the formation, 151-152 feet Recovery is slough, 151-155 feet
					151.0	
155						No SPT; difficult to advance; slough in bottom of hole, 154-156 feet No recovery; losing mud into the formation, 155-157 feet
					157.0 GW **Gravel** multicolored, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 3/4", well graded, wet	Logged via cuttings; biased coarse, 157-165 feet Clasts up to 3/8", 158-161 feet
					158.0 GW **Gravel** multicolored, angular to subangular gravel, most of the clasts are fractured, well graded, wet	
160						Clasts up to 5/8", 161-163 feet
					163.0 GW **Gravel** multicolored, angular to subrounded gravel, 70% of clasts are fractured, clasts up to 3/4", well graded, wet	
					164.0	No recovery, 164-165 feet
165					165.0	
	SS				GW **Sand and Gravel** multicolored, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", well graded sand, wet	Conduct SPT; blow counts: 19-34-31-28, 165-167 feet
					166.5 167.0 SP **Sand** orangey brown, fine grained sand	Logged via cuttings, 167-170 feet
					GW **Gravel** multicolored, angular to subangular gravel, 70% of clasts are fractured, clasts up to 1/2", wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 7 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170	SS				170.0 GW **Sand and Gravel** multicolored, angular to subangular gravel, 70% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	Conduct SPT; blow counts: 14-33-25-26, 170-172 feet
					171.0 SP **Sand** brown, fine to medium grained sand, wet	
					172.0 GW **Gravel** multicolored, angular to subangular gravel, 70% of clasts are fractured, clasts up to 1/2", wet	Logged via cuttings; biased coarse, 172-175 feet
175					175.0 GW **Gravel** multicolored, angular to subangular gravel, most of the clasts are fractured, wet	Conduct SPT; blow counts: 5-10-50; recovery is all slough, 175-177 feet Clasts up to 1/2", 175-180 feet Logged via cuttings; biased coarse, 175-185 feet
180						Clasts up to 3/4", 180-181 feet No SPT; grinding on boulder or cobble, 180-182 feet Clasts up to 1/2", 181-185 feet
						Slow drilling, 183-184 feet
185	SS				185.0 GP **Gravel** multicolored, angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", wet	Conduct SPT; blow counts: 2-2-1; likely slough, 185-187 feet
					187.0 GP **Gravel** multicolored, fine angular gravel, most of the clasts are fractured	Logged via cuttings; biased coarse, 187-204 feet
190						No SPT; grinding on boulder or cobble, 189-191 feet
						Slow drilling, 191-192 feet
						Some weathered clasts starting at 192 feet Smaller clasts from grinding on rock, 193-195 feet No SPT; grinding on boulder or cobble, 194-196 feet Losing mud into the formation, 195-197 feet
195						
						Boulder or cobble starting at 198 feet
	GB					No SPT; grinding on boulder or cobble,

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 8 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
200					GP **Gravel** multicolored, fine angular gravel, most of the clasts are fractured	199-201 feet
						Losing mud into the formation; grinding on boulder or cobble, 203-204 feet
					204.0	
205	SS				GP **Gravel with Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", coarse grained sand	Conduct SPT; blow counts: 1-2-1; likely slough, 204-206 feet
					205.0	Clasts <1/4", 205-208 feet
					GP **Gravel** multicolored, fine angular to subangular gravel, 70% of clasts are fractured, wet	Logged via cuttings; biased coarse, 205-225 feet
						Clasts up to 3/8", 208-210 feet
						Losing mud into the formation, 209-210 feet
210	SS					Conduct SPT; blow counts: 14-15-10-16; recovery is all slough, 210-212 feet
						Clasts <1/4", 210-215 feet
215	GB				215.0	Losing mud into the formation, 214-215 feet
					GP **Gravel** multicolored, angular gravel, most of the clasts are fractured, clasts up to 1/2", iron staining, wet	
					217.0	No SPT; high potential for slough, 214-216 feet
					GP **Gravel** multicolored, fine angular gravel, 70% of clasts are fractured, clasts up to 1/2", iron staining, wet	
220					220.0	No SPT; grinding on boulder or cobble, 219-221 feet
					GP **Gravel** multicolored, fine angular gravel, most of the clasts are fractured, clasts <1/4", iron staining, wet	No longer losing mud into the formation; driller notes that the hole is staying open better than before, 221-225 feet
225	SS				225.0	Conduct SPT; blow counts: 27-24-28-37, 225-227 feet
					GW **Gravel** black, subrounded coarse gravel, most of the clasts are fractured, clasts up to 1 1/2", some white crystalline clasts with black minerals and iron staining, fractured	
					227.0	Logged via cuttings, 227-230 feet
					GP **Gravel** multicolored, clasts <1/4", wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 9 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
230					230.0	
	SS				SW **Sand** brown, trace gravel, well graded sand, iron staining, dense, moist	Conduct SPT; blow counts: 50+-50+-50+, 230-232 feet
					231.0 GP **Sand and Gravel** multicolored, subangular to subrounded gravel, most of the clasts are fractured	Clasts up to 1/4", 231-232 feet Logged via cuttings, 231-235 feet Clasts <1/4", 232-235 feet
235					235.0	
	SS				SM **Silty Sand** brown, well graded, poorly sorted sand, dense	Conduct SPT; blow counts: 12-22-30, 235-237 feet
					237.0	Cuttings not representative of interval; most likely slough, 237-240 feet
240					240.0	
	SS				SM **Silty Sand with Gravel** multicolored, subrounded gravel, clasts up to 1/2", well graded sand, dense	Slow drilling, 240 feet Conduct SPT; blow counts: 1-6-20, 240-242 feet
					241.0	No recovery, 241-242 feet
					242.0 ML **Silt and Gravel**	Hold collapsed after SPT to approximately 140 feet; re-advanced to depth and resumed advancing via mud rotary, 242 feet Logged via cuttings, 242-250 feet
245					245.0	
	SS				ML **Silt and Gravel** multicolored, clasts up to 1/2", brown silt	Very fast drilling; driller indicates drilling behavior is indicative of clay, 245-250 feet Conducted SPT; blow counts: 8-9-5-6; recover is all slough, 245-257 feet
250					250.0	
	SS				CH **Clay** dark gray, moist	Conduct SPT; blow counts: 5-11-25-44, 250-252 feet
					252.0 CH **Clay with Gravel** dark gray	Logged via cuttings, 252-255 feet
255					255.0	
	SS				CH **Clay with Silt** light to dark gray, sticky, moist	Conduct SPT; blow counts: 17-22-42-50+ (3"), 255-257 feet
					257.0 CH **Clay with Gravel** clasts <1/4"	Logged via cuttings, 257-260 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 10 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
260	SS				260.0 CH **Clay** light to dark gray, trace silt, soft to medium stiff, moist 262.0	Conduct SPT; blow counts: 7-8-13, 260-262 feet
					CH **Clay with Gravel** clasts <1/4"	Logged via cuttings, 262-265 feet
265	SS				265.0 CH **Clay** interbedded gray to dark gray dense clay and dark gray to black clay with trace silt, moist 267.0	Conduct SPT; blow counts: 5-9-17, 265-267 feet
					CH **Clay with Gravel** clasts <1/4"	Logged via cuttings, 267-270 feet
270	SS				270.0 CH **Clay** gray, medium dense, soft to medium stiff, moist 272.0	Conduct SPT; blow counts: 7-7-12, 270-272 feet
					CH **Clay with Gravel** clasts <1/4"	Logged via cuttings, 272-275 feet
275	SS				275.0 ML **Silt and Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1", very dense, trace gray clay, iron staining 277.0	Conduct SPT; blow counts: 50+-50+, 275-277 feet
					ML **Silt and Gravel** multicolored, clasts <1/4", fractured	Losing mud into the formation, 277-278 feet
280	SS				280.0 GM **Silty Sand and Gravel** brown, angular to subrounded gravel, clasts up to 1", fine to coarse grained sand, trace gray clay, iron staining, wet 282.0	Conduct SPT; blow counts: 50+-50+, 280-282 feet
					Bedrock (Tertiary Basalt) dark green to black, angular to subrounded clasts, clasts <1/4", aphanitic, moderately magnetic	Slow drilling; drilling behavior consistent with bedrock, 282-283 feet Replaced bit; reduced from 4 1/4" to 3 7/8", 283 feet Losing mud into the formation, 283-284 feet Faster drilling; may be in a fractured bedrock zone, 284-285 feet Drilling behavior is consistent with bedrock; very hard drilling; logged via cuttings, 285-295 feet
285						

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62D
PAGE 11 OF 11

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62D

DATE STARTED 6/2/08 **COMPLETED** 6/6/08 **GROUND ELEVATION** 896.2 feet **TOC ELEVATION** 899.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130826.7 feet **EASTING** 1395806.5 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
290					**Bedrock (Tertiary Basalt)** dark green to black, angular to subrounded clasts, clasts <1/4", aphanitic, moderately magnetic	
295						Faster drilling; logged via cuttings, 295-300 feet
300					300.0	Conduct SPT; no recovery, 300-302 feet Not logged, 300-307.1 feet
305					307.1	
					Bottom of hole at 307.1 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

Well development at P-08-62D was incomplete in 2008. Anticipated completion at future date.

THE pebble PARTNERSHIP

P-08-62M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62M

DATE STARTED 5/31/08 **COMPLETED** 6/1/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130811.1 feet **EASTING** 1395835.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					ML **Sandy Silt** brown, trace fine gravel, moist	
					2.0	
					SM **Silty Sand and Gravel** brown, gravel, most of the clasts are fractured, clasts up to 1/2", fine to coarse grained sand, dry	
					3.0	
					4.0	
					SM **Sand with Silt and Gravel** brown, poorly sorted fine to medium grained sand, dry to moist	
5	GB		no flow		5.0	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 5/8", fine to coarse grained sand, dry to moist	
					6.0	
					7.0	
					SM **Sand with Silt and Gravel** brown, poorly sorted fine to medium grained sand, dry to moist	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 5/8", fine to coarse grained sand, dry to moist	
					9.0	
10	GB				GP **Sand and Gravel** brown to gray, gravel, most of the clasts are fractured, clasts up to 1/2", fine to coarse grained sand, dry	
					11.0	
					Boulder or Cobble multicolored, fractured, fragments up to 3/4", dry	
					GP **Sand and Gravel** brown, gravel, most of the clasts are fractured, clasts up to 1", well graded sand, dry	
						Trace silt; trace clay, 14-15 feet
15	GB		no flow		15.0	
					ML **Sandy Silt** brown, trace gravel, fine grained sand, low to medium-plastic brown silt	
					16.0	Little recovery, 16-17 feet
					ML **Silt** brown, trace fine sand, low to medium-plastic silt	Trace gravel, 17-20 feet Clasts <1/4", 17-19 feet
						Subrounded gravel; 50% of clasts are fractured; clasts up to 1/2", 19-20 feet
20	GB				20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 50# sand

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Native Material, Sand, and Bentonite Pellets

DEVELOPMENT
Method: N/A
Date: Anticipated completion in 2009
Purge Volume: N/A

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/1/08 at 1130 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62M

DATE STARTED 5/31/08 **COMPLETED** 6/1/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130811.1 feet **EASTING** 1395835.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt** light to dark brown, trace fine gravel, low-plastic silt	May be losing air into the formation, 20 feet Adding water while drilling; discharge water is brown, 20-32 feet More gravel than above, 22-23 feet
					23.0	
					GP **Gravel with Sand** subangular gravel, 50% of clasts are fractured, coarse grained sand, trace silt	
					24.0	
25	GB		trace flow		GP **Gravel and Sand** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, coarse grained sand	
					25.0	
					SP **Sand** multicolored, poorly sorted fine to coarse grained sand	
30						
					33.0	
					SP **Sand** multicolored, trace subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", poorly sorted fine to coarse grained sand, trace silt	Little recovery, 34-35 feet
35	GB	▼	trace flow			Adding water while drilling; discharge water is brown, 35-45 feet No recovery, 36-37 feet
					36.0	
					37.0	
					SP **Sand** trace gravel, clasts <1/4", poorly sorted fine to coarse grained sand	
40	GB					
45	GB		trace flow			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62M

DATE STARTED 5/31/08 **COMPLETED** 6/1/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130811.1 feet **EASTING** 1395835.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SP **Sand** trace gravel, clasts <1/4", poorly sorted fine to coarse grained sand	
55	GB		trace flow			
					56.0	
			trace flow		SP **Sand** trace subangular to subrounded gravel, clasts up to 1/2", poorly sorted fine to coarse grained sand	
					57.0	
					SW **Sand with Gravel** subangular to subrounded gravel, 20% of clasts are fractured, clasts up to 1/2", well graded sand	Adding water while drilling; discharge water is brown, 58-59 feet
60	GB					
					61.0	
			no flow		SW **Sand** trace subangular to subrounded gravel, 20% of clasts are fractured, clasts up to 1/2", well graded sand	
65	GB					Adding water while drilling; discharge water is brown, 65-70 feet More gravel than rest of unit, 65-67 feet
					67.0	
					GP **Sand and Gravel** multicolored, fine subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4", poorly sorted coarse grained sand	Sand and gravel unit producing water, 67-75 feet
70	GB					
			8			More gravel than above, 71-72 feet
			7			Adding water while drilling, 72-73 feet
75	GB		trace flow		75.0	
					SW **Sand** multicolored	
					77.0	
					SW **Sand** multicolored, trace gravel, clasts <1/4"	
	GB				79.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62M

DATE STARTED 5/31/08 **COMPLETED** 6/1/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130811.1 feet **EASTING** 1395835.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
					81.0 SW **Sand** brown, poorly sorted fine to coarse grained sand	
					82.0 SW **Sand** multicolored, trace gravel, well graded sand	No recovery, 82-83 feet
					83.0 SW **Sand with Gravel** multicolored, fine subrounded gravel, clasts <1/4", well graded sand	
85	GB					Adding water while drilling, 85-86 feet Trace gravel, 85-90 feet
90	GB				90.0 SW **Sand** brown, poorly sorted fine to coarse grained sand, fines	
					93.0 SW **Sand** brown, trace fine gravel, poorly sorted fine to coarse grained sand, fines	
95	GB		no flow		95.0 SM **Sand with Silt/Clay** trace gravel, fine grained sand, wet	Adding water while drilling; discharge water is brown, 95-96 feet Cuttings are brown, 95-96 feet Cuttings are gray, 96-98 feet Adding water while drilling; discharge water is gray, 97-101 feet
			0.75		98.0 SM **Sand with Silt/Clay** gray, fine grained sand, wet	
100	GB				99.0 SM **Sand with Silt/Clay and Gravel** brown, angular to subangular gravel, most of the clasts are fractured, fine grained sand, wet	Drilling speed slowed; possibly due to an increased percentage of silt, 100-101 feet
			trace flow		100.0 SM **Sand with Silt/Clay** brown, poorly sorted fine to coarse grained sand, wet	Increase in grain size within the sand fraction, 100-103 feet Adding water while drilling; discharge water is brown, 101-104 feet
					102.0 SM **Gravelly Sand with Silt/Clay** brown, subangular gravel, clasts up to 1/2", fine to coarse grained sand, wet	
					103.0 SM **Sand with Silt/Clay** brown, trace subangular gravel, clasts up to 1/2", fine to coarse grained sand, wet	
105	GB		0.75		104.0 SW **Sand with Gravel** brown, subangular gravel, clasts up to 1/2", well graded fine to coarse grained sand, wet	Discharge water is brown, 104-114 feet
					105.0 GM **Sand and Gravel with Silt** multicolored, subangular gravel, 70% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62M

DATE STARTED 5/31/08 **COMPLETED** 6/1/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130811.1 feet **EASTING** 1395835.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, C. Kramer

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					110.0 GP **Sand and Gravel** multicolored, subangular to subrounded gravel, 30% of clasts are fractured, fine to coarse grained sand, trace silt, wet	Clasts up to 3/4", 110-115 feet
			0.25			
115	GB				116.0 GP **Sandy Gravel** multicolored, angular to rounded gravel, 30% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	Adding water while drilling; discharge water is brown, 114-115 feet Clasts up to 1",115-116 feet Discharge water is light brown, 115-123 feet
			2			
120	GB				121.0 SP **Gravelly Sand** multicolored, angular to rounded gravel, 30% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	
			0.5		123.0 Bottom of hole at 123.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

Well development at P-08-62M was incomplete in 2008. Anticipated completion at future date.

THE pebble PARTNERSHIP

P-08-62S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62S

DATE STARTED 6/7/08 **COMPLETED** 6/7/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130830.2 feet **EASTING** 1395826.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SP **Sand** brown, trace subrounded gravel, 15% of clasts are fractured, clasts up to 1/2", poorly graded, well sorted fine to coarse grained sand, dry to moist	
4.0						
5	GB		no flow		SM **Silty Sand** brown, trace subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", poorly graded, well sorted fine to coarse grained sand, brown silt, moist	
6.0					SM **Silty Sand and Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, poorly graded, well sorted fine to coarse grained sand, brown silt, moist	Clasts up to 1/4", 6-7 feet Clasts up to 1/2", 7-16 feet
10	GB		no flow			
15	GB		no flow			
16.0					ML **Silt** brown, trace fine grained sand, moist	Slow drilling, 16-19 feet Silt balls, 16-17 feet
20	GB					Drilling speed increases, 19-21 feet
20.0						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 150# cement

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Hole Plug 3/4" Bentonite Chips

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is dry)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is dry)

Comments: Piezometer is dry; Measured on 6/8/08 at 740 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-62S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-62S

DATE STARTED 6/7/08 **COMPLETED** 6/7/08 **GROUND ELEVATION** 895.5 feet **TOC ELEVATION** 898.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130830.2 feet **EASTING** 1395826.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			no flow		SP **Sand** brown, trace subrounded to rounded gravel, clasts up to 3/8", fine grained sand, moist	
				21.0	Bottom of hole at 21.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-62S. Well dry.

THE pebble PARTNERSHIP

P-08-63D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63D

DATE STARTED 6/8/08 **COMPLETED** 6/9/08 **GROUND ELEVATION** 883 feet **TOC ELEVATION** 886.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128301.2 feet **EASTING** 1396022.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Organic Soil and Sand brown, fine grained sand, moist	Logged from sump, 0-1 feet
					1.0	
					GM **Silty Gravel with Clay** gray, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", brown silt	Cuttings are dry to moist, 1-3 feet
						Cuttings are moist, 3-4 feet
					4.0	
5	GB				ML **Gravelly Silt with Sand and Clay** brown, subangular to subrounded gravel, clasts up to 1/2", well graded sand, dry to moist	
					5.0	75% of clasts are fractured, 5-9 feet
					GM **Silty Gravel with Sand** dark gray, gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, brown silt, moist	
10	GB		no flow			50% of clasts are fractured, 9-13 feet
					13.0	
					ML **Silt with Sand** brown, trace gravel, fine grained sand	Cuttings are moist, 13-14 feet
						Cuttings are moist to wet, 14-17 feet
15	GB					
					17.0	
						No recovery, 17-22 feet Adding water while drilling; discharge water is grayish brown, 17-25 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 5 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/20/2008
Purge Volume: 1781 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/10/08 at 1050 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63D

DATE STARTED 6/8/08 **COMPLETED** 6/9/08 **GROUND ELEVATION** 883 feet **TOC ELEVATION** 886.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128301.2 feet **EASTING** 1396022.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					22.0 ML **Silt with Sand** brown, trace gravel, fine grained sand	
25	GB	▼	no flow			Adding water while drilling; discharge water is brown, 25-27 feet
						Trace gravel, 27-30 feet
30	GB				30.0	Adding water while drilling; discharge water is brown, 29-37 feet No recovery, 30-32 feet
					32.0 ML **Silt** brown, trace gravel, fine grained sand	
35	GB		no flow			
			0.5		37.0 GW **Sand and Gravel** multicolored, subangular to rounded gravel, clasts up to 3/4", well graded	Discharge water is brown; 37-54 feet
40	GB				40.0	No recovery; adding water while drilling, 40-42 feet
			0.25		42.0 SW **Gravelly Sand** multicolored, subangular to rounded gravel, clasts up to 3/4", well graded	
					43.0 SM **Silty Sand** brown, trace gravel, fine grained sand	
45	GB		<0.25		48.0 SW **Gravelly Sand with Silt** multicolored, subangular to subrounded gravel, well graded	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63D

DATE STARTED 6/8/08 **COMPLETED** 6/9/08 **GROUND ELEVATION** 883 feet **TOC ELEVATION** 886.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128301.2 feet **EASTING** 1396022.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					51.0	
			1.5		ML **Sandy Silt with Clay** light brown, moist	
					52.0	Adding water while drilling; silt balls, 52-54 feet
					ML **Silt with Gravel and Sand** subangular to subrounded gravel, clasts up to 1", well graded sand, grayish brown silt, moist	
55	GB					More plastic silt than rest of unit, 54-62 feet
			0.75			Discharge water is grayish brown, 55-67 feet
						Adding water while drilling, 55-83 feet
60	GB					
			4		62.0	No recovery, 62-68 feet
65						
			10		68.0	Discharge water is gray, 67-75 feet
					CL **Silty Clay** brownish gray	
70	GB					
			2.25		73.0	
					GW **Sandy Gravel** multicolored, silt coated angular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", well graded, gray silt	
75	GB					Discharge water is brown, 75-85 feet
			0.75		77.0	
					SM **Silty Sand with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded, brown silt	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63D

DATE STARTED 6/8/08 **COMPLETED** 6/9/08 **GROUND ELEVATION** 883 feet **TOC ELEVATION** 886.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128301.2 feet **EASTING** 1396022.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					SM **Silty Sand with Gravel** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded, brown silt	
85	GB				85.0 SM **Silty Sand with Gravel** light brown, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/8", well sorted fine to coarse grained sand, wet	Discharge water is gray to light brown, 85-91 feet
			7			
90	GB				90.0 SM **Silty Sand** gray, trace subrounded to rounded gravel, clasts up to 3/8", fine to coarse grained sand, wet	Discharge water is brown, 91-93 feet
			45		92.0 SP **Sand** brown, poorly graded, well sorted fine to coarse grained sand, wet	Trace gravel, 93-94 feet Adding foam while drilling, 93-95 feet
95	GB				94.0 SP **Sand with Gravel** brown, poorly graded, well sorted fine grained sand, wet	Adding water while drilling, 95-97 feet
					95.0 **Bedrock (Grandiorite)** crystalline, fractured	Discharge water is milky, 97-102 feet
			6			
100	GB		10			
			8			Discharge water is brown, 102-103 feet
105	GB		8		105.0 **Bedrock (Granodiorite)** crystalline, quartz-feldspar groundmass with plagioclase and k-spar phenocrysts, epidote mineralization, hematilized manetite, minor pyrite, boxy hornblendes (some slighty chloritized)	Discharge water is milky brown, 103-122 feet
			25			
			25			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63D

DATE STARTED 6/8/08 **COMPLETED** 6/9/08 **GROUND ELEVATION** 883 feet **TOC ELEVATION** 886.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128301.2 feet **EASTING** 1396022.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			35		**Bedrock (Granodiorite)** crystalline, quartz-feldspar groundmass with plagioclase and k-spar phenocrysts, epidote mineralization, hematilized manetite, minor pyrite, boxy hornblendes (some slighty chloritized)	
			35			
115	GB		40			
			60			
			60			
120	GB		70			
			70 to 80			Adding foam while drilling, 122-123 feet
			70 to 100			Discharge water is milky brown, 123-130 feet
125						Little recovery, 125-130 feet
			70 to 100			
			70 to 100			
130	GB		70 to 100		130.0	
					Bottom of hole at 130.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-63D
Date: 6/19/08
Project: Pebble
Project #: 005.0189.08002
Technician: ~~C. Kramer~~ V Webb / M Jonti

Summary

	Installed (Well Log)	Start	End
Water level (FTOC)	25.03	24.36	24.46
Total depth (FTOC)	~~124.80~~	~~129.47~~	129.53
pH	127.7	N/A	7.82

Screen interval (btoPVC): ~~105.00~~ 119.8' to ~~124.80~~ 127.7
PVC stick-up height (above ground surface): ~~3.17~~ 3.0

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1303 START – 1' above screen									
1347	~~127.80~~	126.7	5.0	220	0.054	254	3.81	grey/lite brown, trace silts	3.71
1355	~~124.80~~	124.7						move 2' above screen – START	
1440	1	↓ —	4.50	422.50	0.052	38	4.15	lite grey, trace silts	5.01
1447	~~119.80~~	127.7 —						move 2' above screen – START	
1507	1	↓ —	4.75	517.50	0.052	38	3.92	clear, trace silts	5.22
1512	~~117.80~~	120.7 —						move 2' above screen – START	
1548	~~117.80~~	↓ —	3.75	652.50	0.051	35	4.21	slightly grey, trace silts	6.27
1555	~~115.80~~	118.7 —						move 2' above screen – START	
1610	1	↓ —	4.0	742.5	0.051	43	4.17	lite grey, trace silts	6.10
1615	~~113.80~~	116.7 —						move 2' above screen – START	
1630	1	↓ —						Restart – rocked gas – stopped for 10 mins	
1648	1	↓ —	4.0	804.50	0.053	43	4.27	very lite grey, trace silts	7.00
1653	~~111.80~~	114.7 —						move 2' above screen – START, STOP @ 1705	
6/20/08 0805	~~111.80~~	↓ 24.54 —						START	
0845	1	↓ —	4.75	1056.25	0.285	30	3.75	clear, trace silts, < 1/4 TSP	8.22
0852	~~109.80~~	112.7 —						move 2' above screen – START	
0915 ~~0900~~	—	↓ —	4.50	1159.75	0.052	23	3.50	clear, trace silts, < 1/4 TSP	8.38
0921	~~107.80~~	110.7 —						move 2' above screen – START	
0951	1	↓ —	4.25	1287.25	0.059	33	3.47	clear, trace silts, < 1/4 TSP	7.57
0956	—	—						STOP	
0959	~~105.80~~	108.7 —						START move 2' above screen	
1020	↓	↓ —	5.00	1392.25	0.051	19	3.72	clear, trace silts, < 1/8 TSP	7.55
1025	~~103.80~~	106.7 —						move 2' above screen – START	
1045	~~103.80~~	↓ —	4.25	1477.25	0.050	19	3.78	clear, no sediment	7.44
Surge block off START POLISH @ 1105 move screen 4' up									
POLISH 1142	~~99.80~~	102.7 —	4.75	1653	0.051	7	4.15	clear, no sediment	7.49
1152	~~123.80~~	126.7 —						move 1' off bottom – START	
DEBRIS 1220	1	↓ —	4.25	1780.5	0.059	7	4.57	clear, < 1/4 TSP solids	7.82

THE pebble PARTNERSHIP

P-08-63M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63M

DATE STARTED 6/10/08 **COMPLETED** 6/10/08 **GROUND ELEVATION** 883.7 feet **TOC ELEVATION** 886.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128305.7 feet **EASTING** 1396055.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Organic Soil and Sand brown, fine grained sand, moist	Logged from sump, 0-2 feet
					2.0	
					GM **Silty Gravel** brown, subangular to subrounded gravel, clasts up to 1", dry	
					4.0	
5					GM **Silty Gravel and Sand** subangular gravel, clasts up to 1/2", well graded, dry	
					7.0	
					GM **Silty Gravel** black, most of the clasts are fractured, clasts up to 1", brown silt, dry	
10						
					11.0	
					GM **Silty Gravel with Sand** multicolored, 25% of clasts are fractured, clasts up to 1", well graded, brown silt, dry	
					14.0	
15			no flow		SM **Silty Sand** brown, well sorted fine grained sand, dry	
					15.0	
					SM **Silty Sand with Gravel** brown, fine to coarse grained sand, moist	
					16.0	
					ML **Silt with Sand** multicolored, fine to coarse grained sand, medium-plastic brown silt, moist	
					17.0	
					18.0 ML **Silt with Sand and Gravel** multicolored, clasts up to 1/2", fine to coarse grained sand, medium-plastic brown silt, moist to wet	Less plastic silt than above, 18-23 feet
20					ML **Silt with Sand** brown, moist to wet	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/21/2008
Purge Volume: 1428 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/11/08 at 1000 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63M

DATE STARTED 6/10/08 **COMPLETED** 6/10/08 **GROUND ELEVATION** 883.7 feet **TOC ELEVATION** 886.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128305.7 feet **EASTING** 1396055.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt with Sand** brown, moist to wet	
					23.0	Adding water while drilling; discharge water is brown, 22-24 feet
		▼			ML **Silt and Sand** brown, well sorted fine grained sand, non-plastic silt	
25			no flow			
						Adding water while drilling; discharge water is brown, 27-28 feet
30					30.0	
					SM **Silty Sand with Gravel** brown, subrounded gravel, clasts up to 1", well sorted fine grained sand	
						Very little recovery, 33-38 feet
35			no flow			Adding water while drilling; discharge water is brown, 35-38 feet
40					40.0	
					SW **Gravelly Sand** multicolored, subrounded gravel, clasts up to 1", well graded sand, wet	Discharge water is dark brown, 40-44 feet
			0.75		44.0	
					GW **Gravel and Sand with Silt** multicolored, subangular to rounded gravel, clasts up to 1", well graded sand, light brown silt	Silt balls, 44-45 feet
45					45.0	Adding water while drilling, 44-63 feet
					ML **Silt with Gravel and Sand** multicolored, subangular to rounded gravel, well graded sand, light brown medium-plastic silt	Discharge water is light milky brown, 45-62 feet
			trace flow			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63M

DATE STARTED 6/10/08 **COMPLETED** 6/10/08 **GROUND ELEVATION** 883.7 feet **TOC ELEVATION** 886.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128305.7 feet **EASTING** 1396055.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					ML **Silt with Gravel and Sand** multicolored, subangular to rounded gravel, well graded sand, light brown medium-plastic silt	
55						
60						Discharge water is dark brown, 62-65 feet Very little recovery, 63-64 feet
					63.0 ML **Silt with Clay** grayish brown 64.0	No recovery, 64-68 feet
65						Discharge water is dark grayish brown, 65-74 feet
					68.0 SP **Sand with Gravel and Silt** multicolored, subangular to subrounded gravel, clasts up to 3/4", fine grained sand	
70					72.0	
			5		73.0 SP **Sand with Gravel and Silt** brown, subrounded gravel, clasts up to 1/2", fine grained sand, medium-plastic silt	No recovery, 73-75 feet
75					75.0	
			0.5		GW **Sandy Gravel** multicolored, silt coated subangular to rounded gravel, clasts up to 1", coarse grained sand, trace brown silt	Adding water while drilling, 75-78 feet Discharge water is brown, 75-83 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63M
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63M

DATE STARTED 6/10/08 **COMPLETED** 6/10/08 **GROUND ELEVATION** 883.7 feet **TOC ELEVATION** 886.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128305.7 feet **EASTING** 1396055.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					GW **Sandy Gravel** multicolored, silt coated subangular to rounded gravel, clasts up to 1", coarse grained sand, trace brown silt	More silt that rest of unit; cuttings are wet, 80-82 feet
					82.0	
			0.75		SM **Silty Sand and Gravel** multicolored, silt coated subangular to rounded gravel, clasts up to 1", coarse grained sand, brown silt, wet	
					83.0	
					Bottom of hole at 83.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-63M
Date: 6/19/08
Project: Pebble
Project #: 005.0189.08002
Technician: ~~C Kramer~~ V Webb | M Jenti

Summary

	Installed (Well Log)	Start	End
Water level FTOC	~~23~~ 23.97	25.29	23.89
Total depth FTOC	~~83.0~~ 84.5	84.27	~~85.10~~ 84.37
pH			

Screen interval (btoPVC): ~~113~~ 9.8'
(FTOC) Top: ~~57.2'~~ ~~70.2~~ 74.7 VSZ
Bottom: ~~76.5'~~ ~~88.0~~ 84.5
PVC stick-up height (above ground surface): ~~2.44'~~ 2.5

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1217 – START 1' above screen									
VSZ 1314	~~81.0~~ 83.5	—	3.0	171	.143	N/A	4.77	heavily silty, bentonite, ~3 Tbsps, brown	2.88
1317	~~79.0~~ 81.5							Move 2' above screen – START	
1404	1	—	3.75	300.25	.141	254	3.84	silty, dark grey, ~2 Tbsps	4.56
~~M12~~	~~77.0~~ 79.5							Move 2' above screen – START	
1458	1	—	2.75	426.75	.120	38	4.09	silty, dark grey ~2 Tbsps	5.46
1505	~~75.0~~ 77.5							Move 2' above screen – START	
1527	1	—	4.00	514.75	.049	38	4.00	silty, dark grey ~2 Tbsps	5.55
1616	1	—	2.50	637.25	.080	43	3.89	silty, dark grey/brown ~1 Tbspn	6.40
1624	~~73.0~~ 75.5							Move 2' above screen – START, STOP @ 1705	
6/20/08 0805	~~73.0~~ ~~75.5~~ 23.44	—	—	—	—	—	—	START	
0852	1	—	1.75	791.25	0.111	N/A	3.56	silty, dark grey ~2 Tbspl	8.36
0900	~~71.0~~ 73.5							Move 2' above screen – START	
0945	1	—	2.50	923.75	0.271	N/A	3.62	silty, dark grey/brown, ~2 Tbsps	7.60 41
(W) ~~0956~~	~~69.0~~	—	—	—	—	—	—	~~Move 2' above screen – START~~	
1020	—	—	—	—	—	—	—		
Surge block off – START 4' above last 10' above screen – POWER – 1015									
POWER 1215	67.0 69.5	—	—	—	—	—	—	STOP – ran out of gas	
1315	1	—	—	—	—	—	—	START	
1515	1	—	2.25	1193.75	0.088	N/A	4.21		7.54
1700	~~67.0~~ ~~69.5~~ ~~23.6~~	—	—	1430	—	—	—	STOP	
6/21/08 0810	~~67.0~~ 69.5 23.6	—	—	—	—	—	—	START	

(NOTE: N/A = 1000+ = too turbid to read)

0924	67.0 69.5	—	2.00	1337.75	0.080	N/A	3.76	silty, dark brown ~2 Tbsps	7.82
Debris 0930	~~81.0~~ 83.5							move 1' off bottom – START	
0946	—	—	2.5	1427.75	1.08	N/A	2.73	silty, dk brown ~2 Tbsps	7.54

THE pebble PARTNERSHIP

P-08-63S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63S

DATE STARTED 6/11/08 **COMPLETED** 6/11/08 **GROUND ELEVATION** 883.6 feet **TOC ELEVATION** 886.4 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128349.8 feet **EASTING** 1396028.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SW **Gravelly Sand** brown, subangular gravel, clasts up to 1", well graded sand, moist	
6.0					SW **Gravelly Sand** black, silt coated gravel, 50% of clasts are fractured, clasts up to 1", well graded sand, trace brown silt, dry to moist	
9.0					GW **Gravel and Sand** silt coated subangular to subrounded gravel, clasts up to 1", well graded sand, trace brown silt, dry	
			no flow			
18.0					ML **Silt** brown, trace gravel, trace sand, non-plastic silt	Cuttings are moist, 18-25 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/21/2008
Purge Volume: 1091 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/12/08 at 645 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-63S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-63S

DATE STARTED 6/11/08 **COMPLETED** 6/11/08 **GROUND ELEVATION** 883.6 feet **TOC ELEVATION** 886.4 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2128349.8 feet **EASTING** 1396028.7 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt** brown, trace gravel, trace sand, non-plastic silt	
25			no flow			Cuttings are moist to wet, 25-30 feet
30					30.0 SM **Sand with Silt** brown, well sorted fine grained sand, wet 33.0	Discharge water is brown, 33-34 feet
35					SP **Gravelly Sand** brown, subangular gravel, clasts up to 1/2", fine to coarse grained sand 36.0	Discharge water is brown, 36-46 feet
40			0.25		GW **Sand and Gravel** brown, subangular gravel, clasts up to 1", well graded sand	
45			2		46.0 GM **Gravel and Silt with Sand** gravel, clasts up to 1", well graded sand, medium-plastic silt, clay 47.5 Bottom of hole at 47.5 feet.	Discharge water is light brown, 46-47 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-6~~8~~S
Date: 6/20/08
Project: Pebble
Project #: 005.0189.08002
Technician: ~~E. Kramer~~ V Webb / M Jati / A Murphy (guard)

Summary

	Installed (Well Log)	Start	End
Water level	22.97	23.13	23.19
Total depth	47.5	48.20	48.09
pH			

Screen interval (btoPVC): ~~4~~ 9.8
Top: ~~29~~ 35.0
Bottom: ~~30~~ 44.8
PVC stick-up height (above ground surface): ~~3.12~~ 2.8

LAZ

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	
Surge block on 1315 START 1' off bottom of screen									
1332	43.80	23.13	3.25	55.25	0.032	241	6.00	lite brown, ~ 1/2 Tbsp sands	7.79
1410	1	—	350	188.25	0.030	241	5.83	lite brown, ~ 1/2 Tbsp sands	7.65
1416	41.80	—						Move 2' above screen - START	
1505	1	—	2.50	310.75	0.030	448	6.16	lite brown, ~ 1/2 Tbsp sands	7.54
1510	39.80	—						Move 2' above screen - START	
1602	1	—	2.25	427.75	0.033	1000*	6.39	lite brown, ~ 1/2 Tbsp sands	7.93
1605	37.80	—						Move 2' above screen - START	
1652	1	—	2.50	520.25	0.030	1000*	6.61	lite brown, ~ 1/2 Tbsp sands	7.82
1700								STOP	
6/21/08 0811	37.80	23.15						START 6/21/08	
0914	1	—	2.00	662.25	0.288	1000*	5.97	lite brown, ~ 1/2 Tbsp sands	7.29
0921	35.80	—						Move 2' above screen - START	
1008	1	—	2.00	756.25	0.033	655	5.61	lite brown, ~ 1/2 Tbsp sands	7.86
Surge block off - 1031 START - 4' off ~~bottom of screen~~ last run									
~~1114~~	~~33~~.80	—	3.5	906.75	0.031	63	4.88		7.77
~~1125~~	43.80	—						Move 4' off bottom - START	
1200	43.80	—	2.0	976.75	0.030	63	5.39		7.75
1202	43.50	—						Move 1' off bottom - END	
1237	43.50		3.25	1091.5	0.032	63	4.36		7.98

* = higher than 1000

THE pebble PARTNERSHIP

P-08-64D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-64D

DATE STARTED 6/11/08 **COMPLETED** 6/12/08 **GROUND ELEVATION** 892.8 feet **TOC ELEVATION** 895.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127781.7 feet **EASTING** 1397061 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SP **Sand with Gravel** multicolored, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", poorly graded fine grained sand, dry	
2.0					SW **Sand and Gravel** multicolored, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", brown well graded fine to coarse grained sand, dry	
5	GB					Native material around piezometer, 5-10 feet
6.0					SP **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", brown poorly graded fine grained sand, dry	
7.0					SW **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand, dry	
10	GB					
13.0					GW **Gravel with Sand** multicolored, angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", well graded, well sorted fine to coarse grained sand, dry	
15	GB					Adding water while drilling, 16-17 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 30 gal H2O

GROUT
Type: Volclay
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Native Material

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/23/2008
Purge Volume: 681 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/12/08 at 420 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-64D
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-64D

DATE STARTED 6/11/08 **COMPLETED** 6/12/08 **GROUND ELEVATION** 892.8 feet **TOC ELEVATION** 895.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127781.7 feet **EASTING** 1397061 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GW **Gravel with Sand** multicolored, angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", well graded, well sorted fine to coarse grained sand, dry	
					23.0	
					SW **Sand and Gravel** multicolored, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", brown well graded, well sorted fine to coarse grained sand, dry	
					24.0	
25	GB				GW **Gravel with Sand** multicolored, angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", well graded, well sorted fine to coarse grained sand, dry	Adding foam while drilling, 27-28 feet
					29.0	
30	GB	▼			GW **Gravel and Sand** brown, silt coated subrounded to rounded gravel, <10% of clasts are fractured, clasts up to 3/4", well sorted fine to coarse grained sand, trace silt, dry to moist	
					32.0	Slow drilling, 32 feet
					GM **Silty Gravel and Sand** brown, subrounded to rounded gravel, <10% of clasts are fractured, clasts up to 3/4", well sorted fine to coarse grained sand, dry to moist	Adding water while drilling, 33 feet Discharge water is brown; descriptions biased coarse, 33-42 feet
					34.0	
35	GB				GW **Gravel with Silt** angular to subangular gravel, 25% of clasts are fractured, clasts up to 3/4", trace fine to coarse grained sand, brown silt, wet	
					38.0	Light brown silt, 38-42 feet
					SW **Sand and Gravel with Silt** multicolored, subangular gravel, 50% of clasts are fractured, clasts up to 1/4", well graded medium to coarse grained sand, wet	
40	GB		11			
					43.0	Discharge water is yellow; descriptions biased coarse, 42-44 feet Yellow silt, 42-43 feet
					GM **Silty Gravel** multicolored, angular gravel, most of the clasts are fractured, clasts up to 3/4", yellow silt, well graded, wet	
					44.0	Discharge water is brown; descriptions biased coarse, 44-46 feet
45	GB		16.5		SW **Sand with Gravel** multicolored, angular gravel, most of the clasts are fractured, clasts up to 1/4", well graded medium to coarse grained sand, wet	
					46.0	Discharge water is clearing, 46-49 feet
			26		**Bedrock (Tertiary Volcanoclastic)** bimodal trend of clast sizes, fine grained light to dark purple-gray matrix hosting subangular larger volcanic clasts	
	GB					Slow drilling, 49 feet Discharge water is dark brown;

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-64D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-64D

DATE STARTED 6/11/08 **COMPLETED** 6/12/08 **GROUND ELEVATION** 892.8 feet **TOC ELEVATION** 895.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127781.7 feet **EASTING** 1397061 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			25		**Bedrock (Tertiary Volcanoclastic)** bimodal trend of clast sizes, fine grained light to dark purple-gray matrix hosting subangular larger volcanic clasts	descriptions biased coarse, 49 feet Discharge water is clear, 49-55 feet
			22			Moved to open hole hammer, 52.5 feet
55	GB		22			Discharge water is light brown, 55-69.5 feet
			30			
			35			
60	GB		40			
			40			
65	GB		40			
			40			
					69.5 Bottom of hole at 69.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-6AD
Date: 6/23/08
Project: Pebble
Project #: 005.0189.08002
Technician: L. Crawford / M. Jaffi

Summary

	Installed (Well Log)	Start	End
Water level (FTOC)	30.92	30.48	30.48
Total depth (FTOC)	61.43	60.80	61.41
pH			

Screen interval (btoPVC): 10'
(FTOC) Top: 51.53
Bottom: 61.43
PVC stick-up height (above ground surface): 2.73

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1035 = START (1' off bottom of screen)								~~v. lt. brown, < 1 Tbsp fine sand~~	
1105	60.43	—	3.50	105	0.044	35	7.24	v. lt. brown, < 1 Tbsp fine sand	6.95
1112	58.43	—						Move ↑ 2' - START	
1142	↓	—	3.25	202.5	0.042	35	7.85	lt. brown, ~ 1 Tbsp fine sand	6.71
1148	56.43	—						Move ↑ 2' - START	
1121	↓	—	3.00	301.5	0.042	23	7.92	v. lt. gray, ~ 1 tsp fine sand	6.76
1125	54.43	—						Move ↑ 2' - START	
1302	↓	—	2.75	403.25	0.042	23	6.65	almost clear, trace fine sand	6.72
1308	~~52~~.43	—						Move ↑ 2' - START	
1344	↓	—	2.25	484.25	0.042	23	6.90	v. lt. gray, trace sand	6.65
1355	~~50.43~~	—						Move ↑ 2' - START	
1425	↓	—	1.75	536.75	0.043	23	7.02	almost clear, trace fine sand	6.60
Surge block off									
POLISH 1440	46.43	—						Move ↑ 4' - START	
1517	↓	—	1.25	576.75	0.045	23	8.13	clear, no sediment	6.85
1524	60.43	—						Move 1' off bottom - START	
1556	↓	—	3.25	680.75	0.043	23	6.61	lt brown, ~ 1 tsp fine sand	6.81

THE pebble PARTNERSHIP

P-08-64S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-64S

DATE STARTED 6/12/08 **COMPLETED** 6/12/08 **GROUND ELEVATION** 892.8 feet **TOC ELEVATION** 896.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127807 feet **EASTING** 1397066.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-1 feet
					1.0 SW **Gravelly Sand** brown, angular to subangular gravel, up to 3/4", well graded sand, dry	
					3.0 GM **Gravel and Sand with Silt** brown, angular to subrounded gravel, <10% fractured, up to 1", well graded sand	Cuttings are dry to moist, 3-8 feet
5						
						Cuttings are dry, 8-14 feet
10						
						Cuttings are dry to moist, 14-25 feet
15			no flow			
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Chips

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is dry)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is dry)

Comments: Piezometer is dry; Measured on 6/12/08 at 650 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-64S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-64S

DATE STARTED 6/12/08 **COMPLETED** 6/12/08 **GROUND ELEVATION** 892.8 feet **TOC ELEVATION** 896.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127807 feet **EASTING** 1397066.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Gravel and Sand with Silt** brown, angular to subrounded gravel, <10% fractured, up to 1", well graded sand	
					24.0	
25			no flow		GM **Sandy Gravel with Silt** brown, subrounded gravel, up to 1/2", fine to coarse grained sand, brown silt	Cuttings are moist, 25-28 feet
					28.0	
					GM **Silty Gravel with Sand** brown, subrounded gravel, up to 1/2", fine to coarse grained sand, brown silt, moist to wet	
30			no flow		30.0	
					30.5	Slow drilling, 30-30.5 feet
					ML **Silt with Gravel and Sand** medium-plastic, moist	
					Bottom of hole at 30.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-64S. Well dry.

THE pebble PARTNERSHIP

P-08-65D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65D

DATE STARTED 6/13/08 **COMPLETED** 6/14/08 **GROUND ELEVATION** 897.6 feet **TOC ELEVATION** 901.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126554 feet **EASTING** 1396165.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-1 feet
					1.0 GM **Silty Gravel** angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1 1/2", non-plastic brown silt, dry	
					3.0 GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1 1/2", well graded sand, dry to moist	
5	GB					
10	GB					
					14.0 GW **Sand and Gravel** brown, subangular to rounded gravel, clasts up to 1 1/4", well graded sand, dry to moist	
15	GB		no flow			
					19.0	
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Volclay
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/22/2008
Purge Volume: 1060 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/15/08 at 215 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65D
PAGE 2 OF 7

PROJECT LOCATION Iliamna, Alaska
DRILL SITE P-08-65D
DATE STARTED 6/13/08 **COMPLETED** 6/14/08
GROUND ELEVATION 897.6 feet **TOC ELEVATION** 901.3 feet
DRILLING CONTRACTOR Foundex
NORTHING 2126554 feet **EASTING** 1396165.9 feet
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Silty Gravel and Sand** black to gray, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", well graded sand, brown silt, dry	
25	GB		no flow			
					28.0	
					GM **Silty Gravel with Sand** black, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1 1/2", well graded sand, brown silt, dry to moist	
30	GB					
					33.0	
					SM **Silty Sand and Gravel** angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1 1/2", well graded sand, brown silt, dry to moist	
35	GB		no flow			
					38.0	
					39.0	No recovery, 38-39 feet
40	GB				GW **Sandy Gravel** multicolored, subrounded gravel, clasts up to 1", well graded sand, moist to wet	
					41.0	
					GW **Sandy Gravel** multicolored, silt coated subrounded gravel, clasts up to 1", well graded sand, trace brown silt, wet	
					43.0	No recovery, 43-51 feet Discharge water is brown, 43-53 feet
45			trace flow			
			1.5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65D

DATE STARTED 6/13/08 **COMPLETED** 6/14/08 **GROUND ELEVATION** 897.6 feet **TOC ELEVATION** 901.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126554 feet **EASTING** 1396165.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					51.0	
		▼			CL-ML **Silty Clay** brown, medium stiff	Very little recovery, 51-53 feet
						Adding water while drilling; discharge water is light brown, 53-56 feet
55	GB		2			
					56.0	No recovery, 56-60 feet
						Adding water while drilling; discharge water is brown, 56-64 feet
			5			
60					60.0	
					CL-ML **Silty Clay** brown, medium stiff	
					62.0	No recovery, 62-63 feet
					63.0	
			7.5		CL-ML **Silty Clay** brown, medium stiff	
65	GB					Discharge water is light brown, 65-66 feet
					66.0	Adding water while drilling, 65-77 feet
					ML **Silt with Sand and Gravel** light brown, subangular gravel, clasts up to 1/2", fine grained sand, medium-plastic silt	Discharge water is milky brown, 66-68 feet
					68.0	
			6		CL-ML **Silty Clay** brown	Discharge water is grayish brown, 68-93 feet
70	GB					
						Trace gravel, 71-72 feet
					72.0	No recovery, 72-77 feet
75						No sample collected; recovery is mostly liquid, 75 feet
						Very low recovery, 75-95 feet
			0.75		77.0	
					ML **Silt with Gravel** grayish brown, angular gravel, most of the clasts are fractured, clasts up to 1/2", wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65D

DATE STARTED 6/13/08 **COMPLETED** 6/14/08 **GROUND ELEVATION** 897.6 feet **TOC ELEVATION** 901.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126554 feet **EASTING** 1396165.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					ML **Silt with Gravel** grayish brown, angular gravel, most of the clasts are fractured, clasts up to 1/2", wet	No sample collected; recovery is mostly liquid, 80 feet
			0.25			Adding water while drilling, 83-84 feet
						Silt balls, 84-85 feet
85						No sample collected; recovery is mostly liquid, 85 feet Adding water and foam while drilling, 85-94 feet
			1			
90	GB					Sample washed, 90-92 feet
					93.0	
	GB				GP **Sandy Gravel** multicolored, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", well graded medium to coarse grained sand, wet	Discharge water is brown, 93-115 feet
95			3			Adding water and foam while drilling, 95-105 feet
					96.0	
					SW **Gravelly Sand** multicolored, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", well graded, well sorted fine to medium grained sand, wet	
					99.0	
100	GB		4		SP **Gravelly Sand** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", poorly graded fine grained sand, wet	Samples washed, 100-135 feet
					104.0	
105					**Boulder or Cobble** dark and granitic, fractured, trace silt	
	GB		6		105.0 GW **Gravel and Sand** multicolored, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", poorly graded coarse grained sand, wet	Adding water while drilling, 105-133 feet
					108.0	
	GB				SW **Sand and Gravel** multicolored, angular to subangular gravel, 50% of clasts are fractured, clasts up to 1/2", well graded fine to coarse grained sand, wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65D
PAGE 5 OF 7

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65D

DATE STARTED 6/13/08 **COMPLETED** 6/14/08 **GROUND ELEVATION** 897.6 feet **TOC ELEVATION** 901.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126554 feet **EASTING** 1396165.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			6		110.0 GW **Gravel** multicolored, angular to subrounded gravel, clasts up to 1", trace well graded fine to coarse grained sand, wet	Slow drilling, 110-115 feet
						15% of clasts are fractured, 113-114 feet
115	GB		15			75% of clasts are fractured, 114-120 feet
			25			Discharge water is light brown, 115-129 feet
120	GB		25		120.0 GP **Sand and Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 5/8", poorly graded fine to coarse grained sand	
			0.25			
			25			
125	GB					
			3		127.0 SP **Sand** multicolored, trace angular to subrounded gravel, clasts up to 1", poorly graded medium grained sand, wet	
130	GB					Discharge water is brown, 129-133 feet
					131.0 SP **Gravelly Sand** multicolored, angular to subrounded gravel, poorly graded fine grained sand, wet	Clasts up to 1", 131-134 feet
			6			
			35			
135	GB					Clasts up to 1/4", 134-138 feet
						Adding water while drilling; discharge water is brown, 135-141 feet
					138.0	
	GB				139.0 SP **Sand with Gravel** multicolored, angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/8", poorly graded fine grained sand, wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65D
PAGE 6 OF 7

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65D

DATE STARTED 6/13/08 **COMPLETED** 6/14/08 **GROUND ELEVATION** 897.6 feet **TOC ELEVATION** 901.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126554 feet **EASTING** 1396165.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140			3		SW **Sand with Gravel** multicolored, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand, wet	Traces of weathered bedrock, 140-141 feet
					141.0 **Bedrock (Tertiary Volcanoclastic)** light pink to tan volcanic clast supported rock, weathered	Discharge water is clearer, 141-145 feet
			55			
145	GB		60			
			60			
			45			
150					150.0 **Bedrock (Tertiary Volcanoclastic)** light green to gray-pink volcanic clast supported rock	
			50			
			50			
155			50			
			50			
			55			Moved to open hole hammer, 158 feet
160	GB		60 to 75		160.0 **Bedrock (Tertiary Volcanoclastic)** strongly iron oxidized, light brown-red volcanic clast supported rock, fractured	
			60 to 75			
165	GB		60 to 75		165.0 **Bedrock (Tertiary Volcanoclastic)** light green to gray-pink volcanic clasts supported rock, fractured	Discharge water is brown, 165-166 feet
			100+			Discharge water is mostly clear; slow drilling, 166-167 feet
			75 to 90			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65D

DATE STARTED 6/13/08 **COMPLETED** 6/14/08 **GROUND ELEVATION** 897.6 feet **TOC ELEVATION** 901.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126554 feet **EASTING** 1396165.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170			75 to 90		**Bedrock (Tertiary Volcanoclastic)** light green to gray-pink volcanic clasts supported rock, fractured	Discharge water is brown, 170-173 feet
			100+			
175	GB		100+			Discharge water is brown, 175-183 feet
			120+			
			120+			
180	GB					
						Discharge water is white, 183-185 feet
185						Discharge water is brown, 185-186 feet
190					190.0 Bottom of hole at 190.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-~~65~~ D
Date: 6/21/08
Project: Pebble
Project #: 005.0189.08002
Technician: ~~C. Kramer~~ V Webb / M Jati

Summary

	Installed (Well Log)	Start	End
Water level FTOC	52.24	51.68	~~52.08~~
Total depth FTOC	~~190.00~~	190.37	189.08
pH	187.2		

@ 1545 (FTOC)
Screen interval (btoPVC): ~~X~~ 9.7 9.8
Top: ~~171.5~~ ~~173.8~~ 177.4
Bottom: ~~175.5~~ ~~183.5~~ 187.2
PVC stick-up height (above ground surface): ~~3.40~~ 3.7

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1505 - START 1' off bottom of screen									
1531	182.5	51.68	~~4.5~~	~~117~~	.107	148	7.10	lite brown, trace silts	7.92
1536	180.5	—	—	—	—	~~148~~	—	Move 2' above screen - START	~~7.90~~
1608	180.5	—	4.25	253	0091	83	7.11	lite brown, trace silts	7.50
1616	178.5	—	—	—	—	—	—	Move 2' above screen - START	
1646	178.5	—	4.25	380.50	0.090	98	5.89	lite brown, trace silts	7.01
1652	176.5	—	—	—	—	—	—	Move 2' above screen - START	
1700	—	—	—	—	—	—	—	STOP	
6/22/08 1152	176.5	52.70	—	—	—	—	—	START	
1248	1	—	4.25	618.50	0.333	80	6.49	lite brown, trace silts	7.03
1249	174.5	—	—	—	—	—	—	Move 2' above screen - START	
1321	1	—	3.75	738.50	0.096	18	6.05	clear, trace silts	7.51
1329	172.5	—	—	—	—	—	—	Move 2' above screen - START	
1403	1	—	4.00	874.50	0.095	4	6.37	clear, trace silts	7.58
~~1443~~	1	—	~~3.50~~		~~0.093~~	~~13~~	~~6.25~~	—	7.90
Surge block off 1420 - START 4' from last reading (15' above screen)									
POLISH 1443	168.50	—	3.50	955.0	0.093	13	6.25	clear, trace silts	
Debris 1500	182.50	—	—	—	—	—	—	Move 1' off bottom of screen	
1530	1	—	3.50	1060.0	0.094	17	6.37	clear, trace silts	7.93

THE pebble PARTNERSHIP

P-08-65M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65M

DATE STARTED 6/15/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897 feet **TOC ELEVATION** 900.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126581 feet **EASTING** 1396129 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 ML **Silt and Gravel with Sand** brown, clasts up to 3/4", well graded sand, moist	
5					5.0 GW **Gravel and Sand with Silt** clasts up to 3/4", well graded sand, brown silt, moist	
10						
15					15.0 SM **Gravelly Sand with Silt** clasts up to 3/4", well graded sand, brown silt, moist	
					18.0 SP **Gravelly Sand** brown, subangular to rounded gravel, 15% of clasts are fractured, clasts up to 3/8", poorly graded fine grained sand, moist	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/23/2008
Purge Volume: 670 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 6/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/16/08 at 556 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65M

DATE STARTED 6/15/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897 feet **TOC ELEVATION** 900.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126581 feet **EASTING** 1396129 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	Fine grained sand, 21-24 feet
					SP **Gravelly Sand** brown, subangular to rounded gravel, 25% of clasts are fractured, clasts up to 3/4", poorly graded fine to medium grained sand, moist	Adding water while drilling, 23-24 feet
						Fine to medium grained sand, 24-28 feet
25					28.0	Poorly graded coarse grained sand, 28-32 feet
					GP **Gravel with Sand** multicolored, silt coated angular to subangular gravel, 25% of clasts are fractured, clasts up to 1/2", trace silt, moist	
30						Discharge water is light brown, 32-33 feet
						Well graded medium to coarse grained sand, 32-38 feet
						Adding water while drilling, 33-48 feet
						Cuttings are washed clean, 33-34 feet
35						Cuttings are washed clean, 35-48 feet
					38.0	No recovery; discharge water is light brown, 38-43 feet
40						
					43.0	Discharge is entirely liquid silt; no clumps present, 43-52 feet
					ML **Silt** brown, wet	
45					46.0	No recovery, 46-52 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65M
PAGE 3 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65M

DATE STARTED 6/15/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897 feet **TOC ELEVATION** 900.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126581 feet **EASTING** 1396129 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50		▼			52.0 ML **Silt** grayish brown, medium-plastic, wet	Slow drilling, 52-53 feet Adding water while drilling; discharge water is grayish brown and silty, 52-94 feet
55						
60						
65						Slow drilling, 63-64 feet
70						
75					75.0 ML **Silt with Gravel and Sand** 75% of clasts are fractured, poorly graded coarse grained sand, medium-plastic gray silt, wet	Trace gravel, 74-75 feet Subangular to angular gravel; clasts up to 3/8", 75-78 feet
					79.0	Angular to subrounded gravel; clasts up to 5/8", 78-79 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65M

DATE STARTED 6/15/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897 feet **TOC ELEVATION** 900.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126581 feet **EASTING** 1396129 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					GW **Gravel and Silty Sand** angular to subrounded gravel, 75% of clasts are fractured, clasts up to 5/8", poorly graded coarse grained sand, medium-plastic gray silt, wet	
					83.0 ML **Silt with Gravel and Sand** angular to subrounded gravel, 75% of clasts are fractured, clasts up to 5/8", poorly graded coarse grained sand, medium-plastic gray silt, wet	
85						Slow drilling, 85-86 feet
					86.0 ML **Silt** grayish brown, medium-plastic, wet	
					88.0 GM **Gravel with Silt** angular to subrounded gravel, 50% of clasts are fractured, grayish brown silt, wet	Clasts up to 1 1/2", 88-94 feet
90						
						Clasts up to 3/4"; trace coarse sand, 94-99 feet Adding water while drilling, 95-133 feet Discharge water is grayish brown, 95-100 feet
95						
					99.0 GW **Sand and Gravel** multicolored, subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 5/8", medium grained sand, wet	
100						Discharge water is brown, 100-108 feet
					103.0 GW **Gravel with Sand** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 5/8", coarse grained sand, wet	
105						
					108.0 SP **Sand with Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", poorly graded coarse grained sand, wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65M

DATE STARTED 6/15/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897 feet **TOC ELEVATION** 900.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126581 feet **EASTING** 1396129 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					SP **Sand with Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", poorly graded coarse grained sand, wet	
					113.0 GW **Gravel with Sand** angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", poorly graded coarse grained sand, wet	
115					116.0 GW **Gravel with Sand** angular to subrounded gravel, 50% of clasts are fractured, poorly graded medium to coarse grained sand, wet	Discharge water is brown, 115-133 feet Clasts up to 3/4", 116-118 feet Clasts up to 1/2", 118-120 feet
120					120.0 SP **Sand** brown, poorly graded fine grained sand, wet	
					121.0 GW **Gravel with Sand** multicolored, angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", wet	Coarse grained sand, 121-123 feet Fine to medium grained sand, 123-126 feet
125					128.0 SW **Sand** trace angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", well graded, well sorted medium to coarse grained sand, wet	Coarse grained sand, 126-128 feet
130					130.0 GW **Gravel and Sand** angular to subangular gravel, 50% of clasts are fractured, clasts up to 1/2", poorly graded coarse grained sand, wet	
			30		133.0 **Bedrock (Tertiary Volcanoclastic)** light pink to tan, volcanic clast supported rock	Discharge water becomes clearer, 133-134 feet
135			60			
	GB		55			Moved to open hole hammer, 138.5 feet Adding water while drilling; discharge water is cloudy, 139-145 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65M

DATE STARTED 6/15/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897 feet **TOC ELEVATION** 900.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126581 feet **EASTING** 1396129 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. Loomis, C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140			60		**Bedrock (Tertiary Volcanoclastic)** light pink to tan, volcanic clast supported rock	
145	GB		60			Adding water while drilling; discharge water is brown, 146-148 feet
		47.77			147.5 Bottom of hole at 147.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-65M
Date: 6/21/08
Project: Pebble
Project #: 005.0189.08002
Technician: ~~C. Kramer~~ V Webb / M Janti / L. Crawford

Summary

	Installed (Well Log)	Start	End
Water level	52.1	51.76	51.78 @ 0853 6/23/08
Total depth	147.50	151.27	150.78
pH			

Screen interval (btoPVC): ~~140~~ 10'
Top: ~~140~~ 136.0'
Bottom: ~~150~~ 146.0'
PVC stick-up height (above ground surface): 2.96'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on START @ 1522 1' off bottom of screen									
1546	145.0'	51.76	1.75	42	.186	212	6.12	lt brown, trace silt	7.26
1552	143.0	—						move 2' above screen - START	
1630	1	—	2.00	118	.157	18	5.46	clear, trace sands	7.31
1639	141.0	—						move 2' above screen - START	
1712	1	—	1.75	175.75	0.148	8	5.73	clear, no sediments	7.33
1715	—	~~51.81~~						STOP	
6/22/08 1151	141.0	51.87	—					START	
1250	1	—	1.75	279.00	0.157	4	5.28	clear, no sediments	7.00
1255	~~139.0~~							move 2' above screen - START	
1330	139.0	—	1.75	340.25	0.145	4	5.48	clear, no sediments	7.40
1331	~~137.0~~							~~move 2' above screen START~~	
↳	STOP - ACTUATOR BROKE DOWN - NEEDS REPAIR								
* 1544	137.0	—						move 2' above screen - START	
** 1616	1	—	3.75	460.25	0.136	104	6.05	lt. grey, trace fine sand (~1/4 t.)	7.72
DEBRIS 0835	145.0	—	3.50	670.25	0.148	35	6.10	lt. grey, trace fine sand (~1/4 t.) 13' Vac	7.57
Surge block off	1635 - Start 4' from last reading (~~1~~ above screen bottom)								
POLISH 1705	133.0	—	3.50	565.25	0.132	35	6.10		7.61
DEBRIS 1710	145.0	—						move 1' off bottom of screen	
1720		stop							
6/23/08 0805	145.0	51.86	—					START	

* using different pump b/c 1st one broke
** last 2' increment was skipped by mistake & wasn't noticed until "DEBRIS" step was restarted on 6/23

THE pebble PARTNERSHIP

P-08-65S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65S

DATE STARTED 6/16/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897.5 feet **TOC ELEVATION** 900.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126550.8 feet **EASTING** 1396142.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					GW **Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", well graded, moist	
					2.0 GW **Gravel with Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", poorly graded coarse grained sand, moist	
					4.0 SP **Sand with Gravel** multicolored, angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", poorly graded sand, moist	Fine to medium grained sand, 4-5 feet
5						Fine to coarse grained sand, 5-9 feet
					9.0 SP **Sand with Gravel** multicolored, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", poorly graded fine to coarse grained sand, moist	
10						
15						
					18.0	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is dry)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is dry)

Comments: Piezometer is dry; Measured on 6/17/08 at 615 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-65S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-65S

DATE STARTED 6/16/08 **COMPLETED** 6/16/08 **GROUND ELEVATION** 897.5 feet **TOC ELEVATION** 900.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2126550.8 feet **EASTING** 1396142.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SP **Sand and Gravel** multicolored, silt coated angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", poorly graded fine to medium grained sand, trace brown silt, moist	
25					25.0 SW **Sand** multicolored, trace subangular gravel, 50% of clasts are fractured, clasts up to 1/4", well graded fine to coarse grained sand, moist	
					27.0 SP **Sand** multicolored, fine to medium grained sand, moist	
					28.0 GP **Gravel and Sand** multicolored, subangular to subrounded gravel, clasts up to 3/4", poorly graded sand, moist to wet	<10% of clasts are fractured; medium to coarse grained sand, 28-30 feet
30						25% of clasts are fractured; fine to medium grained sand, 30-34 feet
					34.0 SW **Sand** multicolored, trace subangular gravel, 50% of clasts are fractured, clasts up to 1/2", well graded fine to coarse grained sand, moist	
35					37.0 ML **Silt with Sand** brown, fine to coarse grained sand, moist	
					37.8 Bottom of hole at 37.8 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-65S. Well dry.

THE pebble PARTNERSHIP

P-08-66D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-66D

DATE STARTED 6/17/08 **COMPLETED** 6/17/08 **GROUND ELEVATION** 1083.5 feet **TOC ELEVATION** 1086.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135965.1 feet **EASTING** 1386751.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SP **Sand with Gravel** brown, angular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", poorly graded fine grained sand, dry	
					3.0 GW **Gravel** silt coated angular gravel, most of the clasts are fractured, clasts up to 5/8", trace brown silt, wet	
5	GB				5.0 GW **Gravel with Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand, trace brown silt, moist	
					9.0 GW **Gravel with Sand** angular to subangular gravel, 75% of clasts are fractured, poorly graded fine grained sand, trace brown silt, moist	Clasts up to 3/4", 9-10 feet
10	GB					Clasts up to 1 1/4", 10-13 feet
					13.0 GW **Gravel** subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", trace well graded fine to coarse grained sand, trace brown silt, moist	
					14.0 GW **Gravel with Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand, trace brown silt, wet	
15	GB		no flow			Adding water while drilling, 17-18 feet
					18.0 GW **Gravel** angular gravel, 50% of clasts are fractured, clasts up to 3/4", trace coarse grained sand, trace brown silt, wet	
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/28/2008
Purge Volume: 1060 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/18/08 at 847 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-66D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-66D

DATE STARTED 6/17/08 **COMPLETED** 6/17/08 **GROUND ELEVATION** 1083.5 feet **TOC ELEVATION** 1086.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135965.1 feet **EASTING** 1386751.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20		▼			GW **Gravel** angular gravel, 50% of clasts are fractured, clasts up to 3/4", trace coarse grained sand, trace brown silt, wet	
					22.0	Adding water while drilling, 22-24 feet
					GP **Gravel with Silt** angular to subangular gravel, 20% of clasts are fractured, clasts up to 5/8", trace coarse grained sand, brown silt, wet	
					23.0	
					24.0	
25	GB		no flow		GP **Gravel with Silt** angular to subangular gravel, 20% of clasts are fractured, clasts up to 5/8", brown silt, wet	20% of clasts are fractured, 24-25 feet
					GP **Gravel with Sand and Silt** angular to subangular gravel, clasts up to 5/8", well graded fine to coarse grained sand, brown silt, wet	Most of the clasts are fractured, 25-28 feet Adding water while drilling, 26-28 feet
					28.0	
					Bedrock (Tertiary Basalt) light bleached green, non magnetic, moderately iron oxidized, weathered basalt	Cuttings are wet, 28-31 feet
30	GB		no flow			
			no flow			Cuttings are dry, 31-34 feet
			no flow			Moved to open hole hammer, 33 feet
35	GB		no flow		35.0	Cuttings are wet, 34-59.6 feet
					Bedrock (Tertiary Basalt) light bleached green, non magnetic, moderately iron oxidized, weathered basalt, with calcite vein material	
			no flow			
40	GB		trace flow			
			trace flow			
			trace flow			
45	GB		trace flow			
			trace flow			
	GB		trace flow			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-66D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-66D

DATE STARTED 6/17/08 **COMPLETED** 6/17/08 **GROUND ELEVATION** 1083.5 feet **TOC ELEVATION** 1086.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135965.1 feet **EASTING** 1386751.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			trace flow		**Bedrock (Tertiary Basalt)** light bleached green, non magnetic, moderately iron oxidized, weathered basalt, with calcite vein material	
			trace flow			
55	GB					
			trace flow			
			trace flow			
			trace flow		59.6	
					Bottom of hole at 59.6 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-66D
Date: 6/28/08
Project #: 005.0189.08002

Project: Pebble
Technician: L Crawford / M Jarvi

Summary Pumped dry in 5 minutes

	Installed (Well Log)	Start	End
Water level FTOC	21.8	27.12	
Total depth FTOC	60.10	59.80	
pH			

Screen interval (btoPVC): 9.8
(FTOC) Top: 50.3
Bottom: 60.1
PVC stick-up height (above ground surface): 2.8'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on 1445 = START ~~(1' off bottom)~~ (1' off bottom)								
		Note: Pumped well dry after ~5 minutes						
		DTW = 57.75 @ 1540						
		← pumping out thick grey silty material, could be grout.						
Surge block off								

THE pebble PARTNERSHIP

P-08-66S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-66S

DATE STARTED 6/18/08 **COMPLETED** 6/18/08 **GROUND ELEVATION** 1082.9 feet **TOC ELEVATION** 1086.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135965.1 feet **EASTING** 1386729.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Organic Soil**	Little recovery, 0-3 feet
					3.0	
					GP **Gravel** angular to subangular gravel, <10% of clasts are fractured, clasts up to 3/4", trace sand	
					4.0	
5					GP **Sand and Gravel** angular to subangular gravel, clasts up to 3/4", poorly sorted medium to coarse grained sand, trace silt, moist	
					8.0	
					GP **Sand and Gravel** subangular to subrounded gravel, clasts up to 1/2", poorly sorted medium to coarse grained sand, trace silt, moist	
10					10.0	
					GP **Sand and Gravel** subrounded gravel, clasts up to 1/2", poorly sorted medium to coarse grained sand, moist	Easy drilling, 10-11 feet Cuttings are moist, 10-11 feet Cuttings are dry, 11-15 feet
15					15.0	
					GP **Sand and Gravel** subrounded gravel, poorly sorted medium to coarse grained sand, trace silt, dry	Clasts up to 1/2", 15-17 feet
						Clasts up to 1/4", 17-20 feet
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/28/2008
Purge Volume: 670 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/18/08 at 557 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-66S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-66S

DATE STARTED 6/18/08 **COMPLETED** 6/18/08 **GROUND ELEVATION** 1082.9 feet **TOC ELEVATION** 1086.0 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135965.1 feet **EASTING** 1386729.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GP **Sand and Gravel** subangular to subrounded gravel, <10% of clasts are fractured, medium grained sand, dry	Clasts up to 1/2", 20-23 feet
						Clasts up to 1/4", 23-24 feet
					24.0 GP **Sand and Gravel** subrounded gravel, 25% of clasts are fractured, clasts up to 1", medium to coarse grained sand, dry	
25		▼				
					27.5 28.0 **Bedrock (Tertiary Basalt)** light bleached green, non magnetic, iron oxidation staining, weathered	Pulverized rock at 27.5 feet
		25.73			Bottom of hole at 28.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-669
Date: 6/28/08
Project #: 005.0189.08002

Project: Pebble
Technician: L. Crawford/M. Janti

Summary NOT DEVELOPED b/c insufficient water in well

	Installed (Well Log)	Start	End
Water level FTOC	26.77	27.08	
Total depth FTOC	31.1	29.77	
pH			

Screen interval (btoPVC): (FTOC) Top: 26.1 Bottom: 31.1

PVC stick-up height (above ground surface): 3.1

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
1425 = START (6" off bottom)								
WILL NOT PUMP any water — pulled tubing out & changed foot valve								
Note: when tagged bottom of well to determine TD, there did not feel like sediment on bottom (felt like hard surface, could be PVC) so installed depth may be off (?)								
1435 tried to start again 6" off bottom								
WILL NOT PUMP water								
1545 tried to start again 1' off bottom								
will not pump water								
Surge block off								

THE pebble PARTNERSHIP

P-08-67D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-67D

DATE STARTED 6/20/08 **COMPLETED** 6/20/08 **GROUND ELEVATION** 1056.6 feet **TOC ELEVATION** 1059.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135490.3 feet **EASTING** 1384344.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Organic Soil**	Little recovery, 0-1 feet
					2.0 **Silty Soil** brown, wet	
					3.0 **Silty Soil and Gravel** subrounded gravel, clasts up to 1/2"	
5	GB				SM **Sandy Silt and Gravel** subrounded gravel, clasts up to 1/2", poorly sorted	
					8.0 SM **Sandy Silt and Gravel** subangular to rounded gravel, 10% of clasts are fractured, clasts up to 1/2"	
10	GB	▼			11.0 SM **Sandy Silt and Gravel** subrounded gravel, <10% of clasts are fractured, poorly sorted fine to medium grained sand	
					14.0	
15	GB				SP **Sand** trace subrounded gravel, clasts up to 1/2", poorly sorted medium grained sand, trace silt 15.0	
					SP **Sand** trace subrounded gravel, clasts up to 1/4", poorly sorted medium to coarse grained sand 17.0	
					SP **Sand** poorly sorted medium grained sand, moist 19.0	
20	GB				SP **Sand** trace gravel, clasts up to 1/4", poorly sorted medium grained sand, moist	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.2'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/6/2008
Purge Volume: 108 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 8/14/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/20/08 at 615 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-67D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-67D

DATE STARTED 6/20/08 **COMPLETED** 6/20/08 **GROUND ELEVATION** 1056.6 feet **TOC ELEVATION** 1059.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135490.3 feet **EASTING** 1384344.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SP **Sand** trace gravel, clasts up to 1/4", poorly sorted medium grained sand, moist	
					23.0	
					SP **Sand** poorly sorted fine to medium grained sand, moist	
					24.0	Fine gray dust coming from cyclone, 24-25 feet
25					SP **Sand** poorly sorted fine to medium grained sand, trace silt, moist	Water encountered at 24.5 feet
					25.0	
					GM **Silt, Sand, and Gravel** gravel, clasts <1/4", poorly sorted medium grained sand, wet	Adding water while drilling, 26-34 feet
					26.0	
					GM **Silty Sand and Gravel** fine gravel, clasts up to 1/4", medium to coarse grained sand, wet	
					28.0	
					GP **Sand and Gravel** fine gravel, clasts <1/4", coarse grained sand, trace silt, wet	
30	GB					
						Lots of ground water, 34-35 feet
35	GB					
			2			Discharge water is brown, 36-37 feet
						Discharge water is clearer; less fines than above, 37-39 feet
40	GB					Discharge water is brown; more fines than above, 39-41 feet
					41.5	
			10		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** whiteish green to gray speckled granodiorite, distinct green euhedral hornblendes (~5% altered to chlorite) within poorly-developed feldspar/plagioclase dominated groundmass	
45			8			
			5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-67D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-67D

DATE STARTED 6/20/08 **COMPLETED** 6/20/08 **GROUND ELEVATION** 1056.6 feet **TOC ELEVATION** 1059.8 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135490.3 feet **EASTING** 1384344.6 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			10		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** whiteish green to gray speckled granodiorite, distinct green euhedral hornblendes (~5% altered to chlorite) within poorly-developed feldspar/plagioclase dominated groundmass	Moved to open hole hammer, 53 feet
			7			
			8			
55			8			More competent bedrock encountered, 55 feet
			8			
			6			
			6		59.3	
					Bottom of hole at 59.3 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-67D
Date: Aug 6/08

Project: Pebble - development
Technician: JT / EB / JH

Summary (pre)

	Installed (Well Log)	Start	End
Water level	10.72	15.42	
Total depth	59.00	58.85	
pH		7.45	

Screen interval (btoPVC):
Top: 45.6 (bgs)
Bottom: 55.3 (bgs)
PVC stick-up height (above ground surface): 3.3

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
8:35	57.8	~~15.42~~	6.0*	4.5	240	1000+	3.83	fine silt/sand, brown/grey, ~~tsp~~, ~~range of colors~~ Start
8:47	↓	—	—	9	—	—	—	18
8:50	↓	—	—	13.5	—	—	—	↓ moved 2 ft up, ran out of water
9:19	58.8	18.2	6.0*	18	233	E3	5.65	brown, start.
9:30	55.8	—	—	28	—	—	—	
9:37	55.8	50'		31	223	382	4.96	fine silt/sands, brown, trace, ran out H2O, move 2' ↑ End
10:15	53.8	19.0		~~54~~				Start
10:37	↓	48 (1 min after start)	1.04	54	226	129	4.62	fine silt/sand, brown, 1 tsp, move 2' ↑
11:22	51.8	19.7	—	—	—	—	—	start
11:49		37.5 (1 min after start)	1.11	84	215	27	5.27	fine sands/trace silt, brown/grey, ½ tsp, move 2' ↑
12:38	49.8	20.3	—	—	—	—	—	start
12:43	49.8	49	1.33	92	217	123	5.3	fine sand/trace silt, d. brown, trace
Surge block off								
13:10	40.6	—	—	~~98~~	—	—	—	5' ft above screen
13:12	40.6		1.6	95	217	268	8.29	fine sand, d. brown, trace
13:11	54.8	27.1	—	—	—	—	—	1' ft off bottom
13:21	54.3	—	—	107.5	—	—	—	fine sand, d. brown, trace

3.5 35sec
3.5 40 sec

pH 7.45
7.61 ~~7.04~~
7.67
7.72
7.00
7.45
Polish
7.66
Debris

* - point measurement (1 bucket)

THE pebble PARTNERSHIP

P-08-67S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-67S

DATE STARTED 6/20/08 **COMPLETED** 6/20/08 **GROUND ELEVATION** 1057.8 feet **TOC ELEVATION** 1061.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135480.3 feet **EASTING** 1384371 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0	No recovery, 0-1 feet
					Organic Soil and Gravel subrounded gravel, clasts up to 1/4"	Little recovery, 1-3 feet
					3.0 SM **Silty Sand and Gravel** subrounded gravel, poorly sorted, medium grained sand, moist	Clasts up to 1/2", 3-5 feet
5						Clasts up to 1", 5-8 feet
					8.0 SM **Silty Sand and Gravel** subangular gravel, clasts up to 1/2", medium grained sand	Cuttings are wet, 8-9 feet Encountered water, 8.5 feet Cuttings are moist, 9-12 feet
10					11.0 SM **Silty Sand and Gravel** subrounded gravel, clasts up to 1/4", poorly sorted medium grained sand	
					12.0 SM **Silty Sand with Gravel** subrounded gravel, clasts up to 1/4", poorly sorted medium grained sand	
		▼			14.0 SM **Silty Sand** trace fine gravel, poorly sorted medium grained sand, moist	
15					15.0 SM **Silty Sand** trace fine subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4", medium grained sand, moist	
					17.0 SP **Sand** trace gravel, fine to medium grained sand, trace silt, dry	
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 20 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/7/2008
Purge Volume: 256 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 8/14/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/20/08 at 149 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-67S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-67S

DATE STARTED 6/20/08 **COMPLETED** 6/20/08 **GROUND ELEVATION** 1057.8 feet **TOC ELEVATION** 1061.1 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2135480.3 feet **EASTING** 1384371 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SM **Silt and Sand with Gravel** subrounded gravel, fine to medium grained sand, moist	Clasts <1/4", 20-21 feet Slow drilling, 20-27.4 feet Clasts up to 1/4", 21-25.5 feet
25					25.5 **Boulder or Cobble** grey rock fragments and dust 27.0 27.4 Bottom of hole at 27.4 feet.	Possible bedrock, 25.5 feet Not logged, 27-27.4 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-675
Date: Aug 6 - 2008 / Aug 7, 08
Project: Pebble - develop
Technician: SL / EB / JH.

Summary (prc)

	Installed (Well Log)	Start	End
Water level	14.13	16.28	
Total depth	27.4	29.75	
pH			

Screen interval (btoPVC): 10'
Top: 17.4 (bgs)
Bottom: 27.4 (bgs)
PVC stick-up height (above ground surface): 3.3

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on									
13:42	28.7			5	155	E3	7.22	first 5 gals - very silty / brown v. cloudy - ½ cup sed. Start 1 ft off Bottom (fill	9.2
14:40	28.7	26.5	0.5	27	91	E3	7.63	very silty, brown cloudy, 3 Tbs	8.35
15:04	26.7	16.3			Stop			Moved 2 ft up, start.	
16:30	26.7	-	0.75	92	66	E3	6.22	pretty silty still, brown cloudy, 2-3 Tbs	7.97
8:00	24.7	17.43						Moved 2 ft up, start.	Aug 7
9:05	24.7	22.0	0.80	140	63	132	4.63	cloudy fine silt/sand, brown, 1 trace	7.18
9:17	22.7	17.4						Moved 2 ft up, start.	
10:05	22.7	21.45	0.85	180	65	651	4.85	fine silt/sand, brown, 2-3 tsp	7.56
10:23	20.7	17.10						Moved 2 ft up start	
11:25	20.7	19.90	0.65	226	80	57	7.08	fine silt/sand, brown, trace to 1 tsp	6.99
11:30	28.7	17.3						start Debris (Block off)	
11:45	28.7	—	1.35	226				fine silt/s/sand, brown, 1 tsp	
Surge block off 2.5' ft above scree (due to H2O Level & top of scem was 5')									1 tsp.
11:54	18.5	17.6			73	1000+	10.45	Start (First 5 gal) fine silt/sand, brown	PH 7.57
12:23	18.5	17	0.25	234	84	13	10.13	fine sand, brown, trace (pretty clear)	8.12
12:35	28.7	17.5			77	396	5.78	fine silt/sand, brown, 1 Tbs (last 5 gals)	7.64
12:55	28.7	22.7	1.1	256	52	1000+	6.16	fine silt/sand, brown,	7.65

Rebirth
Debris

E3 - Fine

THE pebble PARTNERSHIP

P-08-68D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-68D

DATE STARTED 6/21/08 **COMPLETED** 6/23/08 **GROUND ELEVATION** 1057.2 feet **TOC ELEVATION** 1060.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171872.4 feet **EASTING** 1379620.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Silty/Sandy Organic Soil moist	Advancing via welded casing, 0-87 feet
					1.0 ML **Sandy Silt** fine to medium grained sand	
					2.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", poorly sorted medium to coarse grained sand	
5	GB					Trace silt, 4-8 feet
					8.0 GP **Sand and Gravel** fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, poorly sorted medium to coarse grained sand, dry	<10% of clasts are fractured, 8-10 feet
10	GB					Slower drilling, 9-10 feet
						50% of clasts are fractured, 10-12 feet
					12.0 GP **Gravel with Sand** brown to gray, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", trace silt, dry	
15	GB				15.0	
					GP **Sandy Gravel** gray, angular to subangular gravel, 70% of clasts are fractured, clasts up to 1", poorly sorted fine to coarse grained sand, trace silt, dry	
					16.0	
					17.0 GP **Sandy Gravel** gray, silt coated angular to rounded gravel, 50% of clasts are fractured, clasts up to 1", poorly sorted fine to coarse grained sand, trace brown silt, dry	No recovery, 17-21 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 20 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 6/26/2008
Purge Volume: 1169 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 7/4/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/23/08 at 944 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-68D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-68D

DATE STARTED 6/21/08 **COMPLETED** 6/23/08 **GROUND ELEVATION** 1057.2 feet **TOC ELEVATION** 1060.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171872.4 feet **EASTING** 1379620.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	
					GP **Sand and Gravel** grayish brown, angular to rounded gravel, 50% of clasts are fractured, clasts up to 3/4", poorly sorted fine to coarse grained sand, trace brown silt, dry	
25	GB				28.0	
					GP **Sand and Gravel** brown to gray, angular to rounded gravel, 30% of clasts are fractured, clasts up to 3/4", poorly sorted fine to coarse grained sand, dry	
30	GB				29.0	
					30.0	
					GP **Sand and Gravel** brown to gray, silt coated angular to rounded gravel, 30% of clasts are fractured, clasts up to 1", poorly sorted fine to coarse grained sand, trace brown silt, dry	
					GP **Sand and Gravel** brown to gray, angular to rounded gravel, 30% of clasts are fractured, clasts up to 3/4", poorly sorted fine to coarse grained sand, dry	
35	GB				34.0	Clasts up to 1 1/4", 34-35 feet
					GP **Sand and Gravel** brown to gray, silt coated angular to rounded gravel, 30% of clasts are fractured, poorly sorted fine to coarse grained sand, trace brown silt, dry	Clasts up to 3/4", 35-37 feet
					37.0	
					SW **Gravelly Sand** brown, angular to rounded gravel, 10% of clasts are fractured, clasts up to 3/4", well graded sand, dry	
					39.0	
40	GB				GP **Sand and Gravel** brown to gray, silt coated subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1", well graded sand, trace brown silt, dry	No recovery, 40-42 feet
					40.0	
					42.0	
					SW **Gravelly Sand** brown, angular to rounded gravel, 10% of clasts are fractured, clasts up to 3/4", well graded sand, dry	
					44.0	
45	GB				GP **Sand and Gravel** brown to gray, silt coated gravel, 10% of clasts are fractured, clasts up to 1", well graded sand, trace brown silt, dry	Subangular to subrounded gravel; clasts up to 1", 44-45 feet Angular to rounded gravel; clasts up to 1 1/4", 45-47 feet
					47.0	
					SP **Gravelly Sand** brown to gray, fine angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", well graded sand, dry	
					48.0	No recovery, 48-49 feet
					49.0	
	GB					Casing broke on June 22, 2008 at 1:45AM; pulled casing and resume

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-68D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-68D

DATE STARTED 6/21/08 **COMPLETED** 6/23/08 **GROUND ELEVATION** 1057.2 feet **TOC ELEVATION** 1060.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171872.4 feet **EASTING** 1379620.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						advancing on June 22, 2008 at 4:47PM, 49 feet
					SP **Gravelly Sand** brown to gray, angular to subangular gravel, 10% of clasts are fractured, clasts up to 1/2", poorly sorted fine to coarse grained sand, dry	
					52.0	No recovery, 52-54 feet
					54.0	
55	GB				SP **Gravelly Sand** brown to gray, fine gravel, 10% of clasts are fractured, clasts up to 3/8", poorly sorted fine to coarse grained sand, dry	
					55.0	No recovery, 55-56 feet
					56.0	Clasts up to 3/8", 56-57 feet
					GP **Sand and Gravel** fine subangular to subrounded gravel, 10% of clasts are fractured, poorly sorted fine to coarse grained sand, dry	Little recovery; clasts <1/4", 57-58 feet
					58.0	
					SM **Sand** poorly sorted coarse grained sand, moist	
		▼			59.0	Cuttings are moist, 59-62 feet
60	GB				GP **Sand and Gravel** fine gravel, clasts up to 1/2", poorly sorted medium to coarse grained sand	
						Cuttings are wet, 62-67 feet
						Encountered water; discharge water is brown, 63 feet
65	GB					Little recovery, 64-67 feet
						Difficult to quantify silt fraction - washing away in discharge water; samples and descriptions biased coarse, 65-87 feet
					67.0	
					GW **Sand and Gravel** multicolored, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", poorly sorted sand, brown silt, wet	Discharge water is brown, 67-68 feet
					68.0	No recovery, 68-75 feet
70						Added water while drilling, 70-71 feet
			<0.125			
75					75.0	Discharge water is brown, 75-87 feet
					GW **Sand and Gravel** multicolored, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1 1/4", coarse grained sand, wet	
			<0.125		77.0	
					SP **Gravelly Sand** multicolored, fine gravel, clasts up to 1/2", coarse grained sand, wet	
					78.0	
	GB				GW **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-68D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-68D

DATE STARTED 6/21/08 **COMPLETED** 6/23/08 **GROUND ELEVATION** 1057.2 feet **TOC ELEVATION** 1060.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171872.4 feet **EASTING** 1379620.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
			<0.125		GW **Sand and Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	
					83.0	
85	GB				GW **Sand and Gravel** multicolored, subangular to rounded gravel, 30% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	
			7		87.0	Casing broke on June 22, 2008 at 10:44PM; pulled casing, shoe was lost down the hole; boring terminated, 87 feet
					Bottom of hole at 87.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-68D
Date: 6/26/08
Project: Pebble
Project #: 005.0189.08002
Technician: L. Crawford

Summary

	Installed (Well Log)	Start	End
Water level FTOC		~~60.48~~	60.47 @1635
Total depth FTOC	87.0 * see note	88.1	88.1
pH			

Screen interval (btoPVC): 10'
(FTOC) Top: 77 (used 78)
Bottom: 87 (used 88.1) *
PVC stick-up height (above ground surface): 3.05' see note

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on 1120 = START (1' off bottom)									
1151	87.1	—	4	124	0.085	0	5.32	clear, ~ 1 tsp fine sand	7.16
1200	85.1							Move ↑ 2' - START	
1235	↓	—	4.5	282	0.055	0	5.06	clear, ~ 1 tsp fine sand	7.03
1237	83.1							Move ↑ 2' - START	
1307	↓	—	4.5	417	0.053	0	5.03	clear, 1 tsp. fine sand	7.02
1310	81.1							Move ↑ 2' - START	
1340	↓	—	4.5	552	0.053	172	5.05	lt brown, ~ 1 Tbsp sand	6.91
1344	79.1							Move ↑ 2' - START	
1423	↓	—	4.5	728	0.053	0	5.05	clear, 1 tsp fine sand	7.06
1425	77.1							Move ↑ 2' - START	
1458	↓	—	4.75	885	0.053	0	5.37	v. lt. brown, ~ 1 Tbsp fine sand	6.93
~~1515~~									
Surge block off									
POLISH 1515	73.1	—						Move ↑ 4' - START	
1547	↓	—	4.75	1037	0.054	0	5.09	clear, ~ 2 tsp fine sand	7.03
DEBRIS 1550	87.1							Move to start	
1623	↓	—	4	1169	0.053	0	5.36	clear, 1 tsp. sed.	6.96

* Note: Used drillers' heavy tape to measure bottom of well (total depth) and got measurement that was 1' deeper than total depth (& bottom of screen) that was recorded on completion log. For well development, I used the measured TD as the bottom of screen.

THE pebble PARTNERSHIP

P-08-69D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-69D

DATE STARTED 6/26/08 **COMPLETED** 6/27/08 **GROUND ELEVATION** 1023.3 feet **TOC ELEVATION** 1026.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170782.1 feet **EASTING** 1379696.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil** dark brown, some silt, highly organic, moist	
					2.0 ML **Silt** dark brown, moist	
					3.0 ML **Silt with Gravel** brown, fine subangular to rounded gravel, moist	
					4.0 GM **Gravel with Silty Sand** brown, angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", moist	
5	GB				GM **Gravel with Sand and Silt** brown, silt coated subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", medium to coarse grained sand, moist 7.0	
					8.0 GP **Gravel** gray, gravel, 100% of clasts are fractured, clasts <1/4", dry	
					9.0 GP **Gravel** gray, angular to subrounded gravel, 75% of clasts are fractured, clasts up to 1", dry	
10	GB				GP **Sand and Gravel** brown, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium grained sand, trace silt, dry 11.0	
					Boulder or Cobble gray, fractured, fragments up to 1", dry 13.0	Pulverizing rock with lots of light gray dust being produced, 11-13 feet
					GP **Gravel with Sand and Silt** gray, silt coated angular to subrounded gravel, clasts up to 1 1/4", medium to coarse grained sand, brown silt, dry 15.0	70% of clasts are fractured, 13-14 feet 50% of clasts are fractured, 14-15 feet
15	GB					
					16.0 ML **Gravelly Silt** brown, subrounded gravel, clasts up to 1", moist	Cuttings are moist, 16-18 feet
					ML **Silt** brown, trace fine gravel, trace clay 19.0	Cuttings are wet, 18-19 feet Adding water while drilling; discharge water is brown, 18-22 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/5/2008
Purge Volume: 24 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/5/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/27/08 at 504 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-69D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-69D

DATE STARTED 6/26/08 **COMPLETED** 6/27/08 **GROUND ELEVATION** 1023.3 feet **TOC ELEVATION** 1026.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170782.1 feet **EASTING** 1379696.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
					21.0 GM **Silt and Gravel** gray, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, brown silt, wet	Clasts up to 1", 21-24 feet
					GP **Sand and Gravel with Silt** multicolored, angular to subrounded gravel, 50% of clasts are fractured, medium to coarse grained sand, trace silt, wet	Adding water while drilling; discharge water is brown, 23-27 feet
25	GB	▼			25.0	Clasts up to 1 1/4", 24-25 feet
					GP **Gravelly Sand** multicolored, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/4", medium to coarse grained sand, trace silt, wet	
					27.0	Water encountered at 27 feet
					28.0 GP **Sand and Gravel** multicolored, angular to subangular gravel, 70% of clasts are fractured, clasts up to 3/4", coarse grained sand, wet	Formation making trace amounts of water; discharge water is brown, 27-29 feet
30	GB				GP **Sand and Gravel** multicolored, angular to subangular gravel, 70% of clasts are fractured, clasts up to 1", coarse grained sand, trace light brown silt, wet 30.0	Adding water while drilling; discharge water is light to dark brown, 29-40 feet
					31.0 GM **Sand and Gravel with Silt** gray, angular to subrounded gravel, 30% of clasts are fractured, clasts up to 1 1/2", medium to coarse grained sand, dark brown silt, moist	
					33.0 GM **Silty Sand and Gravel** multicolored, fine gravel, light brown silt, wet	
					34.0 ML **Silt** light brown, trace gravel, wet	
35	GB				35.0 GP **Sand and Gravel** multicolored, angular to subangular gravel, 70% of clasts are fractured, clasts up to 1", coarse grained sand, trace light brown silt, wet	
			0.5		**Bedrock (Tertiary Basalt)** dark green to black, moderately to strongly magenetic, fine grained groundmass basalt	
40	GB					Washed sample, 40 feet
			<0.125			More competent bedrock encountered, 41 feet
						Discharge water is dark gray, 41-42 feet
45	GB		1			Moved to open hole hammer, 42 feet
			0.5			Discharge water is dark gray, 43-53 feet
			0.5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-69D
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-69D

DATE STARTED 6/26/08 **COMPLETED** 6/27/08 **GROUND ELEVATION** 1023.3 feet **TOC ELEVATION** 1026.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170782.1 feet **EASTING** 1379696.9 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			0.5		**Bedrock (Tertiary Basalt)** dark green to black, moderately to strongly magenetic, fine grained groundmass basalt	Adding water while drilling; discharge water is dark gray, 53-60 feet
			<0.125			
			0.25			
55						
			0.25			
			0.25			
60			0.25		60.0 Bottom of hole at 60.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-69D
Date: 2 Aug 2008 / Aug 5th 2008

Project: 005-0189-08002 Task
Technician: IB JT

Summary

	Installed (Well Log)	Start	End
Water level	25.42'	28.16	
Total depth	54.2'	57.45	
pH		8.35 hard Bottom 12:15	

Screen interval (btoPVC): 9.7'
Top: 44.5'
Bottom: 54.2'
PVC stick-up height (above ground surface): 3'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on 11:30-start (first) - 3ft off Bot, 12:5 (2nd)								
11:35	54.5	ran dry			—	—	—	Pumped dry within mins of pumping > trying slower
12:15	56.5	37.15	1.0	4.5	263	E3	7.11	Pumped dry in 5 mins, fine sand/silt, brown, ¼ tsp
13:25	54.5	34.5	1.0	7.5	297	1000+	8.56	Pumped dry 6 mins / fine sand/silt, brown, 1 tsp
14:20	52.5	32.5	20.7	10.5	377	839	9.49	done=8 min / fine sand/silt, brown, ½ tsp
15:35	50.5	30.5	1.5	13.25	403	622	9.76	done=9 min / fine sand/silt, brown(dark), ½ tsp
16:29	48.5	29.8	1.0	15.00	296	379	10.64	done=4 min / fine sand/silt, dark brown, trace
Aug 5 8:03	46.5	28.34	0.8	19.00	184	121	11.76	done=2 min / fine silt, sand trace
Surge block off — start 5' off top of screen								
10:02	39.5	26.5	1.0	21.00	167	679	7.52	fine sand/silt, brown/cloudy, trace
10:35	56.0	34.0	1.5	29.00	189	1000+	5.92	fine sand/silt, brown/cloudy, trace

ph

Zero
8.42
8.65
8.74
8.58
8.83

← very fine
← less cloudy than

Polish debris

PH
8.63
8.34

+- Flushing

tube dia: $\pi(1)^2$
$= 3.14\ cm^2$
$= 5{,}000\ cm^3$
$= 5L$

THE pebble PARTNERSHIP

P-08-69S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-69S

DATE STARTED 6/27/08 **COMPLETED** 6/27/08 **GROUND ELEVATION** 1025.3 feet **TOC ELEVATION** 1028.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170790.2 feet **EASTING** 1379733.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silty Organic Soil** subrounded gravel, clasts <1/4",	Little recovery, 0-2 feet
					2.0 GP **Gravel** subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", trace organic soil	
					3.0 GP **Gravel** subangular gravel, most of the clasts are fractured, clasts up to 1/2", trace sand, dry	
5					4.0 **Boulder or Cobble** gray, crystalline, fractured, fragments up to 5/8", dry	
					8.0 GP **Gravel with Sand** angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/4", dry	
10					10.0 GM **Gravel and Silt** angular to subangular gravel, 100% of clasts are fractured, trace sand, dry	Clasts up to 1/4", 10-13 feet
						No sand, 12-13 feet
						Clasts up to 1", 13-14 feet
					14.0 GM **Silty Gravel with Sand** angular to subangular gravel, clasts up to 1/2", medium to coarse grained sand, dry	
15					15.0 GM **Silt and Gravel** fine gravel, 100% of clasts are fractured, clasts <1/4", dry	Little recovery, 16-18 feet
					16.0 ML **Gravelly Silt**	
					18.0 GP **Sand and Gravel** subangular gravel, 25% of clasts are fractured, medium to coarse grained sand, trace silt	Encountered water, 18.5 feet
20		▼			19.5 20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 20 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Insufficient water)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Insufficient water)

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/27/08 at 130 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-69S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-69S

DATE STARTED 6/27/08 **COMPLETED** 6/27/08 **GROUND ELEVATION** 1025.3 feet **TOC ELEVATION** 1028.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170790.2 feet **EASTING** 1379733.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
					SM **Sandy Silt** Bottom of hole at 20.0 feet.	.

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-69S. Well dry.

THE pebble PARTNERSHIP

P-08-70D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-70D

DATE STARTED 6/27/08 **COMPLETED** 6/28/08 **GROUND ELEVATION** 1799.8 feet **TOC ELEVATION** 1802.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159960.9 feet **EASTING** 1372332.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-3 feet
		▼			3.0 ML **Silt** brown, trace gravel, trace sand, roots, wet 4.0	
5						No recovery, 4-6 feet
					6.0 GM **Silty Gravel with Sand** brown, subangular gravel, clasts up to 1/2", wet 7.0	No recovery, 7-8 feet
					8.0 GP **Sand and Gravel** orangey brown, angular to subangular gravel, most of the clasts are fractured, clasts up to 1", coarse grained sand, trace silt, wet 9.0	
10	GB				SP **Sand** orangey brown, trace gravel, medium to coarse grained sand, wet 10.0	
					SP **Sand with Gravel** orangey brown, subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, moist 13.0	
					SP **Sand** orangey brown, trace gravel, medium to coarse grained sand, wet 14.0	
15	GB		no flow		SP **Sand** orangey brown, medium grained sand, moist 15.0	
					SP **Sand** brown, trace fine subrounded gravel, trace silt, moist 16.0	Water encountered, 16 feet
			1.5		GP **Gravelly Sand** brown, fine gravel, clasts up to 1/2", trace silt, wet 17.0	
20	GB				**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphritic granodiorite, hornblendes altered to chlorite, poorly-developed plagioclase and feldspars, fractured	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 50# bentonite, 20 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/10/2008
Purge Volume: 1730 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/5/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/28/08 at 208 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-70D
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-70D

DATE STARTED 6/27/08 **COMPLETED** 6/28/08 **GROUND ELEVATION** 1799.8 feet **TOC ELEVATION** 1802.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159960.9 feet **EASTING** 1372332.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			1.75		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphritic granodiorite, hornblendes altered to chlorite, poorly-developed plagioclase and feldspars, fractured	
			1.5			Moved to open hole hammer, 22.5 feet
25	GB		1.75			
			1.5			
			2			
30			2			
			2			Slow drilling; more competent bedrock encountered, 31 feet
			2.25			
35			3			Discharge water changed from gray to brown; encountered fracture in bedrock, 36 feet
			3			Discharge water returned back to gray, 36.5 feet
40			2.25			
			2.25			
			2.25			
45			2.25			
			2.5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-70D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-70D

DATE STARTED 6/27/08 **COMPLETED** 6/28/08 **GROUND ELEVATION** 1799.8 feet **TOC ELEVATION** 1802.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159960.9 feet **EASTING** 1372332.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			2.75		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphritic granodiorite, hornblendes altered to chlorite, poorly-developed plagioclase and feldspars, fractured	Discharge water changed from gray to brown; encountered fracture in bedrock, 50 feet
			3.5			Discharge water returned back to gray, 52.5 feet
			3.5			Discharge water changed from gray to brown; encountered fracture in bedrock, 54.5 feet
55			3.75			Discharge water returned back to gray, 56.5 feet
			3.25			
			2.25			
60			4			Discharge water changed from gray to brown; encountered fracture in bedrock, 62 feet
			3.5			Discharge water returned back to gray, 64.5 feet
65			3.5			
			3.5		68.0	Not logged, 68-68.5 feet
					68.5 Bottom of hole at 68.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-70D
Date: August 7 - Aug 9th
Project: Pebble
Technician: JT / JH & JT / JT

Summary (TOP OF PIPE)

	Installed (Well Log)	Start	End
Water level	7.01	5.57	16.8
Total depth	54.1	57.3	57.3
pH		8.57	8.05

Screen interval (btoPVC): Top: 34.6 Bottom: 54.1
PVC stick-up height (above ground surface): 2.8

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
	Surge block on								
8.57	9:18	56.0	5.57	—	—	89	53	4.21	fine silt/sand, grey, 1 Tsp. start	
7.48	16:18	56.0	36.30	2.25	135	90	68	3.44	fine sand, trm silt, d. grey cloudy, 1 TBS	
Aug 8	8:02	54.0	5.85						moved up 2' ft. start	
7.83	9:09	54.0	30.45	2.85	305	92	100	3.10	fine sand, trace silt, cloudy, brown/grey, 1 tsp	
	9:36	52.0	7.63						moved up 2 ft, start	
7.71	10:10	52.0	29.80	3.33	400	91	48	2.91	trace sand/silt, slightly cloudy, ½ tsp	
	10:45	50.0	7.3						moved up 2 ft; start	
7.83	11:23	50.0	32.1	2.63	305	100	75	3.10	minimal sand, slightly cloudy, <½ tsp	
	11:52	48.0	7.47						moved up 2 ft, start	
7.96	12:22	48.0	33.5	3.33	600	~~95~~	84	3.27	min. sand <½ tsp, slightly cloudy	
	12:50	46.0	7.5						moved up 2 ft, start	
7.57	13:14	46.0	38.0	2.5	660	98	78	3.72	no sand, milky	
	13:40	44.0	7.45						moved up 2ft, start	
7.32	14:16	44.0	35.44	2.77	760	93	78	3.55	trace sand, milky, <½ tsp.	
	14:53	42.0	6.9						moved 2' ft, start	
7.10	15:25	42.0	34.1	3.28	875	88	48	3.68	trace sand, cloudy brown, <½ tsp	
	15:50	40.0	7.6						moved 2' ft, start	
7.27	16:11	46.0	32.8	2.3	~~dry~~	~~92~~	27	3.68	trace sand, cloudy brown, <½ tsp	
Aug 9	8:04	38.0	5.61						moved 2' ft, start.	
7.90	8:34	38.0	19.5	1.67	975	96	29	3.26	trace sand, slightly milky	
	8:52	76.0	7.5						moved 2' ft, start,	
7.87	9:35	36.0	28.1	2.31	1075	94	179	3.27		
	10:10	—	7.3						debris peter polish start	
	10:12	—	—	2.5	1080				to bottom (Block off)	
	Surge block off – Start 5' above screen									Ph
polish	10:23	—	~~7.40~~		70	93	49	3.41	trace sand, slight milky	~~7.93~~
	10:30	—	7.9	3.8	1100	93	49	3.4,	~~more~~	7.93
Debris,	10:37	—	—						move to 1 ft of bottom, start	
8.05	10:49	—		5.4	1165	93	72	3.10	trace sand, clear, <½ tsp	8.05

Parameter
* - SP Read taken with Ex-tech (107842)

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-70D
Date: Aug 10

Project: Pebble
Technician: J. Turner / J. Tsao

Summary (bgs) (PVC)

	Installed (Well Log)	Start	End
Water level	16.92	22.57	
Total depth	34.9	37.24	
pH			

Screen interval (btoPVC):
Top: 25.04
Bottom: 34.9
PVC stick-up height (above ground surface): 2.8

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond µS (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH	Surge block on							
8.88	8:05	36.7	22.5	—	5	226	E3	4.3	fine sand/silt, brown (dark), cloudy, 2 Tbs.
7.81	9:02	36.7	22.5	2.16	135	258	111	3.7	fine sand, light brown, cloudy, ½ tsp.
	9:07	34.7	22.5						moved up 2' ft, start.
7.37	9:48	34.7	22.7	2.8	265	104	82	3.1	fine sand, brown sed / brown cloudy, trace
	10:05	32.7	22.5						moved up 2 ft, start.
7.13	10:22	32.7	22.5	3.8	300	117	86	3.6	trace fine sand, milky, ½ tsp
	10:29	30.7	22.7						moved up 2 ft, start
7.48	10:50	30.7	22.8	2.8	360	118	59	3.3	fine silt/sand, milky, trace
	11:02	28.7	22.75						moved up 2 ft, start
7.38	11:20	28.7	22.8	4.1	435	108	80	4.0	fine silt/sand, milky, ½ tsp
	11:36	26.7	22.7						moved up 2 ft, start
7.01	11:56	26.7	22.77	3.0	495	148	46	3.6	
	12:07	36.7							Debris B4 polish, Block off, start
	12:19	36.7		2.8	520				move to 2.5' ft above screen
	Surge block off 2.5 above screen due to H2O level.							
polish 7.78	12:25	24.2	22.7						2.5ft above screen, start
	12:29	24.2	22.8	3.75	535	134	31	3.9	trace sand, slight milky, trace < ½ tsp
	13:35	36.7							* simons stop for redraw
7.03	12:46	36.7			565	152	47	3.5	

THE pebble PARTNERSHIP

P-08-70S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-70S

DATE STARTED 6/28/08 **COMPLETED** 6/28/08 **GROUND ELEVATION** 1798.2 feet **TOC ELEVATION** 1801.2 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159988.8 feet **EASTING** 1372325.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-6 feet
5		▼				
					6.0 GM **Silty Gravel** angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", wet	
					7.0 SM **Sandy Silt with Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", wet	
					9.0 SP **Sand** medium to coarse grained sand, moist	
10					10.0 SP **Sand** fine to coarse grained sand, moist	
					13.0 SM **Sandy Silt** orangey brown, wet	Water encountered, 14 feet
15						
					17.0 SP **Sand** medium to coarse grained sand, moist	
					18.0 SM **Sandy Silt** orangey brown, wet	
			4		19.9	Boring terminated at top of bedrock, 19.9 feet

Bottom of hole at 19.9 feet.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 20 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/9/2008
Purge Volume: 642 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/6/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/28/08 at 654 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-70 S
Date: August 9 th

Project: Pebble
Technician: ~~SLR/CSE~~ J. Turner / J Tsoo

Summary bgs (From PVC)

	Installed (Well Log)	Start	End
Water level	41.55	6.01	
Total depth	49.8	23.11	
pH		7.73	

Screen interval (btoPVC):
Top: 41.88
Bottom: 49.9
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH	Surge block on	Start 6 inch of bottom						
7.73	11:15	19.9			44	E3	5.17	Start 6 inch of bottom
7.90	12:15	19.4	8.6	3.5	210	34	92	2.99 fine sand, brown cloudy, 1 tsp.
	12:37	17.4	6.5					moved up 2 ft, start
7.91	13:21	17.4	8.6	4.09	390	34	73	3.21 fine sand, light brown cloudy, ½ tsp
~~7.65~~	~~13:32~~	~~16.4~~	~~8.2~~	~~2.83~~	~~560~~	~~34~~	~~71~~	~~3.19 fine sand, light brown cloudy, ½ tsp~~ moved 2' start
7.65	14:30	15.41	8.2	2.83	560	34	71	3.19 fine sand, light brown cloudy, ½ tsp
	14:36	19.4						Debris before polish
	14:44				585			↑ (Block off)
	Surge block off							
polish	2:14	10.40	6.40					moved to 5ft ft above screen, start
7.84	2:58	—		2.8	610	33	12	3.51 trace sand, clear
Debris	3:07	19.4						move to 1ft of bottom, start
	3:16	19.4	8.20	3.5	642	34	32	3.15 trace sand, cloudy

THE pebble PARTNERSHIP

P-08-71D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-71D

DATE STARTED 6/29/08 **COMPLETED** 6/29/08 **GROUND ELEVATION** 1504.8 feet **TOC ELEVATION** 1507.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2161557.6 feet **EASTING** 1384970.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** dark brown, trace fine grained sand, organics, moist	
					2.0	
						No recovery, 2-3 feet
					3.0	
					Organic Soil trace sand, moist	Very shallow water encountered, 3 feet
					4.0	
						No recovery, 4-5 feet Discharge water is dark brown, 4-6 feet
5					5.0	
					GW **Gravel** angular gravel, most of the clasts are fractured, clasts up to 1/4", well graded, trace sand, trace silt, wet	
					6.0	
					GM **Silty Gravel with Sand** brown, silt coasted subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1", moist	
					8.0	
					GP **Sand and Gravel** brown, subangular to subrounded gravel, some black subangular clasts, medium to coarse grained sand, moist	
10	GB				10.0	
					GM **Silty Gravel** brown, silt coated subrounded gravel, <10% of clasts are fractured, trace sand, moist	
					11.0	
					ML **Silt with Gravel** brown, trace sand, moist	
					13.0	
					GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, clasts up to 1", moist	
					14.0	
15	GB				GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 3/4", moist	
					16.0	Very little recovery, 16-18 feet
		▼			GP **Sand and Gravel** fine gravel, medium grained sand	
					18.0	
					Bedrock (Tertiary Basalt) dark green to black, strongly magnetic, aphanitic basalt, fractured	Water enountered, 18.5 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/10/2008
Purge Volume: 565 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/6/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/30/08 at 316 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-71D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-71D

DATE STARTED 6/29/08 **COMPLETED** 6/29/08 **GROUND ELEVATION** 1504.8 feet **TOC ELEVATION** 1507.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2161557.6 feet **EASTING** 1384970.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Bentz, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					**Bedrock (Tertiary Basalt)** dark green to black, strongly magnetic, aphanitic basalt, fractured	
			0.25			Flow tests may be biased low, 22-49 feet
25	GB		5			
			8			Moved to open hole hammer, 27 feet
						Discharge water is light brown, 28-29 feet
30	GB		19.5			
			24			More competent bedrock encountered, 31 feet
			30			Slower drilling, 32-34 feet
35	GB		30			
			30			
			30			
40			32			
			30			
45			32			
			28			
			28		49.0 Bottom of hole at 49.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

18 JT/JT P-08-71D

Block Dev
Start 8:05 08/10/08
Stop 11:56

Bail/sw
Start 12:25
Stop 12:29

Debris
Start 12:35
Stop 12:46

- very fast recovery
- P-08-71S not enough water to develop.

JT/JT P-08-72D 19

Blockdev
Start 14:30 08/10/08
Stop 16:42 08/10/08

Bail/sw
start 8:57 08/11/08
Stop 10:44 08/11/08 *

Debris
Start 9:05 08/11/08
Stop 11:12 08/11/08 *

- P-08-72S dry
- ran out of water quickly
moderate to slow recharge

* Repeated Bail/sw & Debris 3x

THE pebble PARTNERSHIP

P-08-71S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-71S

DATE STARTED 6/30/08 **COMPLETED** 6/30/08 **GROUND ELEVATION** 1504.4 feet **TOC ELEVATION** 1507.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2161559.3 feet **EASTING** 1384944.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** L. Crawford

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-4 feet
						Adding water while drilling, 2-10 feet
						Discharge water is brown, 4-5 feet
5		▼				
						Discharge water is brown, 6-7 feet
10						

4.0 GM **Gravel with Silt** brown, subangular gravel, up to 1/2", fractured, poorly sorted

5.0 GM **Gravel with Silt** brown, angular gravel, up to 1/2", poorly sorted

6.0 GM **Silty Gravel** brown, subangular to subrounded gravel, up to 3/4"

7.0 GM **Silt and Gravel** brown, subangular to subrounded gravel, up to 1/4", moist

10.0 Bottom of hole at 10.0 feet.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.2'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 75# cement, 2.5 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Insufficient water)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Insufficient water)

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 6/30/08 at 1220 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-715
Date: Aug 10/08

Project: Pebble
Technician: J. Turner / J. Tsao

Summary (bgs) (PVC)

	Installed (Well Log)	Start	End
Water level	5.3	12.42	
Total depth	10	12.95	
pH			

Screen interval (btoPVC):
Top: 7
Bottom: 10
PVC stick-up height (above ground surface): 3.1

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
Not enough water too Develop								soft bottom.
Surge block off								

THE pebble PARTNERSHIP

P-08-72D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-72D

DATE STARTED 6/30/08 **COMPLETED** 7/1/08 **GROUND ELEVATION** 1191.4 feet **TOC ELEVATION** 1193.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166366.9 feet **EASTING** 1388955.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SM **Silty Sand** brown, poorly graded fine grained sand, trace organics	
1.0					GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1/2", gravel is silt coated, fine grained sand	
4.0						More fine sand than above, 3-4 feet
5	GB				GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", gravel is silt coated, fine grained sand	
5.0					GM **Gravel with Silt and Sand** brown, silt coated gravel, most of the clasts are fractured, well graded sand	Clasts up to 3/4", 5-9 feet
						Less sand than rest of unit, 7-9 feet
10	GB					Clasts up to 1 1/2", 9-10 feet
						Clasts up to 1 1/2", 10-11 feet
						Clasts up to 1", 11-12 feet
12.0					GM **Silty Gravel** brown, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", moist	
15	GB					
16.0					GM **Gravel with Silt** brown, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", trace fine grained sand, moist	
18.0					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to medium grained sand, moist	
20	GB					
20.0						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/11/2008
Purge Volume: 27 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/6/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 7/1/08 at 650 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-72D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-72D

DATE STARTED 6/30/08 **COMPLETED** 7/1/08 **GROUND ELEVATION** 1191.4 feet **TOC ELEVATION** 1193.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166366.9 feet **EASTING** 1388955.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Silty Gravel** brown, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", trace fine grained sand, moist	
					24.0	
25	GB				GM **Gravel with Silt** brown, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", trace fine grained sand	Cuttings are moist, 24-25 feet
					28.0	
30	GB	▼			**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** white to gray speckled granodiorite, poorly-developed feldspar/plagioclase dominated groundmass, fractured	Clasts up to 1", 28-32 feet
			no flow			Moved to open hole hammer, 32- feet
35	GB		no flow			
			no flow			
			0.375			Adding water while drilling, 38-39 feet
40	GB		<0.25			
			<0.25			
			0.25			
45			0.25			
			0.5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-72D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-72D

DATE STARTED 6/30/08 **COMPLETED** 7/1/08 **GROUND ELEVATION** 1191.4 feet **TOC ELEVATION** 1193.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166366.9 feet **EASTING** 1388955.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			<0.25		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** white to gray speckled granodiorite, poorly-developed feldspar/plagioclase dominated groundmass, fractured	Flow test may be biased high, 50 feet
			<0.25			Adding water while drilling, 52-53 feet
			0.25			
55			<0.25			
			0.25			
					58.0	
					58.2	Not logged, 58-58.2 feet
					Bottom of hole at 58.2 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

Parameters to ex-tech.

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-72D
Date: Aug 10
Project: Pebble
Technician: J. Turner / J. Isaac

Summary (bgs) (PVC)

	Installed (Well Log)	Start	End
Water level	30.15	29.53	
Total depth	48.0	50.71	
pH		8.5	

Screen interval (btoPVC):
(bgs) Top: 33.2
Bottom: 48.0
PVC stick-up height (above ground surface): 2.5

* ran out of water and ran *

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	
pH	Surge block on								
	14:20	49.7	29.5	—	—	JS	—	—	start 1 ft off bottom
8.5	14:32	49.7	42.5	1.0	2	321	476	13.8	fine sand/silt, brown cloudy, 1 tsp * ran out of water
	15:21	47.7	29.7	—	—	320 uS	—	—	moved up 2 ft, start.
8.08	15:23	47.7	43.8	1.0	4½	[illegible]	1000+	12.7	fine sand/silt, brown cloudy, 1-2 tsp * ran out of water
	15:39	49.7	29.0	—	—	mS	—	—	moved up 2ft, waited for recharge, start
8.04	15:41	49.7	40.0	1.0	6½	11.67	1000+	11.3	fine sand, brown/cloudy, 1 Tbs * ran out of water
	16:10	48.7	29.0	—	—	mS	—	—	moved up 2ft, waited for recharge, start.
8.40	16:12	48.7	35.0	1.0	8½	6.55	1000+	14.2	fine sand/silt, brown & cloudy, 1 tsp * ran out of water
	16:40	41.7	29.0	—	—	uS	—	—	moved up 2ft, waited for recovery, start
8.56	16:42	46.7	42.00	1.0	11.0	1416	1000+	16.8	fine sand/silt, brown & cloudy, 1 tsp * ran out of water
Block OFF	8:20	49.7	28.1	—	—	—	—	—	1 ft off bottom debris before polish
	8:22	49.7	—	1.0	13.0	—	—	—	fine sand, brown & cloudy, 1 Tbs * ran at of water
Polish #1	8:57	32.2	29.7	—	—	—	—	—	moved 3.5' above screen (due to H2O lvl) start
8.59	8:58	32.2	36.0	1.0	14.0	96 ms	608	11.9	fine sand, brown & cloudy, 1 TSP
Rebris #1	9:05	49.7	25.1	—	—	—	—	—	water up as tub put at bottom 1 ft off start
8.59	9:07	49.7	—	3.0	18.0	N/A	972	6.0	
Polish #2	9:50	32.2	30.0	—	—	ms	—	—	3.5 ft above screen, repeating Polish start
8.35	9:51	32.2	—	1.25	19.25	19.83	621	6.3	fine sand, milky & brown cloudy
Debris #2	10:10	49.7	29.5	—	—	—	920	5.8	1 ft off bottom start
8.68	10:11	49.7	—	2.8	22.25	N/A	920	5.8	fine sand/silt, brown, cloudy 1 Tbs
Polish #3	10:43	32.2	29.6	—	—	uS	—	—	3.5 ft above screen, repeating Polish start
8.44	10:44	32.2	35.4	1.25	23.5	16.92	279	6.6	fine sand & milky, ½ tsp
Debris #3	11:11	49.7	29.5	—	—	—	—	—	1 ft off bottom, start.
	Surge block off								
8.73	11:12	49.7	43.8	2.8	26.5	N/A	636	6.3	fine sand, brown & cloudy, 1 tsp

N/A over 20 uS won't read.

Development done but still cloudy

THE pebble PARTNERSHIP

P-08-72S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-72S

DATE STARTED 7/1/08 **COMPLETED** 7/1/08 **GROUND ELEVATION** 1191.7 feet **TOC ELEVATION** 1194.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166380.2 feet **EASTING** 1388916.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, C. Bentz

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil** brown, trace sand, dry	Very little recovery, 0-3 feet
					2.0 **Topsoil** dark brown, roots/tundra	
					3.0 SP **Sand** brown, trace organics, dry	
					GP **Sand and Gravel** brown, silt coasted, subangular to subrounded gravel, 30% of clasts are fractured, fine to medium grained sand, trace silt, dry	Clasts up to 5/8", 3-4 feet
5	GB				5.0	Clasts up to 1", 4-5 feet
					GP **Sand and Gravel** brown, silt coated angular to subrounded gravel, fine grained sand, trace silt, moist	50% of clasts are fractured; clasts up to 1 1/4", 5-6 feet 30% of clasts are fractured; clasts up to 1", 6-8 feet
10	GB					50% of clasts are fractured; clasts up to 1 1/4", 8-12 feet
						70% of clasts are fractured; clasts up to 1", 12-13 feet 50% of clasts are fractured; clasts up to 1 1/4", 13-14 feet 70% of clasts are fractured; clasts up to 1 1/4", 14-15 feet
15	GB				15.0	Not logged, 15-15.3 feet
					15.3 Bottom of hole at 15.3 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is dry)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is dry)

Comments: Piezometer is dry; Measured on 7/1/08 at 218 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-72S. Well dry.

THE pebble PARTNERSHIP

P-08-73D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73D

DATE STARTED 7/1/08 **COMPLETED** 7/2/08 **GROUND ELEVATION** 1402.9 feet **TOC ELEVATION** 1405.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158962.8 feet **EASTING** 1393537.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					GP **Sand and Gravel with Organics** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand	Very little recovery, 1-2 feet
					2.0	No recovery, 2-4 feet
					4.0	
5	GB				ML **Silt with Sand** dark brown, medium to coarse grained sand, with organics	Cuttings are moist, 4-5 feet
						Cuttings are wet, 5-6 feet
					6.0	
					ML **Silt with Sand** dark brown, trace angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, with organics, wet	
					7.0	
					GM **Silty Gravel with Sand** brown to gray, subangular 75% of clasts are fractured, coarse grained sand, moist	
10	GB	▼				Very little recovery, 11-12 feet
					12.0	No recovery, 12-16 feet
						Losing air into formation, 14-15 feet
15						
					16.0	
					ML **Silt and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", trace coarse grained sand, moist	
					17.0	
					ML **Silt with Gravel** brown, subangular to subrounded gravel, trace coarse grained sand, moist	
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/12/2008
Purge Volume: 645 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/7/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 7/4/08 at 900 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-73D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73D

DATE STARTED 7/1/08 **COMPLETED** 7/2/08 **GROUND ELEVATION** 1402.9 feet **TOC ELEVATION** 1405.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158962.8 feet **EASTING** 1393537.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt with Gravel** brown, subangular to subrounded gravel, trace coarse grained sand, moist	Clasts up to 1", 21-22 feet 50% of clasts are fractured; clasts up to 3/4", 22-25 feet
25					25.0 GM **Silt and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", trace coarse grained sand, moist	75% of clasts are fractured, 26-27 feet
					26.0 GM **Silt and Gravel** light brown to dark gray, subangular to subrounded gravel, clasts up to 3/4", trace coarse grained sand, moist	25% of clasts are fractured, 27-29 feet 50% of clasts are fractured, 29-33 feet
30	GB					
					34.0 ML **Gravelly Silt** dark gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", trace medium grained sand, moist	25% of clasts are fractured, 33-34 feet
35	GB				37.0 GM **Silt and Gravel** dark gray, subangular to subrounded gravel, moist	25% of clasts are fractured, 37-38 feet Clasts up to 3/4", 37-39 feet 75% of clasts are fractured, 38-39 feet Clasts up to 1/2", 39-40 feet
40	GB				40.0 ML **Silt with Gravel** dark gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", moist	
					41.0 ML **Silt** gray, trace subrounded gravel, clasts up to 3/4", trace fine grained sand, moist	
					43.0 GM **Silty Gravel** gray, subangular gravel, most of the clasts are fractured, clasts up to 3/4", moist	
45	GB				45.0 GM **Silt and Gravel** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", wet	
					46.0 ML **Gravelly Silt** gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", wet	Little recovery, 46-47 feet Adding water while drilling, 46-47 feet
					48.0 ML **Silt with Gravel** gray, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2"	Adding water and foam while drilling, 48-49 feet
	GB				50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-73D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73D

DATE STARTED 7/1/08 **COMPLETED** 7/2/08 **GROUND ELEVATION** 1402.9 feet **TOC ELEVATION** 1405.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158962.8 feet **EASTING** 1393537.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GM **Silty Gravel** gray, subangular gravel, 50% of clasts are fractured, clasts up to 3/4", wet	
					52.0 GM **Gravel with Silt** gray, subangular gravel, 75% of clasts are fractured, wet	Clasts up to 1/2", 52-53 feet Clasts up to 1", 53-57 feet
55	GB					
						Clasts up to 3/4", 57-60 feet
60					60.0 GM **Silty Gravel** gray, subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", wet	
					62.0 GM **Silty Gravel** gray, subangular gravel, most of the clasts are fractured, wet	Clasts up to 3/4", 62-63 feet Clasts up to 1/2",63-65 feet
65	GB				65.0 GM **Gravel with Silt** gray, subangular gravel, most of the clasts are fractured, clasts up to 3/4", wet	Slow drilling, 65.5 feet
					67.0 GM **Silty Gravel** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", moist	
70	GB				68.0 69.0 ML **Gravelly Silt** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", trace fine to medium grained sand, moist	
					ML **Silt with Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", trace fine grained sand, moist	
					72.0 SM **Silty Sand** brown, trace gravel, clasts up to 1/2", fine to medium grained sand, moist	
75					73.0 SM **Silty Sand** brown, fine to medium grained sand, moist	
					75.0 SM **Silty Sand** brown, trace subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", fine to medium grained sand, moist	
					77.0	No recovery, 77-82 feet
			no flow			Small amount of water being produced; discharge water is brown, 78-81 feet Dust being created during drilling, 79-82 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-73D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73D

DATE STARTED 7/1/08 **COMPLETED** 7/2/08 **GROUND ELEVATION** 1402.9 feet **TOC ELEVATION** 1405.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158962.8 feet **EASTING** 1393537.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					82.0	
					ML **Silt** light brown, wet	Dust being created during drilling, 83-87 feet
					84.0	Very little recovery, 83-84 feet
85					85.0	No recovery, 84-85 feet
					ML **Silt** light brown, wet	Very little recovery, 85-86 feet
					86.0	No recovery, 86-87 feet
					87.0	
					SP **Sand** brown, fine to medium grained sand, trace silt, wet	
90						Very little recovery, 89-90 feet
						Losing fines, 90-95 feet
					91.0	Little recovery, 91-94 feet
					SM **Sand** brown, poorly graded well sorted medium grained sand, wet 92.0	
			0.125		SM **Sand with Silt** brown, well graded fine to medium grained sand, wet	
					94.0	
95	GB				SW **Sand** brown, well graded poorly sorted fine to coarse grained sand, wet	
					97.0	
					Bedrock (Cretaceous Kaskanak Batholith - Granodiorite) creamy white to light gray, porphyritic granodiorite, needle and tabular hornblendes altered to chlorite, poorly-developed plagioclase and feldspars	
100	GB		1.875			Discharge water is brown; losing fines, 99-114 feet
			2.25			
105	GB		2			
			1.5			
			no flow			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-73D
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73D

DATE STARTED 7/1/08 **COMPLETED** 7/2/08 **GROUND ELEVATION** 1402.9 feet **TOC ELEVATION** 1405.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158962.8 feet **EASTING** 1393537.3 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			0.75		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphyritic granodiorite, needle and tabular hornblendes altered to chlorite, poorly-developed plagioclase and feldspars	More competent bedrock encountered, 111 feet
			0.25			
			no flow		114.0 Bottom of hole at 114.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-73D
Date: 12 Aug 08

Project: 005.0189.08002 Pebble
Technician: IB, JH, JK.

Summary

	Installed (Well Log)	Start TOC	End TOC
Water level	10.39	4.50	—
Total depth	106.0 bgs	98.50	98.70
pH	—	9.58	9.80

Screen interval (btoPVC): 10 4
Top: 96.2
Bottom: 106.2
PVC stick-up height (above ground surface): 2.6

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
10:25	107	39.9	1	61	251	390	6.14	~1 Tbsp brown fine sand.
12:35	105	33	1	116	266	105	6.93	~2 Tsp brown fine sand
13:50	103	—	1.3	156	259	81	6.83	1 Tbsp brown fine sand
14:55	101	—	1.0	196	266	34.3	7.5	1 Tsp brown fine sand
15:45	99	—	0.8	116	257	35	6.76	< 1 Tsp brown fine sand.
Surge block off								
16:00								debris → ½ cup fine sand after 5 gal.
16:15								polish
								debris ~2 Tbsp fine sand after 5 gal.

THE pebble PARTNERSHIP

P-08-73S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73S

DATE STARTED 7/3/08 **COMPLETED** 7/3/08 **GROUND ELEVATION** 1400.8 feet **TOC ELEVATION** N/R feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158978 feet **EASTING** 1393498.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 GP **Gravel with Sand** coarse grained sand, trace silt	Very little recovery, 2-4 feet
		▼			4.0 GM **Gravel with Sand and Silt** coarse grained sand, moist	
5	GB				5.0 GM **Silt and Gravel** gray, subangular to subrounded gravel, clasts up to 1/2", wet	
					6.0 GM **Silt with Gravel** gray, subangular to subrounded gravel, clasts up to 1/2", wet	
					8.0 GM **Silt and Gravel** gray, subangular to subrounded gravel, clasts up to 3/4", wet	
10	GB				9.0 GM **Silt and Gravel** gray, subangular to subrounded gravel, clasts up to 3/4", trace coarse grained sand, wet	No recovery, 10-12 feet
					10.0	
					12.0 GM **Silt and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", trace coarse grained sand, moist	
15	GB				15.0 GM **Silty Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", moist	25% of clasts are fractured, 16-18 feet
					16.0 GM **Silty Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", coarse grained sand, moist	
					19.0	50% of clasts are fractured, 18-19 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A (Never Installed)
Diameter: N/A

WELL CASING
Stickup: N/A
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: N/A
Date: N/A (Monument needs repair)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Monument needs repair)

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 7/4/08 at 500 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-73S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-73S

DATE STARTED 7/3/08 **COMPLETED** 7/3/08 **GROUND ELEVATION** 1400.8 feet **TOC ELEVATION** N/R feet

DRILLING CONTRACTOR Foundex **NORTHING** 2158978 feet **EASTING** 1393498.2 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Gravel with Silt** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", moist	Clasts up to 1", 20-22 feet
					22.0 GM **Gravel with Silt** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", trace coarse grained sand, moist	Clasts up to 1", 23-24 feet
25	GB				23.0 GM **Silt and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, trace coarse grained sand, moist	Clasts up to 1/2", 24-25 feet
					25.0 GM **Silty Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", moist	
					27.0 GM **Silt and Gravel** brown to gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4"	Cuttings are moist, 27-31 feet
30	GB					50% of clasts are fractured, 30-31 feet
						Cuttings are wet, 31-36 feet
35	GB					Little recovery, 34-35 feet
					36.0 GM **Gravelly Silt** gray, subangular to subrounded gravel, clasts up to 3/4", moist to wet	
					37.0 GM **Gravel with Silt** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", moist to wet	
40	GB				38.0 GM **Silt and Gravel** gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", moist to wet	Clasts up to 1/2", 43-44 feet
					44.0	Not logged, 44-44.7 feet
					44.7 Bottom of hole at 44.7 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-73S. Monument needs repair prior to development.

THE pebble PARTNERSHIP

P-08-74D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74D

DATE STARTED 7/4/08 **COMPLETED** 7/4/08 **GROUND ELEVATION** 1372.33 feet **TOC ELEVATION** 1375.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156427.85 feet **EASTING** 1392172.81 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					Silt and Organic Soil with Sand brown, moist to dry 2.0	Little recovery, 1-2 feet
					SM **Silt and Sand** brown, trace angular gravel, 50% of clasts are fractured, dry 3.0	
					GM **Sand and Gravel with Silt** brown, angular to subangular gravel, 50% of clasts are fractured, dry 4.0	
5	GB				GW **Sand and Gravel** brown, angular to subangular gravel, 50% of clasts are fractured, clasts up to 1", trace silt 5.0	
		▼			GW **Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1", well graded, dry to moist 8.0	10% of clasts are fractured, 7-8 feet
						No recovery, 8-10 feet
10					10.0	
					GM **Gravel and Silt with Sand** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/2", well graded, wet 11.0	
					SM **Sand with Silt** brown, poorly graded fine grained sand, wet 12.0	
					SP **Sand** brown, trace subrounded gravel, poorly graded fine grained sand, wet 14.0	
15	GB				GM **Silt and Gravel** brown, subrounded gravel, 25% of clasts are fractured, clasts up to 1", well graded, well sorted, wet 16.0	Discharge water is brown; losing fines, 15-24 feet
					GW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", well graded, fine grained sand 18.0	Very little recovery, 17-18 feet
					19.0	No recovery, 18-19 feet
20	GB				GW **Sand and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1", well 20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/13/2008
Purge Volume: 411 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/7/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 7/6/08 at 818 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-74D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74D

DATE STARTED 7/4/08 **COMPLETED** 7/4/08 **GROUND ELEVATION** 1372.33 feet **TOC ELEVATION** 1375.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156427.85 feet **EASTING** 1392172.81 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					graded, poorly sorted, fine grained sand, trace silt	
					GW **Gravel with Sand** subangular to subrounded gravel, clasts up to 1", well graded, poorly sorted	75% of clasts are fractured, 21-22 feet
					22.0 GW **Gravel** angular to subangular gravel, clasts up to 1", poorly sorted, trace silt	
					23.0 GW **Sand and Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, poorly sorted	Discharge water is reddish brown, 24-30 feet
25	GB		0.25		24.0 GW **Sand with Gravel** angular gravel, 75% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, poorly sorted	
					26.0 GP **Sand** trace angular gravel, most of the clasts are fractured, medium to coarse grained sand, trace reddish brown silt, poorly graded, poorly sorted	Little recovery, 28-30 feet
30	GB		no flow		30.0 GW **Sand with Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", trace silt, well graded, poorly sorted	Discharge water is brown, 30-54 feet
					31.0 GP **Sandy Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1", trace silt, poorly graded, well sorted	
					33.0 GP **Gravel with Sand** gray, angular to subangular gravel, most of the clasts are fractured, clasts up to 1 1/2", trace silt, poorly graded, well sorted	Clasts up to 1 1/2", 34-35 feet
35	GB		0.25		36.0 GW **Gravel** multicolored, angular to subangular gravel, most of the clasts are fractured, trace sand, trace silt, well graded, poorly sorted	
					37.0 SP **Sand** trace angular gravel, most of the clasts are fractured, medium to coarse grained sand, trace silt	
					38.0 SP **Sand** trace subangular gravel, clasts up to 1/2", coarse grained sand	
40	GB		no flow		39.0 GM **Sand and Gravel with Silt** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1/2", trace clay, well graded, poorly sorted	No recovery, 41-44 feet
					40.0 GM **Sand and Gravel with Silt** subangular to subrounded gravel, clasts up to 1/2", well graded, poorly sorted	
					41.0 44.0 CH **Clay** brown, soft	
45			no flow		45.0 CH **Clay** brown, soft, trace silt	Losing fines, 45-55 feet
					47.0 SP **Sand** brown, trace gravel, 20% of clasts are fractured, fine grained sand, well sorted	
					48.0 SP **Sand with Gravel** angular to subangular gravel, 50% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, well graded	
	GB				49.0 50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-74D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74D

DATE STARTED 7/4/08 **COMPLETED** 7/4/08 **GROUND ELEVATION** 1372.33 feet **TOC ELEVATION** 1375.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156427.85 feet **EASTING** 1392172.81 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			2.5		SP **Sand with Gravel** multicolored, angular to subrounded gravel, most of the clasts are fractured, clasts up to 1", medium to coarse grained sand, well graded	Clasts up to 1", 51-52 feet
					53.0 SP **Sand** trace angular gravel, 75% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, well graded	
					54.0 SP **Sand** trace subrounded gravel, 10% of clasts are fractured, medium to coarse grained sand, poorly graded, well sorted	Discharge water is reddish brown, 54-55 feet
55	GB		0.25		55.0	No recovery, 55-56 feet
					56.0 SP **Sand** reddish brown, trace angular to subangular gravel, 75% of clasts are fractured, medium to coarse grained sand, well graded, poorly sorted	Discharge water is brown; losing fines, 55-58 feet
					57.0	
					58.0 SM **Sand and Silt** reddish brown, trace gravel, 25% of clasts are fractured, clasts up to 1/2", coarse grained sand, well graded, poorly sorted	No recovery; discharge water is reddish brown; losing fines, 58-59 feet
					59.0	Little recovery, 59-61 feet
60	GB		2.5		GW **Gravelly Sand** reddish brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1 1/2", well graded	Discharge water is brown; losing fines, 59-65 feet
					60.0 SC **Sand with Clay** trace gravel, 75% of clasts are fractured, coarse grained sand, medium stiff, well graded	
					SW **Sand** reddish brown, trace angular gravel, most of the clasts are fractured, fine to coarse grained sand, well graded	
					64.0 SC **Clayey Sand**	
65	GB		0.75		65.0 SW **Sand** trace clay	Strong iron oxide staining, 65-75 feet
					66.0 SC **Clayey Sand**	
					67.0 **Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphyritic granodiorite, hornblendes altered to chlorite, poorly-developed plagioclase and feldspars	Discharge water is reddish brown; losing fines, 67-70 feet
70	GB		0.25			Very little recovery, 69-71 feet
			<0.25			Discharge water is reddish brown; losing fines, 71-77 feet
						Very little recovery, 72-73 feet
75	GB		0.5			More competent bedrock encountered, 74 feet
			<0.25			Moved to open hole hammer, 77 feet
	GB		1.5			Discharge water is gray, 77-82 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-74D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74D

DATE STARTED 7/4/08 **COMPLETED** 7/4/08 **GROUND ELEVATION** 1372.33 feet **TOC ELEVATION** 1375.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156427.85 feet **EASTING** 1392172.81 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
			1.75		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphyritic granodiorite, hornblendes altered to chlorite, poorly-developed plagioclase and feldspars	Discharge water is light brown, 82-85 feet
			1.75			No recovery, 84-85 feet
85						Discharge water is gray, 85-94 feet
			1.5			
			1.25			
90			1.5			
			1.5			No recovery, 92-93 feet
			1.25		94.0	Not logged, 94-94.7 feet
					94.7 Bottom of hole at 94.7 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: D-08-74D
Date: Aug 12 – Aug 13
Project: Pebble
Technician: J. Weaver / T. Tsao

Summary bg: PVC

	Installed (Well Log)	Start	End
Water level		11.1	
Total depth		87.5	
pH		6.8 off 5	

Screen interval (btoPVC):
Top: 75.1
Bottom: 85.1
PVC stick-up height (above ground surface): 2.7

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
8.93 13:47	~~86.5~~ 85.5	—	2.0	10	769	NA	5.5	fine silt/sand, brown, ½ cup
14:35	84.5	11.4						moved up 2' ft, start
9.30 15:35	84.5	71.4	3.5	220	1420	N/A	5.2	fine silt, brown, very cloudy, ½ cup
15:55	82.5	11.5						moved up 2 ft, start
8.44 16:50	82.9	72.9	1.8	320	858	E3	7.2	fine sand/silt, brown, 1 tsp
AVG 13 8:22	80.9	11.0						moved up 2 ft, start
7.3 9:22	80.9	74.0	1.08	385	990	E3	5.0	fine sand, brown, 1 TBS
10:05	78.9	11.1						~~fine sand~~, moved up 2 ft, start
7.6 10:30	78.9	55	1.02	410.5	857	E2	5.6	fine sand, milky brown, 1 TBS
* - two ft of sand now collected on bottom of well								Debris before pg 13
↳ after start debris, ≈ 1-cup of well sand was collected. Also foot valve now could go approx 2ft deep than was first measured. Moved to new lower depth tryied to pump, but after pump lift is was stuck ∴ we figure there is a hole/crack where well sand is getting into the well ⇒ development was stopped.								
Surge block off								

of so I thought
* Pan out of water after 6 mins

THE pebble PARTNERSHIP

P-08-74S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74S

DATE STARTED 7/5/08 **COMPLETED** 7/5/08 **GROUND ELEVATION** 1373.03 feet **TOC ELEVATION** 1375.43 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156469.9 feet **EASTING** 1392203.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Sand and Organic Soil**	Little recovery, 0-2 feet
					2.0 GP **Sand and Gravel** angular gravel, clasts up to 1/4", well sorted medium grained sand	25% of clasts are fractured, 2-4 feet
					GP **Gravel with Sand** brown, subrounded gravel, clasts up to 1", well graded, poorly sorted, trace silt, dry	
5	GB	▼			5.0	50% of clasts are fractured, 4-5 feet
					GP **Sand and Gravel** brown, subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/2", well graded, poorly sorted, trace silt, dry	Fine to coarse grained sand, 6-7 feet
					7.0	Little recovery; not logged, 7-8 feet
					8.0	
					SP **Sand** brown, trace subrounded gravel, medium to coarse grained sand, moist	<10% of clasts are fractured; clasts up to 1/2", 8-9 feet Clasts up to 1/4", 9-10 feet 20% of clasts are fractured, 9-11 feet Clasts up to 1/2", 10-11 feet
10	GB					
					11.0	
					12.0 SP **Sand** brown, trace subrounded gravel, 20% of clasts are fractured, clasts up to 1/2", pooly graded medium to coarse grained sand, trace silt, wet	Water encountered; discharge water is brown, 12 feet
					13.0 GM **Sand and Gravel with Silt** brown, subrounded gravel, 10% of clasts are fractured, clasts up to 1", well graded, wet	
					14.0 GP **Gravel** clasts up to 1", poorly graded, poorly sorted, trace silt, wet	
15	GB					Coarse grained sand, 15-16 feet Discharge water is brown; losing fines, 15-19 feet Poorly graded, 16-17 feet Well graded; trace clay, 17-18 feet
					16.0 GP **Sand and Gravel** subangular to subrounded gravel, clasts up to 1", well graded, trace silt	
					GP **Gravel with Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 2", trace silt	
					18.0	
					19.0 ML **Silt and Gravel** subrounded gravel, 75% of clasts are fractured, clasts up to 1", well graded, trace clay	
20	GB				20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.4'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/12/2008
Purge Volume: 2388 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/7/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 7/6/08 at 739 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-74S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74S

DATE STARTED 7/5/08 **COMPLETED** 7/5/08 **GROUND ELEVATION** 1373.03 feet **TOC ELEVATION** 1375.43 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156469.9 feet **EASTING** 1392203.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Sand and Silt** trace subangular gravel, 75% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, trace clay, wet	
					22.0 ML **Sand and Silt** 75% of clasts are fractured, poorly graded, well sorted fine to coarse grained sand, trace clay, wet	
					23.0 SC-SM **Clayey Sand and Silt** trace subangular to subrounded gravel, 75% of clasts are fractured	Less clay than rest of unit, 24-25 feet
25	GB				25.0 SC-SM **Clayey Sand and Silt** 75% of clasts are fractured, poorly graded, well sorted fine to coarse grained sand, wet	
					26.0 GW **Gravel with Sand** subangular to subrounded gravel, most of the clasts are fractured, clasts up to 2", well graded, trace silt, wet	Discharge water is brown; losing fines, 26-34 feet Trace sand, 27-28 feet
					28.0 GW **Gravel** subangular, most of the clasts are fractured, clasts up to 1 1/2", well graded, trace silt	
30	GB		no flow		30.0 SW **Sand** trace subangular to subrounded gravel, clasts up to 1/2", well sorted fine to coarse grained sand	Coarse grained sand, 30-32 feet
					GW **Sand and Gravel** clasts up to 1 1/2", well graded	Subangular to subrounded gravel; 75% of clasts are fractured, 30-35 feet Trace silt, 31-38 feet Fine to coarse grained sand, 32-33 feet
						Coarse grained sand, 33-36 feet
35	GB		0.125			Angular to subangular gravel; most of the clasts are fractured, 35-38 feet Discharge water is brown; losing fines, 35-48 feet Medium to coarse grained sand, 36-38 feet
					38.0 GW **Sand and Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1", poorly sorted coarse grained sand	
40	GB		0.125		40.0	Little to no recovery; not logged, 40-41 feet
					41.0 GW **Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1", trace poorly sorted sand	
					42.0 SP **Sand with Gravel** most of the clasts are fractured, clasts up to 1", poorly graded	Trace clay, 43-44 feet
					43.0 ML **Silt and Gravel with Clay** 50% of clasts are fractured, clasts up to 1/2", poorly graded	
45			no flow		45.0 GW **Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1", poorly sorted, trace silt	
					46.0 GW **Sand and Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1", poorly sorted coarse grained sand	Clasts up to 1", 47-48 feet
					47.0 SP **Sand** trace gravel, most of the clasts are fractured, poorly graded, well sorted fine to coarse grained sand	Clasts up to 1 1/2", 48-49 feet More water being produced while drilling, 48-50 feet
	GB		1.5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-74S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-74S

DATE STARTED 7/5/08 **COMPLETED** 7/5/08 **GROUND ELEVATION** 1373.03 feet **TOC ELEVATION** 1375.43 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2156469.9 feet **EASTING** 1392203.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						
			2.75		51.0 51.4 Bottom of hole at 51.4 feet.	Clasts up to 2", 49-51 feet Not logged, 51-51.4 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

parameters

WELL DEVELOPMENT LOG

SLR

Well ID: PO8-745
Date: 8/10/20

Project: Pebble
Technician: J. Turner & J. Tsamo

Summary (bgs) (DVC)

	Installed (Well Log)	Start	End
Water level	5.09	10.18	
Total depth	51.4	54.1	
pH			

Screen interval (btoPVC):
bgs Top: 41.4
bgs Bottom: 51.4
PVC stick-up height (above ground surface): 2.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
PH	Surge block on							
7.91	13:22	53.5	10.9	—	10	NA	E3	4.0 fine sand, brown & cloudy, ¼ cup
8.02	13:56	53.5	11.5	4.1	125	NA	184	3.8 fine sand/silt, brown cloudy, ½ tsp
	14:00	51.5	11.1				27	moved 2 ft up, start
7.56	14:30	51.5	11.9	6.6	325	265	279	4.3 fine sand, brown, 1 tsp.
	14:41	49.5	11.8	—	~~545~~			moved 2 ft up, start
8.56	15:31	49.5	12.1	7.1	645	388	222	3.8 fine sand, brown milky, 1 TSP
	15:41	47.5	17.9					
8.25	16:31	47.5	12.5	8.0	1045	373	655	4.1 fine sand, brown, cloudy, 1 ~~tsp~~
Avg 12	9:27	45.5	11.0					Moved 2 ft up, start
8.40	10:26	45.5	12.0	5.6	1445	474	491	4.0 fine sand, brown cloudy, ¼ TBS
	10:44	~~53.5~~ 45.5	11.9					moved 1 ft off bottom debris 54 polish 46 sec/bucket
8.22	11:14	53.5	11.8	6.5	1640	514	99	4.1 fine sand, clear-cloudy, 1 TBS (block off)
	~~53.5~~	~~53.5~~						
	Surge block off 5 ft above screen							
Polish#1	11:22	38.5	11.8				359	Start
9.60	12:22	38.5	—	7.1	2068	427	334	4.4 fine sand/brown cloudy, 1 TBS
Debris	12:37	53.5	11.8		~~2388~~			1 ft off bottom, start
7.31	13:11	53.5		7.1	2398	492	63	3.9 fine sand, Milky, 1 tsp. to clear

NA - can not recording

THE pebble PARTNERSHIP

P-08-75D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Boulder or Cobble**	Boulder removed prior to drilling, 0-1 feet
					2.0 ML **Silt and Organic Soil** dry	Little recovery, 1-4 feet
					3.0 GW **Sand and Gravel** subrounded gravel, fine grained sand, well graded, dry	
					4.0 GW **Sand and Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, fine grained sand, well graded, dry	
5	GB				SP **Gravelly Sand** 25% of clasts are fractured, clasts up to 1", well graded, trace silt	Fine to medium grained sand; cuttings are dry, 4-5 feet
					6.0	Fine to coarse grained sand; cuttings are moist, 5-6 feet
					7.0 SP **Gravelly Sand** 25% of clasts are fractured, clasts up to 1 1/2", fine grained sand, poorly graded, trace silt, moist	
					SP **Gravelly Sand** angular to subangular gravel, poorly graded, trace silt, moist	25% of clasts are fractured; clasts up to 1"; fine grained sand, 7-8 feet
					9.0	50% of clasts are fractured; clasts up to 1 1/2"; fine to medium grained sand, 8-9 feet
10	GB				SP **Gravelly Sand** 25% of clasts are fractured, fine grained sand, well graded, trace silt, moist	Clasts up to 1 1/2", 9-10 feet
					11.0	Clasts up to 1", 10-11 feet
					SW **Gravelly Sand** 50% of clasts are fractured, clasts up to 1", well graded, trace silt, moist	Encountered water, 11 feet
					13.0	Subangular to subrounded gravel; fine to coarse grained sand, 11-12 feet
					14.0 SP **Sand with Gravel** angular to subangular gravel, clasts up to 1/2", coarse grained sand, poorly graded, trace silt, wet	Angular to subangular gravel; medium to coarse grained sand, 12-13 feet
15	GB				SP **Sand with Gravel** angular to subangular gravel, well graded, trace silt	Clasts up to 1/2"; medium to coarse grained sand, 14-15 feet
						75% of clasts are fractured; clasts up to 1", 15-20 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 10 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/13/2008
Purge Volume: 547 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/7/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/12/08 at 535 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75D
PAGE 2 OF 7

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	75% of clasts are fractured; clasts up to 1 1/2", 20-21 feet
					SP **Sand with Gravel** 75% of clasts are fractured, clasts up to 1/2", well graded medium to coarse grained sand, trace silt, moist	
					22.0	Discharge water is brown, 22-48 feet
					SP **Gravelly Sand** angular to subangular gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, well graded, wet	
					23.0	
					24.0	
25	GB				GW **Sand and Gravel** angular to subangular gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, well graded, wet	
					25.0	Coarse grained sand; poorly graded, 25-27 feet
					SP **Gravelly Sand** angular to subangular gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, well graded, wet	Trace silt, 26-31 feet
					SP **Gravelly Sand** brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", wet	Medium to coarse grained sand; well graded, 27-31 feet
30	GB					
					31.0	
					SP **Sand with Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", medium to coarse grained sand, well graded, trace silt	
35	GB		1.75		35.0	
					SP **Sand with Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, poorly graded	
					37.0	
					SP **Gravelly Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, poorly graded	
40	GB		0.875		40.0	
					SP **Sand with Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, poorly graded	
					42.0	
					SP **Gravelly Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, poorly graded	
45	GB		1.25		45.0	
					SP **Sand with Gravel** subangular gravel, 75% of clasts are fractured, clasts up to 3/4", coarse grained sand, poorly graded, trace silt	Discharge water is reddish brown, 48-58 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			1.25		SP **Sand with Gravel** subangular gravel, 75% of clasts are fractured, clasts up to 3/4", coarse grained sand, poorly graded, trace silt	
55	GB		1.25			
					56.0	Coarse grained sand, 56-57 feet
					SP **Sand with Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, trace silt	Medium to coarse grained sand, 57-58 feet
					58.0	
					SP **Sand** 75% of clasts are fractured, fine to medium grained sand, poorly graded, trace clay	Poorly graded fine to medium grained sand; trace clay; discharge water is brown, 58-59 feet
					59.0	
60	GB		0.75		SP **Sand with Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, well graded, trace silt	Discharge water is reddish brown, 59-63 feet Well graded coarse grained sand, 59-65 feet
						Discharge water is brown, 63-80 feet
65	GB				65.0	
					SP **Sand with Gravel** subangular gravel, 75% of clasts are fractured, coarse grained sand, well graded	Clasts up to 1", 65-67 feet
						Clasts up to 1 1/2", 67-68 feet
						Clasts up to 1", 68-69 feet
70	GB		0.75			Clasts up to 1 1/2", 69-73 feet
						Clasts up to 1", 73-75 feet
75	GB		0.75		75.0	
					SP **Sand with Gravel** angular to subangular gravel, 75% of clasts are fractured, coarse grained sand, well graded	Clasts up to 1", 75-78 feet
						Clasts up to 3/4", 78-80 feet
	GB				80.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			0.5		SW **Gravelly Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", well graded	Discharge water is dark brown, 80-89 feet
					82.0 GW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", medium to coarse grained sand, well graded	
					84.0 SW **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4"	Well graded, 84-85 feet
85	GB		0.75			Well sorted, 85-87 feet
					87.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, well graded	Adding foam while drilling, 87-88 feet Clasts up to 3/4", 87-90 feet
90	GB		1.25			Discharge water is brown, 89-90 feet Clasts up to 1/2", 90-91 feet
					91.0 GW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", well graded	Discharge water is golden brown, 90-95 feet 50% of clasts are fractured; clasts up to 3/4", 91-95 feet
95	GB		2		95.0 SP **Gravelly Sand** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	Discharge water is brown, 95-127 feet
					96.0 GW **Sand and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, coarse grained sand	Clasts up to 1", 96-98 feet Clasts up to 3/4", 98-99 feet
100	GB		1.25			Clasts up to 1", 99-102 feet
					102.0 SP **Gravelly Sand** brown, subangular to subrounded gravel, 75% of clasts are fractured, coarse grained sand, well graded	Clasts up to 1 1/2", 102-103 feet Clasts up to 1", 103-105 feet
105	GB		0.5		105.0 SP **Gravelly Sand** brown, subangular to subrounded gravel, clasts up to 1", medium to coarse grained sand, well graded	
	GB		120			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			12.8		110.0	
					GP **Sand and Gravel** brown, angular to subangular gravel, clasts up to 1 1/2", medium to coarse grained sand, well graded	
					111.0	
					SP **Gravelly Sand** brown, angular to subangular gravel, clasts up to 1", medium to coarse grained sand, well graded	
					112.0	
					GP **Sand and Gravel** brown, angular to subangular gravel, clasts up to 1 1/2", medium to coarse grained sand, well graded	
					113.0	
115	GB		3.25		GP **Gravelly Sand** brown, angular to subangular gravel, clasts up to 1", medium to coarse grained sand, well graded	
					119.0	
120	GB		240		SW **Gravelly Sand** subangular gravel, medium to coarse grained sand, well graded	Clasts up to 1", 119-122 feet Clasts up to 1/2", 122-123 feet Clasts up to 1", 123-125 feet
125	GB		120		125.0	
					SW **Gravelly Sand** subangular gravel, 75% of clasts are fractured, clasts up to 1", medium to coarse grained sand, well graded	
					127.0	No recovery, 127-129 feet Advanced via mud rotary, 127.5-175 feet
					129.0	
130					GP **Gravel** multicolored, fine gravel, most of the clasts are fractured, some coarse grained sand	Logged via cuttings, 129-138 feet
135					138.0	
	SS				GP **Gravel with Sand** multicolored, subangular to rounded gravel, 70% of clasts are fractured, coarse grained sand	Conduct SPT; blow counts: 36-59-50+; sample washed, 138-140 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					140.0 SP **Gravel and Sand** multicolored, fine gravel, most of the clasts are fractured, coarse grained sand	Slow drilling, 140-141 feet
					143.0 SM **Silty Sand** brown, trace gravel, fine grained sand	Conduct SPT; blow counts: 36-50+, 143-145 feet
145	SS				145.0	No recovery, 145-150 feet
						Conduct SPT; blow counts: 50+, 148-150 feet
150					150.0 GP **Gravel and Sand** multicolored, fine gravel, 75% of clasts are fractured, coarse grained sand	Boulder or cobble; logged via cuttings, 150-153 feet
					153.0	Slow drilling, 152-153 feet No recovery; SPT blow counts: 50+, 153-155 feet
155					155.0 ML **Silt and Sand with Gravel** black, fine gravel, most of the clasts are fractured, coarse grained sand, brown silt	Silt balls; logged via cuttings, 155-158 feet
					156.0 ML **Silt and Sand** black, most of the clasts are fractured	Brown silt, 156-157 feet Gray silt, 157-158 feet
160	SS				158.0 ML **Gravelly Silt with Sand** gray, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, wet	Conduct SPT; blow counts: 25-50+, 158-160 feet 90% of clasts are fractured, 159-160 feet Clasts up to 1/4", 159-161 feet Clasts up to 3/4", 160-161 feet Logged via cuttings, 160-168 feet
					160.0 ML **Gravelly Silt with Sand** gray, angular to subangular gravel, most of the clasts are fractured, fine to coarse grained sand, wet	No SPT; grinding on boulder or cobble, 163-165 feet
165					165.0 **Bedrock** black and golden brown, fractured	Slow drilling, 165-167 feet Clasts up to 1/4", 165-168 feet
	SS					Clasts up to 1/2", 168-169 feet Conduct SPT; blow counts: 28-50+, 168-170 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75D
PAGE 7 OF 7

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75D

DATE STARTED 7/9/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1126.15 feet **TOC ELEVATION** 1128.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170961.19 feet **EASTING** 1403240.49 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170					**Bedrock** black and golden brown, fractured	Clasts up to 1/4", 169-175 feet Slow drilling; logged via cuttings, 170-175 feet
175					175.0 Bottom of hole at 175.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: D-08-75D
Date: Aug. 13/08

Project: well development
Technician: Jim Hunter, John Kay

Summary

	Installed (Well Log)	Start	End
Water level		19.52	21.65
Total depth		177.26	177.75
pH		8.57	8.57

From top of stick up

Screen interval (btoPVC): 10'
Top: 163.7'
Bottom: 173.7'
PVC stick-up height (above ground surface): 2.65'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
9:10	176.2	19.52	2.7		120	350	4.63	PH 8.57 ½ cups, brown, f.g. sand
9:40	"		2.7		112	236	3.64	3 TBLS
10:10	"	21.1	2.7	162	112	111	3.62	2 TSP
10:20	174.2		3.16		111	35.2	4.16	2 TSP
10:50	"	21.4	3.03	95	121	47.1	4.01	Trace
10:55	172.2	21.4	3.03		101	72.1	4.09	8.53 "
11:25		21.5	3.33	100	82.0	49.7	4.1	8.40 "
11:30	170.2		3.03		108	77.0	4.41	8.36 "
12:00		21.5	3.0	90	108	42.8	3.65	8.23 "
12:05	168.2		3.33		111	54.2	3.67	8.15 "
12:35		21.5	3.33	100	114	20.4	3.77	8.45 "
Surge block removed								
Foot valve lower to bottom								
- removed 5 gallon								¼ cup brown f.g. sand.
Pulled 5' from top of screen								
- removed 5 gallons								trace
Back to bottom removed 5 gallons.								1/3 cup
DTB								DTB 177.75
				547 (total)				
								10th bucket of first
								bucket, cloudy
								Did not take photo of
								last bucket, clear.
Surge block off								

5 gallon

THE pebble PARTNERSHIP

P-08-75M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75M

DATE STARTED 7/6/08 **COMPLETED** 7/8/08 **GROUND ELEVATION** 1125.8 feet **TOC ELEVATION** 1128.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170926.82 feet **EASTING** 1403193.91 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					ML **Silt and Organic Soil** black, dry	Little recovery, 0-3 feet
					3.0	
					ML **Silt and Grave** brown, subrounded gravel, clasts up to 1/2", well graded, dry	
					4.0	
5	GB				SP **Gravelly Sand** brown, clasts up to 1/2", well graded, fine grained sand, trace silt, moist	25% of clasts are fractured, 5-6 feet
					6.0	
					ML **Silt and Gravel** subrounded gravel, 40% of clasts are fractured, clasts up to 1/2", trace well graded sand, moist	
					7.0	
					8.0	
					SP **Gravelly Sand** brown, clasts up to 1/2", well graded fine grained sand, trace silt, moist	
10	GB				GW **Sand and Gravel** subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1", well graded, trace silt, moist	Little recovery, 9-10 feet
					10.0	
					GW **Gravel with Sand** brown, 30% of clasts are fractured, clasts up to 1", well graded, trace silt, moist	
					11.0	
					12.0	
					GW **Sandy Gravel** brown, 40% of clasts are fractured, clasts up to 1/2", well graded, trace silt, moist	
					13.0	
					SP **Sand with Gravel** 20% of clasts are fractured, clasts up to 1/2", poorly graded, moist	
					14.0	
15	GB				SP **Sand** trace gravel, fine to coarse grained sand	
					SW **Gravelly Sand** 50% of clasts are fractured, clasts up to 1/2", well graded, trace silt	
					16.0	
					SP **Sand with Gravel** brown, 50% of clasts are fractured, clasts up to 1/2", poorly graded, fine grained sand, moist	
		▼			17.0	Medium to coarse grained sand, 17-18 feet
					GW **Sand and Gravel** 75% of clasts are fractured, clasts up to 1", well graded, wet	Coarse grained sand, 18-19 feet
					19.0	
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 30 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/14/2008
Purge Volume: 630 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/7/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 7/10/08 at 440 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75M
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75M

DATE STARTED 7/6/08 **COMPLETED** 7/8/08 **GROUND ELEVATION** 1125.8 feet **TOC ELEVATION** 1128.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170926.82 feet **EASTING** 1403193.91 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
					21.0 GM **Sand and Gravel with Silt** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", well graded coarse grained sand	
					22.0 SP **Sand with Gravel** 75% of clasts are fractured, clasts up to 1/2", poorly graded, medium to coarse grained sand, trace silt	Discharge water is brown, 22-23 feet
					23.0 GW **Sand and Gravel** 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand	
25	GB				GW **Gravel with Sand** most of the clasts are fractured, clasts up to 1", well graded, coarse grained sand	Discharge water is brown; losing fines, 25-35 feet
					26.0 GM **Sand and Gravel with Silt** 75% of clasts are fractured, clasts up to 1 1/2", well graded, coarse grained sand	
					29.0 SW **Sand with Gravel** angular to subangular gravel, most of the clasts are fractured, well graded, medium to coarse grained sand	Clasts up to 1/2", 29-30 feet
30	GB		0.125			Clasts up to 1 1/2", 30-31 feet
					31.0 SW **Gravelly Sand** subangular gravel, most of the clasts are fractured, clasts up to 1", well graded, fine to coarse grained sand	
					32.0 SP **Sand with Gravel** most of the clasts are fractured, poorly graded, coarse grained sand	Clasts up to 1/2", 32-33 feet
					34.0 SP **Gravelly Sand** most of the clasts are fractured, clasts up to 1", poorly graded, coarse grained sand	Clasts up to 1", 33-34 feet
35	GB		40			Cuttings are black, 35-36 feet
					35.0 SP **Sand** trace angular gravel, most of the clasts are fractured, clasts up to 1/2", poorly graded, coarse grained sand	Discharge water is brown, 35-87.5 feet
					37.0 GW **Sandy Gravel** angular to subangular gravel, 75% of clasts are fractured, well graded, coarse grained sand	Cuttings are brown, 36-37 feet
						Cuttings are brown to black, 37-39 feet
40	GB		7			Clasts up to 2", 37-40 feet
					41.0 GW **Sand and Gravel** brown, subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand	Cuttings are brown, 39-41 feet
					43.0 GW **Sandy Gravel** black and brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 2", well graded, coarse grained sand	Clasts up to 1", 40-41 feet
45	GB		18		45.0 GM **Gravelly Sand with Silt** brown, angular to subangular gravel, 75% of clasts are fractured, well graded, coarse grained sand	Clasts up to 1/4", 45-47 feet
						Clasts up to 1", 47-49 feet
	GB				49.0 50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75M

DATE STARTED 7/6/08 **COMPLETED** 7/8/08 **GROUND ELEVATION** 1125.8 feet **TOC ELEVATION** 1128.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170926.82 feet **EASTING** 1403193.91 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			0.5		GW **Sand and Gravel with Silt** brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand	Clasts up to 1", 50-55 feet
					GM **Gravelly Sand with Silt** brown, angular to subangular gravel, 75% of clasts are fractured, well graded, coarse grained sand	
55	GB		0.5			Clasts up to 1/2", 55-56 feet
					56.0 SP **Gravelly Sand** brown, angular to subangular gravel, well graded, coarse grained sand, trace silt	Clasts up to 1", 56-57 feet 75% of clasts are fractured, 56-63 feet Clasts up to 1/2", 57-58 feet
						Clasts up to 1", 58-63 feet
60	GB		1			
					63.0 GP **Sandy Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1 1/2", poorly graded, coarse grained sand	Most of the clasts are fractured, 62-63 feet
65	GB		0.75			
					67.0 SP **Gravelly Sand** brown, angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand, trace silt	
					69.0 SP **Gravelly Sand** brown, subangular gravel, 75% of clasts are fractured, well graded, coarse grained sand	
70	GB		2.75			Clasts up to 1", 71-72 feet
						Clasts up to 1 1/2", 72-73 feet
						Clasts up to 1", 73-74 feet
75	GB		0.25			Clasts up to 1/2", 74-75 feet
						Clasts up to 1", 75-76 feet
					76.0 SP **Gravelly Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand, trace silt	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75M

DATE STARTED 7/6/08 **COMPLETED** 7/8/08 **GROUND ELEVATION** 1125.8 feet **TOC ELEVATION** 1128.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170926.82 feet **EASTING** 1403193.91 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			9.75		SP **Gravelly Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand, trace silt	
85	GB		7		85.0 SP **Gravelly Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand, trace soft clay	
			42		86.0 SP-SC **Sand with Clay** gravel, 75% of clasts are fractured, poorly graded, medium to coarse grained sand, soft to medium stiff clay	
					87.0 ML **Gravelly Silt with Clay** brown, 25% of clasts are fractured, clasts up to 3/4"	Discharge water is clear; increased flow rate, 87.5-88 feet
90	GB		3		88.0 GW **Gravel with Sand** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, trace silt	Discharge water is brown, 88-91.5 feet Adding water while drilling; clasts up to 3/4", 89-90 feet 75% of clasts are fractured, 89-91 feet Discharge water is dark brown, 91.5-92 feet Clasts up to 1", 90-95 feet 25% of clasts are fractured, 91-95 feet
					89.0 GW **Sand and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, medium to coarse grained sand	
95					95.0 GW **Sand and Gravel** subangular to subrounded gravel, medium to coarse grained sand, wet	25% of clasts are fractured, 95-97 feet Clasts up to 1", 95-101 feet Discharge water is brown, 95-137 feet
			3			50% of clasts are fractured, 97-98 feet
						75% of clasts are fractured, 98-105 feet
100	GB					Clasts up to 3/4", 101-105 feet
			0.25		105.0 GW **Sand and Gravel** subangular to subrounded gravel, medium to coarse grained sand	Clasts up to 1/2", 105-106 feet 50% of clasts are fractured, 105-113 feet Clasts up to 1", 106-107 feet
105			6.5			Clasts up to 3/4", 107-110 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75M

DATE STARTED 7/6/08 **COMPLETED** 7/8/08 **GROUND ELEVATION** 1125.8 feet **TOC ELEVATION** 1128.6 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170926.82 feet **EASTING** 1403193.91 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** A. Mosher, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110			1		GW **Sand and Gravel** subangular to subrounded gravel, medium to coarse grained sand	Clasts up to 1/2", 110-112 feet
			3			Clasts up to 3/4", 112-115 feet
						25% of clasts are fractured, 113-115 feet
115	GB				115.0	
					GW **Sand and Gravel** subangular to subrounded gravel, clasts up to 3/4", medium to coarse grained sand	50% of clasts are fractured, 115-116 feet
			4			25% of clasts are fractured, 116-119 feet
120	GB					50% of clasts are fractured, 119-122 feet
			2.5		122.0	
					GP **Sand and Gravel** brown, angular to subangular gravel, 50% of clasts are fractured, medium to coarse grained sand	Clasts up to 1/2", 122-123 feet
						Clasts up to 1", 123-125 feet
125	GB		112.5		125.0	
					SP **Gravelly Sand** medium to coarse grained sand	Clasts up to 1/2", 125-128 feet
						Angular to subangular gravel, 125-132 feet
						50% of clasts are fractured, 125-133 feet
						Clasts up to 1 1/2", 128-129 feet
130	GB		40			Clasts up to 1", 129-135 feet
						Subangular to subrounded clasts, 132-135 feet
						75% of clasts are fractured, 133-135 feet
135	GB		0.75		135.0	
					SP **Gravelly Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded, coarse grained sand	
					137.0	Refusal; boring caved in to 134.5 feet
					Bottom of hole at 137.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-75M
Date: Aug. 8/10 '18

Project: well development
Technician: J. Hunter, J. Kay, Karl Benson

Summary

	Installed (Well Log)	Start	End
Water level		19.36	19.52
Total depth	129.9	[illegible]	133.5
pH		8.38	

132.4 includes stick up

Screen interval (btoPVC): 10'
Top: 110.3'
Bottom: 129.4'
PVC stick-up height (above ground surface): 2.45

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
1:30	131.4	19.36	4.0		152	581	4.17	pH 8.38 light ¼ cup, brown f.g. sand
2:00			4.0		118	439	3.73	7.96 trace
2:30		19.4	4.0	240	122	125	4.11	8.02 no sed.
2:40	129.4		4.0		111	256	5.17	7.88 3 TBSP
3:10		19.4	4.0	120	112	82	3.84	7.76 trace
3:21	127.4		4.0		107	210	4.11	8.14 2 TBSP
3:50		19.4	4.0	120	120	126	3.91	8.14 trace
3:55	125.4		4.0		106	223	4.92	7.76 1 TBSP
4:25		19.4	4.0	120	111	108	3.79	7.6 trace
Aug 14 8:00am	123.4	19.5	4.0		109	178	5.01	7.29 1 TBSP
8:30		19.5	4.0		106	122	3.27	7.4 Trace
8:35	121.4		4.0		108	259	4.14	7.3 1½ TBSP
09:05		19.5	4.0		110	84	3.41	pH=7.41 Trace
0910	119.4		4.0		107	206	4.2	7.3 2 TBSP
0940	"	19.4	4.0		112	[illegible]	3.5	7.5 trace
0945	117.4	"	4.0		111	167	4.5	7.3 2 TBSP
10:15		19.52	4.0		112	69.2	3.47	7.38 trace
10:20	115.4	"	4.0		109	99	4.65	7.33 Teaspoon
10:50		19.50	4.0		110	45.3	3.59	7.31 trace
10:55	113.4		4.0		114	50.8	4.13	7.37 trace
11:25		19.52	4.0		109	168	3.61	7.35 none, clear
Surge block off								
	131.4			10				⅓ cup
	107.4			10				trace - polish
	131.4			10				trace

Took photo of first bucket of water, did not take photo of last bucket as it was clear.

THE pebble PARTNERSHIP

P-08-75S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75S

DATE STARTED 7/12/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1125.88 feet **TOC ELEVATION** 1128.98 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170945.9 feet **EASTING** 1403218.08 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-4 feet
					4.0	
5					GM **Silty Gravel** dark brown, wet	
					5.0	
					GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	
					7.0	
					8.0	No recovery, 7-8 feet
					GM **Silty Sand with Gravel** brown, clasts up to 1/2", coarse grained sand, wet	
					9.0	
10					SM **Gravelly Sand with Silt** brown, subangular gravel, 50% of clasts are fractured, clasts up to 1/2", wet	
					11.0	
					SM **Gravelly Sand with Silt** brown, subangular gravel, clasts up to 3/4", wet	
					12.0	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, wet	
					13.0	
					GM **Gravel with Sand and Silt** brown, wet	
					14.0	
15					ML **Gravel and Silt** brown, wet	
		▼			15.0	
					ML **Silt and Gravel** brown, <25% of clasts are fractured, coarse grained sand	Clasts up to 1/2"; cuttings are wet, 15-16 feet
					17.0	Clasts up to 1"; cuttings are moist, 16-17 feet
					ML **Silt and Gravel** brown, 50% of clasts are fractured, coarse grained sand, moist	
					18.0	Clasts up to 1", 18-20 feet
					GW **Gravel with Sand** silt coated gravel, 75% of clasts are fractured, coarse grained sand, brown silt, wet	
20						Discharge water is brown, 19-42.5 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 230# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/14/2008
Purge Volume: 375 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/7/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/13/08 at 631 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-75S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-75S

DATE STARTED 7/12/08 **COMPLETED** 7/12/08 **GROUND ELEVATION** 1125.88 feet **TOC ELEVATION** 1128.98 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170945.9 feet **EASTING** 1403218.08 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			no flow		GW **Gravel with Sand** silt coated gravel, 75% of clasts are fractured, coarse grained sand, brown silt, wet	Clasts up to 3/4", 20-22 feet Clasts up to 1", 22-24 feet
					24.0	
25			0.5		25.0 GW **Sand and Gravel** brown, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	Clasts up to 3/4", 25-26 feet Losing fines, 25-35 feet Clasts up to 1", 26-28 feet
			0.25		GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand 28.0 SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
30			0.5		30.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand	Clasts up to 1", 30-31 feet Clasts up to 3/4", 31-33 feet
			1.5		33.0 SP **Gravelly Sand** brown, subangular to subrounded gravel, clasts up to 3/4", medium to coarse grained sand	50% of clasts are fractured; cuttings are wet, 33-35 feet
35			1.25			25% of clasts are fractured, 35-37 feet
			0.25		37.0 GP **Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
			0.25			
40			0.5		40.0	No recovery, 40-41 feet
					41.0 GP **Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
			0.25		42.0 42.5 Bottom of hole at 42.5 feet.	Not logged, 42-42.5 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-755
Date: Aug. 14/08

Project: Well Development
Technician: J. Hunter, Carl Benson

Summary

	Installed (Well Log)	Start	End
Water level		17.61	17.6
Total depth		45'	44.9'
pH		7.65	7.59

Screen interval (btoPVC): 40'
Top: 36.1
Bottom: 41.1
PVC stick-up height (above ground surface): 2.9'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								light Brown
12:40	44'	17.6	2.0		36	520	5.26	pH 7.65 2 Tbsp Fine sand
1:10		[illegible]	1.95	100	36	28.3	5.70	7.51 trace
1:20	42'	17.6	2.0		37	20.1	5.97	7.48 trace
1:45		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	40'		2.0		36	339	6.82	7.35 1 TSPN
2:30		17.6	2.0	140	37	19.2	6.15	7.41 Trace clear
2:55	38'	17.6	2.0		36	6.93	5.51	6.31 Trace clear
3:05		17.6	2.0	60	23		5.74	7.39 Trace clear
3:10	36'		2.0		35	63.1	8.84	6.99 Trace clear
3:40	41'	17.6	2.0	60	39	16.6	6.03	7.58 Trace clear
Took start and end photos of water.								
Surge block off								
	44'	sed. removal			5 gal		trace	clear
	31'	polish			5 gal		trace	"
	44'	sed. removal			5 gal		trace	"
	[illegible]							

do a start reading at 1:50

2 min 40 sec = 5 gal.

812 of 996

THE pebble PARTNERSHIP

P-08-76D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76D

DATE STARTED 7/18/08 **COMPLETED** 7/19/08 **GROUND ELEVATION** 953.42 feet **TOC ELEVATION** 956.22 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170553.56 feet **EASTING** 1367182.14 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** moist	
					2.0 **Topsoil with Gravel** coarse gravel	
					4.0	
5	GB				**Topsoil with Gravel** coarse gravel, 75% of clasts are fractured, dry 5.0	Cuttings are dry, 5-12 feet
					SP **Sand with Gravel** gray to black, subangular gravel, 75% of clasts are fractured, coarse grained sand	
10	GB	▼				Little recovery, 9-12 feet
						Discharge water is brown, 12-13 feet Cuttings are wet, 12-14 feet Encountered water, 13 feet
					14.0	
15	GB				GP **Gravel with Sand** multicolored, coarse grained sand, wet 15.0	Discharge water is brown, 15-25 feet
					GP **Gravel with Sand** subangular gravel, trace silt, wet	
					17.0	
					GP **Gravel** fine subangular gravel, trace silt, wet	
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 50# grout

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/4/2008
Purge Volume: 388 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/8/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/20/08 at 847 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-76D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76D

DATE STARTED 7/18/08 **COMPLETED** 7/19/08 **GROUND ELEVATION** 953.42 feet **TOC ELEVATION** 956.22 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170553.56 feet **EASTING** 1367182.14 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			10		GP **Gravel** fine subangular gravel, trace silt, wet	
25	GB					
	GB					
					28.0	
					SP **Sand with Gravel** angular to subrounded gravel, wet	
30	GB		30		30.0	
					GP **Gravel and Sand** subrounded gravel, trace silt	
			30		33.0	
					SP **Sand with Gravel** multicolored, rounded gravel	Discharge water is brown, 32-33 feet
35	GB					
					38.0	
					SW **Sand with Gravel** multicolored, angular to subangular gravel, 30% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	Discharge water is brown and silty, 38-58 feet
40	GB				41.0	
					GW **Sand and Gravel** multicolored, angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
45	GB					
			4			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-76D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76D

DATE STARTED 7/18/08 **COMPLETED** 7/19/08 **GROUND ELEVATION** 953.42 feet **TOC ELEVATION** 956.22 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170553.56 feet **EASTING** 1367182.14 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GW **Sand and Gravel** multicolored, angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
			16			
55	GB					
			35			Discharge water is clearer, 58-63 feet Adding water while drilling, 58-75 feet
60	GB					
			6			Discharge water is brown, 63-73 feet
65	GB					
			1			
70					70.0	
	GB		6		GW **Sand and Gravel** multicolored, angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
					73.0	
75	GB		4		GW **Sand and Gravel** multicolored, angular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", wet	Fine to medium grained sand, 73-74 feet Discharge water is brown and silty, 73-75 feet Fine to coarse grained sand, 74-91 feet Discharge water is reddish brown and silty, 75-85 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-76D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76D

DATE STARTED 7/18/08 **COMPLETED** 7/19/08 **GROUND ELEVATION** 953.42 feet **TOC ELEVATION** 956.22 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170553.56 feet **EASTING** 1367182.14 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			4		GW **Sand and Gravel** multicolored, angular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", wet	
85	GB		5			Discharge water is brownish red and silty, 85-92 feet
						Adding water while drilling, 88-110 feet
90	GB					Fine to medium grained sand, 91-95 feet
						Discharge water is reddish brown, 92-94 feet
95	GB				95.0	Discharge water is light brown, 94-95 feet
					SW **Gravelly Sand** multicolored, most of the clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	Discharge water is brownish-gray, 95-101 feet
100	GB					
					102.0	Discharge water is gray, 101-108 feet
					GW **Sand and Gravel** gray to white, angular to subrounded gravel, most of the clasts are fractured, clasts up to 1 1/4", fine to coarse grained sand, wet	
105	GB					
					108.0	
			0.25		SM **Silty Sand with Gravel** multicolored, 60 to 75% of clasts are fractured, poorly sorted coarse grained sand	Slow drilling, 108-110 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-76D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76D

DATE STARTED 7/18/08 **COMPLETED** 7/19/08 **GROUND ELEVATION** 953.42 feet **TOC ELEVATION** 956.22 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170553.56 feet **EASTING** 1367182.14 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110	GB				SM **Silty Sand with Gravel** multicolored, 60 to 75% of clasts are fractured, poorly sorted coarse grained sand	Discharge water is gray, 110-115 feet
			0.25			Adding water while drilling, 114-138 feet
115	GB				116.0	
					SM **Silty Sand with Gravel** multicolored, 75 to 80% of clasts are fractured, poorly sorted coarse grained sand	
					117.0	
					GW **Sand and Gravel** black, angular gravel, 50% of clasts are fractured, poorly sorted sand	
			0.75			
120	GB					
						Discharge water is brown, 123-131 feet
					124.0	
125					SP **Sand with Gravel** white, angular gravel, 75% of clasts are fractured, clasts up to 1"	Poorly sorted, 125-126 feet
	GB				126.0	
			0.75		SP **Sand with Gravel** multicolored, angular gravel, 75% of clasts are fractured, poorly sorted coarse grained sand	
130	GB					Slow drilling, 131-132 feet
						Clasts up to 1", 132-137 feet
			1.75			
			3.5			
135	GB					Adding water and foam while drilling, 135-137 feet
					137.0	
			20		GM **Gravel** multicolored, coarse angular gravel, 75% of clasts are fractured, poorly sorted coarse grained sand	
					138.0	Boring terminated due to slow advancement, 138 feet
					Bottom of hole at 138.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-76D
Date: 4 Sept 2008

Project: Pebble
Technician: D. Pardue / M Swain

Summary

	Installed (Well Log)	Start	End
Water level		12.73	
Total depth		142.1	
pH			

Screen interval (btoPVC): 10 ft
Top: 128.00
Bottom: 138.00
PVC stick-up height (above ground surface): 2.8

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
8.41 3.37pm	137.00	12.73	5gpm	5	721	Error 71000	4.2	Sand + silt, brown opaque, 2 cups of sand
9.76 4.07pm	135.00	15.60	5	305	923	71000	4.6	Sand + silt, brown, 1 cup of sand
8.38 4.40pm	133.00	13.99	2.5	3875	486	71000	5.6	Sand + silt brown, 1 cup of sand
Surge block off								

THE pebble PARTNERSHIP

P-08-76S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76S

DATE STARTED 7/20/08 **COMPLETED** 7/20/08 **GROUND ELEVATION** 953.6 feet **TOC ELEVATION** 956.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170544.33 feet **EASTING** 1367156.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-3 feet
					3.0 GW **Gravel with Sand** black, angular gravel, 50% of clasts are fractured, clasts up to 3/4", coarse grained sand	Cuttings are dry, 3-9 feet
5						
10		▼				Cuttings are moist, 9-10 feet Little recovery, 9-12 feet Cuttings are dry, 10-13 feet
						Cuttings are moist, 13-14 feet
						Encountered water, 14 feet Cuttings are wet, 14-15 feet
15					16.0 GW **Gravel with Sand** multicolored, subangular gravel, 50% of clasts are fractured, poorly sorted coarse grained sand, wet	
			5			
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 100# grout

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/5/2008
Purge Volume: 860 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/8/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/20/08 at 230 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-76S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-76S

DATE STARTED 7/20/08 **COMPLETED** 7/20/08 **GROUND ELEVATION** 953.6 feet **TOC ELEVATION** 956.3 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2170544.33 feet **EASTING** 1367156.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GW **Gravel with Sand** multicolored, subangular gravel, 50% of clasts are fractured, poorly sorted coarse grained sand, wet	
			30			
25						
			42			
30						Discharge water is brown, 30-38 feet
			42			
35						
			15		38.0	
					Bottom of hole at 38.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: BH08-76-S
Date: 5 sept 08

Project: Pebble
Technician: D. Pardoe M Swain

Summary

	Installed (Well Log)	Start	End
Water level		13.22	13.19
Total depth		38.8	38.9
pH		8.83	8.05

Screen interval (btoPVC): 10ft
Top: 25
Bottom: 35
PVC stick-up height (above ground surface): 2.7

Development Observations

	Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
	Surge block on								
8.83	10.21	34.0	13.22	5gpm	5	197.8	115	3.83	Silty, fine Sand, yellowish brown, half a cup
7.92	10.53	32.0	13.17	5gpm	165	177.2	16	2.9	silty, fine Sand, clear
8.42	11.24	30.0	13.21	5gpm	320	424	26	3.8	silty, fine Sand, clear
8.23	12.00	28.0	13.19	5	500	332	11	4.0	silty fine, clear, 1½ teaspoons
7.90	12.32	26.00	13.18	5	660	284	14	3.9	~~Silt~~ Fine sand, clear 1 teaspoon
	Surge block off								
8.23	12.52	34.0	13.19	5gpm	760	311	8	4.1	fine Sand, clear ≤ 1 teaspoon.
8.05	1.12	20ft	13.19	5gpm	860	171	4	4.4	fin sand, clear ½ teaspoon

THE pebble PARTNERSHIP

P-08-77D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE P-08-77D
DATE STARTED 7/20/08 **COMPLETED** 7/21/08
GROUND ELEVATION 973.65 feet **TOC ELEVATION** 976.45 feet
DRILLING CONTRACTOR Foundex **NORTHING** 2173791 feet **EASTING** 1368318.69 feet
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** dry	
					3.0	
5	GB		no flow		GP **Sandy Gravel** subangular gravel, 50% of clasts are fractured, dry	
10	GB	▼				
15	GB					Discharge water is brown and silty, 15-49 feet
					17.0	
20	GB				SW **Sand with Gravel** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 5 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/14/2008
Purge Volume: 2351 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/3/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/22/08 at 615 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-77D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-77D

DATE STARTED 7/20/08 **COMPLETED** 7/21/08 **GROUND ELEVATION** 973.65 feet **TOC ELEVATION** 976.45 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2173791 feet **EASTING** 1368318.69 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SW **Sand with Gravel** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
			1			Adding water while drilling, 23-78 feet
25	GB					
			1			
30	GB					
			<1			
35	GB					
			3.5			
40	GB					
			9			
45	GB					
					47.0	
			2		SW **Gravelly Sand** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
	GB					Discharge water is very dark brown and silty, 49-55 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-77D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-77D

DATE STARTED 7/20/08 **COMPLETED** 7/21/08 **GROUND ELEVATION** 973.65 feet **TOC ELEVATION** 976.45 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2173791 feet **EASTING** 1368318.69 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SW **Gravelly Sand** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
			1			
55						Discharge water is brown and silty, 55-59 feet
			3			
60	GB					Discharge water is dark brown, 59-65 feet
			1			
65			<1			Discharge water is light brown, 65-78 feet
			<1			
70	GB					
75	GB		60		75.0 GM **Silty Sand and Gravel** subangular to subrounded gravel, most of the clasts are fractured, clasts up to 1/2", fine to coarse grained sand, light brown silt, wet	
			80		78.0 SW **Gravelly Sand** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-77D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-77D

DATE STARTED 7/20/08 **COMPLETED** 7/21/08 **GROUND ELEVATION** 973.65 feet **TOC ELEVATION** 976.45 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2173791 feet **EASTING** 1368318.69 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80	GB		75		SW **Gravelly Sand** multicolored, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
85	GB		75			
89.0					**Bedrock (Tertiary Rhyolite)** creamy white to gray rhyolite, lacks flow banding, pyrolucite and iron oxide staining	
90	GB		75			Discharge water is white, 91-93 feet
93.0					Bottom of hole at 93.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-77D
Date: 14 Aug 08

Project:
Technician: IB, JT.

12.91 12.26 91.60

Summary

	Installed (Well Log)	Start	End
Water level	8.63 (bgs)	12.26	
Total depth	89.0 (bgs)	91.60	
pH		7.59	

soft bottom

Screen interval (btoPVC): 4.0 ft.
Top: 79.0 bgs
Bottom: 89.0 bgs

PVC stick-up height (above ground surface): 2.8 ft.

Development Observations

pH

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond E (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
7.59 8:53	90.6	12.26	5	~~300~~	328	E3	4.3	fine sand, yellow brown, cloudy 1 tbs
~~9:55~~	~~90~~.6	12.20	5	300	134.1	755	4.6	translucent yel-brn water ½ tsp fine sand / 5gal
9:58	88.6		5	305				
10:15	88.6		~~6.7~~					cloudy yellow brown water 1 tsp fine sand/5gal * increased flowrate
10:5x	88.6	12.20	6.7	700		961		
7.45 11:00	86.6	12.20	6.7	—	160.6	—	3.8	1 tsp fine sand in cloudy yel-brn water
7.42 12:01	86.6	12.20	6.7	1100	112.9	504	4.1	fine sand, cloudy yellow/brown, ½ tsp fine sand per 5gal
12:05	84.6	12.20						
7.34 13:00	84.1	12.20	6.7	1775	90.5	219	4.0	semi-cloudy light yel-brn water ~½ tsp fine sand per 5 gal
13:04	82.6	12.20						
7.33 14:05	82.6	12.20	6.7	2177	81.3	76	4.7	trace sand, clear, <½ tsp
Blanket off 14:14	90.6	12.2						Start
Rebuild 8.79 14:30	90.6	12.2	6.7	2284	97.6	476	4.3	
polish ← 14:35	75.6	12.2	6.7					move 4' above screen
7.55 14:45	75.6	12.2	6.7	2351	99.4	45	4.4	trace sand, clear, <½ tsp
Pumps ← 14:50	90.6	12.2	6.7					
79								
82								
Surge block off								

photo ☑

photo ☑

Shallow DTW 12.91 ft.
TD 25.33 ft

THE pebble PARTNERSHIP

P-08-77S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-77S

DATE STARTED 7/21/08 **COMPLETED** 7/21/08 **GROUND ELEVATION** 974.5 feet **TOC ELEVATION** 976.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2173772.35 feet **EASTING** 1368287.87 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					GW **Gravel** silt coated subangular to rounded gravel, <10% of clasts are fractured, clasts up to 1", brown silt, wet	Very little recovery, 0-1 feet
					3.0	
					GP **Sand and Gravel** brown angular to subangular gravel, most of the clasts are fractured, moist	Coarse grained sand, 3-4 feet Clasts up to 3/4", 3-5 feet Fine to coarse grained sand, 4-8 feet
5			no flow			Clasts up to 1 1/2", 5-8 feet
					8.0	
		▼			SP **Sand with Gravel** brown angular to subangular gravel, most of the clasts are fractured, clasts up to 1 1/2", fine to coarse grained sand	Cuttings are moist, 8-13 feet
10						
						Cuttings are wet, 13-14 feet Discharge water is brown, 13-23 feet
					14.0	
15	GB				GP **Sand and Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 5/8", coarse grained sand, wet	
					19.0	
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.4'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 15 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Hole Plug 1/4" Chips

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/15/2008
Purge Volume: 1031 gallons

RESPONSE TEST
Equipment: N/A
Date: Anticipated completion in 2009

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/22/08 at 545 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-77S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-77S

DATE STARTED 7/21/08 **COMPLETED** 7/21/08 **GROUND ELEVATION** 974.5 feet **TOC ELEVATION** 976.9 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2173772.35 feet **EASTING** 1368287.87 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			<1		GP **Sand and Gravel** subangular to rounded gravel, most of the clasts are fractured, clasts up to 1 1/2", coarse grained sand, wet	
					23.0	
					Bottom of hole at 23.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-775.
Date: 14 Aug 08
Project: Pebble
Project #: 005.0189.08002
Technician: Joey Tsao, Jonathan Kay

Summary

	Installed (Well Log)	Start	End
Water level	10.32	12.92	
Total depth	23.00		
pH		7.3	

Screen interval (btoPVC): 0.5'
Top: 13.2
Bottom: 23.0
PVC stick-up height (above ground surface): 2.4'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond EC (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								Photo ☑
3:25	24.9	12.92	4.0	5	293	E3	7.6	1/2 cup brown fine sand,
9:05	24.9	12.92	4.0	240	252	132	3.0	pH 7.3 (1 tsp brown fine sand)
9:10	22.9	12.92	4.0	5	198.0	E3	3.8	pH 7.58 brown cloudy, fine sand 1/2 tsp
9:50	22.9	13.00	4.0	160	160.3	91	3.1	pH 7.53 fine sand, brown 1/2 tsp
10:00	20.9	13.00	3.33	5	154.5	>1000	3.3	pH 7.41 " " - 2 tbl sp
11:00	20.9	12.95	3.33	200	128.0	89	3.3	pH 7.24 " " - trace
11:10	18.9	12.92	3.33	5	135.8	E3	3.9	pH 7.67 " " - 1/2 cup
12:05	18.9	13.20	2.86	171	109.7	44	4.0	pH 7.56 " " - trace
12:10	16.9	12.95	2.86	5	110.1	E3	5.4	pH 7.55 " " - 2 tbl sp Photo
1:25	16.9	13.00	2.86	215	113	121	4.2	pH 8.37 " " - trace ☐
Surge block off								
1:35	24.9	12.95	4.0	10	98.0	18	3.5	pH 7.48 trace fine brn sand
1:40	14.6	12.95	4.0	5	93.9	20	3.6	pH 7.55 " "
1:45	24.9	13.05	4.0	5	113.6	12	4.0	pH 7.68 " "

14 Aug - 08 (until 3:00 (95 min)
15 Aug - 08 9:05 (5:30 - 9:05 (215 min = 3.58 hr)
Total = 24.9
Avg Flow = 3.01 gpm
1' above screen interval for period as H2O level is only 2.08 above top of screen

THE pebble PARTNERSHIP

P-08-78D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-78D

DATE STARTED 7/22/08 **COMPLETED** 7/23/08 **GROUND ELEVATION** 1012.03 feet **TOC ELEVATION** 1015.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2176073.39 feet **EASTING** 1368928.24 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Topsoil** moist	
					2.0	
					SP **Sand with Gravel** multicolored, 50% of clasts are fractured, coarse grained sand	Cuttings are moist, 3-5 feet
5	GB					Cuttings are dry, 5-8 feet
						Cuttings are wet, 8-10 feet
10	GB				10.0	
					SP **Sand with Gravel** multicolored, 50% of clasts are fractured, clasts up to 3/4", coarse grained sand	Smaller clasts than rest of unit, 13-19 feet
15	GB					Cuttings are dry, 10-16 feet
						Cuttings are moist to wet, 16-23 feet
20						Little recovery, 18-19 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 100# grout

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/16/2008
Purge Volume: 2720 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/2/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/23/08 at 1145 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-78D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-78D

DATE STARTED 7/22/08 **COMPLETED** 7/23/08 **GROUND ELEVATION** 1012.03 feet **TOC ELEVATION** 1015.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2176073.39 feet **EASTING** 1368928.24 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20	GB				SP **Sand with Gravel** multicolored, 50% of clasts are fractured, clasts up to 3/4", coarse grained sand	
					23.0	
					GP **Gravel and Sand** 50% of clasts are fractured, clasts up to 1/2", coarse grained sand	Trace silt; cuttings are wet, 23-25 feet
25	GB					Trace silt; cuttings are moist, 25-26 feet
						Adding water while drilling, 27-42 feet
30	GB					
					32.0	
					GP **Gravel and Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, moist	
35	GB					
					38.0	
					GP **Gravel and Sand** subangular gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, moist	Little recovery, 39-40 feet
40	GB	▼				
						Discharge water is brown, 43-63 feet
45	GB					
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-78D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-78D

DATE STARTED 7/22/08 **COMPLETED** 7/23/08 **GROUND ELEVATION** 1012.03 feet **TOC ELEVATION** 1015.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2176073.39 feet **EASTING** 1368928.24 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			5		GP **Gravel and Sand** subangular gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, moist	
					53.0	
55	GB				SW **Sand with Gravel** multicolored, subangular to rounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	
			18			
60	GB					
			3.5			Discharge water is dark brown, 63-65 feet
65	GB					Discharge water is brown, 65-70 feet
			3			
70	GB				70.0	
					GP **Gravel and Sand** multicolored, subangular to rounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	Discharge water is dark brown, 70-72 feet
			7			Discharge water is reddish brown, 72-78 feet
75	GB					
			11		78.0	Slow drilling, 78-79 feet
	GB					Discharge water is light brown, 78-90 feet Silt balls, 78-84 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-78D
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-78D

DATE STARTED 7/22/08 **COMPLETED** 7/23/08 **GROUND ELEVATION** 1012.03 feet **TOC ELEVATION** 1015.03 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2176073.39 feet **EASTING** 1368928.24 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
			16		GM **Silty Sand and Gravel** multicolored, angular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", medium to coarse grained sand, light brown silt, wet	
					84.0	
85	GB				GW **Gravel with Sand** multicolored, angular to subrounded gravel, most of the clasts are fractured, clasts up to 1 1/4", coarse grained sand, wet	
			1.5			Traces of weathered bedrock, 88-89 feet
					89.0	
90	GB				**Bedrock (Tertiary Rhyolite)** creamy white to gray rhyolite, lacks obvious flow banding, pyrolucite and iron oxide staining	
					91.0	Not logged, 91-92.5 feet
					92.5	
					Bottom of hole at 92.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: ~~P-08-61A~~ P-08-78D
Date: 16-Aug-08
Project: Pebble well Development
Project #: 005.0189.08002
Technician: J. Isaac / J. Kay

Summary

	Installed (Well Log)	Start	End
Water level	41.69	43.44	
Total depth		94.83	
pH			

Screen interval (btoPVC): ~~67.2~~ 82.5' + 3.0 (stick up) = 85.5'
Top: ~~77.0~~ 92.5' + 3.0 (stick up) = 95.5'
Bottom:
PVC stick-up height (above ground surface): 3.0'

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
10:05	94.50'	43.44	5	10	528	E3	3.7	pH 7.54 fine sand, brown ≈ 2 tbl sp
10:35	94.50'		5	150	545	386	3.7	pH 8.74 " " ≈ 1 tbl sp
11:05	94.50'	44.31	5	300	582	325	4.3	pH 8.30 " " ≈ ½ tsp
11:35	94.50	44.00	5	450	598	273	4.5	pH 8.26 " " ≈ trace (< ½ tsp)
11:40	92.50	43.60	5	5	360	>1000	3.9	pH 8.1 " " ≈ 1 tbl sp
12:10	92.50		5	150	240	158	4.2	pH 8.72" " ≈ ½ tsp
12:30	92.50	44.50	5	250	195.6	131	4.6	pH 8.36" " trace
12:40	90.50	43.61	5	5	212	E3	3.9	pH 8.09" " ≈ 1 tbl sp
13:10	90.50		5	150	386	306	4.1	pH 8.67" " trace
13:40	90.50		5	300	626	221	4.3	pH 8.34" " trace
13:45	88.50	43.70	5	5	638	>1000	4.4	pH 8.16" " ≈ 1 tbl sp
14:15	88.50		5	150	555	367	4.2	pH 8.08" " ≈ 1 tsp
14:35	88.50	44.51	5	250	426	277	4.3	pH 8.10" " trace
14:45	86.50	43.51	5	5	395	>1000	4.3	pH 7.79" " ≈ 1 tsp
15:15	86.50		5	150	526	228	4.2	pH 8.04" " ≈ ½ tsp
15:45	86.50	43.78	5	300	540	198	3.8	pH 8.30" " trace
Surge block off								
15:55-16:05	94.00	43.50'	5	50	464	262	4.0	pH 7.96" " Trace
16:10-16:15	80.50	43.50'	5	25	369	311	4.2	pH 7.68" " Trace
16:17-16:20	94.00	43.50	5	15	538	279	4.1	pH 7.76" " Trace

Picture Taken →

Debris (1)
Pellet
Debris (2)

THE pebble PARTNERSHIP

P-08-78S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-78S

DATE STARTED 7/23/08 **COMPLETED** 7/23/08 **GROUND ELEVATION** 1011.03 feet **TOC ELEVATION** 1014.53 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2176036.94 feet **EASTING** 1368942.68 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-3 feet
					3.0	
					SP **Sand with Gravel** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, coarse grained sand	Clasts up to 1/4", 3-6 feet Cuttings are dry, 3-8 feet
5			no flow			
						Clasts up to 3/4", 6-14 feet Poorly sorted gravel, 7-14 feet Cuttings are moist, 8-11 feet
10						Cuttings are dry, 11-14 feet
					14.0	
					GW **Gravel with Sand** multicolored, subangular to subrounded gravel, clasts up to 3/4", coarse grained sand	Cuttings are moist, 14-15 feet Cuttings are dry, 15-18 feet Finer gravel than rest of unit, 16-20 feet
15						
						Cuttings are moist, 18-20 feet
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 50# grout

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is dry)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Piezometer is dry)

Comments: Piezometer is dry; Measured on 7/23/08 at 500PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-78S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-78S

DATE STARTED 7/23/08 **COMPLETED** 7/23/08 **GROUND ELEVATION** 1011.03 feet **TOC ELEVATION** 1014.53 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2176036.94 feet **EASTING** 1368942.68 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", fine grained sand	Cuttings are dry, 20-27 feet
25						Cuttings are moist, 27-30 feet
30						Poorly graded, 31-33 feet
					33.0 Bottom of hole at 33.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-78S. Well dry.

THE pebble PARTNERSHIP

P-08-79D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79D

DATE STARTED 7/23/08 **COMPLETED** 7/25/08 **GROUND ELEVATION** 900.49 feet **TOC ELEVATION** 903.29 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166414.22 feet **EASTING** 1361306.76 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					GW **Gravel with Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded fine to coarse grained sand, dry to moist	
3.0					GW **Gravel and Sand** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", well graded fine to coarse grained sand, dry to moist	
5	GB		no flow			
9.0					GW **Gravel and Sand** silt coated angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, trace brown silt, wet	
10	GB					
10.0					GW **Sandy Gravel** silt coated angular to subangular gravel, 75% of clasts are fractured, clasts up to 1", coarse grained sand, trace brown silt, wet	Discharge water is brown, 12-13 feet
13.0					SP **Sand with Gravel** silt coated angular to subangular gravel, 75% of clasts are fractured, trace brown silt, wet	Coarse grained sand, 13-16 feet
15	GB		trace flow			Discharge water is brown, 15-63 feet
						Fine to medium grained sand, 16-19 feet Fine to coarse grained sand, 19-24 feet
18.0					SP **Sand with Gravel** subangular to rounded gravel, clasts up to 3/4", trace brown silt, wet	75% of clasts are fractured, 18-25 feet
20	GB					Medium to coarse grained sand, 24-29 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 15 gal H2O

GROUT
Type: Volclay
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/20/2008
Purge Volume: 1645 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/26/08 at 1003 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79D
PAGE 2 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79D

DATE STARTED 7/23/08 **COMPLETED** 7/25/08 **GROUND ELEVATION** 900.49 feet **TOC ELEVATION** 903.29 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166414.22 feet **EASTING** 1361306.76 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SP **Sand with Gravel** subangular to rounded gravel, clasts up to 3/4", trace brown silt, wet	
25	GB					25% of clasts are fractured, 25-33 feet Medium grained sand, 29-33 feet
			2			
30	GB					Medium grained sand, 29-33 feet
			2		33.0	
35	GB				SW **Sand** multicolored, trace subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	
			2		38.0	
40	GB				SP **Sand with Gravel** multicolored, trace subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/2", fine to medium grained sand, wet	
			1.75			
45	GB					
			2		48.0	
	GB				SP **Gravelly Sand** multicolored, subangular to rounded gravel, <10% of clasts are fractured, clasts up to 5/8", wet	Fine to medium grained sand, 48-53 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79D
PAGE 3 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79D

DATE STARTED 7/23/08 **COMPLETED** 7/25/08 **GROUND ELEVATION** 900.49 feet **TOC ELEVATION** 903.29 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166414.22 feet **EASTING** 1361306.76 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SP **Gravelly Sand** multicolored, subangular to rounded gravel, <10% of clasts are fractured, clasts up to 5/8", wet	
			1.5			Fine to coarse grained sand, 53-59 feet
55	GB					
			6			
					59.0	
60	GB				SP **Sand** brown, trace subangular to rounded gravel, clasts up to 3/8", fine grained	
					63.0	
			8		GM **Silty Gravel** angular to subangular gravel, 30% of clasts are fractured, clasts up to 5/8", fine grained, brown silt	Discharge water is brown and silty, 63-85 feet
65	GB					
			3			
					69.0	
70					ML **Silt** brown	Little recovery; recovery is mostly liquid, 69-113 feet
			2.5			
75						
			1.5			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79D

DATE STARTED 7/23/08 **COMPLETED** 7/25/08 **GROUND ELEVATION** 900.49 feet **TOC ELEVATION** 903.29 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166414.22 feet **EASTING** 1361306.76 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					ML **Silt** brown	Adding water and foam while drilling, 80-83 feet
			1.75			
					84.0 ML **Silt with Sand** gray, fine grained sand	
85						Discharge water is gray and silty, 85-91 feet
90			1.5			
					91.0 ML **Silt** grayish brown, trace gravel, fine grained sand	Discharge water is grayish brown and silty, 91-113
					93.0 SM **Silty Sand** grayish brown, fine grained sand, wet	
95	GB		1.5			
			1.5			
100						
			1.75			
105						
			2			

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79D

DATE STARTED 7/23/08 **COMPLETED** 7/25/08 **GROUND ELEVATION** 900.49 feet **TOC ELEVATION** 903.29 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166414.22 feet **EASTING** 1361306.76 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					SM **Silty Sand** grayish brown, fine grained sand, wet	Silt balls, 110-111 feet
			4			
115						Discharge water is grayish brown and silty, 115-123 feet
					118.0	
					ML **Silt with Sand and Gravel** subangular to subrounded gravel, clasts up to 1/2", coarse grained sand, gray silt, wet	Silt balls, 118-124 feet
120	GB		4			
					124.0	Discharge water is brown, 123-144 feet
125	GB				GW **Sand and Gravel** multicolored, angular to subrounded gravel, most of the clasts are fractured, clasts up to 1", medium to coarse grained sand, brown silt, wet	Silt and sand washed out of sample, 124-125 feet
					125.0	Silt balls, 125-126 feet
					126.0	
					ML **Silt with Gravel** black, angular gravel, 100% of clasts are fractured, clasts up to 1", gray silt	
					GW **Gravel with Sand** multicolored, subangular to rounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand	
130	GB				130.0	
					GW **Gravel and Sand** multicolored, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, trace silt, wet	Adding water and foam while drilling, 133-135 feet
135	GB					
			1			Adding water and foam while drilling, 137-142 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79D

DATE STARTED 7/23/08 **COMPLETED** 7/25/08 **GROUND ELEVATION** 900.49 feet **TOC ELEVATION** 903.29 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166414.22 feet **EASTING** 1361306.76 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140	GB				141.0	
					ML **Silt and Sand with Gravel** multicolored, subangular to subrounded gravel, clasts up to 3/4", fine grained sand	Adding water while drilling; discharge water is brown, 142-144 feet
					143.0 ML **Silt with Sand** gray, trace gravel, fine grained sand	Silt balls, 143-144 feet
					144.0	No recovery, 144-145 feet
145					145.0	Advanced via mud rotary, 144-153.5 feet
					GP **Sand and Gravel** coarse grained sand	Logged from mud rotary cuttings, 145-146 feet
					146.0	No recovery, 146-150 feet
150	GB				150.0	
					GP **Sand with Gravel** subangular to subrounded gravel, clasts up to 1/2", fine grained sand	Very slow drilling; logged from mud rotary cuttings, 151-152 feet
					151.0	
					GP **Sand and Gravel** coarse grained sand	Bedrock clasts, 151-153.5 feet
					152.0	No recovery 152-153 feet
					153.0	
					153.5 **Bedrock** black	Stopped advancing; boring terminated, 153.5 feet
					Bottom of hole at 153.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-79-D
Date: 19-Aug-08
Project: Pebble
Project #: 005.0189.08002
Technician: Jonathan Kay / Joey Tsao

Summary

	Installed (Well Log)	Start	End
Water level	Not provided	6.25	
Total depth	153.5		
pH			

Screen interval (btoPVC): ∅
Top: 140.7 + 2.8 (stick up) = 143.5
Bottom: 150.7 + 2.8 = 153.5
PVC stick-up height (above ground surface):

≃ 8.8' of sand on bottom w probe on H_2O level meter dropping very slowly (Removed prior to initiating development flow)

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
11:50	152.5	14.30	4.3	5	357	E3	5.29	pH 8.39 fine sand, org-brn, ≃ 2 cups
12:50	152.5		3.0	180	155	E3	5.18	pH 8.14 " " ≃ 1 cup
13:20	150.5		4.3	5	375	E3	5.90	pH 8.74 " " ≃ 1 3/4 cups
14:20	150.5		5	280	166	E3	5.00	pH 8.22 " " ≃ 2 tbl sp
14:40	148.5	10.20						pH " " ½ cup
15:40	148.5	12.10	5	300	142	>1000	5.43	pH 8.26 " " 2 tbl sp
8:10	146.5	6.25	5	5	354	E3	4.80	pH 7.62 " " ½ cup
9:10	146.5	8.60	5	300	143	E3	4.64	pH 7.03 " " 2 tbl sp
9:30	144.5		5	5	137	E3	5.08	pH 7.04 " " 2 tsp
10:30	144.5	12.20	5	300 (380)	128	397	4.95	pH 7.57 " " 1 tbl sp
Surge block off								
10:40 - 11:20	152.5	8.90	5	200	132	>1000	5.08	pH 7.11 " " ≃ 2 tbl sp
11:30 - 11:37	138.5		5	35	129	818	4.89	pH 7.62 " " ≃ 1 tbl sp
11:45-11:51	152.5	10.10	5	30	128	1.3	5.00	pH 7.75 " " ≃ 2 tsp

19-Aug-08
20-Aug-08
Debris
Polish
Debris

Water remained brown (silt + sand) following removal of ≃ 2000 gal
Recommend additional debris & polish as required.

THE pebble PARTNERSHIP

P-08-79M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79M

DATE STARTED 7/26/08 **COMPLETED** 7/26/08 **GROUND ELEVATION** 899.06 feet **TOC ELEVATION** 902.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166365.4 feet **EASTING** 1361318.04 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil** trace coarse angular to subangular gravel, clasts up to 1"	No recovery, 1-3 feet
					3.0 GP **Sand and Gravel** subrounded gravel, clasts up to 1/2", medium to coarse grained sand	
5					5.0 GP **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, coarse grained sand	Cuttings are moist, 5-7 feet Clasts up to 3/4", 5-8 feet
		▼				Cuttings are wet, 7-16 feet
						Encountered water, 8 feet Fine gravel; clasts up to 1/4", 8-15 feet
10						
						Adding water while drilling, 11-13 feet
15			<0.125		15.0 GP **Sand and Gravel** fine subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/4", wet	Encountered water, 14.5 feet Discharge water is reddish brown, 15-21 feet Medium to coarse grained sand, 15-22 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.2'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/18/2008
Purge Volume: 798 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/27/08 at 630 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79M

DATE STARTED 7/26/08 **COMPLETED** 7/26/08 **GROUND ELEVATION** 899.06 feet **TOC ELEVATION** 902.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166365.4 feet **EASTING** 1361318.04 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			0.6		GP **Sand and Gravel** fine subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/4", wet	Adding water while drilling, 21-22 feet Discharge water is reddish brown, 22-26 feet Fine to coarse grained sand, 22-32 feet
25			0.25			Adding water while drilling, 26-47 feet Discharge water is brown, 27-47 feet
30			1.25		32.0 SP **Gravelly Sand** subrounded gravel, clasts up to 1/4", fine to coarse grained sand, wet	Less gravel than rest of unit, 31-32 feet
35			10		35.0 GP **Sand and Gravel** subrounded gravel, 25% of clasts are fractured, wet	Clasts up to 1/2", 35-42 feet Medium to coarse grained sand, 35-49 feet
40			4			Clasts up to 1/4", 42-50 feet
45			no flow			Slow drilling, 46-48 feet Discharge water is light brown, 48-50 feet Slow drilling; trace fine to coarse grained sand, 49-50 feet
					50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-79M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79M

DATE STARTED 7/26/08 **COMPLETED** 7/26/08 **GROUND ELEVATION** 899.06 feet **TOC ELEVATION** 902.26 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166365.4 feet **EASTING** 1361318.04 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			12		GP **Sand and Gravel** subrounded gravel, 25% of clasts are fractured, fine to coarse grained sand, wet	Clasts up to 1/2", 50-52 feet Adding water while drilling, discharge water is brown, 50-70 feet Clasts up to 1/4", 52-56 feet
55			0.5		56.0 SP **Gravelly Sand** clasts up to 1", fine to medium grained sand, trace silt 57.0 GP **Sand and Gravel** fine subrounded gravel, clasts up to 1/4", fine to medium grained sand 58.0 ML **Gravelly Silt** subangular gravel, clasts <1/4"	Little recovery, 58-60 feet
60			2.75		60.0 SP **Sand** trace gravel, fine to medium grained sand 63.0	
65			0.125		SM **Silty Sand** fine grained sand 64.0 SM **Silty Sand** fine to coarse grained sand 65.0 SM **Silty Sand** trace gravel, fine to coarse grained sand 66.0 SM **Silty Sand** fine grained sand	
70					70.0 Bottom of hole at 70.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-79 M
Date: 17, 18- Aug-08

Project: Pebble
Technician: Jonathan Kay / Joey Tsao

Summary

	Installed (Well Log)	Start	End
Water level	Not provided	7.75	
Total depth	69 + 3.2 = 72.2	64.20	soft bottom
pH			

Screen interval (btoPVC): 0
Top: 59.19 + 3.2 = 62.39
Bottom: 69 + 3.2 = 72.2
PVC stick-up height (above ground surface): 3.20'

16-Aug-08 : Removed ≃ 8' of sediment from bottom of well prior to development noted below.

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
17-Aug-08	Surge block on 17- Aug-08							Photo ☑
≃8" off Bottom 9:20	71.15'	7.75	5	5	72	E3	3.82	pH 5.25 fine sand, org-brn, ≃ 1/2 cup
10:00	71.5'	Dry	0	125	87	439	4.62	pH 6.70 " , ≃ 1/2 cup
12:30	71.15	27.15	1	150	74	227	7.37	pH 7.29 " , ≃ 1/2 tbl sp
12:40	69.15	8.43	3.5	5	102	456	4.30	pH 7.46 " , ≃ 2 tbl sp
13:40	69.15	53.50	1.88	115	80	669	5.27	pH 7.53 " , ≃ 1 tbl sp
14:05	67.15	8.00	5	5	89	492	4.89	pH 7.53 " , ≃ 1/2 cup
15:05	67.15	61.10	1.88	115	83	194	5.55	pH 7.72 " , ≃ 2 tsp
15:15	65.15	8.00	4.29	5	96	189	4.57	pH 7.78 " , ≃ 2 tbl sp
16:15	65.15	60.10	1.67	100	90	113	5.43	pH 7.78 " , ≃ 2 tsp
18-Aug-08 8:00	63.15	7.75	4.29	5	83	120	4.55	pH 5.72 " , ≃ 2 tbl sp
9:00	63.15	55.24	1.67	100	90	240	4.63	pH 6.22 " , ≃ 2 tsp Photo ☐
	Surge block off		start stop					
Bottom 9:3	59:55	71.15'	8:00 - 55.00	2.5	50	97	180	4.61 pH 6.70 " , ≃ 2 tsp
2' above scrn	10:12-10:14	57.39	8:00 - 45.8	5.0	8	123	34	4.M pH 6.87 " , trace (< 1/2 tsp)
Bottom	10:33-34	71.15'	8:00 - 47.4	5.0	10	91	72	4. pH 7.08 " , 1/2 tsp

11p 5.26 7.30

THE pebble PARTNERSHIP

P-08-79S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-79S

DATE STARTED 7/27/08 **COMPLETED** 7/27/08 **GROUND ELEVATION** 899.75 feet **TOC ELEVATION** 902.65 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2166391.28 feet **EASTING** 1361320.45 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0		
	1.0 **Topsoil** gravel, sand, organic material	No recovery, 0-1 feet
	2.0 GP **Sand and Gravel** fine subrounded gravel, clasts up to 1/4", coarse grained sand, moist	Little recovery, 1-2 feet
	3.0 GP **Sand and Gravel** fine subangular to subrounded gravel, clasts up to 1/2", coarse grained sand, moist	
5	5.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, coarse grained sand	Clasts up to 1/4"; cuttings are moist, 5-6 feet
	7.0 GP **Gravel** subangular to subrounded gravel, clasts up to 1/4", trace sand, wet	Clasts up to 1/2"; cuttings are wet, 6-7 feet
	8.0 GP **Sand and Gravel** fine subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", wet	Coarse grained sand, 8-12 feet
10		Trace silt, 11-16 feet
		Fine to coarse grained sand, 12-16 feet
15	16.0 Bottom of hole at 16.0 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 188# cement, 10# grout

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 8/17/2008
Purge Volume: 776 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/27/08 at 104 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-79S
Date: 17-Aug-08

Project: Pebble
Technician: Jonathan Kay / Joey Isao

Summary

	Installed (Well Log)	Start	End
Water level	Not Available	7.75	
Total depth	16.0	19.95	
pH			

Screen interval (btoPVC): 0
Top: 11.20 (According to info provided)
Bottom: 16.55 (According to measurement in field)
PVC stick-up height (above ground surface): 3.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond µS/cm (~~mS/cm~~)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
11:30	19.45	7.75	3.75	5	41	E3	9.15	pH 7.30 fine sand, org-brn, ~ ½ cup Photo ☑
12:30	19.45	7.75	3.75	225	40	62	8.05	pH 7.56 " " Trace (< ½ tsp)
12:45	17.45	7.75	3.75	5	40	926	8.38	pH 7.45 " " ¼ cup
13:45	17.45	7.75	3.75	225	40	46	8.09	pH 7.43 " " Trace (< ½ tsp)
13:50	15.45	7.75	3.75	5	41	E3	8.90	pH 7.37 " " ¼ cup
14:00	15.45	7.75	3.75	262.5	44	21	8.43	pH 7.52 " " trace ☑ Photo
Surge block off								
14:15	19.45	7.75	3.75	18.75	38	13	8.25	pH 7.05 trace sed
14:25	10.45	7.75	3.75	18.75	38	7	8.88	pH 6.87 trace sed
14:30	19.45	7.75	3.75	11.25	39	7	8.14	pH 7.16 trace sed

(6" off Bott) →

* Actual bottom of pipe measured in field was 19.95' compared to what was previously reported as 19.40'!

THE pebble PARTNERSHIP

P-08-80D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80D

DATE STARTED 7/27/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.66 feet **TOC ELEVATION** 833.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154871.24 feet **EASTING** 1355540.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Organic Material and Soil** 1.0	
					SP **Sand** medium to coarse grained 2.0	
					SP **Sand with Gravel** subangular to subrounded gravel, clasts up to 1/4", medium to coarse grained sand, dry 3.0	Medium to coarse grained sand, 3-7 feet
5	GB				GP **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/4"	
						Fine to coarse grained sand, 7-10 feet
10	GB					Medium to coarse grained sand, 10-11 feet
					11.0	
					SP **Sand** trace fine subangular gravel, clasts <1/4", medium to coarse grained sand, dry 12.0	No recovery, 12-15 feet
15					15.0	Encountered water, 14 feet Adding water while drilling, 14-15 feet
	GB	▼			GW **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
						Discharge water is brown, 18-116 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 188# cement, 25# grout, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/4/2008
Purge Volume: 1255 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/30/08 at 1205 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-80D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80D

DATE STARTED 7/27/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.66 feet **TOC ELEVATION** 833.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154871.24 feet **EASTING** 1355540.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GW **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	Trace fine grained sand, 20-23 feet
					23.0 GW **Sand and Gravel** subangular to rounded gravel, 10% of clasts are fractured, clasts up to 1", fine to coarse grained sand, trace silt, wet	
25	GB					
			<1			
30	GB					
			1		33.0 GW **Sand and Gravel** subangular to rounded gravel, 25% of clasts are fractured, clasts up to 1 1/4", fine to coarse grained sand, trace silt, wet	Very slow drilling, 33-34 feet Adding water while drilling, 34-54 feet
35	GB					
					38.0 ML **Silt** brown, trace fine to coarse grained sand, wet	
40	GB					
					41.0 GM **Silty Gravel** angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/8", wet	
					43.0 ML **Silt** brown, trace fine to coarse grained sand, wet	
45	GB					
					48.0 SW **Sand with Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	Slow drilling, 49-53 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-80D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80D

DATE STARTED 7/27/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.66 feet **TOC ELEVATION** 833.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154871.24 feet **EASTING** 1355540.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SW **Sand with Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	
			30			Adding water and foam while drilling, 54-55 feet
55						Slow drilling, 55-62 feet
			7			
60	GB					Less gravel and fines than rest of unit, 60-65 feet
			0.75			Adding water while drilling, 62-75 feet
65	GB				65.0	
					SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand, wet	
					66.0	
			12		GP **Sand and Gravel** fine gravel, 10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand, wet	
70	GB					
					71.0	
					SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
			1.25		72.0	
					GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand, wet	
75	GB					Slow drilling, 74-75 feet
						Adding water and foam while drilling, 75-87 feet
			6			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-80D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80D

DATE STARTED 7/27/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.66 feet **TOC ELEVATION** 833.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154871.24 feet **EASTING** 1355540.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			3.25		GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand, wet	
					84.0	
85	GB				SP **Sand** trace subrounded gravel, clasts up to 1/8", medium to coarse grained sand, wet	
					85.0	
			<0.125		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphyritic granodiorite, hornblendes altered to chlorite, unaltered coarse biotite, poorly-developed plagioclase and feldspars	Casing broke on 7/28/08 at 5:07PM; resumed advancing on 7/29/08 at 11:31AM, 87 feet Adding water while drilling, 87-93 feet
90	GB		7			
			15			Adding foam while drililng, 93-97 feet
95						Adding water while drilling, 95-116 feet
			5.5			Adding foam while drililng, 98-112 feet
100	GB					
			7.5			
105	GB					
			10			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-80D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80D

DATE STARTED 7/27/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.66 feet **TOC ELEVATION** 833.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154871.24 feet **EASTING** 1355540.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** creamy white to light gray, porphyritic granodiorite, hornblendes altered to chlorite, unaltered coarse biotite, poorly-developed plagioclase and feldspars	
			11.25			
115	GB					
			13			Adding water while drilling; discharge water is light brown, 116-125 feet
120	GB					
			20			
125						Adding water while drilling; discharge water is cloudy brown, 125-126 feet
	GB				126.5	Not logged, 126.5-127.1 feet
			20		127.1 Bottom of hole at 127.1 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-80D
Date: 3/4 Sept 08

Project: Pebble
Technician: D. Pardoe, M. Swain

Summary

	Installed (Well Log)	Start	End
Water level	18.22	18.3	19.9
Total depth	127.1	131.3	131.0
pH		8.35	8.38

Screen interval (btoPVC): 10.04 ft
Top: 117.05 ft
Bottom: 127.01 ft
PVC stick-up height (above ground surface): 3.5 ft

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
8.35 pH Sept 4th 8.50am	126.01	18.30	5gpm	5	342	1000	4°C	sand/silt fine, brown, orange ½ cup
8.25pH 9.20am	124.01	21.61	5gpm	120	575	1000	8.8°C	silt fine, cloudy white, ¼ cup
8.24pH 9.53am	122.01	20.16	5gpm	285	351	656	3.7°C	silt fine, cloudy white, 1 tablespoon
8.26 pH 10.20am	120.01	23.71	5gpm	420	267	92	3.7°C	silt fine, cloudy white, 1 tablespoon
8.21PH 10.54am	118.01	20.08	5gpm	640	269	64	4.1	silt fine, clear white, ½ tablespoon
8.24PH 11.27am	116.01	26.20	5gpm	805	452	47	4.0	silt fine, clear, 1 teaspoon
Surge block off								
8.7 pH 12:01	126.01	20.16	5gpm	975	461	38	4.6	sand fine, clear, 1 teaspoon
8.[illegible]PH 12.37	111.01	20.08	5gpm	1155	292	16	4.3	sand fine, clear < 1 teaspoon
12.57	126.01	19.9	5gpm	1255	274	12	4.1	sand, clear < 1 teaspoon

THE pebble PARTNERSHIP

P-08-80M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80M

DATE STARTED 7/30/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.96 feet **TOC ELEVATION** 832.86 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154890.78 feet **EASTING** 1355511.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 GP **Gravel** angular, 100% of clasts are fractured	Little recovery, 2-4 feet
					4.0 GP **Gravel** subangular to subrounded, <10% of clasts are fractured, clasts up to 1/4"	Adding water while drilling, 3-22 feet
5					5.0 GP **Sand and Gravel** fine subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", coarse grained sand	
					7.0	No recovery, 7-8 feet
					8.0 GP **Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4"	
10						Trace coarse grained sand, 10-12 feet
					12.0 GP **Sand and Gravel** fine subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4"	Coarse grained sand, 12-13 feet
						Medium to coarse grained sand, 13-17 feet
15		▼				Discharge water is brown, 15-62.5 feet
						Fine to medium grained sand, 17-19 feet
20						Fine to coarse grained sand, 19-36 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 300# cement, 30 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/1/2008
Purge Volume: 2861 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/31/08 at 638 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-80M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80M

DATE STARTED 7/30/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.96 feet **TOC ELEVATION** 832.86 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154890.78 feet **EASTING** 1355511.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GP **Sand and Gravel** fine subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4"	Encountered water, 22 feet
25			0.75			
30			6			
35					36.0	
			3		GP **Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1", medium to coarse grained sand, wet	Silt balls, 38-39 feet
					39.0	Adding foam while drilling, 39-62.5 feet
40					ML **Silt** brown, trace fine to coarse grained sand, wet	
			1			Very little recovery, 43-45 feet
45						Little recovery, 45-47 feet
			10.5			Little recovery, 48-50 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-80M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80M

DATE STARTED 7/30/08 **COMPLETED** 7/30/08 **GROUND ELEVATION** 829.96 feet **TOC ELEVATION** 832.86 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154890.78 feet **EASTING** 1355511.1 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					ML **Silt** brown, trace fine to coarse grained sand, wet	
					51.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	Slow drilling, 52-53 feet
			1.5		53.0 GW **Sandy Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", medium to coarse grained sand	
55			9		54.0 55.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	Clasts up to 1", 55-56 feet
			6.75		57.0 GW **Sandy Gravel** subangular to subrounded gravel, 50% of clasts are fractured, medium to coarse grained sand	Clasts up to 3/4", 56-57 feet
			5.25		GW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
60			2.25		62.5 62.7 Bottom of hole at 62.7 feet.	Not logged, 62.5-62.7 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-80m
Date: Sept 1/08

Project: Pebble
Technician: J. Turner, M. Swain, D. Pardoe

Summary PVC

	Installed (Well Log)	Start	End
Water level	16.39	16.65	16.13
Total depth		66.37	66.41
pH		8.69	8.35

Screen interval (btoPVC): 9.95
(PVC) Top: 52.85
Bottom: 62.70
PVC stick-up height (above ground surface): 2.9

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond µS (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on Start								
12:51	61.7	16.65	-	5	128 µS	E3	5.8	sand/silt fine, brown, 1 cup
13:51	61.7	-	6	360	281 µS	355	4.5	fine sand/silt, brown/grey, 1 Tbs
14:01	59.7	17.30	—	—				move 2 ft ↑, start
15:01	59.7	18.6	6	720	246	281	4.0	fine sand/silt, brown/cloudy, 1 tsp
15:14	57.7	17.38						move 2 ft ↑, start, DO
16:21	57.7	18.69	6	1020	126.4	180	3.7	fine sand, brown/cloudy, 1 tsp
16:37	55.7	17.37						move 2 ft ↑, start
17:14	55.7	18.15	6.25	1251	133.3	246	3.5	fine sand brown/cloudy, 1 tsp
14:30	53.7	17.56	6.25	1551	236	71	4.4	fine sand brown cloudy 1 tsp
15:29	52.7	17.60	6.00	1911	242	34	4.2	fine sand, clear, slightly cloudy
Surge block off (Start 15:36)								
4:00	60.70	17.45	6.00	2211	264	24	4.2	Fine silt, clear, ↓ turbidity
6:30	52.85	17.56	6.00	2511	285	12	4.0	Fine silt clear, none
4:45	60.70	17.37	6.00	2861	253	12	3.7	Fine silt clear, none

Ph

8.69
9.2
7.82
8.26
7.94
8.49
8.54

Ph not calibrating properly

-10 min down for fuel

45 = 56 = 6.2

E3 - ≥ 1000

56 =

THE pebble PARTNERSHIP

P-08-80S

PAGE 1 OF 1

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-80S

DATE STARTED 7/31/08 **COMPLETED** 7/31/08 **GROUND ELEVATION** 830.54 feet **TOC ELEVATION** 833.84 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2154923.13 feet **EASTING** 1355518.4 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-1 feet
					1.0 GP **Sand and Gravel**	Some organic matter, 1-2 feet Little recovery, 1-5 feet
5					5.0 GP **Sand and Gravel** subangular gravel, 25% of clasts are fractured, clasts up to 5/8", medium to coarse grained sand, dry	Little recovery, 6-7 feet
					7.0	No recovery, 7-10 feet
10					10.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, fine to coarse grained sand, dry	Cuttings are dry, 10-12 feet Clasts up to 1/4", 10-15 feet
		▼				Encountered water, 12.5 feet Cuttings are wet, 12-17 feet
15						Clasts up to 1/2", 15-17 feet
		8.52	trace flow		17.0 Bottom of hole at 17.0 feet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 188# cement, 20# grout

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Insufficient water)
Purge Volume: N/A

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/31/08 at 124 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

16.65
66.33

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-80S
Date: Sept 2 /08

Project: Pebble
Technician: J. Turner, Mark Swain, Dave Pardoe

Summary

	Installed (Well Log)	Start	End
Water level		13.5	
Total depth			
pH			

Screen interval (btoPVC):
Top: 12.6
Bottom: 17.0
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
					not enough Water			
					for Development			
Surge block off								

THE pebble PARTNERSHIP

P-08-81D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-81D

DATE STARTED 7/31/08 **COMPLETED** 8/1/08 **GROUND ELEVATION** 763.64 feet **TOC ELEVATION** 766.74 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2143388.75 feet **EASTING** 1350986.52 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0	
					Organic Soil with Sand brown, coarse grained sand	
					3.0	
					Organic Soil and Sand brown, trace gravel, fine to coarse grained sand	
5	GB				5.0	
					SW **Sand with Gravel** gray, clasts up to 1/2", fine to coarse grained sand, moist	Clasts up to 1/2", 6-7 feet
					6.0	
					GP **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, fine to coarse grained sand, moist	Clasts up to 3/4", 7-8 feet
					8.0	Very little recovery, 8-9 feet
10	GB				GP **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand	
					11.0	
					GW **Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4"	Trace fine grained sand, 11-12 feet
		▼			13.0	Adding water while drilling, 13-14 feet
					GW **Gravel with Sand** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", coarse grained sand	
15	GB				15.0	Adding water while drilling, 15-35 feet
					GW **Gravel with Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand, wet	
			0.25		18.0	Discharge water is brown, 18-37 feet
					GW **Sandy Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	
20	GB				20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/6/2008
Purge Volume: 1222 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/1/08 at 340 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-81D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-81D

DATE STARTED 7/31/08 **COMPLETED** 8/1/08 **GROUND ELEVATION** 763.64 feet **TOC ELEVATION** 766.74 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2143388.75 feet **EASTING** 1350986.52 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			0.5		GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand, wet	Clasts up to 1/2", 20-24 feet
25	GB				25.0	Clasts up to 3/4", 24-25 feet
			0.5		GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand, wet	Clasts up to 3/4", 25-28 feet
30	GB				29.0 GW **Sandy Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand, wet 30.0	Clasts up to 1", 28-29 feet
			0.5		GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", medium to coarse grained sand, wet 32.0	
35	GB				GW **Gravel** subrounded gravel, clasts up to 3/4", trace medium to coarse grained sand 33.0	
					GW **Gravel with Sand** subangular to subrounded gravel, 25% of clasts are fractured, coarse grained sand 34.0	
					SP **Sand with Gravel** brown, subrounded gravel, medium to coarse grained sand 35.0	
					GP **Gravel with Sand** subangular gravel, 50% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand 37.0	Clasts up to 1", 37-39 feet Discharge water is lighter brown, 37-41 feet
40	GB		3		GW **Sandy Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand 40.0	Clasts up to 3/4", 39-40 feet
					GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand	Clasts up to 3/4", 40-44 feet Discharge water is dark brown, 41-45 feet
45	GB		0.5		45.0 SP **Sand** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand 46.0	Clasts up to 1", 44-45 feet 80% of clasts are fractured, 44-55.5 feet Discharge water is brown, 45-46 feet
			3.5		GW **Sand and Gravel** subangular to subrounded gravel, medium to coarse grained sand	Clasts up to 3/4", 46-48 feet 25% of clasts are fractured, 46-50 feet Discharge water is golden brown, 46-52 feet Clasts up to 1/2", 48-49 feet
	GB					Clasts up to 3/4", 49-50 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-81D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-81D

DATE STARTED 7/31/08 **COMPLETED** 8/1/08 **GROUND ELEVATION** 763.64 feet **TOC ELEVATION** 766.74 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2143388.75 feet **EASTING** 1350986.52 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GW **Sand and Gravel** subangular to subrounded gravel, medium to coarse grained sand	50% of clasts are fractured, 50-52 feet
			48		52.0	
					Bedrock (Cretaceous Kaskanak Batholith - Granodiorite) white to gray speckled granodiorite, distinctive green euhedral hornblendes (~20% altered to chlorite), poorly-developed feldspar/plagioclase dominated groundmass	Very slow drilling; discharge water is light brown, 52-55.5 feet
55			48		55.5	
					Bottom of hole at 55.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-810
Date: 6/Sept 08
Project: Pebble
Project #: 005.0189.08002
Technician: D. Pardoe, M Swain

Summary

	Installed (Well Log)	Start	End
Water level	12.83	13.08	
Total depth	58.40	58.7	
pH			

Screen interval (btoPVC): 55.30
Top: 45.30
Bottom: 55.3
PVC stick-up height (above ground surface): 3.1

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
7.52 10.37	54.3	13.08	6	6	1136	1000	5	white, milky silt, 2 cups
7.56 11.32	52.3	13.06	5	281	286	44	3.6	white, milky silt, 1 cup
7.56 12.10	50.3	13.01	5	471	222	154	3.5	white, milky, silt, 1 cup
7.39 12.39	48.3	13.01	5	616	196.8	21	3.4	white, [illegible], cloudish, silt 1/2 teaspoon
7.51 1.13pm	46.3	13.13	6	820	1143	18	3.5	clear, fine silt, 1/2 teaspoon
Surge block off								
7.52 1.50	54.3	13.13	6	1042	1147	13	3.8	clear, fine sand 1/4 teaspoon
2.20	40.30	13.08	6	1222	1172	11	3.6	clear fine sand 1/4

THE pebble PARTNERSHIP

P-08-81S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-81S

DATE STARTED 8/1/08 **COMPLETED** 8/1/08 **GROUND ELEVATION** 763.13 feet **TOC ELEVATION** 766.13 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2143370.66 feet **EASTING** 1350973.5 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Organic Material** trace gravel, trace sand	Little recovery, 0-4 feet
					2.0 GP **Sand and Gravel**	
					4.0 GP **Sand and Gravel** subangular to subrounded gravel, clasts <1/4", medium to coarse grained sand	
5					5.0 GP **Sand and Gravel** subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand, dry	
					7.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4",	
					8.0 medium to coarse grained sand, trace silt, dry	No recovery, 8-13 feet
10		▼				
					13.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand, wet	Encountered water, 13 feet
15					16.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", fine	
		10			17.0 to coarse grained sand, wet	
					17.5 Bottom of hole at 17.5 feet.	Not logged, 17-17.5 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 100# cement, 15# grout, 10 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/5/2008
Purge Volume: 874 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/1/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/1/08 at 642 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08- S15
Date: 5 / Sept 08

Project: Pebble
Technician: D. Pardoe, M. Swain

Summary

	Installed (Well Log)	Start	End
Water level	11.00	11.30	11.29
Total depth	17.5	18.8	18.7
pH			

Screen interval (btoPVC): 5 ft
Top: 11 ft
Bottom: 16 ft
PVC stick-up height (above ground surface): 3 ft

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
3.05pm	15.00	11.30	3.5	3.5	551	71000	9.4	silt, fine sand, Brown
3.48pm	13.00	11.28	3	132.5	672	111	9.3	silt fine sand, Brown/yellow loop
4.30pm	11.00	11.26	3.5	271.5	676	87	9.7	silt fine, brown
5.05pm	9.00	11.27	3.5	402	351	10	9.2	silt fine, clear, ½ teaspoon
Surge block off								
9.12	15.00	11.29	3.5	552	307	57	7.8	silt fine, clear, 1 teaspoon
9.49	12.00	11.29	3.5	737	123	55	8.0	silt fine, clear, ½ teaspoon
10.28	15.00	11.29	3.5	873.5	114.7	25	7.7	silt fine, clear, ½ teaspoon.

7.62M
7.42
7.50

6 sept 08

THE pebble PARTNERSHIP

P-08-82D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82D

DATE STARTED 8/2/08 **COMPLETED** 8/3/08 **GROUND ELEVATION** 893.64 feet **TOC ELEVATION** 897.34 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127914.8 feet **EASTING** 1400533.51 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0	
					SP **Sand with Gravel** silt coated gravel, clasts up to 1/2", fine to medium grained sand	Subangular gravel, 2-3 feet
						Subangular to subrounded gravel, 3-5 feet
5	GB				5.0	
					GW **Sand and Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
					7.0	
					GW **Gravel with Sand** angular to subangular gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
					9.0	
10	GB				SW **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand	No recovery, 10-11 feet
					10.0	
					11.0	
					GP **Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand	No recovery, 12-13 feet
					12.0	
					13.0	
					GW **Sand and Gravel** brown, subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand	Very little recovery, 14-15 feet
15	GB				15.0	
					16.0	No recovery, 15-16 feet
					GW **Sand and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", coarse grained sand	Very little recovery, 16-17 feet
		▼			17.0	Clasts up to 1/2", 17-20 feet
					GP **Gravel** subangular to subrounded gravel, most of the clasts are fractured, trace coarse grained sand	Adding water while drilling, 17-59 feet
20	GB					Little recovery, 19-20 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 188# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/13/2008
Purge Volume: 1986 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/3/08 at 604 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-82D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82D

DATE STARTED 8/2/08 **COMPLETED** 8/3/08 **GROUND ELEVATION** 893.64 feet **TOC ELEVATION** 897.34 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127914.8 feet **EASTING** 1400533.51 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	Clasts up to 3/4", 20-21 feet
					GW **Gravel with Sand** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", coarse grained sand	
					22.0	Discharge water is brown, 22-55 feet
			<0.25		23.0 GM **Sand and Gravel with Silt** clasts up to 1/2", fine to coarse grained sand	
					24.0 **Boulder or Cobble** black, fractured, fragments up to 3/4"	75% of clasts are fractured, 24-25 feet
25	GB				GW **Sand and Gravel** subangular to subrounded gravel, clasts up to 3/4", trace silt	25% of clasts are fractured, 25-30 feet
			3			
30	GB				30.0	No recovery, 30-31 feet
					31.0 SP **Sand** brown, trace gravel, fine to medium grained sand	
					32.0	Clasts up to 3/4", 32-34 feet
			0.5		GP **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand	
35	GB				35.0	Clasts up to 1/2", 34-35 feet
					GP **Gravel with Sand** angular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	75% of clasts are fractured, 35-40 feet
						Trace silt, 36-38 feet
			0.5		38.0 GW **Sandy Gravel** angular to subrounded gravel, clasts up to 3/4", medium to coarse grained sand	
40	GB					
					41.0	50% of clasts are fractured, 40-41 feet
					GP **Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
					42.0	
			0.5		43.0 GW **Sandy Gravel** angular to subrounded gravel, 75% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
					44.0	Coarse grained sand, 44-45 feet
45					GP **Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	Medium to coarse grained sand, 45-46 feet
					46.0 SP **Gravelly Sand** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2"	
			0.5		48.0 GP **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
					49.0	
	GB				50.0 SP **Sand** trace gravel, medium to coarse grained sand	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-82D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82D

DATE STARTED 8/2/08 **COMPLETED** 8/3/08 **GROUND ELEVATION** 893.64 feet **TOC ELEVATION** 897.34 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127914.8 feet **EASTING** 1400533.51 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GP **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	<10% of clasts are fractured, 50-53 feet.
					SP **Gravelly Sand** subrounded gravel, clasts up to 1/2", medium to coarse grained sand	Slower drilling, 52-55 feet
			1.5			50% of clasts are fractured, 53-54 feet
					54.0	
55	GB				GW **Sand and Gravel** black subangular gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
			54		55.0	Discharge water is almost clear, 55-57 feet
			54		**Bedrock (Tertiary Basalt)** dark green to black, aphanitic, magnetic basalt	Adding water and foam while drilling, 55-59 feet
						Moved to open hole hammer, 55.8 feet
			96			Discharge water is light brown, 57-59 feet
			96			
60			120			Discharge water is clear, 59-60 feet
						Adding water while drilling, 61-62 feet
						Slower drilling; adding water and foam while drilling, 62-64 feet
65			100+			Adding water and foam while drilling; discharge water is light brown, 65-73 feet
70			100+			
		10.52			73.0	
					Bottom of hole at 73.0 feet.	Hole drilled to 73 feet, but collapsed to 71.6 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-~~S1~~ S2D
Date: Sept 12/08
Project: Pebble
Project #: 005.0189.08002
Technician: D.D. / S.T

Summary

	Installed (Well Log)	Start	End
Water level	17.4	18.~~00~~	~~17.82~~
Total depth	71.6	71.85	18.15
pH		7.92	7.77

Screen interval (btoPVC):
Top: ~~62.2~~ 62.47
Bottom: ~~77.0~~ 71.6
PVC stick-up height (above ground surface): 3.7

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
7.92 13:00	76.00	18.00	6	6	246	562	5.9	brown, fine sand, 1 table spoon
7.55 14:00	76.00	18.00	6	366	250	269	5.2	brown, fine sand/silt 1 teaspoon
14:10	74.00	—	—	—	—	—	—	
7.99 14:50	74.00	18.00	6	606	383	152	5.2	milky, trace fine sand, ½ teaspoon
15:00	72.00	—	—	—	—	—	—	
7.77 15:40	72.00	18.00	6	846	390	85	5.1	milky, trace fine sand, <½ teaspoon
15:50	70.00	—	—	—	—	—	—	
7.80 16:30	70.00	18.00	6	1086	310	76	5.1	milky, trace fine sand, <½ tsp
Sept 13/08 8:40	68.00	—	—	—	—	—	—	
7.78 9:20	68.00	17.95	6	1326	305	67	5.0	clear, trace fine sand, <½ tsp
Surge block off								
debris 9:35	76.00	—	—	—	—	—	—	
7.70 10:10	76.00	18.~~00~~	6	1436	263	133	5.0	cloudy, light brown, trace fine sand <½ tsp
Rolgh. 10:15	57.00	—	—	—	—	—	—	
7.65 10:~~30~~	59.00	17.93	6	1806	305	65	5.0	clear, trace sand, <½ tsp
debris 10:55	76.00	—						
7.77 11:25	76.00	19.92	6	1986	167.7	95	5.1	clear, trace sand <½ tsp

THE pebble PARTNERSHIP

P-08-82M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82M

DATE STARTED 8/4/08 **COMPLETED** 8/4/08 **GROUND ELEVATION** 892.96 feet **TOC ELEVATION** 896.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127894.03 feet **EASTING** 1400514.04 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 **Sand and Organic Soil** fine grained sand	Little recovery, 2-3 feet
					3.0 ML **Silt with Sand** brown, trace angular gravel, clasts <1/4", fine grained sand, dry	
					4.0 ML **Silt** trace gravel, clasts <1/4", dry	
5					5.0 GM **Silty Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/4", fine grained sand, dry	
					6.0 ML **Silt and Gravel** 100% of clasts are fractured, clasts <1/4", dry	
					7.0 SM **Silty Sand** fine to coarse grained sand	Adding water while drilling, 7-17 feet
						Little recovery, 8-17 feet
10					10.0 ML **Silt** trace fine grained sand, dry	
					13.0 ML **Silt with Sand** coarse grained sand	
					14.0 ML **Silt and Sand** medium to coarse grained sand	
15		▼				Trace gravel; clasts up to 1/8", 15-17 feet
					17.0 SM **Silty Sand** trace fine subangular to subrounded gravel, clasts <1/4", medium to coarse grained sand, wet	
					19.0 GP **Sand and Gravel** angular to subangular gravel, 10% of clasts are fractured, clasts up to 1/4", wet	Encountered water, 18 feet Adding water while drilling; discharge water is brown, 18-22 feet Medium to coarse grained sand, 19-20
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.2'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 30 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/12/2008
Purge Volume: 1720 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/5/08 at 530 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-82M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82M

DATE STARTED 8/4/08 **COMPLETED** 8/4/08 **GROUND ELEVATION** 892.96 feet **TOC ELEVATION** 896.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127894.03 feet **EASTING** 1400514.04 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20			0.125		GP **Sand and Gravel** angular to subangular gravel, 10% of clasts are fractured, clasts up to 1/4", wet	feet Coarse grained sand, 20-22 feet Little recovery, 21-25 feet
					22.0 GM **Sand and Gravel with Silt** medium to coarse grained sand, wet	Subangular to subrounded gravel, clasts up to 1/4", 22-24 feet Adding water while drilling; discharge water is brown, 22-48 feet
25					25.0	Angular gravel; clasts up to 1", 24-25 feet
			1.5		SM **Silty Sand** trace angular gravel, clasts up to 1", fine grained sand, trace medium grained sand, wet 26.0 SM **Silty Sand** trace subangular gravel, clasts up to 1/4", fine to medium grained sand, wet	
					28.0 SM **Silty Sand** trace gravel, clasts up to 1/4", poorly sorted fine to coarse grained sand	Poorly sorted fine to coarse grained sand, 28-32 feet
30			1		32.0 GM **Silty Sand and Gravel** subangular to subrounded gravel, fine to coarse grained sand, wet	Clasts up to 1", 32-33 feet Clasts up to 1/2", 33-34 feet
					34.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, fine to coarse grained sand, trace silt	Clean gravel; clasts up to 1", 34-35 feet
35			0.5		36.0 GW **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	Clasts up to 1/2", 35-36 feet Trace fine grained sand; larger clasts, 37-38 feet
			14		38.0 GP **Sand and Gravel** clasts <1/4", coarse grained sand	
40			25		41.0 GP **Sand and Gravel** subangular to subrounded gravel, clasts up to 1/4", fine to coarse grained sand, trace silt	
45			0.25 0.6 0.125			
			2.5		48.0 **Bedrock (Tertiary Basalt)** dark green to black, aphanitic, magnetic basalt	Discharge water is clearer, 48-49 feet
			32		49.0	Not logged, 49-50.2 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-82M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82M

DATE STARTED 8/4/08 **COMPLETED** 8/4/08 **GROUND ELEVATION** 892.96 feet **TOC ELEVATION** 896.16 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127894.03 feet **EASTING** 1400514.04 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** R. Jacobson, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					50.2 Bottom of hole at 50.2 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-~~[illegible]~~ 8244
Date: 10 Sept 08
Project: Pebble
Technician: D.P & J.T
Project #: 005.0189.08002

Summary

	Installed (Well Log)	Start	End
Water level	16.1	16.3	16.83
Total depth	50.2	54.0	
pH		8.31	7.68

Screen interval (btoPVC):
Top: ~~[illegible]~~ 40.2
Bottom: ~~[illegible]~~ 50.2
PVC stick-up height (above ground surface): 3.2

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
3:30pm	49.0	16.30	6	6	380	>1000	5.8	Brown, silt + fine sand, 1 cup
4:15pm	49.0	16.83	6	276	270	76	5.6	
4:20	47.0	—	—	—	—	—	—	light brown, trace fine sand < ½ tsp
5:00	47.0	16.83	6	516	322	83	5.9	
8:40am	45.0	—	—	—	—	—	—	
9:20	45.0	16.82	6	756	177	36	4.8	
9:30	43.0	—	—	—	—	—	—	clear, trace sand, light brown
10:00	43.0	16.85	6	990	178	62	4.9	cloudy, light brown, trace sand ½ tsp
10:10	41.00	—	—	—	—	—	—	
10:40	41.00	16.83	6	1170	142	74	4.9	light brown, trace fine sand < ½ tsp
Surge block off								
10:50	49.00	~~[illegible]~~	—	—	—	—	—	
11:20	49.00	16.83	6	1360	187	25	5.0	
11:30	35.00	—	—	—	—	—	—	trace fine sand, < ½ tsp, light brown
12:00	35.00	16.82	6	1540	240	14	5.1	
12:10	49.00							light brown, ~~trace fine sand~~, < ½ tsp
12:40	49.00	16.82	6	1720	410	14	5.5	clear, trace sand, < ½ tsp

THE pebble PARTNERSHIP

P-08-82S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82S

DATE STARTED 8/5/08 **COMPLETED** 8/5/08 **GROUND ELEVATION** 892.02 feet **TOC ELEVATION** 895.12 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127903.41 feet **EASTING** 1400487.73 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-1 feet
					1.0	
					Organic Soil, Sand, and Gravel subangular to subrounded gravel, clasts up to 1/4", coarse grained sand	
					2.0	
					GP **Sand and Gravel** subangular to subrounded gravel, clasts up to 1/2", fine to medium grained, trace brown silt, dry	
5						
10		▼			11.0	
					GP **Sand and Gravel** subangular to subrounded gravel, clasts up to 1/4", medium to coarse grained sand, wet	Encountered water, 11.5 feet
					13.0	
					GP **Gravel** angular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/4", trace silt, wet	
15			1.75			
					18.0	
					GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", coarse grained sand, trace silt, wet	Discharge water is brown, 18-21 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 188# cement, 30 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/10/2008
Purge Volume: 1114 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/5/08 at 248 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-82S
PAGE 2 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-82S

DATE STARTED 8/5/08 **COMPLETED** 8/5/08 **GROUND ELEVATION** 892.02 feet **TOC ELEVATION** 895.12 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2127903.41 feet **EASTING** 1400487.73 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	Not logged, 21-22 feet
					22.0 Bottom of hole at 22.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-[redacted] 825
Date: 9 Sept 08
Project: [redacted] Pebble
Project #: 005.0189.08002
Technician: D. Pardee, J Tsao

Summary

	Installed (Well Log)	Start	End
Water level	13.10	12.86	12.79
Total depth	21.0	24.3	24.50
pH			

Screen interval (btoPVC): 10ft
Top: [redacted] 11.83
Bottom: [redacted] 21.0
PVC stick-up height (above ground surface): 3.1

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cohd (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
7.88 4:05	20.00	12.86	4	4	555	71005	10.8	Brown, silt + fine sand, 1 cup
7.58 4:35	20.00	12.86	4	124	554	260	11.0	light brown, fine sand & silt, ½ teaspoon
Sept 10/08 → 4:45	18.00	—	—	—	—	—	—	
7.60 11:10	18.00	12.81	4	244	560	24	10.9	clear, trace sand < ½ teaspoon
11:15	16.00	—	—	—	—	—	—	
7.52 11:45	16.00	12.79	5	394	505	52	11.0	clear, trace sand < ½ teaspoon
11:55	14.00	—	—	—	—	—	—	
7.36 12:25	14.00	12.79	5	544	500	118	11.2	milky, brown fine sand, ½ teaspoon
13:30	12.00	—	—	—	—	—	—	
7.40 13:45	12.00	12.77	3	724	496	51	11.8	milky clear, trace sand, < ½ teaspoon
Surge block off								
13:25	20.00	—	—	—	—	—	—	
7.45 13:55	20.00	12.79	5	874	516	34	11.8	clear, trace sand, < ½ teaspoon
14:05	12.00	—	—	—	—	—	—	
7.50 14:35	12.00	12.79	3	964	491	38	12.0	clear, trace sand, < ½ teaspoon
14:40	20.00	—	—	—	—	—	—	
8.05 15:10	20.00	12.79	5	1114	490	22	12.2	clear, trace sand

EOH 24.50

THE pebble PARTNERSHIP

P-08-83D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					Organic Soil brown	
					1.0	
					SP **Sand** brown, trace gravel, clasts up to 1/2", fine to medium grained sand, moist	
					3.0	
					SP **Gravelly Sand** subangular to subrounded gravel, clasts up to 1/2", fine to medium grained sand, trace silt	
5	GB				5.0	
					GW **Sandy Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
					7.0	
					GP **Gravel** angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", wet	Adding water while drilling, 7-8 feet
					8.0	
					GP **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	Little recovery, 9-10 feet
10	GB				9.0	
					SP **Gravelly Sand** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, moist	Very little recovery, 11-15 feet
					11.0	
					SW **Sand** brown, trace gravel, clasts up to 1/4", fine to coarse grained sand, moist	
					12.0	
					SP **Gravelly Sand** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, moist	
15					15.0	
					GP **Sandy Gravel** brown, angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", fine to coarse grained sand, moist	
					17.0	
					GP **Gravel** most of the clasts are fractured, clasts up to 1/2", wet	Angular gravel, 17-18 feet Very little recovery, 17-21 feet Adding water while drilling, 17-47 feet
					19.0	
20	GB				GP **Gravel with Sand** most of the clasts are fractured, clasts up to 1/2", coarse grained sand, wet	Angular to subangular gravel, 18-21 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 30 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/9/2008
Purge Volume: 1500 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/10/08 at 749 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83D
PAGE 2 OF 7

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0	No recovery, 21-24 feet
					24.0	
25	GB				GP **Gravel with Sand** angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", coarse grained sand, wet	Little recovery; clasts up to 1/2", 25-26 feet
					25.0	
					GP **Gravel** angular to subangular gravel, 75% of clasts are fractured, trace coarse grained sand, wet	Clasts up to 3/4", 26-27 feet
					27.0	Discharge water is brown, 26-46 feet
			no flow			No recovery, 27-29 feet
					29.0	
30	GB				GP **Gravel with Sand** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	No recovery, 30-31 feet
					30.0	
					31.0	Clasts up to 1/2", 31-33 feet
		▼			GP **Gravel with Sand** subangular to rounded gravel, 75% of clasts are fractured, coarse grained sand, wet	Little recovery, 32-33 feet
			no flow			Clasts up to 3/4", 33-35 feet
35					35.0	
					GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand	Clasts up to 3/4", 35-36 feet
					37.0	Clasts up to 1/2", 36-37 feet
			no flow		GP **Gravel** angular to subrounded gravel, most of the clasts are fractured, clasts up to 3/4", trace coarse grained sand	
40	GB					Encountered water, 39 feet
					42.0	50% of clasts are fractured, 41-42 feet
			4		SP **Gravelly Sand** subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand	
					43.0	
					GP **Gravel** angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", trace coarse grained sand	
45					45.0	
					GW **Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", trace coarse grained sand	Discharge water is dark brown, 46-47 feet
					46.0	
					47.0	Discharge water is brownish white, 47-50 feet
					SP **Gravelly Sand** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	Adding foam and water while drilling, 47-53 feet
			<0.25		48.0	
	GB				GW **Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", trace coarse grained sand	Angular to subrounded gravel; 50% of clasts are fractured, 48-50 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						
					51.0 GP **Sand and Gravel** clasts up to 1/2", medium to coarse grained sand	Subangular to subrounded gravel, 25% of clasts are fractured, 50-51 feet
					SP **Gravelly Sand** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	Discharge water is brown, 50-84 feet
			1		53.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
55	GB				55.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", coarse grained sand	Clasts up to 3/4", 55-57 feet
			1			Adding foam and water while drilling; clasts up to 1/2", 57-58 feet
						Clasts up to 3/4", 58-60 feet
60	GB					Clasts up to 1/2", 60-63 feet
						Adding foam and water while drilling, 60-66 feet
			<0.125		63.0	No recovery, 63-64 feet
					64.0	
65					65.0 GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", coarse grained sand	
			1		SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand 67.0	Clasts up to 1/2", 67-69 feet
					GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, coarse grained sand	
70	GB					Clasts up to 3/4", 69-71 feet
					71.0	Adding foam while drilling, 71-72 feet
			0.25		SP **Sand with Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand 72.0	Very little recovery, 72-73 feet
					73.0 SP **Sand with Gravel** brown, trace gravel, medium grained sand	10% of clasts are fractured, 73-74 feet
					GP **Sand and Gravel** subangular to subrounded gravel, clasts up to 1/2", coarse grained sand 75.0	Adding foam while drilling, 73-80 feet
75						25% of clasts are fractured, 74-75 feet
					GW **Sand and Gravel** angular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
			1.5		77.0	
					GW **Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", coarse grained sand 78.0	Clasts up to 3/4", 78-79 feet
	GB				GW **Sandy Gravel** angular to subrounded gravel, 50% of clasts are fractured, coarse grained sand 80.0	Clasts up to 1/2", 79-80 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
			0.5		SP **Sand with Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	Adding foam while drilling, 81-82 feet
					82.0 SP **Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium grained sand	Adding foam while drilling, 83-84 feet
					84.0 SP **Sand** brown, trace gravel, medium grained sand	
85						Clasts up to 1/2", 85-87 feet Discharge water is brown, 85-88 feet Adding foam while drilling, 85-97 feet
			<0.125		87.0 SP **Sand with Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
					88.0 SP **Sand** brown, trace gravel, clasts up to 1/2"	Medium to coarse grained sand, 88-89 feet Discharge water is golden brown, 88-95 feet
90	GB					Medium grained sand, 89-90 feet Medium to coarse grained sand, 90-91 feet Medium grained sand, 91-92 feet Medium to coarse grained sand, 92-93 feet
			0.75		93.0 SP **Sand with Gravel** brown, subangular gravel, clasts up to 3/4", medium to coarse grained sand	
					94.0 SP **Sand** brown, trace gravel, clasts up to 1/2", medium to coarse grained sand	
95					95.0 SP **Sand** brown, trace gravel, medium to coarse grained sand	Discharge water is brown, 95-105 feet
						Slow drilling, 97-102 feet Adding water while drilling, 97-105 feet
100	GB					
			0.25		102.0 GP **Sand and Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", coarse grained sand, trace silt, wet	
					103.0 SP **Sand** trace fine gravel, medium to coarse grained sand, wet	
105	GB				105.0 GP **Gravel** brown, medium grained sand, wet	
			0.75			Adding water while drilling; discharge water is brown, 106-107 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83D
PAGE 5 OF 7

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110						
			1.25		111.0 GP **Gravel** brown, medium grained sand, wet	
					113.0 GM **Sand and Gravel with Silt** grayish brown, 75% of clasts are fractured, medium to coarse grained sand, wet	Adding water while drilling, 111-112 feet Discharge water is brown, 111-113 feet More silt than rest of unit, 112-113 feet
115	GB				GM **Silty Gravel** grayish brown, 75% of clasts are fractured, coarse grained sand, wet	
			0.75		117.0	Adding water while drilling; discharge water is brown, 116-117 feet
					118.0 GM **Silty Gravel** brown, 75% of clasts are fractured, fine to coarse grained sand, wet	
120	GB				GM **Silty Gravel** grayish brown, 75% of clasts are fractured, medium to coarse grained sand, wet	
					120.0 SP **Sand** brownish gray, trace gravel, 10% of clasts are fractured, fine to coarse grained sand, trace silt, wet	Little recovery, 119-120 feet Slow drilling, 120-121 feet
			1.5		122.0	
					123.0 GP **Gravel with Sand** brown, subangular gravel, 75% of clasts are fractured, fine to coarse grained sand, trace silt, wet	
125	GB				124.0 GP **Gravel** brown, subangular gravel, 75% of clasts are fractured, trace fine to coarse grained sand, trace silt, wet	
					126.0 GP **Sandy Gravel** brown, subangular gravel, 75% of clasts are fractured, fine to coarse grained sand, wet	Adding water while drilling; discharge water is brown, 126-127 feet
			1.1		127.0 GM **Gravel with Silt** subangular gravel, most of the clasts are fractured, some medium to coarse grained sand, wet	
					128.0 GM **Sandy Gravel with Silt** brown, subangular gravel, 75% of clasts are fractured, medium to coarse grained sand, wet	
130	GB				130.0 GP **Gravel with Sand** brown, subangular gravel, most of the clasts are fractured, clasts up to 1"	Not logged, 129-130 feet
					131.0 GP **Gravel** brown to black, subangular gravel, 100% of clasts are fractured, wet	Adding water while drilling; discharge water is brown, 131-132 feet
			0.75		133.0 GM **Sand and Gravel with Silt** gray, subangular gravel, 75% of clasts are fractured, well graded fine to coarse grained sand, wet	Slow drilling; little recovery; adding foam while drilling, 133-134 feet 75% of clasts are fractured, 133-135 feet
			1.75		GM **Sandy Gravel with Silt** gray, subangular gravel, 75% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	
135	GB					
			2.5			Adding water while drilling; discharge water is brown, 136-137 feet 100% of clasts are fractured, 136-140 feet Slow drilling, 137-138 feet Some black angular gravel, 137-140 feet
			2.5			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					140.0 GM **Sand and Gravel with Silt** brown, 75% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	75% of clasts are fractured; clasts up to 1/2", 140-142 feet Adding foam while drilling, 140-141 feet
			2.5			100% of clasts are fractured; clasts up to 1/4", 142-144 feet
					144.0 GM **Sandy Gravel with Silt** gray, subangular gravel, 100% of clasts are fractured, fine to coarse grained sand, wet	
145	GB				146.0 SP **Gravelly Sand** gray, subangular gravel, 100% of clasts are fractured, clasts up to 1/2", wet	
					147.0 SP **Gravelly Sand** gray, angular to subangular gravel, most of the clasts are fractured, clasts up to 1/2", wet	Discharge water is gray, 147-165 feet
			0.75		148.0 GP **Sand and Gravel** gray, subangular to subrounded gravel, most of the clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	Adding foam while drilling, 149-151 feet
150	GB				151.0 GP **Sand and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2"	Coarse grained sand, 151-152 feet Medium to coarse grained sand, 152-153 feet
					154.0	Flow test may be biased high, 154 feet
155	GB		18		155.0 GP **Gravel** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", coarse grained sand	Clasts up to 1/2", 155-156 feet
					GP **Sandy Gravel** subangular to subrounded gravel, 75% of clasts are fractured, medium to coarse grained sand	Clasts up to 3/4", 156-158 feet
			1			Clasts up to 1/2", 158-159 feet
					159.0	
160	GB				160.0 GP **Sand and Gravel** subangular gravel, most of the clasts are fractured, clasts up to 1/2", medium to coarse grained sand	Clasts up to 3/4", 160-164
					GP **Sand and Gravel** subangular to subrounded gravel, most of the clasts are fractured, medium to coarse grained sand	Adding foam while drilling, 162-163 feet
			0.25			Clasts up to 1/2", 164-165 feet
165	GB				165.0	Discharge water is brown, 165-168 feet
					166.0 GP **Sand and Gravel** subangular gravel, most of the clasts are fractured, clasts up to 1/2", fine grained sand	Adding foam while drilling, 166-168 feet
					GP **Sand and Gravel** subangular to subrounded gravel, most of the clasts are fractured, clasts up to 1/2", fine grained sand	
			1		168.0	Advanced via mud rotary, 168-189 feet No recovery, 168-169 feet Very little recovery, 169-170 feet
					169.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83D

DATE STARTED 8/5/08 **COMPLETED** 8/8/08 **GROUND ELEVATION** 922.95 feet **TOC ELEVATION** 925.75 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130236.56 feet **EASTING** 1405003.41 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, S. O'Neill

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170						
					171.0 SP **Sand with Gravel** brown, some subangular gravel, 100% of clasts are fractured, clasts up to 1/4", coarse grained sand, trace silt, wet	
					GP **Gravel** subangular gravel, 100% of clasts are fractured, clasts up to 1/4", trace sand, trace silt	Fine grained sand, 174-177 feet
175						
						Slow drilling, 176-177 feet
					177.0	
	SS				**Bedrock (Tertiary Volcanoclastic)** dark green and pinkish red volcanoclastic rock, chlorite and hematite present throughout	SPT blow counts: 71-65-X-X, 177-179 feet
180						
185						
					189.0	
					189.7	Not logged, 189-189.7 feet
					Bottom of hole at 189.7 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-[redacted] 83D
Date: 8 Sept 2008
Project: Pebble
Project #: 005.0189.08002
Technician: D. Pardoe / J. Tsao

Summary

	Installed (Well Log)	Start	End
Water level	29.75	29.5	
Total depth	189.0		
pH			

Screen interval (btoPVC): 2 8
Top: [redacted] 180.1
Bottom: [redacted] 189.7
PVC stick-up height (above ground surface):

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH	Surge block on							
8.95	2:30	188.0	29.5	5	5	1028	>1000	4.5 white/brown, silt fine sand, ½ tablespoon
8.74	3:30	188.0	36.3	4	245	690	471	4.6 brown, fine sand, 1 tablespoon
	3:30	186.0	–	–	–	–	–	–
8.12	4:30	186.0	36.27	5	545	790	394	5.0 light brown, fine sand/silt, 1 tablespoon
sept 8 →	8:35	184.0	–	–	–	–	–	–
8.28	9:11	184.0	38.31	5	725	729	373	4.5 light brown, fine sand silt, ½ tablespoon
	9 20	180.0	–	–	–	–	–	–
8.40	10:00	182.0	37.50	4	880	700	355	4.5 light brown, fine sand/silt, 1 teaspoon
	10:10	180.0	–	–	–	–	–	–
8.65	10:05	180.0	37.51	4	1080	765	142	4.6 light brown, fine sand, ½ teaspoon
	~~11:15~~	~~175.0~~						
	~~12:00~~							
pH	Surge block off							
debris	11:15	188.0	–	–	–	–	–	–
8.51	12:00	188.0	36.1	4	1260	641	198	4.5 light brown, fine sand, ½ teaspoon
polish	12:10	175.0	–	–	–	–	–	–
8.40	12:40	175.0	36.95	4	1380	653	34	4.5 clear, trace sand, <½ teaspoon
	12:50	188.0	–	–	–	–	–	–
8.39	13:20	188.0	36.50	4	1500	697	70	4.4 clear, trace sand, <½ teaspoon

THE pebble PARTNERSHIP

P-08-83M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83M

DATE STARTED 8/10/08 **COMPLETED** 8/10/08 **GROUND ELEVATION** 923.52 feet **TOC ELEVATION** 926.62 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130215.8 feet **EASTING** 1405015.28 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist	
					2.0	No recovery, 2-3 feet
					3.0	
					SM **Silty Sand** brown, trace gravel, clasts up to 1/4", medium to coarse grained sand, moist	
					4.0	
5					SM **Silty Sand with Gravel** brown, trace gravel, clasts up to 1/4", medium to coarse grained sand, moist	
					5.0	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, moist	10% of clasts are fractured, 6-7 feet
					7.0	
					SW **Sand** brown, trace subangular gravel, fine to coarse grained sand, trace silt, dry	
					8.0	
					SM **Sand with Gravel and Silt** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, dry to moist	
					9.0	
10					10.0	
					GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, medium to coarse grained sand, moist	
					GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, medium to coarse grained sand, moist	Clasts up to 1/2", 13-14 feet
						Hard drilling; clasts up to 1/4", 14-15 feet
15						Little recovery, 14-17 feet
					17.0	No recovery, 17-19 feet
					19.0	
20						Medium to coarse grained sand, 19-21 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.1'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/7/2008
Purge Volume: 1812 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/11/08 at 618 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83M

DATE STARTED 8/10/08 **COMPLETED** 8/10/08 **GROUND ELEVATION** 923.52 feet **TOC ELEVATION** 926.62 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130215.8 feet **EASTING** 1405015.28 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
					21.0 GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, moist	Hard drilling, 20-22 feet
					22.0 GM **Gravel with Silt and Sand** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, moist	Fine grained sand, 21-22 feet
					23.0 GM **Gravel** brown, subangular to subrounded gravel, clasts up to 1/4", trace fine to medium grained sand, trace silt, moist	Little recovery, 23-26 feet
25					25.0 SM **Sand with Silt** brown, trace gravel, clasts up to 1/4", fine to coarse grained sand, moist	
					26.0 SM **Gravelly Sand with Silt** brown, subangular gravel, 25% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, moist	10% of clasts are fractured; clasts up to 1/2", 26-27 feet 25% of clasts are fractured; clasts up to 1", 27-28 feet
					GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", moist	Less fractured gravel, 28-31 feet Hard drilling, 29-30 feet
30					31.0	No recovery, 31-32 feet
					32.0	Very little recovery, 32-33 feet
		▼			GP **Gravel** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/4", trace medium to coarse grained sand, trace silt, moist 33.0	No recovery, 33-34 feet
					34.0	Very little recovery, 34-35 feet
35					GP **Gravel with Sand** brown, subangular gravel, 10% of clasts are fractured, clasts up to 1/4", trace fine to coarse grained sand, trace silt, moist 35.0	Hard drilling, 35-36 feet No recovery, 35-37 feet
					37.0	
					GP **Gravel** brownish gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/4", trace coarse grained sand, wet 38.0	Encountered water, 38 feet Discharge water is brown, 38-39 feet
40					GM **Silty Gravel** brownish gray, subangular to subrounded gravel, 50% of clasts are fractured, trace coarse grained sand, wet	Clasts up to 1/4", 38-40 feet Little to very little recovery, 38-41 feet More sand than rest of unit, 39-42 feet Clasts up to 1/2", 40-41 feet Clasts up to 1/4", 41-42 feet
					42.0	
			0.7		GM **Sand and Gravel with Silt** brown, subangular gravel, clasts up to 1/2", coarse grained sand, wet 43.0	Discharge water is brown, 42-72 feet Adding water while drilling, 43-72 feet
45					SM **Silty Sand with Gravel** brown, subangular to subrounded gravel, fine to coarse grained sand, wet	
					47.0	
			1.4		GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, fine to coarse grained sand, wet	Little recovery, 48-49 feet
					50.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83M

DATE STARTED 8/10/08 **COMPLETED** 8/10/08 **GROUND ELEVATION** 923.52 feet **TOC ELEVATION** 926.62 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130215.8 feet **EASTING** 1405015.28 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, wet	
			10			
55						Slow drilling, 56-57 feet
						10 to 20% of clasts are fractured, 57-60 feet
			6.5			
60					60.0	
					GM **Sand and Gravel with Silt** subangular to subrounded gravel, 10% of clasts are fractured, wet	Fine grained sand, 60-61 feet
					62.0	Medium to coarse grained sand, 61-62 feet
					SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, fine to coarse grained sand, wet	
			2.5		63.0	
					SM **Sand with Silt and Gravel** brown, subangular to subrounded gravel, fine to coarse grained sand, wet	
65					65.0	
					SM **Sand with Silt** brown, trace gravel, fine to medium grained sand, wet	
					66.0	
					SM **Sand with Silt and Gravel** brown, subangular gravel, fine to medium grained sand, wet	
					67.0	Very little recovery, 67-68 feet
			1.25		GP **Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", trace sand, trace silt, wet	
					68.0	
					69.0	
70					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, medium to coarse grained sand, wet	
					SM **Silty Sand with Gravel** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	
			0.25			
75						Adding water while drilling; discharge water is brown, 75-82 feet
					77.0	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, medium to coarse grained sand, wet	
			1		78.0	
					SM **Silty Sand** brown, trace subrounded gravel, fine to coarse grained sand, wet	More silt than rest of unit, 79-80 feet
					80.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83M

DATE STARTED 8/10/08 **COMPLETED** 8/10/08 **GROUND ELEVATION** 923.52 feet **TOC ELEVATION** 926.62 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130215.8 feet **EASTING** 1405015.28 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					ML **Silt and Sand** brown, trace gravel, fine to coarse grained sand, wet	Discharge water is dark brown; increase in silt content in discharge, 80-81 feet
					82.0	No recovery, 82-84 feet
			0.75		84.0	
85					ML **Silt and Sand** brown, trace gravel, fine to coarse grained sand, wet	Discharge water is dark brown, 84-89 feet
					87.0	Trace gravel, 86-87 feet
					GM **Sand and Gravel with Silt** brown, subangular gravel, 50% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, wet	Adding water while drilling, 87-102 feet
			1		88.0	
					89.0 SM **Sand with Silt and Gravel** subangular gravel, clasts up to 1/2", fine to coarse grained sand	
90					90.0 GM **Silty Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, trace coarse grained sand, wet	
					91.0	No recovery, 91-92 feet
					92.0 GM **Sandy Gravel with Silt** brown, subangular gravel, 50% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	Little recovery, 92-93 feet
			2.1		93.0	
					GM **Sandy Gravel with Silt** brown, subangular gravel, 50% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	Hard drilling, 94-95 feet
95					95.0	Little recovery, 94-96 feet
					SP **Sand with Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
					96.0	10% of clasts are fractured, 96-97 feet
					GM **Sand and Gravel with Silt** subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
			7.5		99.0 SP **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, wet	
100					100.0	No recovery, 100-101 feet
					101.0 SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, medium to coarse grained sand, wet	
					102.0 GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand, wet	
					Bottom of hole at 102.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-83M
Date: 7/7/08

Project: Pebble
Technician: D. Pardee / M. Swain

Summary

	Installed (Well Log)	Start	End
Water level		37.77	37.85
Total depth		106.25	106
pH		7.58	

Screen interval (btoPVC):
Top: 91.40
Bottom: 101.2
PVC stick-up height (above ground surface): 3.1

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
7.58 11.20	100.2	37.77	6	6	790	587	4.6	Brown, silty fine Sand, 1 cup
7.64 12.16	098.2	37.44	6	324	1749	315	4.6	Brown, silty fine Sand ½ cup
8.17 12.49	096.2	37.41	6	534	705	89	4.9	white/ milky, fine sand 1 tablespoon
13.41	096.2	38.22	6	846	712	68	5.2	white/ milky, fine Sand, 1 tablespoon
8.62 DRY	092.2	38.44	6	990	660	142	4.7	white/ milky, fine sand, 1 teaspoon
7.99 3.01	090.2	38.24	6	1206	642	82	4.5	White/ milky, fine sand, 1 teaspoon
	120							
Surge block off								
7.72 3.36	100.2	38.19	6	1416	612	65	4.7	clear, silt, fine sand 1 teaspoon
8.62 4.10	86.4	35.22	6	1632	708	26	5.3	
7.95 4.40	101.2	37.95	6	1812	782	50	5.3	

THE pebble PARTNERSHIP

P-08-83S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83S

DATE STARTED 8/11/08 **COMPLETED** 8/11/08 **GROUND ELEVATION** 922.94 feet **TOC ELEVATION** 926.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130195.55 feet **EASTING** 1405035.28 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist (2.0)	
					SM **Sand with Silt and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist (4.0)	
5					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist (7.0)	
					8.0	Very little recovery; not adequate for logging, 7-8 feet
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist (11.0)	
10					SM **Sand with Silt** brown, trace subrounded gravel, fine to coarse grained sand, moist (12.0)	Little recovery, 12-13 feet
					SM **Sand with Silt and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist (13.0)	Clasts up to 1/2", 13-14 feet
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, medium to coarse grained sand, moist (15.0)	Clasts up to 1/4", 14-15 feet
15					SM **Sand with Silt** brown, trace subrounded gravel, fine to coarse grained sand, moist (17.0)	Little recovery, 15-17 feet
					GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist (18.0)	More gravel than rest of unit; clasts up to 1/2", 16-17 feet
					SM **Sand with Silt and Gravel** brown, subangular to subrounded gravel, fine to coarse grained sand, moist (19.0)	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 30 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/8/2008
Purge Volume: 1211 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/11/08 at 230 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-83S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-83S

DATE STARTED 8/11/08 **COMPLETED** 8/11/08 **GROUND ELEVATION** 922.94 feet **TOC ELEVATION** 926.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130195.55 feet **EASTING** 1405035.28 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
					21.0 GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, moist	Difficult drilling, 21 feet
					22.0 SM **Sand with Silt** brown, trace subangular gravel, clasts up to 3/4", fine to medium grained sand, moist	Little recovery, 22-24 feet
					24.0 SW **Sand** gray, fine to coarse grained sand, trace silt, moist	
25					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, fine to coarse grained sand, moist	Clasts up to 1", 24-25 feet
					26.0	Clasts up to 3/4", 25-26 feet
	GB				27.0 SW **Sand** gray, trace gravel, fine to coarse grained sand, trace silt, moist	
					28.0 SW **Sand with Gravel** gray, clasts up to 1/4", fine to coarse grained sand, trace silt, moist	Little to very little recovery, 27-31 feet
					29.0 SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, moist	
30					30.0 SM **Sand with Silt** grayish brown, trace gravel, clasts up to 1/4", fine to coarse grained sand, trace silt, moist	
					31.0	No recovery, 31-32 feet
	GB	▼			32.0 SM **Sand with Silt and Gravel** grayish brown, clasts up to 1/2", fine to coarse grained sand, trace silt, moist to wet	
					33.0 SM **Sand with Silt and Gravel** grayish brown, clasts up to 1/2", fine to coarse grained sand, trace silt, moist to wet	Encountered water, 34 feet
35					35.0 GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, moist	
					37.0 SM **Sand with Silt** brown, trace subrounded gravel, fine to coarse grained sand, wet	Discharge water is brown, 37-38 feet
	GB		no flow		GM **Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", trace fine to coarse grained sand, wet	Discharge water is silty, 38-39 feet
40					42.0	
					Bottom of hole at 42.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-835
Date: 8/Sept 08
Project: Pebble
Project #: 005.0189.08002
Technician: D. Pardoe, J Tsao

Summary

	Installed (Well Log)	Start	End
Water level	29.78	36.73	
Total depth	45.3	45.3	
pH			

Screen interval (btoPVC): 10 ft
Top: 32.40
Bottom: 42.0
PVC stick-up height (above ground surface): 3.3 ft

Development Observations

	Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
	Surge block on								
8.89	8:45am	41.3	29.78	5	5	321	>1000	4.5	Brown, fine sand, one cup
7.75	9:28	39.3	27.78	5	205	180	135	4.4	Brown, fine sand, ± tablespoon
8.20	10:18	37.3	36.72	5	455	140.8	143	4.7	Brown, fine sand 1 teaspoon
7.77	11:08	35.3	36.71	4	655	138.4	165	4.9	Brown, fine sand ½ teaspoon
7.76	12:00	—	36.69	3	811	220	540	4.9	Brown, fine sand, milky, 1 teaspoon
		43	—						
	Surge block off								
7.52	12:00	44.3	36.74	5	1011	322	213	4.8	Brown, fine sand, <½ teaspoon
7.51	12:40	35.3	36.72	5	1211	272	84	5.1	brown, fine sand, <½ teaspoon
	13:30								END

42.90

THE pebble PARTNERSHIP

P-08-84D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-84D

DATE STARTED 8/12/08 **COMPLETED** 8/12/08 **GROUND ELEVATION** 852.79 feet **TOC ELEVATION** 855.19 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130954.93 feet **EASTING** 1378293.49 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Silty Organic Soil with Sand** brown, trace gravel, moist	Fine grained sand, 0-2 feet
					3.0	Fine to coarse grained sand, 2-3 feet
					ML **Silt** dark brown, trace gravel, trace fine grained sand, moist to wet	
5	GB				5.0	More gravel than rest of unit, 4-5 feet
					ML **Sandy Silt with Gravel** brown, fine grained sand, moist to wet	
					6.0 SW **Sand with Gravel** brown, fine to coarse grained sand, trace silt, moist	
					8.0 GP **Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", trace silt, moist	
10	GB				9.0 SW **Sand with Gravel** brown, subangular to subrounded gravel, fine to coarse grained sand, trace silt, moist	No recovery, 10-12 feet
					10.0	Hard drilling, 11-12 feet
					12.0 GM **Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand	Cuttings are moist, 12-13 feet
					14.0	Cuttings are moist to wet, 13-14 feet
15	GB	▼			GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist to wet	
					16.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/4", moist to wet	
					17.0 GM **Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", trace coarse grained sand, wet	Encountered water; discharge water is brown, 18 feet
20	GB					Less silt than rest of unit, 19-20 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.4'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/15/2008
Purge Volume: 1211 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/13/08 at 610 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-84D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-84D

DATE STARTED 8/12/08 **COMPLETED** 8/12/08 **GROUND ELEVATION** 852.79 feet **TOC ELEVATION** 855.19 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130954.93 feet **EASTING** 1378293.49 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", trace coarse grained sand, wet	Smaller clasts than rest of unit, 20-22 feet
					22.0	
			0.25		GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, clasts up to 1/2", coarse grained sand, wet	
					24.0	
25	GB				GP **Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, trace silt, wet	Clasts up to 1/2", 25-29 feet
					25.0	Discharge water is brown, 25-41 feet
					GM **Silty Sand and Gravel** brown, subangular gravel, coarse grained sand, wet	
			0.125			
30	GB					25% of clasts are fractured; clasts up to 1", 29-30 feet
					30.0	
					SM **Silty Sand** brown, trace gravel, fine to coarse grained sand, wet	
					31.0	No recovery, 31-33 feet
						Adding water while drilling, 32-41 feet
					33.0	
			0.5		GW **Gravel** brown, subangular gravel, clasts up to 1", trace sand, trace silt, wet	
					34.0	
35	GB				SM **Sand with Gravel and Silt** brown, subangular to subrounded gravel, clasts up to 1", fine to coarse grained sand, wet	
					36.0	
					GM **Silty Sand and Gravel** brown, subangular gravel, clasts up to 1/2", fine to coarse grained sand, wet	
					37.0	
			2.5		SM **Sand with Gravel and Silt** brown, subangular gravel, fine to coarse grained sand, wet	More gravel than rest of unit, 38-39 feet
					39.0	Hard drilling, 39-40 feet
40	GB				GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand, wet	
					40.0	
					SM **Sand with Gravel and Silt** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, wet	Discharge water is light brown, 42-43 feet
			5.5			
45	GB					
					47.0	
					GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, wet	Discharge water is dark brown, 47-48 feet
			0.75			
					49.0	
	GB					Hard drilling, 49 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-84D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-84D

DATE STARTED 8/12/08 **COMPLETED** 8/12/08 **GROUND ELEVATION** 852.79 feet **TOC ELEVATION** 855.19 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130954.93 feet **EASTING** 1378293.49 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom, R. Jacobson

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			15	50.5	GW **Gravel with Sand** subangular gravel, 50% of clasts are fractured, clasts up to 1", fine to coarse grained sand,	Very hard drilling, 50-57 feet
			9		**Bedrock (Cretaceous Kaskanak Batholith - Granodiorite)** white to gray speckled granodiorite, distinctive green euhedral hornblendes (~10% altered to chlorite) within poorly-developed feldspar/plagioclase dominated groundmass	Adding water while drilling, 53-54 feet
55	GB		7.5			Moved to open hole hammer, 54 feet Discharge water is white to gray, 54-59 feet
			7			
60	GB		6.5			Discharge water is gray to brown, 59-61 feet
			8.25			Discharge water is gray, 61-79 feet
			12			
65			11			
			11			
			11			
70			16			
			14			
			19.5			
75			16.5			
			13.5			
			13.5	79.0		Not logged, 79-79.7 feet
				79.7		

Bottom of hole at 79.7 feet.

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-~~[illegible]~~ 84D
Date: Sept 5
Project: Pebble
Project #: 005.0189.08002
Technician: DP / JT

Summary

	Installed (Well Log)	Start	End
Water level	12.92	12.27	
Total depth	749	7839	
pH			

Screen interval (btoPVC):
Top: ~~[illegible]~~ 65 10
Bottom: ~~[illegible]~~ 749
PVC stick-up height (above ground surface): 2.4

Development Observations

7.83

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
8.51 1345	73.9	12.27	5	5	351	>1000	6.0	brown, fine sand, 2 bubbles/sec.
1350	→ well out of water							
	waited for recharge to confirm static							
	→ slow recovery rate							
Surge block off								

THE pebble PARTNERSHIP

P-08-84S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-84S

DATE STARTED 8/13/08 **COMPLETED** 8/13/08 **GROUND ELEVATION** 853.85 feet **TOC ELEVATION** 856.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130999.24 feet **EASTING** 1378275.21 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Silty Organic Soil with Sand** brown, fine to coarse grained sand, moist	
					Silty Organic Soil brown, trace subangular gravel, clasts up to 1/2", trace fine to coarse grained sand, moist	
					3.0 ML **Silt with Organic Soil** brown, trace subangular to subrounded gravel, clasts up to 1/2", wet	
5					6.0	
					7.0	No recovery, 6-7 feet
					GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1/4", medium to coarse grained sand, wet	
					8.0 SM **Sand with Silt** brown, medium to coarse grained sand, moist	
10					9.0 10.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, moist	Hard drilling, 10 feet No recovery, 10-12 feet Hard drilling, 11-11.8 feet
					12.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist	
15		▼			15.0	
	GB				16.0 GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", medium to coarse grained sand, moist	
					17.0 SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist to wet	No recovery, 17-18 feet Encountered water, 17.5 feet Discharge water is brown, 17.5-32 feet
					18.0 GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 200# cement, 30 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/15/2008
Purge Volume: 1431 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/30/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 11/13/08 at 220 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-84S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-84S

DATE STARTED 8/13/08 **COMPLETED** 8/13/08 **GROUND ELEVATION** 853.85 feet **TOC ELEVATION** 856.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2130999.24 feet **EASTING** 1378275.21 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	More sand than rest of unit, 20-21 feet
					22.0	
	GB		0.25		GM **Gravel with Sand and Silt** brown, subangular gravel, 25% of clasts are fractured, clasts up to 3/4", wet	Some angular gravel present, 23-24 feet
						More sand than rest of unit, 24-25 feet
25					25.0	
					GM **Sand and Gravel with Silt** brown, subangular gravel, clasts up to 1/2", wet	Medium to coarse grained sand, 25-26 feet
					27.0	Coarse grained sand, 26-27 feet
	GB		0.15		GM **Sandy Gravel with Silt** subangular gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand, wet	
					29.0	
30					SM **Gravelly Sand with Silt** brown, subangular gravel, clasts up to 1/2", fine to coarse grained sand, wet	
					31.0	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, wet	Not logged, 32-32.8 feet
					32.0	
					32.8	
					Bottom of hole at 32.8 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

845

Well ID: ~~R-08-04m~~

Date: Sept 13/08

Project: Pebble

Project #: 005.0189.08002

Technician: DP / JT

Summary

	Installed (Well Log)	Start	End
Water level	12.85	14.1	12.75
Total depth	32.8	36.15	36.2
pH		8.12	7.45

Screen interval (btoPVC):

Top: ~~0~~ 22.2 23.2 +3.0

Bottom: ~~0~~ 32.8 +3.0

PVC stick-up height (above ground surface): 3.0

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
8.12 14:00	34.8	14.1	6	6	370	>1000	5.8	brown, fine sand, 1 cup
8.34 14:30	34.8	14.09	5	156	230	109	4.9	light brown, fine sand, 1 teaspoon
14:35	32.8	-	-	-	-	-	-	
7.45 15:05	32.8	14.00	5	306	210	80	4.9	light brown, trace fine sand, <½ tsp
15:10	30.8	-	-	-	-	-	-	
7.51 15:55	30.8	14.00	5	531	243	111	5.0	light brown, trace fine sand, <½ tsp
Sept 15/08 → 09:20	28.8	-	-	-	-	-	-	
8.20 10:00	28.8	12.73	5	731	110 mS	196	5.1	brown, fine sand, <1 tsp
10:10	26.8	-	-	-	-	-	-	
7.80 11:00	26.8	12.75	5	981	72 mS	173	5.1	light brown, fine sand, <1 tsp
11:10	24.8	-	-	-	-	-	-	
7.60 11:40	24.8	12.75	5	1031	107.5 mS	86	5.5	brown, trace fine sand, <½ tsp
11:45	22.8	-	-	-	-	-	-	
8.00 12:05	22.8	12.75	5	1131	108.1 mS	65	5.4	brown, trace fine sand, <½ tsp
Surge block off								
debris 12:07	34.8	-	-	-	-	-	-	
7.51 12:27	34.8	12.75	5	1231	160.1 mS	16	5.2	clear, trace fine sand
pulled 2" 12:30	21.0	-	-	-	-	-	-	
7.60 12:50	21.0	12.75	5	1331	165.2 mS	20	5.2	clear, trace sand
debris 12:55	34.8	-	-	-	-	-	-	
7.48 13:20	34.8	12.75	5	1431	170 mS	21	5.1	

THE pebble PARTNERSHIP

P-08-85D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85D

DATE STARTED 8/13/08 **COMPLETED** 8/15/08 **GROUND ELEVATION** 795.52 feet **TOC ELEVATION** 798.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159988.68 feet **EASTING** 1417344.09 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Topsoil** trace silt, roots	Very little recovery; descriptions from sump, 0-5 feet
					Silty Organic Soil gray to brown, trace sand, trace roots	Adding water while drilling; discharge water is brown, 0-7 feet
					4.0	
5					ML **Silt** gray, trace sand, trace roots 5.0	
					ML **Silt** gray, trace coarse grained sand, trace roots moist	
						Adding water while drilling; discharge water is gray, 7-15 feet
10					10.0	
	GB				ML **Silt with Gravel** black, subangular gravel, clasts up to 3/4", trace sand	
15	GB				15.0	
					ML **Gravelly Silt** gray to black, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 3/4", trace coarse grained sand	Discharge water is brownish gray, 15-20 feet
20	GB				20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: Pure Gold Bentonite Chips

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is flowing)
Purge Volume: N/A

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/19/2008

Comments: Piezometer is flowing (artesian); Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-85D
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85D

DATE STARTED 8/13/08 **COMPLETED** 8/15/08 **GROUND ELEVATION** 795.52 feet **TOC ELEVATION** 798.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159988.68 feet **EASTING** 1417344.09 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Sand and Gravel with Silt** multicolored, subangular to subrounded gravel, clasts up to 1", well graded sand, gray silt	20% of clasts are fractured, 20-22 feet Discharge water is gray, 20-89 feet 30% of clasts are fractured, 22-26 feet
25	GB				25.0	Clasts up to 1", 25-33 feet
					GM **Sand and Gravel with Silt** subangular to subrounded gravel, well graded fine to coarse grained sand,	35-40% of clasts are fractured, 26-28 feet 30% of clasts are fractured, 28-33 feet
30	GB					
35	GB					40-50% of clasts are fractured, clasts up to 1 1/2", 33-39 feet
40	GB					60% of clasts are fractured, clasts up to 1", 39-46 feet
45	GB				46.0	
	GB				ML **Silt with Gravel and Sand** 20% of clasts are fractured, clasts up to 1", fine to coarse grained sand	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-85D
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85D

DATE STARTED 8/13/08 **COMPLETED** 8/15/08 **GROUND ELEVATION** 795.52 feet **TOC ELEVATION** 798.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159988.68 feet **EASTING** 1417344.09 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					ML **Silt with Gravel and Sand** 20% of clasts are fractured, clasts up to 1", fine to coarse grained sand	
					53.0	
					ML **Silt** trace gravel, <10% of clasts are fractured, clasts up to 1/2", trace sand	
					54.0	
55	GB				ML **Silt** trace well graded sand	
					56.0	
					ML **Silt with Gravel and Sand** angular to subrounded gravel, 20% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand	
					59.0	
60	GB				ML **Silt** gray, trace gravel, clasts up to 3/4", trace well graded sand	
					60.0	
					ML **Silt** gray, trace well graded sand	
					63.0	
					CL-CH **Clay** gray, trace sand, trace silt	
65	GB					Adding water while drilling, 65-75 feet
					66.0	
					CL-CH **Clay** trace sand, medium stiff to hard, trace silt	
					68.0	
					CL-CH **Clay** trace subangular gravel, clasts up to 1/2", trace well graded fine to coarse grained sand, trace silt	
70	GB				70.0	
					CLG **Clay with Gravel** subangular gravel, 30% of clasts are fractured, clasts up to 1/2", trace well graded fine to coarse grained sand, trace silt	More sand than rest of unit, 71-79 feet
75	GB					
	GB					More sand and gravel than rest of unit, 79-82 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-85D
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85D

DATE STARTED 8/13/08 **COMPLETED** 8/15/08 **GROUND ELEVATION** 795.52 feet **TOC ELEVATION** 798.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159988.68 feet **EASTING** 1417344.09 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					CLG **Clay with Gravel** subangular gravel, 30% of clasts are fractured, clasts up to 1/2", trace well graded fine to coarse grained sand, trace silt	
					82.0 CL-ML **Silty Clay with Sand and Gravel** subrounded to rounded gravel, 30% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand	
					84.0 GM **Sandy Gravel with Silt and Clay** multicolored, subangular to rounded gravel, 40% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand	
85	GB				87.0 GM **Gravel with Silt and Clay** gray, subangular gravel, 50% of clasts are fractured, clasts up to 3/4", trace sand, wet	Little recovery, 87-88 feet
					88.0 GM **Silty Sand and Gravel with Clay** gray, subangular to subrounded gravel, 40% of clasts are fractured, fine to coarse grained sand, wet	Very slow drilling, 88-89 feet Clasts up to 1", 88-90 feet
90	GB				91.0 CL-ML **Silty Clay** reddish brown, trace subangular gravel, trace fine grained sand, dense, wet	Clasts up to 1/2", 90-91 feet
					93.0 CL-ML **Silty Clay** reddish brown, trace fine grained sand, dense, wet	Discharge water is light brown, 91-92 feet Adding water while drilling, 91-93 feet
					94.0 CL-ML **Silty Clay with Sand** reddish brown, fine grained sand, dense, wet	Adding water and foam while drilling; discharge water is reddish brown, 93-94 feet
95	GB				95.0 CLG **Gravelly Clay** reddish brown, subrounded gravel, clasts up to 1/2", trace sand, wet	Discharge water is brown, 94-95 feet
					96.0 GM **Gravel with Silt and Clay** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", trace coarse grained sand, wet	Very little recovery, 96-98 feet
			1		98.0 GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1/2", coarse grained sand, wet	Encountered water, 97 feet
100	GB				99.0 GM **Gravel with Silt and Sand** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand, wet	50% of clasts are fractured, 99-100 feet
					101.0 GW **Gravel with Sand** gray to black, most of the clasts are fractured	80% of clasts are fractured, 100-101 feet
			1.5		104.0 GM **Silty Sand and Gravel** gray, subangular to subrounded gravel, clasts up to 1", fine to coarse grained sand, wet	More sand than rest of unit, 102-103 feet Very hard drilling, 103-104 feet Discharge water is gray, 103-105 feet
105	GB					
			0.5			Less fractured than rest of unit, 107-111 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-85D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85D

DATE STARTED 8/13/08 **COMPLETED** 8/15/08 **GROUND ELEVATION** 795.52 feet **TOC ELEVATION** 798.02 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2159988.68 feet **EASTING** 1417344.09 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					111.0	75% of clasts are fractured, 110-111 feet
					SM **Silty Sand** gray, trace subangular gravel, clasts up to 1/4", fine grained sand, wet	
					112.5	Adding water and foam while drilling; very difficult drilling, 112-113 feet
			16		113.0 SP **Sand** fine grained	
					SP **Sand** trace subangular to subrounded gravel, fine grained sand	
					114.0	No recovery, 114-115 feet
115					115.0	Advanced via mud rotary, 114-137 feet
					SP **Sand** trace subangular to subrounded gravel, fine grained sand	Losing mud to formation, 115-118 feet
					118.0	
	SS				SP **Sand** subangular to subrounded gravel, clasts up to 1/4", sand, trace silt, wet	
					119.0	
120					ML **Sandy Silt** gray, low-plastic	Losing mud into the formation, 120-123 feet
					121.0	
					Bedrock light gray with black and tan, fractured, weathered	
					123.0	Fast drilling, 123-125 feet
					Bedrock light gray with some black, clasts up to 1/4", fractured	
125						Very little mud loss to formation; mud is turning gray while advancing, 125-137 feet
130						
135					137.0	
					137.6	Not logged, 137-137.6 feet
					Bottom of hole at 137.6 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-85D. Flowing well. Plugged after drilling.

THE pebble PARTNERSHIP

P-08-85S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85S

DATE STARTED 8/16/08 **COMPLETED** 8/16/08 **GROUND ELEVATION** 794.57 feet **TOC ELEVATION** 797.37 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2160019.91 feet **EASTING** 1417392.85 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						Boring advanced at slight angle No recovery; very soft ground consisting mostly of mossy, wet, soils near surface; casing advanced by pressure (no hammering), 0-8 feet
5		▼				
8.0					ML/CL **Silt and Clay** brown, trace fine grained sand, high-plastic, wet	Very little recovery, 8-11 feet
10						
10.0					**Organic Soil** brown to gray	
11.0						No recovery, 11-13 feet
13.0					ML/CL **Silt and Clay with Sand** brown, fine to coarse grained sand, high-plastic, wet	
15						Trace subrounded gravel, 15-16 feet
16.0						No recovery, 16-17 feet
17.0						
18.0	GB		no flow		ML/CL **Silt and Clay** trace subangular gravel, clasts up to 3/4"	No recovery, 18-19 feet Adding water while drilling, 18-32.3 feet
19.0						
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.8'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 220# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Piezometer is flowing)
Purge Volume: N/A

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/19/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/17/08 at 815 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-85S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-85S

DATE STARTED 8/16/08 **COMPLETED** 8/16/08 **GROUND ELEVATION** 794.57 feet **TOC ELEVATION** 797.37 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2160019.91 feet **EASTING** 1417392.85 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0 ML/CL **Sandy Silt/Clay** grayish brown, trace subangular to subrounded gravel, fine to coarse grained sand, wet	No recovery, 21-22 feet
	GB		no flow		22.0 GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, wet	More silt than rest of unit, 23-24 feet
25					26.0	No recovery, 26-27 feet
	GB		0.25		27.0 28.0 ML **Sandy Silt** brown, trace subangular to subrounded gravel, fine to coarse grained sand, trace clay, wet	
30					ML **Silty Sand with Gravel** grayish brown, subangular to subrounded gravel, fine to coarse grained sand, trace clay, moist to wet	More gravel than rest of unit, 29-32.3 feet
					32.4 Bottom of hole at 32.4 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-85S. Flowing well. Plugged after drilling.

THE pebble PARTNERSHIP

P-08-86D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-86D

DATE STARTED 8/17/08 **COMPLETED** 8/18/08 **GROUND ELEVATION** 1137.34 feet **TOC ELEVATION** 1140.64 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169842.32 feet **EASTING** 1391935.62 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					GM **Sand and Gravel with Silt** brown, subangular gravel, <10% of clasts are fractured, clasts up to 1/4", coarse grained sand, moist	Very little recovery, 1-3 feet
					3.0	
					GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/2", well graded fine to coarse grained sand, dry to moist	Little recovery, 3-4 feet
5	GB				5.0	
					6.0 GM **Sitly Gravel with Sand** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand, dry to moist	
					GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist	
10	GB				10.0	
					11.0 GP **Gravel** gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", trace fine to coarse grained sand, trace silt, dry to moist	
					12.0 GP **Gravel with Sand** gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, trace silt, dry to moist	Little recovery, 12-13 feet
					13.0 SM **Sand with Gravel and Silt** brown, subangular gravel, 50% of clasts are fractured, fine to coarse grained sand, dry to moist	
15	GB				GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, dry to moist	Little recovery, 16-17 feet
					17.0	No recovery, 17-19 feet
					19.0	
20	GB				20.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.3'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 220# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand and Bentonite Pellets

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/24/2008
Purge Volume: 1375 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/2/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/18/08 at 1125 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-86D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-86D

DATE STARTED 8/17/08 **COMPLETED** 8/18/08 **GROUND ELEVATION** 1137.34 feet **TOC ELEVATION** 1140.64 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169842.32 feet **EASTING** 1391935.62 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					up to 3/4", medium to coarse grained sand, moist	Fine to coarse grained sand, 20-21 feet
					SM **Sand with Silt** brown, dry	Very little recovery, 20-25 feet
						Fine grained sand, 21-24 feet
25						Fine to coarse grained sand, 24-26 feet
					26.0	Very little recovery; fine dust coming out of cyclone, 25-29 feet
					28.0	
					SM **Sand with Silt** brown, fine to coarse grained sand, dry 29.0	
30	GB				SM **Sand with Gravel and Silt** brown, subangular to subrounded gravel, fine to coarse grained sand, dry 30.0	Little recovery, 29-30 feet
					GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	Cuttings are dry, 30-31 feet
						Less sand and silt than rest of unit; cuttings are moist, 31-33 feet
					33.0	Possible shallow water encountered, 32 feet
					Boulder or Cobble gravel, fractured 34.0	Harder drilling, 33-34 feet
35	GB				GM **Gravel with Sand and Silt** subrounded gravel, most of the clasts are fractured 35.0	
					GM **Silty Gravel** brown, subangular to subrounded gravel, 80% of clasts are fractured, clasts up to 1", trace sand, moist 36.0	Less fractured than above, 36-39 feet
					GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, clasts up to 1", fine to coarse grained sand, moist	
					39.0	
40	GB				SM **Silty Sand** bluish gray, trace gravel, 10% of clasts are fractured, fine to coarse grained sand, brown silt 40.0	Little recovery, 39-40 feet
					GM **Silty Gravel with Sand** subangular to subrounded gravel, 60% of clasts are fractured, well graded sand	
					42.0	Adding water while drilling, 41-42 feet
					SP **Sand with Gravel** gray to brown, subangular to subrounded gravel, 60% of clasts are fractured, trace silt	
45	GB				45.0	
		▼			GW **Sand and Gravel** subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 1 1/4", fine to coarse grained sand, trace silt 47.0	
					GW **Gravel** trace sand, trace silt 48.0	Encountered water; discharge water is brown, 47.5 feet
	GB				GW **Gravel with Sand** subangular to subrounded gravel, clasts up to 1 1/2", fine to coarse grained sand, trace silt, wet	40% of clasts are fractured, 48-50 feet
						Discharge water is grayish brown, 48-55 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-86D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-86D

DATE STARTED 8/17/08 **COMPLETED** 8/18/08 **GROUND ELEVATION** 1137.34 feet **TOC ELEVATION** 1140.64 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169842.32 feet **EASTING** 1391935.62 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						70% of clasts are fractured, 50-51 feet
					51.0	
					GM **Sand and Gravel with Silt** subangular to subrounded gravel, fine to coarse grained sand, wet	Clasts up to 3/4", 51-54 feet 50% of clasts are fractured, 51-59 feet
55	GB					Clasts up to 1/4", 54-61 feet
			16			Discharge water is brown, 55-67 feet
60	GB					90% of clasts are fractured, 59-61 feet
					61.0	
			6		GW **Gravel with Sand** bluish gray, most of the clasts are fractured, clasts up to 1", trace silt	
65	GB					
			7		67.0	Discharge water is gray, 67-73 feet
					SW **Sand with Gravel** gray, most of the clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand	
70	GB					
			8		73.5	Discharge water is getting clearer; but discharge water is still gray, 73-74 feet Clasts are gray, 73.5-76 feet
			5		**Bedrock** fractured, clasts up to 3/4"	
75						Discharge water is gray, 75-77 feet
	GB		7			Some clasts are purplish gray; faster drilling, 76-77 feet
			4		77.0	Discharge water is brown, 77-78 feet
					Bedrock brownish gray, fractured, clasts up to 3/4", weathered	Discharge water is grayish brown, 78-82 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-86D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-86D

DATE STARTED 8/17/08 **COMPLETED** 8/18/08 **GROUND ELEVATION** 1137.34 feet **TOC ELEVATION** 1140.64 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169842.32 feet **EASTING** 1391935.62 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80			3		**Bedrock** brownish gray, fractured, clasts up to 3/4", weathered	Very little discharge water, 80-81 feet
			no flow			Discharge water is gray, 82-87 feet
85	GB		3			
					86.0	
			4		**Bedrock** gray, fractured, clasts up to 3/4"	More competent bedrock encountered, 86 feet Moved to open hole hammer, 87 feet
						Discharge water is gray, 88-89 feet
			11		89.0	Not logged, 89-89.6 feet
					89.6	
					Bottom of hole at 89.6 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-86[redacted]D
Date: 24/September 08
Project: Pebble
Project #: 005.0189.08002
Technician: DP, MS

Summary

	Installed (Well Log)	Start	End
Water level	43.3	49.6	48.57
Total depth	89.6	79.0	79.0
pH			

Screen interval (btoPVC): 9.80
Top: [redacted] 64.20
Bottom: [redacted] 74.0
PVC stick-up height (above ground surface): 2.8

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
7.7 10.06	73.00	49.60	4.5	4.5	903	71000	3.6°	Brown Milky, silt + fine sand, ½ cup
8.27 10.55	73.00	48.56	5	249.5	327	141	3.7°	white milky, silt, 1 tablespoon
11.00	71.00	—	—	—	—	—	—	
7.53 11.30	71.06	48.58	4.5	384.5	488.3	179	3.7	
11.35	69.00	—	—	—	—	—	—	
7.55 12.05	69.00	48.57	5	519.5	167.9	109	3.6	
12.10	67.00	—	—	—	—	—	—	
7.5 12[redacted]	67.00	48.57	5	664.5	169.5	154	3.7	
12.45	65.00			—	—	—	—	
7.6 13.15	65.00	48.58	4	784.5	161.4	176	3.6	
13.20	63—	—	—	—				
7.8 13.54	63.00	48.58	4	920.5	186.5	188	3.9	
Surge block off								
14.00	73.00	—	—	—	—	—	—	
8.13 14.30	73.00	48.56	4	1046.5	280	378	4	
14.35	59.20	—	—	—	—	—	—	
8.4 3.05	51.20	48.56	4	1190.5	328	257	3.9°	
3.10	—	—	—	—	—	—	—	
7.12 3.56	73.00	48.57	4	13745360	261	4.7°		

THE pebble PARTNERSHIP

P-08-86S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-86S

DATE STARTED 8/18/08 **COMPLETED** 8/18/08 **GROUND ELEVATION** 1136.88 feet **TOC ELEVATION** 1139.38 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169865.14 feet **EASTING** 1391946.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0 GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, fine to coarse grained sand, wet	More sand than rest of unit, 3-4 feet
					4.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 25% of clasts are fractured, fine to coarse grained sand, moist	
5					6.0 GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, 25% of clasts are fractured, fine to coarse grained sand, moist	
					7.0 SM **Sand with Silt** brown, trace subangular gravel, fine to coarse grained sand, moist	
					8.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist	
					9.0 GM **Sandy Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist	
10					12.0	No recovery, 12-16 feet
15					16.0 SM **Sand with Silt** brown, fine to medium grained sand, dry to moist	Very poor recovery, 16-19 feet
						Trace subangular gravel, 18-20 feet
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 220# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A (Insufficient water)
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A (Insufficient water)

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/19/08 at 336 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-86S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-86S

DATE STARTED 8/18/08 **COMPLETED** 8/18/08 **GROUND ELEVATION** 1136.88 feet **TOC ELEVATION** 1139.38 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169865.14 feet **EASTING** 1391946.32 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					21.0 GP **Gravel with Sand** brown, subangular gravel, 50% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, dry to moist	Poor recovery, 20-21 feet No recovery, 21-28 feet
25					28.0 GM **Gravel with Sand and Silt** brown, subangular to subrounded gravel, fine grained sand, moist	
					29.0 GM **Gravel with Silt** gravel, clasts up to 3/4", dry to moist	Silt balls, 29-30 feet
30					30.0 GM **Sandy Silt** moist	
	GB				31.0 **Boulder or Cobble** subangular, fractured, trace brown silt, moist	Harder drilling, 31-32 feet
					32.0 GM **Silty Gravel and Sand** subangular gravel, 100% of clasts are fractured, fine grained sand, moist to wet	Water encountered, 33-34 feet More sand than rest of unit, 33-36 feet
35					36.0	
	GB				37.0 ML **Gravelly Silt** brown, subangular gravel, 50% of clasts are fractured, clasts up to 1/2", trace fine to medium grained sand, wet	
					ML **Silt and Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, wet	More coarse grained sand than rest of unit, 38-39 feet No recovery, 39-47.5 feet
40					39.0	
		▼				
45					47.5	
					Bottom of hole at 47.5 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-[redacted]865
Date: 24/September 08
Project: Pebble
Project #: 005.0189.08002
Technician: DP/MS

Summary unable to develop inadequate water in the well

	Installed (Well Log)	Start	End
Water level	42.55	47.4	
Total depth	45.70	48.7	
pH			

Screen interval (btoPVC): 7.80
Top: [redacted] 3540
Bottom: 77.0 45.70
PVC stick-up height (above ground surface): 2.5ft

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
Surge block off								

THE pebble PARTNERSHIP

P-08-87D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-87D

DATE STARTED 8/19/08 **COMPLETED** 8/19/08 **GROUND ELEVATION** 1141.77 feet **TOC ELEVATION** 1144.67 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169844.11 feet **EASTING** 1393969.59 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0 **Organic Soil and Silt** brown, trace subangular gravel, trace fine grained sand, moist	
					2.0 SM **Silty Sand** brown, well graded fine to coarse grained sand, moist	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand, moist	
5	GB				6.0	
					7.0 SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand, moist	No recovery, 7-9 feet
					9.0	
10	GB				10.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, fine to coarse grained sand, moist	No recovery, 10-12 feet
					12.0	Adding water while drilling, 12-13 feet
					13.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, fine to coarse grained sand, moist	No recovery, 13-15 feet
15					15.0	Little recovery, 15-17 feet
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, fine to coarse grained sand, moist	
					17.0	No recovery, 17-29 feet
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: Pure Gold Bentonite Chips

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/17/2008
Purge Volume: 2115 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/3/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/20/08 at 558 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-87D
PAGE 2 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-87D

DATE STARTED 8/19/08 **COMPLETED** 8/19/08 **GROUND ELEVATION** 1141.77 feet **TOC ELEVATION** 1144.67 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169844.11 feet **EASTING** 1393969.59 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						
25						Discharge water is silty, 27-29 feet
					29.0	
30	GB				GW **Gravel with Sand** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", trace silt 30.0	Very little recovery, 29-30 feet No recovery; discharge water is silty, 30-31 feet
					31.0 GW **Gravel** subangular, 75% of clasts are fractured 32.0	Adding water while drilling, 31-32 feet No recovery, 32-35 feet
			no flow			
35		▼			35.0	
					GW **Gravel** subangular, 75% of clasts are fractured 36.0	Very lilttle recovery, 35-36 feet No recovery, 36-39 feet
			no flow			Adding water while drilling; formation not producing water, 37-38 feet
					39.0	
40	GB				GM **Gravel with Sand and Silt** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand 41.0	Disharge water is slightly silty, 39-40 feet No recovery, 41-45 feet
			no flow			
45					45.0	Silty discharge, 44-46 feet
					GM **Silty Sand and Gravel** gray, subangular to subrounded gravel, clasts up to 3/4", medium to coarse grained sand, wet 46.0	
					47.0 GW **Gravel** subangular, 50% of clasts are fractured, clasts up to 1 1/2"	Water encountered, 47 feet Harder drilling, 47.5 feet
			10		**Boulder or Cobble** multicolored, fractured, weathered	Discharge water is golden brown; very slow drilling with little to no advancement; moved to open hole hammer, 47-48 feet
	GB				49.5	Discharge water is brown and silty, 49-54

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-87D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-87D

DATE STARTED 8/19/08 **COMPLETED** 8/19/08 **GROUND ELEVATION** 1141.77 feet **TOC ELEVATION** 1144.67 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169844.11 feet **EASTING** 1393969.59 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey, B. Vroom

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50						feet Moved back to advancing casing after getting out of boulder or cobble, 49.5 feet Coarse grained sand, 49.5-51 feet Fine to coarse grained sand, 51-54 feet
			3.25		GM **Silty Sand and Gravel** gray to black, subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 3", wet	
					54.0	
55	GB				GW **Gravel** gravel, most of the clasts are fractured	No recovery, 54-55 feet
					56.0	
					Bedrock gray to black, fractured, weathered	Discharge water is brownish white, 57-58 feet
			7		58.0	Moved to open hole hammer, 58 feet
					Bedrock dark gray, fractured, weathered	Discharge water is gray, 59-66 feet
60	GB		10			
					61.0	
					Bedrock light to dark gray, some white clasts, fractured	
			15		62.0	Harder drilling, 62-63 feet
					Bedrock light gray, fractured, clasts up to 3/8"	
			14			Little recovery, 64-65 feet
65						
			10		66.0	
					Bedrock dark gray, fractured	Easier drilling; discharge water is dark gray and contains fines, 66-68 feet
			12		68.0	
					Bedrock light to dark gray, some white clasts, fractured	Harder drilling; discharge water is light gray, 68-70 feet
70	GB		10		70.0	
					70.4	Not logged, 70-70.4 feet
					Bottom of hole at 70.4 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

8.7D

SLR

Well ID: P-08-~~64~~M
Date: Sept 17/08
Project: Pebble
Project #: 005.0189.08002
Technician: DP / TT

Summary

	Installed (Well Log)	Start	End
Water level	32.65	35.8	35.8
Total depth	69.6	72.55	72.82
pH		8.65	8.27

Screen interval (btoPVC):
Top: ~~67.2~~ 62.62
Bottom: ~~72.0~~ 72.5'
PVC stick-up height (above ground surface): 2.9

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	~~Sp Cond~~ EC (µS) ~~mS/cm~~	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH	Surge block on							
8.65	9:00	71.5	35.8	5	5	710	>1000	5.5	gray, fine sand/silt, 1 cup
9.10	10:00	71.5	35.8	4	245	520	650	4.9	brown, fine sand/silt, 2 tablespoons
	10:10	69.5	—	—	—	—	—	—	
8.45	10:40	69.5	35.8	5	395	394	252	5.1	milky, fine sand/silt, 1 tsp.
	10:45	67.5	—	—	—	—	—	—	
8.41	11:15	67.5	36.0	5	545	246	409	5.0	milky, trace silt, < 1 tsp
	11:20	65.5	—	—	—	—	—	—	
8.17	11:50	65.5	36.0	4	665	430	420	4.8	milky, trace sand/silt, < ½ tsp
	11:55	63.5	—	—	—	—	—	—	
8.38	12:20	63.5	36.8	4	765	430	383	4.7	milky, no sand
	12:25	61.5	—	—	—	—	—	—	
8.20	12:50	61.5	37.6	4	868	497	340	4.7	milky, no sand
	Surge block off							
debris	12:55	71.5	—	—	—	—	—	—	
8.32	13:30	71.5	36.81	5	1985	380	220	4.8	Milky, no sand (trace)
Rise	13:35	57.6	—	—	—	—	—	—	
8.16	13:55	57.6	37.35	2	2085	410	415	5.1	Milky, trace sand
debris	14:00	71.5	—	—	—	—	—	—	
8.27	14:30	71.5	35.8	5	2115	370	480	5.0	Milky, trace sand

THE pebble PARTNERSHIP

P-08-87S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-87S

DATE STARTED 8/20/08 **COMPLETED** 8/20/08 **GROUND ELEVATION** 1142.43 feet **TOC ELEVATION** 1145.83 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169867.78 feet **EASTING** 1393987.41 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-1 feet
					1.0 GM **Silty Gravel with Sand** brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand, dry	
5					6.0 GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, dry to moist	Less gravel than rest of unit, 7-8 feet
						Little recovery, 8-10 feet
10						Adding water while drilling, 11-14 feet
					13.0	No recovery, 13-14 feet
					14.0	
15					15.0 GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand, dry to moist	Discharge water is brown, 15-18 feet
					SM **Gravelly Sand with Silt** brown, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand	
					17.0 GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, fine to coarse grained sand	Little recovery, 18-19 feet
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.4'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 220# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/16/2008
Purge Volume: 2010 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 10/3/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/21/08 at 737 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-87S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-87S

DATE STARTED 8/20/08 **COMPLETED** 8/20/08 **GROUND ELEVATION** 1142.43 feet **TOC ELEVATION** 1145.83 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169867.78 feet **EASTING** 1393987.41 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20						No recovery, 20-29 feet
25						Discharge water is brown and silty, 27-29 feet
29.0						
30	GB				GM **Sand and Gravel with Silt** gray, subangular to subrounded gravel, clasts up to 1/2", fine to coarse grained sand	
32.0						Harder drilling; possible boulder or cobble, 32 feet No recovery, 32-35 feet
35		▼				
35.0						
					GM **Sand and Gravel with Silt** gray to black, subangular to subrounded gravel, clasts up to 3/4", fine to coarse grained sand	
37.0						No recovery, 37-40 feet
			no flow			
40						Discharge water is brown and silty, 39-47 feet Little recovery, 40-42 feet
40.0						
					GM **Gravel with Sand and Silt** grayish brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
43.0	GB		no flow			No recovery, 43-44 feet
44.0						
45					GM **Gravel with Sand and Silt** grayish brown, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1/2", medium to coarse grained sand	
47.0	GB		no flow			
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	
50.0						

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

P-08-87S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-87S

DATE STARTED 8/20/08 **COMPLETED** 8/20/08 **GROUND ELEVATION** 1142.43 feet **TOC ELEVATION** 1145.83 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2169867.78 feet **EASTING** 1393987.41 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Halsey

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GM **Silty Sand and Gravel** brown, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet	
52.1					Bottom of hole at 52.1 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

8.75

SLR

Well ID: P-08-~~[illegible]~~
Date: Sept 16/08
Project: Pebble
Project #: 005.0189.08002
Technician: DP / JT

Summary

	Installed (Well Log)	Start	End
Water level	32.42	37.08	37.02
Total depth	52.1	55.36	56.1
pH		8.35	8.15

Screen interval (btoPVC):
Top: ~~[illegible]~~ 42.5 +3.4
Bottom: ~~[illegible]~~ 52.1 +3.4
PVC stick-up height (above ground surface): 3.4

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	~~Sp Cond~~ EC mS (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)	pH
Surge block on									
9:00	54.0	37.08	5	5	615 ms	1000	13.3	brown, fine sand, 3/4 cup	8.35
10:00	54.0	37.09	6	365	157.1 ms	425	4.0	brown, fine sand, 1 tablespoon	8.25
10:10	52.0	—	—	—	—	—	—		
11:00	52.0	37.09	6	665	125 ms	500	4.1	brown, fine sand, 2 tsp.	8.40
11:05	50.0	—	—	—	—	—	—		
12:05	50.0	37.09	5	965	175 ms	134	4.8	brown, trace fine sand, 1 tsp	7.85
12:10	48.0	—	—	—	—	—	—		
13:00	48.0	37.09	5	1265	220 ms	17	4.9	clear, trace fine sand, <1/4 tsp	8.10
13:05	46.0	—	—	—	—	—	—		
13:45	46.0	37.09	5	1365	240 ms	6	4.7	clear, trace fine sand, <1/4 tsp	7.69
13:50	44.0	—	—	—	—	—	—		
14:20	44.0	37.09	5	1510	270 ms	4	4.8	clear, trace sand, <1/4 tsp	7.70
Surge block off									
14:30	54.00	—	—	—	—	—	—		debris
15:00	54.00	37.07	5	1660	330 ms	134	5.0	light brown, trace sand, 1/2 tsp	8.20
15:05	39.00	—	—	—	—	—	—		finish
15:45	39.00	37.02	5	1860	298 ms	13	5.1	clear, trace sand, <1/4 tsp	8.35
15:50	54.00	—	—	—	—	—	—		debris
16:20	54.00	37.02	5	2010	239 ms	26	5.5	clear, trace sand, <1/2 tsp	8.15

THE pebble PARTNERSHIP

P-08-88D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-88D

DATE STARTED 8/22/08 **COMPLETED** 8/23/08 **GROUND ELEVATION** 905.81 feet **TOC ELEVATION** 909.01 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.57 feet **EASTING** 1439761.34 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Vroom, J. Kay

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery, 0-2 feet
					2.0	
					ML **Sand and Silt with Organic Soil** brown, fine grained sand, moist	Very little recovery, 2-3 feet
					3.0	
					ML **Sand and Silt with Organic Soil** brown, trace angular to subrounded gravel, clasts up to 1", fine grained sand, moist	
5	GB				5.0	
					SM **Silty Sand** brown, trace subangular to subrounded gravel, clasts up to 1", medium grained sand, moist	
					8.0	
10	GB				GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, medium grained sand, moist	
					11.0	Cuttings are moist, 11-13 feet
					SP **Sand** brown, trace subangular to subrounded gravel, coarse grained sand	
15	GB					Cuttings are wet, 13-15 feet
					19.0	
20	GB	▼				

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.2'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/25/2008
Purge Volume: 1778 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/29/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/24/08 at 125 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-88D
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-88D

DATE STARTED 8/22/08 **COMPLETED** 8/23/08 **GROUND ELEVATION** 905.81 feet **TOC ELEVATION** 909.01 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.57 feet **EASTING** 1439761.34 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Vroom, J. Kay

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GP **Gravel with Sand** brown to gray, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1", trace silt, moist	Adding water while drilling, 20-25 feet
					22.0	
					ML **Silt and Sand** brown, trace subangular to subrounded gravel, coarse grained sand, wet	Discharge water is slighty gray, 23-25 feet
					23.0	
					GP **Gravel with Sand** subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", coarse grained sand, trace silt, moist	
25	GB				25.0	
					GP **Gravel** subangular to subrounded, 40% of clasts are fractured, trace sand, trace silt	
					28.0	Adding water while drilling, 28-29 feet
					SW **Sand with Gravel** subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand, trace silt, moist	Discharge water is brown, 28-36 feet
30	GB				31.0	
					GP **Gravel with Sand** subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
					33.0	
					SW **Sand with Gravel** subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand	
35	GB				36.0	
					SW **Sand** gray, trace gravel, 30% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	Discharge water is grayish brown, 36-38 feet Adding water while drilling, 36-58 feet Discharge water is gray, 38-55 feet
40	GB				40.0	
					SP **Sand** gray, fine to coarse grained sand, trace silt	
					43.0	
					SP **Sand** gray, trace subangular to subrounded gravel, clasts up to 3/8", fine to coarse grained sand, trace silt	
45	GB				49.0	
	GB					Little recovery, 49-55 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-88D
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-88D

DATE STARTED 8/22/08 **COMPLETED** 8/23/08 **GROUND ELEVATION** 905.81 feet **TOC ELEVATION** 909.01 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.57 feet **EASTING** 1439761.34 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Vroom, J. Kay

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SW **Sand** gray, trace gravel, some of the clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
55	GB				55.0	
					GP **Sand and Gravel** multicolored, subrounded gravel, 10% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	Discharge water is grayish brown, 55-65 feet
					57.0	
					SW **Sand** trace gravel, 10% of clasts are fractured, clasts up to 3/4", well graded fine to coarse grained sand	Adding water and foam while drilling, 58-65 feet
60	GB					
					63.0	
					SW **Sand with Gravel** subangular to subrounded gravel, clasts up to 1/2", well graded fine to coarse grained sand	20% of clasts are fractured, 63-65 feet
65	GB					30% of clasts are fractured, 65-66 feet
					66.0	Discharge water is gray, 65-75 feet
					SW **Sand** gray, trace subangular to subrounded gravel, 15% of clasts are fractured, clasts up to 1/2", well graded fine to coarse grained sand	
70	GB					
					73.0	
					SP **Sand** trace subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 3/4", poorly graded, fine to coarse grained sand	
75	GB					Adding water while drilling; discharge water is grayish brown, 75-95 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-88D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-88D

DATE STARTED 8/22/08 **COMPLETED** 8/23/08 **GROUND ELEVATION** 905.81 feet **TOC ELEVATION** 909.01 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.57 feet **EASTING** 1439761.34 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Vroom, J. Kay

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					SP **Sand** trace subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 3/4", poorly graded, fine to coarse grained sand	
85	GB					
					88.0 GP **Gravel with Sand** subangular to subrounded gravel, 60% of clasts are fractured, clasts up to 3/4", coarse grained sand, trace silt	
90	GB				91.0 GM **Silty Gravel with Sand** subangular to subrounded gravel, clasts up to 1", coarse grained sand	
95	GB				95.0 GM **Sandy Gravel with Silt** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	Discharge water is brown, 95-105 feet
					97.0 SM **Silty Sand with Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
100	GB				98.0 99.0 GP **Gravel with Sand** 70% of clasts are fractured, clasts up to 3/4", coarse grained sand, trace silt	
					100.0 GP **Gravel** subangular to subrounded, 70% of clasts are fractured, clasts up to 3/4", trace sand, trace silt	
					GP **Gravel with Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", well graded sand, trace silt	
105	GB				105.0 **Bedrock** black with some white clasts, fractured, weathered	Hard drilling; discharge water is brown to black, 105-106 feet
			3.5		106.2 Bottom of hole at 106.2 feet.	No measurable flow above 106 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

88D

SLR

Well ID: P-08-[redacted]D
Date: 25/sept 08
Project: Pebble
Project #: 005.0189.08002
Technician: DP/ MS

Summary

	Installed (Well Log)	Start	End
Water level	19.65	21.20	22.2
Total depth	106.2	110.0	110.0
pH		5.89	

Screen interval (btoPVC): 10ft
Top: [redacted] 96.25
Bottom: [redacted] 106.2
PVC stick-up height (above ground surface): 3.2

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
Surge block on								
12.10	105.2	21.20	4	4	94.5	>1000	4.3	Brown, silty, fine sand 1½ cups
1.30	105.2	26.80	4	320	310	71000	5.3	Brown, silty fine sand 1 cup
1.35	103.2	-	-	-	-	-	-	
2.41	103.2	26.40	4	595	335	71000	4.6	Light brown/yellow, silt + fine sand, 1cup
2.46	101.2	-	-			-	-	
3.26	101.2	29.56	4	779	254	71000	5.5	
3.30	99.2	-	-	-	-	-	-	Light brown/yellow, silt + fine sand 1cup
4.30	99.2	28.56	4	1019	316	1000	3.6	white milky, silt, 1 cup
4.34	97.2	-	-	-	-	-	-	
10 [redacted]31	97.2	28.02	4	1259	1718	>1000	4°C	Light brown, silty sandy, 1cup
Surge block off								
10.43	105.2	-	-	-	-	-	-	
11.52	105.2	23.21	3	1466	300	64/4	4.5°	white, milky, silt fine sand ½ cup
11.58	92.2	-	-	-	-	-	-	
12.44	92.2	22.02	3	1604	316	71000	6.5°C	white milky silt fine
12.50	105.2	-	-	-	-	-	-	
1.48	105.2	23.00	3	1778	436	>1000	9.3°C	white milky silt 1 teaspoon

THE pebble PARTNERSHIP

P-08-88S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-88S

DATE STARTED 8/23/08 **COMPLETED** 8/23/08 **GROUND ELEVATION** 905.71 feet **TOC ELEVATION** 908.31 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136853.78 feet **EASTING** 1439762.95 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Vroom, J. Kay, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						
					1.0	No recovery, 0-1 feet
					ML **Sandy Silt with Organic Soil** brown, wet	Very little recovery, 1-3 feet
					3.0	
					SM **Silty Sand** brown, trace angular to subrounded gravel, clasts up to 1", moist	
5					5.0	
					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, clasts up to 1", coarse grained sand, moist	
					7.0	
					SM **Sand with Silt** brown, trace subangular to subrounded gravel, clasts up to 1", moist	
10						
					12.0	
					SP **Sand** coarse grained sand	
					13.0	
					SM **Sand with Silt** brown, trace subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", moist	
15	GB					
					18.0	
		▼			GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1 1/4"	Cuttings are wet, 18 feet Adding water while drilling; discharge water is brown, 18-32 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.6'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: Pure Gold Bentonite Chips

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/25/2008
Purge Volume: 701 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/24/08 at 123 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-88S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-88S

DATE STARTED 8/23/08 **COMPLETED** 8/23/08 **GROUND ELEVATION** 905.71 feet **TOC ELEVATION** 908.31 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136853.78 feet **EASTING** 1439762.95 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** B. Vroom, J. Kay, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GM **Sand and Gravel with Silt** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1 1/4"	
					23.0	
					SM **Silty Sand with Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 3/4"	
25	GB					
					28.0	
					GM **Sandy Gravel with Silt** grayish brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1"	
					29.0	
30	GB				SM **Silty Sand with Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1/4"	
					31.0	
					32.0 CL/ML **Silty Clay** brown	
					Bottom of hole at 32.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-[redacted]885
Date: 25 Sept 08
Project: Pebble
Project #: 005.0189.08002
Technician: DP/M Swain

Summary

	Installed (Well Log)	Start	End
Water level	18.85	20.0	20.00
Total depth	30.00	30.00	3260
pH		8.49	

Screen interval (btoPVC): 10ft
Top: [redacted] 21.13
Bottom: [redacted] 30.00
PVC stick-up height (above ground surface): 2.6

Development Observations

pH	Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
	Surge block on								
8.49	12.10	29.00	20.00	1	1	250	71000	4.4	Brown, silty, 2 cups
7.74	1.30	29.00	19.86	1	80	261	71000	5.3	Brown, silty, 2 cups
	1.35	27.00	—	—	—	—	—	—	
8.31	2.41	27.00	19.93	1	145	251	71000	4.5	Yellow/brown, silty fine sand, 1 cup
	2.46	25.00	—	—	—	—	—	—	
8.22	3.26	25.00	19.91	1	191	208	71000	4.5	Brown, silty fine sand, 1 cup
	3.30	23.00	—	—	—	—	—	—	
7.82	4.30	23.00	19.91	1	251	[illegible]	1000	4.0°	[illegible] fine sand ½ cup
	9.39	21.00	—	—	—	—	—	—	
8.00	10.39	21.00	19.91	1	312	15.2	1000	3.7°C	Brown silty, fine sand 1 cup
	Surge block off								
	10.03	29.00	—	—	—	—	—	—	—
8.18	11.32	29.00	—	2.5	469.5	236	235	3.8	Brown, milky, silty fine sand ½ cup
	11.58	16.00	—	—	—	—	—	—	
	12.44	~~16~~ 26.00	19.87	2.5	584.5	269	86	5.9	White, Milky, silty fine sand 1 tablespoon
	12.50	29.00	—	—	—	—	—	—	
8.1	1.48	29.00	20.00	2.5	700.5	382	531	6.7	white, milky, silty fine sand, 1 teaspoon

THE pebble PARTNERSHIP

P-08-89D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SM **Silty Sand** light brown, fine to medium grained sand	No flow tests were conducted on this hole; flow test data presented is from HH-08-X Abandoned, which is approximately 45 feet east of this hole, 0-242 feet
5	GB					
10	GB					
15	GB					
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.5'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Inertial Pump (w/ and w/out surge block)
Date: 9/26/2008
Purge Volume: 206 gallons

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 8/31/08 at 1140 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D
PAGE 2 OF 9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SM **Silty Sand** light brown, fine to medium grained sand	
25	GB					Adding water while drilling, 25-35 feet Discharge water is brown and silty, 25-96 feet
					27.0 SW **Sand** brown, trace gravel, <10% of clasts are fractured, clasts up to 1/2", well graded fine to coarse grained sand	Subangular to rounded gravel, 27-35 feet
30	GB					
35	GB					Subangular to subrounded gravel, 35-45 feet
40	GB					
45	GB				45.0 GW **Sand and Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1", medium to coarse grained sand 46.0	No recovery, 46-51 feet
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D
PAGE 3 OF 9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					51.0	
					SW **Sand** brown, well graded fine to coarse grained sand	
55	GB		0.1			
					57.0	
			0.55		GW **Gravel** brown, angular to subangular gravel, 80% of clasts are fractured, clasts up to 1"	Adding water and foam while drilling, 57-65 feet
60	GB				60.0	No recovery, 60-68 feet
			0.55			
65						
			0.66		68.0	
					GW **Gravel** brown, angular to subangular gravel, 80% of clasts are fractured, clasts up to 1"	
70	GB				71.0	No recovery, 71-79 feet
			0.2			
75	GB					
			0.24		79.0	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					GW **Gravel** brown, angular to subangular gravel, 80% of clasts are fractured, clasts up to 1"	
			0.33		82.0	No recovery, 82-85 feet
85					85.0	
		▼			CLG **Gravelly Clay** brown, subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 1"	
			0.4			
90	GB				90.0	
					GM **Silty Gravel** brown, angular to rounded gravel, 80% of clasts are fractured, clasts up to 1"	
			0.66			
95	GB					
			0.45			
100	GB					
			0.5			
105	GB					Discharge water is brown and silty, 105-135 feet
			0.8			
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D
PAGE 5 OF 9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					111.0	
			0.66		GW **Gravel with Sand** brown, subangular to subrounded gravel, 60% of clasts are fractured, clasts up to 3/4", coarse grained sand	
115	GB					
			0.55		118.0	
					GW **Sandy Gravel** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 3/4", coarse grained sand	
120	GB					
			0.3			
125	GB					
			0.1			
130	GB					
			0.1		134.0	
135	GB				SP **Sand with Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand	Subangular to subrounded gravel, 134-135 feet Subangular to rounded gravel, 135-138 feet Adding water and foam while drilling; discharge water is brown, 135-145 feet
			0.05		138.0	
	GB				GW **Sand and Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1", fine to coarse grained sand	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140						
			no flow		GW **Sand and Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 1", fine to coarse grained sand	
145	GB				145.0	
					SP **Sand with Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4", medium to coarse grained sand	Discharge water is brown and silty, 145-155 feet
					146.0	
			0.25		SP **Sand** brown, trace fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, well sorted medium to coarse grained sand	
150	GB				150.0	
						Discharge water is brown, 150-180 feet Advanced via mud rotary, 150-244 feet
						Very little recovery, 153-161 feet
			0.25		153.0	
					ML **Sandy Silt** brown, fine to medium grained sand	No recovery; lithologic information and comments (when available) for this interval were taken from HH-08-X Abandoned, located approximately 45 east of this hole, 150-216 feet
155						
			no flow		158.0	
					ML **Sandy Silt** brown, trace subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand	Hard drilling, 158-163 feet
160					161.0	
			no flow		163.0	
					SM **Silty Sand with Gravel** brown, subangular to rounded gravel, 60% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	Very little recovery, 163-175 feet
165						
			no flow			Slow drilling, 168-170 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D
PAGE 7 OF 9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
170					170.0	
			no flow		GM **Silty Sand and Gravel with Clay** brown, subangular to subrounded gravel, 70% of clasts are fractured, clasts up to 1/4", fine to coarse grained sand	
					174.0	
175						Little recovery, 175-180 feet
			0.05			
					179.0	
					CL/ML **Silty Clay** brown	
180					181.0	
					CL/ML **Silty Clay** gray, trace fine to coarse subangular gravel	Little recovery, 181-183 feet
			0.98		183.0	Adding water and foam while drilling, 182-183 feet
					184.0	
					GM **Silty Gravel with Sand** fine to coarse subangular to subrounded gravel, 20% of clasts are fractured, well sorted	Discharge water is brown, 184-188 feet
185						
					188.0	
			0.65		GP **Sand Gravel** fine to coarse gravel, 30% of clasts are fractured, well graded fine to coarse grained sand	Discharge water is light brown, 188-194 feet
190					190.0	
					191.0	
					GP **Sandy Gravel** fine to coarse gravel, 60% of clasts are fractured, well sorted, fine to coarse grained sand	
			0.33			
195					195.0	
					GW **Sandy Gravel** fine to coarse subangular to subrounded gravel, 30% of clasts are fractured, well sorted, coarse grained sand	Discharge water is very light brown, 195-198 feet Very slow drilling; frequent boulders or cobbles, 195-241 feet
			0.43		198.0	
					199.0	Coarse gravel, 199-202 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
200					GW **Sandy Gravel** subangular to subrounded gravel, well sorted	Discharge water is light brown, 199-203 feet 30% of clasts are fractured, 199-205 feet Fine to coarse gravel, 202-208 feet
			0.05			
205						Discharge water is light brown, 20% of clasts are fractured, 205-207 feet
			1.13		208.0	
210						
					213.0	
					GW **Gravel** brown, angular to rounded gravel, 80% of clasts are fractured, clasts up to 1", trace coarse sand	Little recovery; adding water and foam while drilling, 213-214 feet
					214.0	
215					GW **Gravel with Sand** angular to rounded gravel, 80% of clasts are fractured, clasts up to 1", medium to coarse grained sand	
					215.0	
					GW **Gravel** angular to rounded gravel, 80% of clasts are fractured, clasts up to 1", trace poorly graded coarse sand	Logged via cuttings, 216-221 feet
					216.0	
					GW **Gravel** brown, angular to rounded gravel, 80% of clasts are fractured, clasts up to 1/2"	
					219.0	
220	GB				GW **Gravel** brown, angular to subrounded gravel, most of the clasts are fractured, clasts up to 1/4"	
					221.0	
	SS				GW **Sandy Gravel** brown, angular to rounded gravel, 80% of clasts are fractured, clasts up to 1", trace clay	Conduct SPT; blow counts: 100 (3"), 221-223 feet Logged via cuttings, 222-244 feet
					224.0	
225	GB				GW **Gravel** angular to rounded gravel, most of the clasts are fractured, clasts up to 1/4"	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89D

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89D

DATE STARTED 8/27/08 **COMPLETED** 8/30/08 **GROUND ELEVATION** 843.74 feet **TOC ELEVATION** 846.24 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136845.89 feet **EASTING** 1428723.81 feet

DRILLING METHOD Air Percussion/Mud Rotary **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
230					GW **Gravel** angular to rounded gravel, most of the clasts are fractured, clasts up to 1/4"	
235	GB					
240	GB					
					241.0	
					Bedrock black, weathered	Conduct SPT; blow counts: 100; no recovery, 241-243 feet
					243.0	
	GB				**Bedrock** black, angular, fractured, slightly weathered	
					244.0	Not logged, 244-246 feet
245						
					246.0	
					Bottom of hole at 246.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

WELL DEVELOPMENT LOG

SLR

Well ID: P-08-[redacted]89D
Date: 9/26/2008
Project: PEBBLE
Project #: 005.0189.08002
Technician: M. SWAIN / D. PARDOE

Summary

	Installed (Well Log)	Start	End
Water level		218.3	241.4
Total depth	250.0	250.0	250
pH			

Screen interval (btoPVC):
Top: 67.2
Bottom: 77.0
PVC stick-up height (above ground surface): 2.9

Development Observations

Time	Foot valve depth (ft btoPVC)	WL (ft btoPVC)	Flow (gpm)	Purge Volume (gal)	Sp Cond (mS/cm)	Turbidity (NTU)	Temp (deg C)	Sediment (grain size, color, quantity)
pH	Surge block on							
11.7	10.12	249	218.3	0.5	0.5	257	>1000	2.9	Cup of brown silt
8.57	11.14	249	229.2	1	31	171.4	419	3.7	Table spoon of brown silt
8.96	12.18	247	233.7	0.5	95	151.6	405	4.5	Tea spoon of brown silt
8.63	13.28	245	238.5	0.5	115	136.9	16	5.3	12.30 – 13.00 = FIX PUMP / CHANGE
8.18	14.03	243	240.1	0.5	130.5	124.9	151	6.4	
									RAN OUT OF WATER @ 14.28
									HAD TO CHANGE VALVE
									AND ADJUST PIPE.
									DROPPED PIPE BACK TO
									THE BASE OF HOLE
									AT 15.25
pH	Surge block off								
8.27	16.25	249	241.4	1.25	205.5	126.5	24	6.5	RAN FOR 1 hr at base
									of hole

THE pebble PARTNERSHIP

P-08-89M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89M

DATE STARTED 8/31/08 **COMPLETED** 9/1/08 **GROUND ELEVATION** 843.22 feet **TOC ELEVATION** 846.92 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.17 feet **EASTING** 1428773.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SM **Silty Sand** brown, fine to medium grained sand	
5						
10						
15						
20						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.7'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: Anticipated completion in 2009
Purge Volume: N/A

RESPONSE TEST
Equipment: N/A
Date: N/A

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/1/08 at 136 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89M

DATE STARTED 8/31/08 **COMPLETED** 9/1/08 **GROUND ELEVATION** 843.22 feet **TOC ELEVATION** 846.92 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.17 feet **EASTING** 1428773.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					SM **Silty Sand** brown, fine to medium grained sand	
25						Discharge water is brown, 26-35 feet
30						
					32.0	
					SM **Silty Sand** brown, trace subangular to subrounded gravel, 20% of clasts are fractured, clasts up to 1", fine to medium grained sand	
35						Adding water while drilling, 26-85 feet Discharge water is brown and silty, 35-146 feet
					39.0	
40	GB				SW **Gravelly Sand** brown, subangular to rounded gravel, 20% of clasts are fractured, clasts up to 1", fine to coarse grained sand	
45						

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89M
PAGE 3 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89M

DATE STARTED 8/31/08 **COMPLETED** 9/1/08 **GROUND ELEVATION** 843.22 feet **TOC ELEVATION** 846.92 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.17 feet **EASTING** 1428773.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					51.0 GW **Sandy Gravel** brown, subangular to subrounded gravel, 10% of clasts are fractured, clasts up to 3/4", fine to coarse grained sand	
55						
60					60.0 GW **Gravel** brown, subangular to rounded gravel, 40% of clasts are fractured, clasts up to 1", trace coarse grained sand	
65		▼				
70						
75	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89M

DATE STARTED 8/31/08 **COMPLETED** 9/1/08 **GROUND ELEVATION** 843.22 feet **TOC ELEVATION** 846.92 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.17 feet **EASTING** 1428773.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
					81.0 CLG **Gravelly Clay** brown, gravel, clasts up to 1"	
85					85.0 CLG **Gravelly Clay** brown, subangular to subrounded gravel, 30% of clasts are fractured, clasts up to 1"	Adding water and foam while drilling, 85-105 feet
90					90.0 GC **Clayey Gravel** brown, subangular to subrounded gravel, clasts up to 1"	40% of clasts are fractured, 90-95 feet
95					96.0 GW **Gravel with Sand** brown, subangular to subrounded gravel, 80% of clasts are fractured, clasts up to 3/4", coarse grained sand	
100						
105						Little recovery; adding water while drilling, 105-146 feet

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89M

DATE STARTED 8/31/08 **COMPLETED** 9/1/08 **GROUND ELEVATION** 843.22 feet **TOC ELEVATION** 846.92 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.17 feet **EASTING** 1428773.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					GW **Gravel with Sand** brown, subangular to subrounded gravel, 80% of clasts are fractured, clasts up to 3/4", coarse grained sand	
115						
120	GB					
125						
130						
135					136.0 SM **Silty Sand** brown, fine to coarse grained sand	
	GB					

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89M

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89M

DATE STARTED 8/31/08 **COMPLETED** 9/1/08 **GROUND ELEVATION** 843.22 feet **TOC ELEVATION** 846.92 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136887.17 feet **EASTING** 1428773.72 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					SM **Silty Sand** brown, fine to coarse grained sand	
145						
150	GB					
					152.0	Not logged, 152-152.7 feet
					152.7	
					Bottom of hole at 152.7 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-89M in 2008. Anticipated completion at future date.

THE pebble PARTNERSHIP

P-08-89S

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89S

DATE STARTED 8/31/08 **COMPLETED** 8/31/08 **GROUND ELEVATION** 844.98 feet **TOC ELEVATION** 847.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136857.67 feet **EASTING** 1428782.11 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					SM **Sand with Silt and Organic Matter** brown, trace fine to coarse subangular to subrounded gravel, poorly sorted, moist	
7.0					SW **Sand** brown, well sorted fine grained sand, moist	
15.0						No recovery, 15-17 feet
17.0					GP **Sandy Gravel** brown, fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, poorly sorted, fine grained sand, moist	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 2.9'
Type: Schedule 80 PVC
Diameter: 2"

SURFACE SEAL
Mix Used: 400# cement, 15 gal H2O

GROUT
Type: Aquaguard
Method of Placement: Tremie

PLUG
Type: Cetco 1/4" Coated Bentonite Pellets

FILTER PACK
Type: 10/20 Colorado Silica Sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: Anticipated completion in 2009
Purge Volume: N/A

RESPONSE TEST
Equipment: 1" Waterra Tubing
Date: 9/28/2008

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 9/1/08 at 1015 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89S
PAGE 2 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89S

DATE STARTED 8/31/08 **COMPLETED** 8/31/08 **GROUND ELEVATION** 844.98 feet **TOC ELEVATION** 847.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136857.67 feet **EASTING** 1428782.11 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GP **Sandy Gravel** brown, fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, poorly sorted, fine grained sand, moist	
25						
					28.0	
					GP **Sandy Gravel** brown, fine to coarse subangular to subrounded gravel, 30% of clasts are fractured, poorly sorted, fine to coarse grained sand, moist	
30						
					32.0	
					GP **Sandy Gravel** brown, fine to coarse subrounded gravel, 20% of clasts are fractured, poorly sorted	Finer and more angular gravel than rest of unit, 33-34 feet
					34.0	No recovery, 34-36 feet
35						
					36.0	
					GW **Sandy Gravel** brown, fine to coarse subangular to subrounded gravel, 30% of clasts are fractured, well sorted, coarse grained sand	
40	GB					
					44.0	
45					SP **Sand** brown, trace fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, well sorted, coarse grained sand	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89S
PAGE 3 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89S

DATE STARTED 8/31/08 **COMPLETED** 8/31/08 **GROUND ELEVATION** 844.98 feet **TOC ELEVATION** 847.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136857.67 feet **EASTING** 1428782.11 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					SP **Sand** brown, trace fine to coarse subangular to subrounded gravel, <10% of clasts are fractured, well sorted, coarse grained sand	
55					55.0 SP **Sand with Gravel** brown, subangular to subrounded gravel, 20% of clasts are fractured, poorly sorted, coarse grained sand	
					57.0	No recovery, 57-59 feet
60					59.0 SP **Sand with Gravel** fine to coarse subangular to subrounded gravel, 30% of clasts are fractured, poorly sorted, fine grained sand	
					62.0	No recovery, 62-66 feet
65		▼			66.0 SP **Sand** gray, trace fine to coarse subangular to subrounded gravel, 75% of clasts are fractured, poorly sorted, fine grained sand	
70	GB				70.0	No recovery, 70-75 feet
75					75.0 SM **Sand with Gravel and Silt** fine to coarse subangular to subrounded gravel, 60% of clasts are fractured, poorly sorted, fine grained sand	
	GB				79.0	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

P-08-89S
PAGE 4 OF 4

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** P-08-89S

DATE STARTED 8/31/08 **COMPLETED** 8/31/08 **GROUND ELEVATION** 844.98 feet **TOC ELEVATION** 847.88 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2136857.67 feet **EASTING** 1428782.11 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** D. Pardoe, M. Swain

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
	GB				GM **Silty Gravel** fine to coarse subangular to subrounded gravel, 60% of clasts are fractured, poorly sorted	
85					85.0	
					86.0 ML **Silt and Sand** trace fine to coarse subangular to subrounded gravel, 30% of clasts are fractured, poorly sorted, fine grained sand	
					Bottom of hole at 86.0 feet.	

2008 PEBBLE LOGS 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

No well development at P-08-89S in 2008. Anticipated completion at future date.

BORING NUMBER PW-1

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/17/04 **COMPLETED** 9/18/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641734 **EASTING** 372557

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0						
					2.0 **Organic Silt with Gravel and Sand (OL)** Brown, rounded and subrounded gravel to >1 inch. **Silty Gravel with Sand (GP)** Brown, moist, rounded and subrounded gravel to >1 inch.	Varing amounts of sand 10 to 20% Varing amounts of silt 5 to 20%
						Start drilling with water, 2 gpm
10						
						19:50 at 13-feet, Stop for the day 10:05 09/17/2004 Start drilling
					19.0	
20					20.5 **Clay with Gravel (CL)** Gray.	
					Poorly-graded Sandy Gravel with Silt (GP) Fine sand, subrounded to sub-angular gravel.	
					23.5	11:46 at 23-feet, Production = No significat water (Hammer holes may be silted up) Varing amounts of silt 10 to 15%
					Well-graded Sand with Silt (SW-SM) Gray, fine sand.	
30						
						11:54 at 33-feet, Production = 1 gpm (lots of sand and silt in water)

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: 6" steel casing with lid

Weep hole?: No

Concrete pad dimensions: None

WELL CASING

Dia.: 5 inches

Type: Steel

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: Steel

Slot size: 0.060"

SCREEN FILTER

Type: None

Quantity used: None

SEAL

Type: None

Quantity used: None

GROUT

Mix used: None

Method of placement: None

Vol. in surface casing: None

Vol. in well casing: None

DEVELOPMENT

Method Air surging

Time: 6 hours

Estimated purge volume: >2040 gallons

Comments: Water cloudy with clay and fine sand at the end of development. See field book for well construction comments.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER PW-1

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/17/04 **COMPLETED** 9/18/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** 6641734 **EASTING** 372557

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					40.0	
					Well-graded Sand with Silt (SW-SM) Light orange brown, medium grain.	13:16 at 43-feet, Production = 1 gpm
					45.0 **Well-graded Sand with Silt (SW-SM)** Gray, fine grain.	
50					Coarser than above with <5% gravel.	
					54.0	14:32 at 53-feet, Production = 1 gpm
					Clay (CL) Gray, plastic, firm.	
60						
						15:50 at 63-feet, Production = 1 gpm
70					70.0	
					Silty Sand (SM) Gray, medium sand.	17:20 at 73-feet, Hammer frozen, working again at 19:21, Production = NA
					75.0	
					77.0 **Clay with Sand (CL)** Gray, plastic.	
80					**Sandy Gravel (GP)** Gray, coarse, subangular sand ~30%.	
					Sub-rounded and rounded, 50% sand.	
					83.0	19:50 at 83-feet, Stop for the day, 10:05 09/18/2004, Production = <0.5 gpm
					85.0 **Clay with Sand and Gravel (CL)** Gray, plastic, firm.	
					Clay (CL) Gray, plastic, firm.	
90					90.0	
					91.5 **Poorly Graded Gravelly Sand (SP)** Coarse grain,	
					92.5 gravel up to 1/2-inch, sub-rounded, 30% gravel.	
					Clay with Gravel and Sand (CL) 20% sand.	11:53 at 93-feet, Production = <0.5 gpm
					95.0 **Silty Sand with Gravel (SM)** Angular and sub-angular,	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER PW-1

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/17/04 **COMPLETED** 9/18/04 | **GROUND ELEVATION** | **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** 6641734 **EASTING** 372557

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Dave Lacey

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
					some sub-rounded, 20% gravel. **Clay (CL)** Gray, plastic.	
100						13:36 at 103-feet, Production = <0.5 gpm
					105.0	
					106.0 **Silty Sand with Gravel (SM)** Mostly angular few sub-rounded.	Black staining and floating sheen down to 112-feet
					No sub-rounded, Fractured Bedrock.	
110					Color change - Light brownish gray.	Bedrock?
						14:30 at 113'
					Bedrock Cuttings = Well-graded sand (SW), Medium, angular. Color change - Light brown.	
					119.0 Color change - Light reddish brown	
					Bottom of hole at 119.0 feet.	TD = 119

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

BORING NUMBER PW-1b

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/15/04 **COMPLETED** 9/16/04 **GROUND ELEVATION** _____ **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Dave Lacey

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					2.0 **Organic Silt with Gravel and Sand (OL)** Brown, rounded to subrounded gravel to >1". **Poorly-graded Gravel with Silt and Sand (GP-GM)** Brown, moist, rounded to subrounded gravel to >1-inch.	9:10 on 9-16-2004 start drilling Varying amounts of silt 15 to 20% Varying amounts of sand 0 to 40% Start drilling with water 1gpm
10						9:20 at 13-feet (Completed casing weld at 10:34)
					19.0	
20					21.0 **Silt (ML)** Gray.	
					Silty Sand with Gravel (SM) Brown, coarse grain, 10% gravel. Change in grain size - Medium to fine grain.	10:40 at 23-feet (Continued drilling at 11:50) Production = 0 gpm (Hammer may be silted up) Varying amounts of silt 20 to 40%
30					30.0 **Silty Sand (SM) Gray, fine grain.**	
						12:07 at 33-feet Production = No significant water

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): Boring abandoned

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: Boring abandoned.

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: _____

Type: _____

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: _____

Slot size: _____

SCREEN FILTER

Type: _____

Quantity used: _____

SEAL

Type: _____

Quantity used: _____

GROUT

Mix used: _____

Method of placement: _____

Vol. in surface casing: _____

Vol. in well casing: _____

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: _____

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER PW-1b

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 9/15/04 **COMPLETED** 9/16/04 | **GROUND ELEVATION** | **WATER LEVELS** NA feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** | **EASTING**

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Dave Lacey

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Silty Sand (SM) Gray, fine grain.** ***(continued)***	(Hammer may be silted up)
					40.0	
					Silty Sand (SM) Light orangish brown, Fine sand, 5% gravel.	13:19 at 43-feet (completed weld at 14:20)
					Change in grain size - Medium grain.	
50					50.0 Color Change - Gray.	Return line clogged.
					Bottom of hole at 55.0 feet.	TD = 50 Casing broke. Boring abandon with 14 bgs of 3/4 chips. 15-feet of casing lost in boring. Moved 5-feet to the east to start PW-1(A).

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

BORING NUMBER PW-3

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/5/04 **COMPLETED** 10/7/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Organic Silt (OL)**	
					3.0 **Silty Gravel with Sand (GM)** Brown, moist, gravel is sub-rounded and rounded, fine to >3/4-inch, sand is sub-rounded-sub-rounded, medium to coarse.	
					Poorly-graded Gravel with Sand (GP) Moist, 1/2 to >3/4-inch, angular and sub-rounded gravel; medium to coarse, angular to subrounded sand.	75% gravel 25% sand
10					Occasional cobble.	
						Start drilling with water
					17.0 **Well-graded Gravel with Sand (GW)** Brownish gray, moist, angular and rounded, grading fine to >3/4-inch gravel, medium to coarse subrounded to angular sand..	80% gravel, 20% sand
20					Increasing sand 30%.	Adding polymer.
						Stopped for day at 24-feet on 10/05/2004
30					34.0	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: _____

WELL CASING

Dia.: 5 inches

Type: Steel

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: Steel

Slot size: 0.060"

SCREEN FILTER

Type: None

Quantity used: None

SEAL

Type: None

Quantity used: None

GROUT

Mix used: None

Method of placement: None

Vol. in surface casing: None

Vol. in well casing: None

DEVELOPMENT

Method Air surging

Time: _____

Estimated purge volume: _____

Comments: See field book for well construction and developlment comments.

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER PW-3

Northern Dynasty Minerals Ltd.

CLIENT | **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 | **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/5/04 **COMPLETED** 10/7/04 | **GROUND ELEVATION** | **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC | **NORTHING** | **EASTING**

DRILLING DRILLING METHOD | **EQUIPMENT** | **LOGGER** Matt Flynn

NOTES

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Well-graded Sand (SW)** Brown, Moist, fine to medium grain, occasional gravel.	95% sand 5% gravel
					Increasing gravel with depth.	80% sand 20% gravel 70% sand 30% gravel
					47.0	
50					**Well-graded Gravely Sand (SW)**	
					51.0	
60					**Well-graded Gravel with Sand (GW)** Moist, grayish brown, fine to >3/4-inch, sub-rounded and angular gravel.	
					Less sand.	
					Larger gravels (based on angular cuttings).	
70					69.0	
					Poorly-graded Sand with Gravel (SP) Brown, wet, medium sub-angular sand; gravel up to 1/2-inch, 10% gravel.	
					Less gravel with depth. Finer than above - Medium to fine sand.	
80					81.0	
					Well-graded Sandy Gravel (GW) Grayish brown, wet, fine to >3/4-inch, R-A.	75% gravel 25% sand
					Small lense of silt (1 to 2-inches) at 85-feet.	
					87.0	
90					89.0 **Poorly-graded Sand with Gravel (SP)** Brown, wet, medium grain, gravel 1/2-inch.	
					Well-graded Gravel with Sand (GW) Brown to gray, fine to >3/4-inch, rounded and angular gravel; sand-medium to coarse grain.	70% gravel 30% sand
						80% gravel 20% sand
					95.0	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

(Continued Next Page)

BORING NUMBER PW-3

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/5/04 **COMPLETED** 10/7/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun Drilling LLC **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Matt Flynn

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
100					**Well-graded Gravel with Sand (GW)** Brown to gray, fine to >3/4-inch, rounded and angular gravel; sand-medium to coarse grain.	90% gravel 10% sand 80% gravel 20% sand 90% gravel 10% sand
					106.0	95% gravel 5% sand
					107.0 **Poorly-graded Sand (SP)** Brown, wet, medium/fine, rounded and angular.	100% sand
110					**Well-graded Sandy Gravel (GW)** Brown, wet, fine to >1-inch, rounded to angular gravel; medium to coarse sand.	70% gravel 30% sand
					110.5 **Well-graded Sand with Gravel (SW)** Brown, wet, medium to coarse sand; subrounded to angular fine gravel to >3/4-inch.	
					115.0 Sand is fine to medium from 114 to 115-feet.	
					Bottom of hole at 115.0 feet.	TD - 115-feet at 11:00 on 10/7/2004

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 1/24/05

BORING NUMBER PW-4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/11/04 **COMPLETED** 10/13/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Alex Rosenberg

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
0					1.0 **Organic w/silt (OL)**	
					Poorly-graded gravel w/sand (GP) - cobbles	
10					Boulder chips, grey, angular, dry.	
					Gravel w/coarse sand (GP), multicolored	
					17.0 **Sand w/gravel (SP)**	
20					21.0 **Boulders (GP)**	
					Increasing fines, dark grey/brown. No fines.	
30					30.0 **Gravelly sand (SW)** subangular, dark brown	
					32.5 **Coarse sand (SP)** few gravel pieces, angular, immature.	

WELL COMPLETION INFORMATION

CASING

Top elevation (feet): _____

Vent hole?: _____

WELLHEAD PROTECTION COVER

Type: _____

Weep hole?: _____

Concrete pad dimensions: None

WELL CASING

Dia.: 2 inches

Type: Steel

SURFACE CASING

Dia.: _____

Type: _____

SCREEN

Type: Steel continuous wire

Slot size: 0.050" to 0.060"

SCREEN FILTER

Type: None

Quantity used: None

SEAL

Type: None

Quantity used: None

GROUT

Mix used: None

Method of placement: None

Vol. in surface casing: None

Vol. in well casing: None

DEVELOPMENT

Method _____

Time: _____

Estimated purge volume: _____

Comments: _____

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

(Continued Next Page)

BORING NUMBER PW-4

Northern Dynasty Minerals Ltd.

CLIENT _____ **PROJECT NAME** Pebble Gold Copper Project

PROJECT NUMBER 316349.PP.GW.02.04 **PROJECT LOCATION** Iliamna, Alaska

DATE STARTED 10/11/04 **COMPLETED** 10/13/04 **GROUND ELEVATION** _____ **WATER LEVELS** feet

DRILLING DRILLING CONTRACTOR Midnight Sun **NORTHING** _____ **EASTING** _____

DRILLING DRILLING METHOD _____ **EQUIPMENT** _____ **LOGGER** Alex Rosenberg

NOTES _____

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE NUMBER	RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM
40					**Coarse sand (SP)** few gravel pieces, angular, immature. *(continued)*	
					42.5	
					44.0 **Gravelly sand (SW)** 60% gravel, 40% sand, small amount of silt. Very brown water.	
					Medium coarse sand w/gravel (SP) grey, (many different rock types).	
50					**Gravelly sand (SP)** 70% sand and 30% angular gravel up to 1-inch, small amount of silt, brown water.	
60					60.0	
					61.0 **Coarse sand w/gravel (SP)** 80% sand and 20% gravel up to 1-inch, increasing fines.	
					62.5 **Sandy gravel (GP)** medium grain sands, angular.	
					Poorly-sorted gravelly sand (SP) angular.	
70					65% sand, 35% gravel	
					72.0 **Coarse sand w/some gravel (SP)**	
					73.0 **Sand w/silt and gravel (SW)** 60% sand, 20% silt, 20% gravel.	
					Poorly graded, coarse gravelly sand (SP)	
					Medium to coarse sand w/gravel (SP) 65% sand, 35% gravel.	
					82.5	
					Bottom of hole at 71.0 feet.	

NORTHERN DYNASTY PEBBLE.GPJ GINT US.GDT 3/4/05

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site O

DATE STARTED 8/1/05 **COMPLETED** 8/3/05 **GROUND ELEVATION** 925.37 feet **TOC ELEVATION** 927.98 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6634398.178 meters **EASTING** 372493.217 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Tundra, Grass**	
					4.0	
5	GB				5.0 **Gravel with sand and silt** Brown, well-graded gravel and sand, trace minor silt, subrounded to subangular, dry.	
					Gravel with sand and silt Brown, well-graded, subrounded to subangular, gravel and sand, trace minor silt, dry.	
					9.0	
10	GB				**Silty sand and gravel** Brown, well-graded sand, minor gravel, dry.	
					14.0	
15	GB				15.0 **Gravel and sand** Brown, well-graded, subangular to subrounded gravel and sand, trace silt, dry.	
					Gravel and sand Brown, well-graded, subangular to subrounded gravel and sand, trace silt, dry.	
					19.0	
20	GB				**Gravel and sand** Same as above.	
					24.0	
25	GB				25.0 **Gravel and sand** Increased silt content.	
					Gravel and sand Brown, well-graded, subrounded gravel and sand with silt.	
					29.0	
30					**Silty gravel with sand** Gray-brown, dry.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: 2.61 feet
Type: Steel
Diameter: 5 inch

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

SCREEN FILTER
Type: N/A

SCREEN
Type: N/A
Slot Size: N/A

RATHOLE
Type: N/A

DEVELOPMENT
Method: Air Lift
Date: 3 Aug., 2005
Purge Volume: 675 gallons

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Welded Steel casing to 78 ft (bgs), Open hole drilling with rock hammer to 110 ft (bgs).

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-5

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 8/1/05 **COMPLETED** 8/3/05
GROUND ELEVATION 925.37 feet **TOC ELEVATION** 927.98 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634398.178 meters **EASTING** 372493.217 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB				**Silty gravel with sand** Gray-brown, dry.	
					34.0	
35	GB				**Gravel and sand** Brown, well-graded sand and gravel with silt, dry.	
					36.0	
					Sand Light brown, fine to medium grained, dry.	
					37.5	
					Heaving sands	Broke casing at 37 feet (August 1), resumed drilling (August 2). Added lots of foam.
					38.8	
40					**Sandy gravel** Brown, <3/4"-diameter, medium- to coarse-grained, subangular clasts.	
					44.0	
45					**Sandy gravel** Grayish brown, medium- to coarse-grained, subangular clasts.	
					45.0	
					Sandy gravel Grayish brown, medium- to coarse-grained, subangular to angular clasts. Grades with less sand.	
					49.0	
50					**Bedrock** Dark gray, angular clasts, siltstone-bedrock?	Slower drilling. Kelly agrees that we are in bedrock-competent rock. All cuttings fresh. Slower drilling. Started making some water. Flow test ~2 gpm.
		2	2		54.0	
55					**Bedrock** Dark gray (siltstone).	
					55.0	
					Siltstone Dark gray to black. Occasional zones with calcite veins.	
					58.0	
			2		**Siltstone** Gray, as above.	Flow test ~<2 gpm @ 50 psi. Seemed to be making more water.
60					Cuttings very small, very competent.	
					64.0	
			2		**Siltstone** As above.	Flow test @ 50 psi, <2 gpm, losing water where cyclone tube connects to steel casing). Slow drilling.
65					65.0	
					Siltstone Gray, massive, competent.	
					69.0	Flow test @ 50 psi, <2 gpm.
			2		**Siltstone** Gray.	Cuttings small and pulverized. Slow drilling.
70					73.0	
			2		**Siltstone** As above.	Makes ~2 gpm.
					75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site O

DATE STARTED 8/1/05 **COMPLETED** 8/3/05 **GROUND ELEVATION** 925.37 feet **TOC ELEVATION** 927.98 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6634398.178 meters **EASTING** 372493.217 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Siltstone** Brown staining, larger cuttings, possible weathering zone.	Seems to be making more water now.
			5		79.0	
80					**Siltstone** Dark gray, slightly reactive with/hci.	Flow test 10 sec. for 0.5 gal @ 59 psi, 30 gpm. Resumed drilling with rock bit at 1525, running at full air (160 psi).
			60			
85	GB				85.0 **Siltstone** Black, slightly calcareous.	Drill rate: 1 ft. every 2 min.
			60			
90	GB				Water: silt content alters fairly rapidly, almost clear to slightly silty. Slight calcareous siltstone.	
			60			
95	GB				95.0 **Siltstone**	
			75			5 gal. in 4 sec. Work on compressors, bit is clogged with something.
100	GB				100.0 **Siltstone**	
			60			
105						
			60			
110					110.0 Bottom of hole at 110.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

PW-6
PAGE 1 OF 2

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site O

DATE STARTED 8/7/05 **COMPLETED** 8/7/05 **GROUND ELEVATION** 925.38 feet **TOC ELEVATION** 927.49 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6634399.772 meters **EASTING** 372486.547 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat**	
					Gravelly sand Coarse to fine sand, <15% fines.	
					3.0	
					4.0 **Sand** Gray, fine, dry.	
5					5.0 **Gravelly sand** Well-graded gravel, <15% fines.	
	GB				**Gravelly sand** Well-graded gravel, coarse to fine sand, >15% fines and silt, damp.	Cuttings starting to stick from a little bit of silt in gravels.
					Gravels with coarse to fine sand and silt.	
10					10.0	
	GB				**Gravelly sand** Well-graded gravel, coarse to fine sand, <15% fines.	
15					15.0	
					16.0 **Sand** 80% medium to fine sand, 20% small gravel, <15% fines, dry.	
	GB				**Gravelly sand** Coarse to fine sand, dry.	Cuttings.
20					20.0	
					21.0 **Gravelly sand** Well-graded gravel, fine sand and ash.	Cuttings.
	GB				22.0 **Sand** Light gray, ash, very fine sand.	Cuttings.
					23.0 **Gravelly sand** Brown, coarse sand.	Cuttings.
					Gravelly sand and silt Coating of silt on gravels.	
25					25.0	
	GB				**Gravelly sand** Brown, well-graded, coarse to fine sand and silt. Silt increases with gravels >15%.	Dry.
					29.0	
30						

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: 2.12 feet
Type: Steel
Diameter: 5 inch

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

SCREEN FILTER
Type: Natural material

SCREEN
Type: 4" wire wrap, stainless steel
Slot Size: Not specified

RATHOLE
Type: N/A

DEVELOPMENT
Method: Air Lift
Date: 8-9 Aug., 2005
Purge Volume: 300 gallons

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Welded Steel casing to 44.5 ft, pulled back to 40.5 ft. to expose well screen. Open hole drilling with rock hammer, 2" PVC placed inside steel casing with 5 ft screen to help with pumping test.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-6

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site O
DATE STARTED 8/7/05 **COMPLETED** 8/7/05
GROUND ELEVATION 925.38 feet **TOC ELEVATION** 927.49 feet
DRILLING CONTRACTOR Foundex
NORTHING 6634399.772 meters **EASTING** 372486.547 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravelly sand** Brown, well-graded gravel, coarse sand, dry.	Some water being made. Broke casing. Started drilling again after reinstalling casing to 40 ft. bgs. on 8/5/05. Stopped drilling to let water collect in casing below blowing pipe to see how much water. Let stand for 5 min. and produced 1 gal. of very soupy silt mud. Let casing sit 5 min. and blew out about 2 gal. of very soupy silty mud. Flow test after testing pipe, 5 min. at 50 psi, produced 1.5 gal. per minute. 1.5 gpm. Let pipe sit and then reblew pipe again. Let hole sit for 15 min., produced 2.5 gpm then hole dried up. Water level in casing 36.34 bgs.
35					35.0 **Gravelly sand** Brown, well-graded, subrounded, <3/4"-diameter gravel clasts, medium- to coarse-grained sand.	
40					39.0 40.0 **Gravelly sand and silt** As above, wet cuttings.	
					Gravelly sand and silt Brown, well-graded gravel, wet.	
					43.0 **Weathered bedrock** (Cuttings.)	
					44.5 Bottom of hole at 44.5 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** meters **EASTING** meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Gravelly silty sand** Brown.	
					No significant sample volume in cuttings.	
5					5.0 **Gravelly silty sand** Brown, damp.	
	GB				8.0	Some water coming up with cuttings, water is from drilling previous piezometer.
10						Added foam.
					13.0 **Gravelly silty sand** Brown, damp.	Cutting has a lot of silt and is damp and sticking in pipe.
	GB				**Gravelly silty sand** Brown.	
15					15.0 **Gravelly sand** Well-graded gravel, coarse sand.	Driller adding foam to get cuttings up the hole.
					17.0 **Gravelly sand** Well-graded gravel, coarse sand.	
	GB					Driller adding foam.
20						
					22.0 **Sand** Coarse sand, small amount of gravel.	
	GB				24.0	Drilling adding foam.
25					25.0 **Gravelly sand** Well-graded gravel, some coarse sand.	Cuttings.
					27.0 **Gravelly sand** 1/2"-diameter gravel, some coarse sand.	Cuttings.
	GB				**Gravelly sand** Well-graded gravel, coarse sand, <15% fines.	Added foam.
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: N/A
Type: N/A
Diameter: N/A

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

SCREEN FILTER
Type: N/A

SCREEN
Type: N/A
Slot Size: N/A

RATHOLE
Type: N/A

DEVELOPMENT
Method: N/A
Date: N/A
Purge Volume: N/A

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Casing broke, Boring abandoned.

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05 **GROUND ELEVATION** _____ **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** meters **EASTING** meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravelly silt**	Driller losing circulation, started to pick up silt in the cuttings.
					32.0 **Gravelly silt** Gray elastic silt, <15% gravel, damp.	
	GB					Driller said we are still in silts by pressure rotating on the air compressor.
35					35.0 **Gravelly silt** Silt, some gravel.	
					37.0	
	GB				38.0 **Gravelly silt** Gray, elastic silt, <15% gravel, damp.	
					Gravelly silt Silt, some gravel.	Starting to pick up more gravel with the silt.
40					39.5 **Silty gravel** Gravel, some silt.	Added foam.
					41.5	
					42.0 **Gravel** Pea gravel.	
					43.0 **Gravel and silt** 60% gravel, 40% silt, damp.	
	GB				**Gravel** Well-graded gravel, coarse sand.	
45					45.0 **Gravel** Coarse sand.	Added foam.
					47.0	
	GB				**Gravel** 50% well-graded, 1/2"-diameter gravel, coarse to fine sand mix, 10% silt.	Added foam.
50						
					52.0 **Gravel** Well-graded gravel with sand and silt, <15% fines.	
	GB					
55					55.0 **Gravel** Gravel, coarse sand.	Added foam.
					57.0	
	GB				**Gravel** Poorly-graded gravel, coarse to fine sand, <15% sand, dry.	Added foam.
60					Gravel and coarse sand.	
					62.0 **Gravel** Well-graded gravel, coarse sand, <15% fines, dry.	
	GB					
65					65.0 **Gravel** Gravel, coarse sand.	Added foam.
					67.0	
					Gravel 60% 1/2"-diameter, well-graded gravel, 40% coarse to fine sand, dry.	Added foam.
70					71.0	
					72.0 **Gravel and sand** More coarse sand.	
	GB				73.0 **Sand** Coarse to fine sand, some 1/2"-diameter gravel, dry.	Added foam.
					Sand and gravel Pea gravel.	
					75.0	

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** meters **EASTING** meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sand and gravel**	
					77.0	
	GB				**Gravel and sand** 70% 1/4"-diameter, poorly-graded gravel, 30% coarse to fine sand, <15% fines, dry.	Added foam.
80						
					82.0	
	GB				**Gravel** Poorly-graded pea gravel, little to no fines, dry.	
					85.0	Added foam.
85					**Gravel** Well-graded gravel, little to no sand or fines.	
					87.0	
	GB				**Gravel** Well-graded gravel, little to no sand, 10% sand, dry.	Driller said he hadn't seen any indication of water.
90						Added foam.
					91.5	
					Sand Coarse to fine gravel, <15% fines.	
	GB				93.0	
					Sand with gravel Some gravel.	
95						Added foam.
					97.0	
	GB				**Sand with gravel** Medium- to fine-grained sand, <15% fines, clean, dry.	
					99.0	Added foam.
100					**Gravel with sand** Coarse sand (cuttings).	
					102.0	
	GB				103.0 **Gravel with sand** Well-graded gravel, coarse sand, <15% fines, dry.	Injected foam.
105					**Gravel with sand** Coarse sand.	
					106.0	
					107.0 **Sand** Coarse sand (in cuttings).	Driller said we are now into sands.
	GB				**Gravel with sand** 50% well-graded gravel, 50% coarse sand, dry.	
110						Added foam.
					111.0	
					112.0 **Gravel with sand** Gravel with coarse to medium sand (cutting).	Torque gauge on rig indicates gravels.
	GB				**Gravel with sand** 80% well-graded, up to 1/2"-diameter gravel, 20% coarse to fine sand, <15% fines, dry.	
115					115.0	Inject foam.
					Gravel with sand Coarse to medium sand (cuttings).	
					117.0	
	GB				**Gravel with sand** 80% poorly-graded, 1/4"-diameter pea gravel, 80@ coarse to medium sand, <15% fines, dry.	Started drilling again after welding casing.
					120.0	Inject foam.

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7 (Attempt #1)

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05 **GROUND ELEVATION** **TOC ELEVATION** feet
DRILLING CONTRACTOR Foundex **NORTHING** meters **EASTING** meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
					Bottom of hole at 119.0 feet.	. Broke casing.

TEMPLATE WITHOUT WELL STICKUP (ABANDONED BOREHOLE) PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05
GROUND ELEVATION 1013.50 feet **TOC ELEVATION** 1015.67 feet
DRILLING CONTRACTOR Foundex
NORTHING 6635469.085 meters **EASTING** 370739.92 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.3 **Peat**	
					Sand Gray brown, medium to fine sand, <15% fines, dry.	
	GB				4.5	
5					**Gravel** Gravel, fine sand, silt, damp.	Started getting into 1/2"-diameter gravels.
					7.0 **Gravel** Brown, 50% 1/2"-diameter, well-graded gravel, 35% fine sand, <15% silt, damp.	
	GB					
10					10.0 **Gravel** Brown, well-graded gravel with sand and silt, ~15% silt.	Injected water to get cuttings up.
					12.0 **Gravel** Brown, 50% 1/2"-diameter well-graded gravel, 35% medium sand, >15% silt.	
	GB				14.0	
15					15.0 **Gravel** Poorly-graded, 1/2"- to 3/4"-diameter gravel, very little sand.	Injected water.
					16.0 **Gravel** Poorly-graded, 1/2"- to 3/4"-diameter gravel, very little sand.	Injected water.
					17.0 **Gravel** Well-graded gravel, coarse sand.	
	GB				**Gravel** 50% 1/2"-diameter or less, well-graded gravel, 40% coarse sand, 10% fines, dry.	
20					21.0	
					22.0 **Sand and gravel** Coarse sand.	
	GB		1/8-1/4		**Sand and gravel** 70% coarse sand, 30% 1/4"-diameter pea gravel, dry. 23.5	
					Gravel with sand Coarse sand, wet (cuttings).	Injected water. Water returns are silty colored.
25			1/8-1/4		25.0 **Gravel with sand** Coarse sand, wet.	
					27.0	
					28.0 **Gravel** 40% 1/4"- to 1/2"-diameter, well-graded gravel, 40% coarse sand, 20% fine sand, wet.	
	GB				**Gravel with sand** Coarse sand, some silt.	Injected water.
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: 2.17 feet
Type: Steel
Diameter: 5 inch

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

SCREEN FILTER
Type: Natural material

SCREEN
Type: 4" wire wrap, stainless steel
Slot Size: N/A

RATHOLE
Type: N/A

DEVELOPMENT
Method: Air Lift
Date: 19 Aug., 2005
Purge Volume: 1650 gallons

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Welded Steel casing to 177 ft (bgs), Pulled back to 165.75 ft (bgs) to expose 11.25 ft screen.

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7
PAGE 2 OF 5

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05
GROUND ELEVATION 1013.50 feet **TOC ELEVATION** 1015.67 feet
DRILLING CONTRACTOR Foundex
NORTHING 6635469.085 meters **EASTING** 370739.92 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30						
					32.0 **Gravel with sand** Coarse sand, some silt/groundwater, some out of hole is silty colored.	
					33.0 **Gravel with sand and silt** Well-graded gravel, coarse sand.	
	GB				**Silt with gravel** Stiff, dry.	Injected water (low rate).
35						Injected water, small amount, low rate.
					37.0 **Silt with gravel** Pea-sized gravel with sand and silt, dry.	
	GB				39.0	
40					**Gravel, sand and silt** 50% 1/2"-diameter gravel, 30% coarse to fine sand, 20% silt.	Injected water.
					42.0	Injected water.
	GB				**Gravel with sand** Well-graded gravel, coarse sand, dry.	
45						
					47.0	
	GB				**Sandy gravel** Brown, <3/4"-diameter, angular to subrounded gravel clasts, medium- to coarse-grained sand.	
50						Add foam.
					52.0 **Sandy gravel-gravelly sand** <1/2"-diameter, subangular, medium-grained sand clasts.	
	GB				55.0 **Sandy gravel** Brown, <1/2"-diameter, subangular gravel clasts, medium-grained sand.	
55					57.0 **Sandy gravel** Brown, <3/4"-diameter, subangular to subrounded gravel clasts, medium- to coarse-grained sand.	
	GB					Added water and foam.
60						
					62.0 **Sandy gravel** Brown, <1/2"-diameter, subangular to subrounded gravel clasts, medium- to coarse-grained sand.	Added water and foam.
65					65.0 **Sandy gravel** Brown, <1/2"-diameter, subangular to subrounded gravel clasts, medium- to coarse-grained sand.	
					67.0 **Sandy gravel-gravelly sand** Brown, <3/4"-diameter, subangular to subrounded gravel clasts, medium- to coarse-grained sand.	Added water and foam.
	GB				72.0 **Sandy gravel** Brown, <3/4"-diameter, angular to subrounded gravel clasts.	
70						Added foam.
	GB				75.0	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7
PAGE 3 OF 5

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05
GROUND ELEVATION 1013.50 feet **TOC ELEVATION** 1015.67 feet
DRILLING CONTRACTOR Foundex
NORTHING 6635469.085 meters **EASTING** 370739.92 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sandy gravel** Brown, <3/4"-diameter, angular to subrounded gravel clasts.	
	GB				77.0 **Sandy gravel** Brown, <1/2"-diameter, angular to subrounded gravel clasts, medium- to coarse-grained sand.	Added foam.
80					82.0 **Sandy gravel** As above.	
	GB				85.0 **Sandy gravel** Brown, <3/4"-diameter, angular to subrounded gravel clasts, medium- to coarse-grained sand.	
85					87.0 **Sandy gravel** Brown, <1"-diameter, angular to subrounded gravel clasts, medium- to coarse-grained sand.	Added foam.
	GB				92.0 **Gravelly sand** Brown, medium- to coarse-grained sand.	Added foam.
90					95.0 **Gravelly sand** Brown, medium- to coarse-grained sand.	
	GB				97.0 **Gravelly sand-sandy gravel** Brown, <3/4"-diameter, angular to subrounded clasts.	Added foam.
95					102.0 **Gravelly sand-sandy gravel** Brown, <3/4"-diameter, angular to subrounded gravel clasts, medium- to coarse-grained sand.	Added foam.
	GB				105.0 **Gravelly sand-sandy gravel** Brown, <3/4"-diameter, angular to subrounded gravel clasts, medium- to coarse-grained sand.	Added foam.
100					107.0 **Gravel with sand** 60% 1/2"-diameter, well-graded gravel, 40% coarse to medium sand, dry.	Injected foam.
	GB				112.0 **Gravel with sand** 60% 1/2"- to 1/4"-diameter, well-graded gravel, 40% coarse to medium sand, dry.	Injected foam.
105					117.0 **Gravel with sand** 50% 1/2"- to 1/4"-diameter, well-graded gravel, 50% coarse to medium sand, dry.	Injected foam. Injected foam.
	GB					Injected foam.
110						
	GB					
115						
	GB					

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7
PAGE 4 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05 **GROUND ELEVATION** 1013.50 feet **TOC ELEVATION** 1015.67 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635469.085 meters **EASTING** 370739.92 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120						
					Gravel with sand 50% 1/2"- to 1/4"-diameter, well-graded gravel, 50% coarse to medium sand, dry.	
					122.0	
	GB				**Gravel with sand** 50% 1/2"- to 1/4"-diameter, well-graded gravel, 50% medium to fine sand, dry.	
125					125.0	
					126.0 **Gravel** 1/2"- to 1/4"-diameter, subangular gravel, medium sand, dry (cuttings).	Injected foam.
					127.0 **Gravel** Poorly-graded gravel, coarse sand, dry.	
	GB				**Gravel with sand** 50% 3/4"- to 1/2"-diameter, well-graded gravel, 50% medium to fine sand, dry.	Injected foam.
130					132.0	
					133.0 **Gravel with sand** 50% 1/2"- to 1/4"-diameter, well-graded gravel, 50% coarse to medium sand, dry.	
	GB				**Sand** Brown, medium to fine sand, 1/4"-diameter gravel, <15% fines, dry (cuttings).	Injected foam.
135					137.0	
	GB				**Gravel with sand** Well-graded gravel, medium to fine sand, dry.	Injected foam.
140					142.0	
	GB				**Gravel with sand**	
145					145.0	
					Gravel with sand	
					147.0	
	GB				**Gravel with sand** Brown.	Added foam.
150					153.0	
					Gravel with sand Brown.	
155	GB				157.0	
	GB				**Gravel with sand** Brown, <1/2"-diameter, angular to subrounded clasts.	Added foam.
160					162.0	
	GB				**Gravel with sand** Brown, <1/2"-diameter, angular to subrounded clasts	Added foam.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-7
PAGE 5 OF 5

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site N
DATE STARTED 8/17/05 **COMPLETED** 8/17/05 **GROUND ELEVATION** 1013.50 feet **TOC ELEVATION** 1015.67 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6635469.085 meters **EASTING** 370739.92 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Daigle/Scola

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
165						
					165.0 **Gravel with sand** Brown, <1/2"-diameter, angular to subrounded clasts.	
					167.0	Added foam.
					168.0 **Gravel with sand** As above.	
	GB				**Sand** Brown, fine grained.	Making water.
170						Making lots of water.
					171.0	
					172.0 **Sand** Gray (cuttings).	
					Sand with silt Gray, fine-grained sand.	
175					175.0	
					176.0 **Sand with silt** Gray.	
					177.0 **Silt**	Hit silt @ 0340.
					Bottom of hole at 177.0 feet.	

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project

NORTHERN DYNASTY MINES INC.

PW-8
PAGE 1 OF 3

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** Pebble/Site AW

DATE STARTED 9/13/05 **COMPLETED** 9/14/05 **GROUND ELEVATION** 999.52 feet **TOC ELEVATION** 1002.12 feet

DRILLING CONTRACTOR Foundex **NORTHING** 6641440.132 meters **EASTING** 372952.526 meters

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Tundra**	
					4.0	No water added.
5					5.0 **Silt with gravel and sand** Brown, well-graded sand, moist.	
					Silt with gravel and sand Brown, well-graded sand, moist.	
10						
15					15.0	
					Silt with gravel and sand Brown, well-graded sand, moist.	Added water.
20						Added water.
					24.0	
25					25.0 **Gravel with sand** Well-graded sand, minor subangular to subrounded gravel and fines.	Added water.
					Gravel with sand Well-graded sand, minor subangular to subrounded gravel and fines.	Added water.
30						Difficult drilling. Air going into formation, low recovery.

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: N/A
Diameter: N/A

WELL CASING
Stickup: 2.60 feet
Type: Steel
Diameter: 5 inch

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

SCREEN FILTER
Type: N/A

SCREEN
Type: N/A
Slot Size: N/A

RATHOLE
Type: N/A

DEVELOPMENT
Method: Air Lift
Date: 14 Sept., 2005
Purge Volume: 3200 gallons

RESPONSE TEST
Response Method: N/A
Date: N/A

Comments: Welded Steel casing, to 77 ft, Open hole drilling with rock hammer to 177

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

Pebble Project
NORTHERN DYNASTY MINES INC.

PW-8

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 9/13/05 **COMPLETED** 9/14/05
GROUND ELEVATION 999.52 feet **TOC ELEVATION** 1002.12 feet
DRILLING CONTRACTOR Foundex **NORTHING** 6641440.132 meters **EASTING** 372952.526 meters
DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					**Gravel with sand** Well-graded sand, minor subangular to subrounded gravel and fines.	Added water.
					34.0	
35					35.0 **Gravel with sand** Well-graded sand and up to 3/4"-diameter gravel.	
					36.0 **Gravel with sand** Brown, well-graded sand and up to 3/4"-diameter gravel.	
					Silty sand	
40					41.0	
					Sand with silt Well-graded sand, wet.	
45					46.0	
					Sand with gravel Well-graded sand, trace subangular to subrounded, up to 1/2"-diameter gravel, and silt, wet.	
50					51.0	
					Sand Well-graded, trace gravel, wet.	
55					56.0	
					Sand with silt Well-graded sand, wet.	
					59.0	
60					**Silt** Trace sand, trace gravel, wet.	Started adding foam.
65					66.0	
					66.8 **Silt** Well-graded sand and gravel, wet.	
					Gravel 1/2"-diameter, rounded to subangular clasts and fragments, well-graded sand, trace silt, wet.	
70					73.0	
					Bedrock TC conglomerate, greenish matrix, calceous, with sand- to gravel-sized clasts within matrix.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR
SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

Pebble Project

NORTHERN DYNASTY MINES INC.

PW-8
PAGE 3 OF 3

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AW
DATE STARTED 9/13/05 **COMPLETED** 9/14/05
GROUND ELEVATION 999.52 feet **TOC ELEVATION** 1002.12 feet
DRILLING CONTRACTOR Foundex
NORTHING 6641440.132 meters **EASTING** 372952.526 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Klieforth

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					76.0	Hard drilling, competent material, high water production. Open hole drilling below 77'. Trip out hammer, trip back in with smaller hammer to go through shoe on casing.
	GB				**Bedrock** TC conglomerate, black matrix, fractured material with sand- to gravel-sized clasts.	
80	GB	15			79.0	
					Bedrock TC conglomerate, greenish brown to black matrix, pulverized.	
85						
	GB	20				
90	GB	25				
95						
100	GB	40				
105		50				
					109.0	
110	GB				**Bedrock** TC conglomerate, purplish matrix, pulverized.	
		33				
115	GB					
		38			117.0	
					Bottom of hole at 117.0 feet.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

SLR International Corp
4601 Business Park Blvd., Suite K42
Anchorage, Alaska 99503
Telephone: 907.222.1112
Fax: 907.222.1113

THE pebble PARTNERSHIP

PW-08-9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-9

DATE STARTED 5/16/08 **COMPLETED** 5/18/08 **GROUND ELEVATION** 1033.6 feet **TOC ELEVATION** 1035.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.2 feet **EASTING** 1410049.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**Organic Soil with Gravel** dark brown, fine subangular to subrounded gravel, dry	
					2.0 **Organic Soil with Gravel** brown, subangular to subrounded gravel, 40% of clasts are fractured, clasts up to 1", dry	
					3.0 ML **Silt with Gravel and Sand** brown, subangular to rounded gravel, well graded sand, dry	
5	GB				5.0 ML **Silt with Gravel** brown, some subangular to subrounded gravel, clasts up to 1", trace sand, dry	
					9.0 ML **Silt** dark brown, trace gravel, clasts up to 1/2", trace fine grained sand, dry	
10	GB				12.0 ML **Silt with Gravel** brown, silt coated rounded gravel, clasts up to 3/4"	Cuttings are dry to moist, 12-15 feet
						25% of clasts are fractured, 14-15 feet
15	GB					<10% of clasts are fractured, 15-18 feet Cuttings are moist, 15-18 feet
						25% of clasts are fractured, 18-19 feet
					19.0 ML **Silt with Gravel** subangular gravel, 25% of clasts are fractured, moist	Clasts up to 1/2", 19-20 feet
20	GB					

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 1.9'
Type: Welded Steel
Diameter: 6"

SURFACE SEAL
Mix Used: N/A

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

FILTER PACK
Type: N/A

SCREEN
Type: Stainless Steel
Slot Size: 0.025 inch

RATHOLE
Type: Sand

DEVELOPMENT
Method: Air Lift Pumping
Date: 5/20/2008
Purge Volume: N/R

RESPONSE TEST
Equipment: N/A
Date: N/A

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 5/20/2008 at 300 PM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-9

DATE STARTED 5/16/08 **COMPLETED** 5/18/08 **GROUND ELEVATION** 1033.6 feet **TOC ELEVATION** 1035.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.2 feet **EASTING** 1410049.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					ML **Silt with Gravel** subangular gravel, 25% of clasts are fractured, moist	Clasts up to 1", 20-22 feet
					22.0 ML **Gravelly Silt** some subangular gravel, 25% of clasts are fractured, clasts up to 1", moist	
					23.0 ML **Gravel and Silt** gray angular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", brown silt, moist	
25	GB				24.0 ML **Gravelly Silt** gray, subrounded gravel, 25% of clasts are fractured, clasts up to 1", brown silt, moist	Silt balls, 24-27 feet
					27.0 ML **Silt and Gravel** gray, silt coated subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", brown silt, moist	
					28.0 ML **Gravelly Silt** gray, silt coated subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", brown silt, moist	
30	GB				29.0 ML **Gravel and Silt** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", brown silt, moist	Silt balls, 31-36 feet
					31.0 ML **Gravelly Silt** gray, subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", brown silt, moist	
					34.0 ML **Silt with Gravel** gray, subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", brown silt, moist	
35	GB				36.0 ML **Silt and Sand with Gravel** brown, fine gravel, well graded sand, dry	
					39.0 SM **Silty Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 3/4", well graded sand, dry to moist	
40	GB				40.0 ML **Silt with Gravel** brown, subangular to subrounded gravel, <10% of clasts are fractured, clasts up to 1"	Silt balls, 40-45 feet
45					45.0 GM **Silty Sand and Gravel** brown, subrounded to rounded gravel, 50% of clasts are fractured, clasts up to 1/2", fine to coarse grained sand, dry	
	GB	▼			46.0 GM **Silty Sand and Gravel** some subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 5/8"	Cuttings are wet, 47 feet Little recovery, 47-49 feet
					49.0	No recovery, 49-52 feet

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-9

DATE STARTED 5/16/08 **COMPLETED** 5/18/08 **GROUND ELEVATION** 1033.6 feet **TOC ELEVATION** 1035.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.2 feet **EASTING** 1410049.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50			<1			
					52.0	
					ML **Silt with Gravel** angular to subangular gravel, 75% of clasts are fractured, clasts up to 1/4", brown silt, wet	No recovery, 53-54 feet
					53.0	
					54.0	
55	GB		<1		ML **Silt and Gravel** angular gravel, most of the clasts are fractured, clasts up to 1/2"	
					59.0	Adding water while drilling; discharge water is brown, 59-86 feet
60						No recovery, 59-63 feet
					63.0	
					SP **Gravelly Sand** multicolored, angular to subrounded gravel, clasts up to 1", fine to coarse grained sand	
65	GB				65.0	
					SP **Sand** brown, trace fine gravel, fine to coarse grained sand	
					69.0	
70	GB				GM **Sandy Gravel with Silt** multicolored, angular to subangular gravel, clasts up to 1", well graded sand, brown silt	
					71.0	
					SM **Silty Sand** brown, fine grained sand, wet	
					73.0	
					ML **Silt** brown, trace fine grained sand	Silt balls, 73-74 feet
					74.0	
75	GB				GW **Gravel and Sand** multicolored, silt coated subangular gravel, clasts up to 1", well graded sand, trace brown silt	
					79.0	More silt and sand than rest of unit, 78-79 feet
	GB					

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-9

DATE STARTED 5/16/08 **COMPLETED** 5/18/08 **GROUND ELEVATION** 1033.6 feet **TOC ELEVATION** 1035.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.2 feet **EASTING** 1410049.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80					SM **Gravelly Sand with Silt** multicolored, subangular to subrounded gravel, clasts up to 1/2", well graded sand	
85	GB					
					89.0	
90	GB				GM **Sand and Gravel with Silt** multicolored, subrounded gravel, clasts up to 1", well graded sand	More sand than rest of unit, 92-108 feet
95	GB					Adding water while drilling; discharge water is brown, 95-108 feet
100	GB					
105	GB					
					108.0	No recovery, 108-117 feet
	GB		4			

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-9

DATE STARTED 5/16/08 **COMPLETED** 5/18/08 **GROUND ELEVATION** 1033.6 feet **TOC ELEVATION** 1035.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.2 feet **EASTING** 1410049.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110						
115	GB		4			
					117.0	Losing fines in discharge water, 116-151 feet
					ML **Silt** gray, trace angular to subangular gravel, clasts up to 1/4", trace coarse grained sand, wet	Slow drilling, 117-118 feet Adding water while drilling, 117-151 feet
120	GB				120.0	
					ML **Gravelly Silt** gray, angular to subangular gravel, trace coarse grained sand, wet	Clasts up to 1/4", 120-123 feet
						Clasts up to 1/2", 123-129 feet
125	GB					
					129.0	
130	GB		5		GW **Gravel and Sand** fine angular to subangular gravel, well sorted medium to coarse grained sand, trace silt	Clasts up to 3/4", 129-133 feet
						Clasts up to 1", 133-137 feet
135	GB		<1			
					137.0	
					ML **Silt with Gravel** brown, subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/4", well sorted, wet	
	GB		3			

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-9

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-9

DATE STARTED 5/16/08 **COMPLETED** 5/18/08 **GROUND ELEVATION** 1033.6 feet **TOC ELEVATION** 1035.5 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2153567.2 feet **EASTING** 1410049.8 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, S. Loomis

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140						
					141.0	
					GW **Gravel** subrounded gravel, 50% of clasts are fractured, clasts up to 1 1/4", trace brown silt, wet	
					142.0	Flow rate changes, 142 feet
			15		GW **Sand and Gravel** subangular to subrounded gravel, 75% of clasts are fractured, clasts up to 1/2", well sorted fine to coarse grained sand, wet	
145	GB		17			
150	GB		15			
			20		151.0	Pumping well; welded casing 0-144 feet, stainless steel screen exposed to native material 144-157 feet, and sand 157-163 feet
					SP **Sand** brown, fine to medium grained sand, wet	Discharge water is brown; losing fines, 151-155 feet
			20			
					154.0	
155	GB				SP **Sand with Gravel** brown, some subangular to subrounded gravel, clasts up to 1/2", fine grained sand, wet	
					155.0	
					SP **Sand** brown, fine grained sand, wet	
					158.0	
					SP **Sand with Gravel** brown, subangular to subrounded gravel, clasts up to 1/2", fine grained sand	
					159.0	
160	GB				SP **Sand** brown, trace subangular to subrounded gravel, clasts up to 1/2", fine grained sand	
					163.0	
					Bottom of hole at 163.0 feet.	

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-10

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-10

DATE STARTED 7/13/08 **COMPLETED** 7/15/08 **GROUND ELEVATION** 1056.85 feet **TOC ELEVATION** 1059.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171905.97 feet **EASTING** 1379612.76 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0						No recovery (on boulder or cobble), 0-1 feet
					1.0 ML **Sand and Silt with Gravel** brown, 25% of clasts are fractured, clasts up to 1", well graded, dry	
					3.0 GM **Gravel with Sand and Silt** brown, 25% of clasts are fractured, clasts up to 1", well graded, dry	
5			no flow			
10					10.0 SM **Silty Sand with Gravel** gray, subangular gravel, 50% of clasts are fractured, well graded	Cuttings are dry, 10-13 feet
						Cuttings are dry to moist, 13-17 feet
15			no flow			
					17.0 SW **Gravelly Sand** gray, subangular gravel, 50% of clasts are fractured, well graded, dry	
20					20.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6"

WELL CASING
Stickup: 3.0'
Type: Welded Steel
Diameter: 6"

SURFACE SEAL
Mix Used: 300# cement, 15 gal H2O

GROUT
Type: N/A
Method of Placement: N/A

PLUG
Type: N/A

FILTER PACK
Type: N/A

SCREEN
Type: Stainless Steel
Slot Size: 0.030 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Air Lift Pumping
Date: 7/15/08
Purge Volume: N/R

RESPONSE TEST
Equipment: N/A
Date: N/A

Comments: Static Water Level is denoted by solid triangle (measured from top of casing): 07/18/08 at 635 AM; Coordinates are presented in Alaska State Plane, Zone 5

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-10

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-10

DATE STARTED 7/13/08 **COMPLETED** 7/15/08 **GROUND ELEVATION** 1056.85 feet **TOC ELEVATION** 1059.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171905.97 feet **EASTING** 1379612.76 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
20					GW **Gravel with Sand** gray, subangular gravel, well graded, dry	75% of clasts are fractured, 20-23 feet
						Gravel is slightly less angular; 65% of clasts are fractured, 23-25 feet
25			no flow			Clasts up to 1/4", 25-27 feet
						Less sand than rest of unit, 27-28 feet Adding water while drilling, 27-31 feet Slight increase in clast size, 28-33 feet
30						
						Less sand than rest of unit, 33-38 feet
35			no flow			
					38.0	No recovery, 38-39 feet Adding water while drilling, 38-42 feet
					39.0	
40					SP **Gravelly Sand** multicolored, 75% of clasts are fractured, coarse grained sand 40.0	
					GW **Sand and Gravel** multicolored, subangular gravel, 75% of clasts are fractured, coarse grained sand	Encountered shallow water, 43 feet Smaller clasts that rest of unit; cuttings are wet, 43-44 feet Little recovery, 44-47 feet
45						
						Mixed sized clasts, 47-50 feet
					50.0	

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-10

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-10

DATE STARTED 7/13/08 **COMPLETED** 7/15/08 **GROUND ELEVATION** 1056.85 feet **TOC ELEVATION** 1059.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171905.97 feet **EASTING** 1379612.76 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
50					GM **Silty Gravel/Silty Sand**	Trace water, 50-53 feet
					53.0	
					SM **Silty Sand with Gravel**	Cuttings are wet, 53-54 feet
						Cuttings are dry, 54-55 feet
55					55.0	
					SP **Gravelly Sand** 75% of clasts are fractured, wet	
						Cuttings are less wet, 59-60 feet
60					60.0	
					SM **Gravelly Sand with Silt** subangular gravel, 80% of clasts are fractured	Cuttings are dry, 60-62 feet
		▼				Cuttings are wet, 62-65 feet
						Encountered water, 63 feet
65						Decrease in water content, 65-68 feet
					68.0	
			<0.125		GM **Gravelly Sand with Silt** coarse gravel, fine grained sand, wet	
70						Smaller clasts than rest of unit, 71-73 feet
					73.0	
					GP **Gravel with Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand, wet	
75						Discharge water is brown, 75-120 feet
					76.0	
			0.25		SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	Adding water while drilling, 77-78 feet
					79.0	
					80.0	

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-10

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-10

DATE STARTED 7/13/08 **COMPLETED** 7/15/08 **GROUND ELEVATION** 1056.85 feet **TOC ELEVATION** 1059.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171905.97 feet **EASTING** 1379612.76 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
80						
			<0.125		GP **Gravel with Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 1", coarse grained sand, wet	Clasts up to 3/4", 80-83 feet
					GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand, wet	
					84.0	Clasts up to 1", 83-85 feet
85					SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, medium to coarse grained sand, wet	Clasts up to 3/4", 85-87 feet
					87.0	
			<0.125		GW **Gravel with Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand	
					88.0	
					89.0 **Boulder or Cobble** green, fractured, fragments up to 3/4"	
90					90.0	
					SP **Gravelly Sand** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	25% of clasts are fractured; fine to coarse grained sand, 90-95 feet
					GW **Sand and Gravel** subangular to subrounded gravel, clasts up to 3/4", wet	Flow tests may be biased low, 92-145 feet
			<0.125			
95						50% of clasts are fractured; medium to coarse grained sand, 95-98 feet
					98.0	
			0.25		GW **Sandy Gravel** angular to subangular gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	
					99.0	
100					GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	
					101.0	
					GW **Gravel with Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", fine to coarse grained sand	
			0.75		103.0	
					GW **Sand and Gravel** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand, wet	
105					105.0	
					GW **Sandy Gravel** subangular to subrounded gravel, 50% of clasts are fractured, coarse grained sand	Clasts up to 3/4", 105-108 feet
			0.125			Clasts up to 1", 108-109 feet
					109.0	25% of clasts are fractured, 109-113 feet
						Clasts up to 3/4", 109-114 feet

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-10

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-10

DATE STARTED 7/13/08 **COMPLETED** 7/15/08 **GROUND ELEVATION** 1056.85 feet **TOC ELEVATION** 1059.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171905.97 feet **EASTING** 1379612.76 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
110					GW **Sand and Gravel** subangular to subrounded gravel, fine to coarse grained sand, wet	
			3			50% of clasts are fractured, 113-114 feet
						Clasts up to 1", 114-116 feet
115					115.0	
					GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, fine to coarse grained sand	Clasts up to 1/2", 116-117 feet
					117.0	
					GW **Gravel with Sand** 30% of clasts are fractured, clasts up to 1", coarse grained sand	
			0.25		118.0	Clasts up to 3/4", 118-121 feet
					GW **Sand and Gravel** subangular to subrounded gravel, fine to coarse grained sand	25% of clasts are fractured, 118-123 feet
120						Discharge water is brown and silty, 120-125 feet
						Clasts up to 1", 121-125 feet
						Very little recovery, 122-123 feet
			13			50% of clasts are fractured, 123-125 feet
125					125.0	
					GW **Gravel with Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 1", coarse grained sand	Very little recovery, 125-126 feet
					126.0	Discharge water is brown, 125-130 feet
					GW **Sandy Gravel** subangular to subrounded gravel, medium to coarse grained sand	50% of clasts are fractured; clasts up to 1", 126-128 feet
			0.75			25% of clasts are fractured; clasts up to 3/4", 128-129 feet
					129.0	50% of clasts are fractured, 129-131 feet
130					GW **Sand and Gravel** subangular to subrounded gravel, clasts up to 3/4", medium to coarse grained sand	Possible boulder or cobble; discharge water is grayish brown, 130-131 feet
						25% of clasts are fractured, 131-132 feet
					132.0	Discharge water is brown, 131-152 feet
					133.0	No recovery, 132-133 feet
			1		GW **Sand and Gravel** subangular to subrounded gravel, 25% of clasts are fractured, clasts up to 3/4", medium to coarse grained sand	
					134.0	
135					135.0 SP **Sand** brown, trace subrounded gravel, clasts up to 1/2", medium to coarse grained sand	
					136.0	
					SP **Gravelly Sand** subangular to subrounded gravel, 50% of clasts are fractured, clasts up to 3/4", fine to medium grained sand	Clasts up to 3/4", 136-137 feet
						Clasts up to 1", 137-139 feet
			3.75		GW **Gravel with Sand** subangular to subrounded gravel, 75% of clasts are fractured, fine to coarse grained sand	
					139.0	Medium to coarse grained sand, 139-141 feet

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

THE pebble PARTNERSHIP

PW-08-10

PAGE 6 OF 6

PROJECT LOCATION Iliamna, Alaska **DRILL SITE** PW-08-10

DATE STARTED 7/13/08 **COMPLETED** 7/15/08 **GROUND ELEVATION** 1056.85 feet **TOC ELEVATION** 1059.85 feet

DRILLING CONTRACTOR Foundex **NORTHING** 2171905.97 feet **EASTING** 1379612.76 feet

DRILLING METHOD Air Percussion **EQUIPMENT** ODEX/HT700 **LOGGER** C. Lee, V. Webb

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
140					SP **Sand with Gravel** subangular to subrounded gravel, 25% of clasts are fractured,	Clasts up to 3/4", 139-144 feet
			34			Slow drilling, 141-142 feet Clasts up to 3/4", 141-144 feet Coarse grained sand, 141-145 feet
			54			Clasts up to 1", 144-145 feet
145					145.0 GW **Sand and Gravel** multicolored, angular to rounded gravel, clasts up to 3/4", coarse grained sand, wet	20% of clasts are fractured, 145-147 feet Adding water and foam while drilling; losing fines, 145-152 feet
			2			30% of clasts are fractured, 147-148 feet
					148.0 149.0 SP **Gravelly Sand** multicolored, angular to rounded gravel, 30% of clasts are fractured, clasts up to 3/4", coarse grained sand, wet	
150	GB					
			80		151.0 SW **Sand with Gravel** multicolored, angular to subrounded gravel, 40% of clasts are fractured, clasts up to 1", fine to coarse grained sand, wet **Bedrock** dark gray to green, angular clasts, fractured	Pumping well; welded casing 0-151 feet, and native material (no screen) 151-165 feet Moved to open hole hammer, 151 feet Discharge water is clear, 152-165 feet
155	GB		90+		155.0 **Bedrock** blue to gray, crystalline clasts	
			90+			
			90+			
160	GB		90+			Competent bedrock encountered, 160 feet
			90+			
165	GB		90+		165.0	
					Bottom of hole at 165.0 feet.	

2008 PEBBLE LOGS - PUMPING WELL 2008 BORING LOGS.GPJ PEBBLE2.GPJ 8/24/09

APPENDIX 8.1B

Geologic Cross Sections

Pebble Project Environmental Baseline Document, 2004 through 2008
Geologic Cross Sections

Table of Contents

Abbreviations and References 1
Location of Cross Sections 2
E-1 3
E-2 4
E-3 5
E-4 6
E-5 7
E-6 8
E-7 9
E-8 10
E-9 11
E-10 12
E-11 13
E-12 14
E-22 15
E-23 16
E-24 17
E-25 18
E-26 19
E-27 20
E-28 21
E-29 22
E-30 23
D-1 24
D-2 25
L-1 26
L-2 27
L-3 28
L-4 29
L-5 30
M1 31
M2 32
M3 33
M4 34
M5 35
M6 36
M7 37
M8 38
M9 39
M10 40
M11 41
M12 42
M13 43
M14 44
M15 45

Pebble Project Environmental Baseline Document, 2004 through 2008
Geologic Cross Sections

Table of Contents cont'd

M16 46
M17 47
M18 48
M19 49
M20 50
E-13 51
E-14 52
E-15 53
E-16 54
E-17 55
E-18 56
E-19 57
E-20 58
E-21 59
S-1 60
S-2 61
S-3 62
S-4 63
S-5 64
S-6 65
S-7 66
S-8 67
S-9 68

Explanation of Key for Geologic Cross Sections

- The geologic cross sections were created by EnviroInsite software. This software allows the efficient storage of the bore hole data, water levels, installation details, and results of testing in a simple Excel spreadsheet.

- Each figure contains one cross section as shown in the two insets. The top inset is a simplified version of Figure 1. The thick blue line shows the section line of the particular section being shown in the figure.

- The bottom inset shows the location of the section in the Pebble Project study area delineated by a red rectangle.

- The two lines of each section, shown in red, are derived from topographic models of terrain and bedrock surfaces.

- The blue triangles indicate groundwater head elevations as measured in the fall of 2008. Each triangle is connected to one screened interval of a given monitoring well with a thin blue line.

- Monitoring wells are labeled using currently valid names.

Pebble Project Environmental Baseline Document, 2004 through 2008

Abbreviations

KP: boreholes drilled and/or installed by Knight Piesold.

MW: name of series for monitoring wells.

P series drill holes: name of series for piezometers

GH series: name of the series for geotechnical drill holes

References

Appendix 8.1A: Drillhole and Installation Logs

Appendix 8.1G: Time Series of Piezometric Elevations (Uniforme Scale)

Knight Piesold 2004: 2004 Open Pit Geotechnical Investigations. Ref. No. VA101-176/8-2. January.

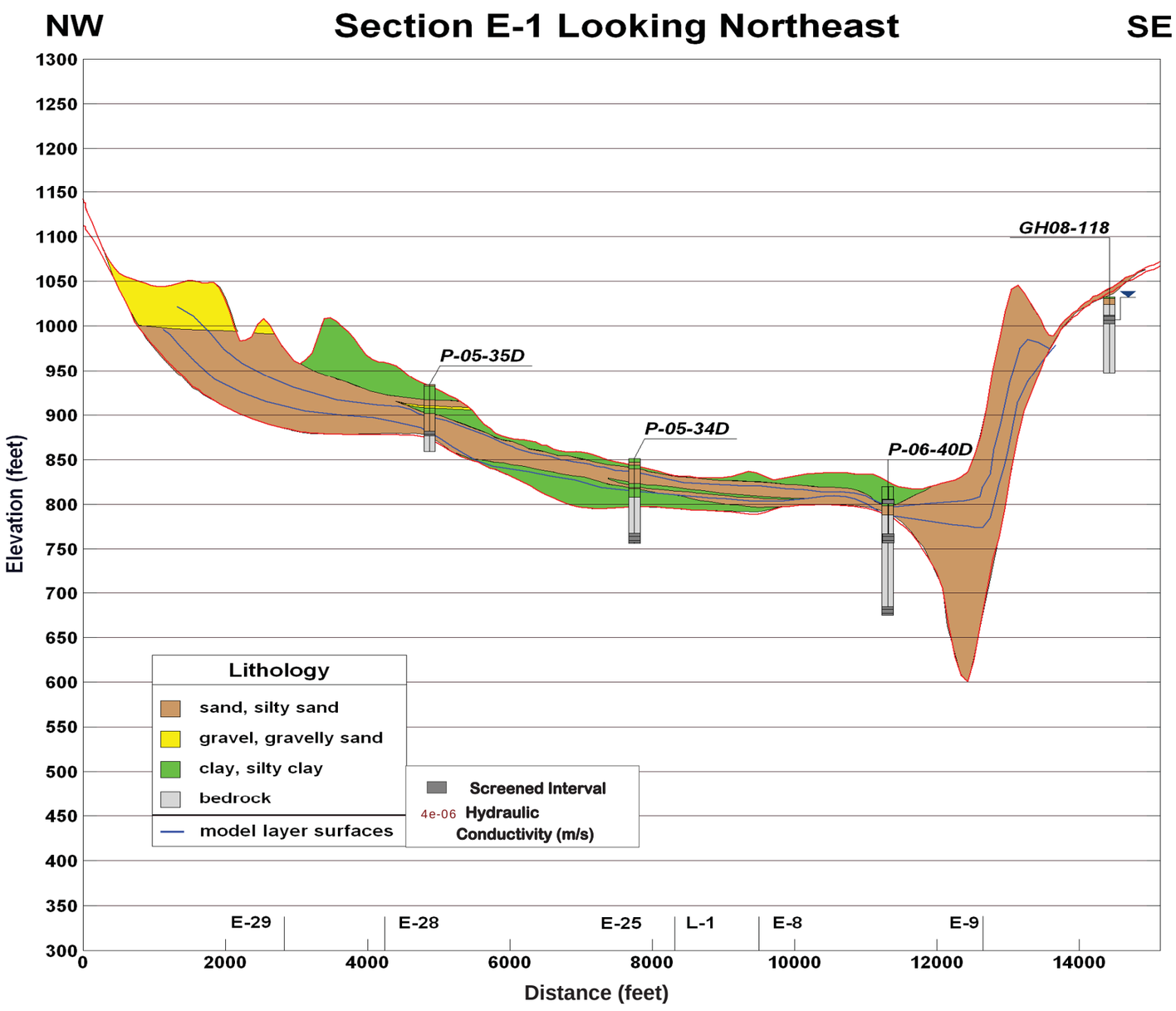
Knight Piesold 2005a: 2005 Geotechnical Site Investigation Data Report. 2 Volumes. Ref. No. VA101-176/8-3. March.

Knight Piesold 2005b: 2005 Open Pit Geotechnical Investigations. Ref. No. VA101-176/8-5. December.

Knight Piesold 2006: 2006 Geotechnical Site Investigation Data Report. 2 Volumes. Ref. No. VA101-176/8-9. March

Knight Piesold 2007: 2007 Geotechnical Site Investigation Data Report. Ref. No. VA101-176/20-4. November.

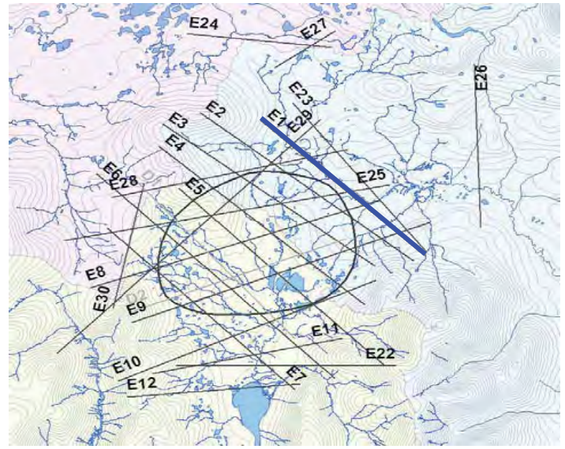
Knight Piesold 2008: 2008 Geotechnical Site Investigation Data Report. 3 Volumes. Ref. No. VA101-176/23-4. October.



THE pebble PARTNERSHIP

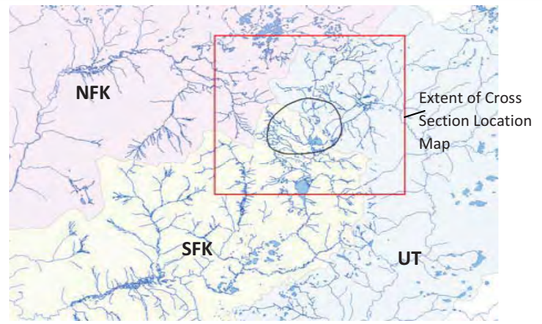
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



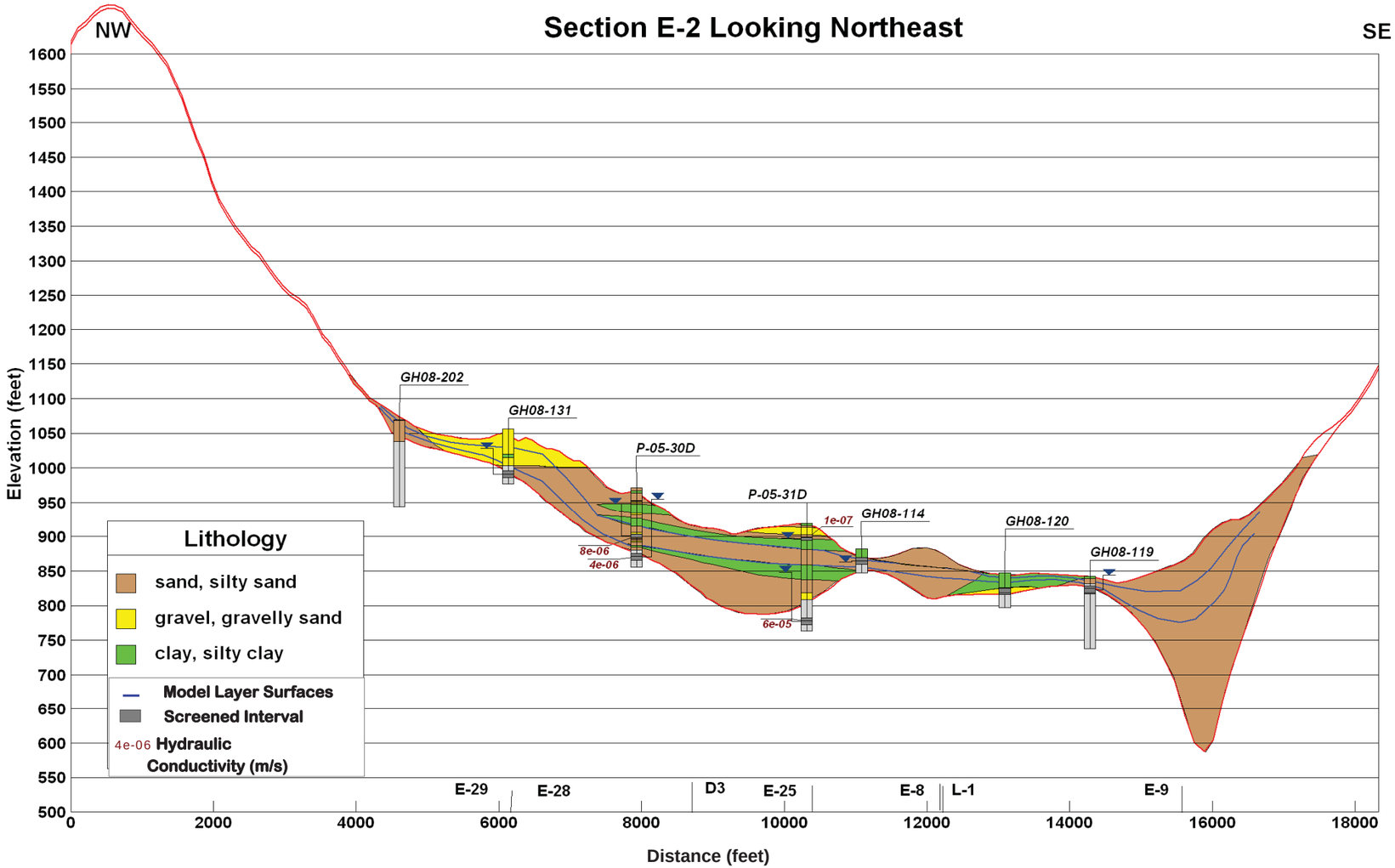
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-1**
Author: SWS-PP	Date: December 20, 2010

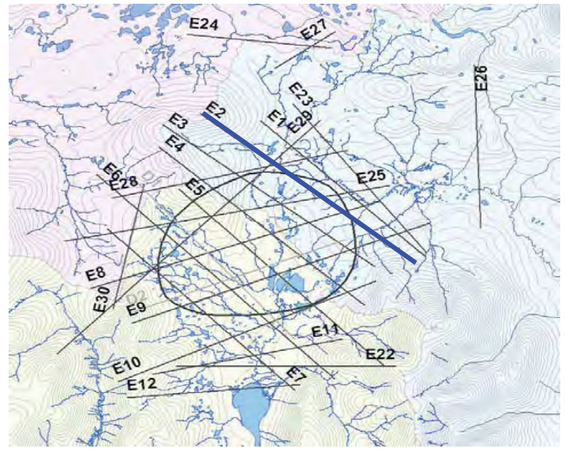
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



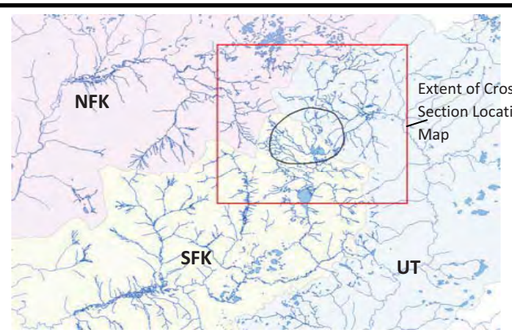
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

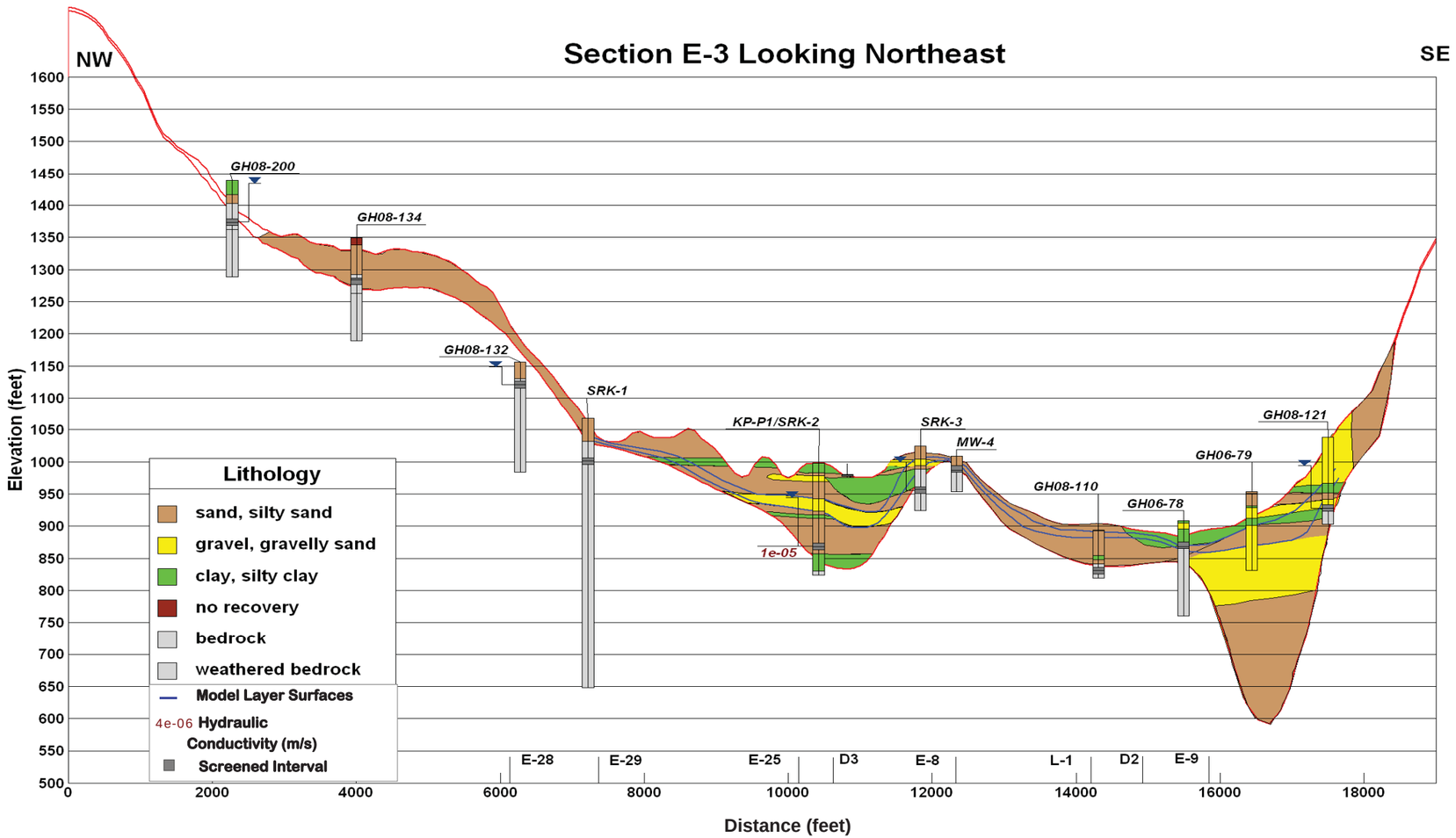


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-2**
Author: SWS-PP	Date: December 20, 2010

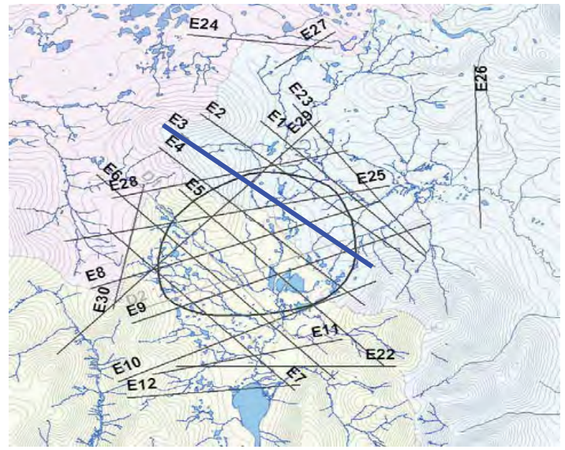
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



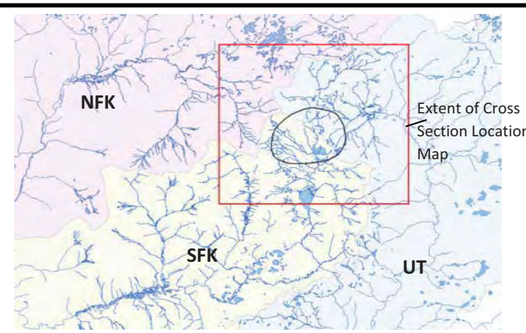
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

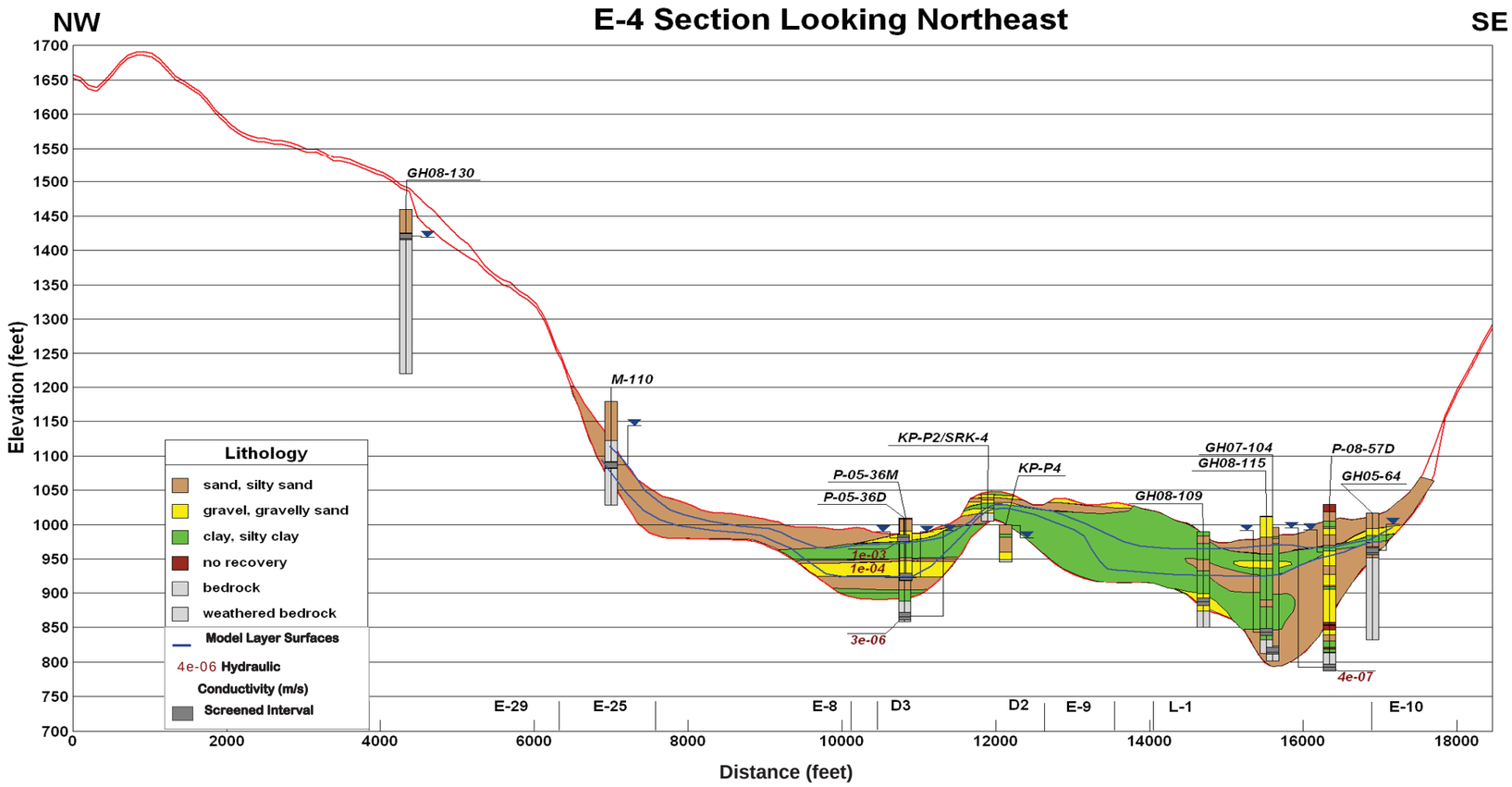


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-3**
Author: SWS-PP	Date: December 20, 2010

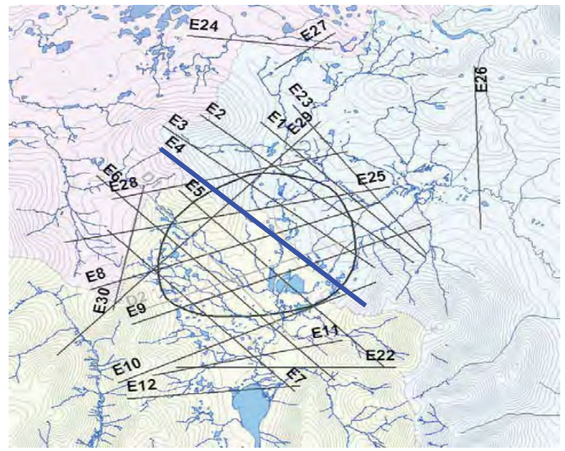
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

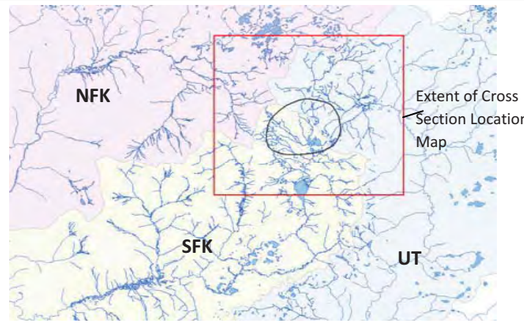
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



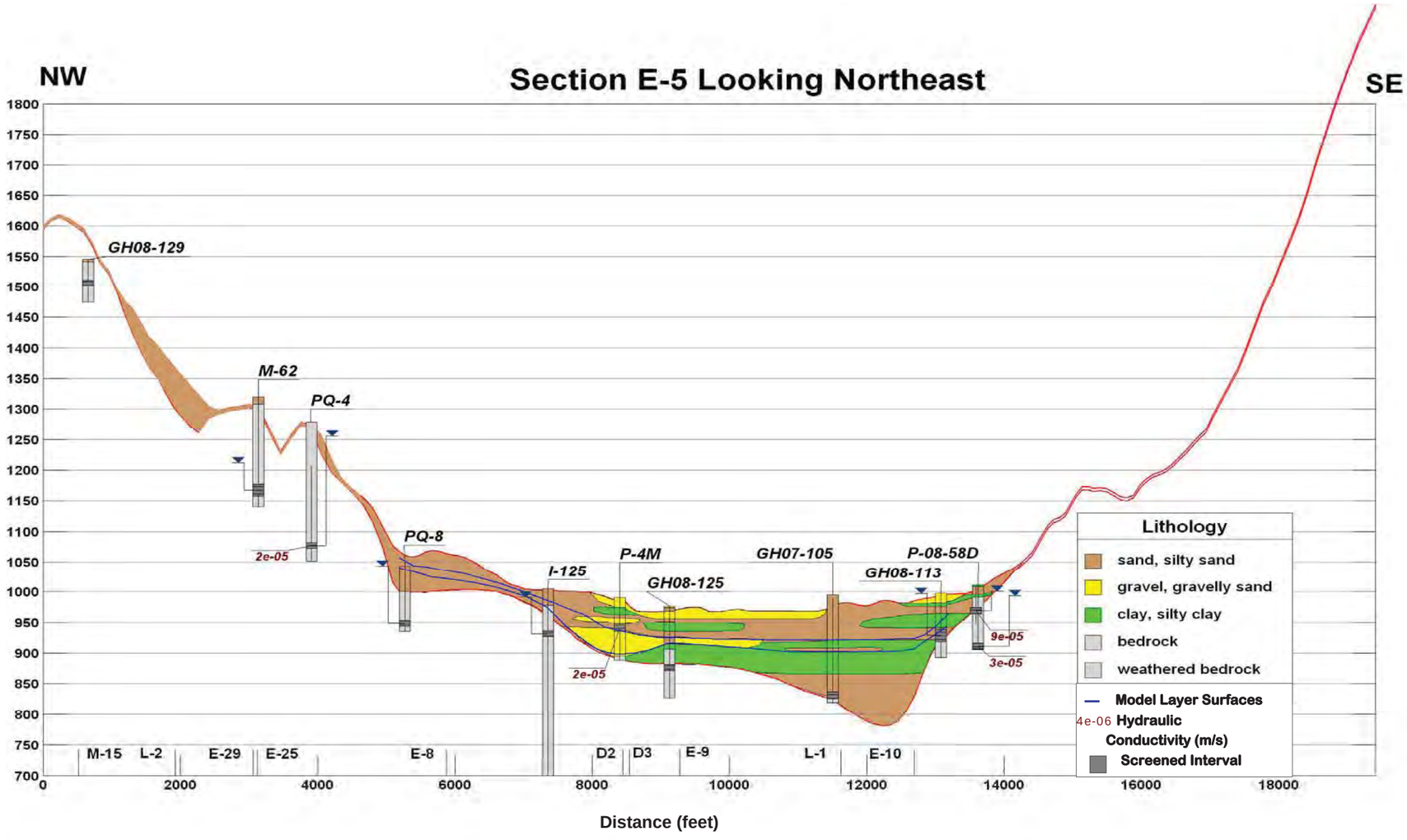
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



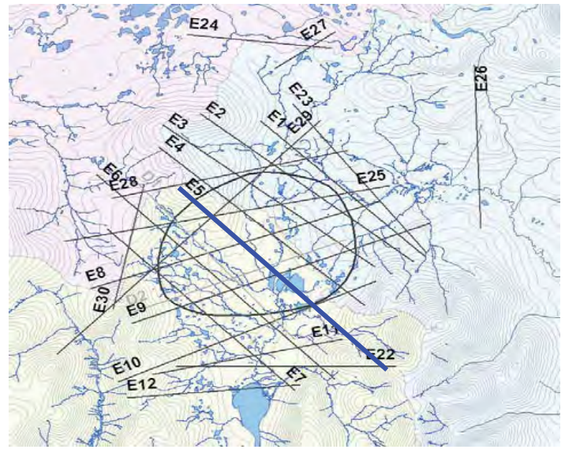
Project No: 7126	**Section E-4**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



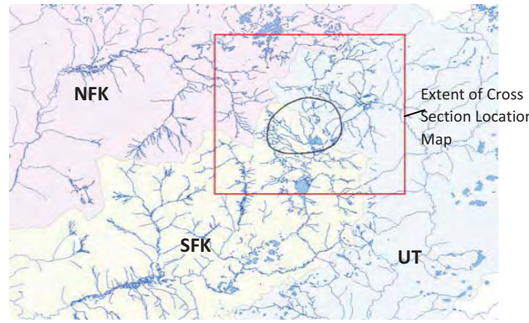
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections
Cross Section Location Map



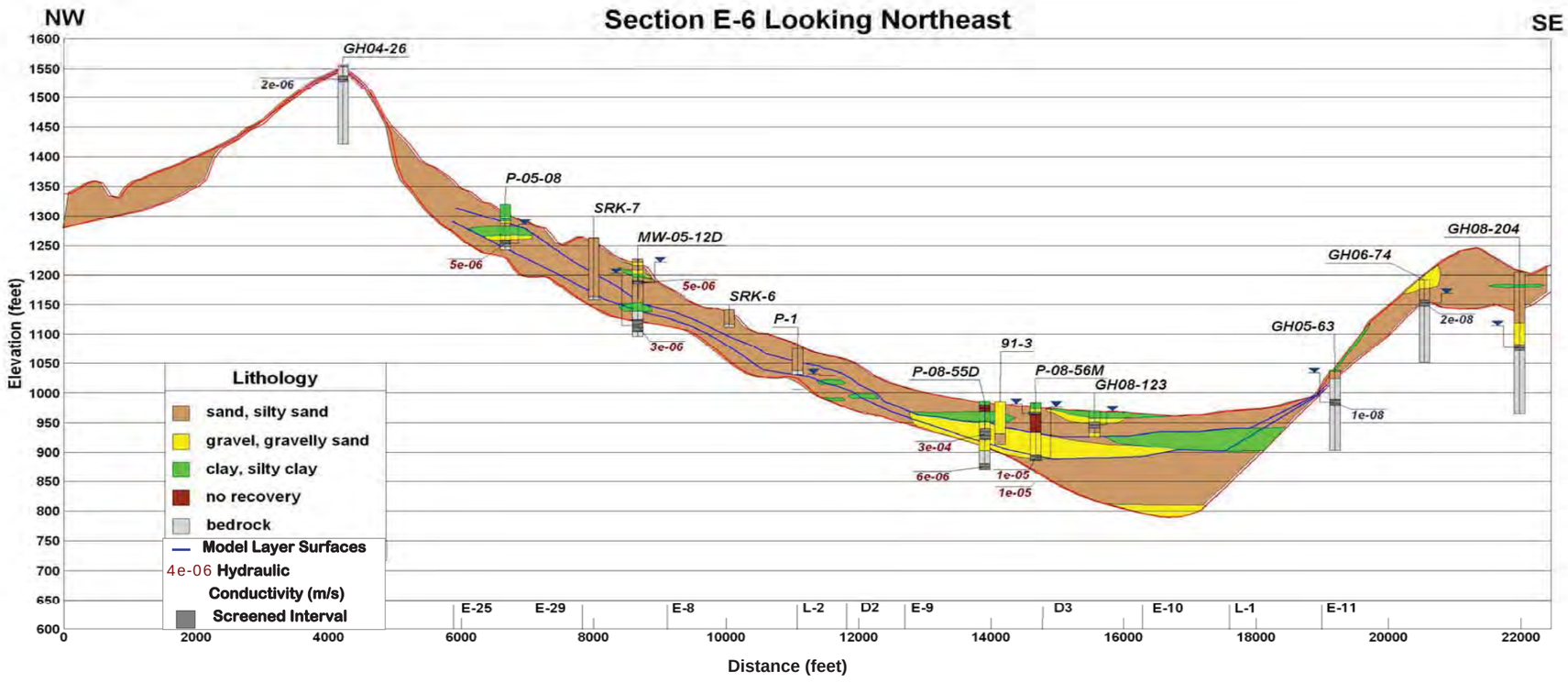
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



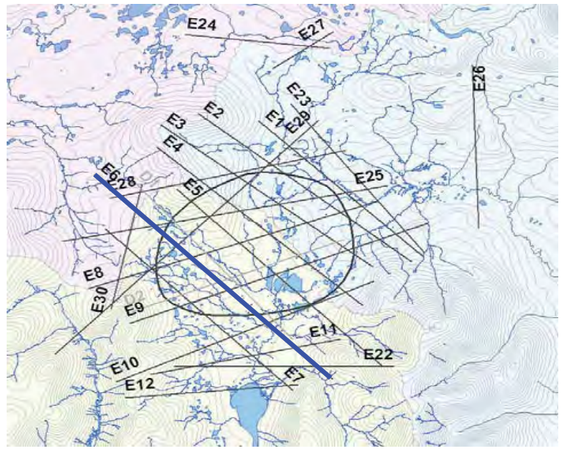
Project No: 7126	**Section E-5**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

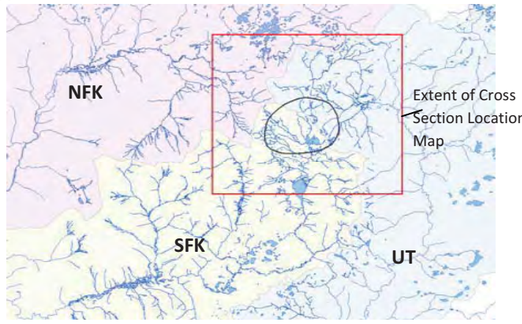


THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections
Cross Section Location Map

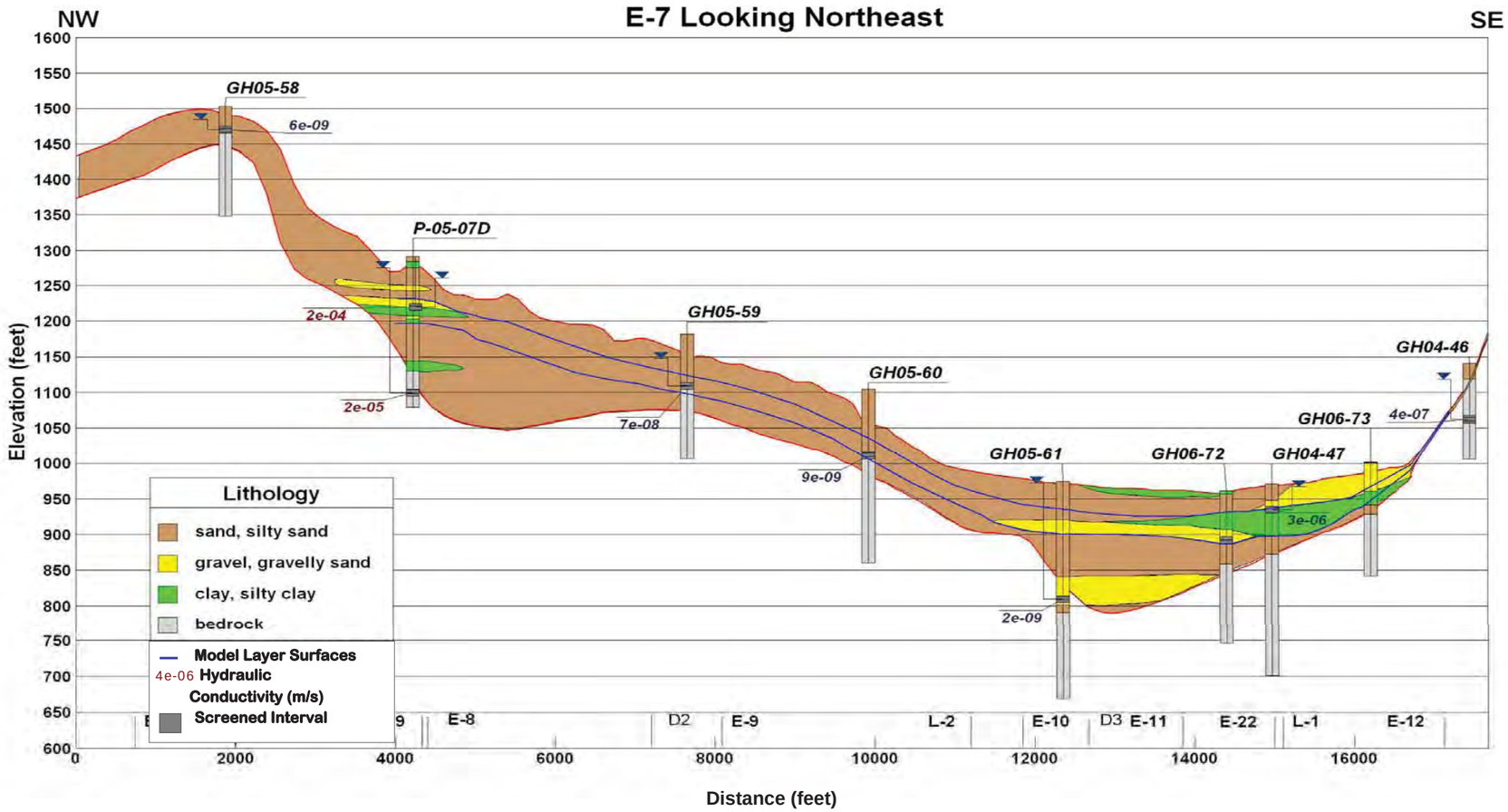


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-6**
Author: SWS-PP	Date: December 20, 2010

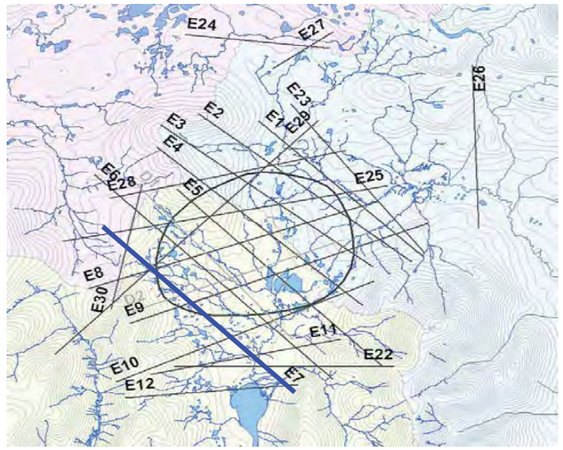
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

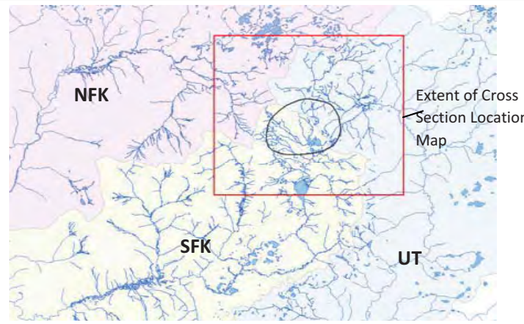
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



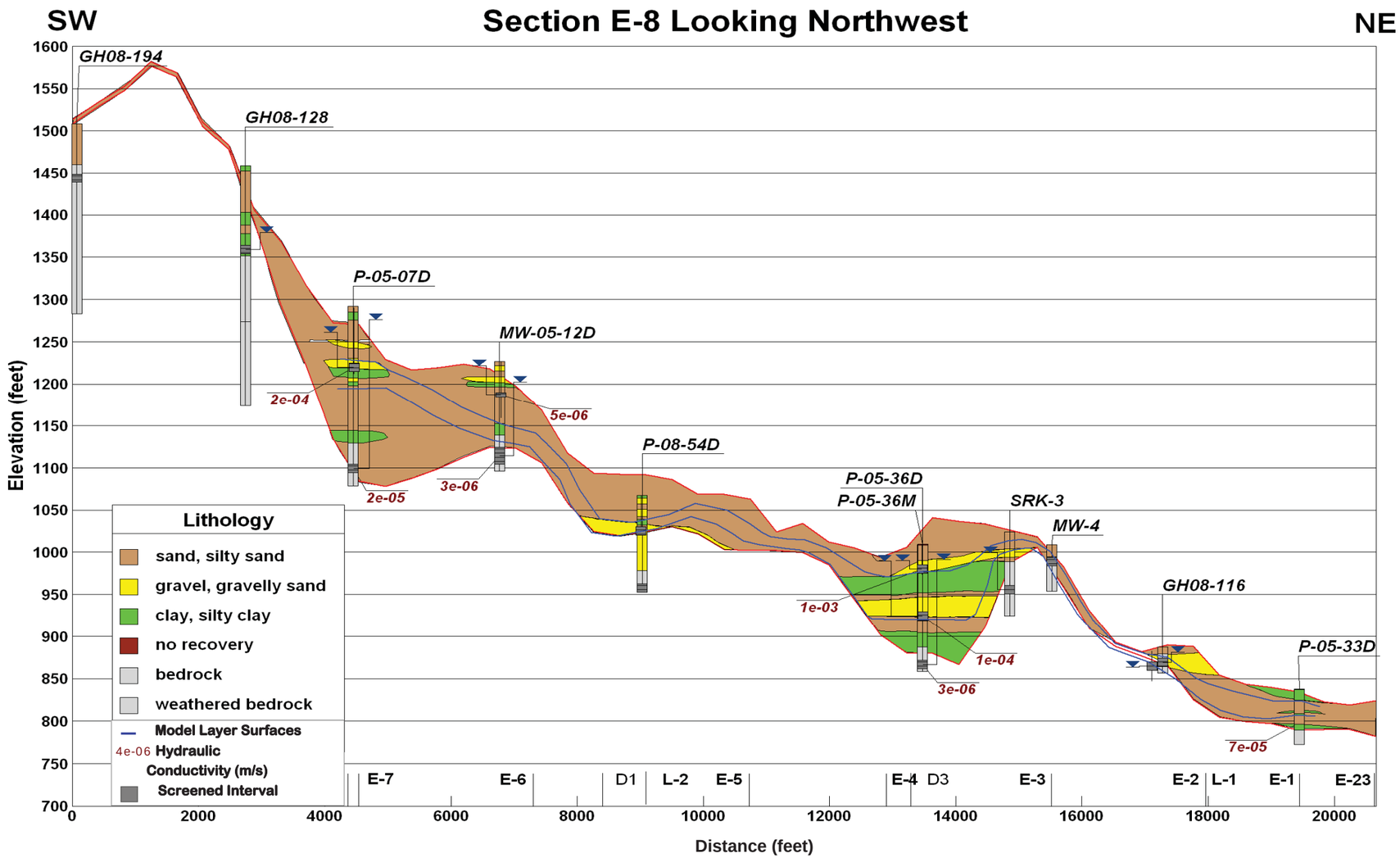
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-7**
Author: SWS-PP	Date: December 20, 2010

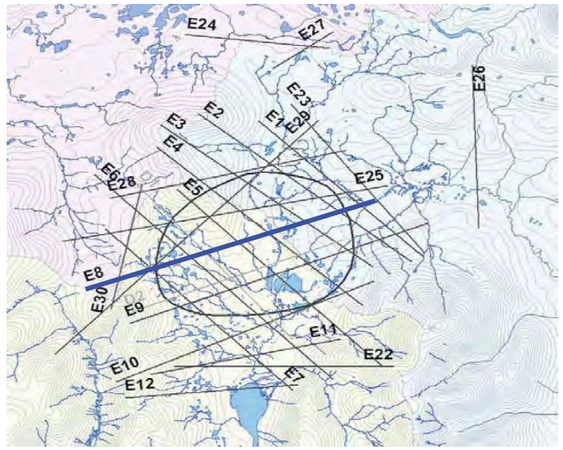
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



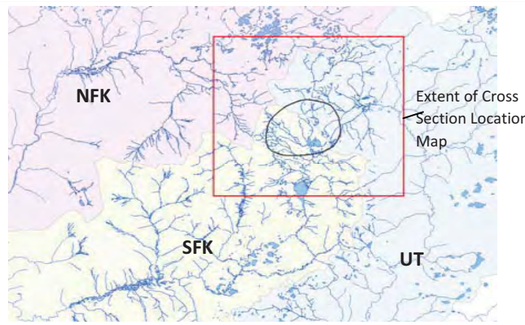
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

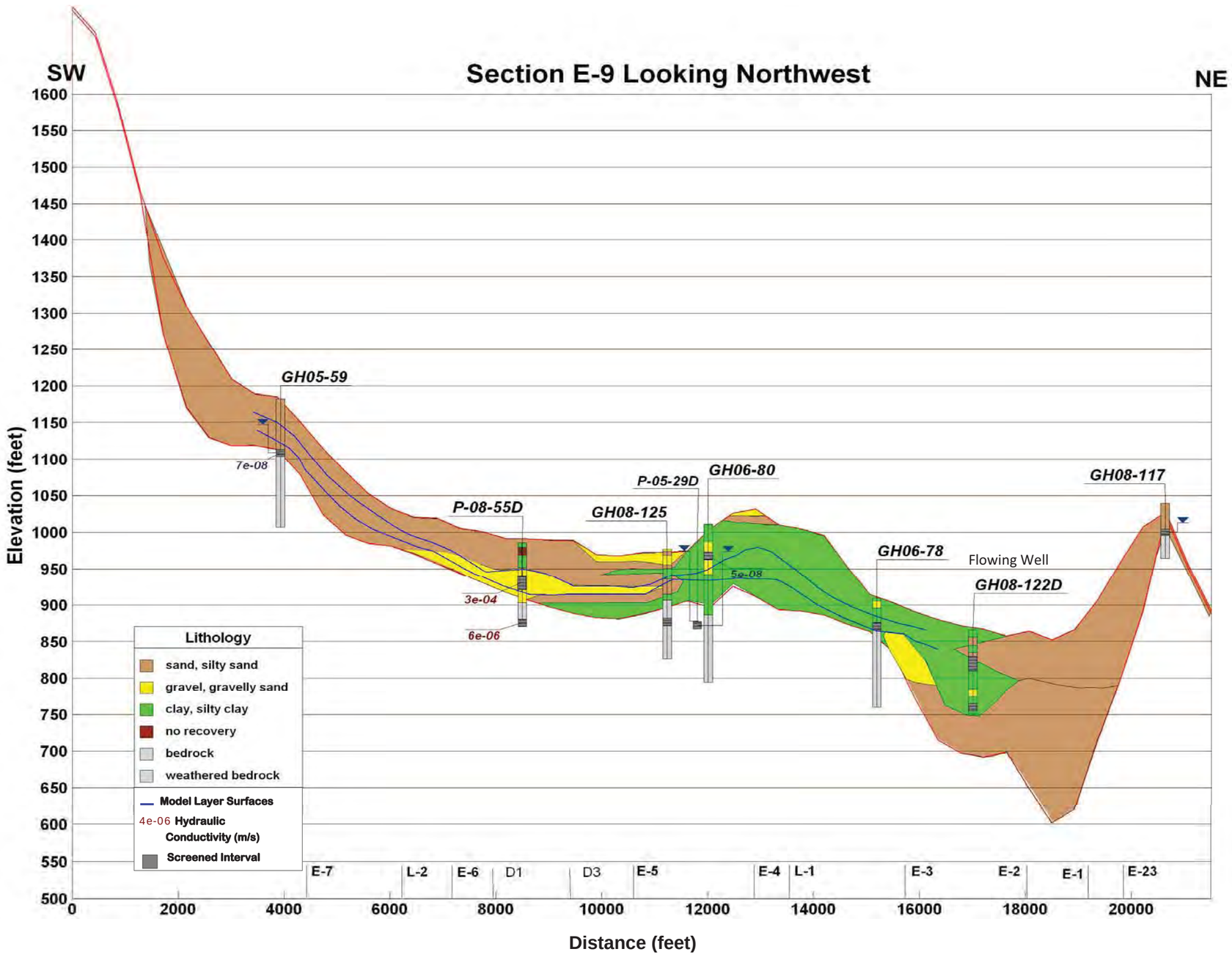


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-8**
Author: SWS-PP	Date: December 20, 2010

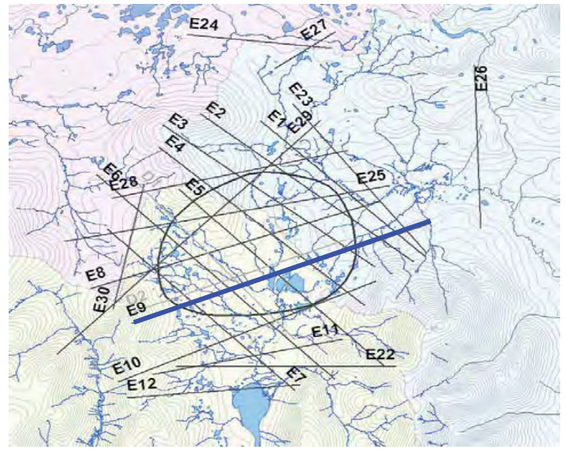
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

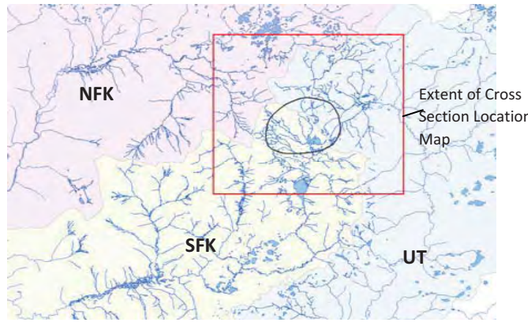
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



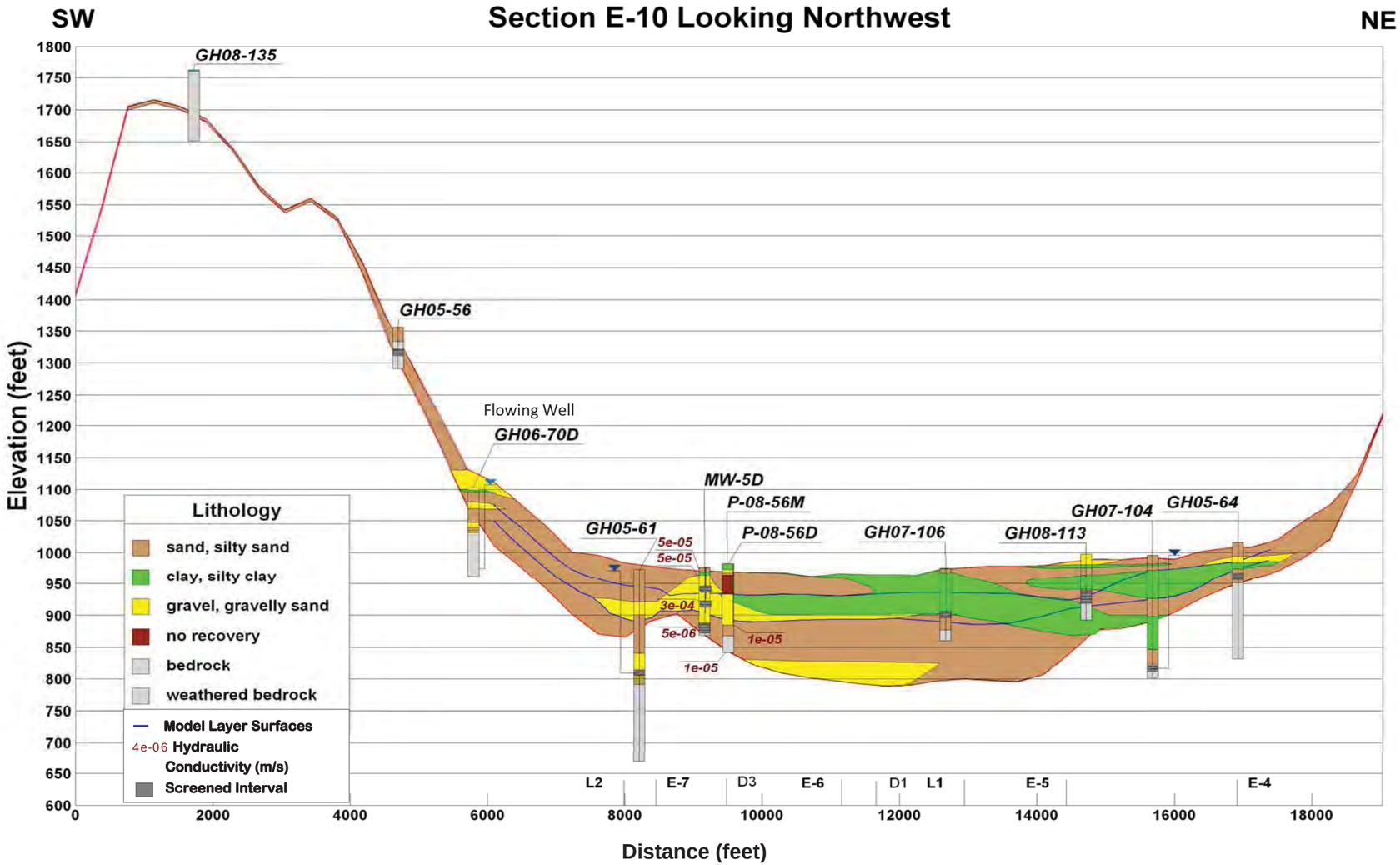
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-9**
Author: SWS-PP	Date: December 20, 2010

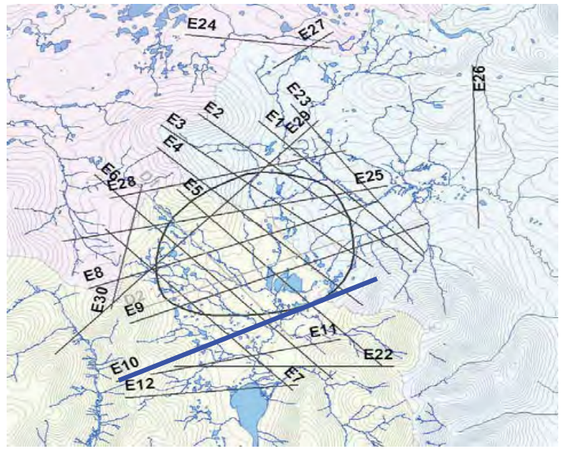
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



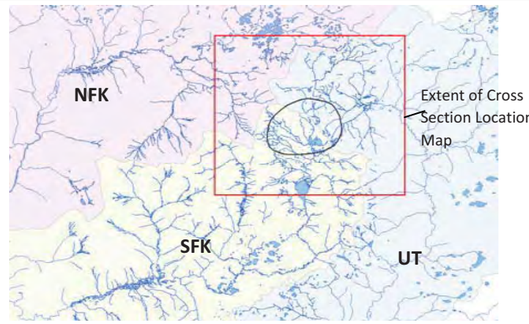
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

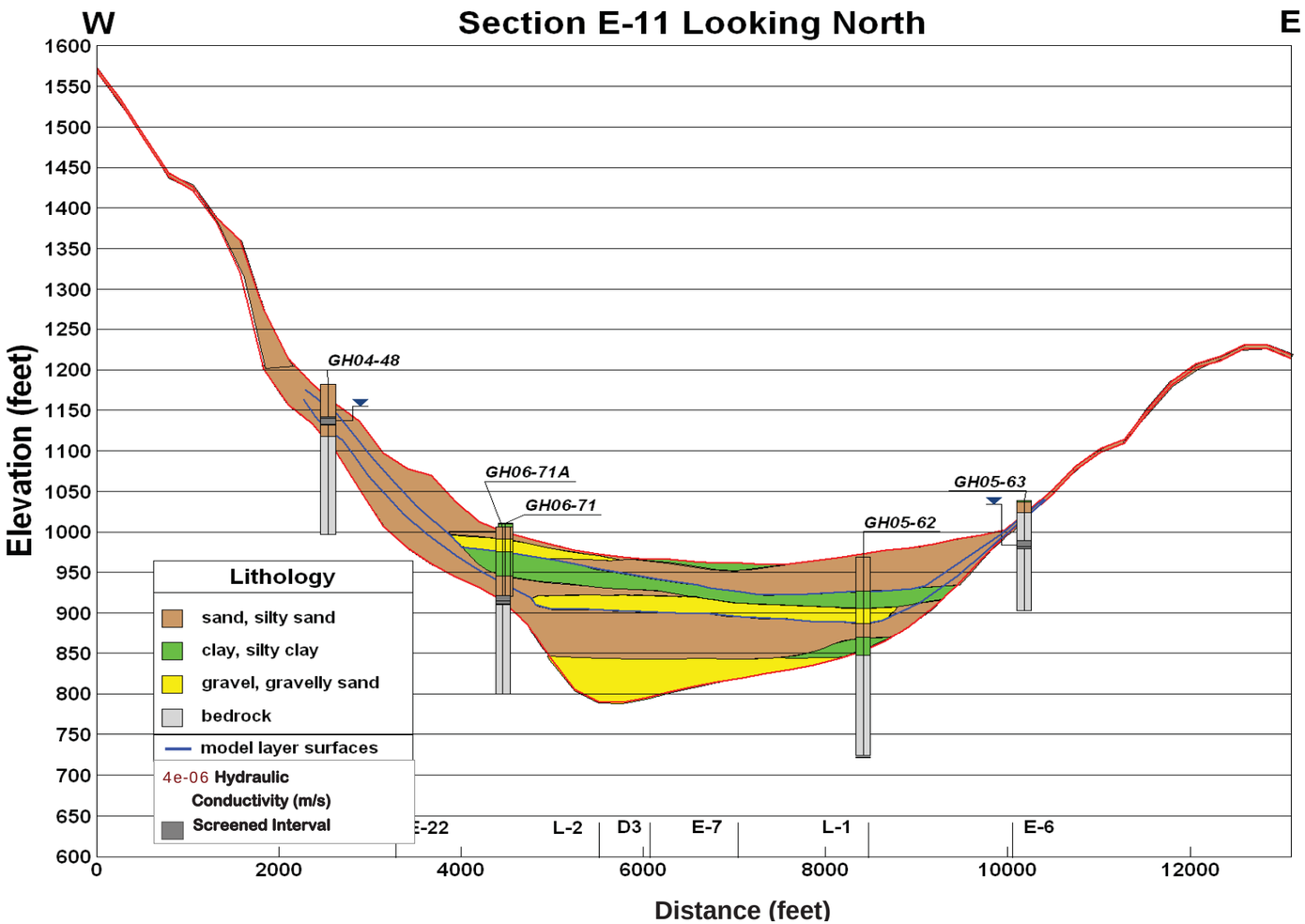


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-10**
Author: SWS-PP	Date: December 20, 2010

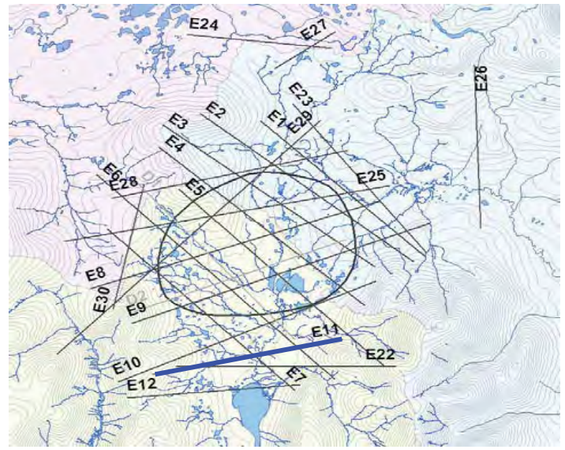
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



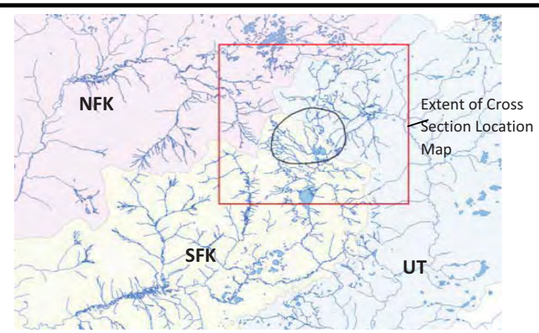
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

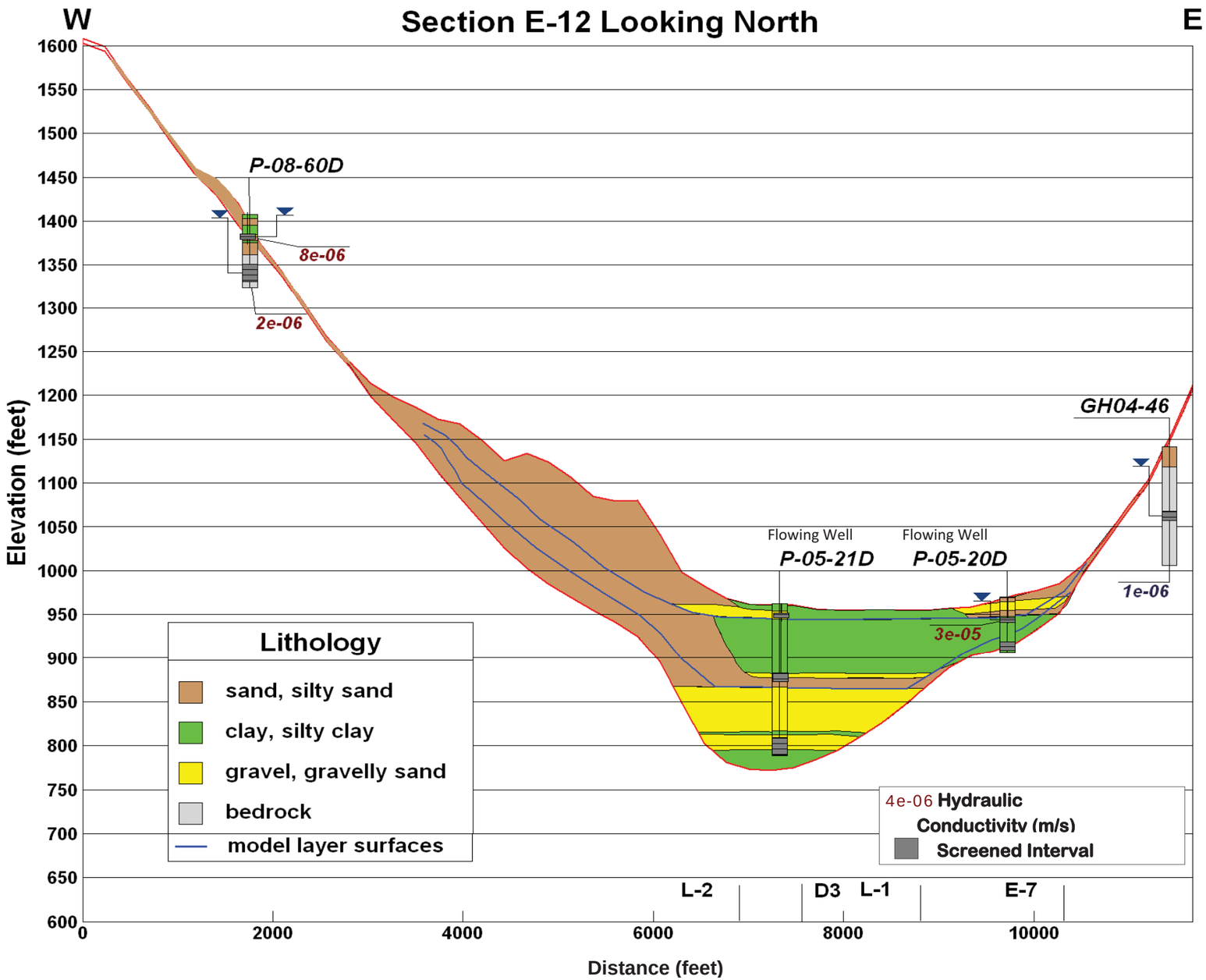


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-11**
Author: SWS-PP	Date: December 20, 2010

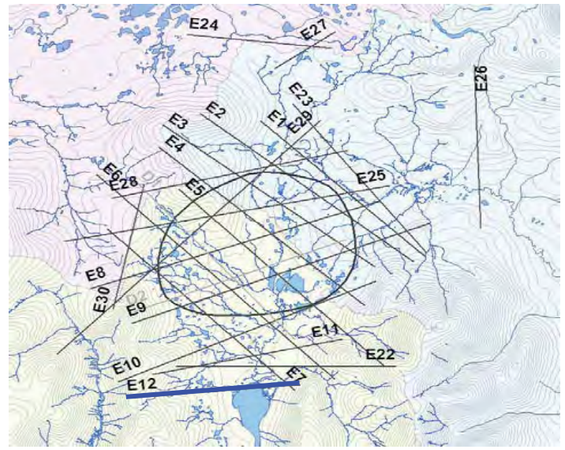
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



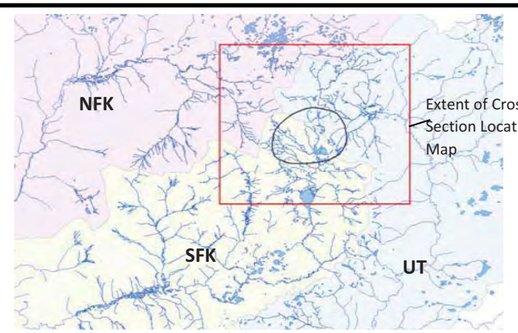
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

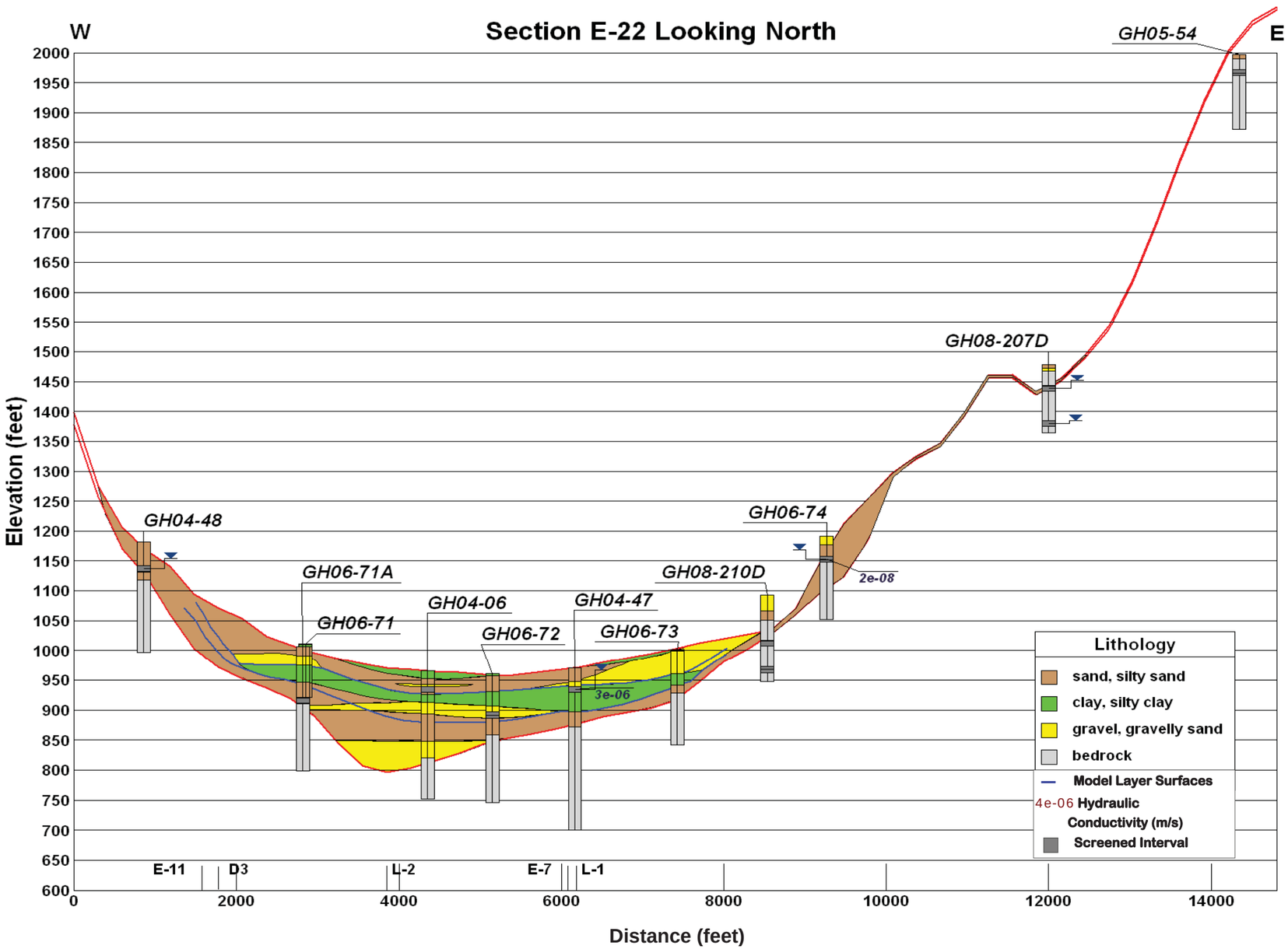


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-12**
Author: SWS-PP	Date: December 20, 2010

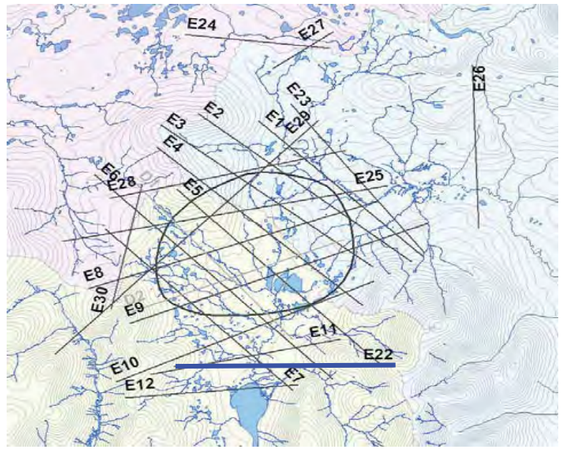
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



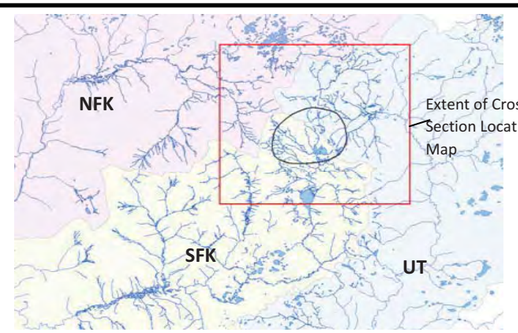
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

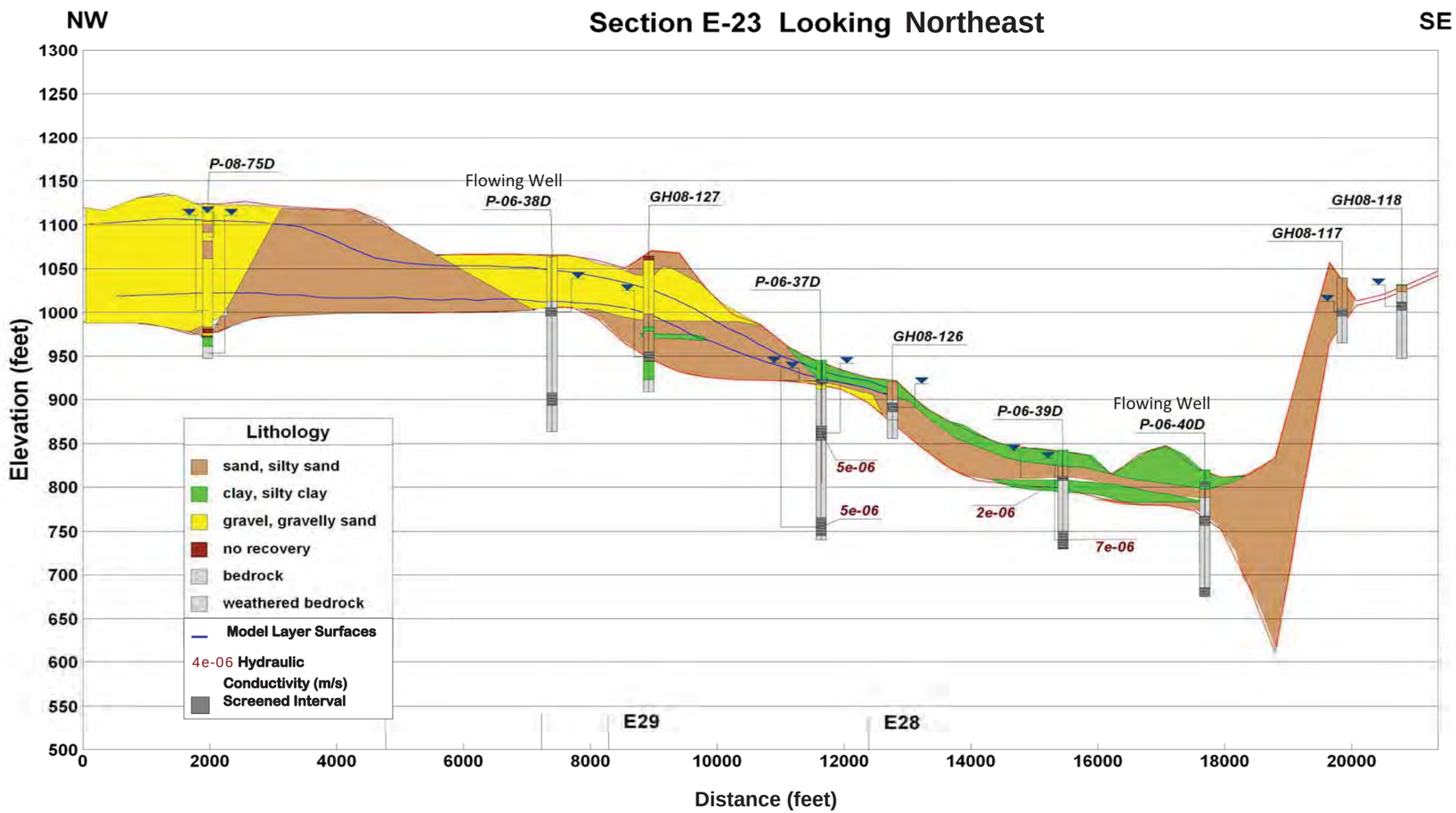


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-22**
Author: SWS-PP	Date: December 20, 2010

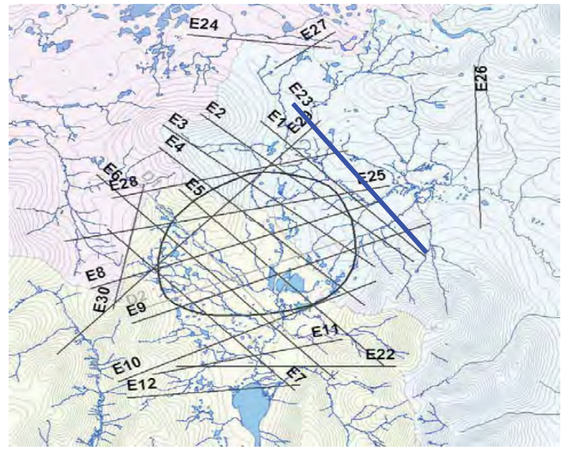
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



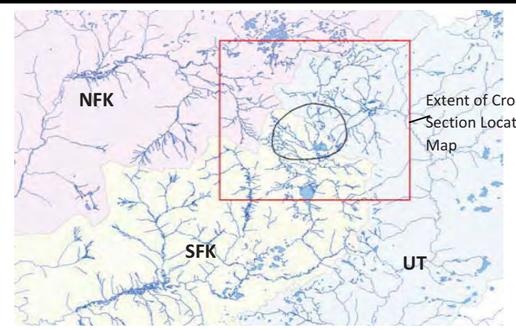
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

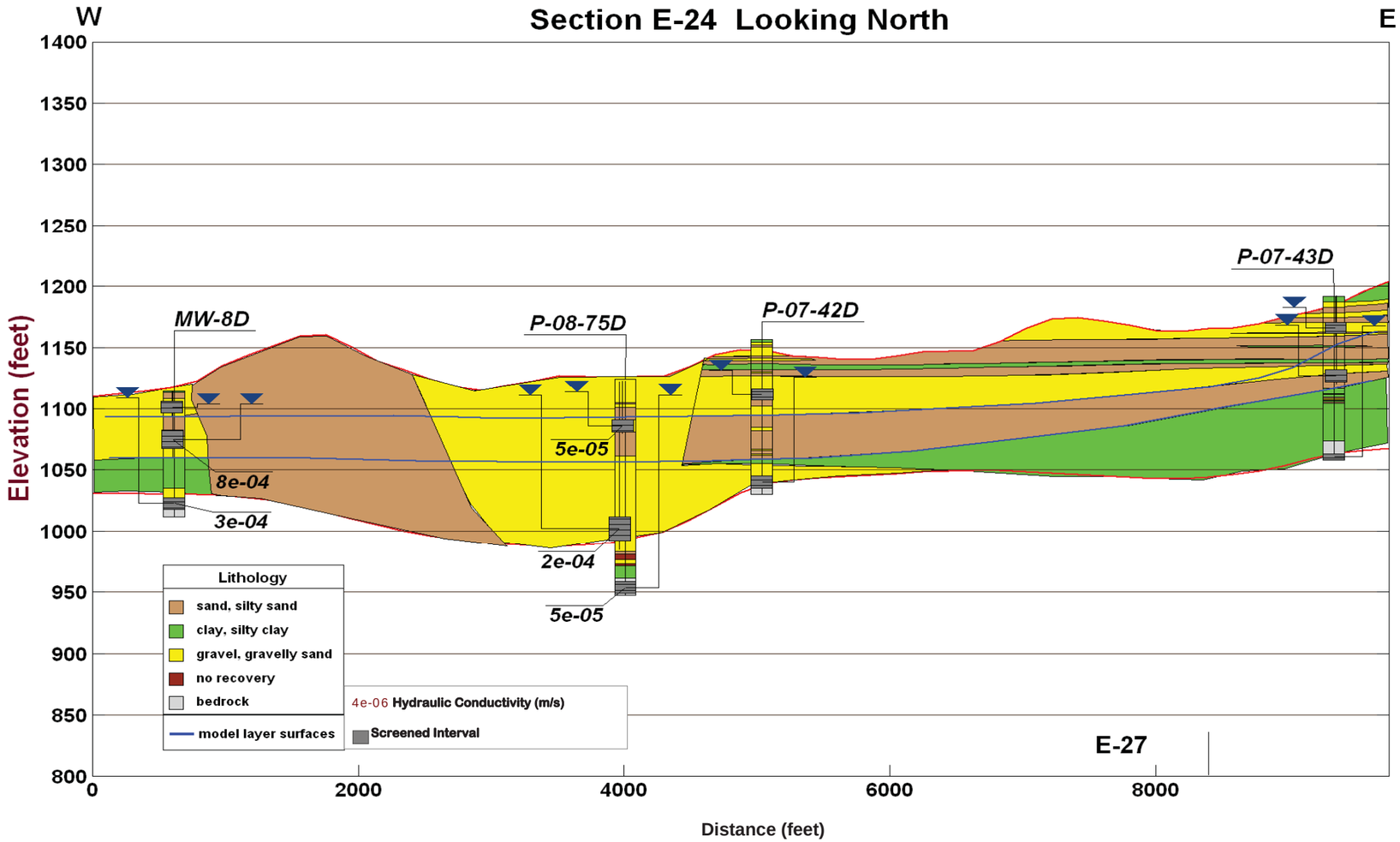


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-23**
Author: SWS-PP	Date: December 20, 2010

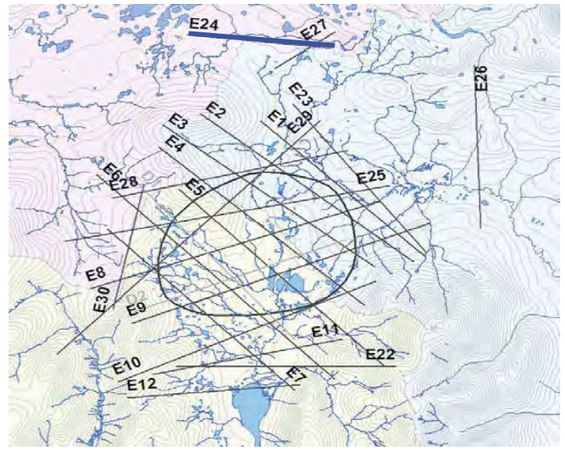
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



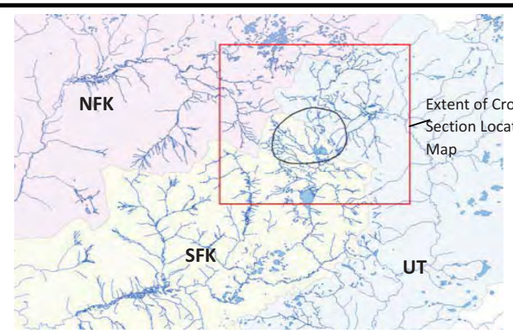
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

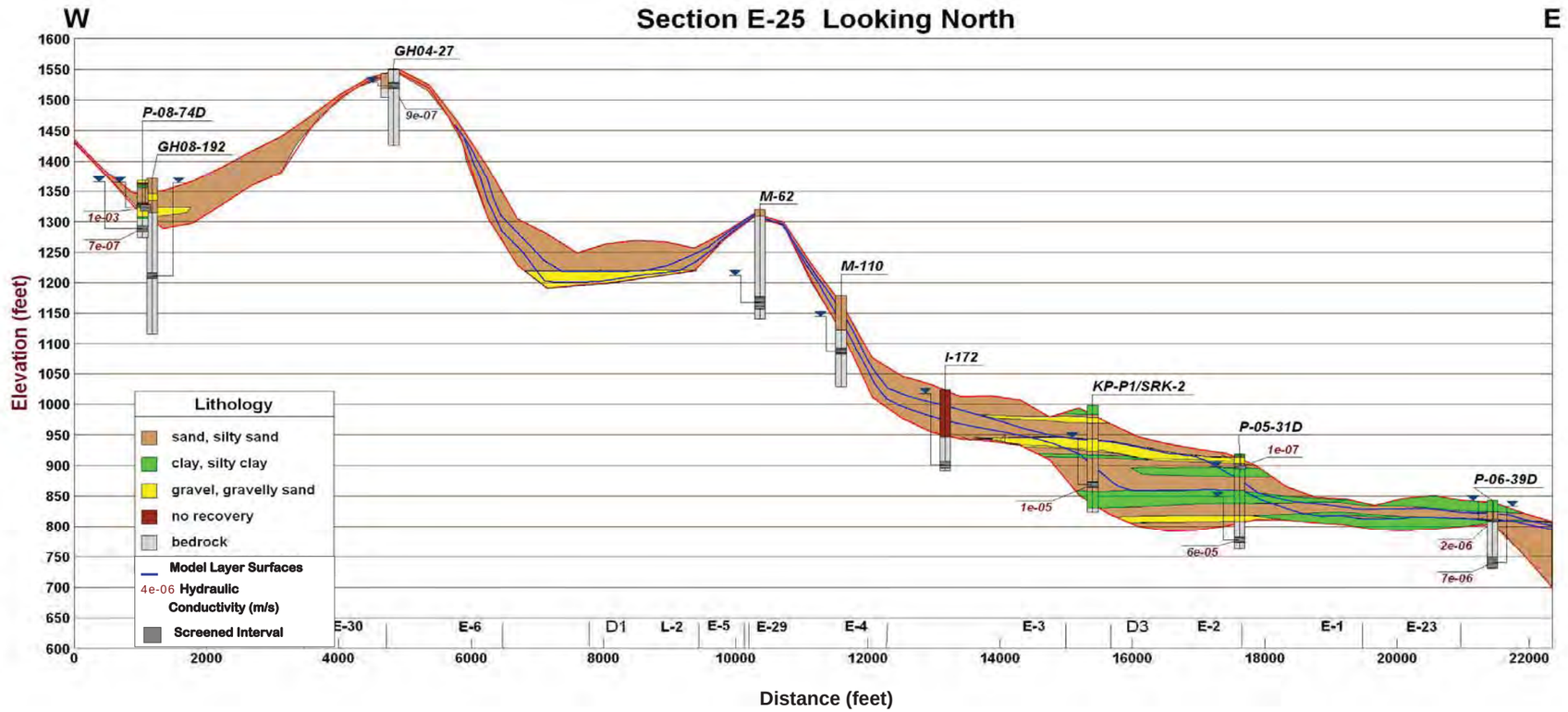


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-24**
Author: SWS-PP	Date: December 20, 2010

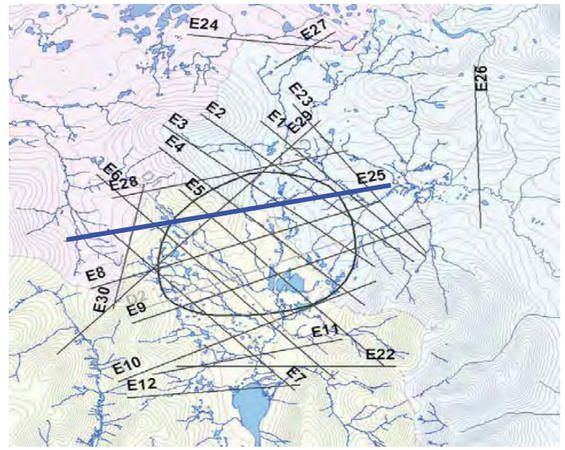
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



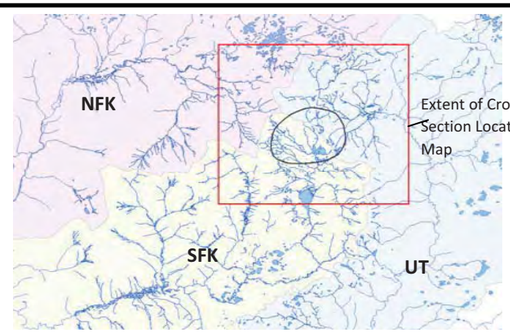
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

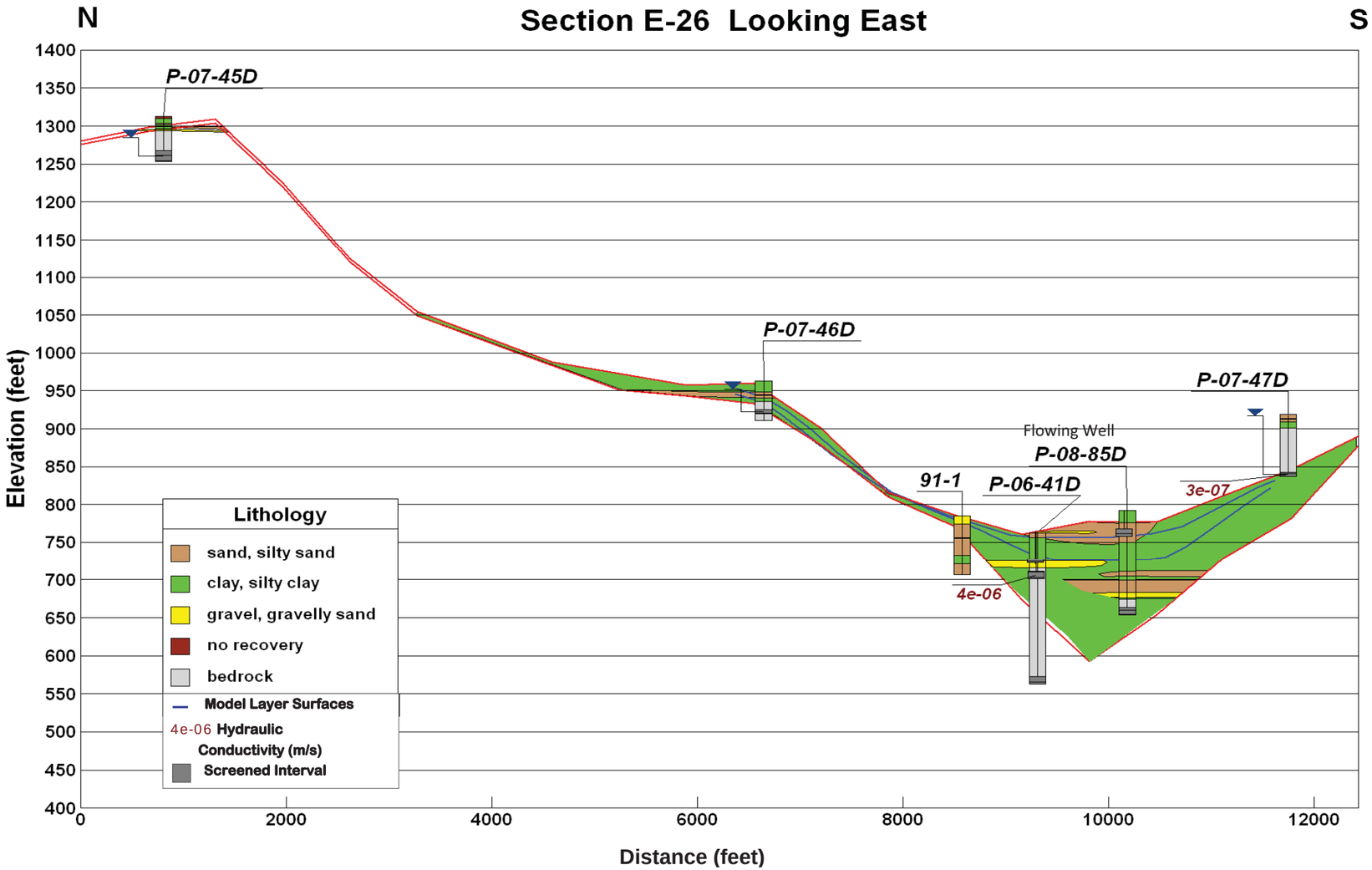


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-25**
Author: SWS-PP	Date: December 20, 2010

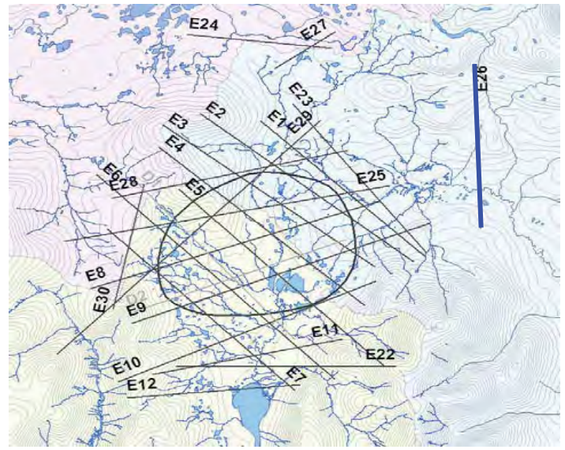
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



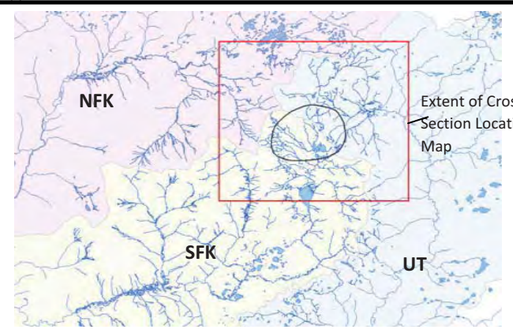
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

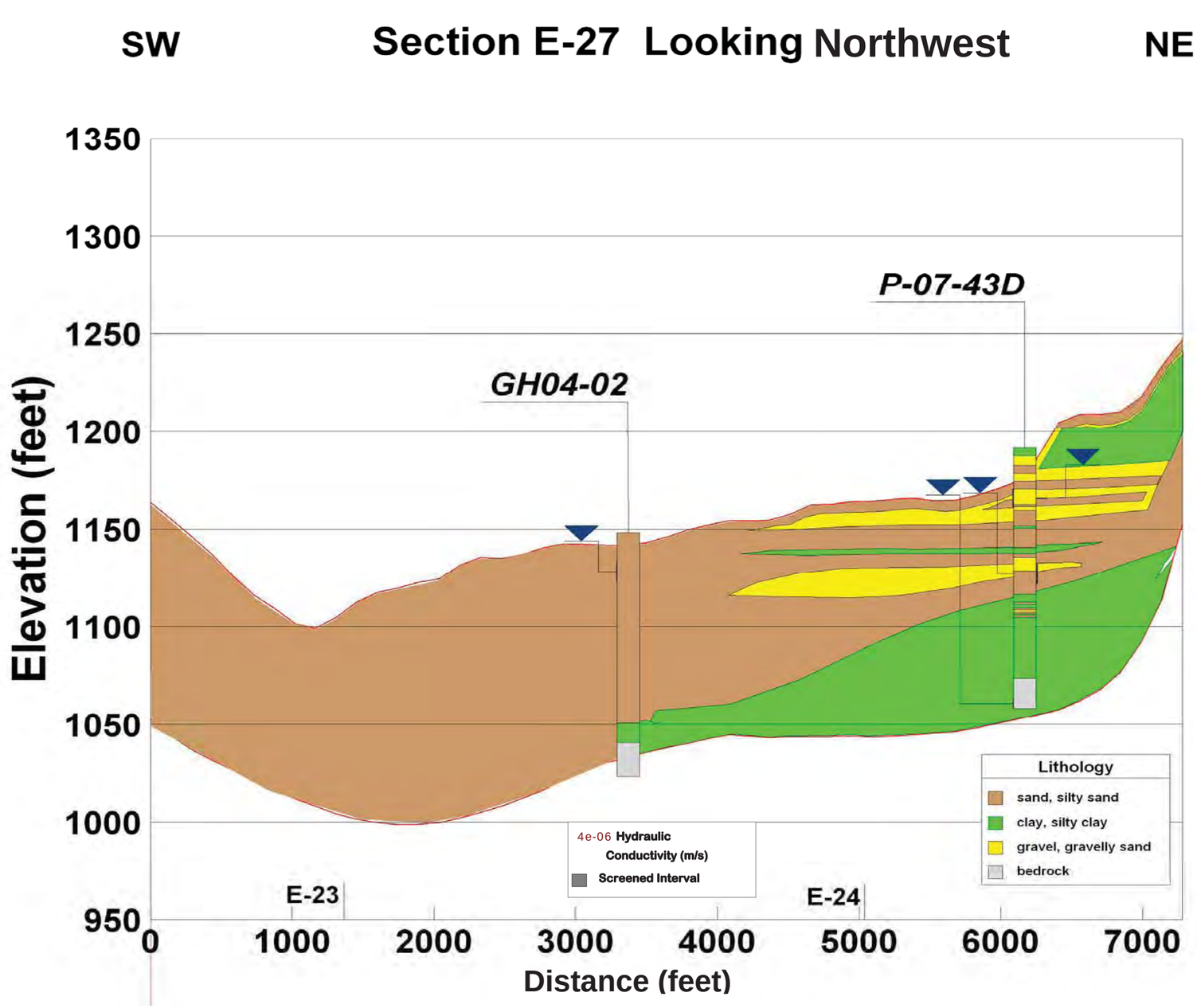


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-26**
Author: SWS-PP	Date: December 20, 2010

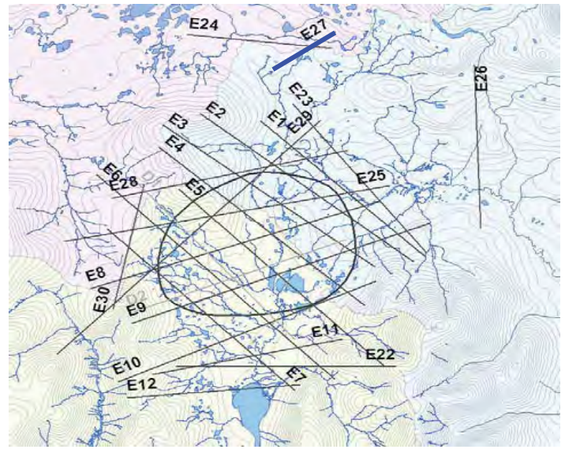
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



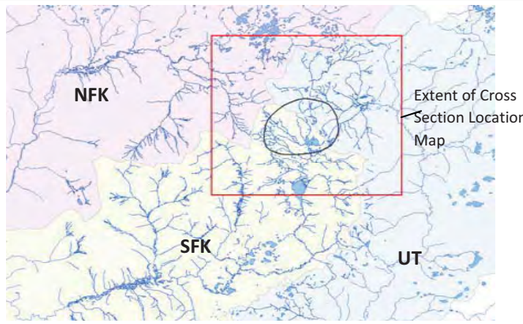
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

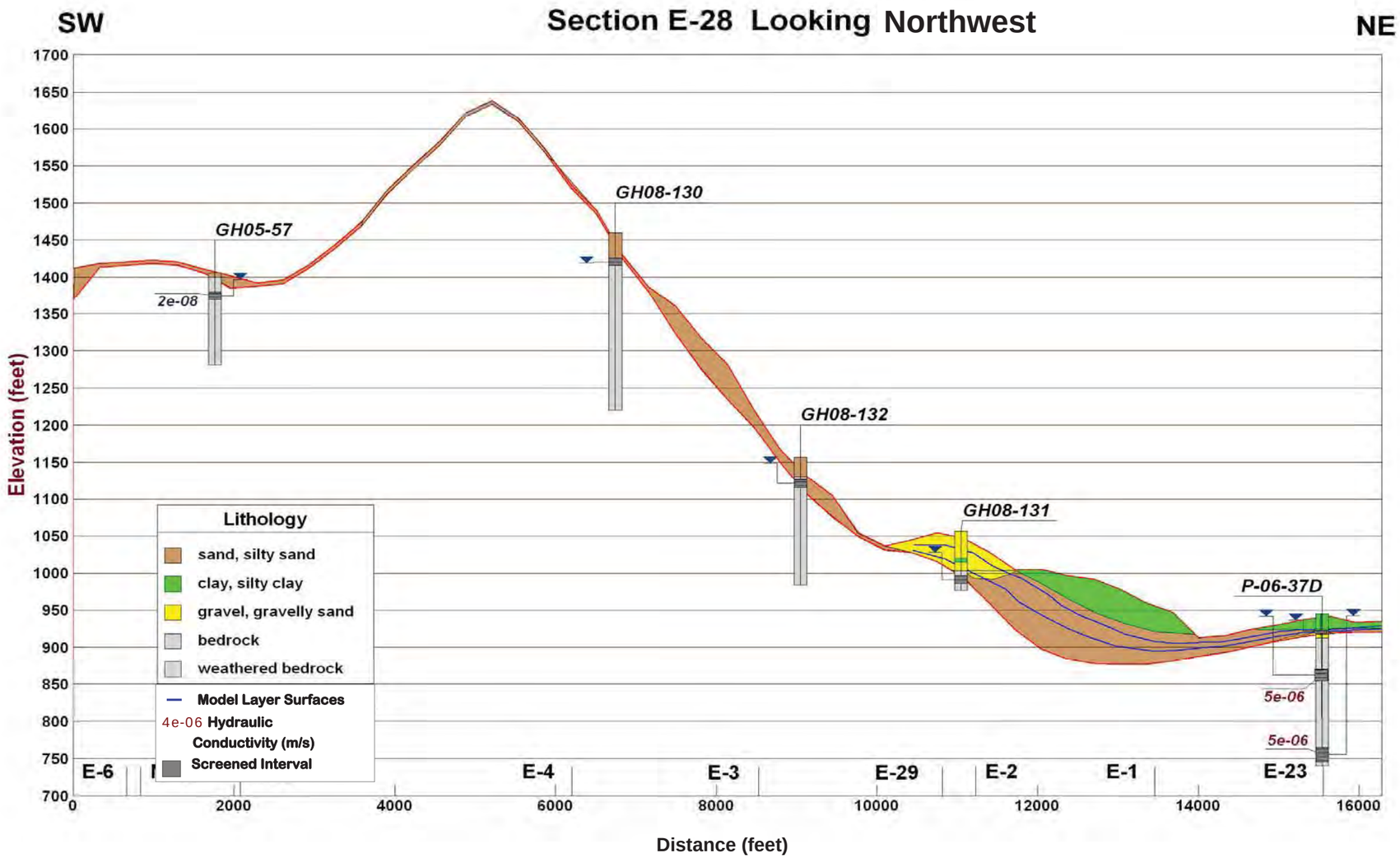
Cross Section Location Map



Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



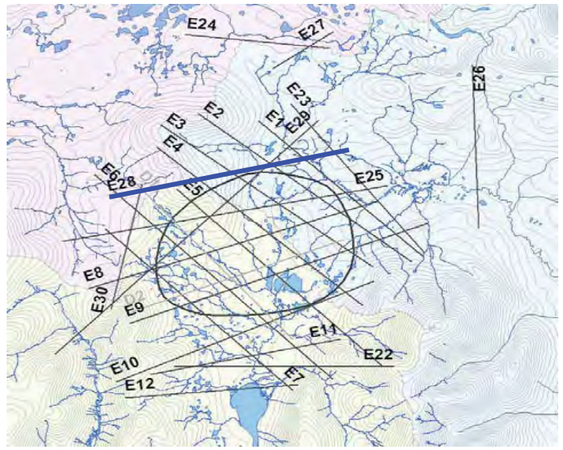
Project No: 7126	**Section E-27**
Author: SWS-PP	Date: December 20, 2010



THE pebble PARTNERSHIP

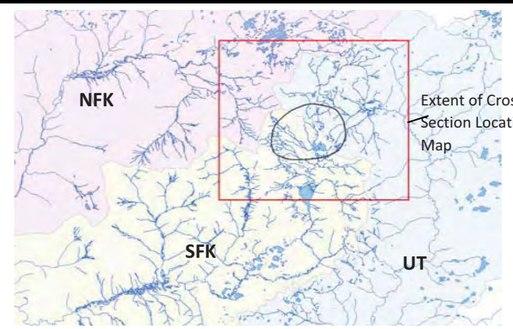
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



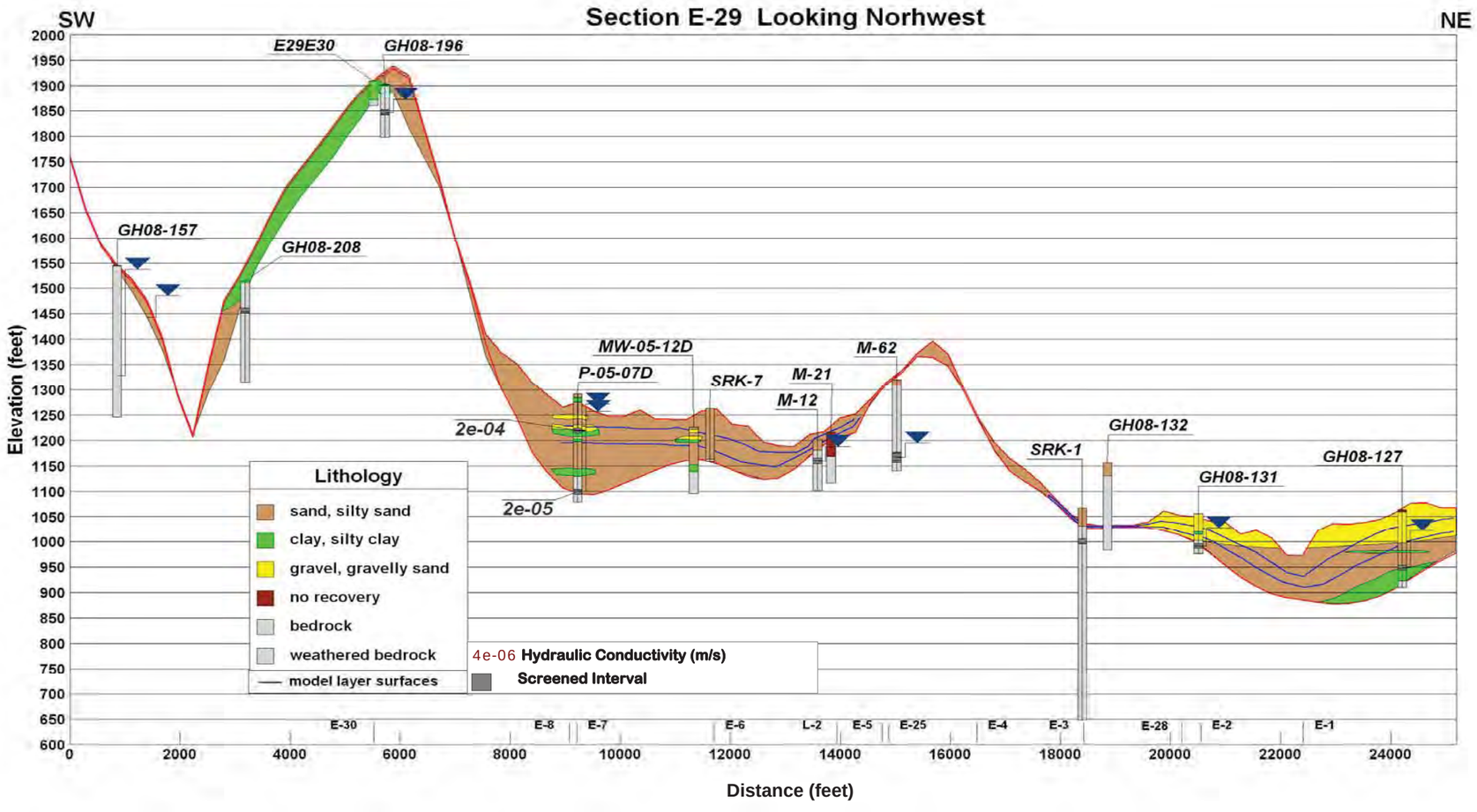
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-28**
Author: SWS-PP	Date: December 20, 2010

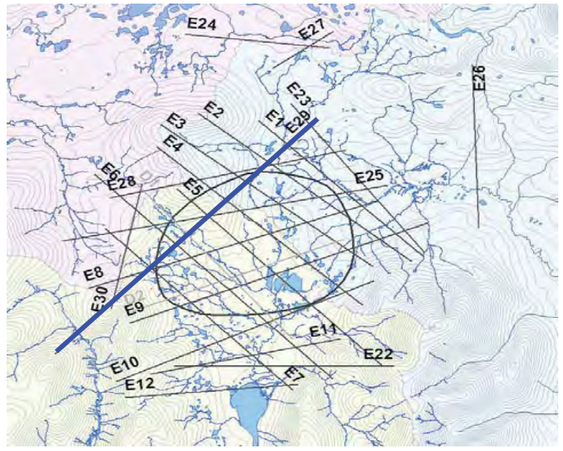
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

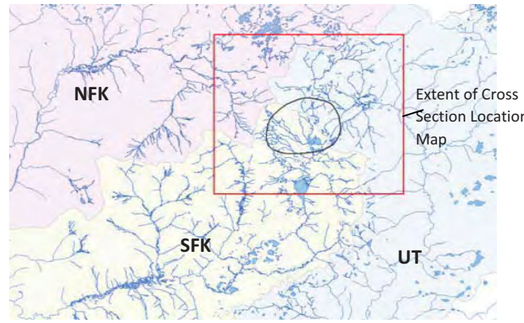
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



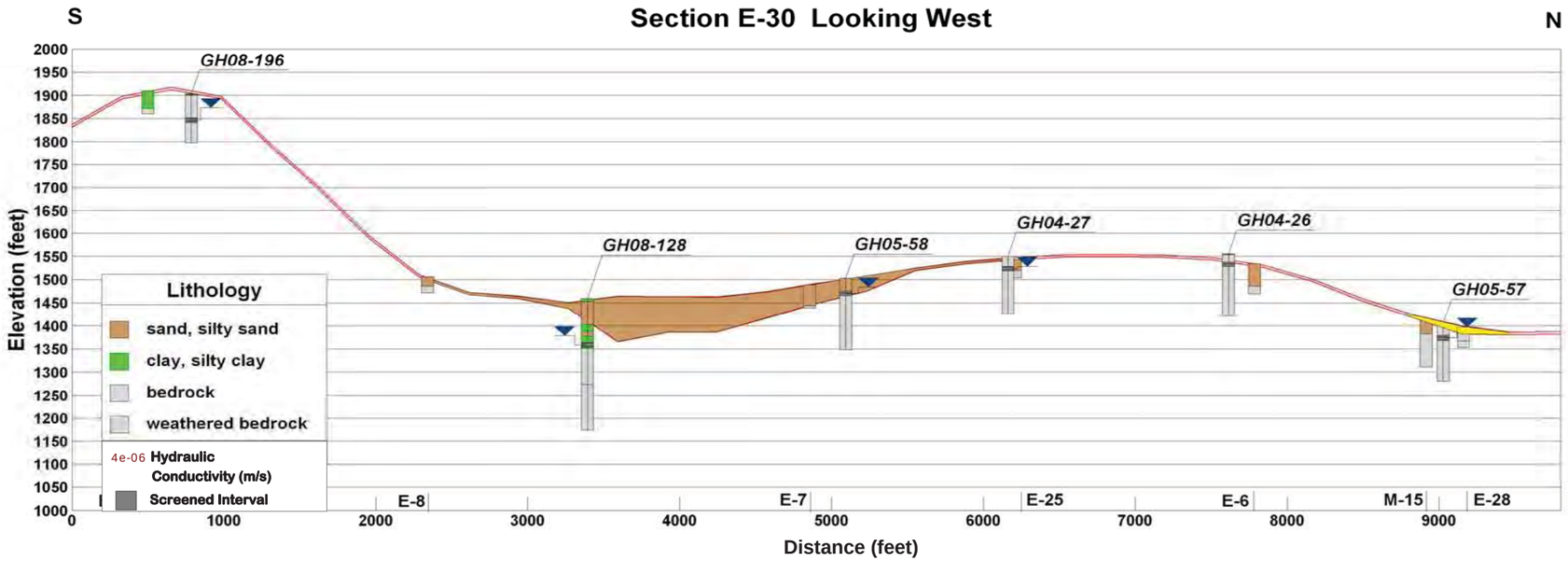
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-29**
Author: SWS-PP	Date: December 20, 2010

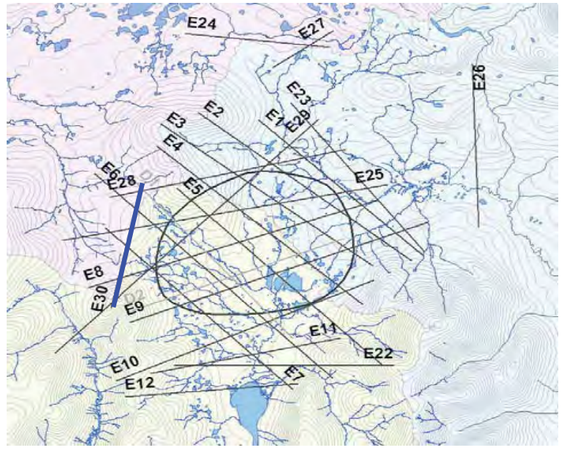
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



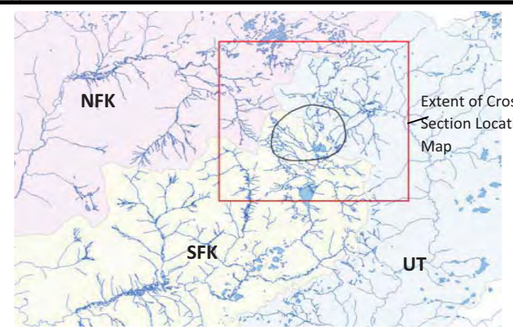
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

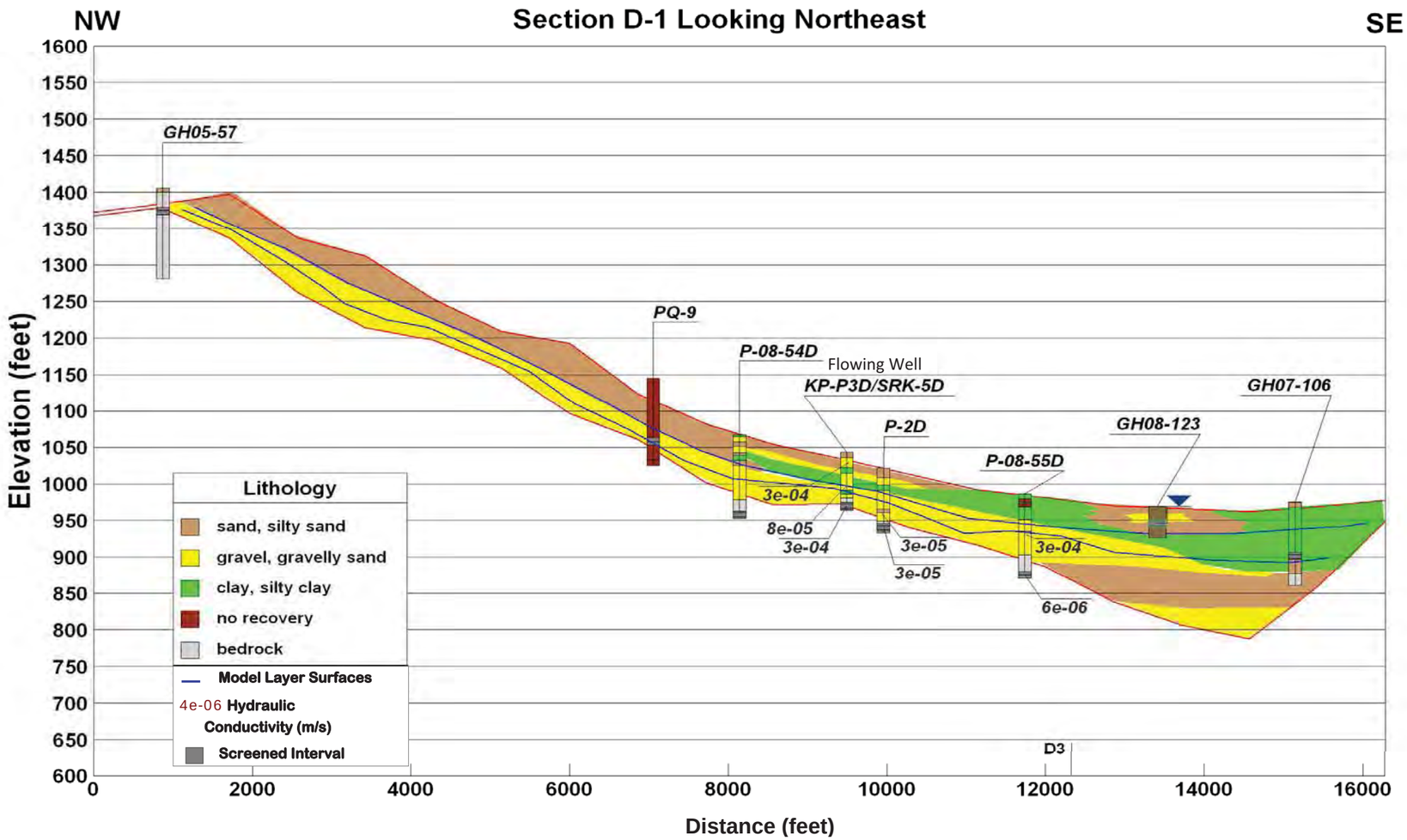


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-30**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

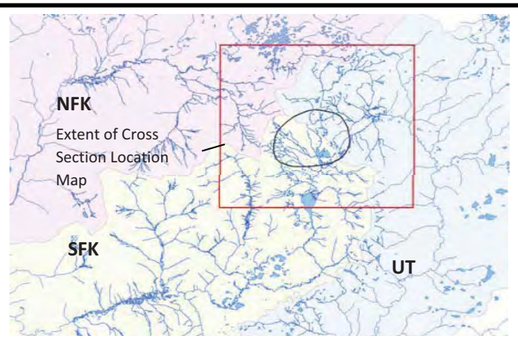


Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

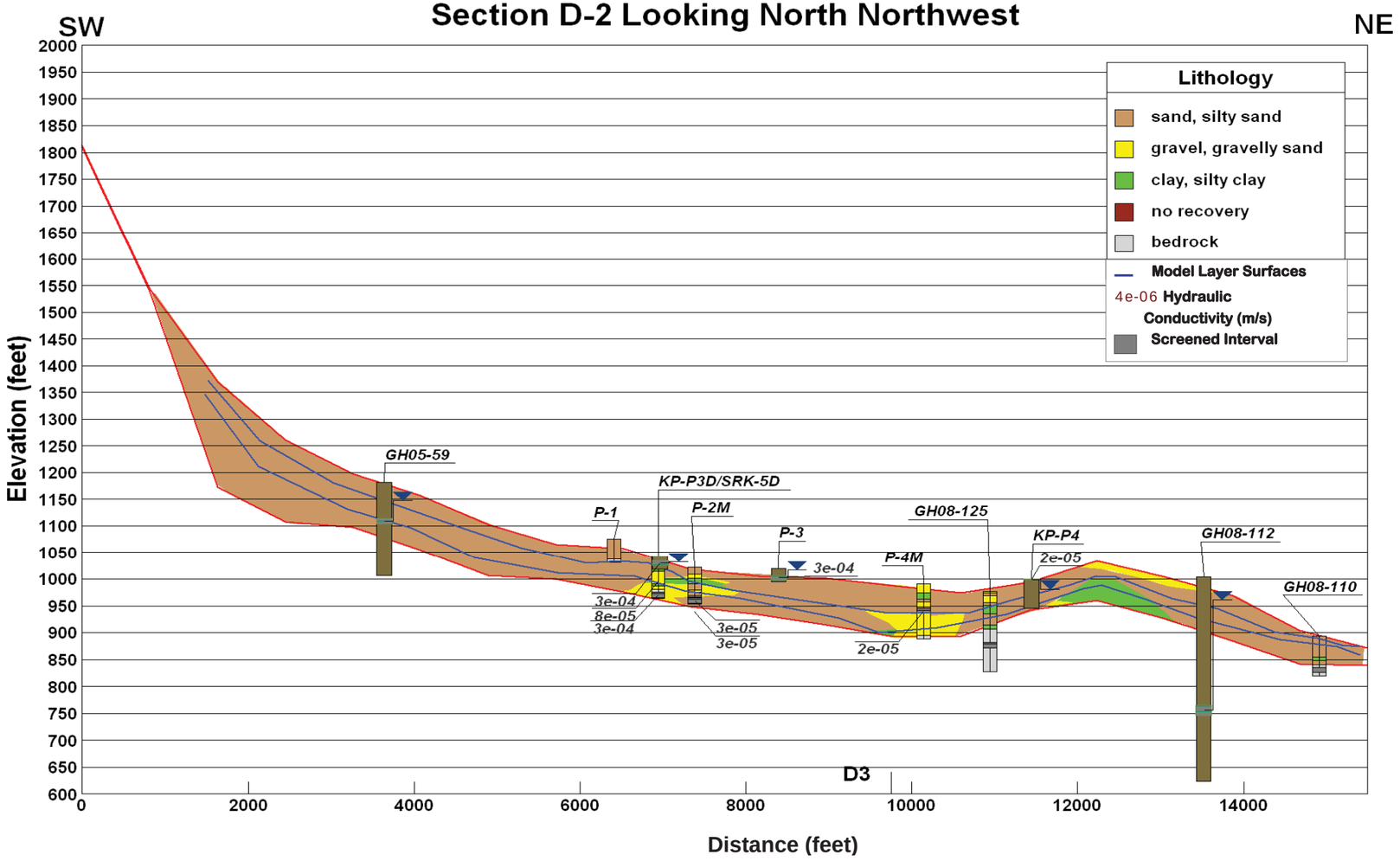


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



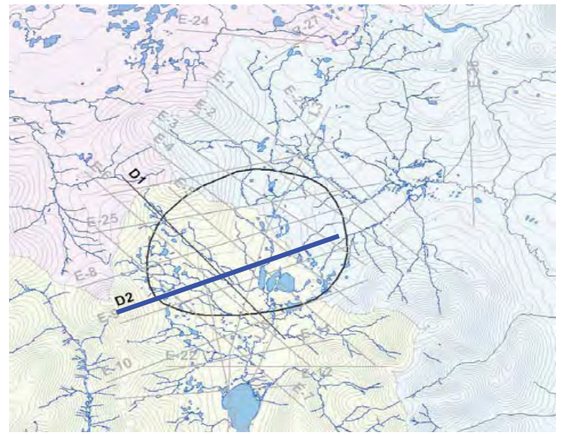
Project No: 7126	**Section D-1**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

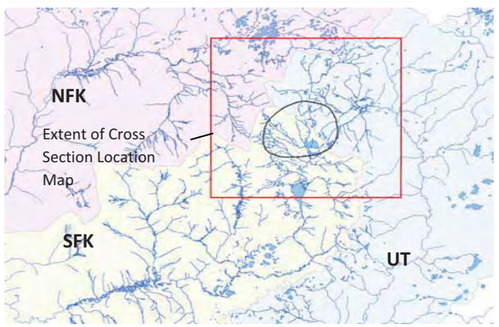


Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



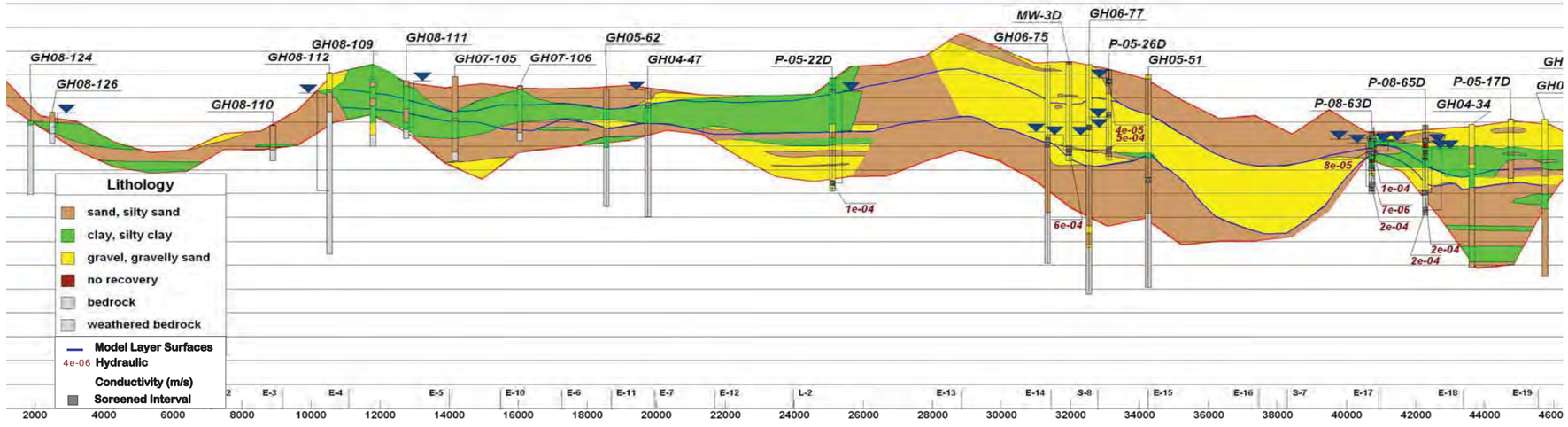
Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section D-2**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

Section L-1 Looking Eastsoutheast

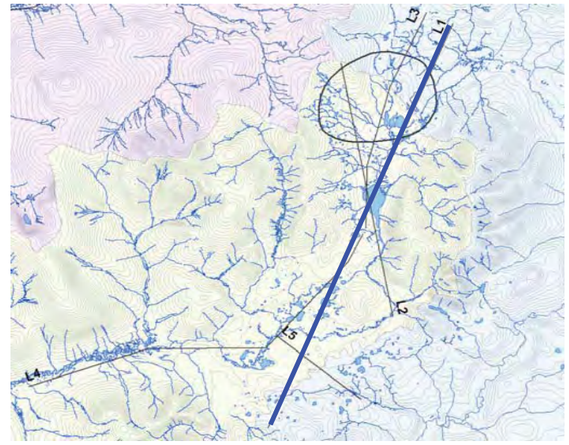


Distance (feet)

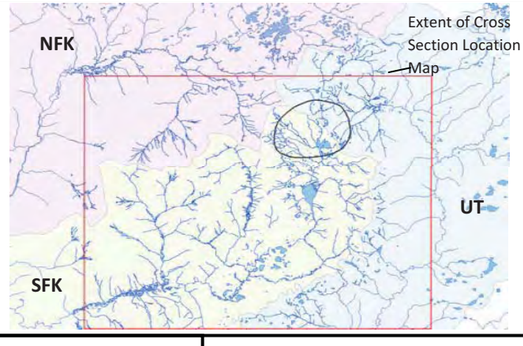
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

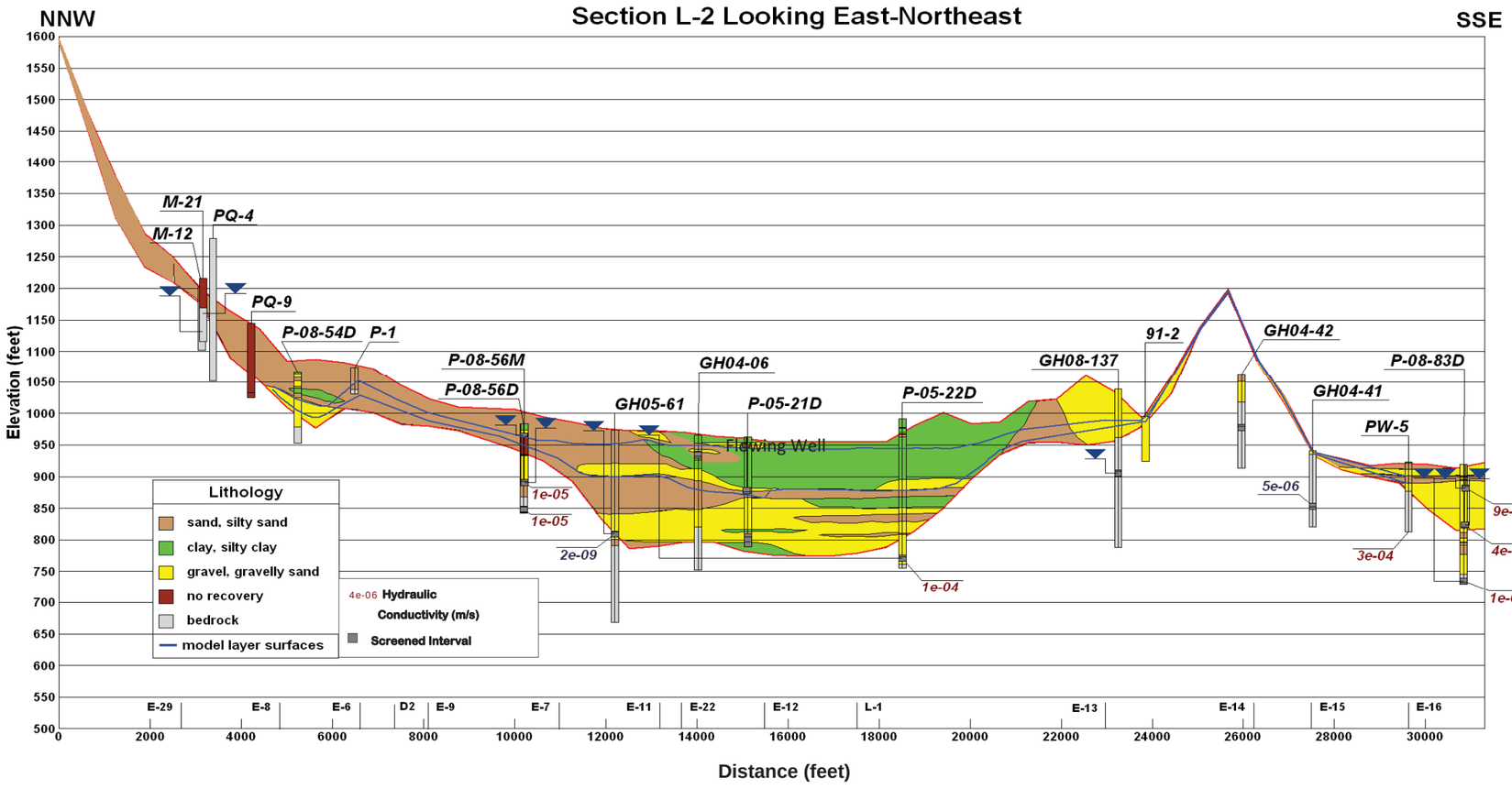


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section L-1**
Author: SWS-PP	Date: December 20, 2010

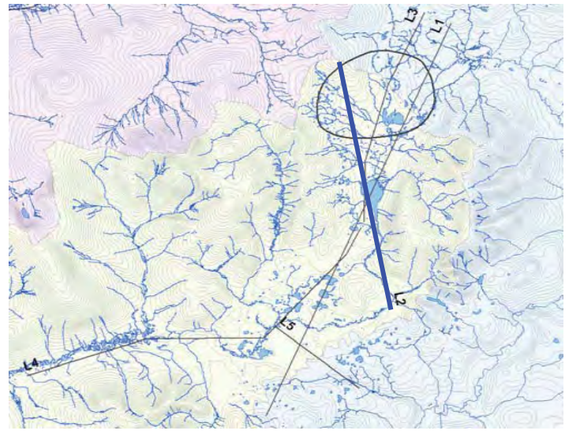
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

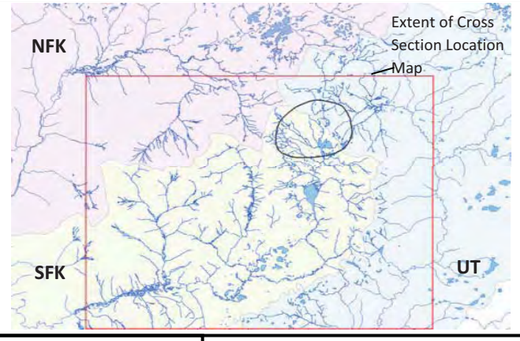
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



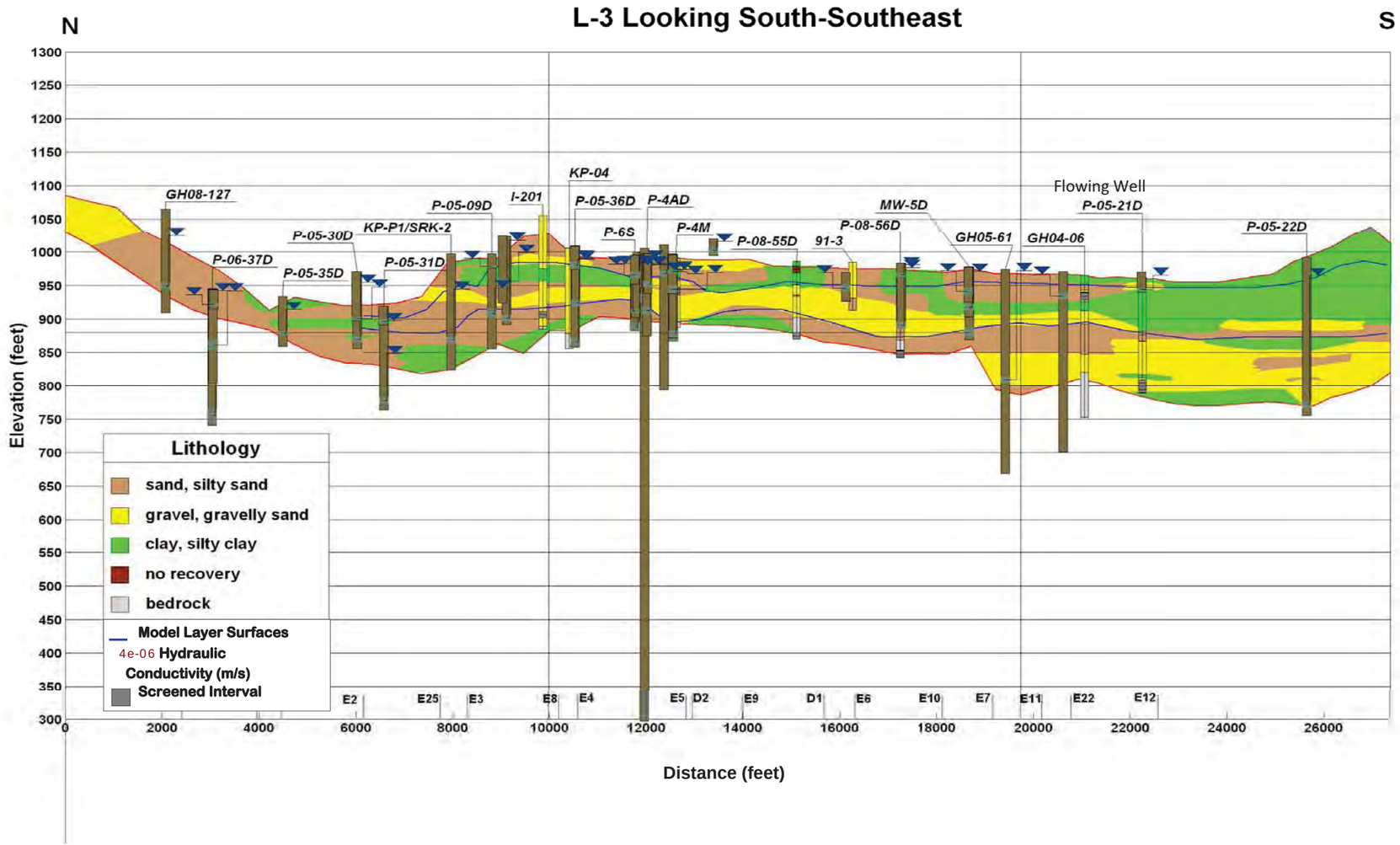
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section L2**
Author: SWS-PP	Date: December 20, 2010

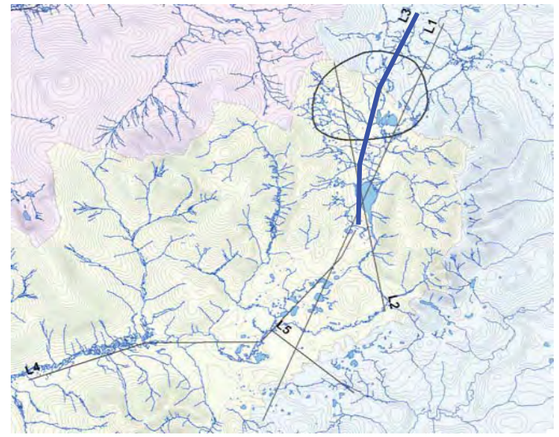
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

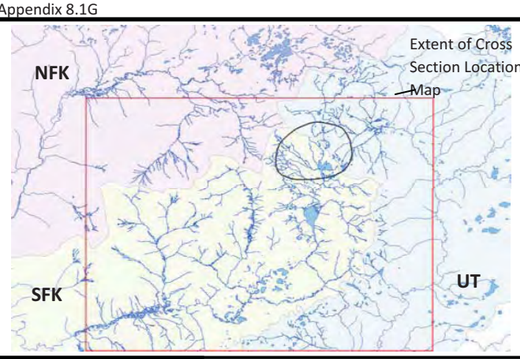
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



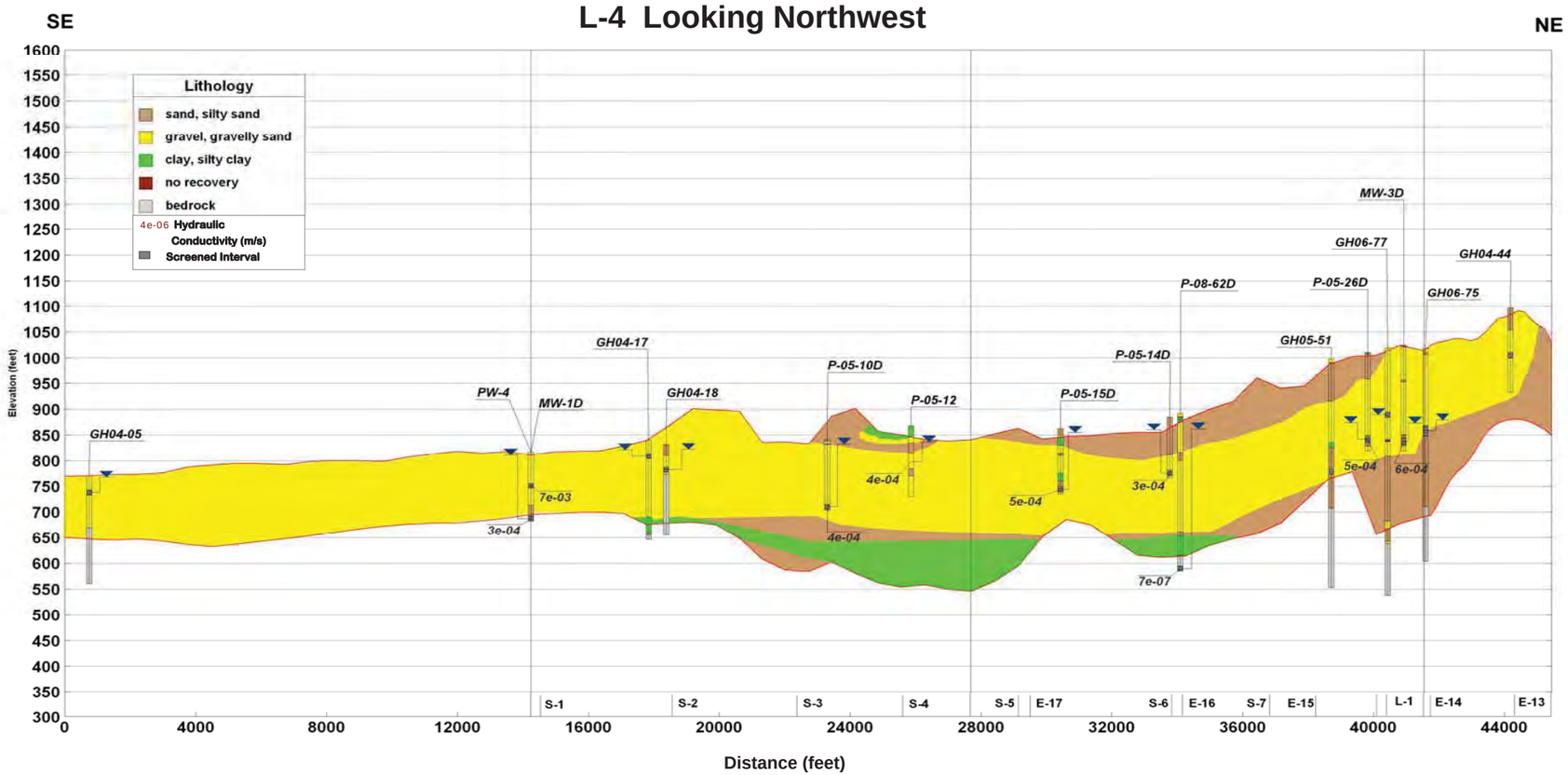
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section L3**
Author: SWS-PP	Date: December 20, 2010

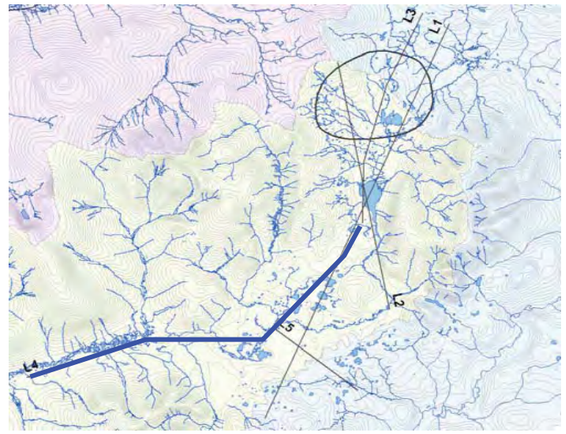
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



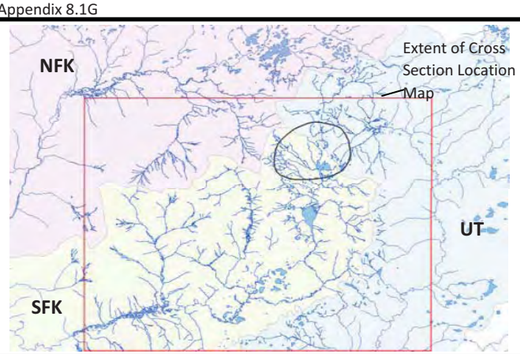
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

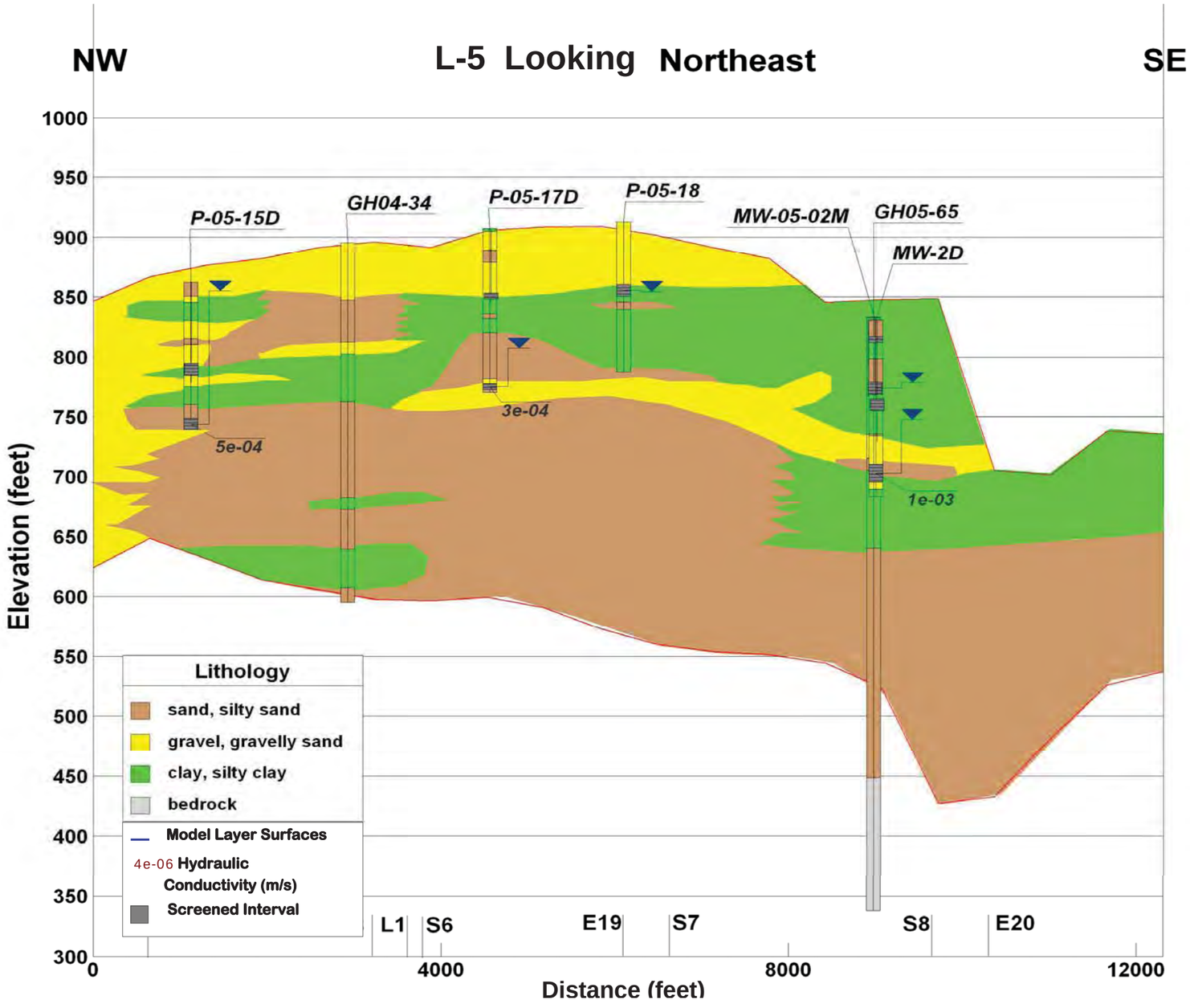


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section L-4**
Author: SWS-PP	Date: December 20, 2010

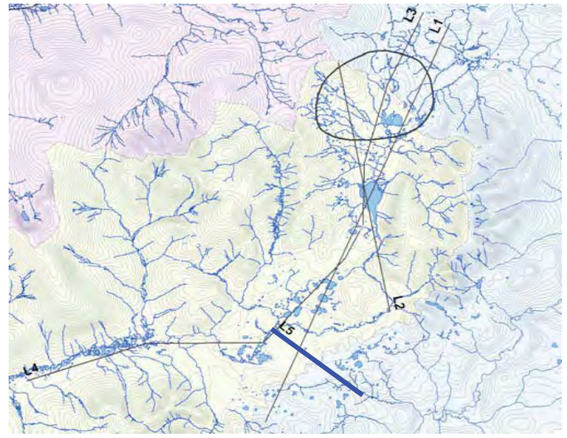
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

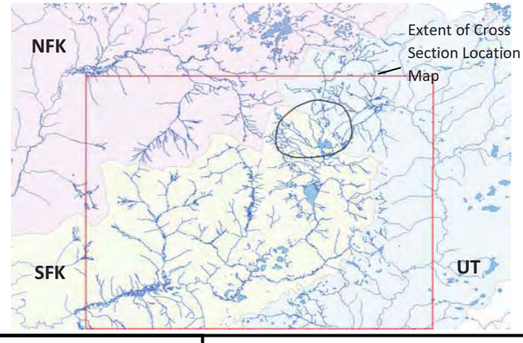
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



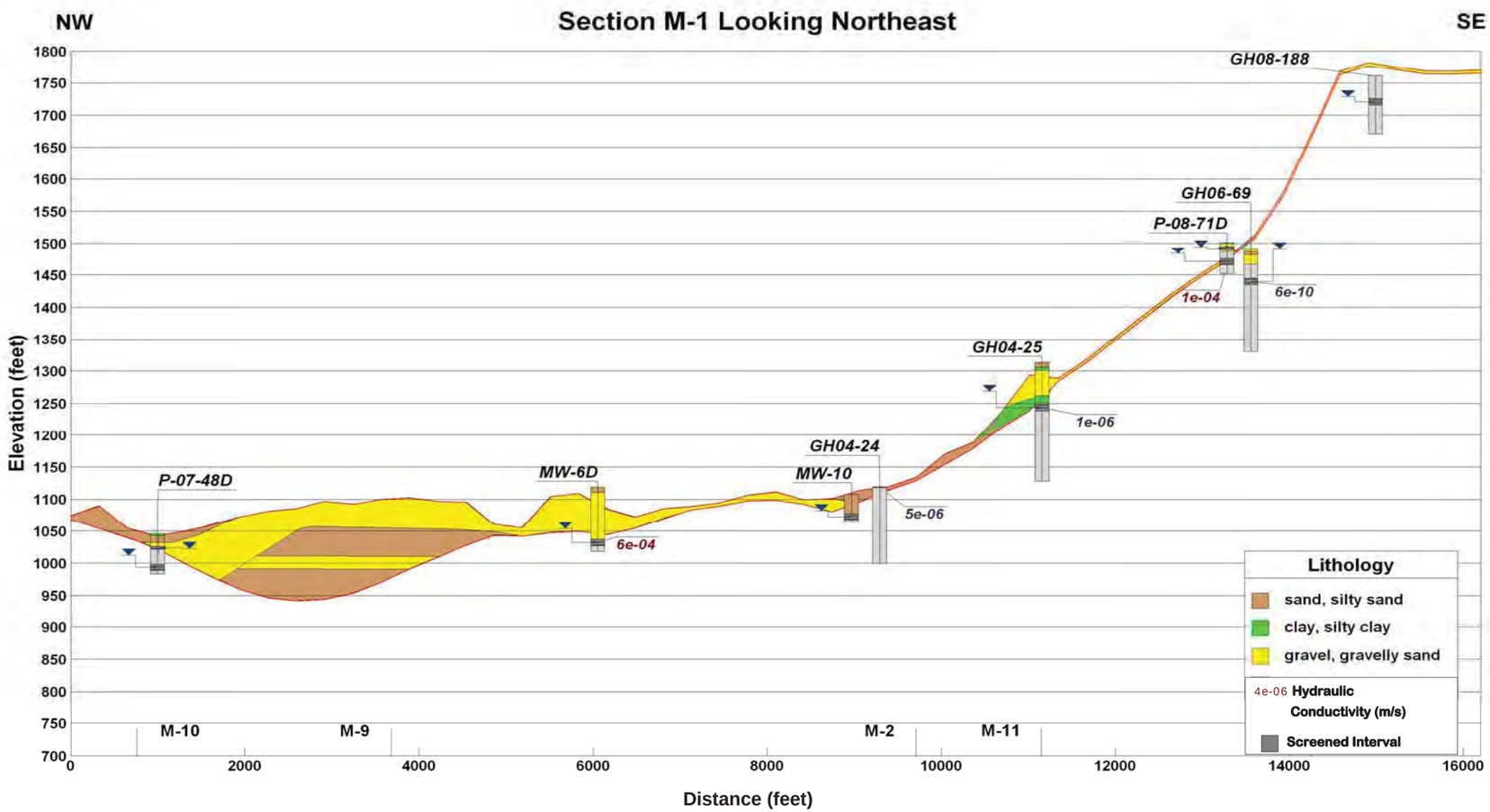
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section L-5**
Author: SWS-PP	Date: December 20, 2010

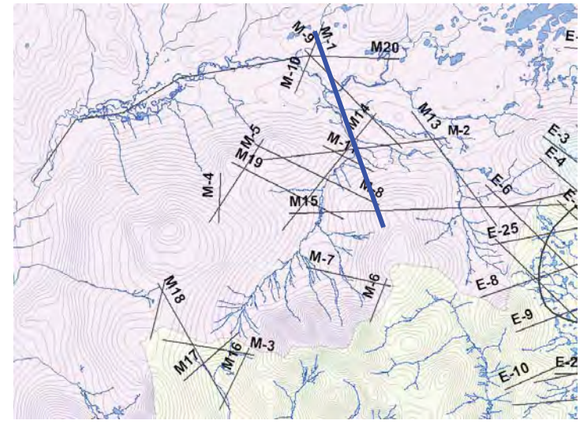
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

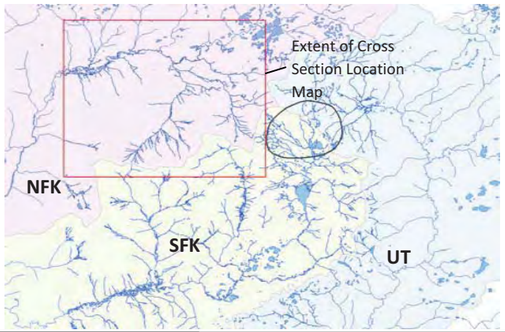
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



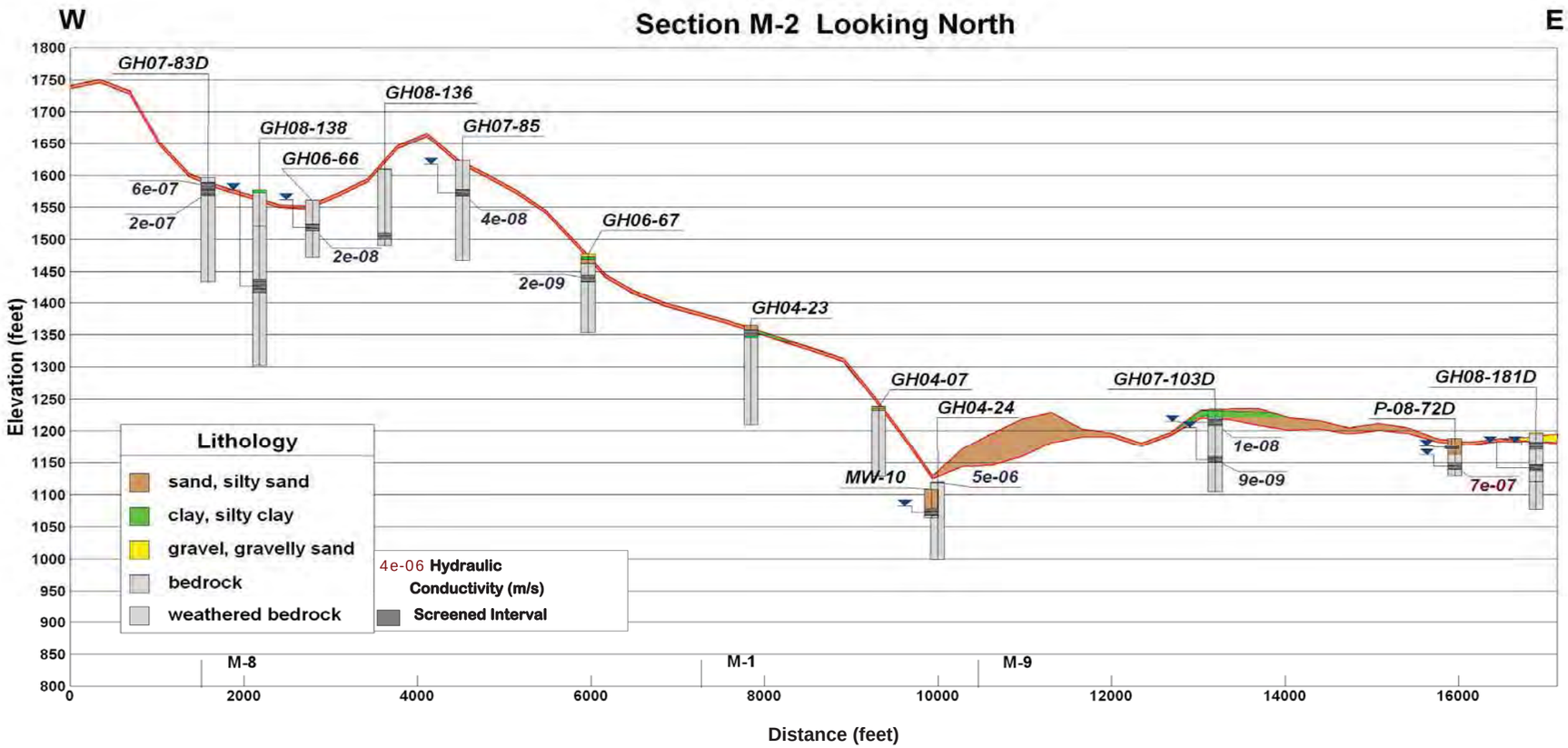
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



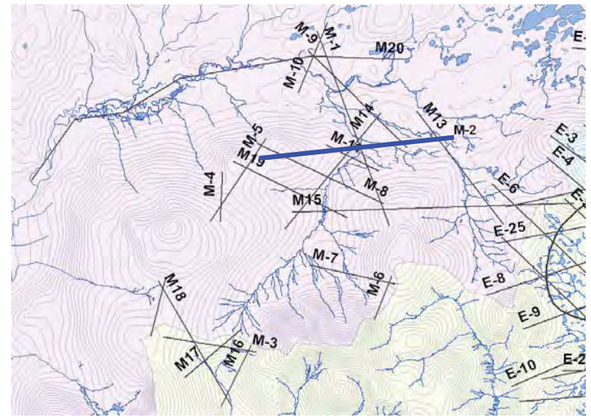
Project No: 7126	**Section-M1**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

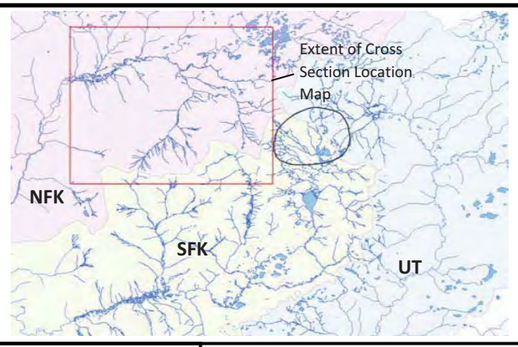


Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

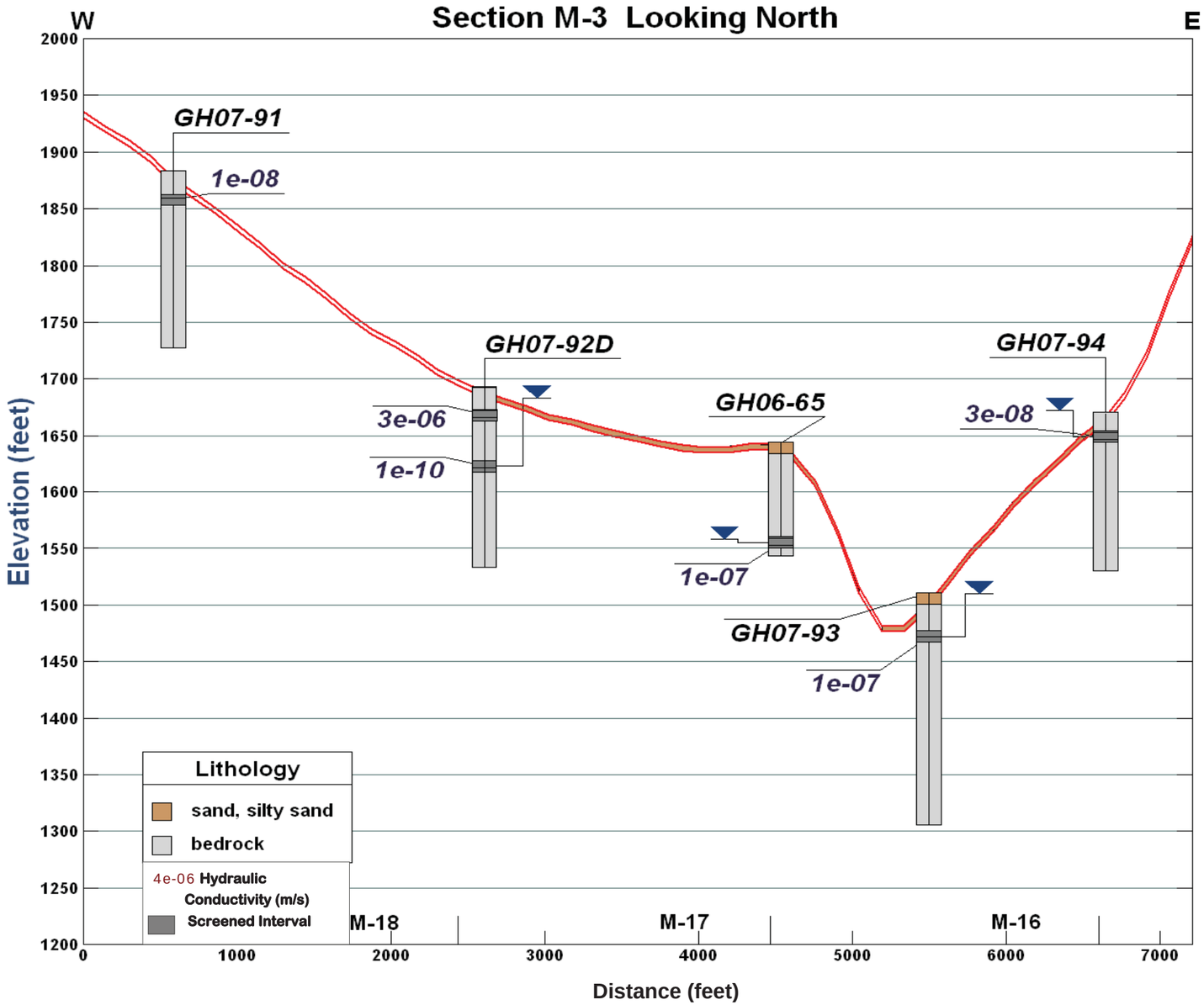


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M2**
Author: SWS-PP	Date: December 20, 2010

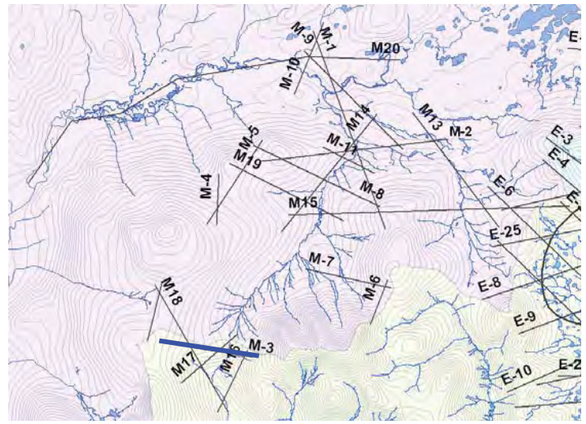
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



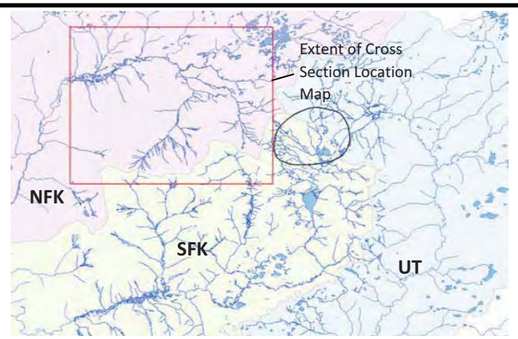
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

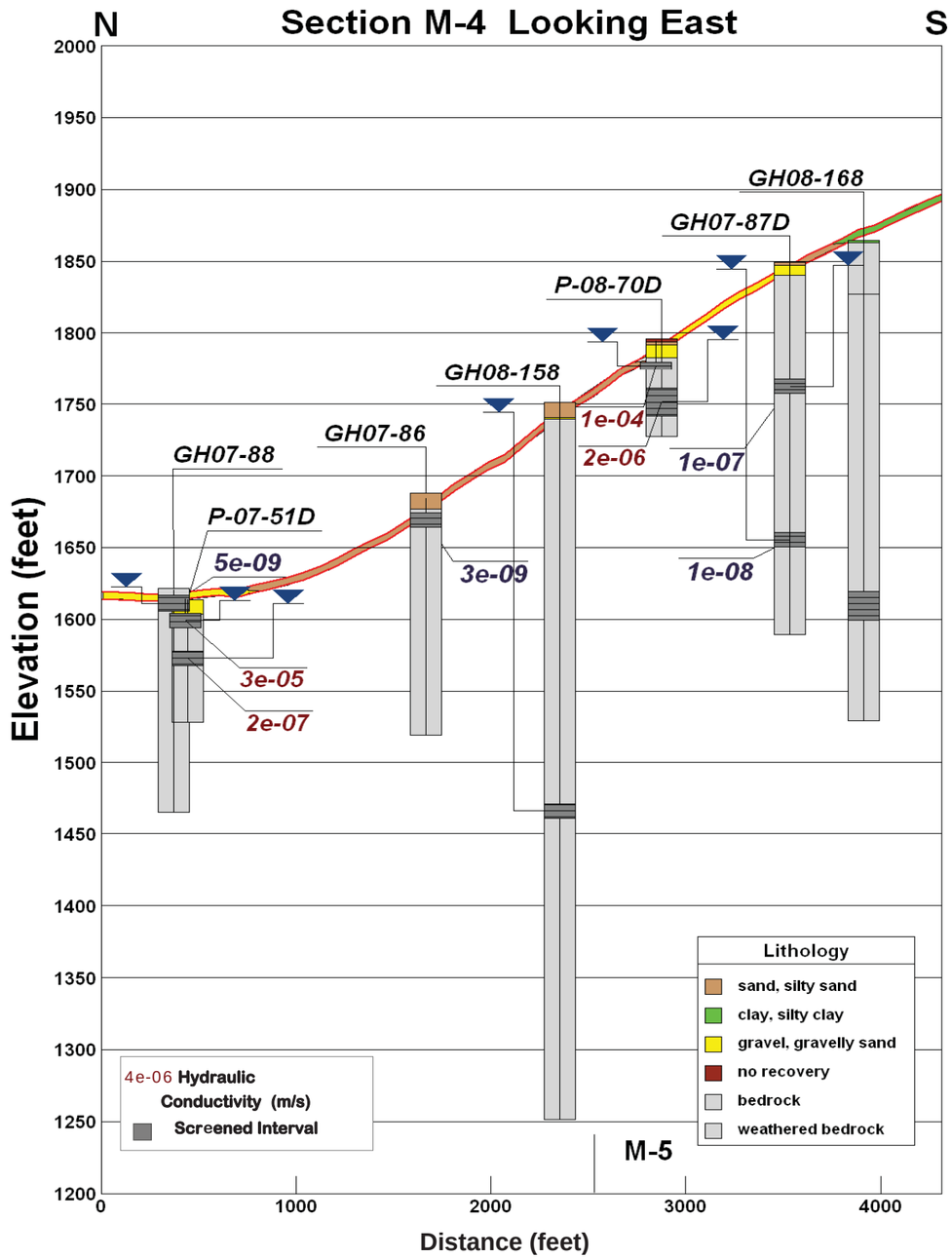


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M3**
Author: SWS-PP	Date: December 20, 2010

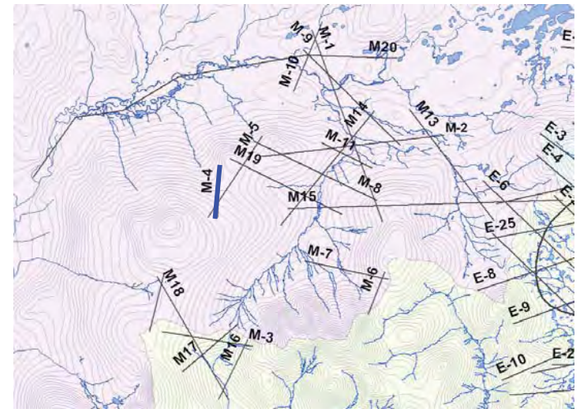
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



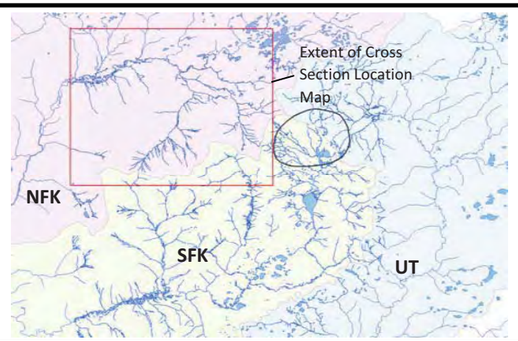
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

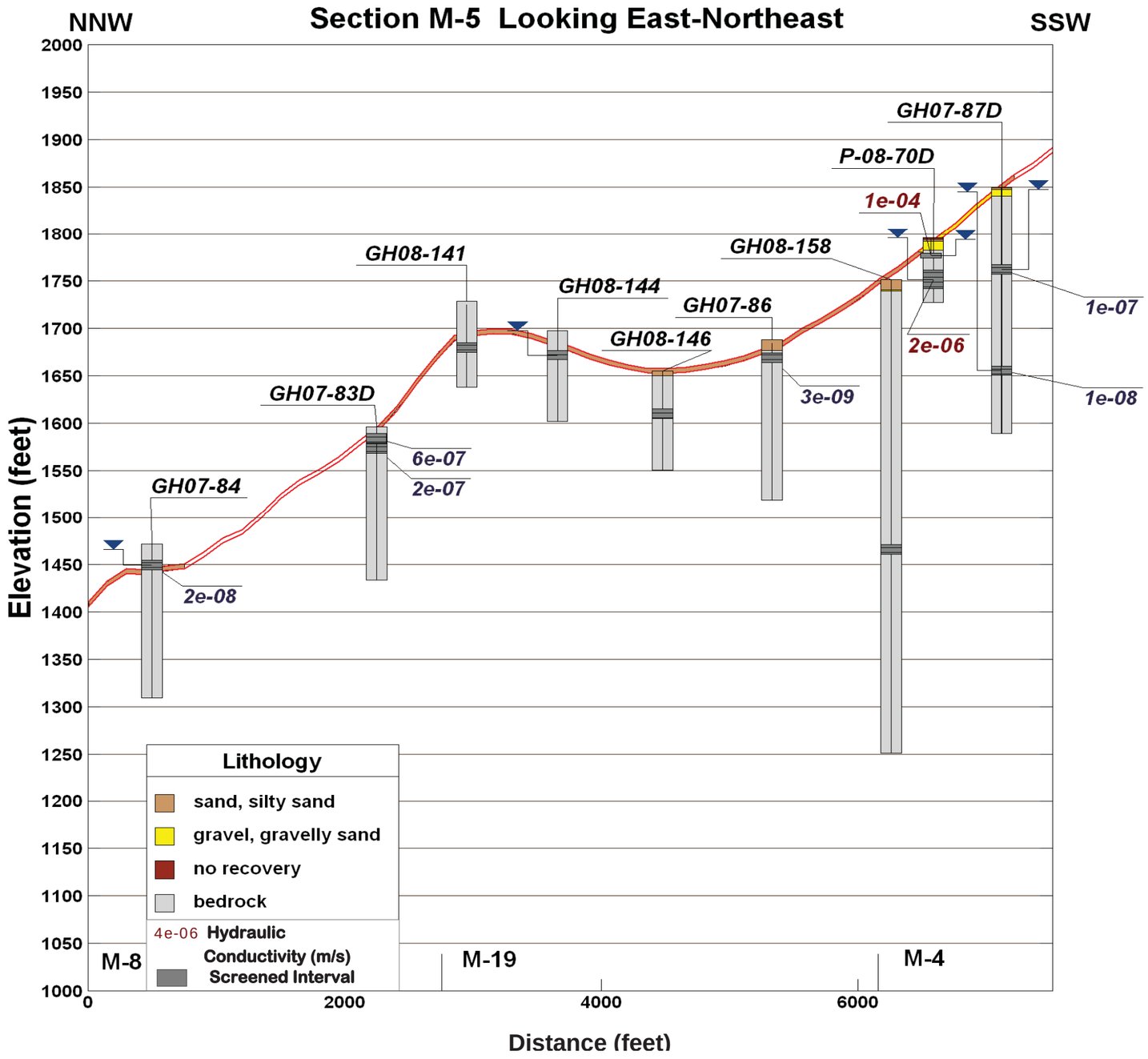


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M4**
Author: SWS-PP	Date: December 20, 2010

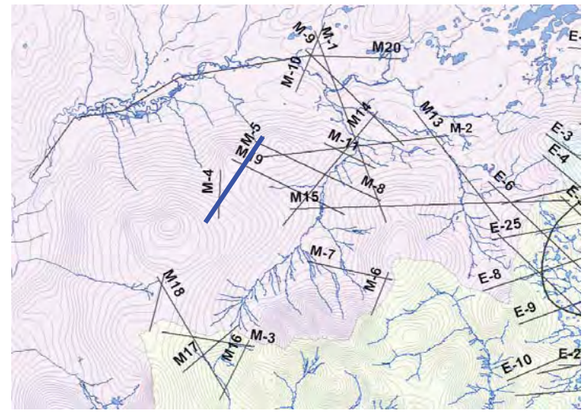
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



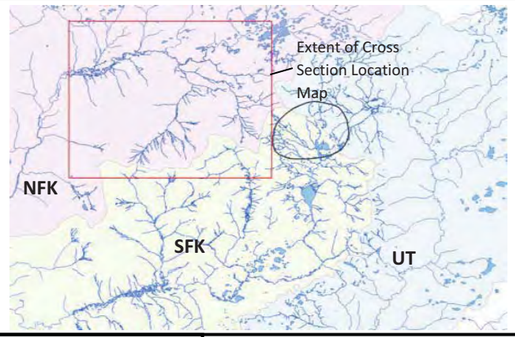
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

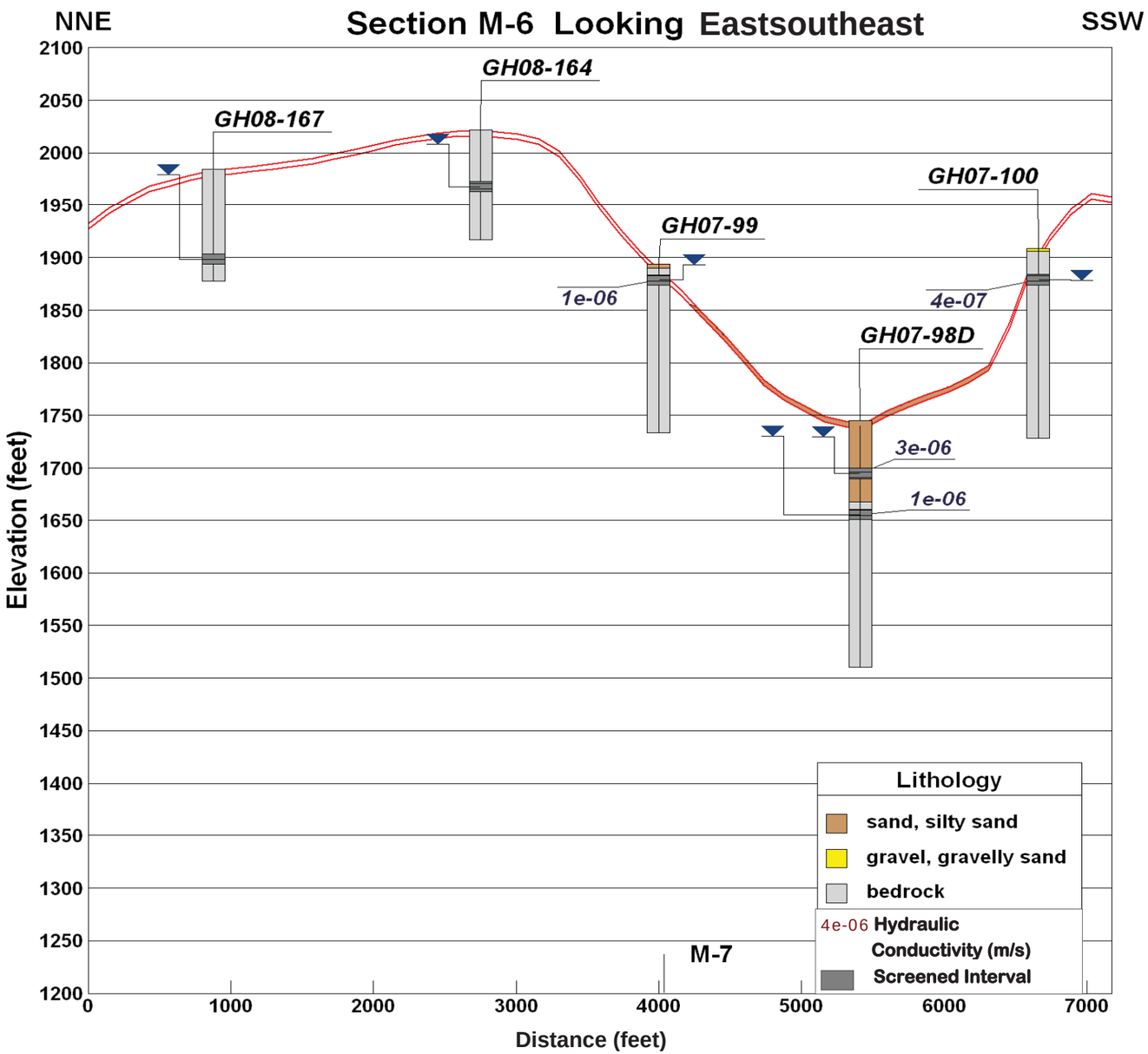


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M5**
Author: SWS-PP	Date: December 20, 2010

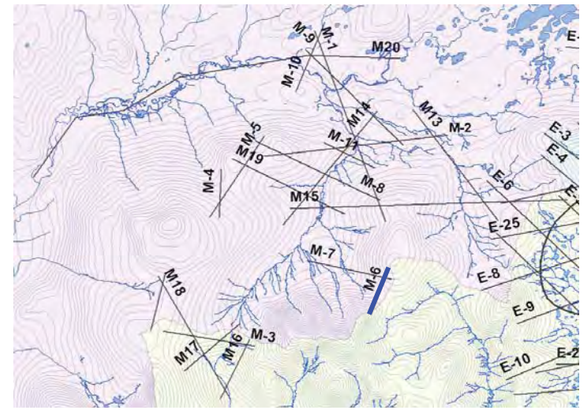
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



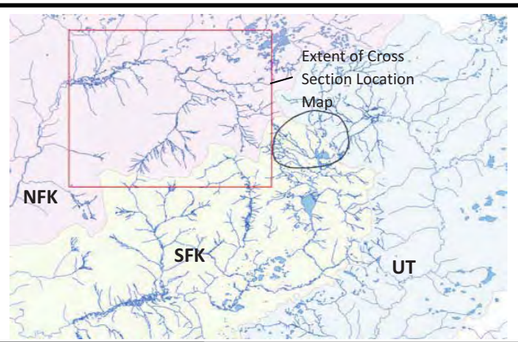
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

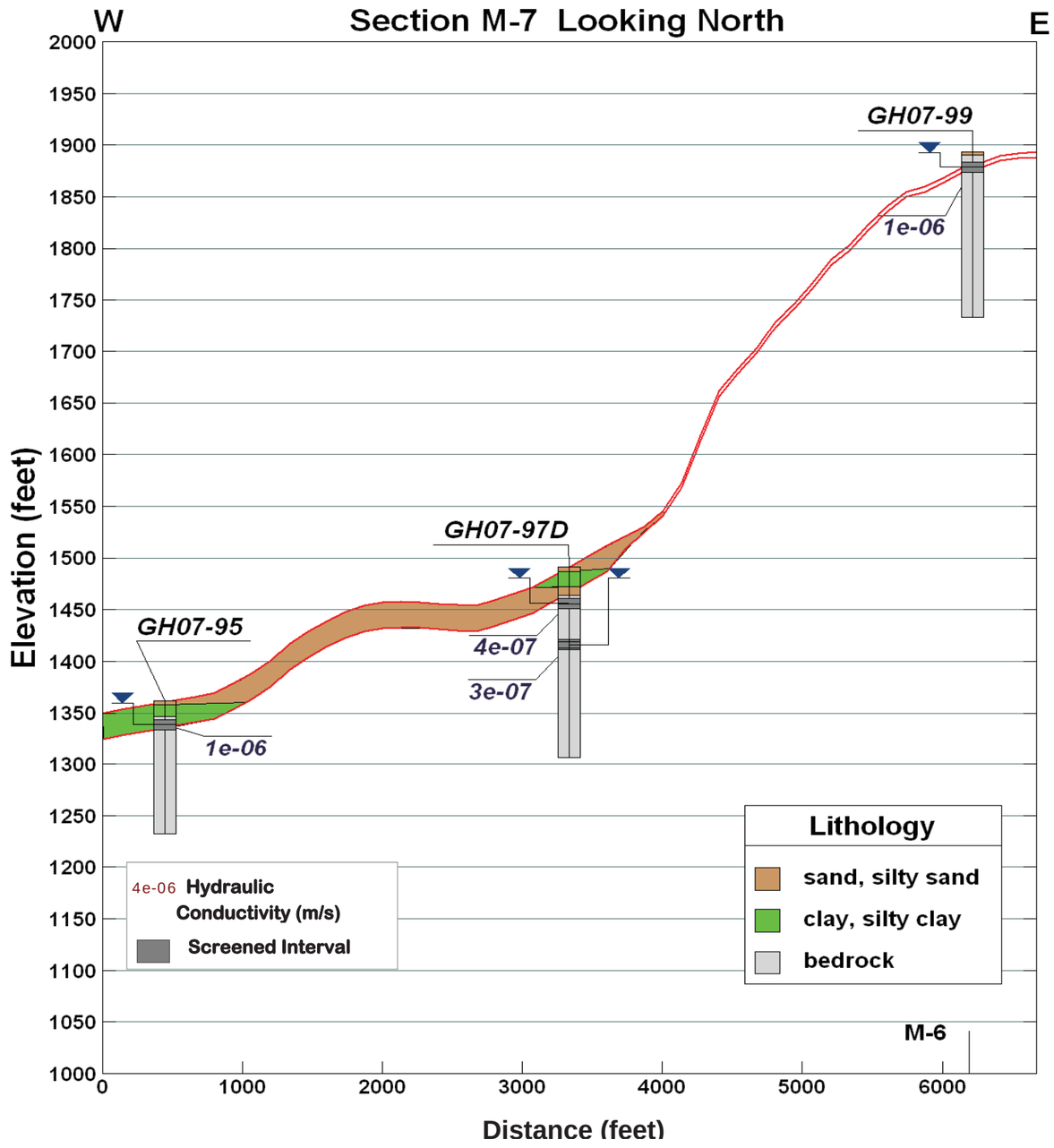


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M6**
Author: SWS-PP	Date: December 20, 2010

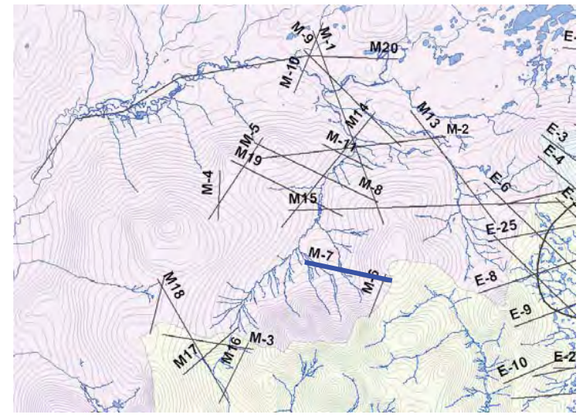
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



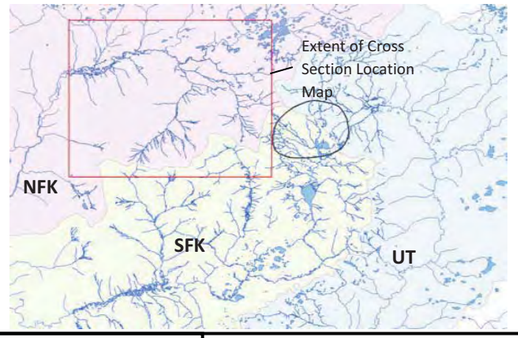
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

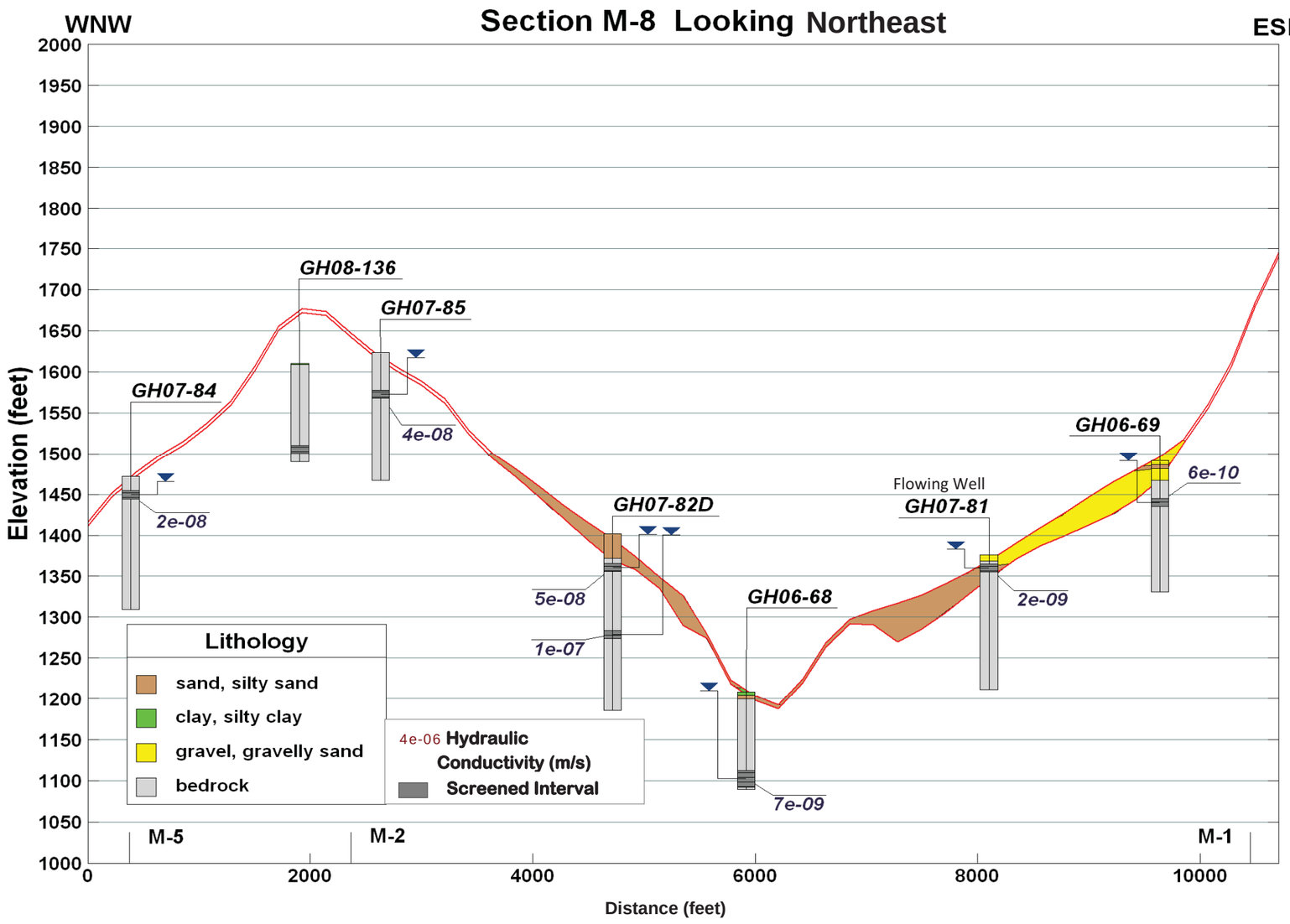


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M7**
Author: SWS-PP	Date: December 20, 2010

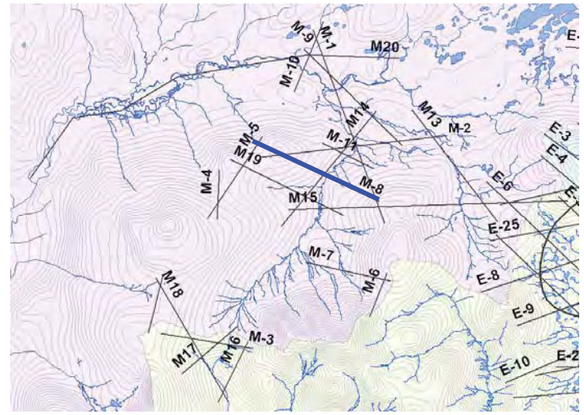
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



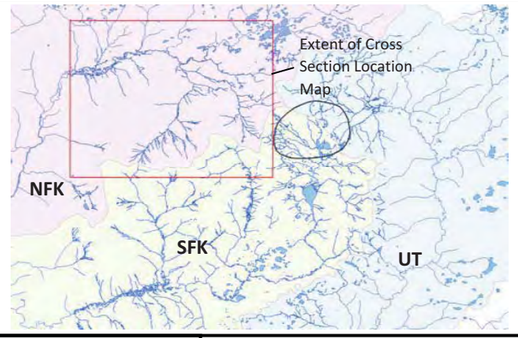
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

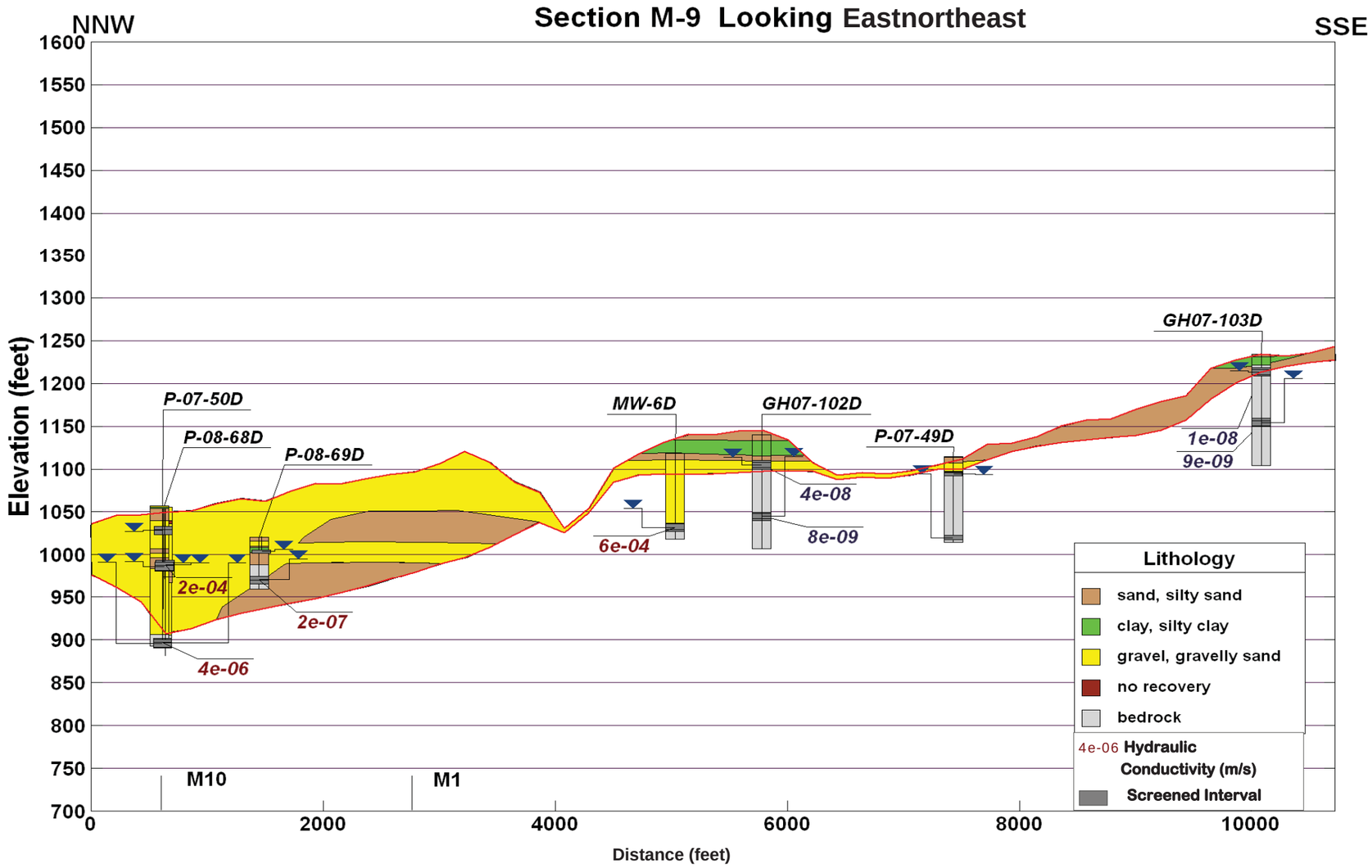


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M8**
Author: SWS-PP	Date: December 20, 2010

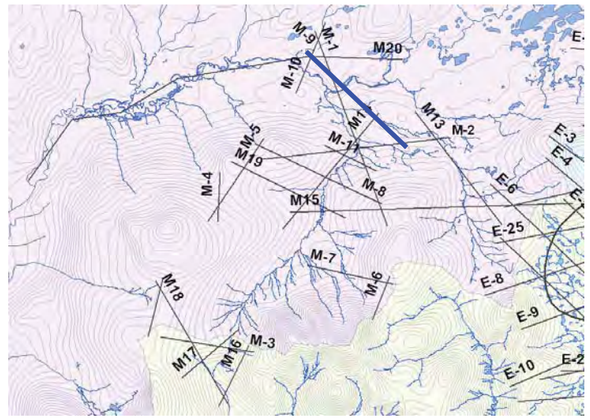
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



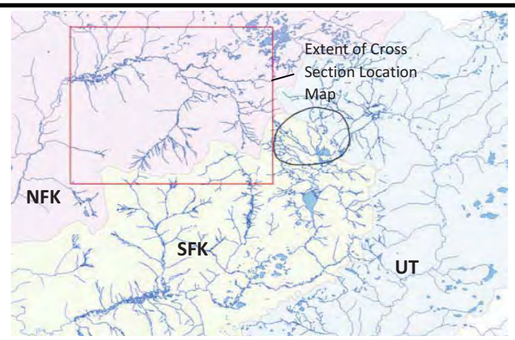
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

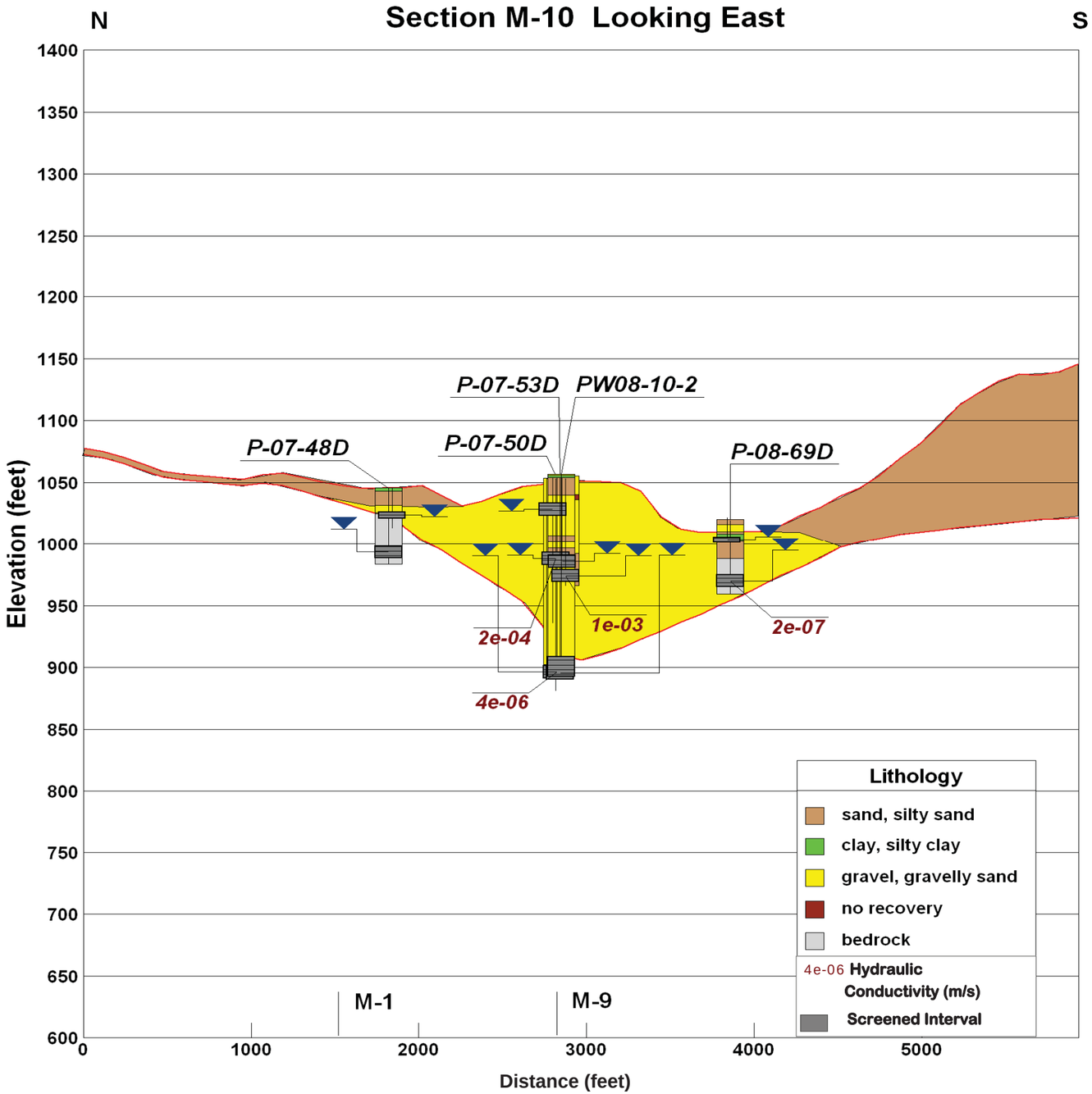


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M9**
Author: SWS-PP	Date: December 20, 2010

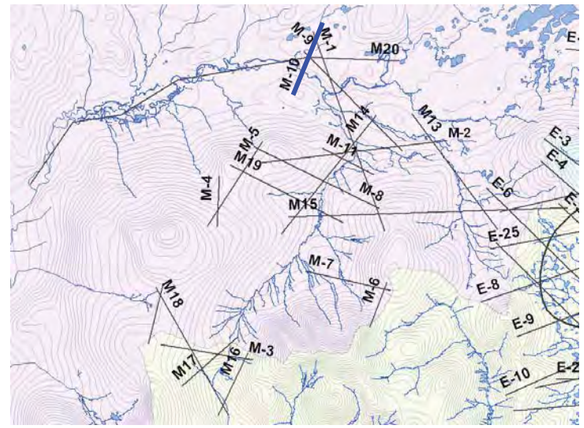
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



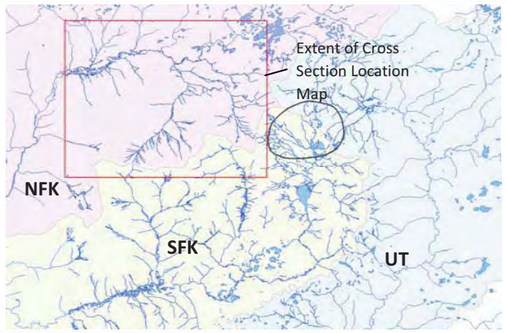
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

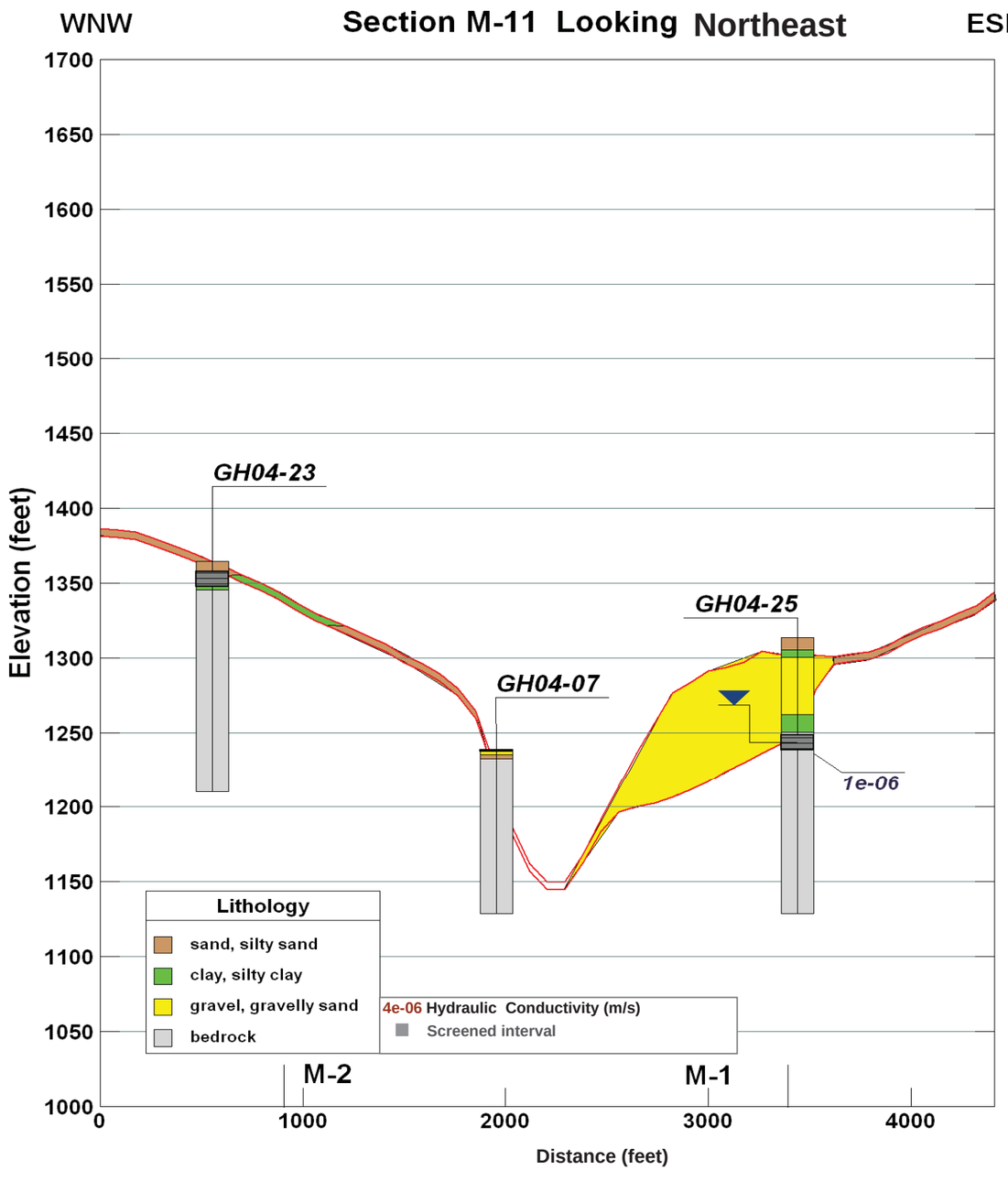


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M10**
Author: SWS-PP	Date: December 20, 2010

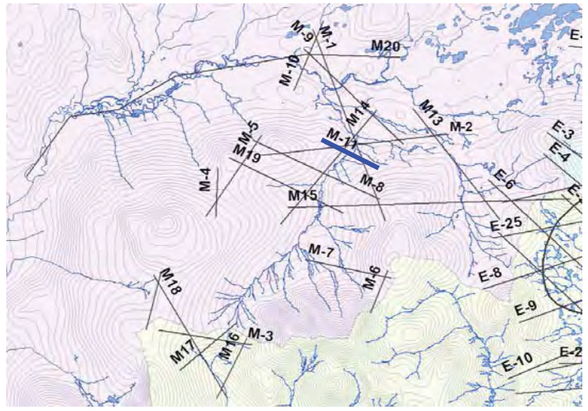
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



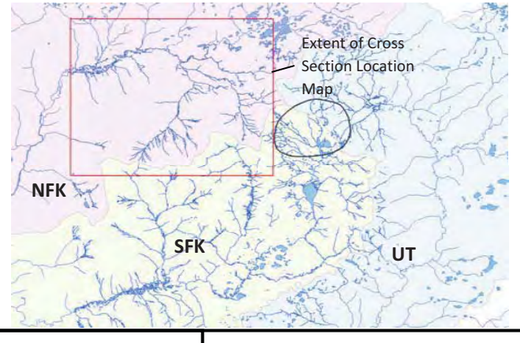
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

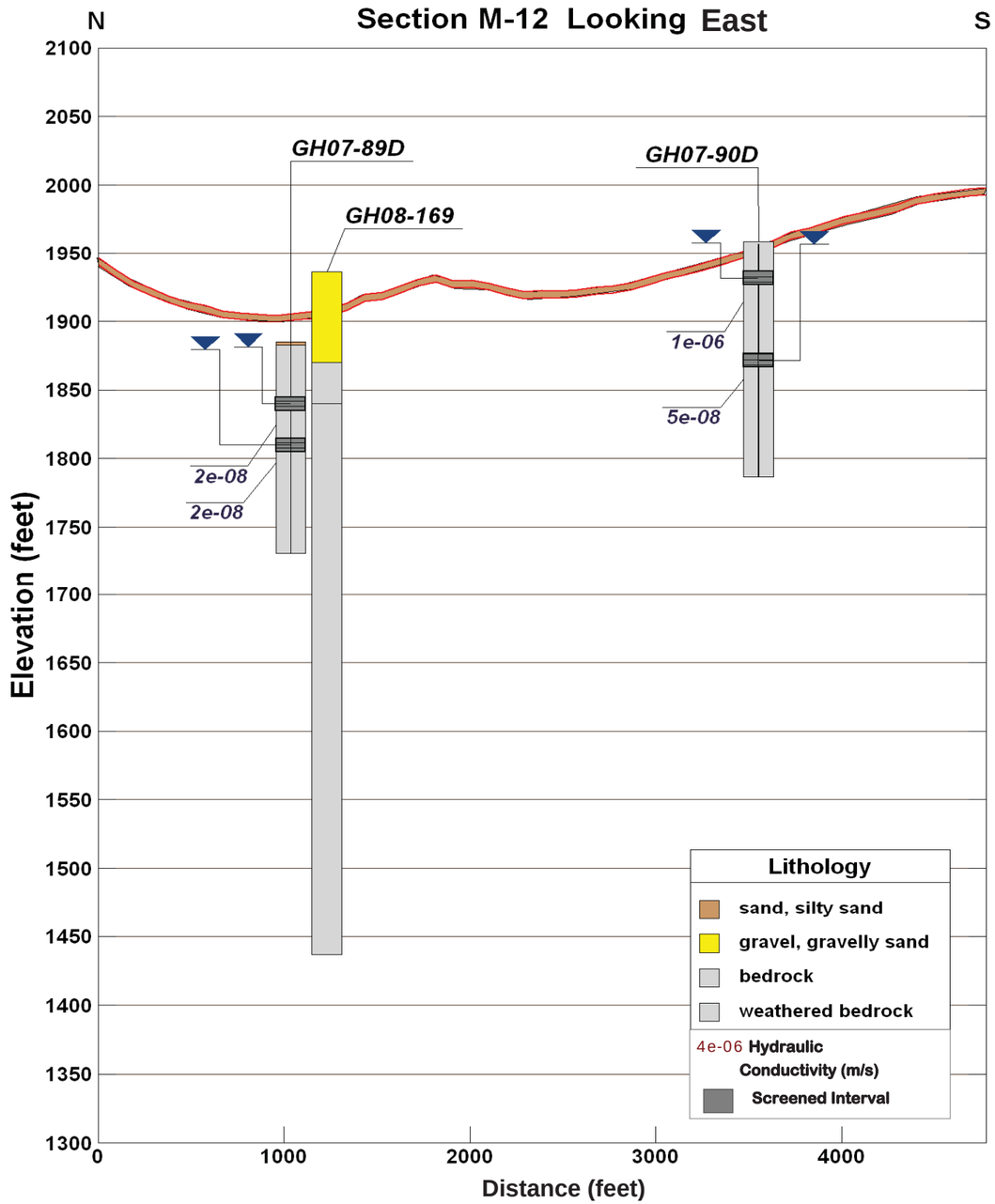


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M11**
Author: SWS-PP	Date: December 20, 2010

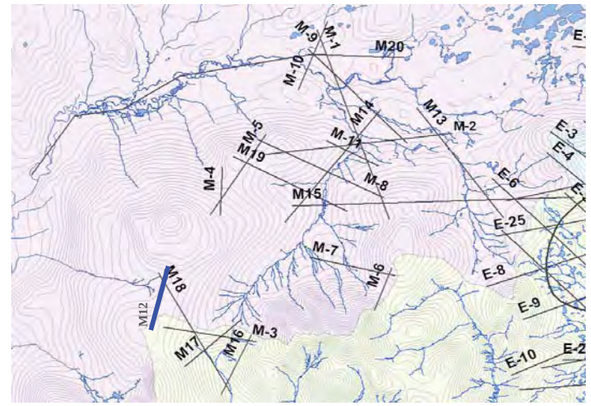
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



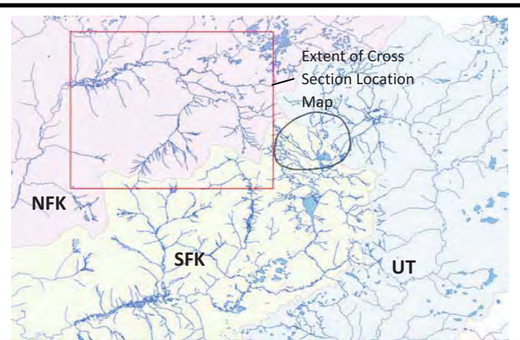
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

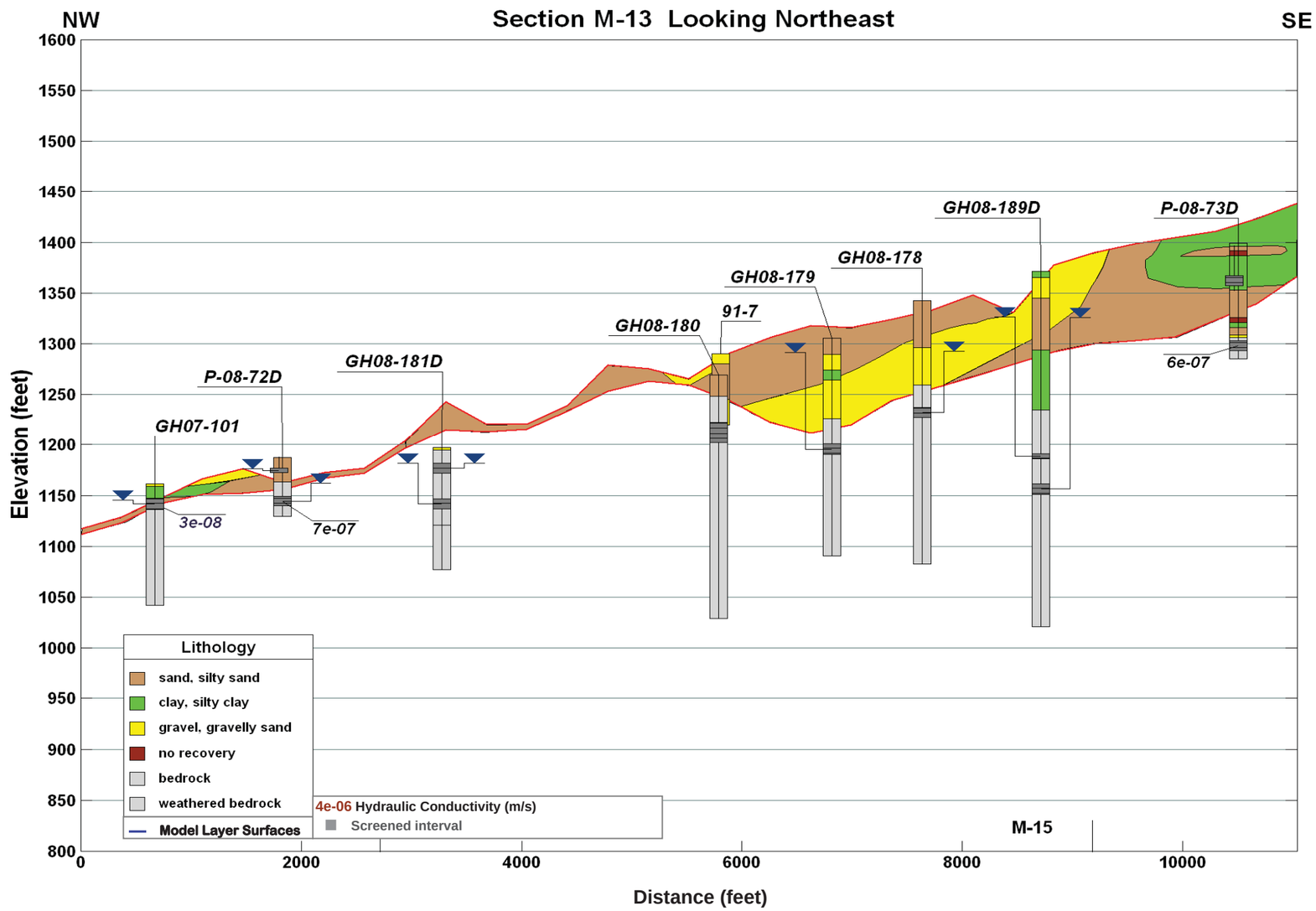


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M12**
Author: SWS-PP	Date: December 20, 2010

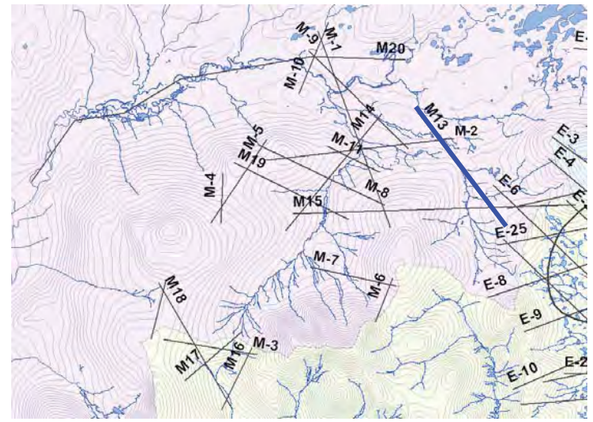
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



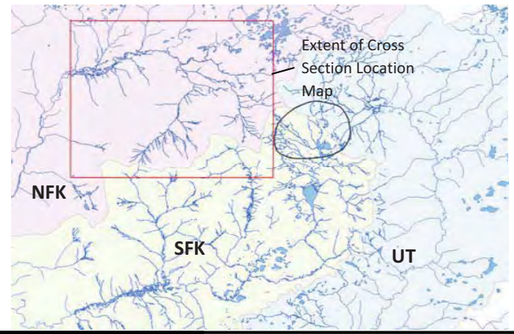
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

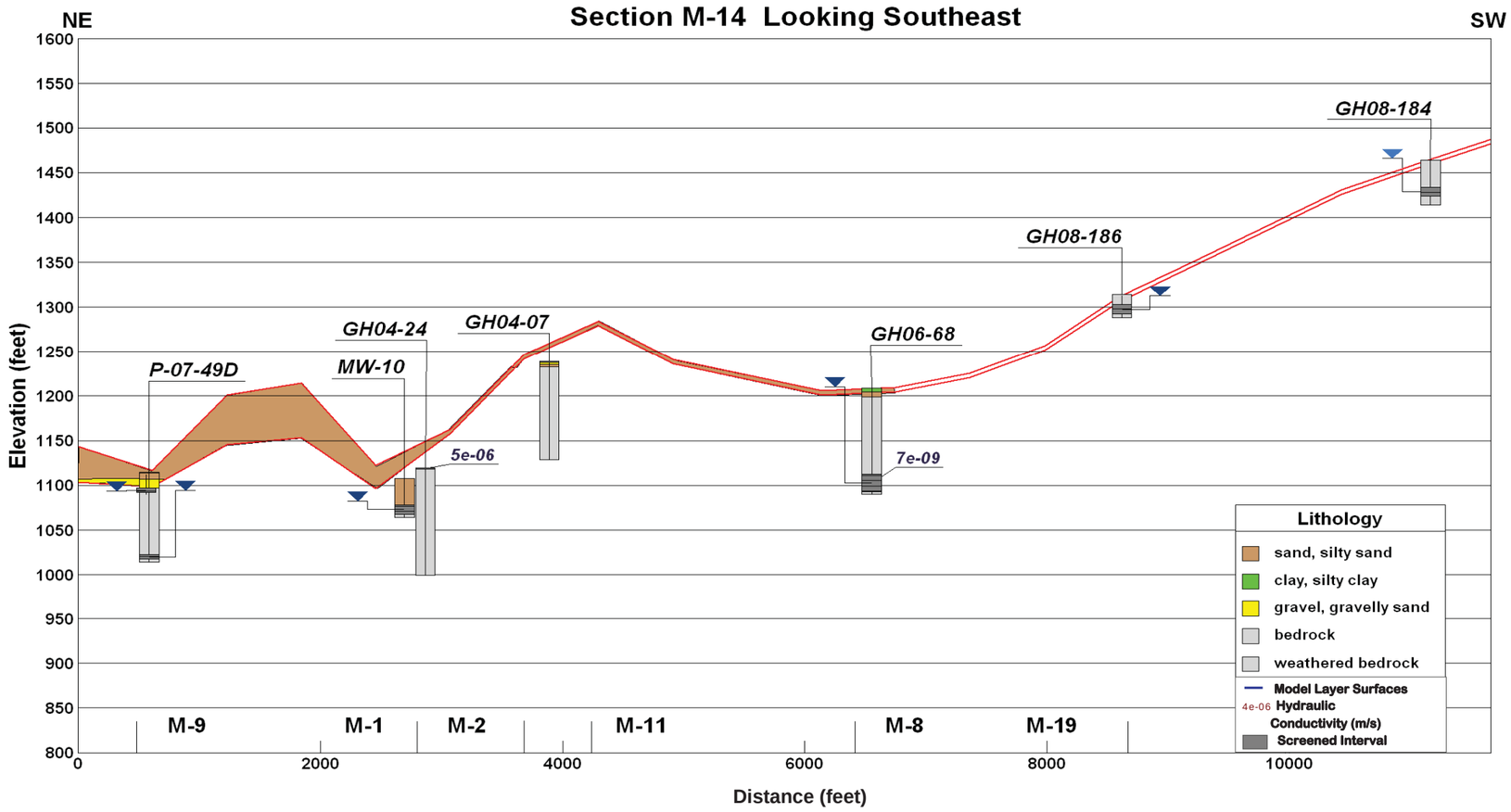


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M13**
Author: SWS-PP	Date: December 20, 2010

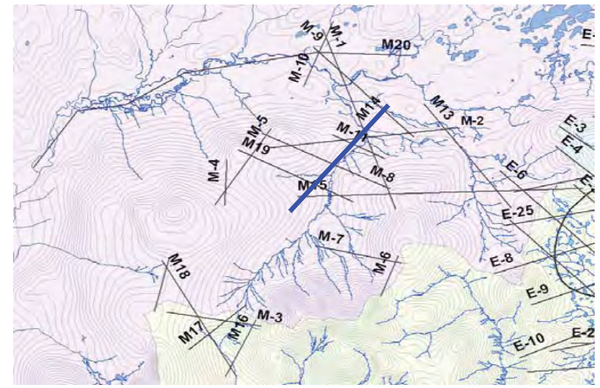
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



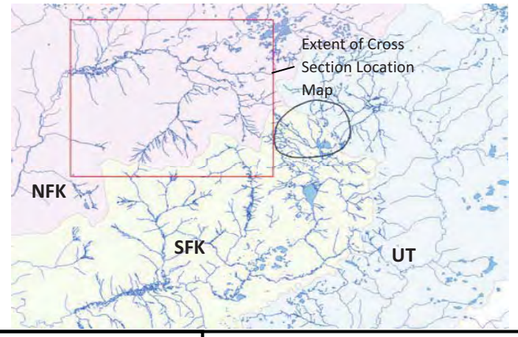
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

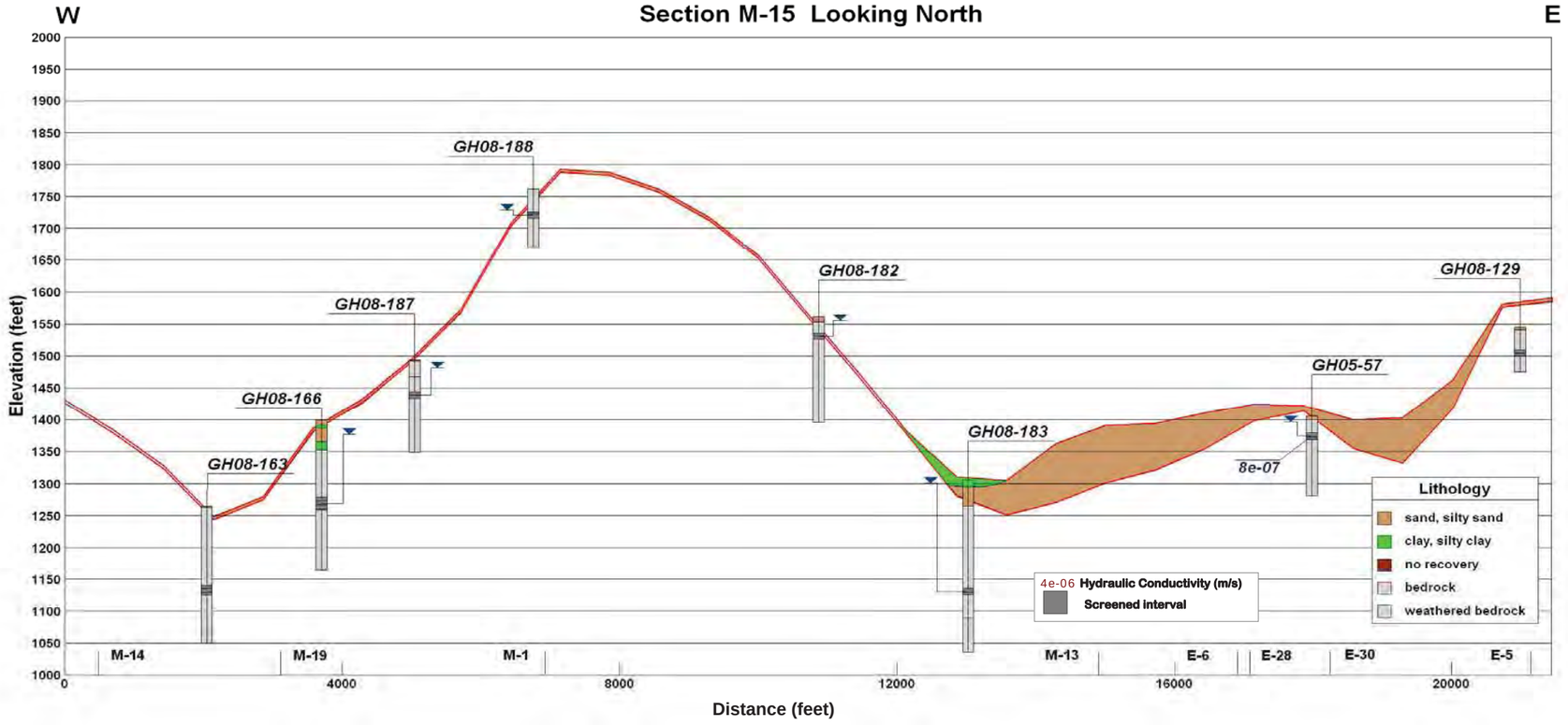


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M14**
Author: SWS-PP	Date: December 20, 2010

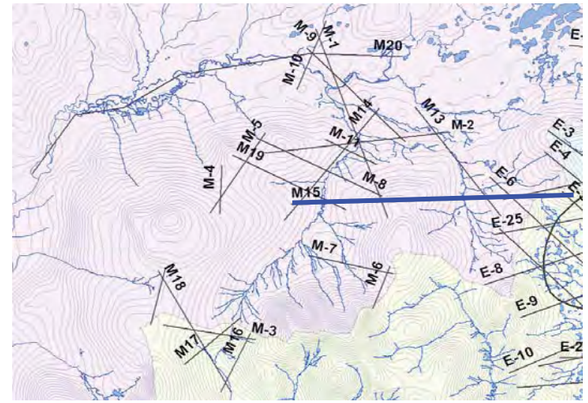
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



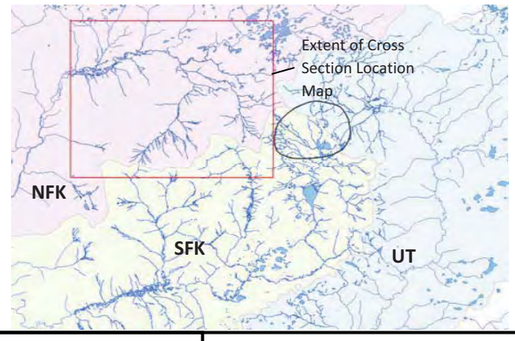
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

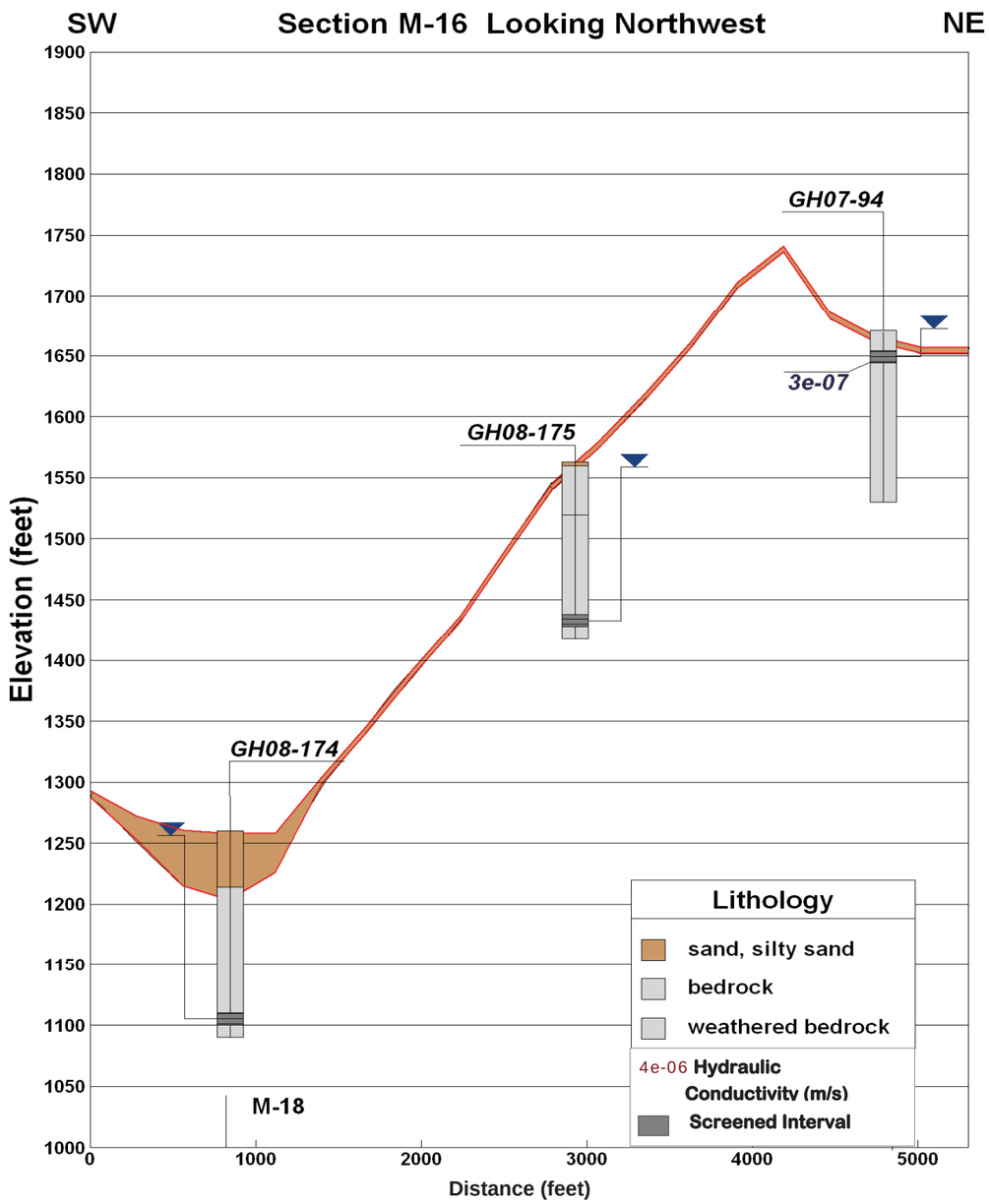


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M15**
Author: SWS-PP	Date: December 20, 2010

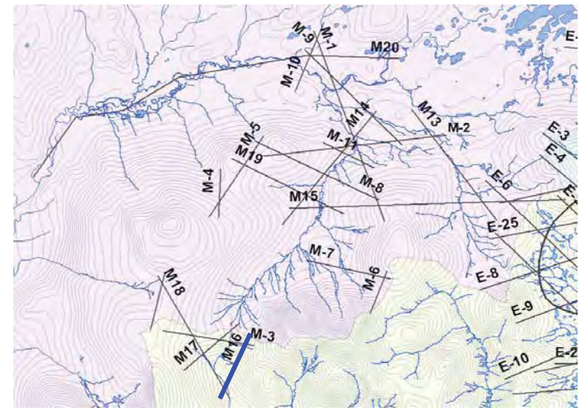
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



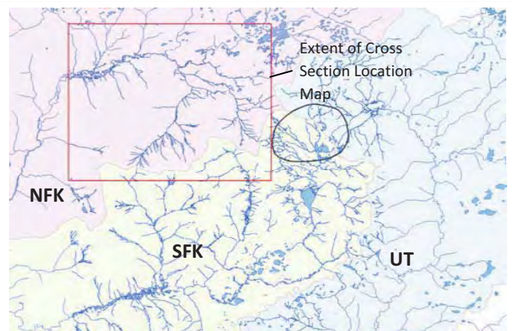
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

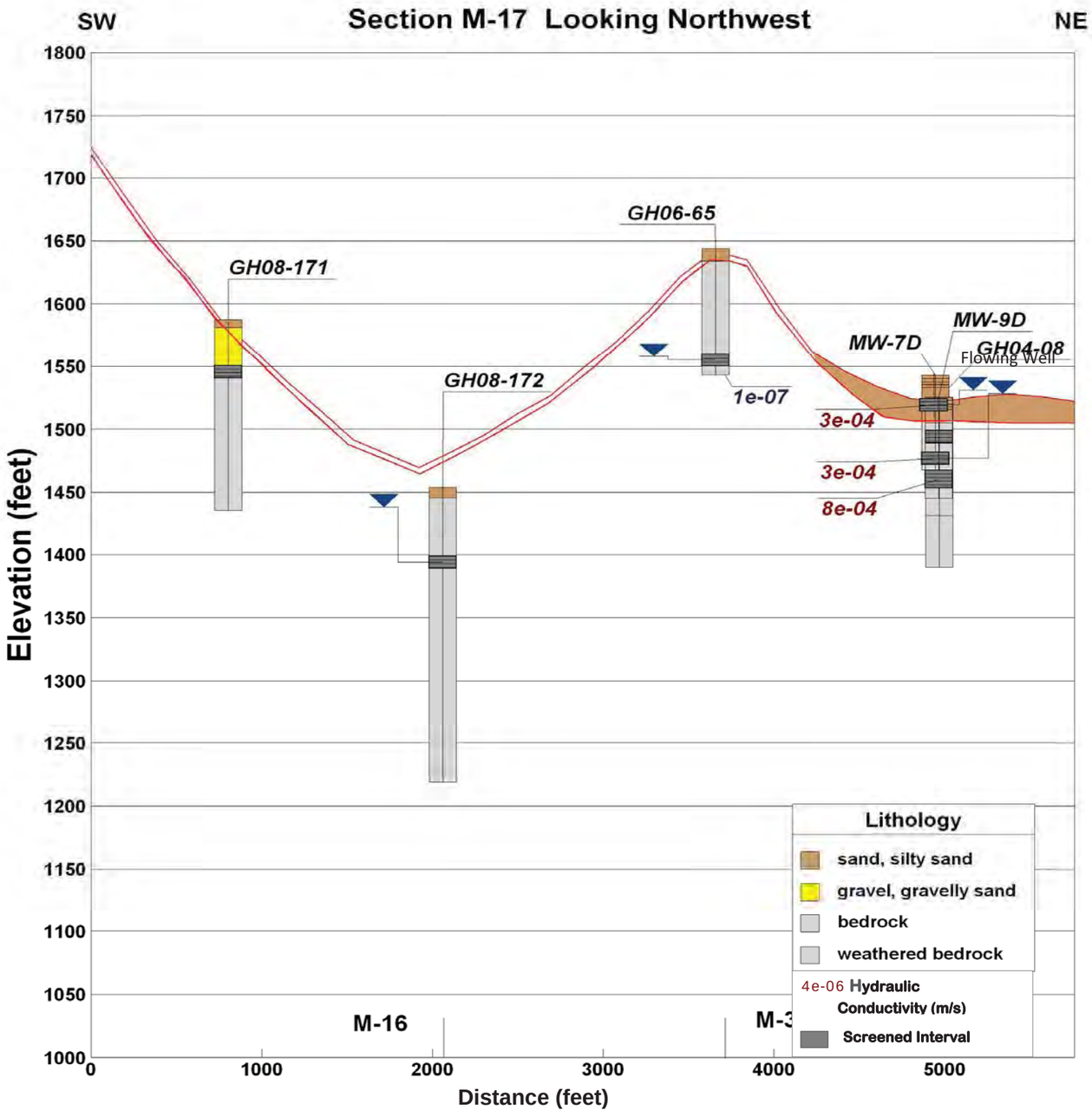


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M16**
Author: SWS-PP	Date: December 20, 2010

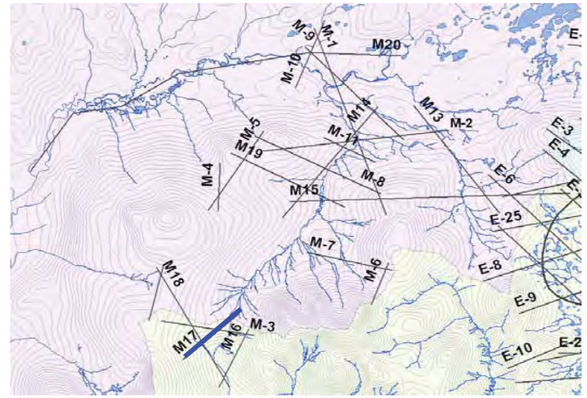
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



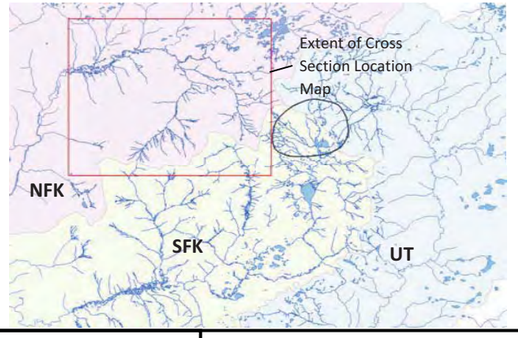
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

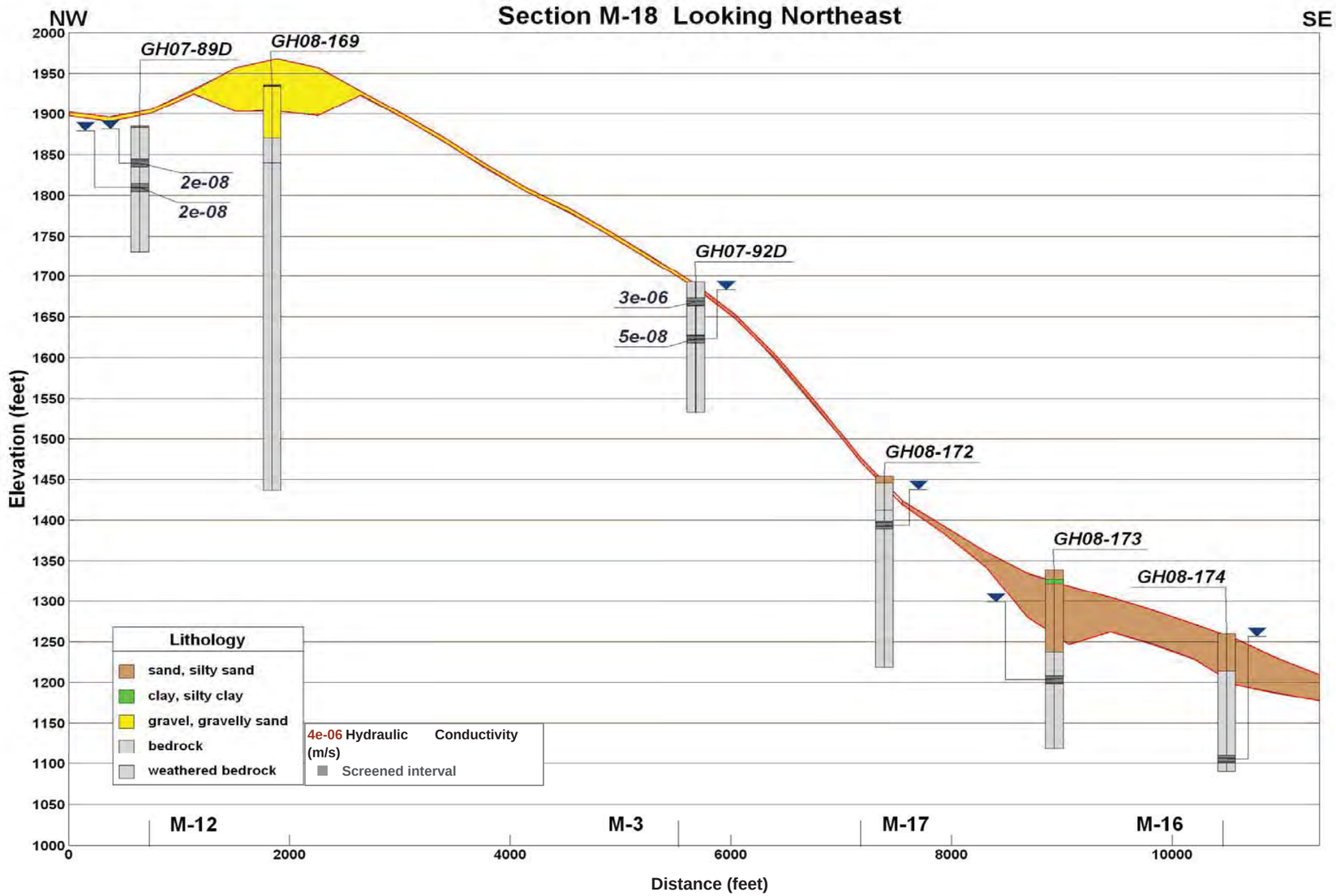


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M17**
Author: SWS-PP	Date: December 20, 2010

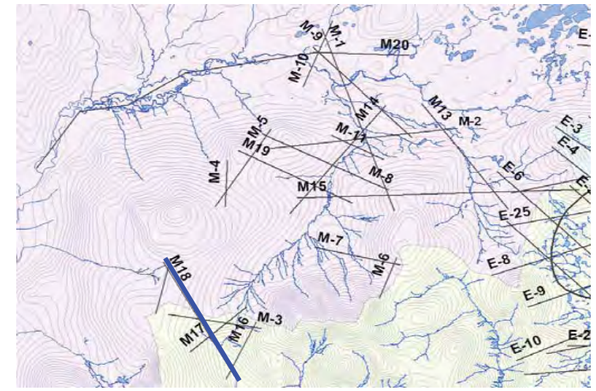
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



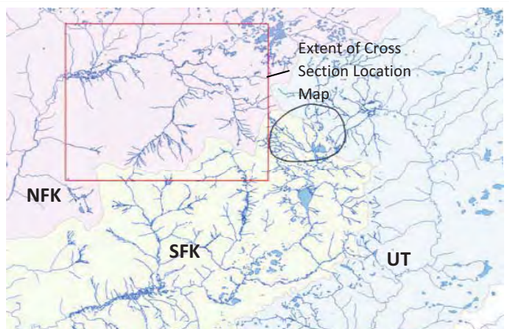
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

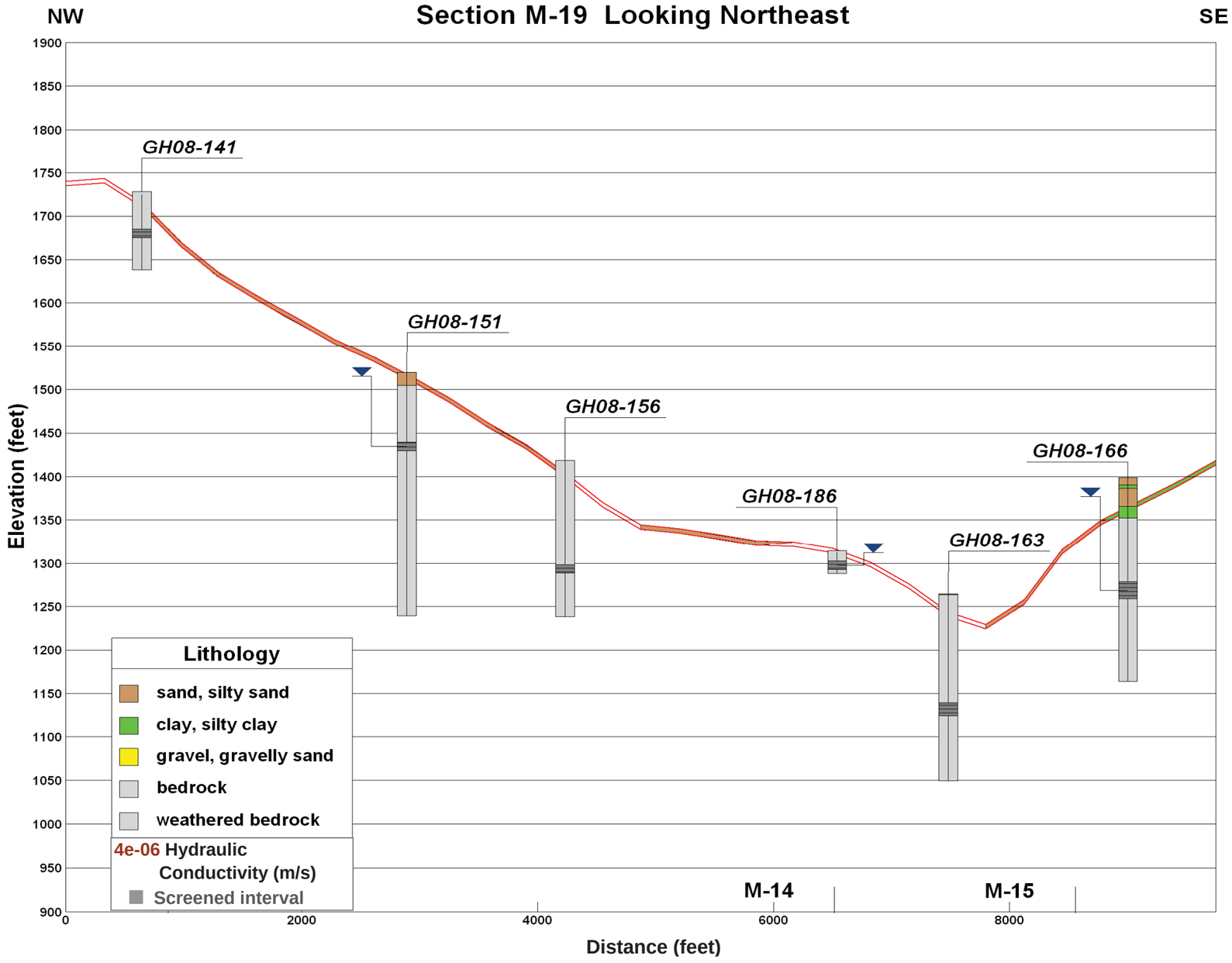


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M18**
Author: SWS-PP	Date: December 20, 2010

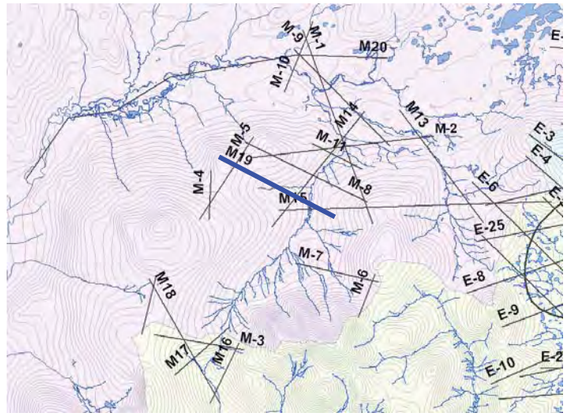
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



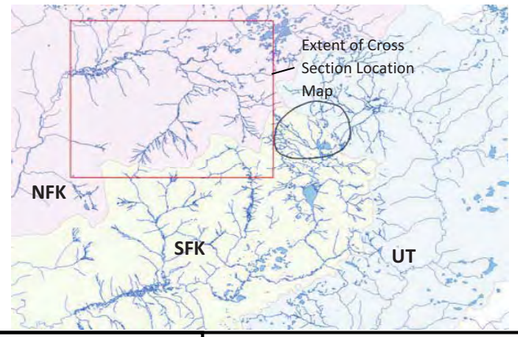
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

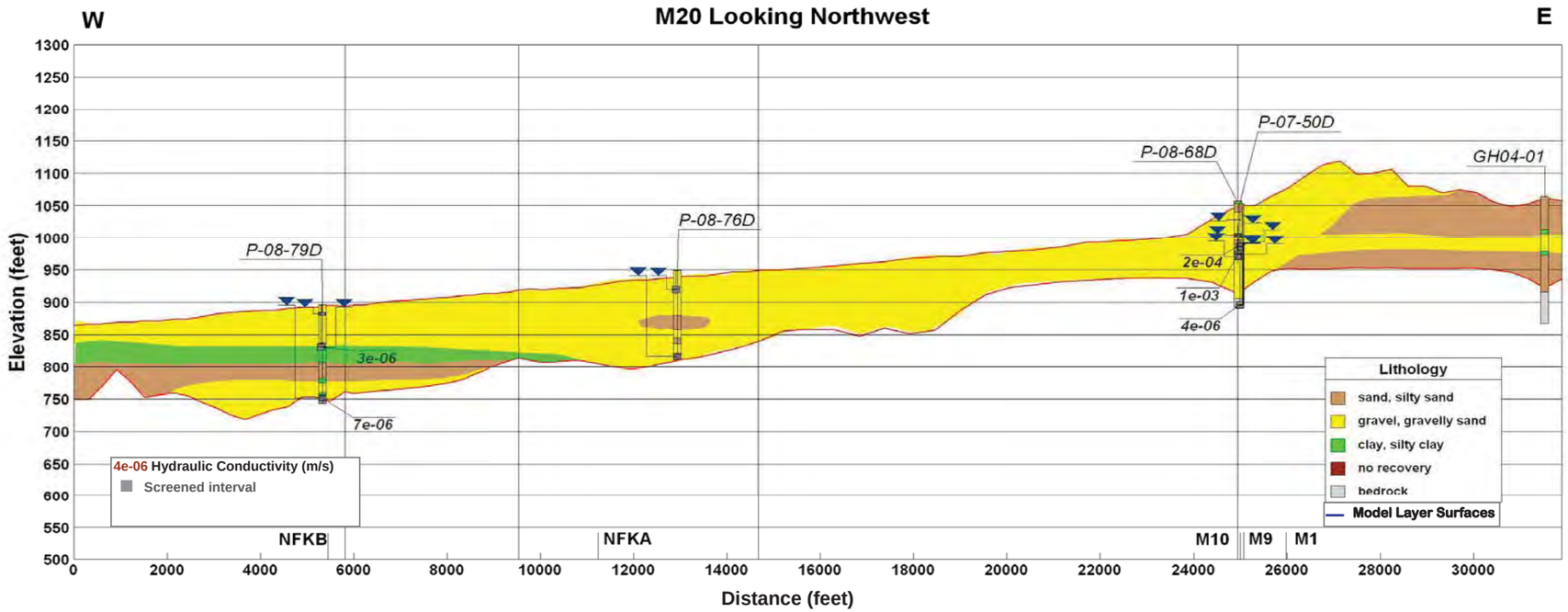


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M19**
Author: SWS-PP	Date: December 20, 2010

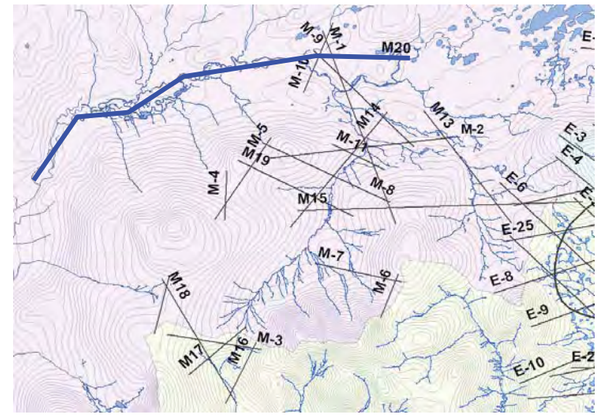
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



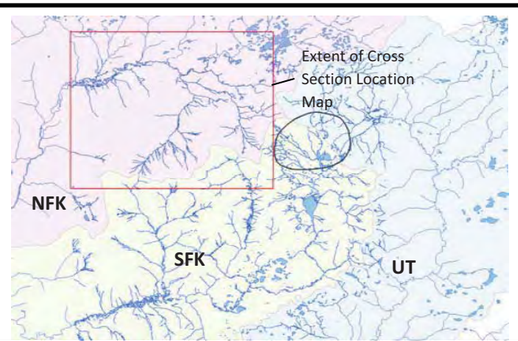
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

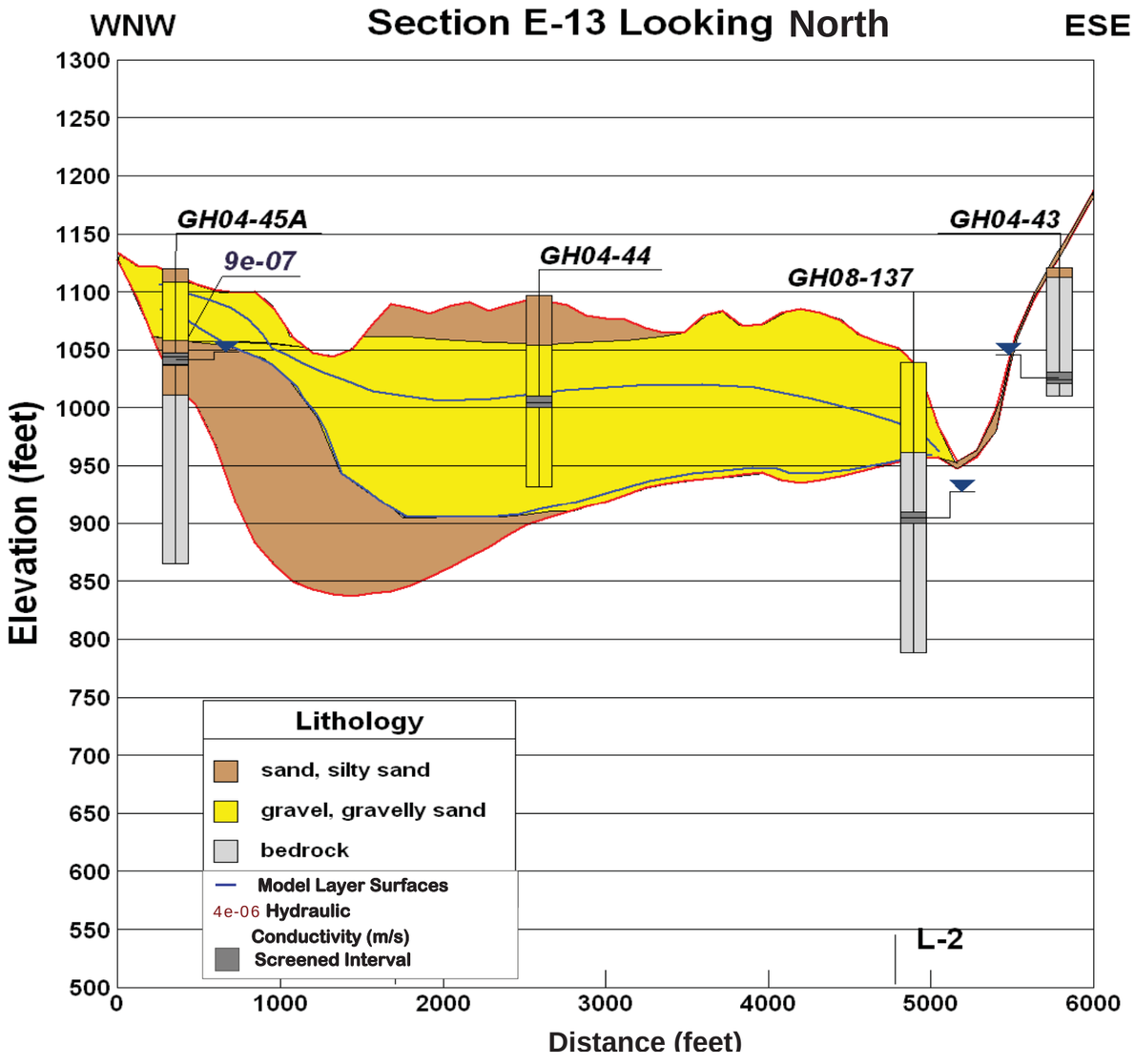


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section-M20**
Author: SWS-PP	Date: December 20, 2010

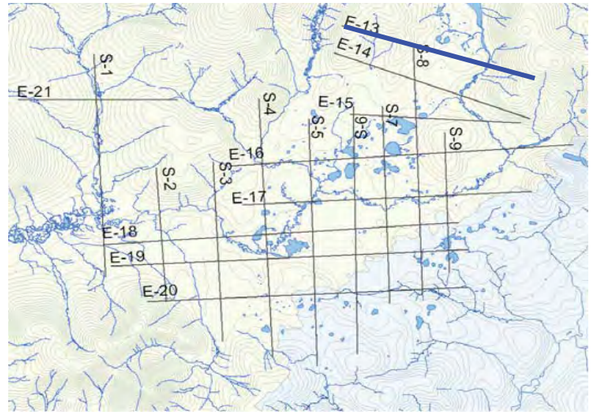
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



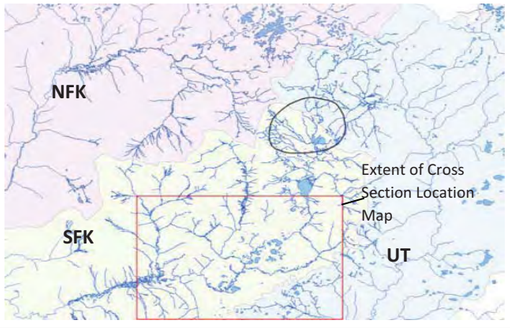
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

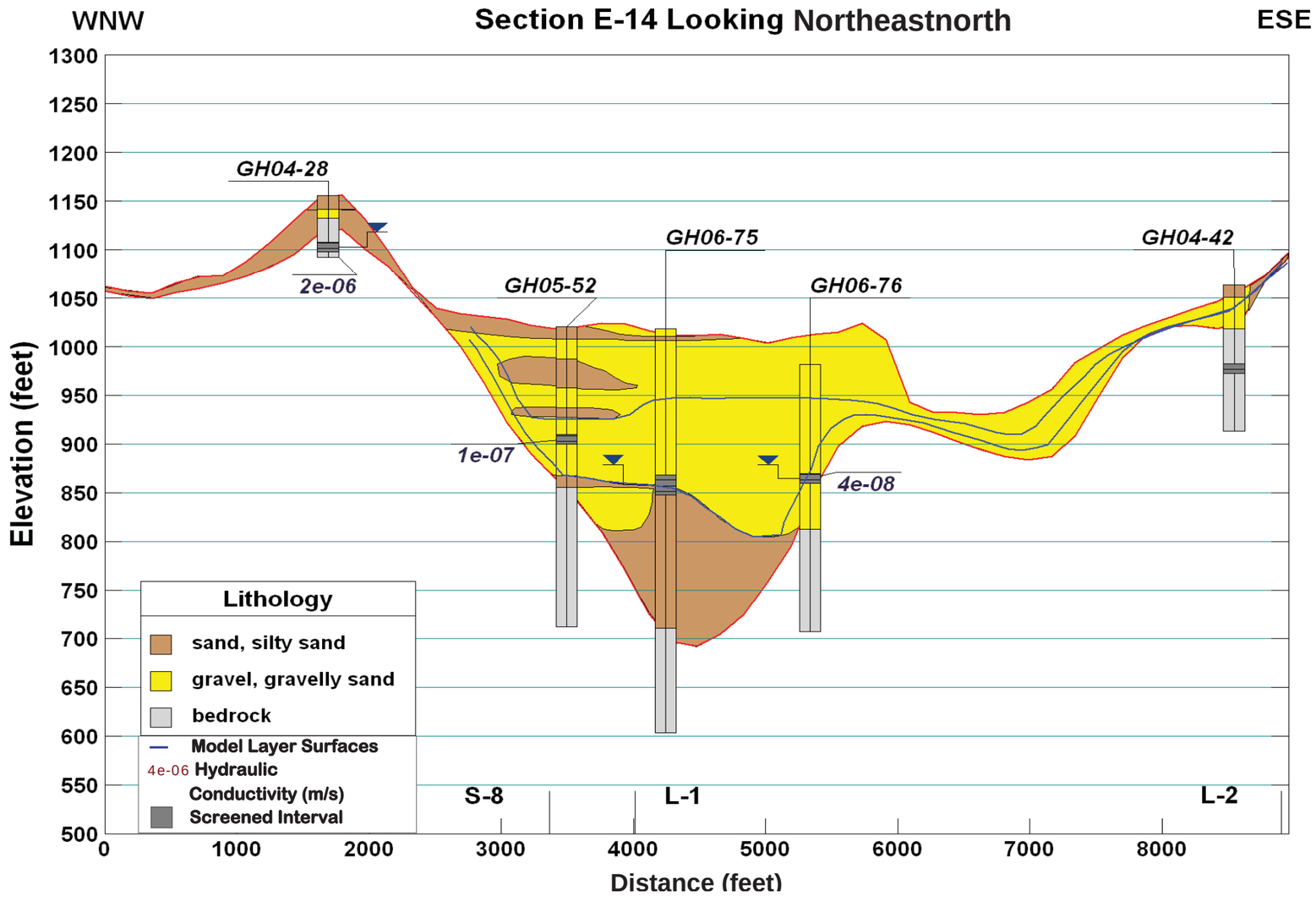


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-13**
Author: SWS-PP	Date: December 20, 2010

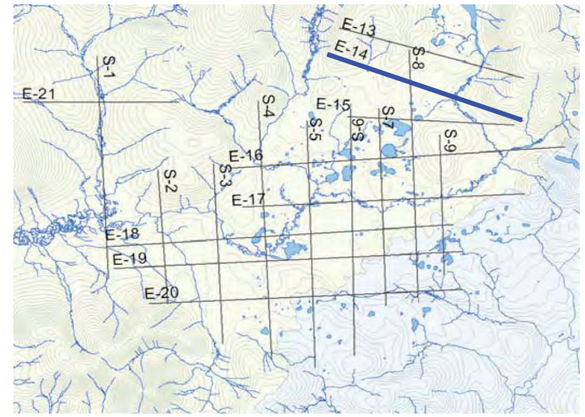
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



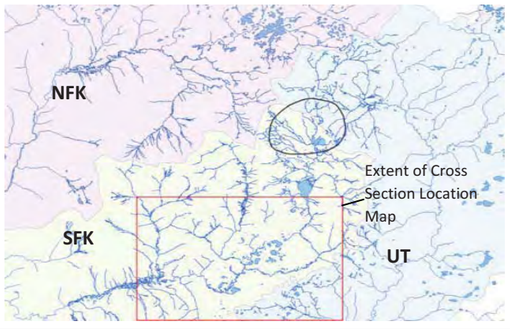
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

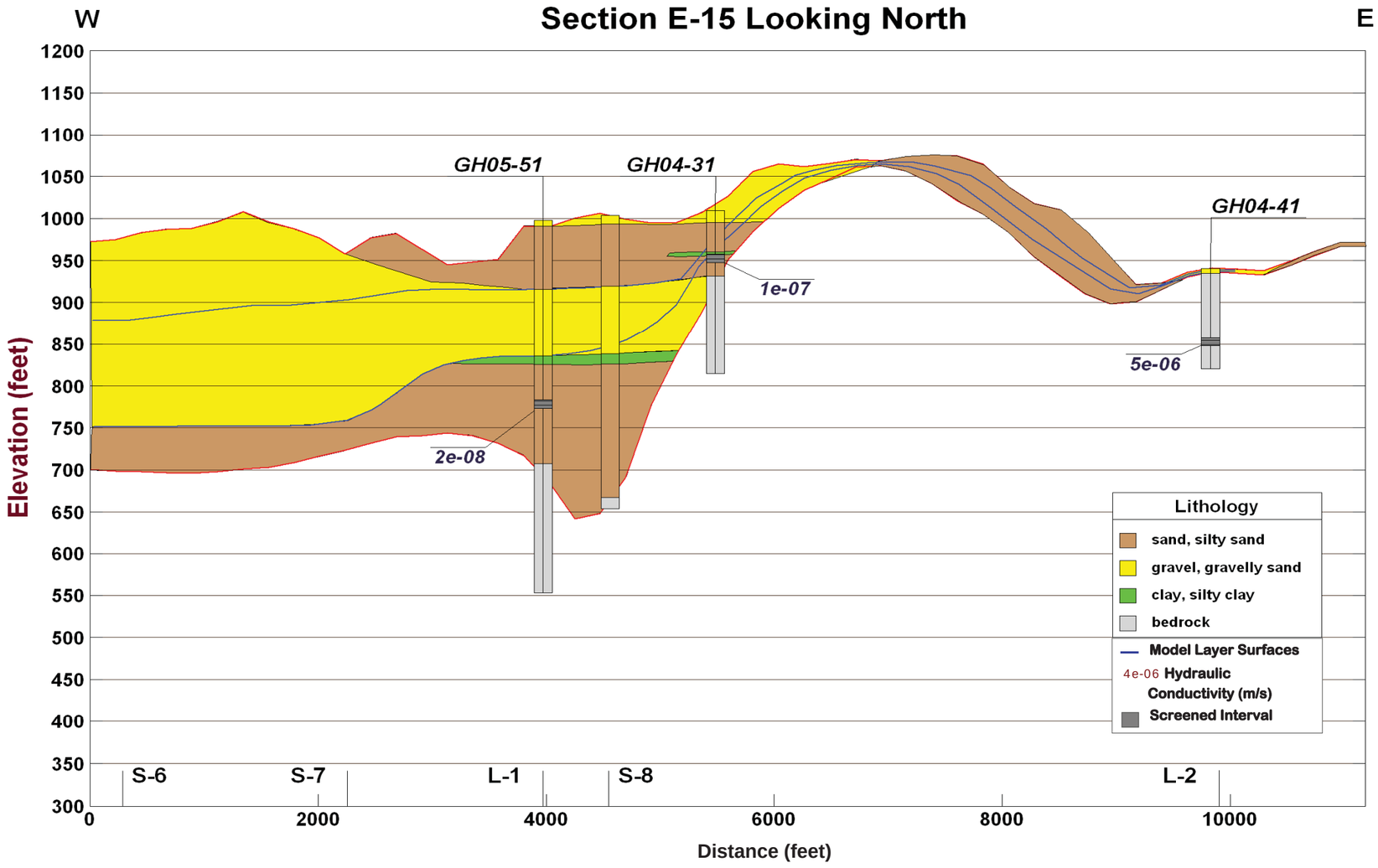


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-14**
Author: SWS-PP	Date: December 20, 2010

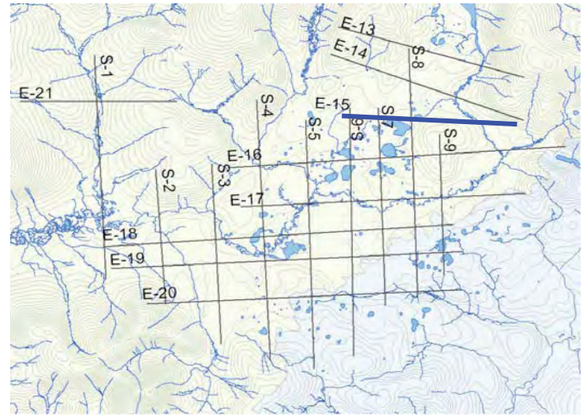
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



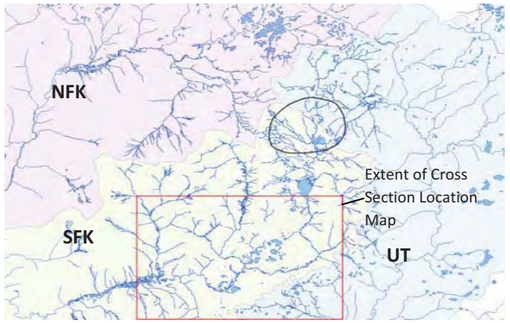
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

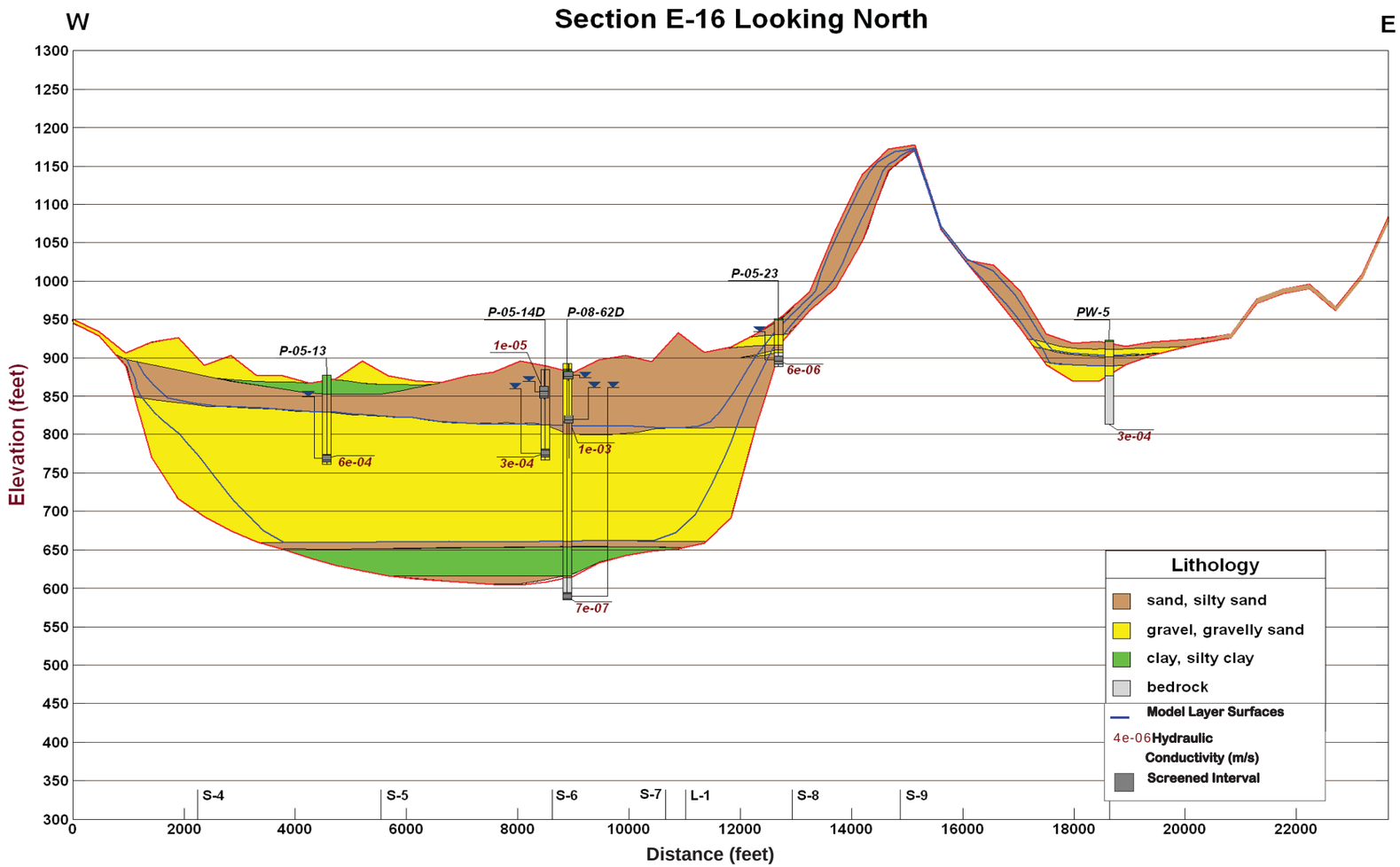


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-15**
Author: SWS-PP	Date: December 20, 2010

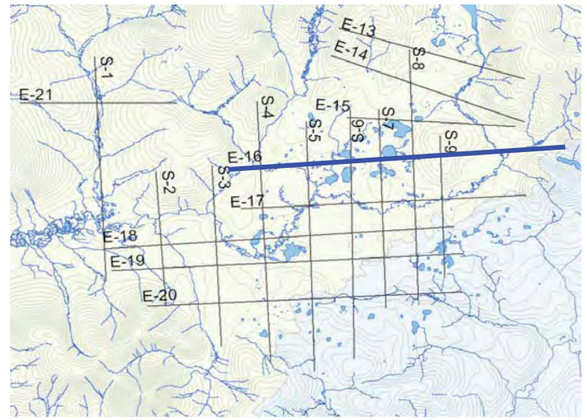
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



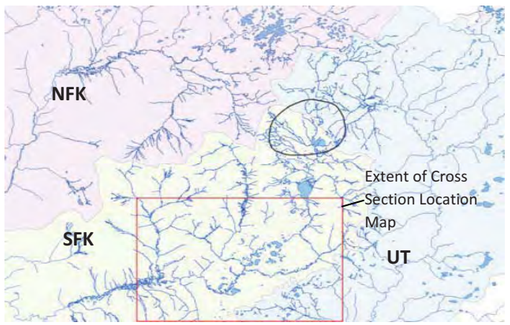
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

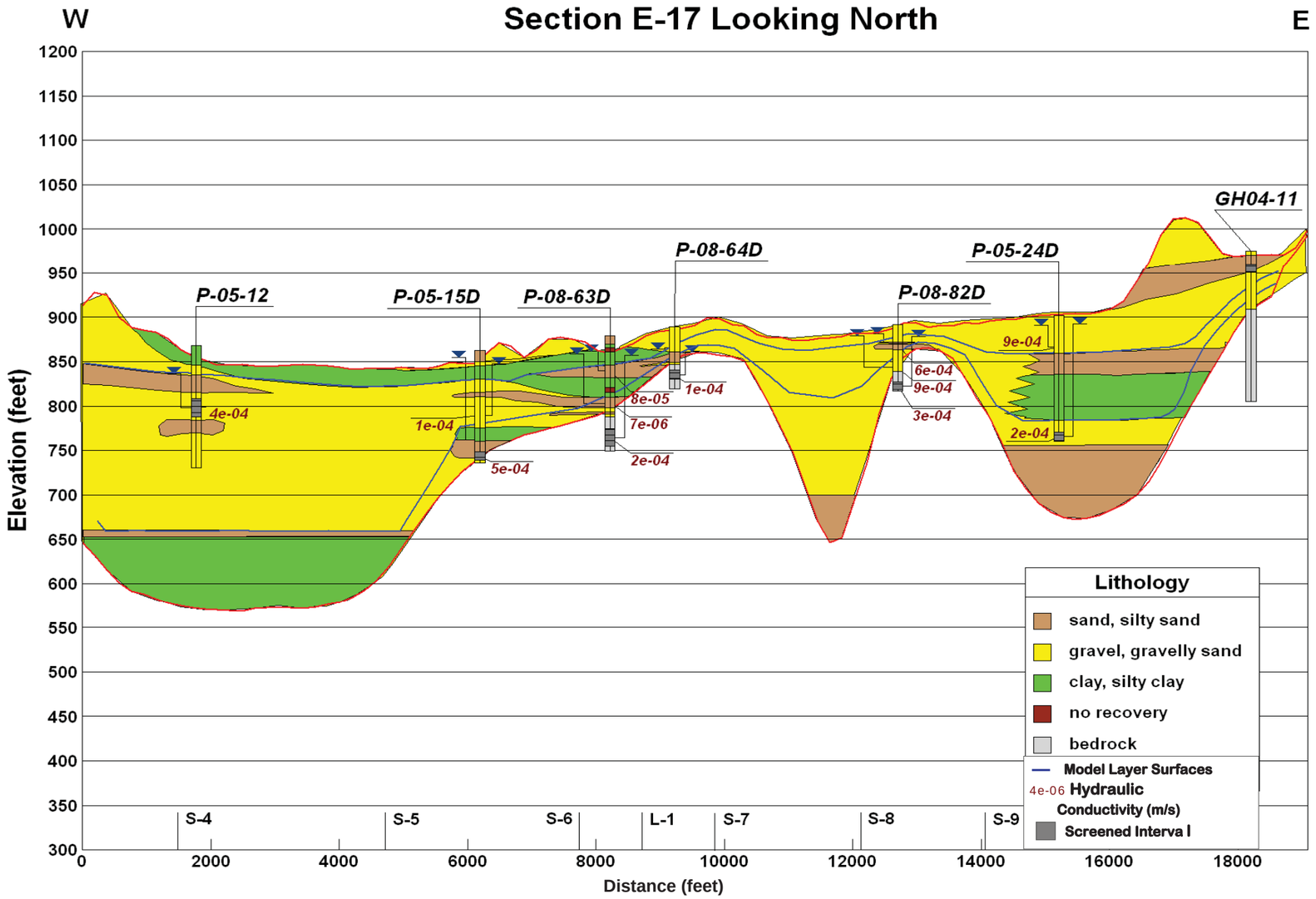


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-16**
Author: SWS-PP	Date: December 20, 2010

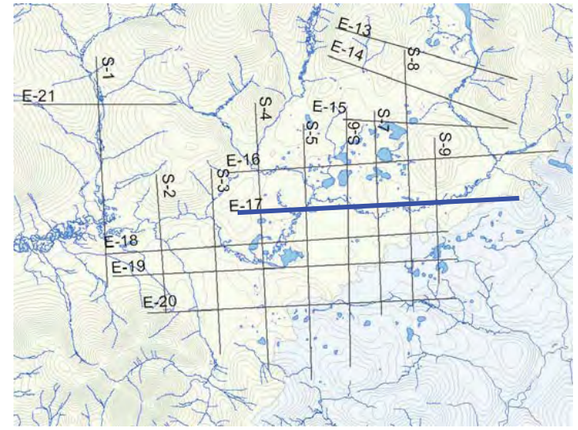
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



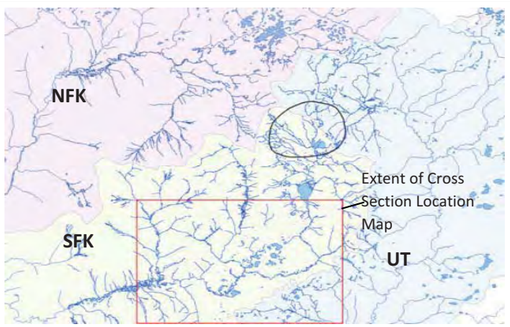
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

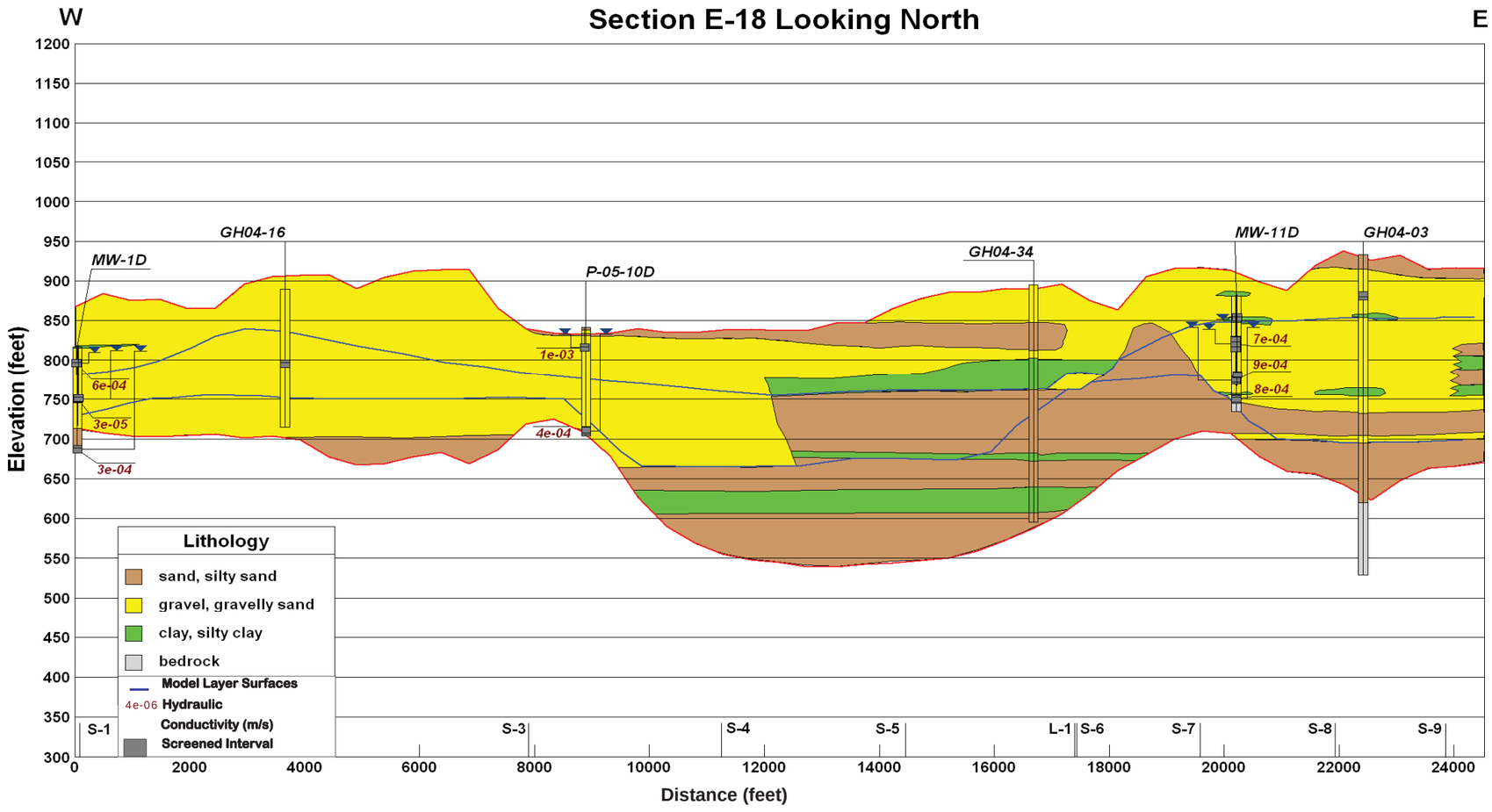


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-17**
Author: SWS-PP	Date: December 20, 2010

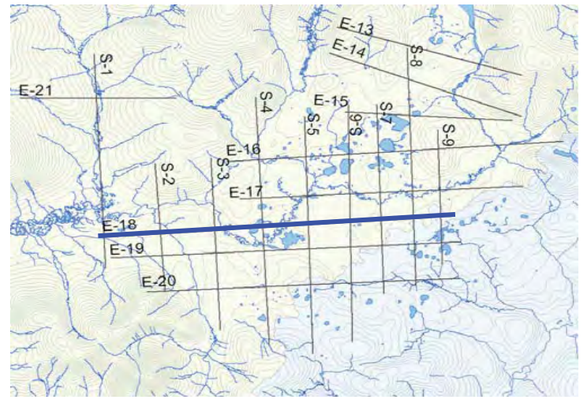
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



THE pebble PARTNERSHIP

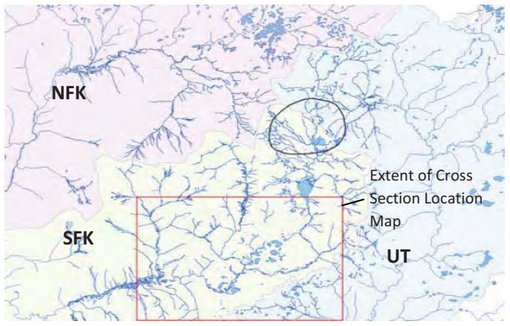
Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



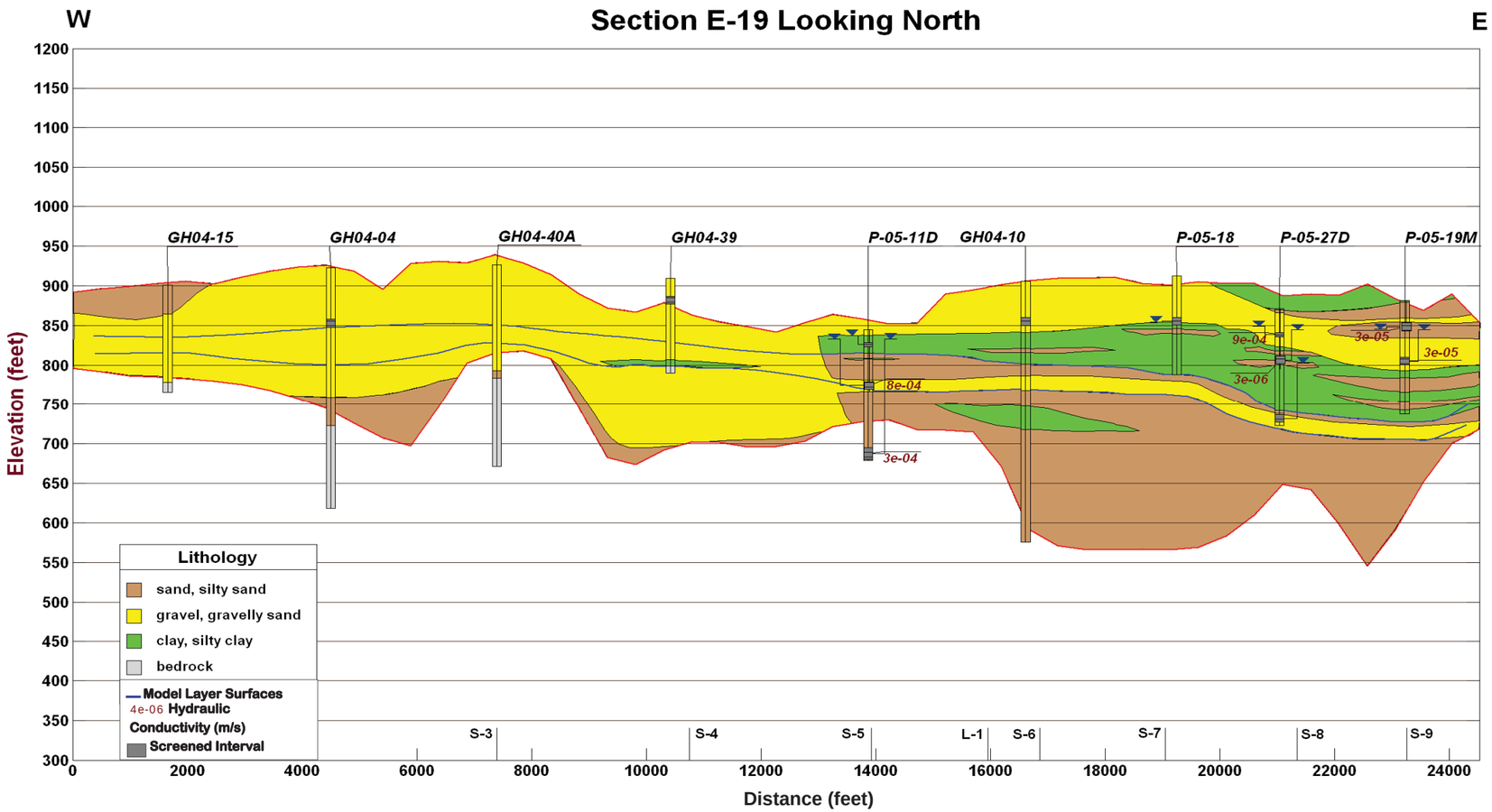
Notes:

1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



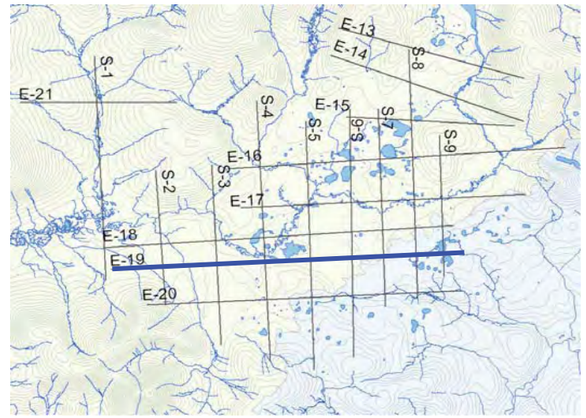
Project No: 7126	**Section E-18**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

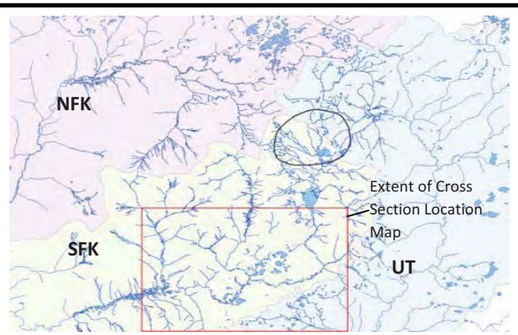


Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

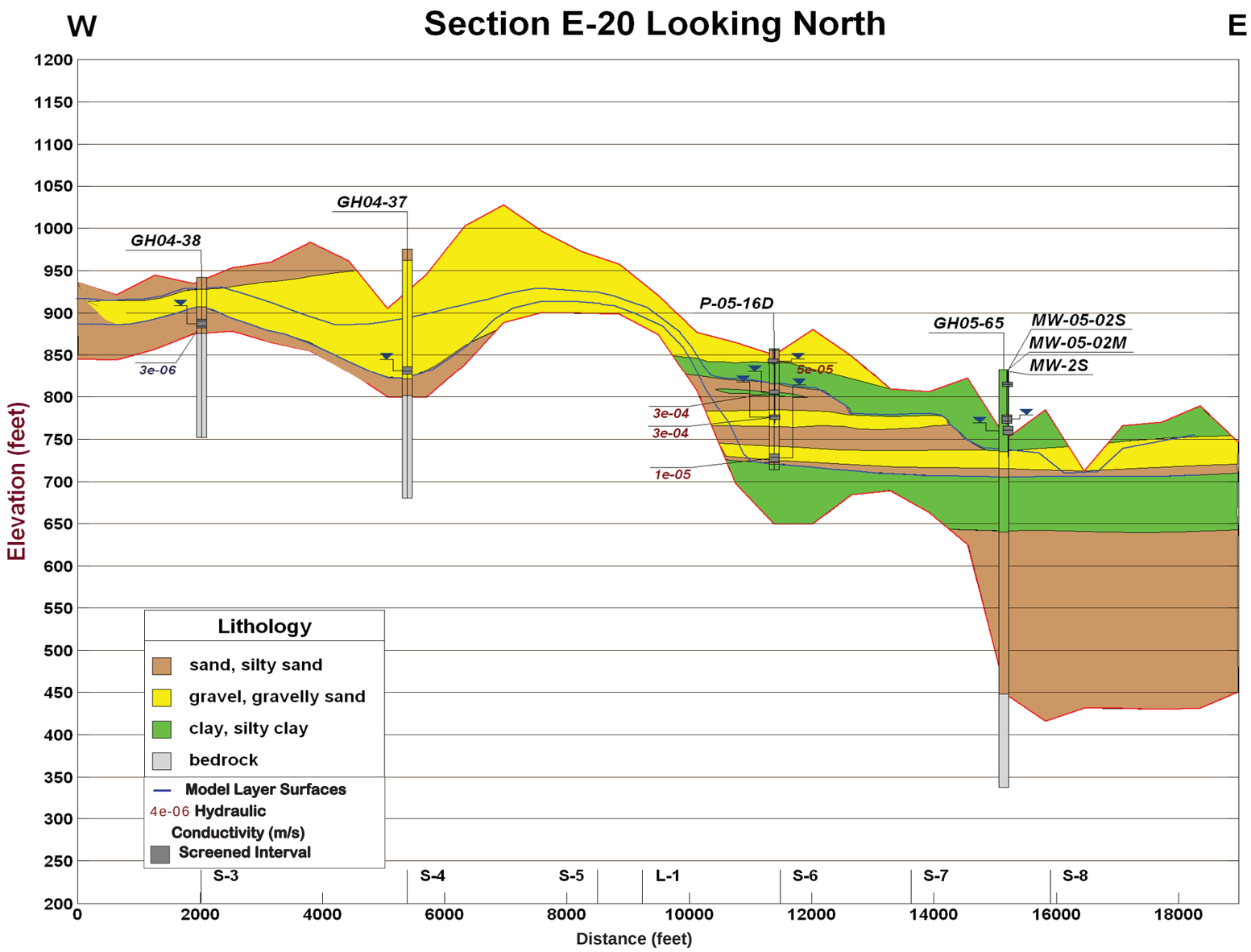


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-19**
Author: SWS-PP	Date: December 20, 2010

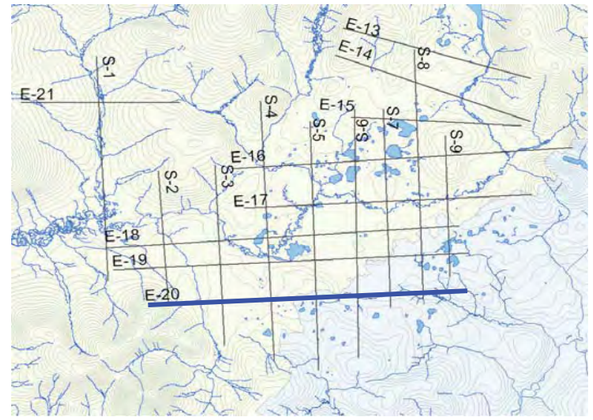
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



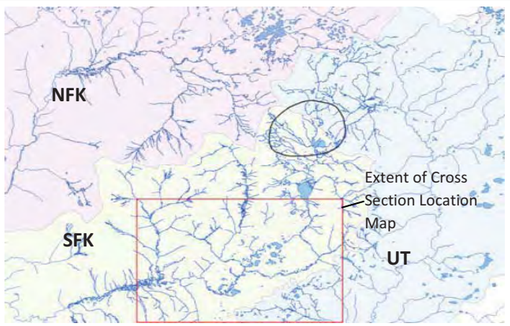
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

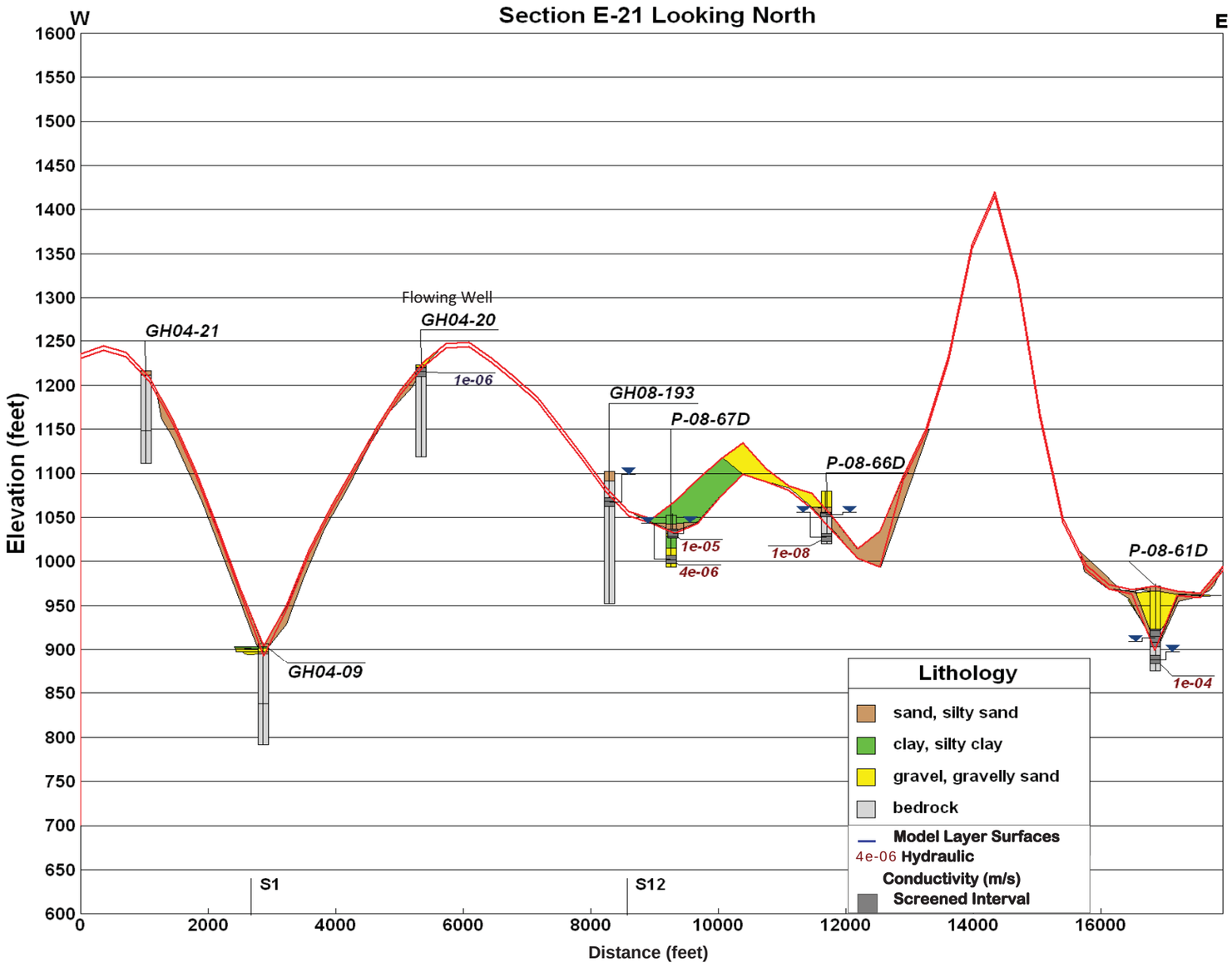


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section E-20**
Author: SWS-PP	Date: December 20, 2010

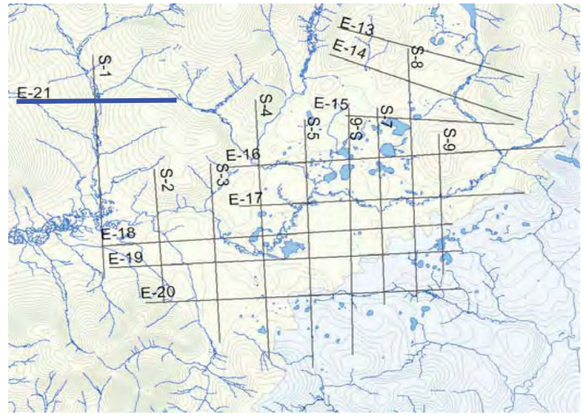
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



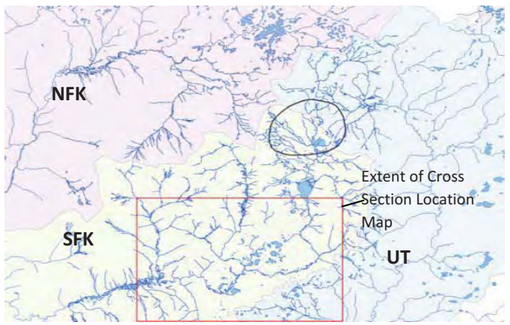
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

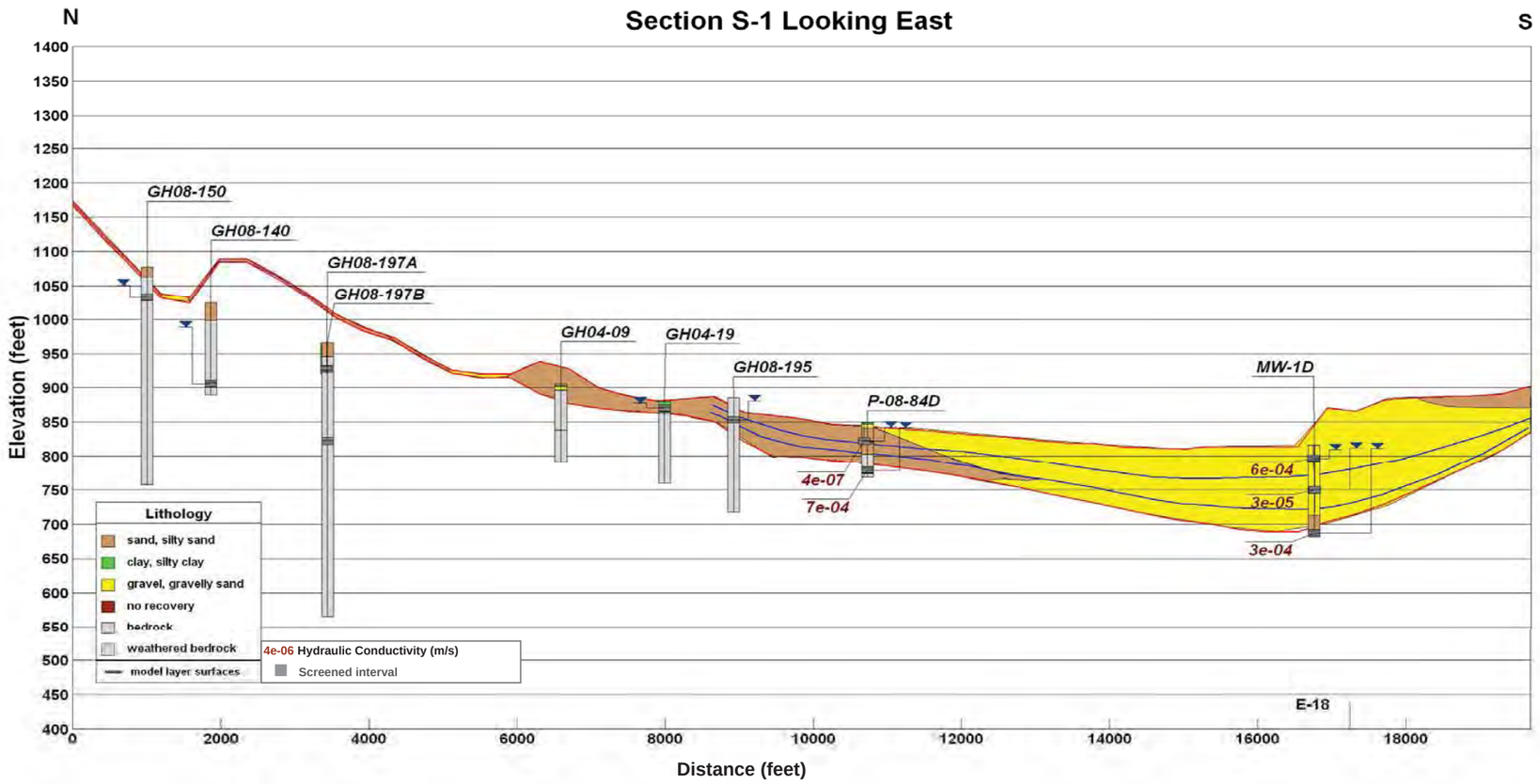


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



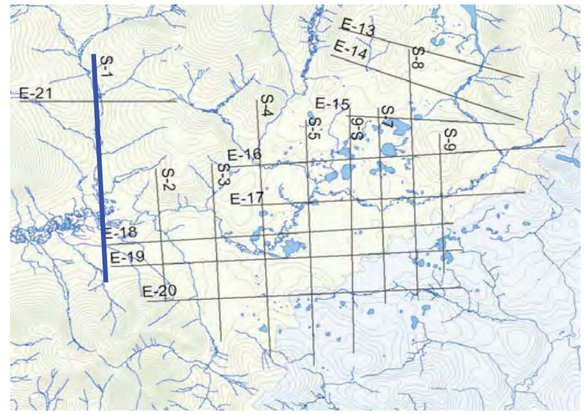
Project No: 7126	**Section E-21**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

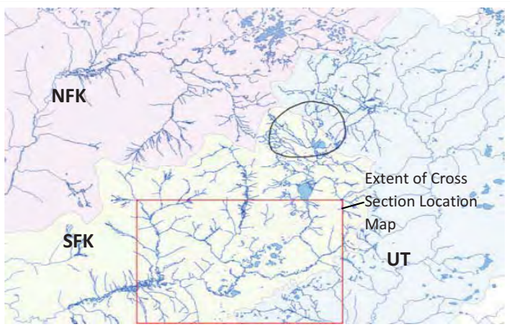


Appendix 8.1B
Geologic Cross Sections

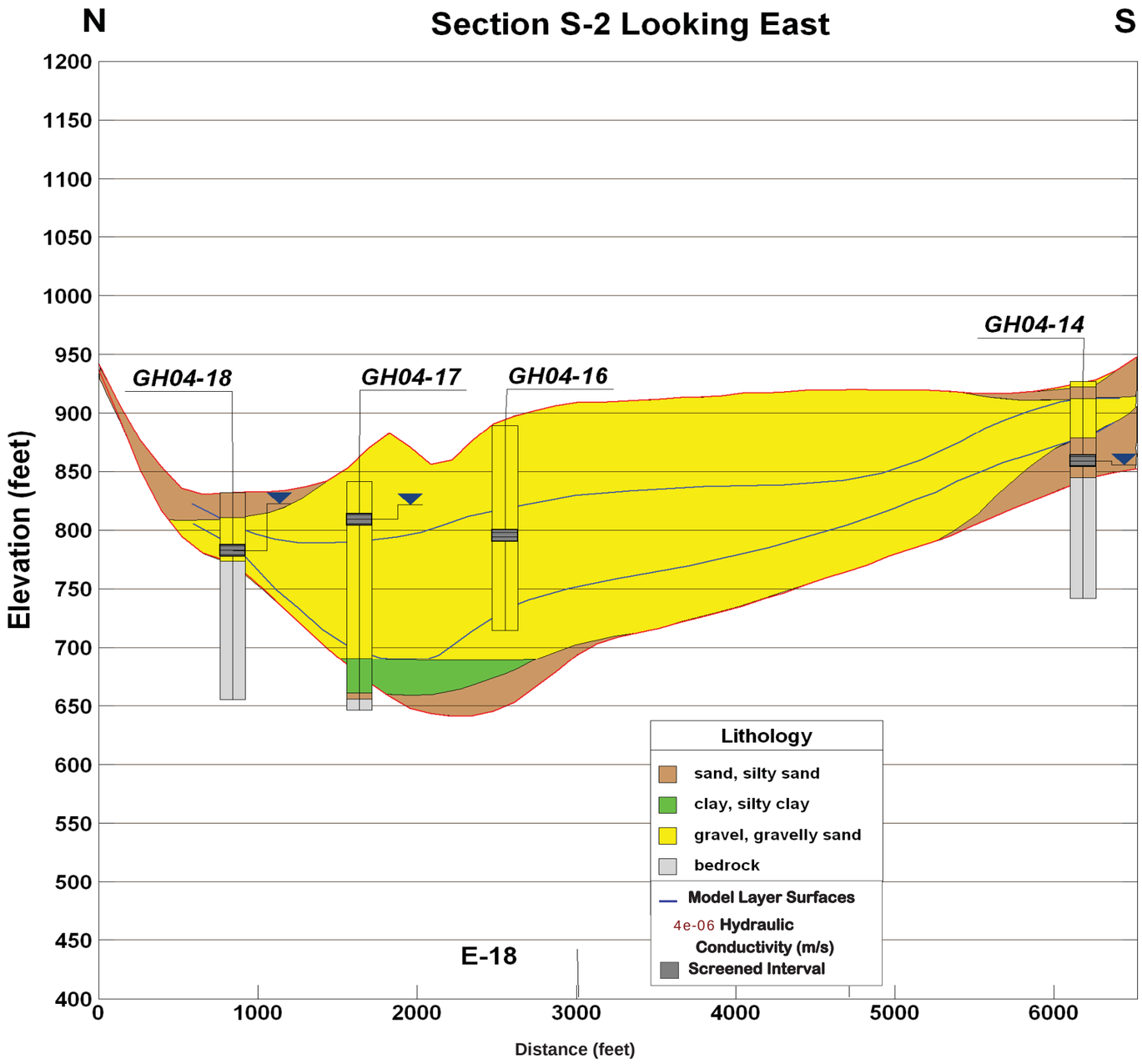
Cross Section Location Map



Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



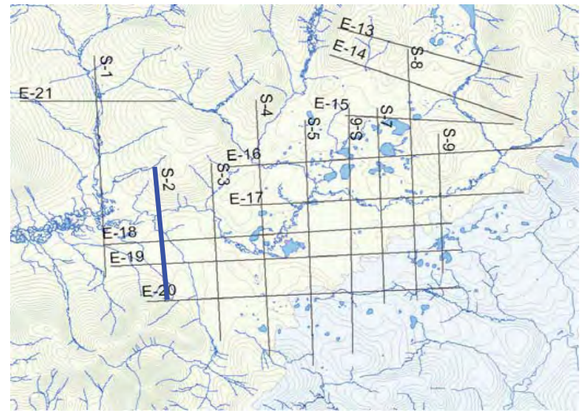
Project No: 7126	**Section S-1**
Author: SWS-PP	Date: December 20, 2010



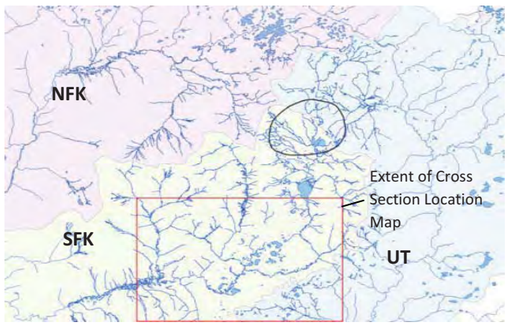
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

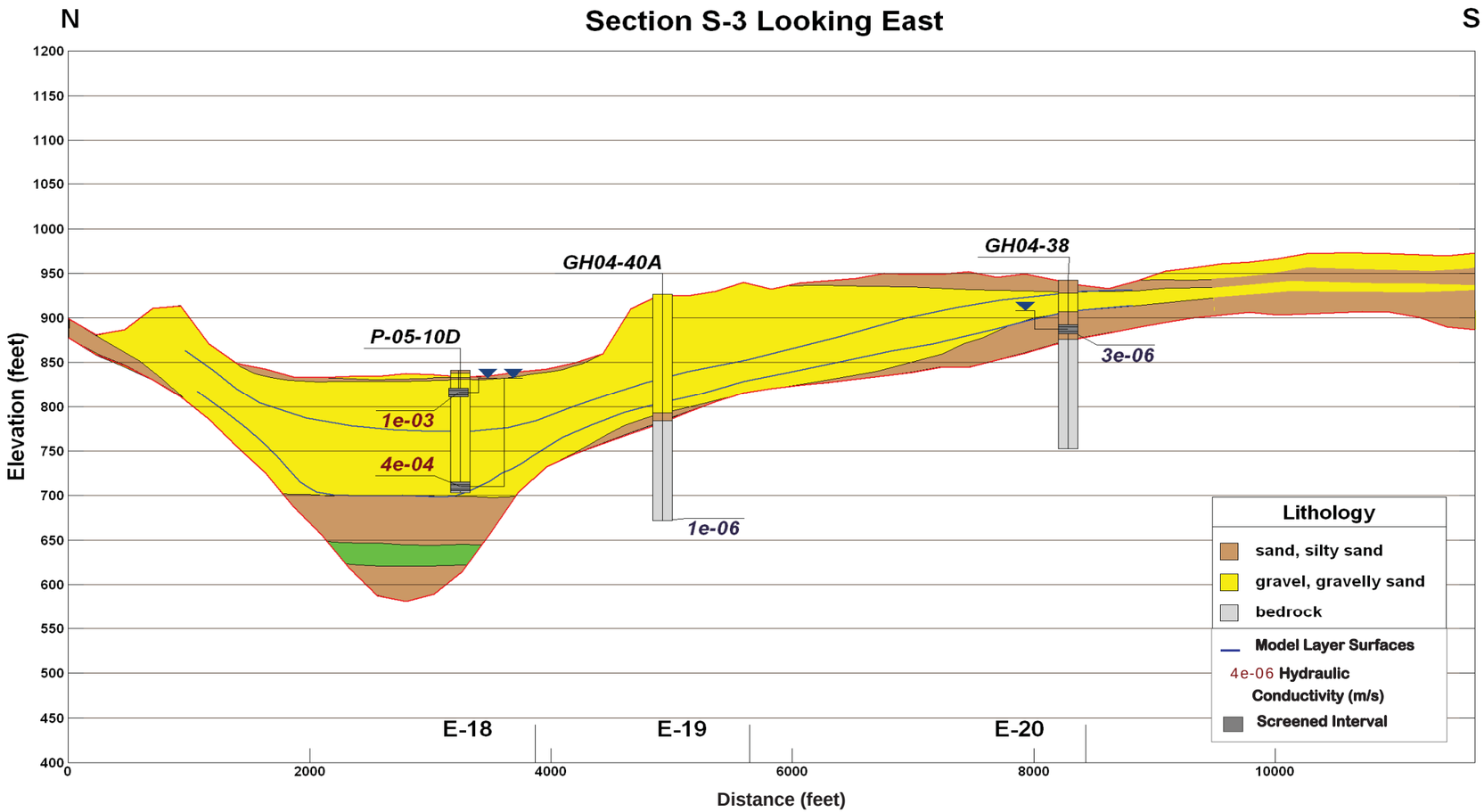


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-2**
Author: SWS-PP	Date: December 20, 2010

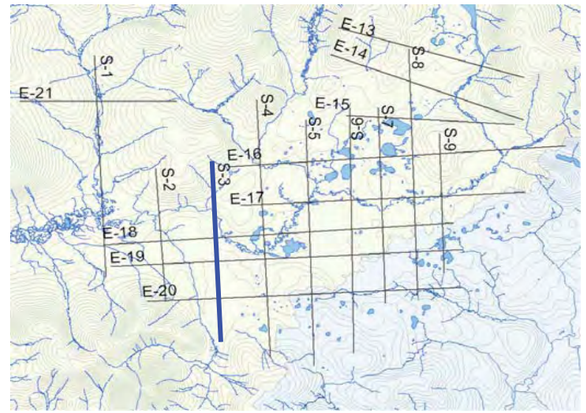
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



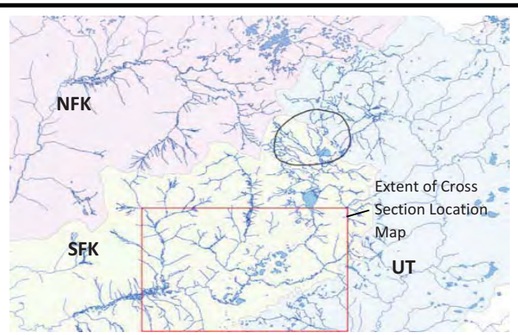
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

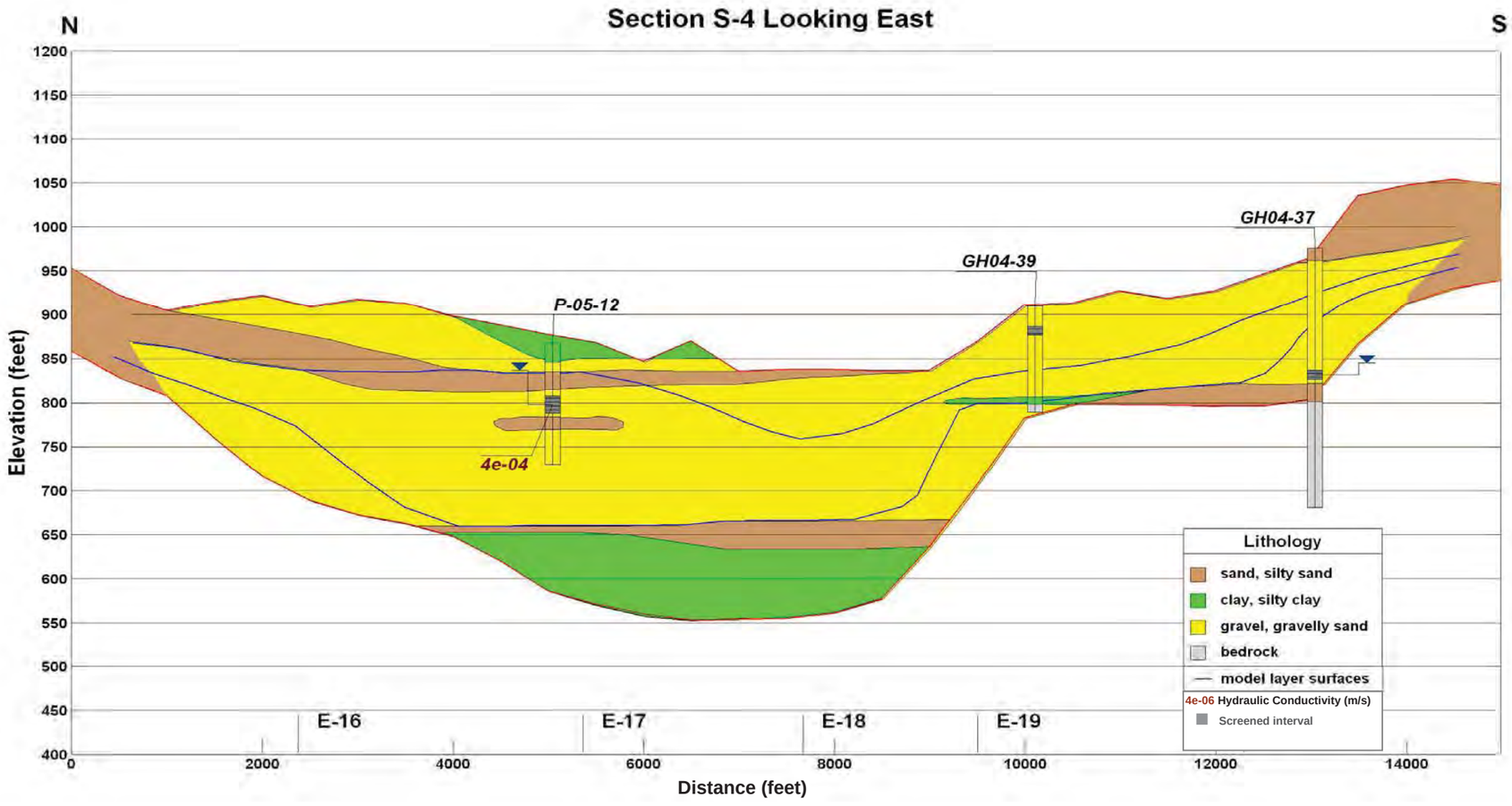


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-3**
Author: SWS-PP	Date: December 20, 2010

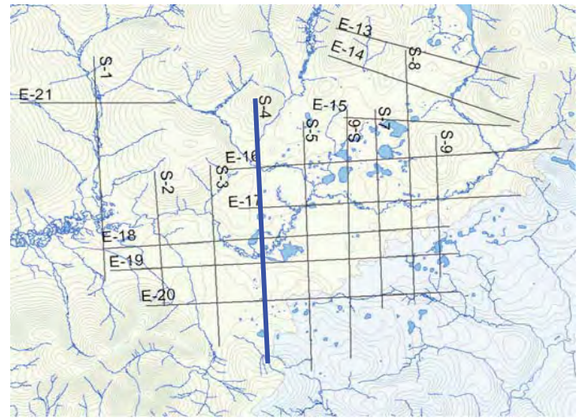
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



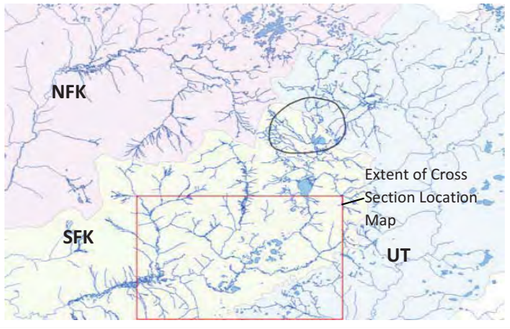
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

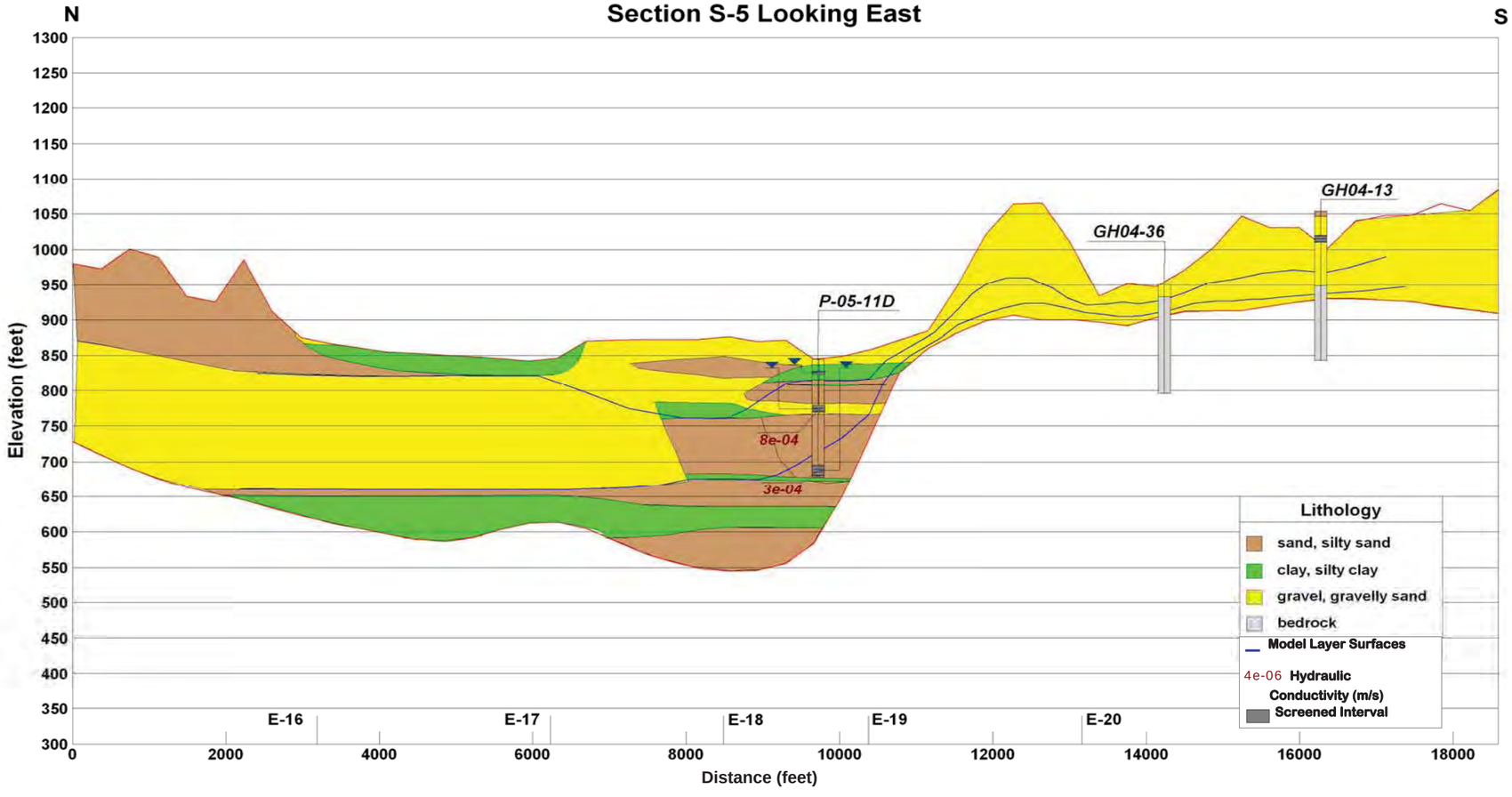


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-4**
Author: SWS-PP	Date: December 20, 2010

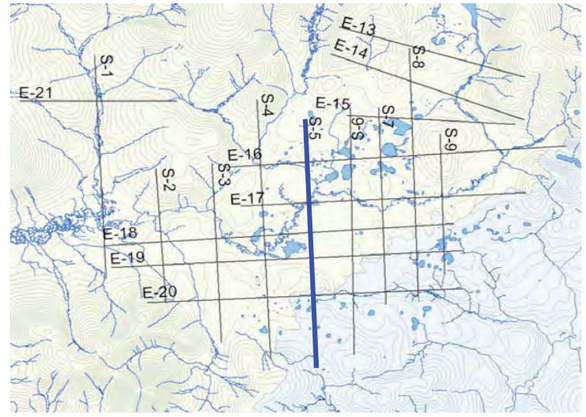
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



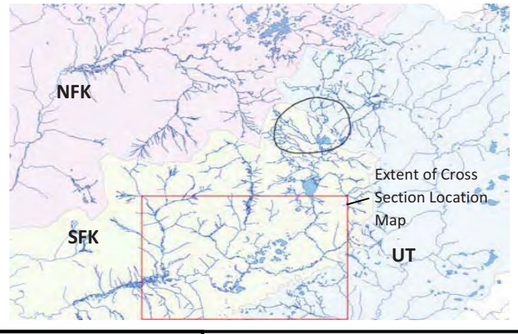
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

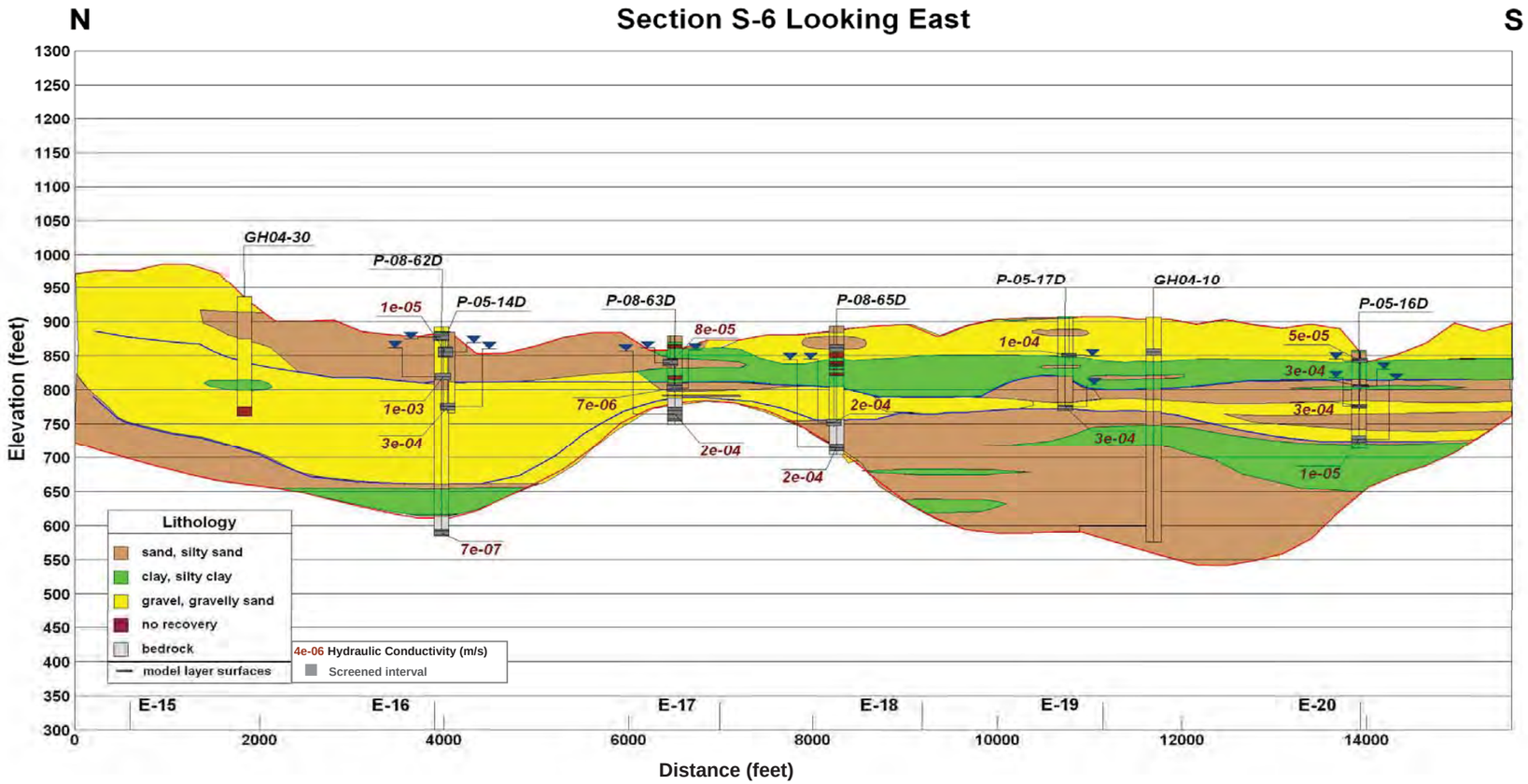


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-5**
Author: SWS-PP	Date: December 20, 2010

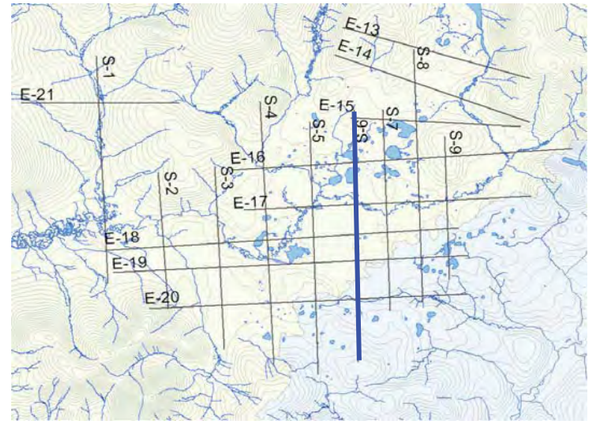
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



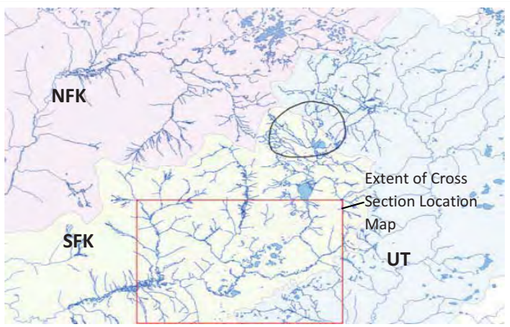
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

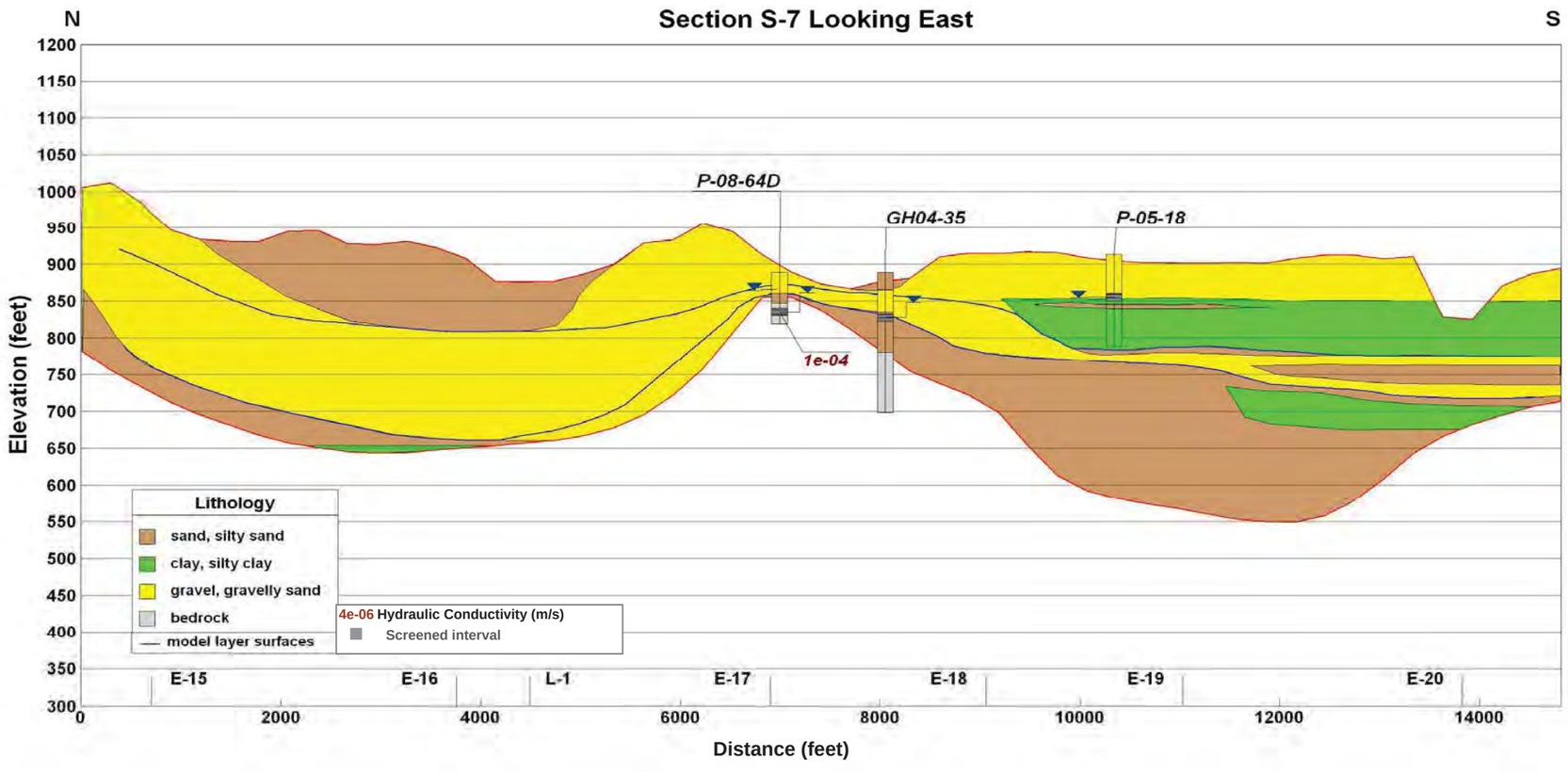


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-6**
Author: SWS-PP	Date: December 20, 2010

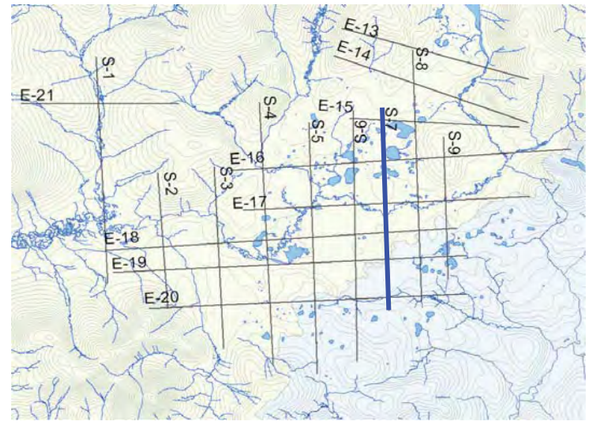
\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls



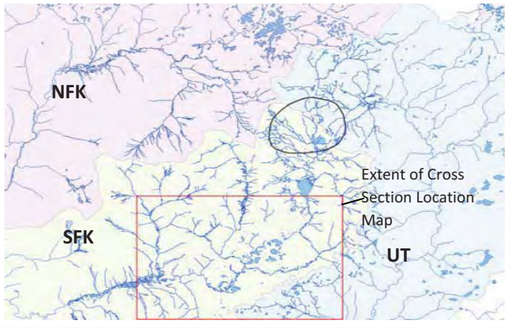
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map

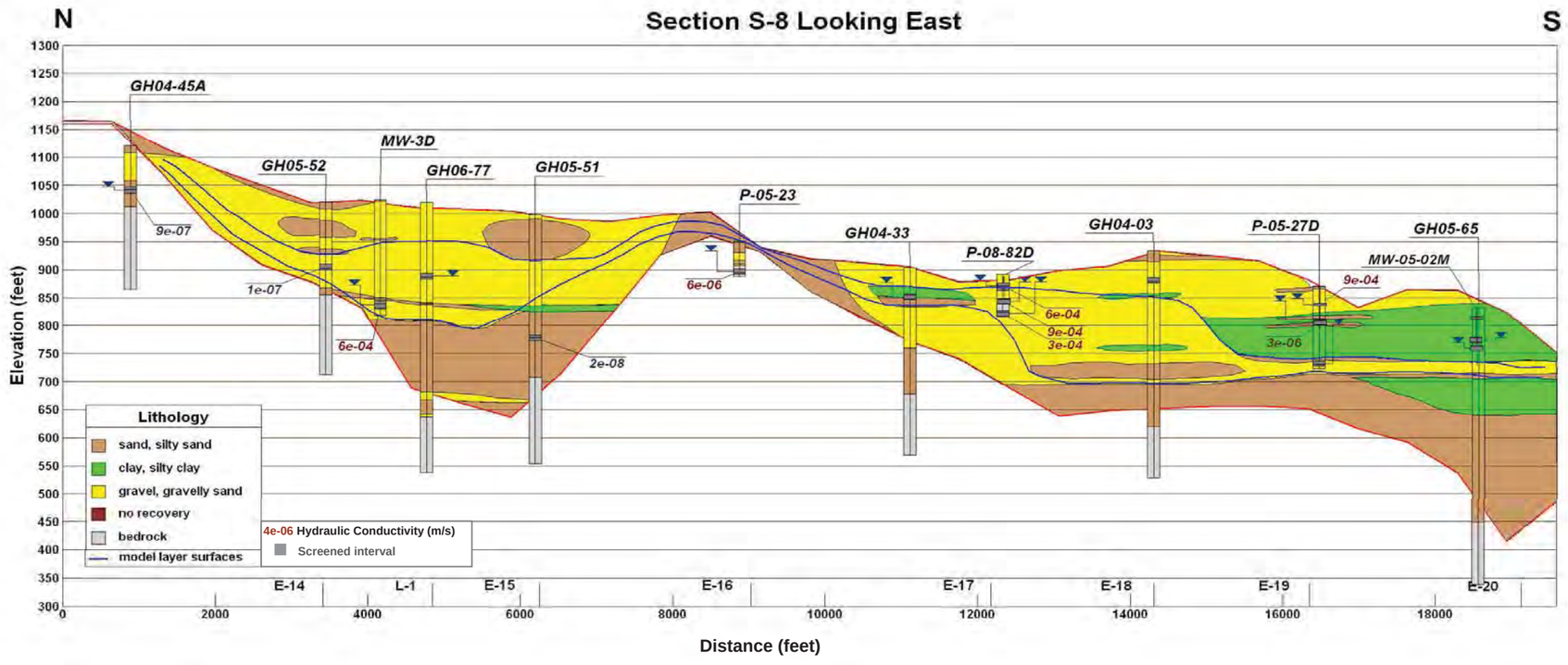


Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-7**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

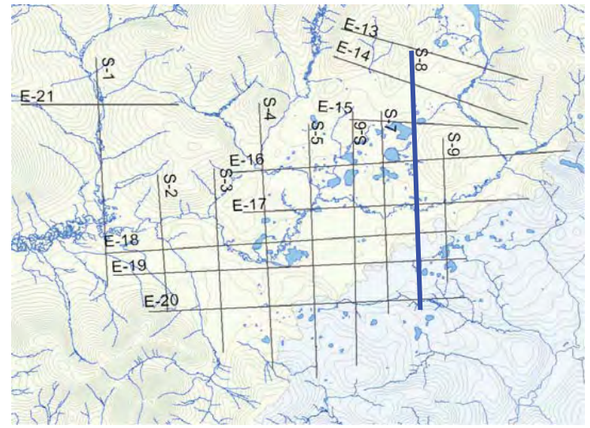


85

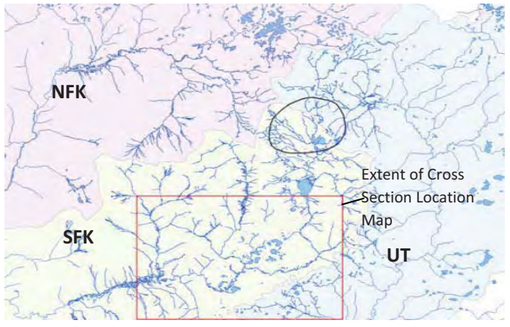
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



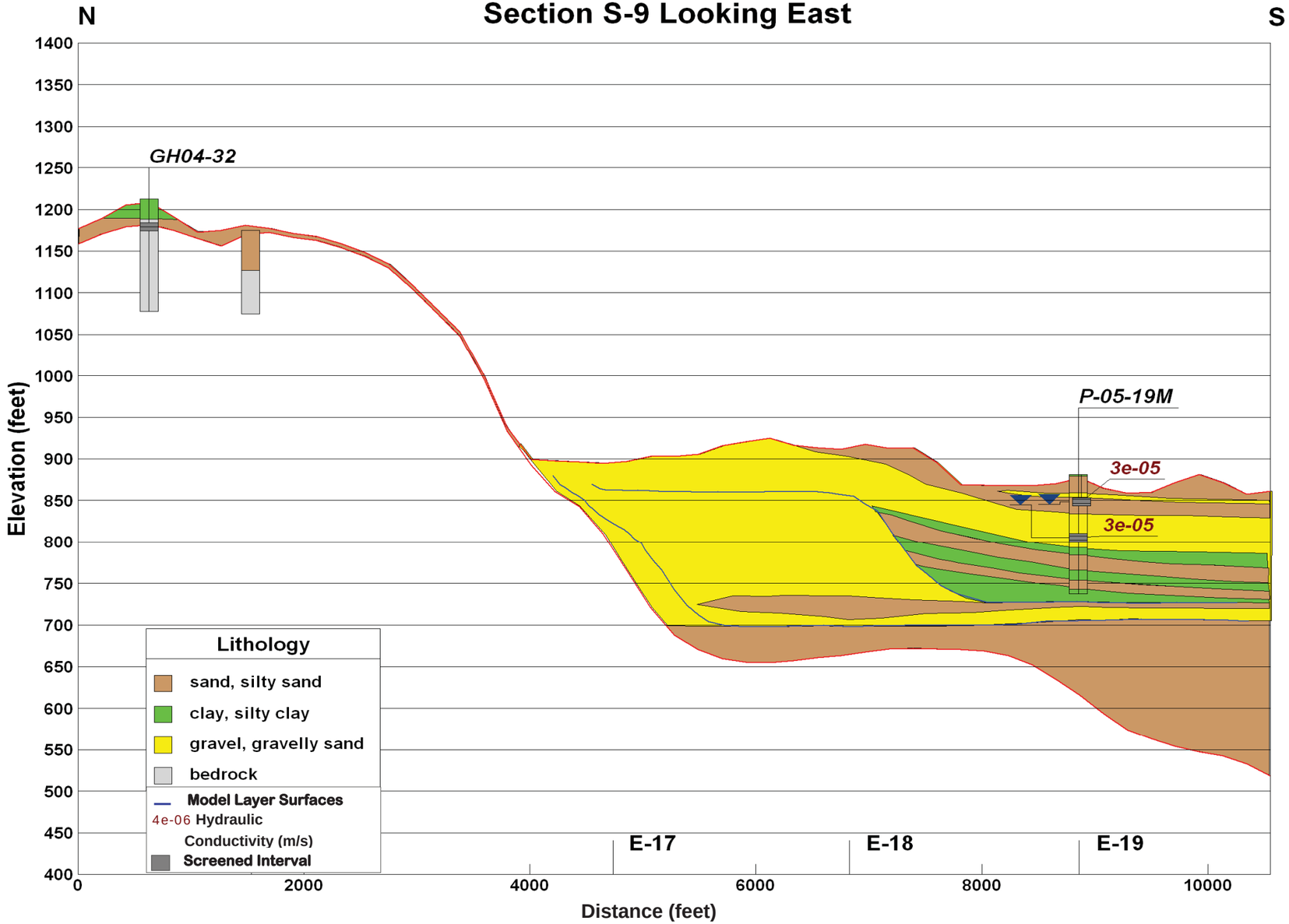
Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-8**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

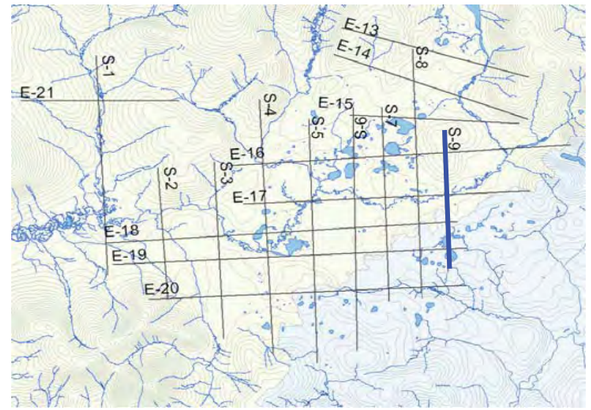
Section S-9 Looking East



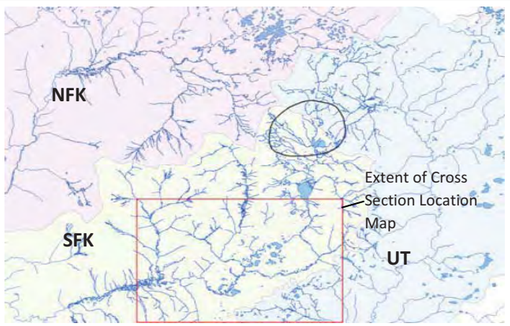
THE pebble PARTNERSHIP

Appendix 8.1B
Geologic Cross Sections

Cross Section Location Map



Notes:
1. Water levels measured October, 2008
2. Drill hole logs for the KP, MW and P series drill holes are in Appendix 8.1A
3. Drill hole logs for the GH series are included in Knight Piesold 2004, 2005, 2005a, 2006, 2007, 2008
4. Water levels are plotted as time series in Appendix 8.1G



Project No: 7126	**Section S-9**
Author: SWS-PP	Date: December 20, 2010

\\Manu\projects\Pebble\reporting\WMC 2009 EBD\Appendix_8.1B_Geologic_Cross_Sections\Cross Section s.xls

APPENDIX 8.1C

Response Testing Results

Hydrogeology – 2008 Environmental Baseline Document
Appendix 8.1C Response Testing Results

Table of Contents

Response Testing Results:

P-2M 1
P-2D....3
P-3 5
P-4AS 7
P-4 Mid 9
P-4AD 11
P-6S....13
P-6M 14
P-6D....15
KP-P1 16
KP-P3S 17
KP-P3M 18
KP-P3D....19
KP-P4 20
MW-1S....21
MW-1M 22
MW-1D....24
MW-2D....25
MW-3D....26
MW-5S....27
MW-5M 28
MW-5D....29
MW-6D....31
MW-7S....32
MW-7D....34
MW-8S....35
MW-8M 36
MW-8D....37
MW-9 38
MW-11S....39
MW-11M 41
MW-11D....42
P-05-07S....44
P-05-07D 47
P-05-08 50
P-05-09D 55
P-05-10S....57
P-05-10D 59
P-05-11M 60
P-05-11D 61
P-05-12 62

Hydrogeology – 2008 Environmental Baseline Document
Appendix 8.1C Response Testing Results

Table of Contents cont'd

Response Testing Results:

P-05-13 63
P-05-14S 64
P-05-14D 66
P-05-15S 67
P-05-15D 68
P-05-16S 69
P-05-16SS 72
P-05-16M 75
P-05-16D 79
P-05-17S 84
P-05-17D 87
P-05-19D 91
P-05-20S 93
P-05-22 95
P-05-23 96
P-05-24S 98
P-05-24D 99
P-05-25 100
P-05-26S 105
P-05-26D 108
P-05-27S 109
P-05-27M 110
P-05-28D 113
P-05-30S 114
P-05-30D 116
P-05-31S 121
P-05-31D 123
P-05-32 125
P-05-33 127
P-05-34 129
P-05-35 130
P-05-36S 132
P-05-36M 133
P-05-36D 135
PQ-4 137
MW-05-12S 139
MW-05-12D 142
MW-05-13S 145
MW-05-13D 149
P-06-37M 153
P-06-37D 155

Hydrogeology – 2008 Environmental Baseline Document
Appendix 8.1C Response Testing Results

Table of Contents cont'd

Response Testing Results:

P-06-39S....157
P-06-39D....159
P-06-41M....161
P-07-50S....163
P-07-50D....164
P-07-47D....165
P-07-51D....166
P-07-51S....167
P-07-52D....168
P-08-55D....169
P-08-55S....170
P-08-56D....171
P-08-56M....172
P-08-57D....173
P-08-58D....174
P-08-58M....175
P-08-59D....176
P-08-59S....177
P-08-60D....178
P-08-60S....179
P-08-61D....180
P-08-62D....181
P-08-62M....182
P-08-63D....183
P-08-63M....184
P-08-63S....185
P-08-64D....186
P-08-65D....187
P-08-65M....188
P-08-66D....189
P-08-67D....190
P-08-67S....191
P-08-68D....192
P-08-69D....193
P-08-70D....194
P-08-70S....195
P-08-71D....196
P-08-72D....197
P-08-73D....198
P-08-74D....199
P-08-74S....200

Hydrogeology – 2008 Environmental Baseline Document
Appendix 8.1C Response Testing Results

Table of Contents cont'd

Response Testing Results:

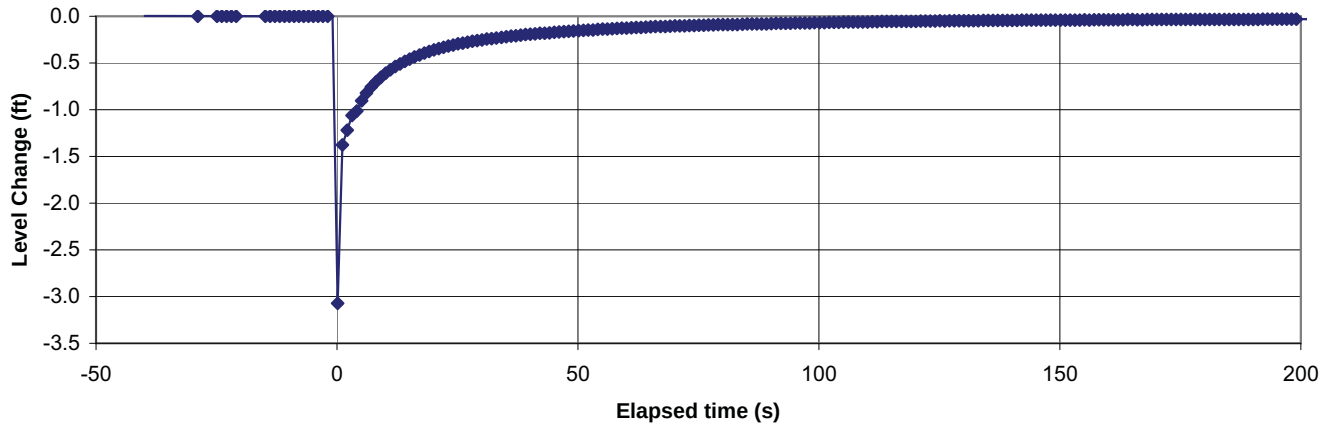
P-08-75D 201
P-08-75M 202
P-08-75S.....203
P-08-76D 204
P-08-76S.....205
P-08-78D 206
P-08-79D 207
P-08-79M 208
P-08-79S.....209
P-08-80D 210
P-08-80M 211
P-08-80S.....212
P-08-81D 213
P-08-82D 214
P-08-82M 215
P-08-82S.....216
P-08-83D 217
P-08-83M 218
P-08-83S.....219
P-08-84D 220
P-08-84S.....221
P-08-86D 222
P-08-87D 223
P-08-87S.....224
P-08-88D 225
P-08-88S.....226
P-08-89D 227
P-08-89S.....228

Borehole Response Test - Cooper Papadopulos Method

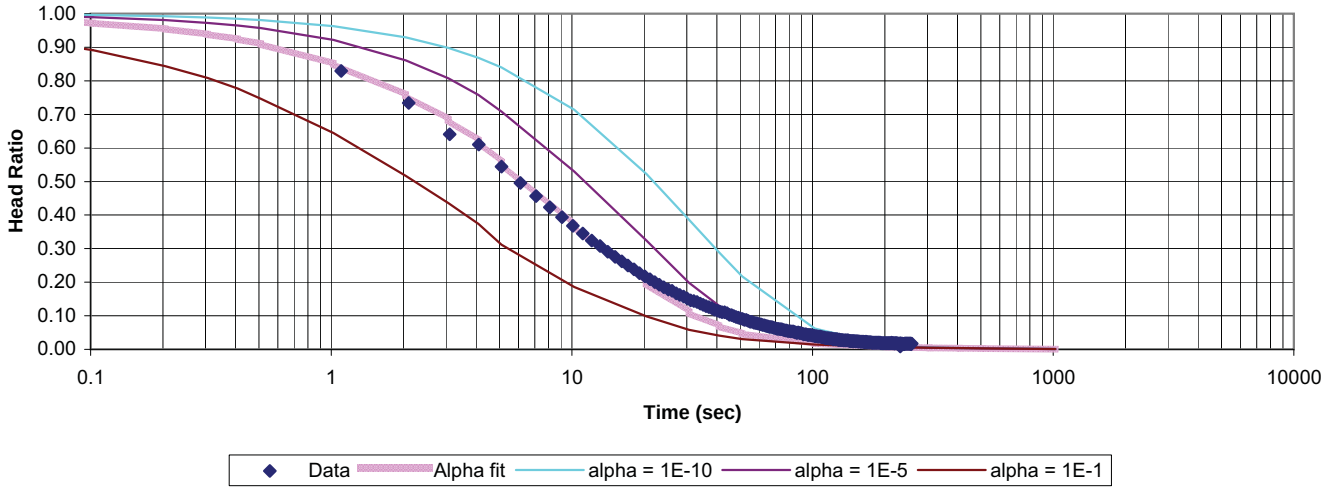
THE PEBBLE PARTNERSHIP

Borehole No:	P2M	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	16.8-21.3	Test time:	4:39 PM
Test zone length (m):	4.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.053	Analyst:	Alex Rosenberg
K (m/s):	3.0E-05	Transmissivity (m^2/s):	1.35E-04
Storage:	4.00E-04	Alpha:	2.34E-03

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

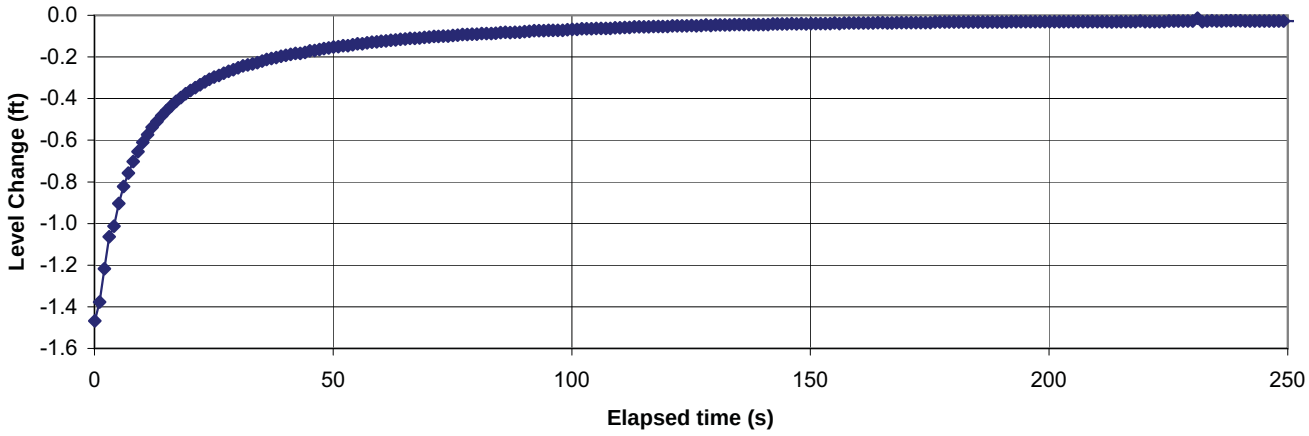
THE PEBBLE PARTNERSHIP

Borehole No:	P2M rising	Test date:	04-Sep-04
Instrument type:	In-situ transducer	Test time:	4:39 PM
Zone depth (m):	16.8-21.3	Screen type:	2 " PVC - 20 slot
Test length (m):	4.5	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser diameter (m):	0.053		
Hvorslev intercept:	1		

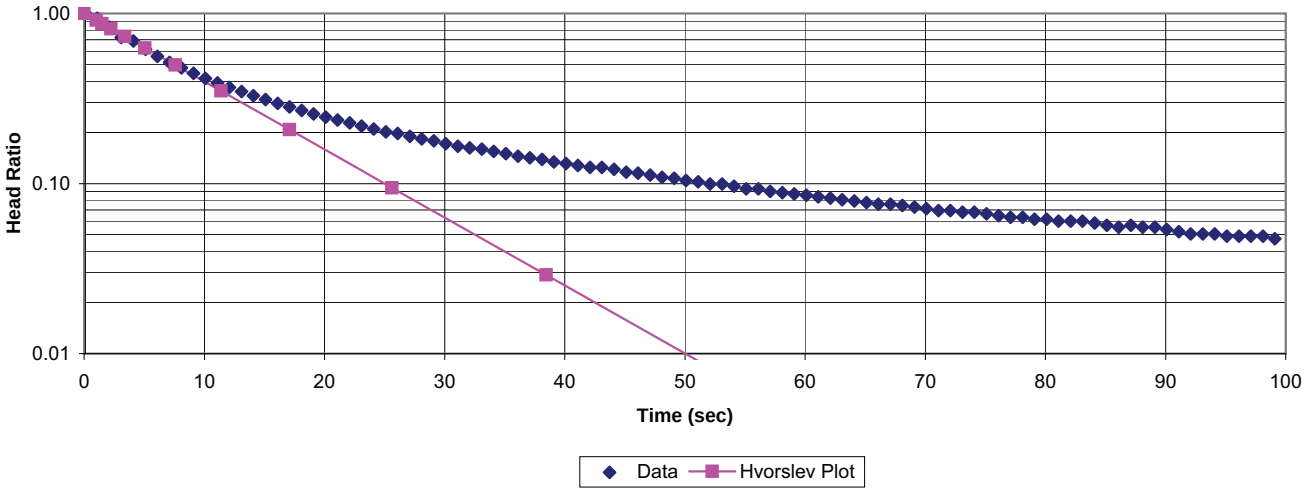
K (m/s): 3.0E-05

Transmissivity (m^2/s) 1.35E-04

Water Level Change



Head Ratio Plot

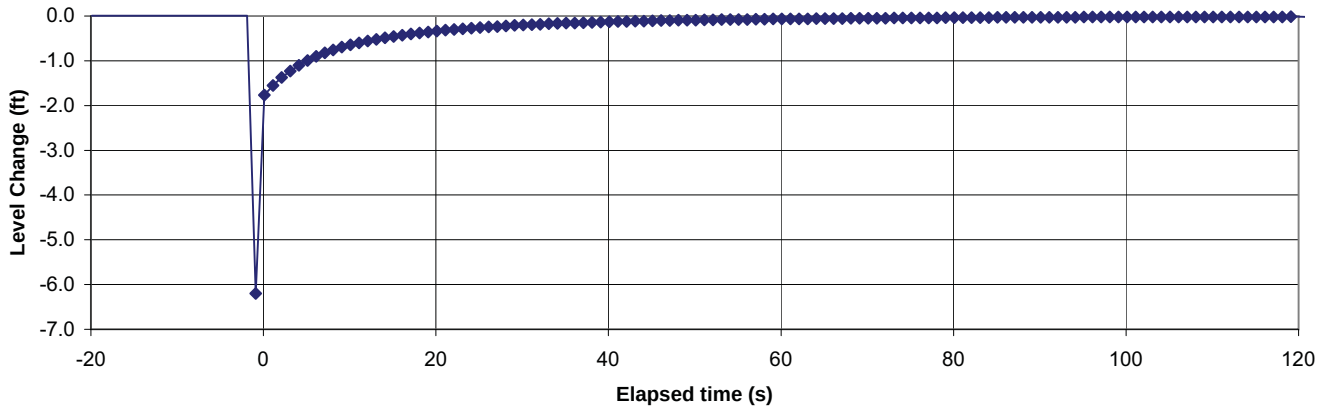


Borehole Response Test - Cooper Papadopulos Method

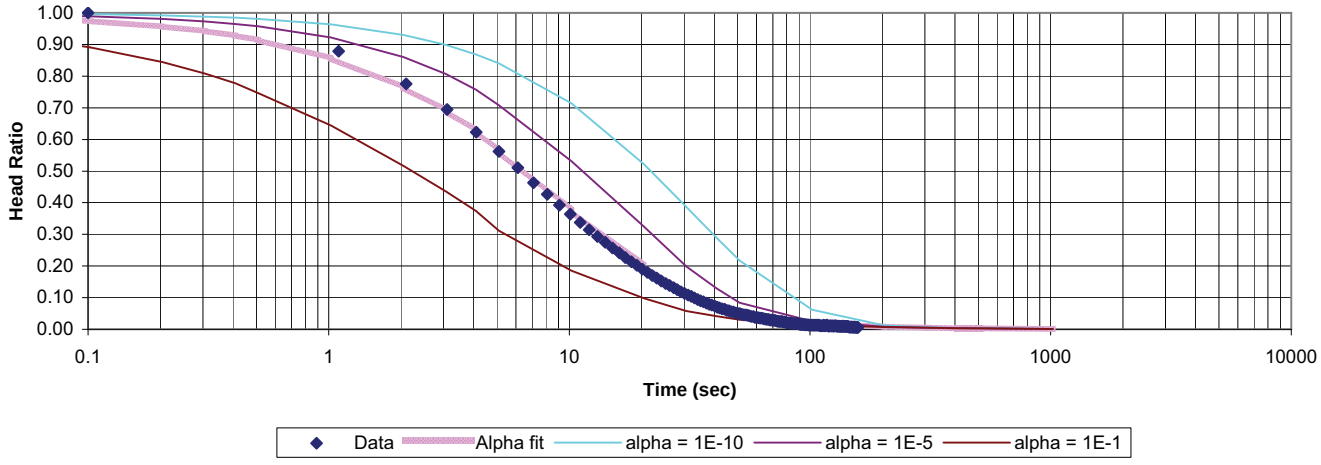
THE PEBBLE PARTNERSHIP

Borehole No:	P2D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	22.3-26.8	Test time:	3:30 PM
Test length (m):	4.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.053	Analyst:	Alex Rosenberg
K (m/s):	3.0E-05	Transmissivity (m^2/s):	1.35E-04
Storage:	3.00E-04	Alpha:	1.76E-03

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

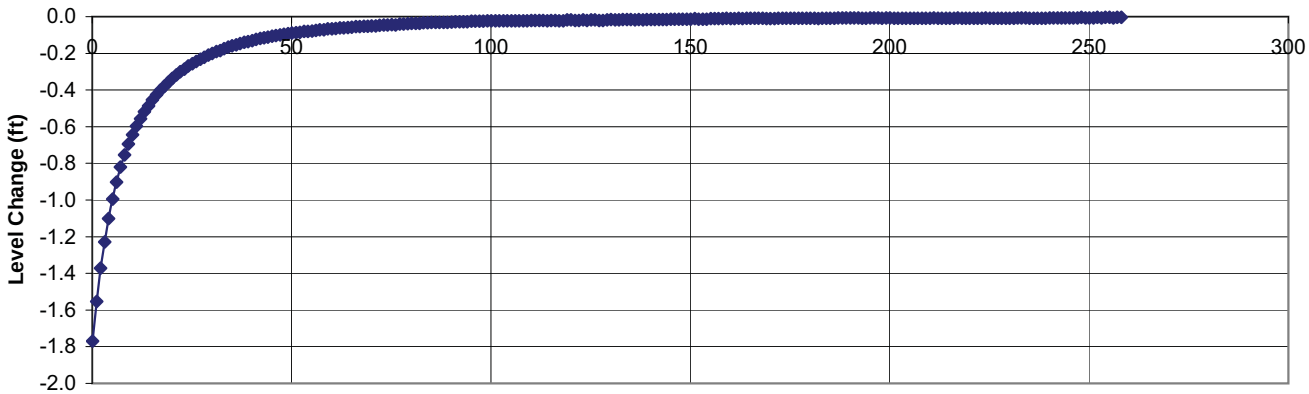
THE PEBBLE PARTNERSHIP

Borehole No:	P2D rising	Test date:	04-Sep-04
Instrument type:	In-situ transducer	Test time:	3:30 PM
Zone depth (m):	22.3-26.8	Screen type:	2 " PVC - 20 slot
Test length (m):	4.5	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser diameter (m):	0.053		
Hvorslev intercept:	1		

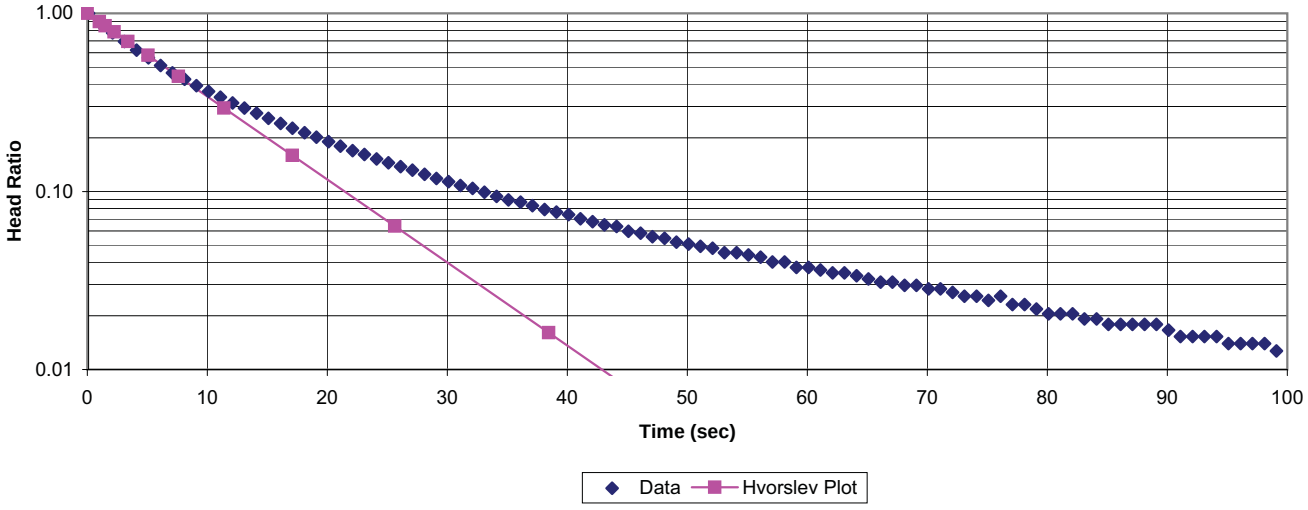
K (m/s): 3.5E-05

Transmissivity (m^2/s) 1.58E-04

Water Level Change



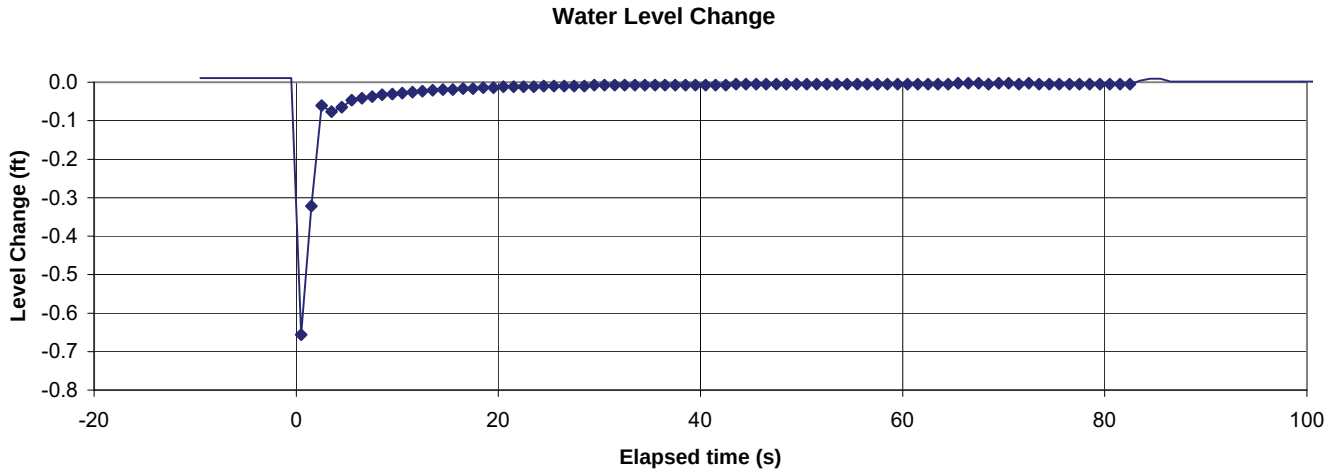
Head Ratio Plot

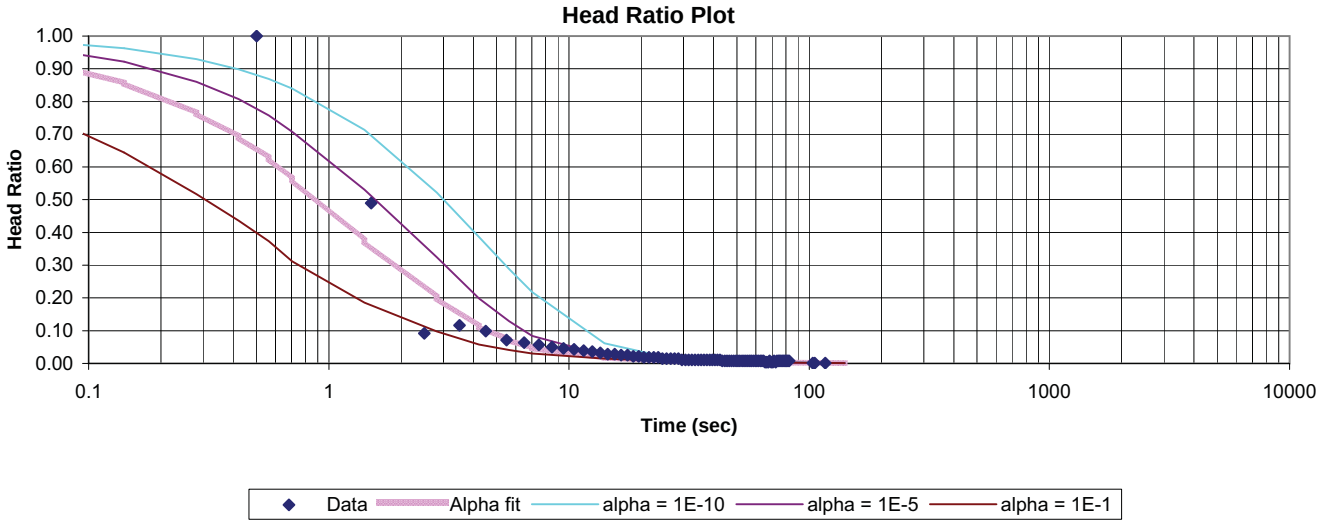


Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

Borehole No:	P3	Test type:	Falling head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	2.7-7.6	Test time:	8:40 PM
Test length (m):	4.9	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.053	Analyst:	Alex Rosenberg
K (m/s):	2.0E-04	Transmissivity (m^2/s):	9.80E-04
Storage:	3.00E-04	Alpha:	1.76E-03

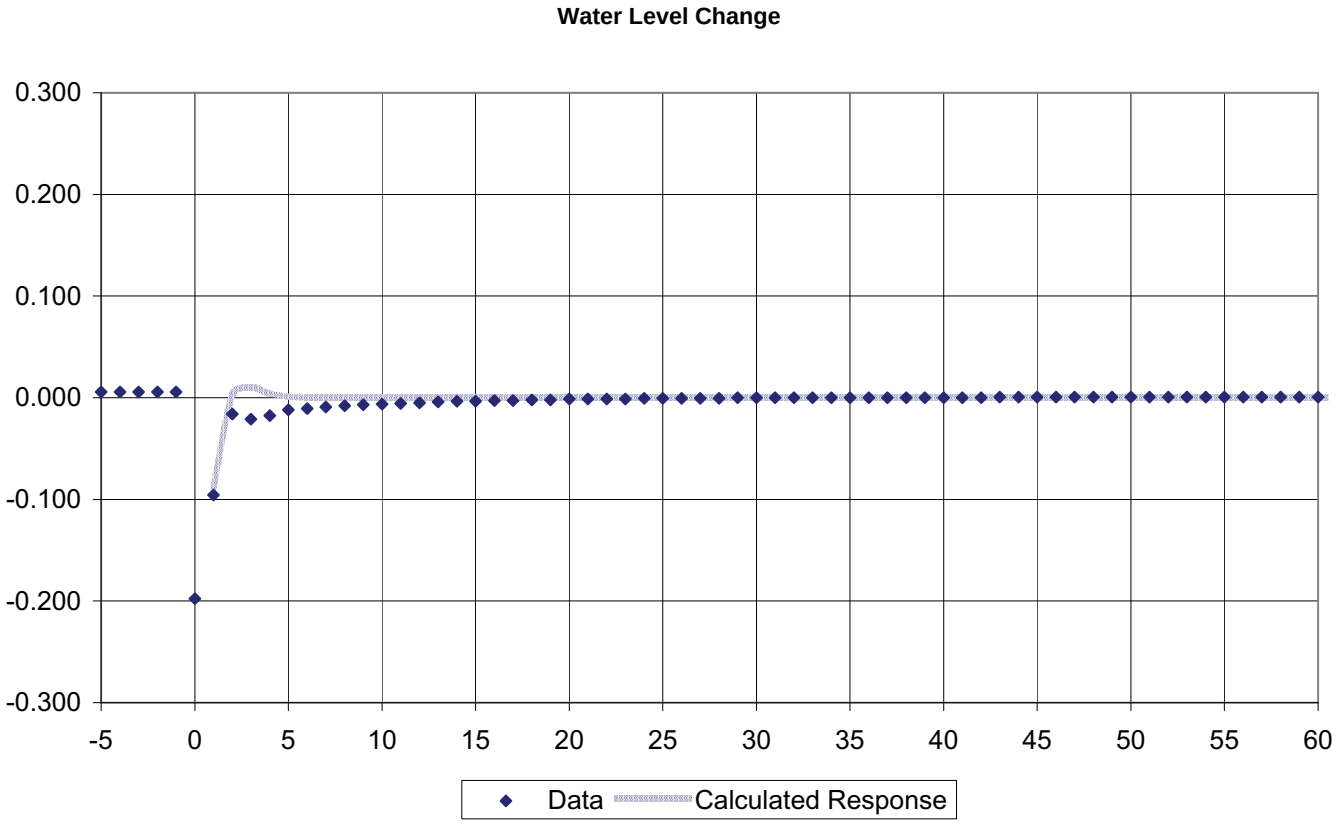




Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P3 insert	Test date:	04/09/2004
Instrument type:	In-situ transducer	Test time:	8:42 PM
Zone depth (m):	2.7-7.6	Screen type:	2 " PVC - 20 slot
Test length (m):	4.9	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser diameter (m):	0.0525		
		d:	8.12E-01
Depth of screen (m):	5.30	angular frequency (per second):	0.82
Depth to water (m):	0.30	damping constant:	1.14
Height of water predicted(m):	5.00	Initial amplitude:	-0.4
Height of water (m):	5.00		
K (m/s):	2.0E-04	Transmissivity (m^2/s)	9.80E-04
Storage:	3.00E-04		

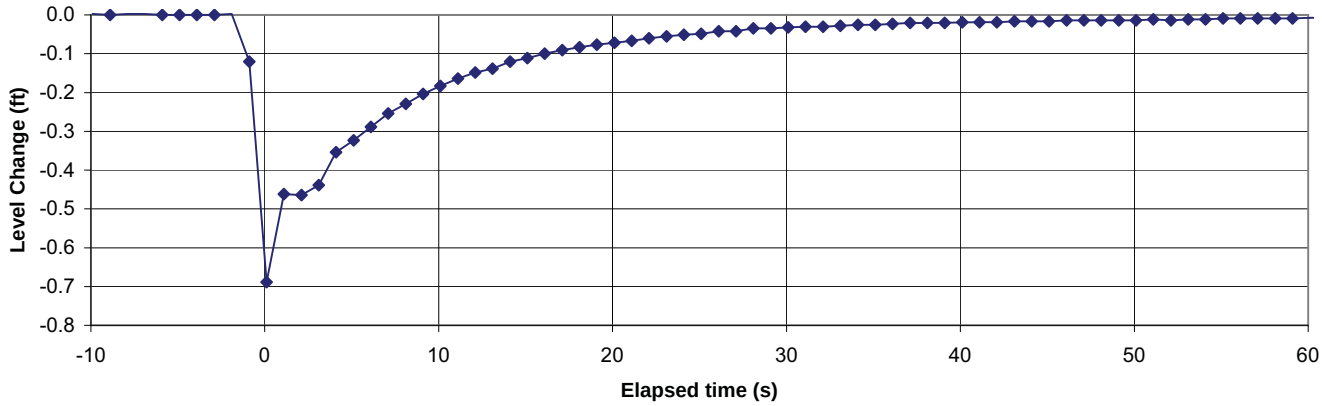


Borehole Response Test - Cooper Papadopulos Method

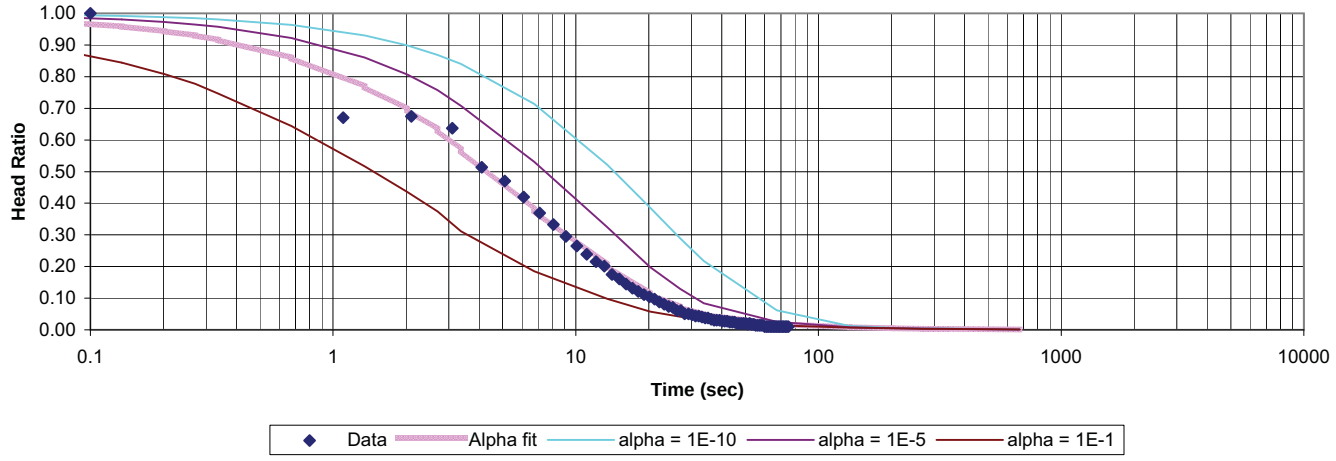
THE PEBBLE PARTNERSHIP

Borehole No:	P4AS	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	14-Sep-04
Zone depth (m):	11.1-15.5	Test time:	4:50 PM
Test length (m):	4.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.049	Analyst:	Alex Rosenberg
K (m/s):	4.0E-05	Transmissivity (m^2/s):	1.80E-04
Storage:	2.00E-04	Alpha:	1.33E-03

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

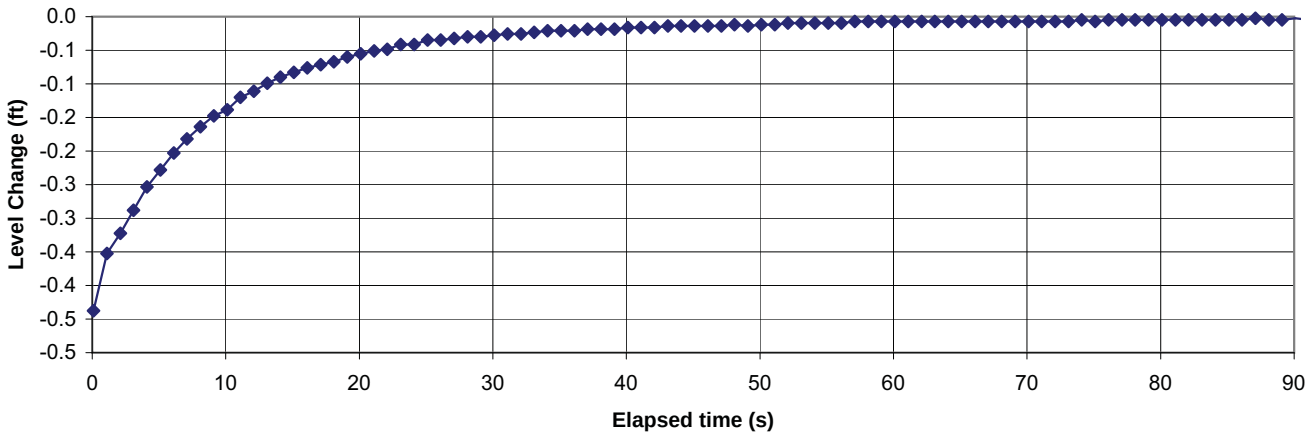
THE PEBBLE PARTNERSHIP

Borehole No:	P4AS rising	Test date:	14-Sep-04
Instrument type:	In-situ transducer	Test time:	4:50 PM
Zone depth (m):	11.1-15.5	Screen type:	2 " PVC - 20 slot
Test length (m):	4.5	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser diameter (m):	0.049		
Hvorslev intercept:	1		

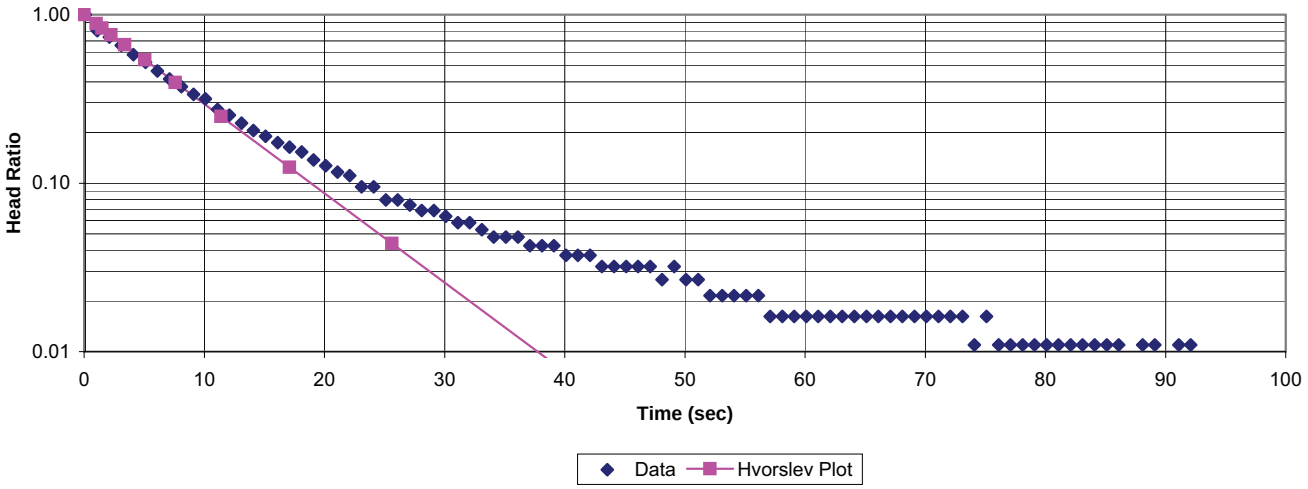
K (m/s): 3.5E-05

Transmissivity (m^2/s) 1.58E-04

Water Level Change



Head Ratio Plot

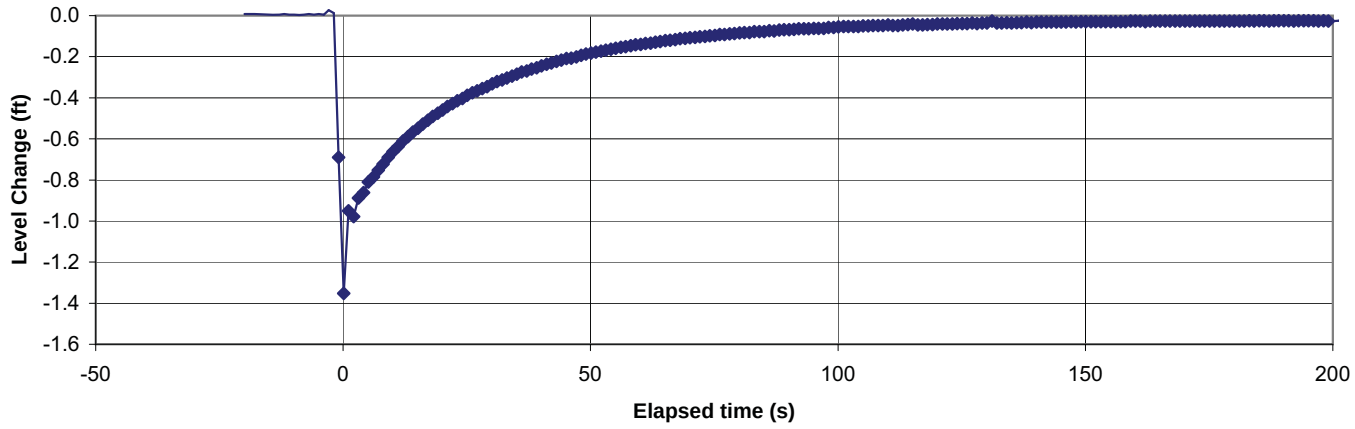


Borehole Response Test - Cooper Papadopulos Method

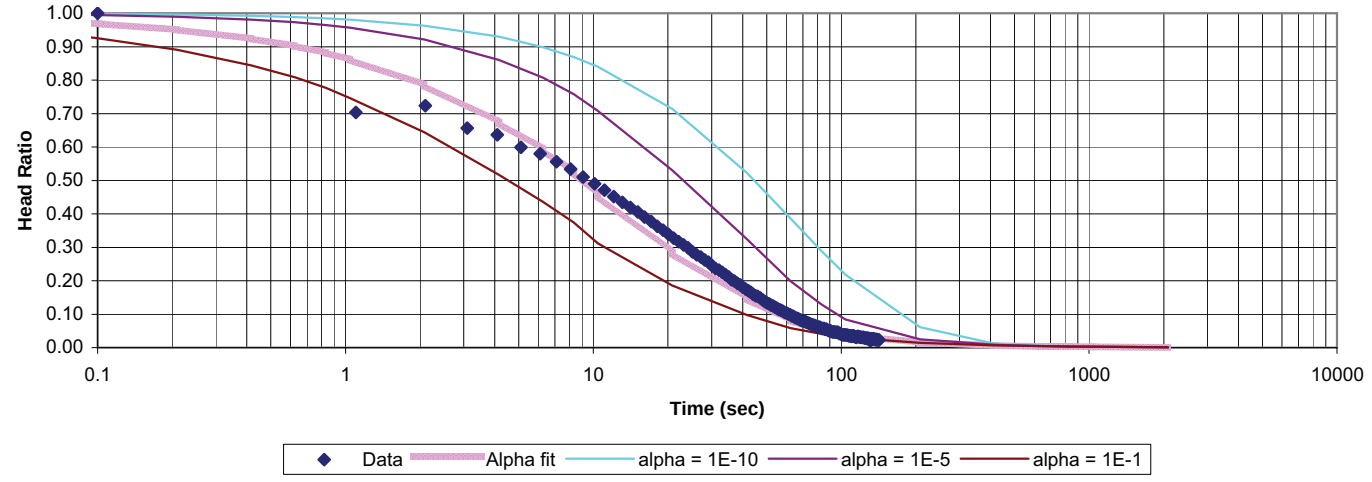
THE PEBBLE PARTNERSHIP

Borehole No:	P4 (mid)	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	13.7-16.8	Test time:	2:00 PM
Test length (m):	3.1	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.0508	Analyst:	Alex Rosenberg
K (m/s):	2.0E-05	Transmissivity (m^2/s):	6.20E-05
Storage:	2.00E-03	Alpha:	1.25E-02

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

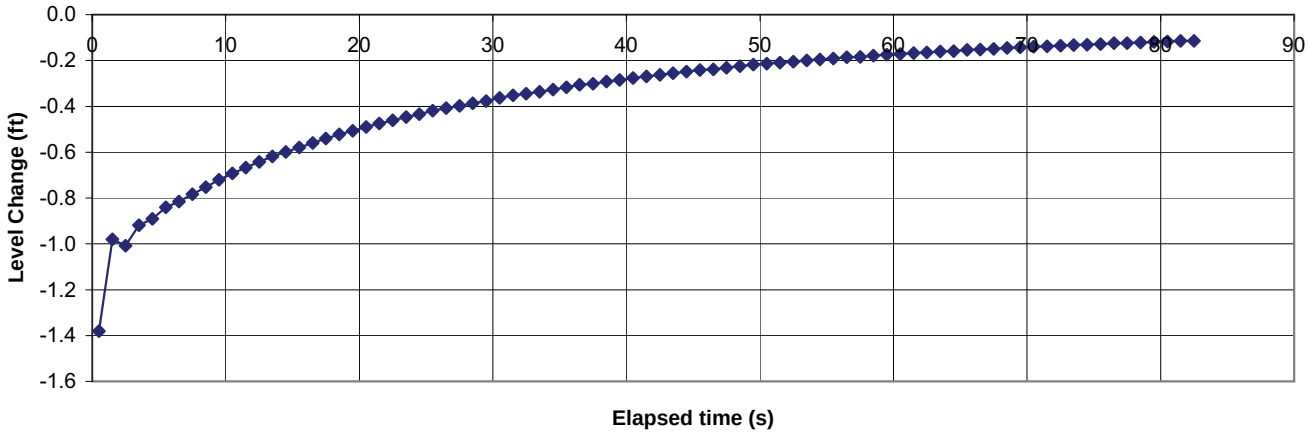
THE PEBBLE PARTNERSHIP

Borehole No:	P4 (mid) rising	Test date:	04-Sep-04
Instrument type:	In-situ transducer	Test time:	2:00 PM
Zone depth (m):	13.7-16.8	Screen type:	2 " PVC - 20 slot
Test length (m):	3	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser diameter (m):	0.049		
Hvorslev intercept:	0.8		

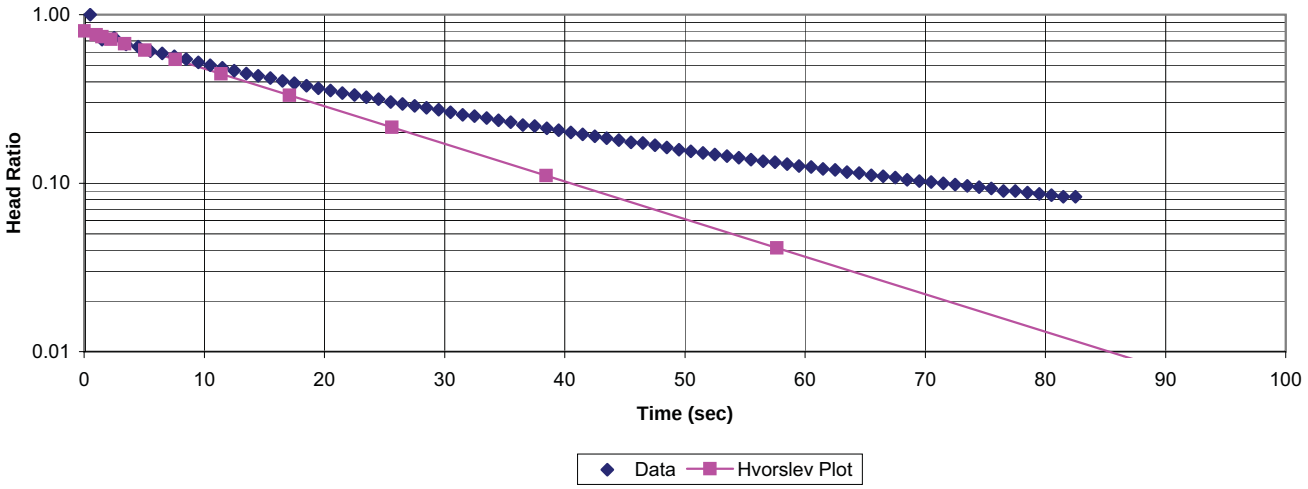
K (m/s): 2.0E-05

Transmissivity (m^2/s) 6.00E-05

Water Level Change



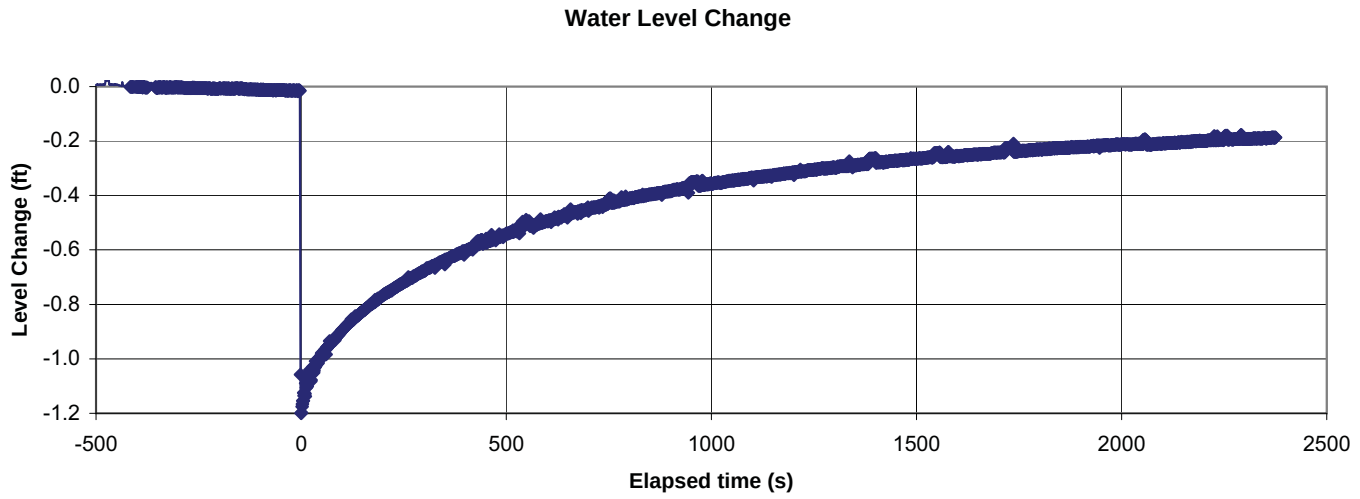
Head Ratio Plot

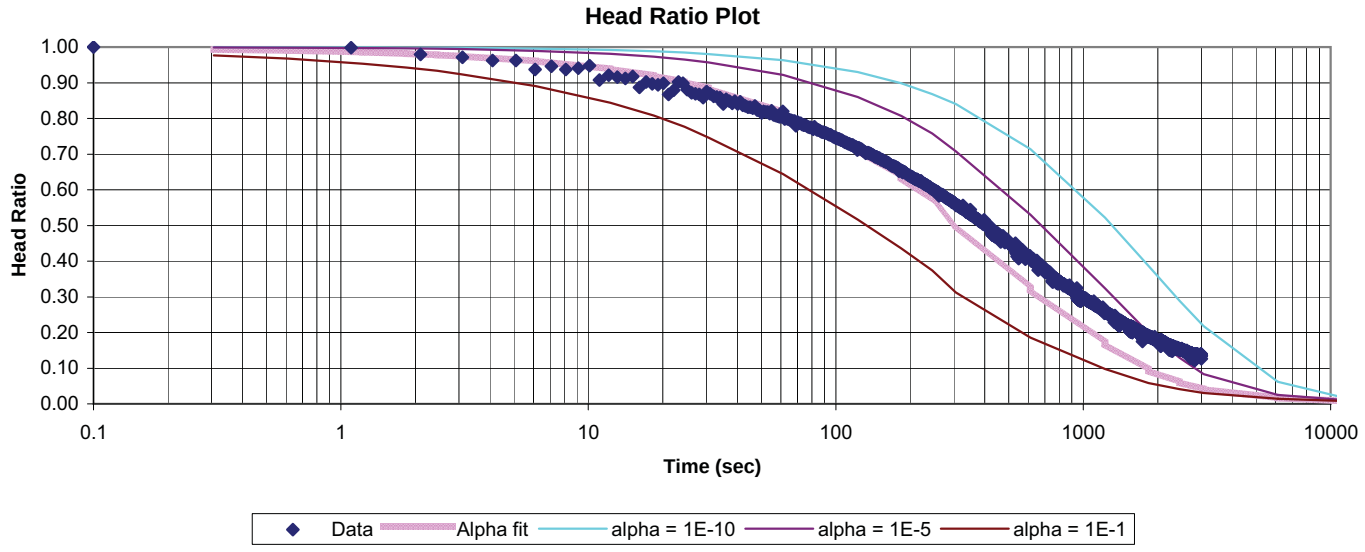


Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

Borehole No:	P4AD	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	14-Sep-04
Zone depth (m):	24.7-28.0	Test time:	11:18 AM
Test length (m):	3.3	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.049	Analyst:	Alex Rosenberg
K (m/s):	6.0E-07	Transmissivity (m^2/s):	1.98E-06
Storage:	1.00E-03	Alpha:	6.65E-03





Borehole Response Test - Hvorslev Method

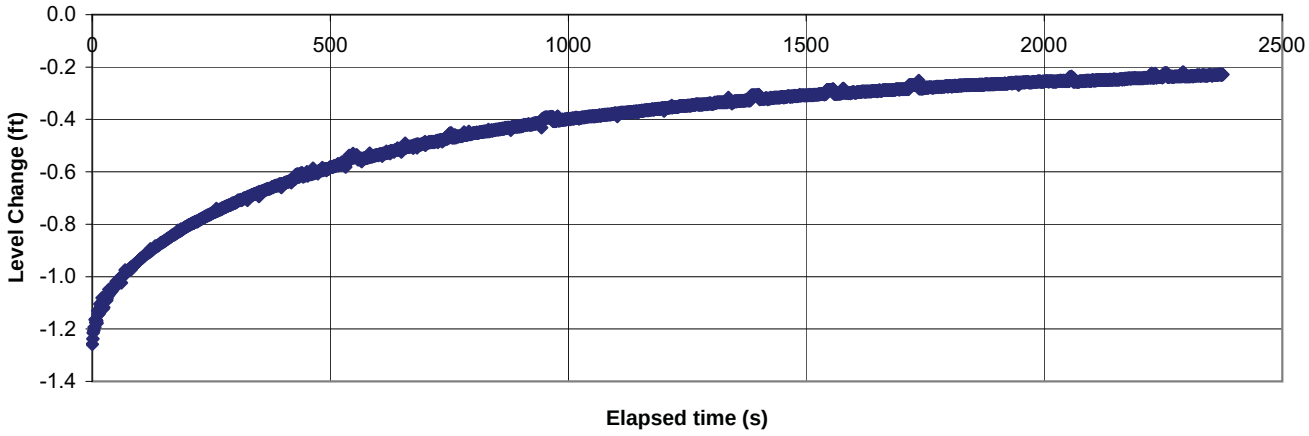
THE PEBBLE PARTNERSHIP

Borehole No:	P4AD rising	Test date:	14-Sep-04
Instrument type:	In-situ transducer	Test time:	11:18 AM
Zone depth (m):	24.7-28.0	Screen type:	2 " PVC - 20 slot
Test length (m):	3.3	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser diameter (m):	0.049		
Hvorslev intercept:	0.9		

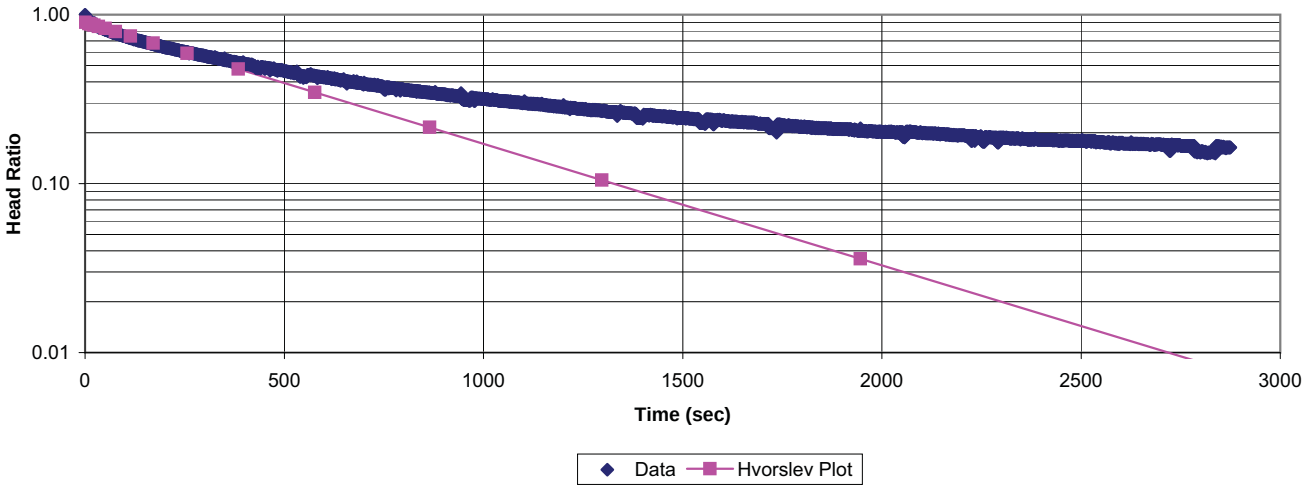
K (m/s): 6.0E-07

Transmissivity (m^2/s) 1.98E-06

Water Level Change



Head Ratio Plot

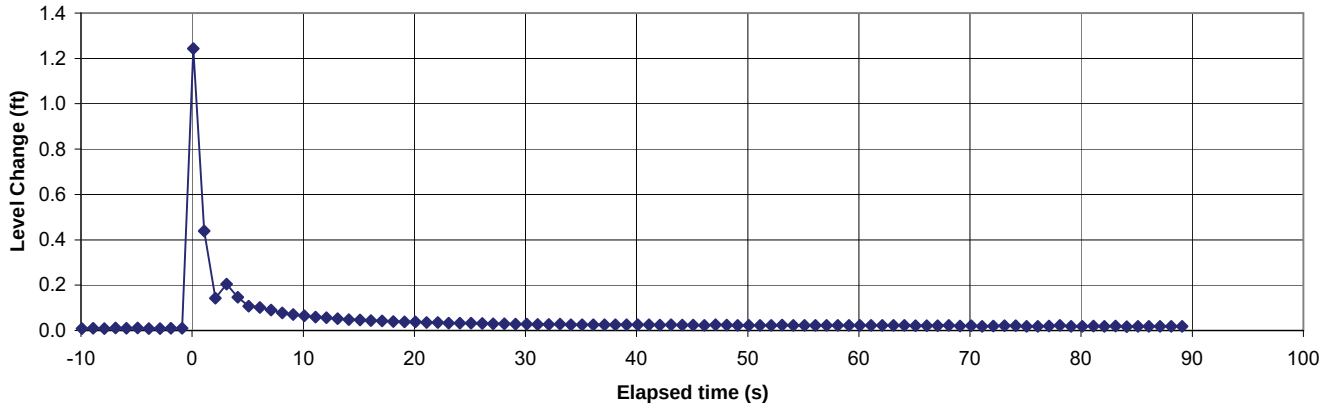


Borehole Response Test - Cooper Papadopulos Method

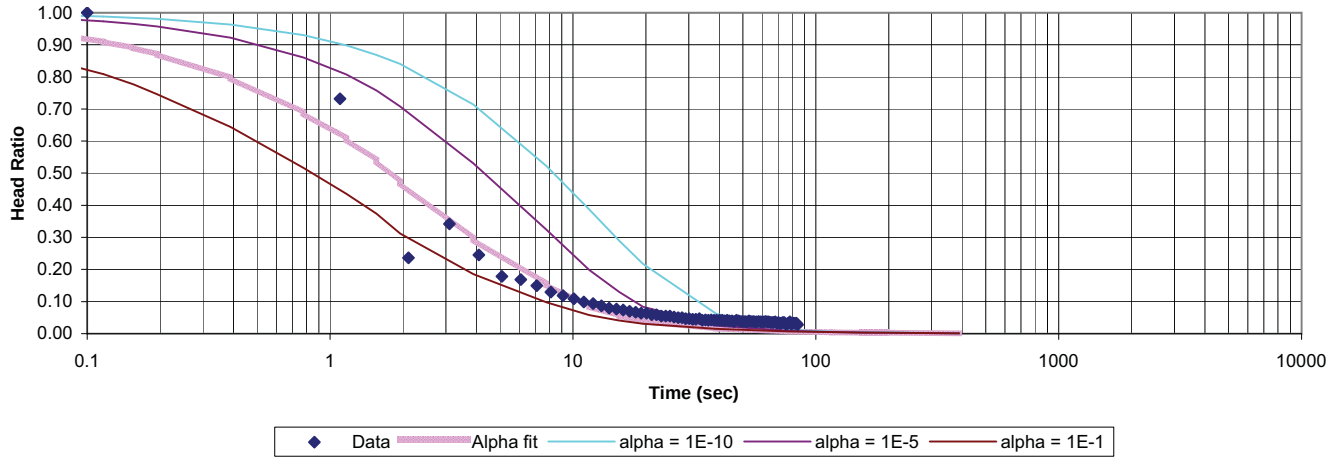
THE PEBBLE PARTNERSHIP

Borehole No:	P6S	Test type:	Falling head
Instrument type:	In-situ transducer	Test date:	17/09/2004
Zone depth (m):	6.5-12.2	Test time:	3:54 PM
Test length (m):	5.7	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.042	Analyst:	Alex Rosenberg
K (m/s):	4.0E-05	Transmissivity (m^2/s)	2.28E-04
Storage:	1.00E-03	Alpha	9.10E-03

Water Level Change



Head Ratio Plot



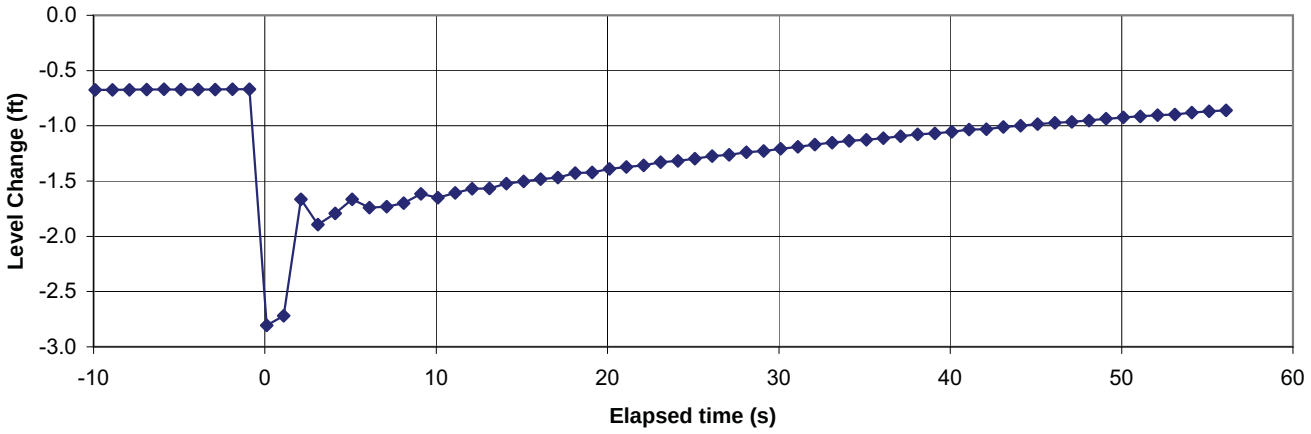
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

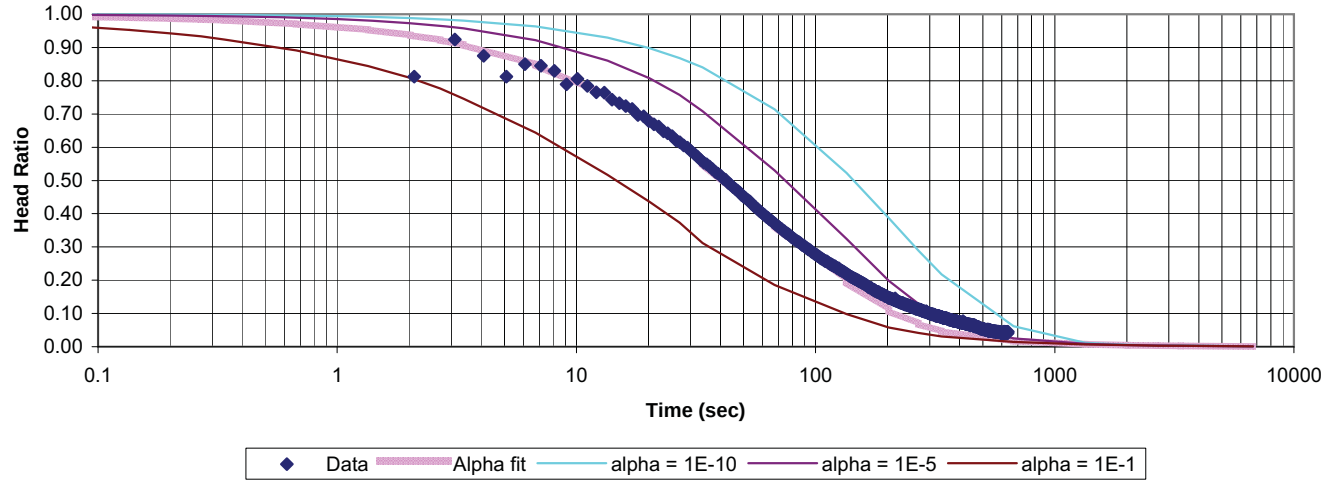
Borehole No:	P6M	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	17-Sep-04
Zone depth (m):	23.8-27.4	Test time:	12:47 PM
Test length (m):	3.6	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser diameter (m):	0.049	Analyst:	Alex Rosenberg

K (m/s):	5.0E-06	Transmissivity (m^2/s):	1.80E-05
Storage:	4.00E-04	Alpha:	2.66E-03

Water Level Change



Head Ratio Plot

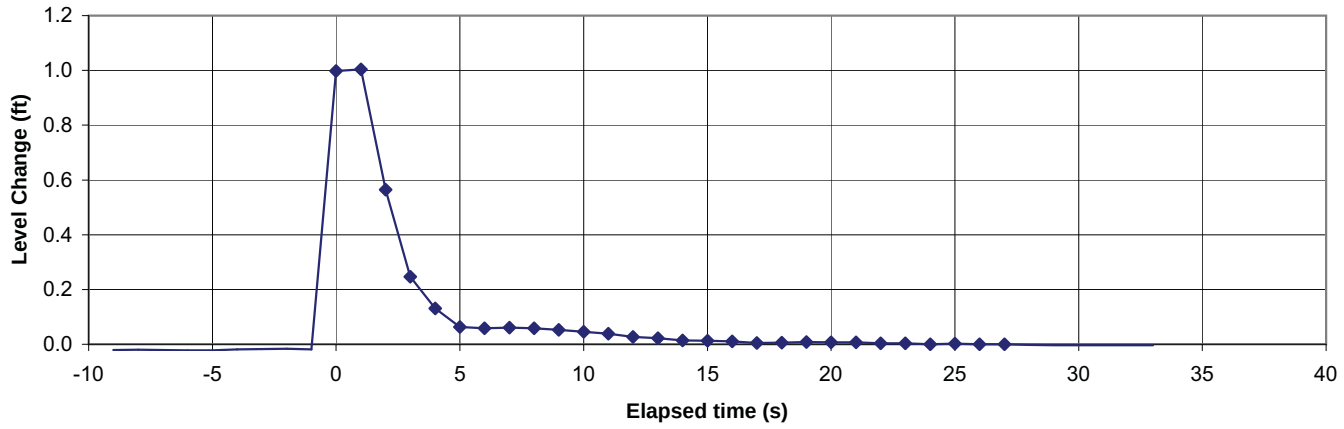


Borehole Response Test - Cooper Papadopulos Method

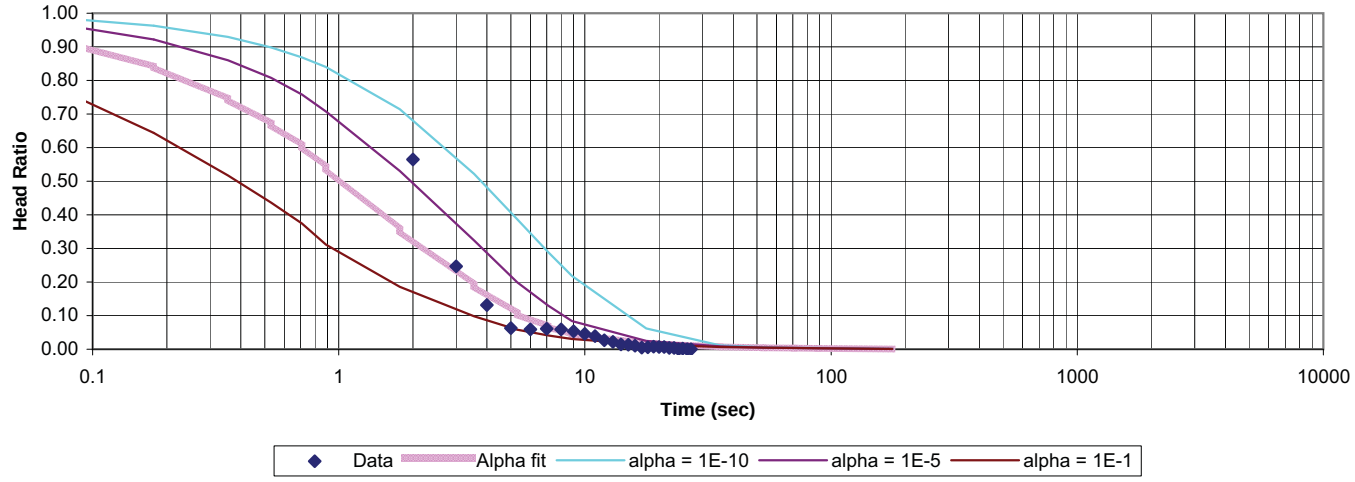
THE PEBBLE PARTNERSHIP

Borehole No:	P6D	Test type:	Falling head
Instrument type:	In-situ transducer	Test date:	9/17/04
Zone depth (m):	31-33.5	Test time:	16:32:10
Test length (m):	2.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inside diameter (m):	0.042	Analyst:	Alex Rosenberg
K (m/s):	2.0E-04	Transmissivity (m^2/s)	5.00E-04
Storage:	4.00E-04	Alpha	3.64E-03

Water Level Change



Head Ratio Plot

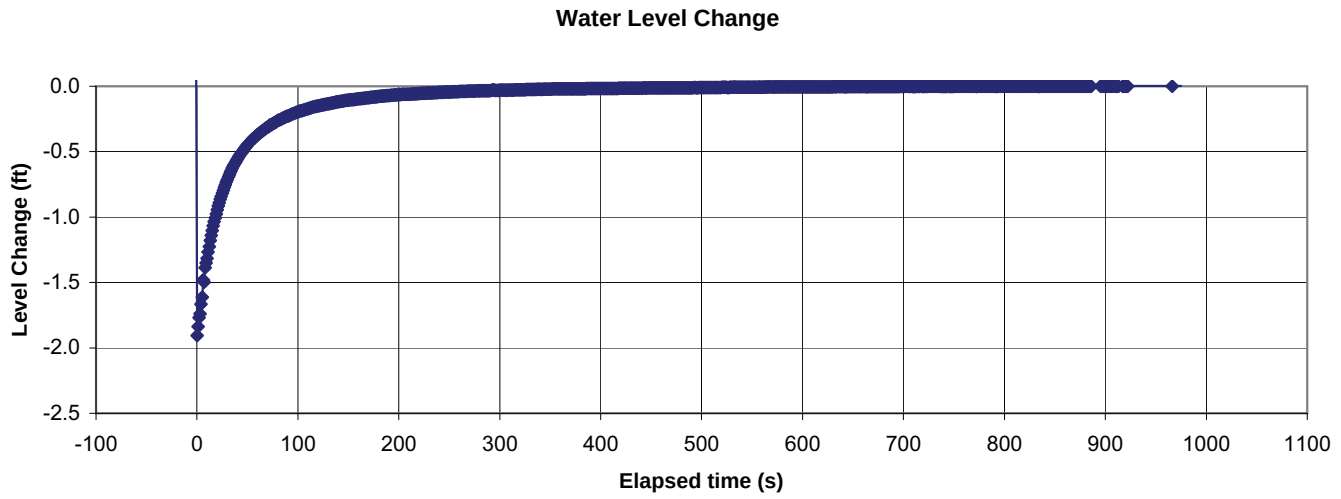


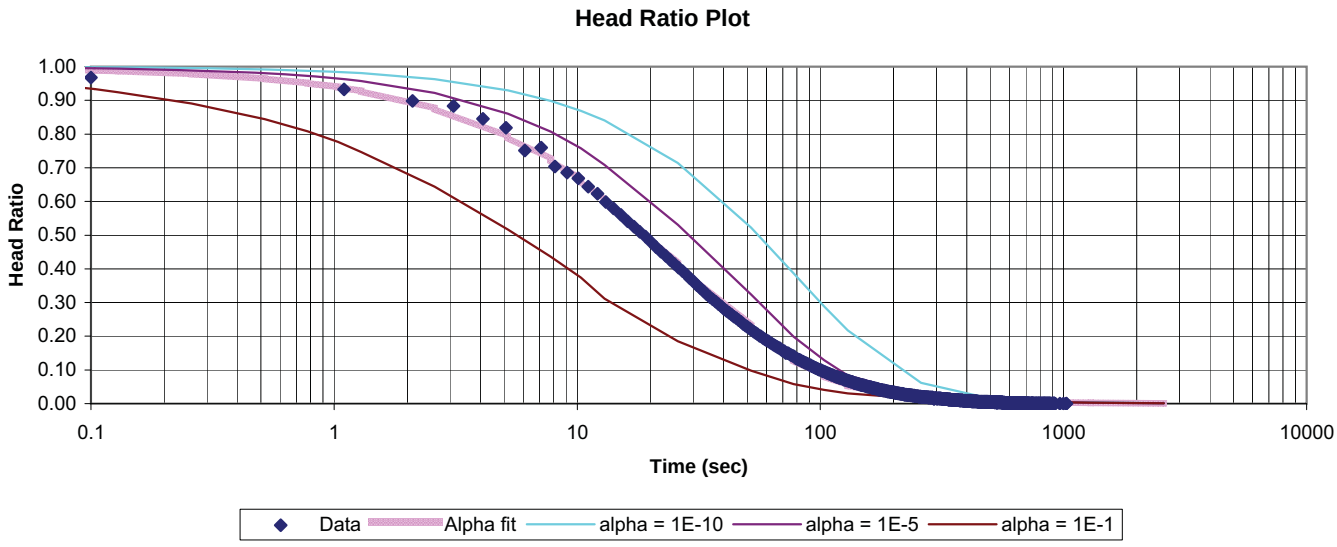
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

Borehole No:	KP-P1	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	05-Sep-04
Zone depth (m):	36.9-40.8	Test time:	12:08 PM
Test length (m):	3.9	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.049	Analyst:	Alex Rosenberg
K (m/s):	1.2E-05	Transmissivity (m^2/s):	4.68E-05
Storage:	1.00E-04	Alpha:	6.65E-04

Comment: changed initial displacement to match cooper plot



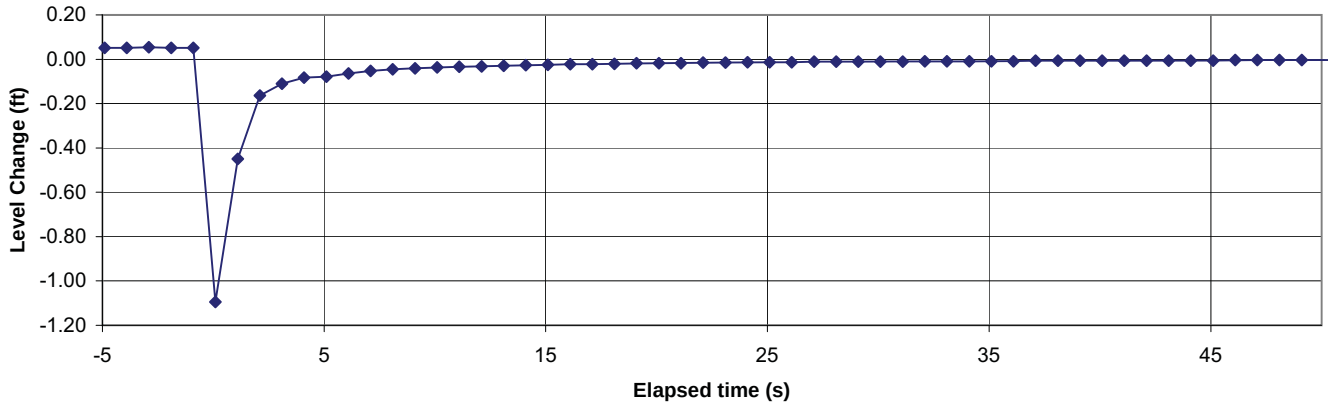


Borehole Response Test - Cooper Papadopulos Method

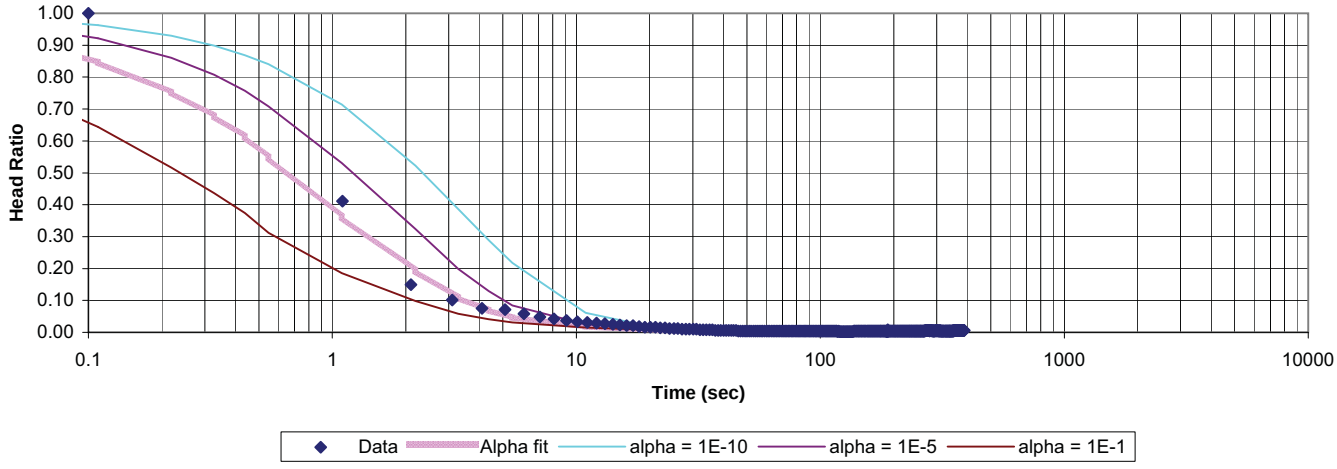
THE PEBBLE PARTNERSHIP

Borehole No:	KP-P3S	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	1.8-6	Test time:	7:34 PM
Test length (m):	4.2	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.052502	Analyst:	Alex Rosenberg
K (m/s):	3.0E-04	Transmissivity (m^2/s):	1.26E-03
Storage:	5.00E-04	Alpha:	2.93E-03

Water Level Change



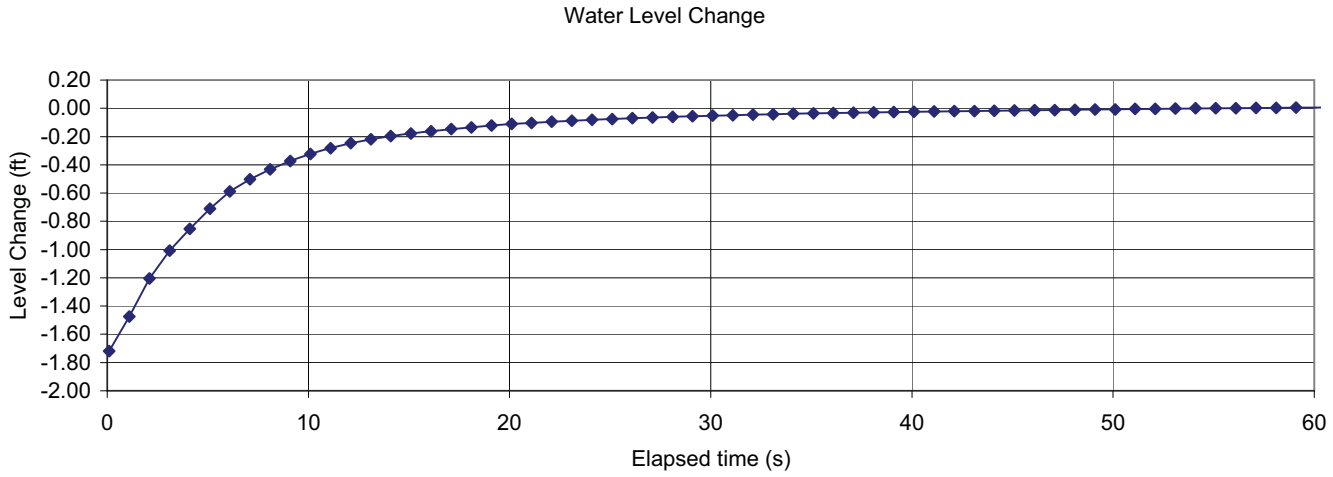
Head Ratio Plot

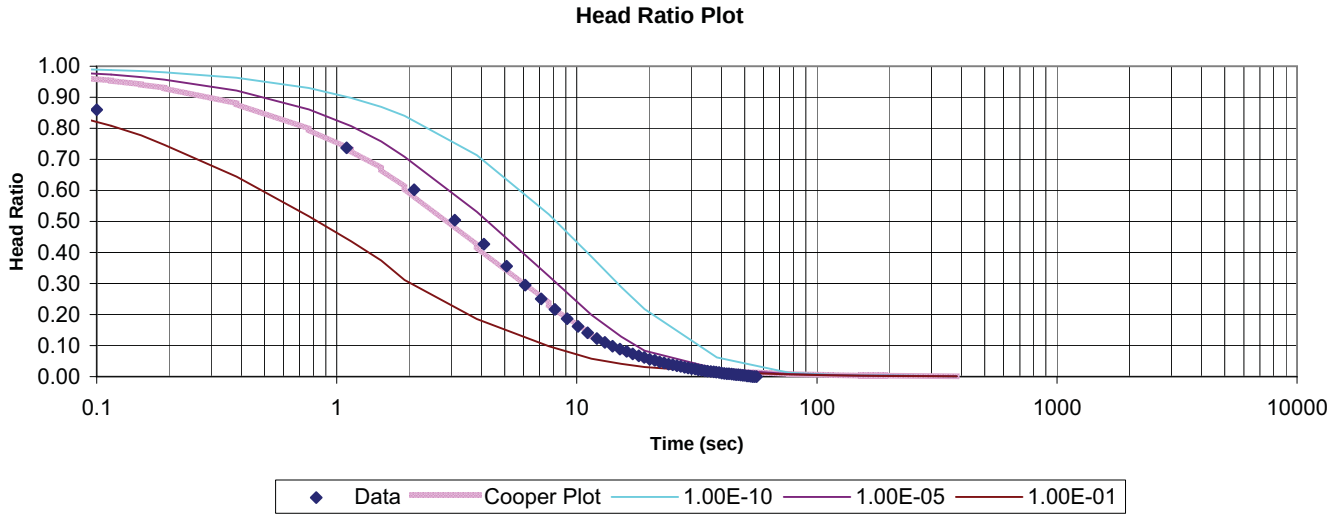


Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

Borehole No:	KP-P3M	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	11.3-15.8	Test time:	5:50 PM
Test length (m):	4.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.052502	Analyst:	Alex Rosenberg
K (m/s):	8.0E-05	Transmissivity (m^2/s):	3.60E-04
Storage:	1.00E-04	Alpha:	5.85E-04

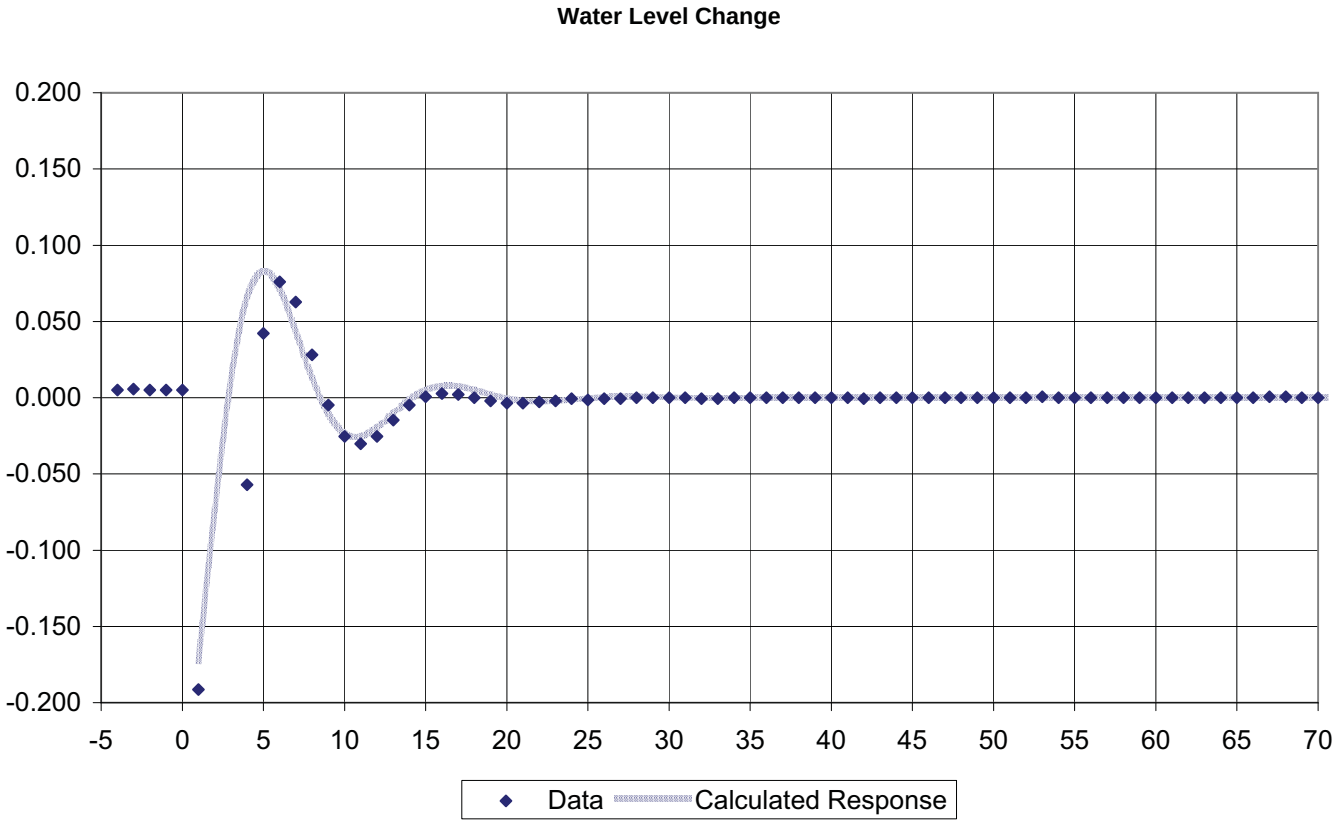




Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	KP-P3D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04/09/2004
Zone depth (m):	19.8-24	Test time:	6:49 PM
Test length (m):	4.2	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.053	Analyst:	Alex Rosenberg
Depth of screen (m):	22.00	d:	0.35
Depth to water (m):	0.10	angular frequency (per second):	0.55
Height of water predicted(m):	28.00	damping constant:	0.21
Height of water (m):	21.90	Initial amplitude:	-0.25
K (m/s):	2.8E-04	Transmissivity (m^2/s)	1.18E-03
Storage:	2.00E-04		

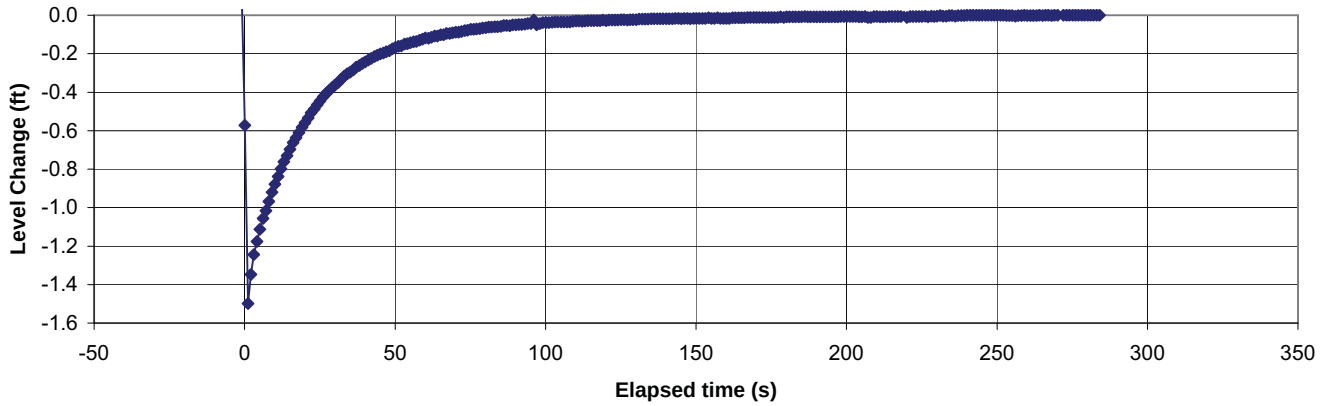


Borehole Response Test - Cooper Papadopulos Method

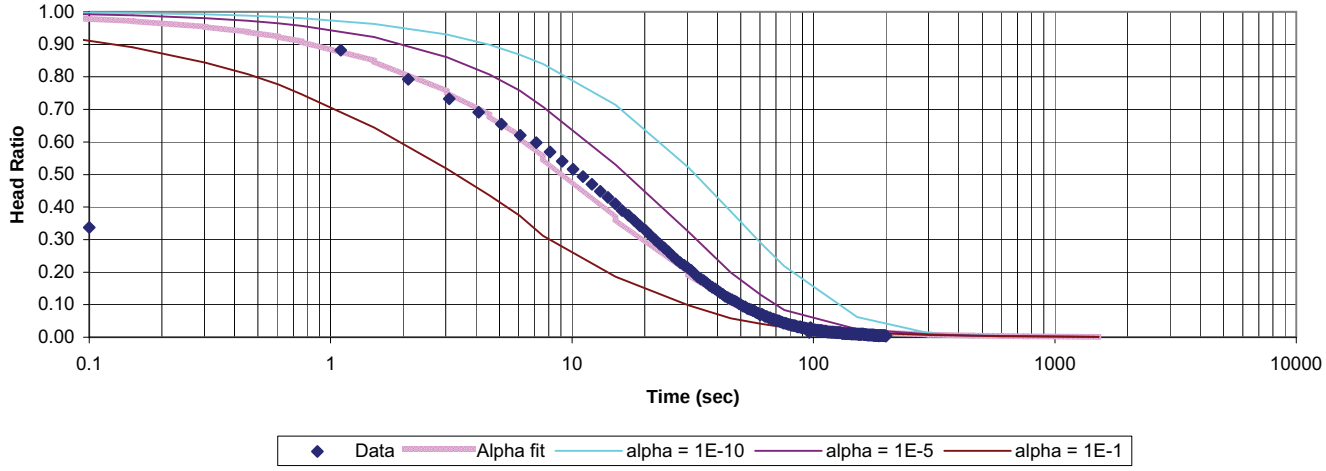
THE PEBBLE PARTNERSHIP
Northern Dynasty Minerals

Borehole No:	KP-P4	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	04-Sep-04
Zone depth (m):	8.8-12.8	Test time:	12:17 PM
Test length (m):	4	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inside diameter (m):	0.049	Analyst:	Alex Rosenberg
K (m/s):	2.0E-05	Transmissivity (m^2/s):	8.00E-05
Storage:	4.00E-04	Alpha:	2.66E-03

Water Level Change



Head Ratio Plot

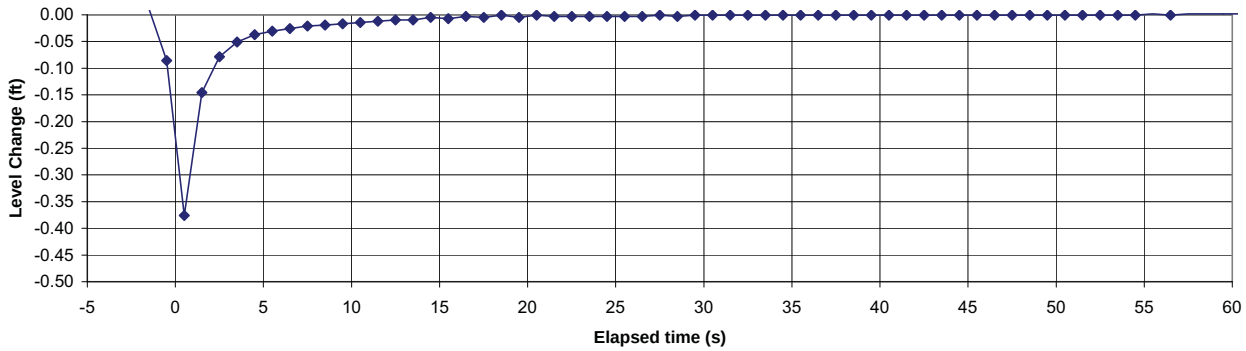


Borehole Response Test - Cooper Papadopulos Method

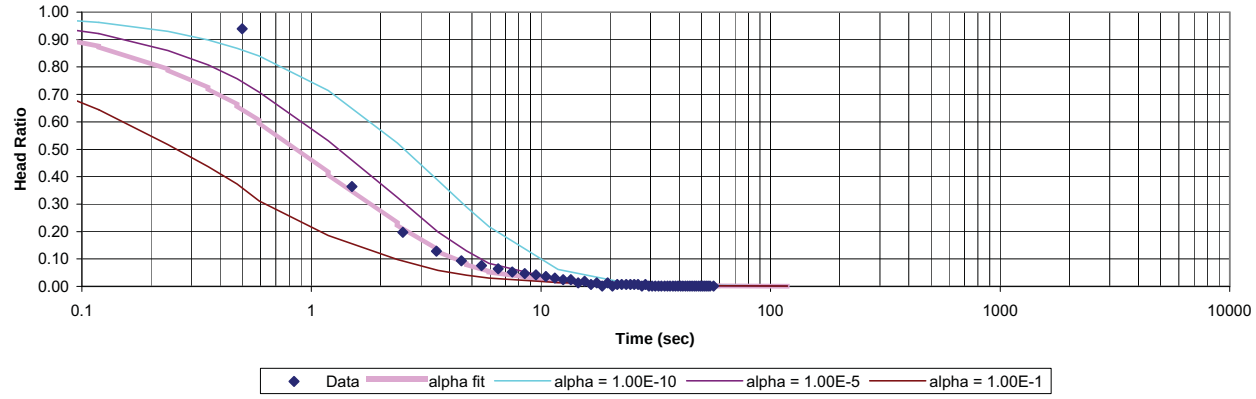
THE PEBBLE PARTNERSHIP

Borehole No:	MW-1S	Test Type	Rising head
Instrument type:	In-situ transducer	Test date:	17/08/2004
Test zone depth (m):	2-7	Test time:	3:52 PM
Test zone length (m):	5	Screen type:	2 " Sch 80 PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.084	Analyst:	Alex Rosenberg
K (m/s):	6.0E-04	Transmissivity (m^2/s)	3.00E-03
Storage:	3.00E-04	Alpha	6.80E-04

Water Level Change



Head Ratio Plot

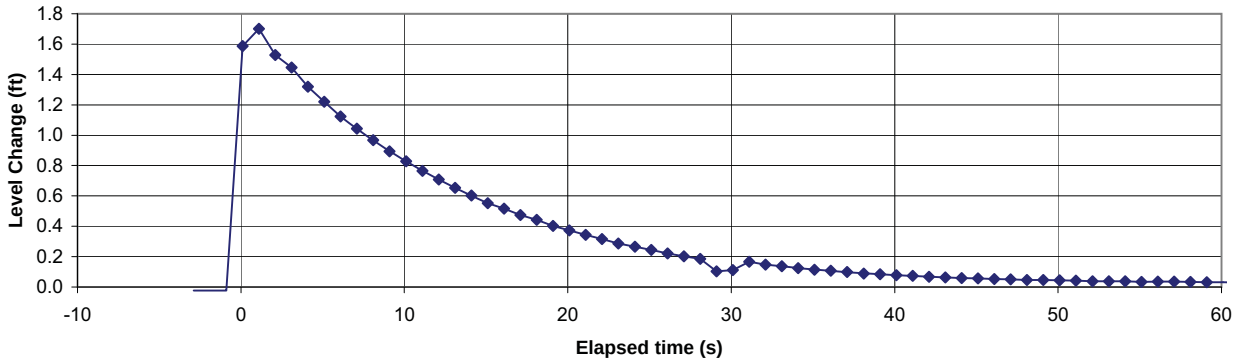


Borehole Response Test - Cooper Papadopulos Method

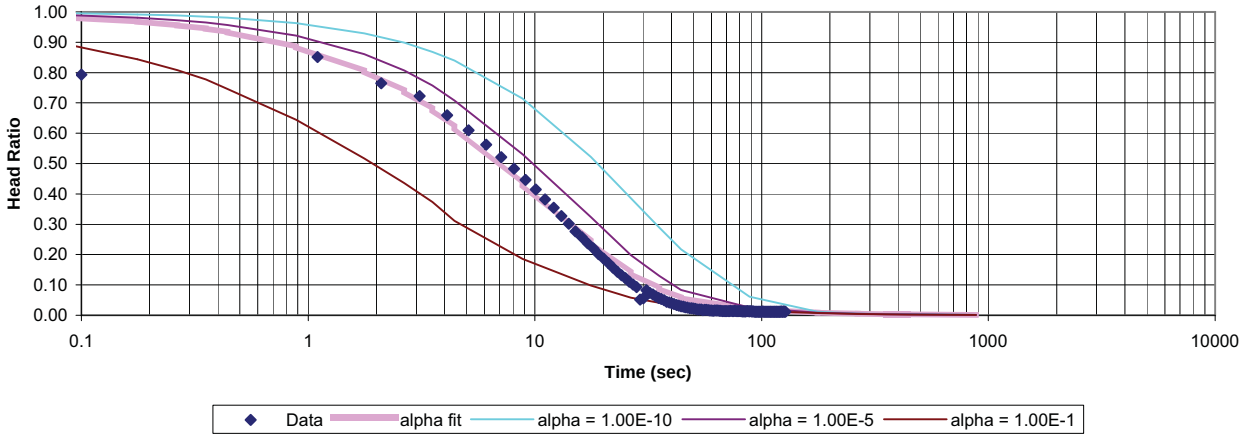
THE PEBBLE PARTNERSHIP

Borehole No:	MW1M	Test Type:	Falling head
Instrument type:	In-situ transducer	Test date:	########
Test zone depth (m):	20.4-29.6	Test time:	5:11 PM
Test zone length (m):	9.2	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inner diameter (m):	0.046	Analyst:	Alex Rosenberg
K (m/s):	1.3E-05	Transmissivity (m^2/s)	1.20E-04
Storage:	6.00E-05	Alpha	4.58E-04

MW-1M
Water Level Change



Head Ratio Plot

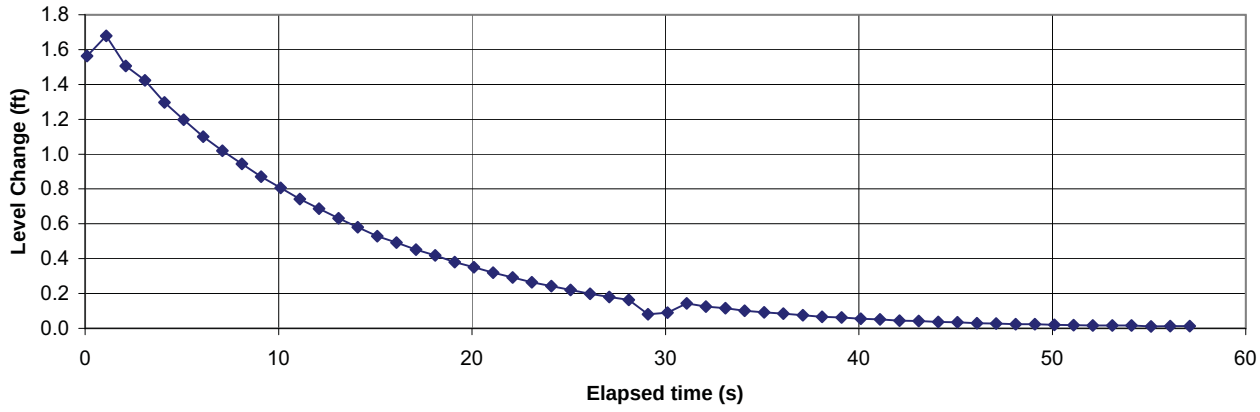


Borehole Response Test - Hvorslev Method

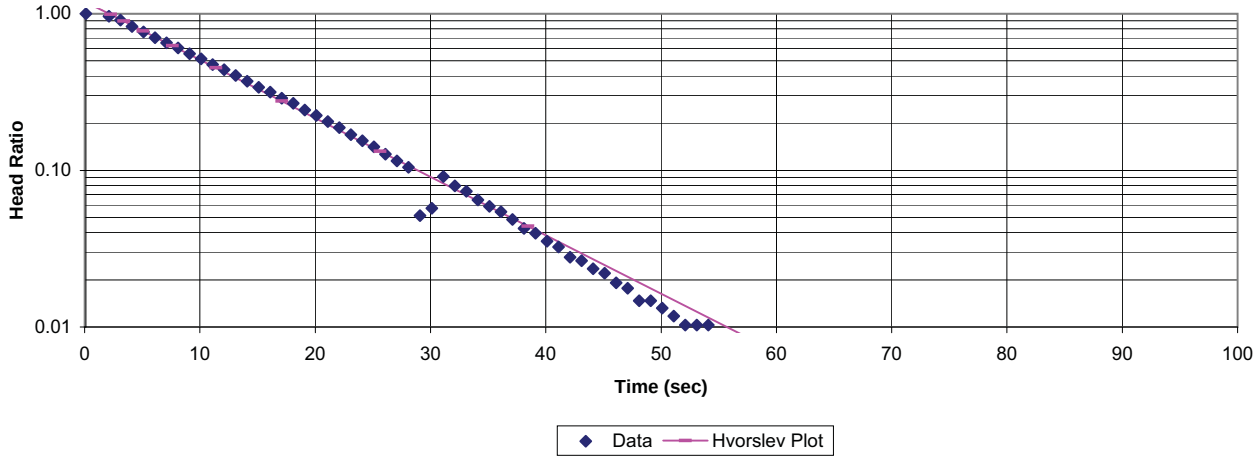
THE PEBBLE PARTNERSHIP

Borehole No:	MW1M rising	Test date:	17-Aug-04
Instrument type:	In-situ transducer	Test time:	5:11 PM
Test zone depth (m):	29.6	Screen type:	2 " PVC - 20 slot
Test zone length (m):	9.2	Field technician:	Alex Rosenberg
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser inner diameter (m):	0.053		
Hvorslev intercept:	1.2		
K (m/s):	1.6E-05	Transmissivity (m^2/s)	1.47E-04
Water level within test zone:	No		

Water Level Change



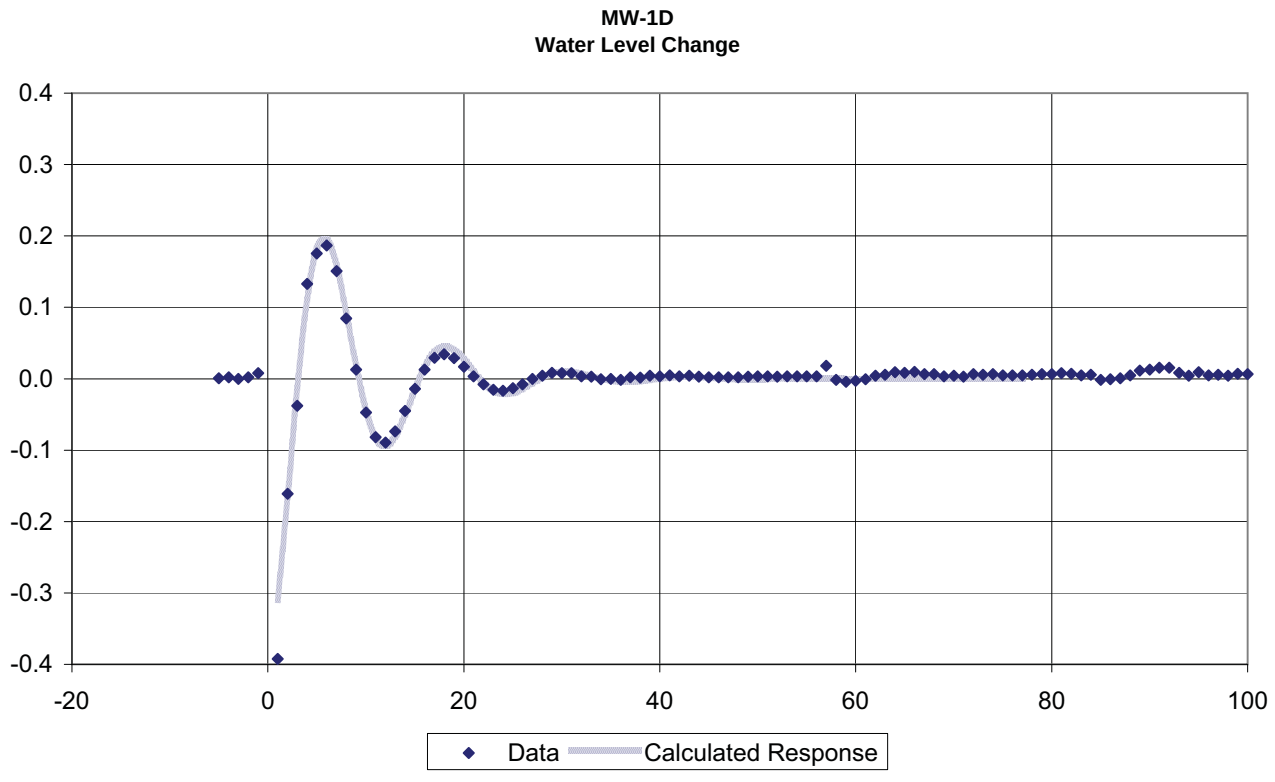
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

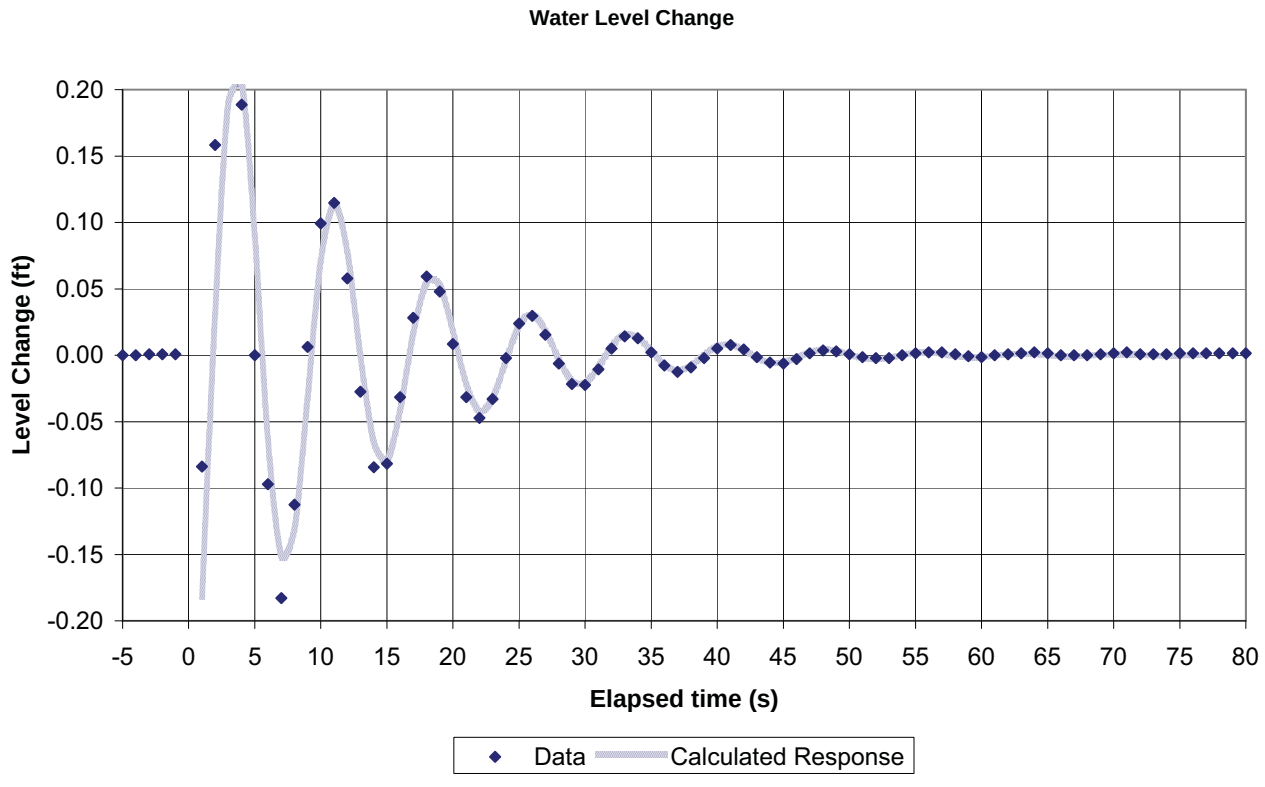
Borehole No:	MW1D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	17/08/2004
Test zone depth (m):	36.6-41.5	Test time:	4:37 PM
Test zone length (m):	4.9	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	40.00	d:	0.23
Depth to water (m):	1.70	angular frequency (per second):	0.51
Height of water predicted(m):	36.00	damping constant:	0.12
Height of water (m):	38.30	Initial amplitude:	-0.4
K (m/s):	2.6E-04	Transmissivity (m^2/s)	1.27E-03
Storage:	5.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

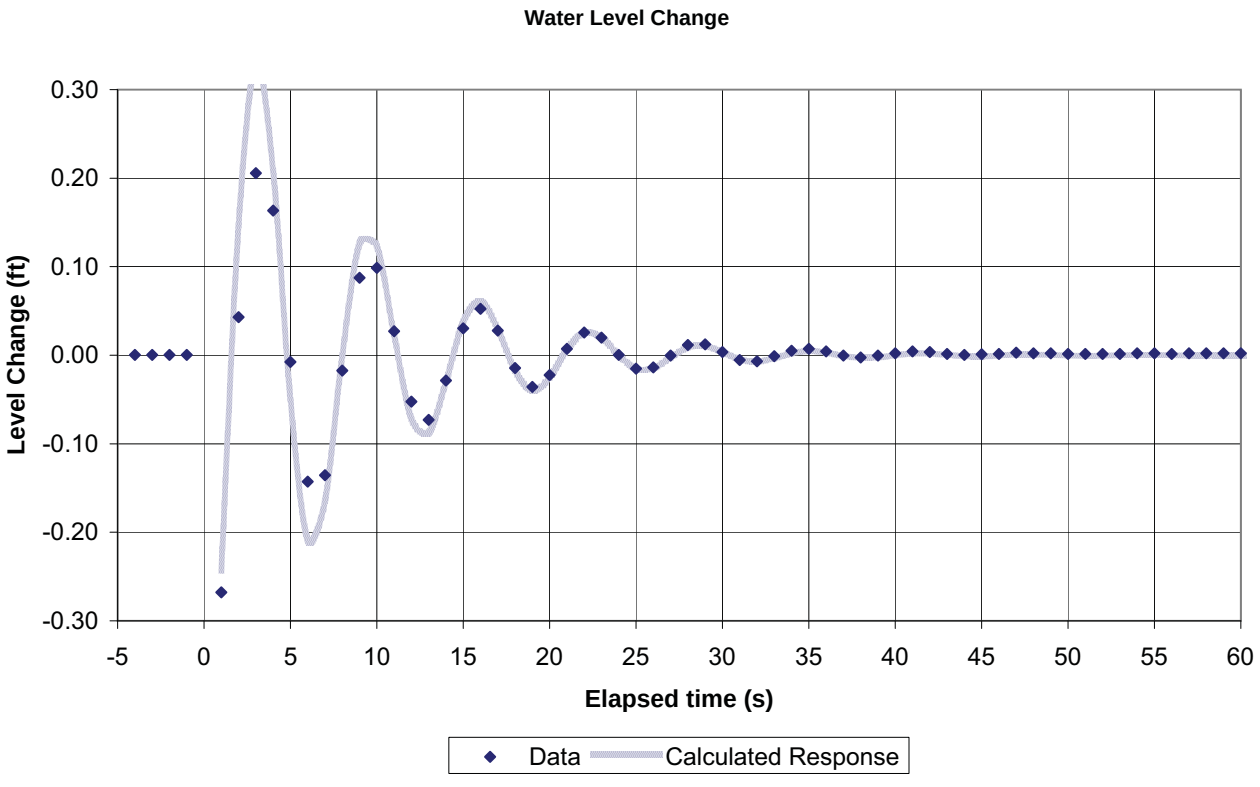
Borehole No:	MW2D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	18/08/2004
Test zone depth (m):	36 - 41	Test time:	5:47 PM
Test zone length (m):	5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.0508	Analyst:	Alex Rosenberg
Depth of screen (m):	38.50	d:	0.104
Depth to water (m):	26.70	angular frequency (per second):	0.85
Height of water predicted(m):	13.56	damping constant:	0.09
Height of water (m):	11.80	Initial amplitude:	-0.3
K (m/s):	1.1E-03	Transmissivity (m^2/s)	5.50E-03
Storage:	5.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW3D	Test Type:	Rising head
Instrument type:	In-situ transducer	Test date:	19/08/2004
Test zone depth (m):	54-60	Test time:	6:00 PM
Test zone length (m):	7.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.0492506	Analyst:	Alex Rosenberg
Depth of screen (m):	57.00	d:	1.33E-01
Depth to water (m):	46.60	angular frequency (per second):	0.98
Height of water predicted(m):	10.00	damping constant:	0.13
Height of water (m):	10.40	Initial amplitude:	-0.5
K (m/s):	6.4E-04	Transmissivity (m^2/s)	4.80E-03
Storage:	3.00E-04		

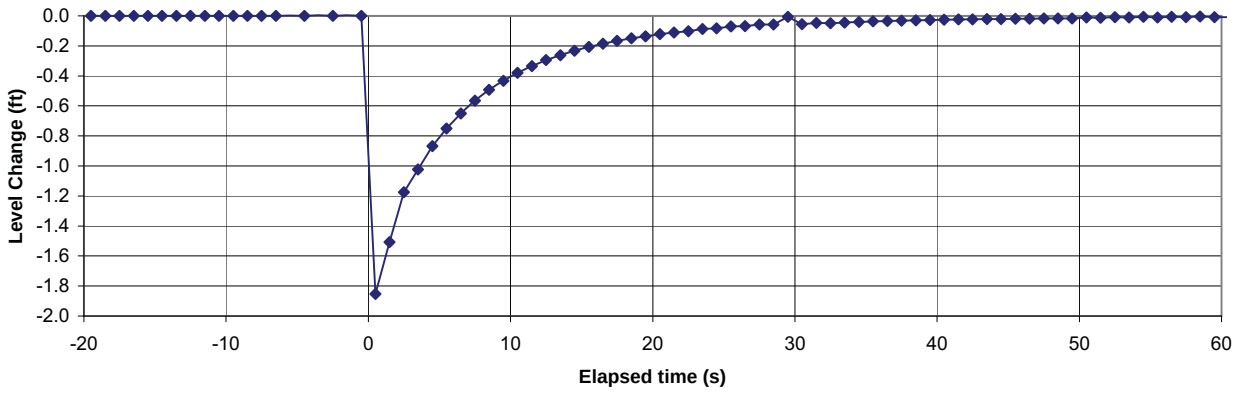


Borehole Response Test - Cooper Papadopulos Method

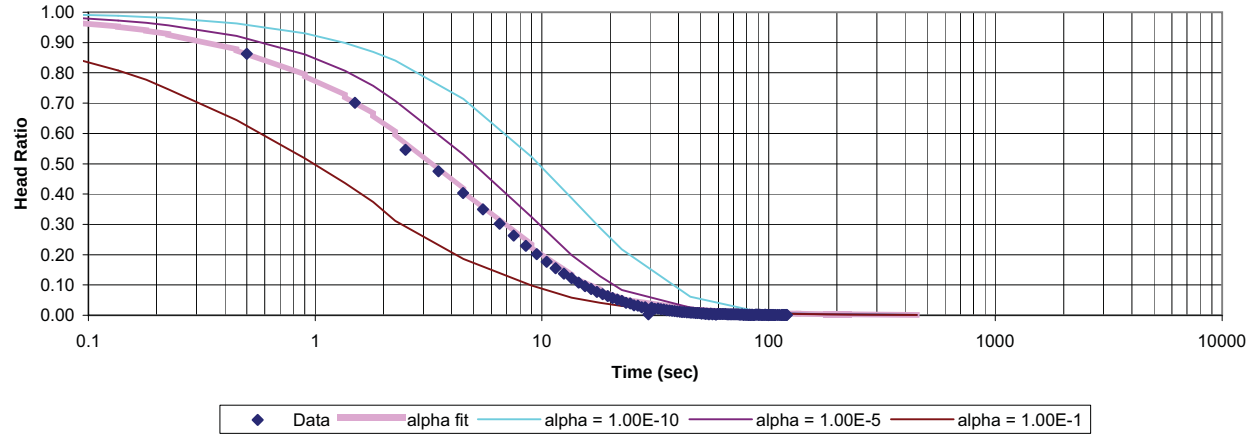
THE PEBBLE PARTNERSHIP

Borehole No:	MW5S	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	########
Test zone depth (m):	7.62-13	Test time:	1:50 PM
Test zone length (m):	5.38	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
K (m/s):	5.0E-05	Transmissivity (m^2/s)	2.69E-04
Storage:	1.00E-04	Alpha	6.65E-04

Water Level Change



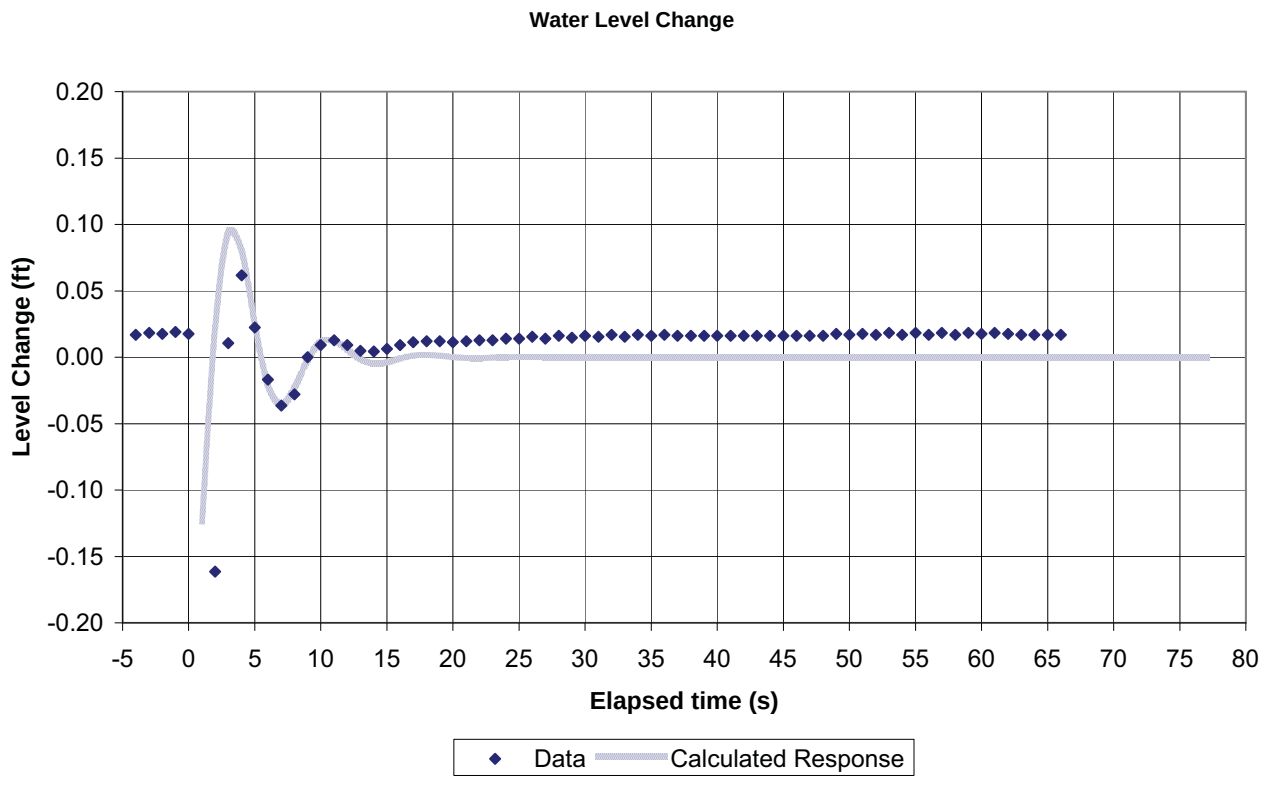
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW5M	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	20/08/2004
Test zone depth (m):	15.8-21.3	Test time:	1:36 PM
Test zone length (m):	5.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	19.00	d:	0.302
Depth to water (m):	0.60	angular frequency (per second):	0.86
Height of water predicted(m):	12.00	damping constant:	0.27
Height of water (m):	18.40	Initial amplitude:	-0.25
K (m/s):	3.0E-04	Transmissivity (m^2/s)	1.65E-03
Storage:	4.00E-04		

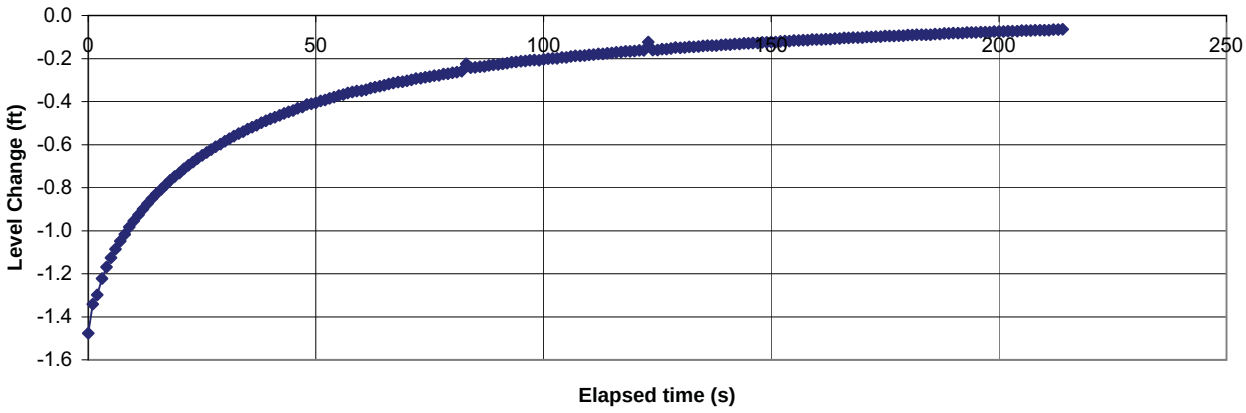


Borehole Response Test - Cooper Papadopulos Method

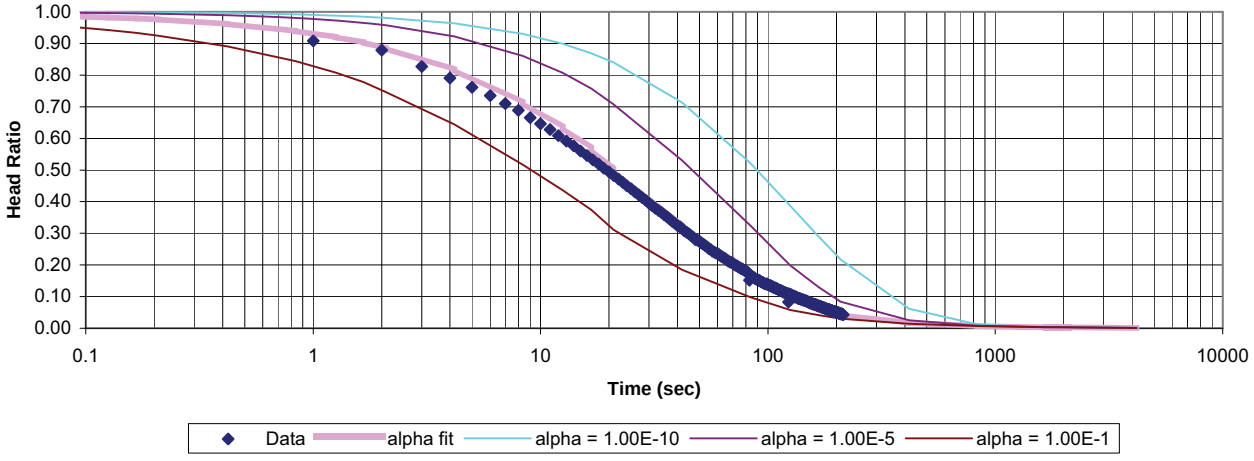
THE PEBBLE PARTNERSHIP

Borehole No:	MW-5D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	20-Aug-04
Test zone depth (m):	25.9-31.7	Test time:	12:17 PM
Test zone length (m):	5.8	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
	1		
K (m/s):	5.0E-06	Transmissivity (m^2/s)	2.90E-05
Storage:	1.00E-03	Alpha	6.65E-03

Water Level Change



Head Ratio Plot

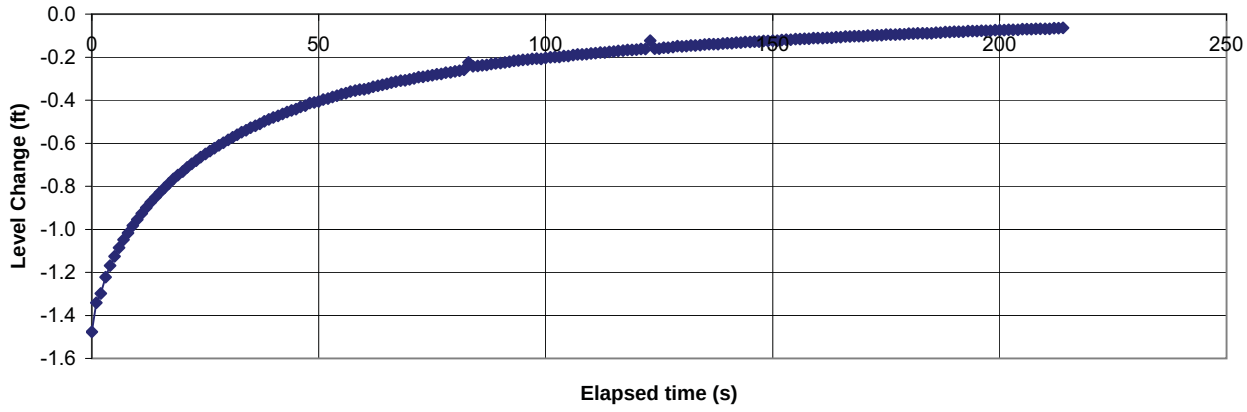


Borehole Response Test - Hvorslev Method

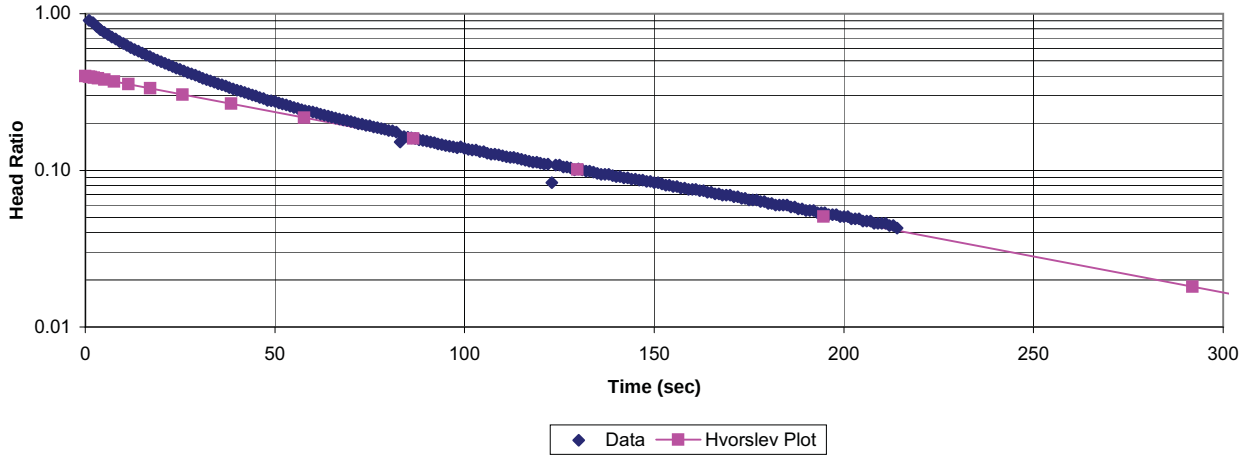
THE PEBBLE PARTNERSHIP

Borehole No:	MW5D rising	Test date:	20-Aug-04
Instrument type:	In-situ transducer	Test time:	12:17 PM
Test zone depth (m):	25.9-31.7	Screen type:	2 " PVC - 20 slot
Test zone length (m):	5.8	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser inner diameter (m):	0.049		
Hvorslev intercept:	0.4		
K (m/s):	2.5E-06	Transmissivity (m^2/s)	1.45E-05
ter level within test zone:	No		

Water Level Change



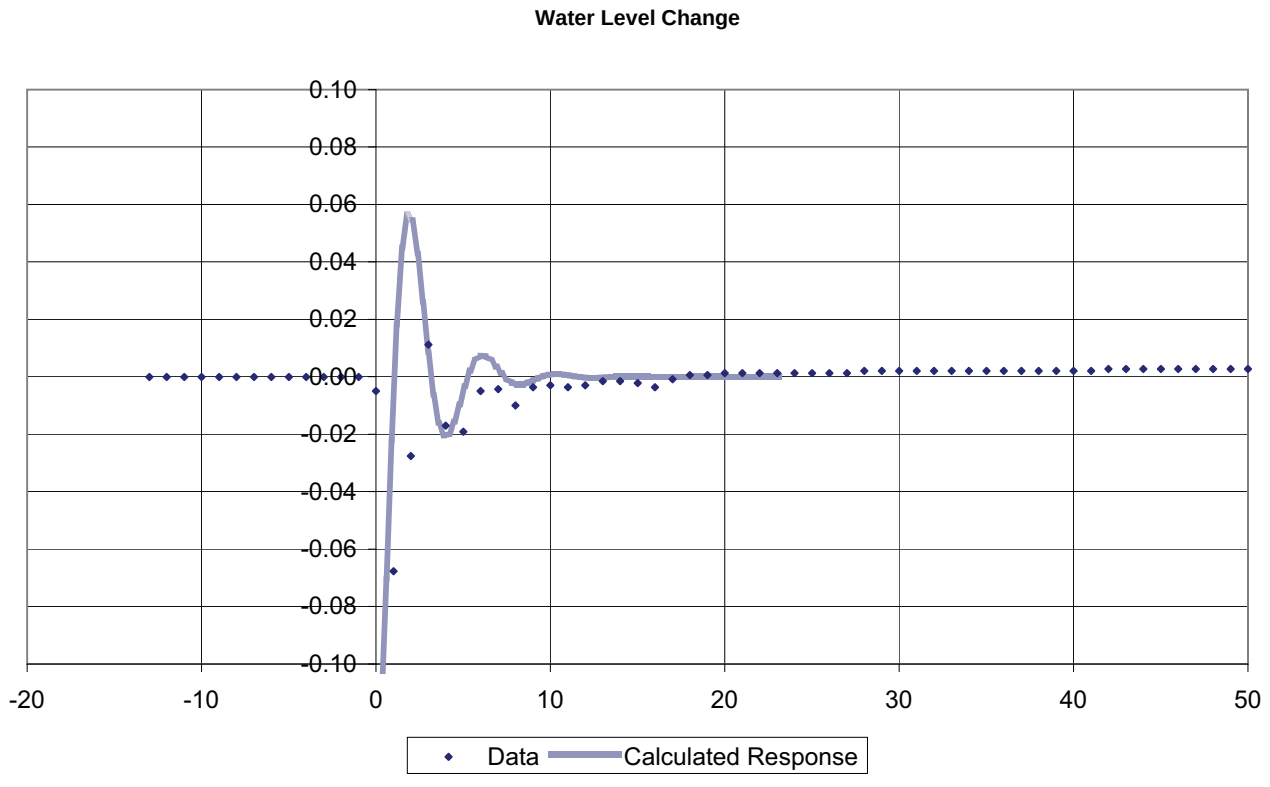
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW6D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	05/09/2004
Test zone depth (m):	23.8-30	Test time:	2:12 PM
Test zone length (m):	6.2	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	30.00	d:	0.307
Depth to water (m):	20.30	angular frequency (per second):	1.49
Height of water predicted(m):	4.00	damping constant:	0.48
Height of water (m):	9.70	Initial amplitude:	-0.15
K (m/s):	5.5E-04	Transmissivity (m^2/s)	3.41E-03
Storage:	1.00E-04		

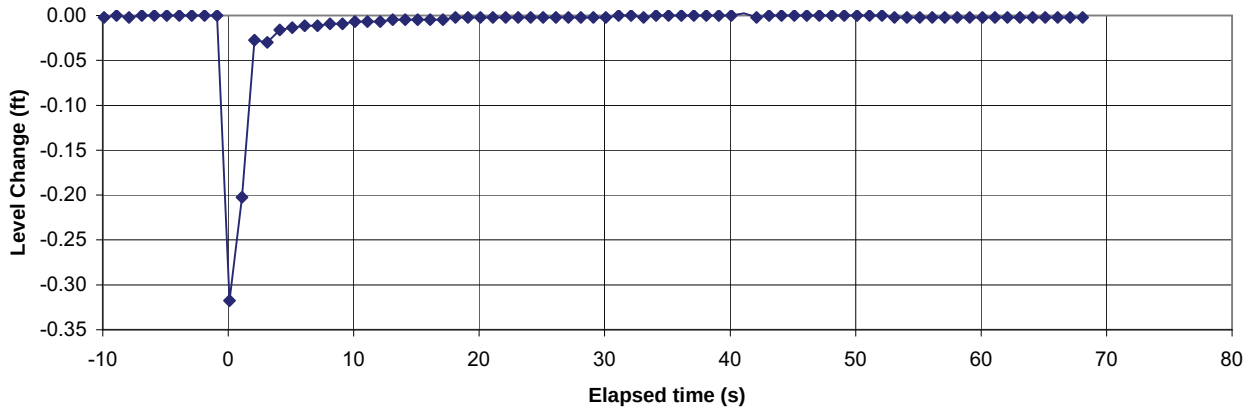


Borehole Response Test - Cooper Papadopulos Method

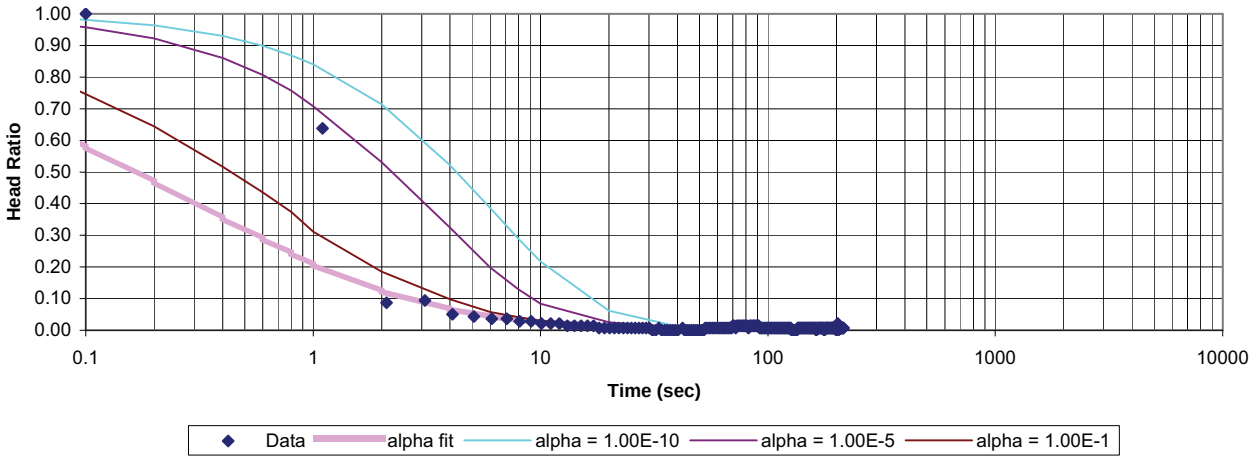
THE PEBBLE PARTNERSHIP

Borehole No:	MW-7S	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	16-Aug-04
Test zone depth (m):	4.6-10	Test time:	7:08 PM
Test zone length (m):	5.4	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.081	Analyst:	Alex Rosenberg
K (m/s):	3.0E-04	Transmissivity (m^2/s)	1.62E-03
Storage:	3.00E-01	Alpha	7.47E-01

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

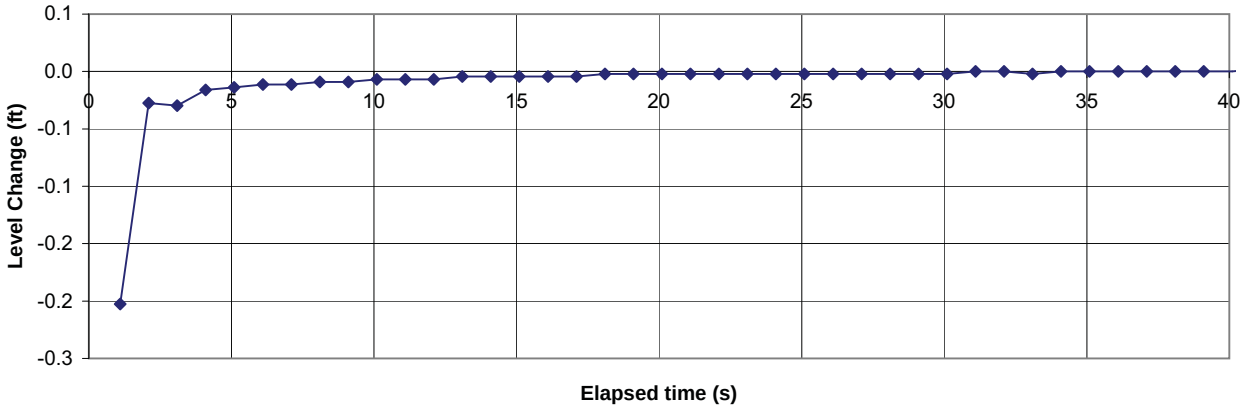
Borehole No:	MW7S rising	Test date:	16-Aug-04
Instrument type:	In-situ transducer	Test time:	7:08 PM
Test zone depth (m):	4.6-10	Screen type:	2 " PVC - 20 slot
Test zone length (m):	5.4	Field technician:	
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser inner diameter (m):	0.081		
Hvorslev intercept:	0.12		

K (m/s): 1.0E-04

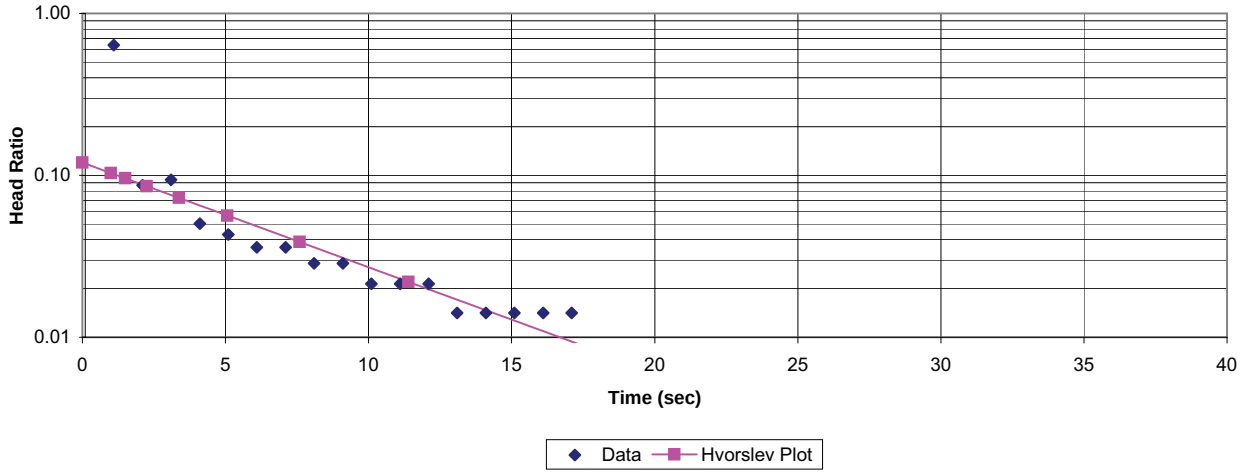
Transmissivity (m^2/s) 5.40E-04

ter level within test zone: Yes

Water Level Change



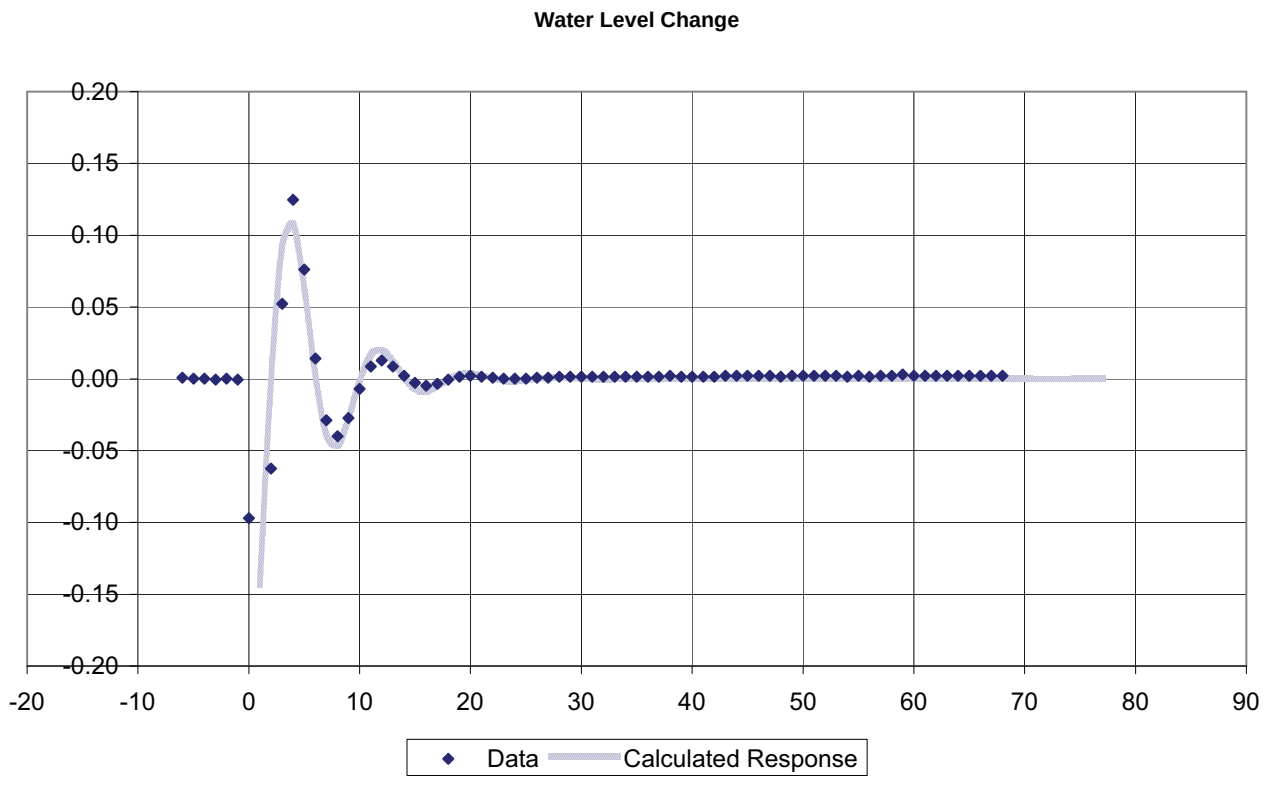
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

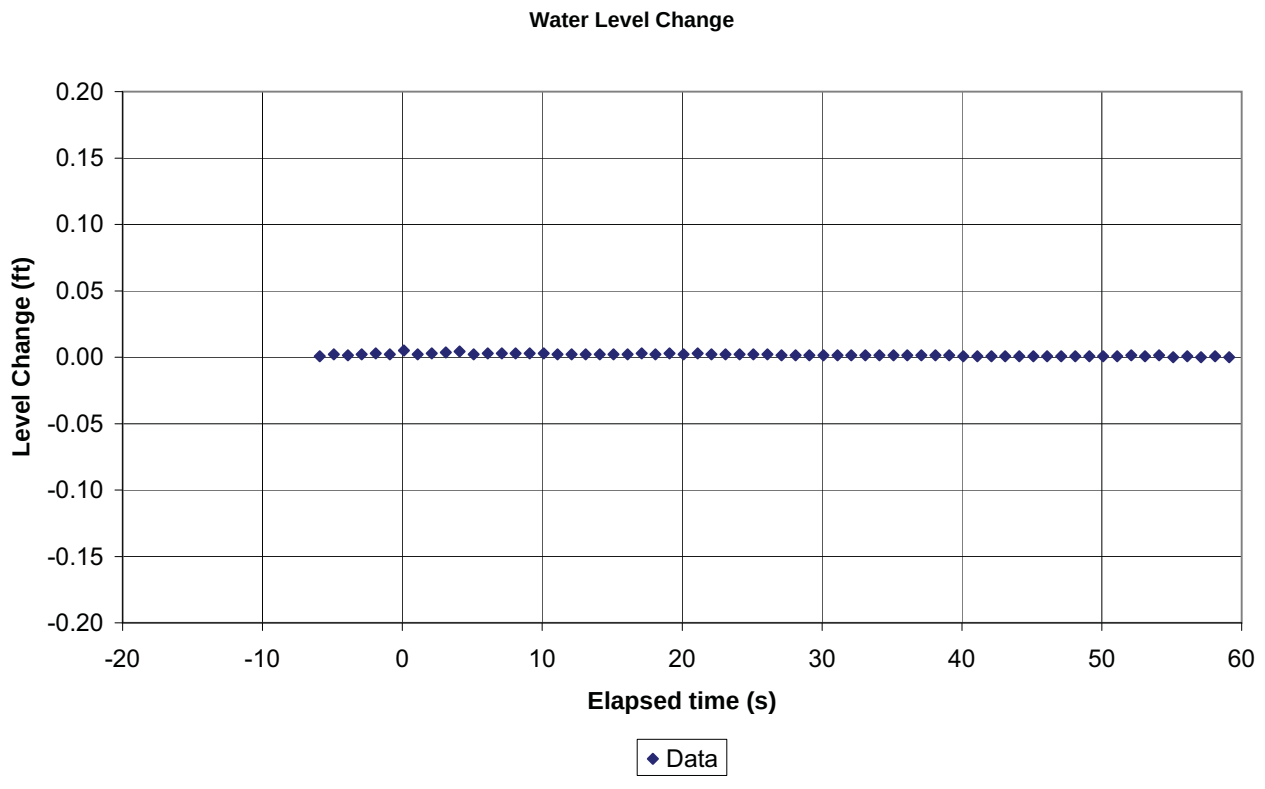
Borehole No:	MW7D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	16/08/2004
Test zone depth (m):	16.46-22.3	Test time:	6:26 PM
Test zone length (m):	5.84	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	21.00	d:	0.260
Depth to water (m):	4.70	angular frequency (per second):	0.78
Height of water predicted(m):	15.00	damping constant:	0.21
Height of water (m):	16.30	Initial amplitude:	-0.25
K (m/s):	3.0E-04	Transmissivity (m^2/s)	1.75E-03
Storage:	4.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

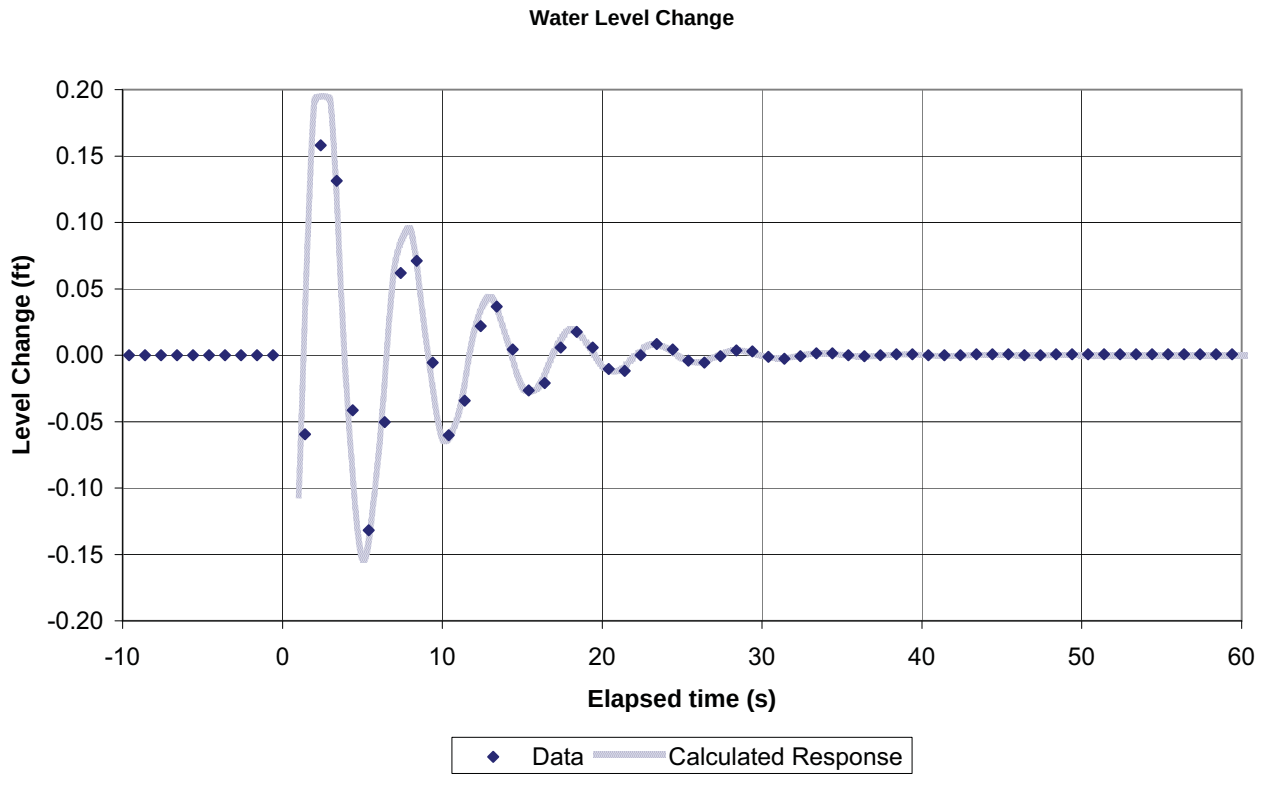
Borehole No:	MW8S	Test type:	Falling head
Instrument type:	In-situ transducer	Test date:	14/08/2004
Test zone depth (m):	1.8-5.5	Test time:	5:48 PM
Test zone length (m):	3.7	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.081	Analyst:	Alex Rosenberg
Depth of screen (m):	57.00	d:	
Depth to water (m):	57.00	angular frequency (per second):	
Height of water predicted(m):	10.40	damping constant:	
Height of water (m):	10.40	Initial amplitude:	
K (m/s):		Transmissivity (m^2/s)	
Storage:			



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

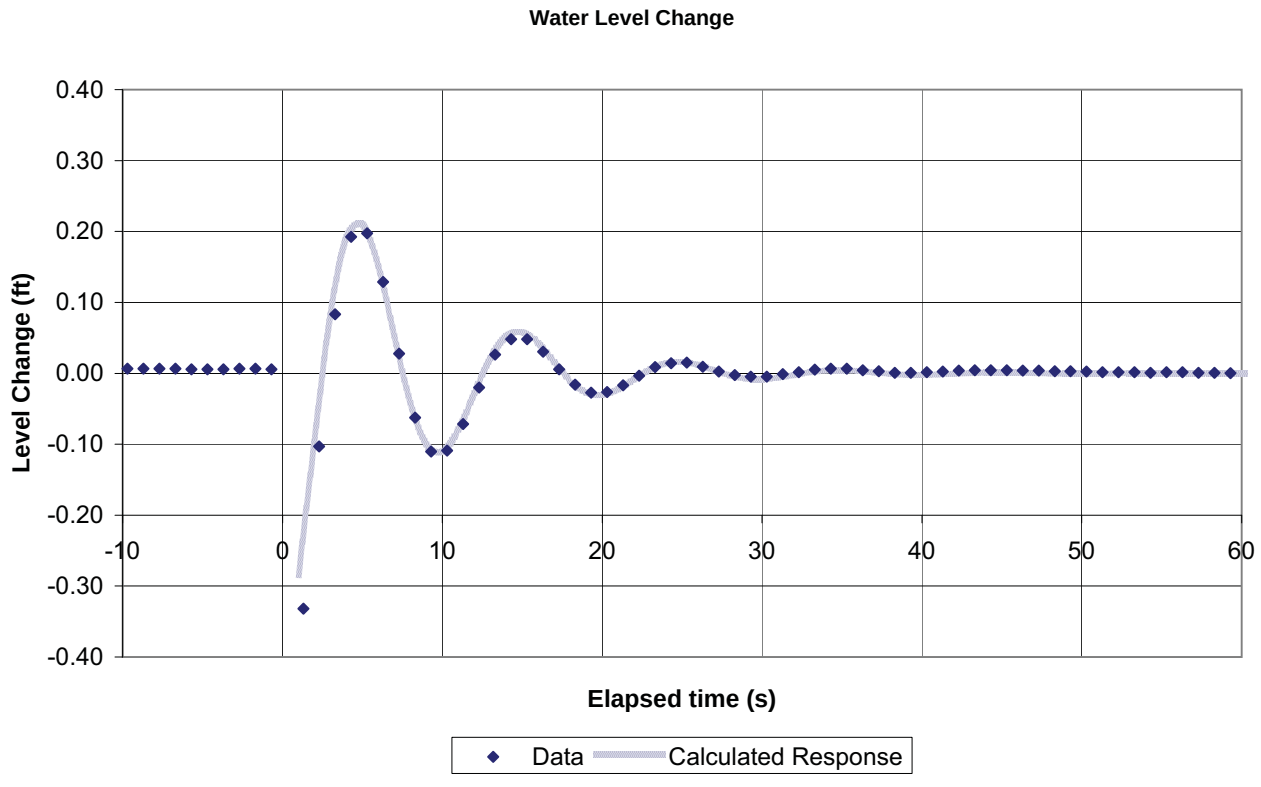
Borehole No:	MW8M	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	14/08/2004
Test zone depth (m):	8-15.5	Test time:	5:15 PM
Test zone length (m):	7.5	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	12.00	d:	0.131
Depth to water (m):	3.60	angular frequency (per second):	1.21
Height of water predicted(m):	6.60	damping constant:	0.16
Height of water (m):	8.40	Initial amplitude:	-0.35
K (m/s):	7.5E-04	Transmissivity (m^2/s)	5.63E-03
Storage:	5.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

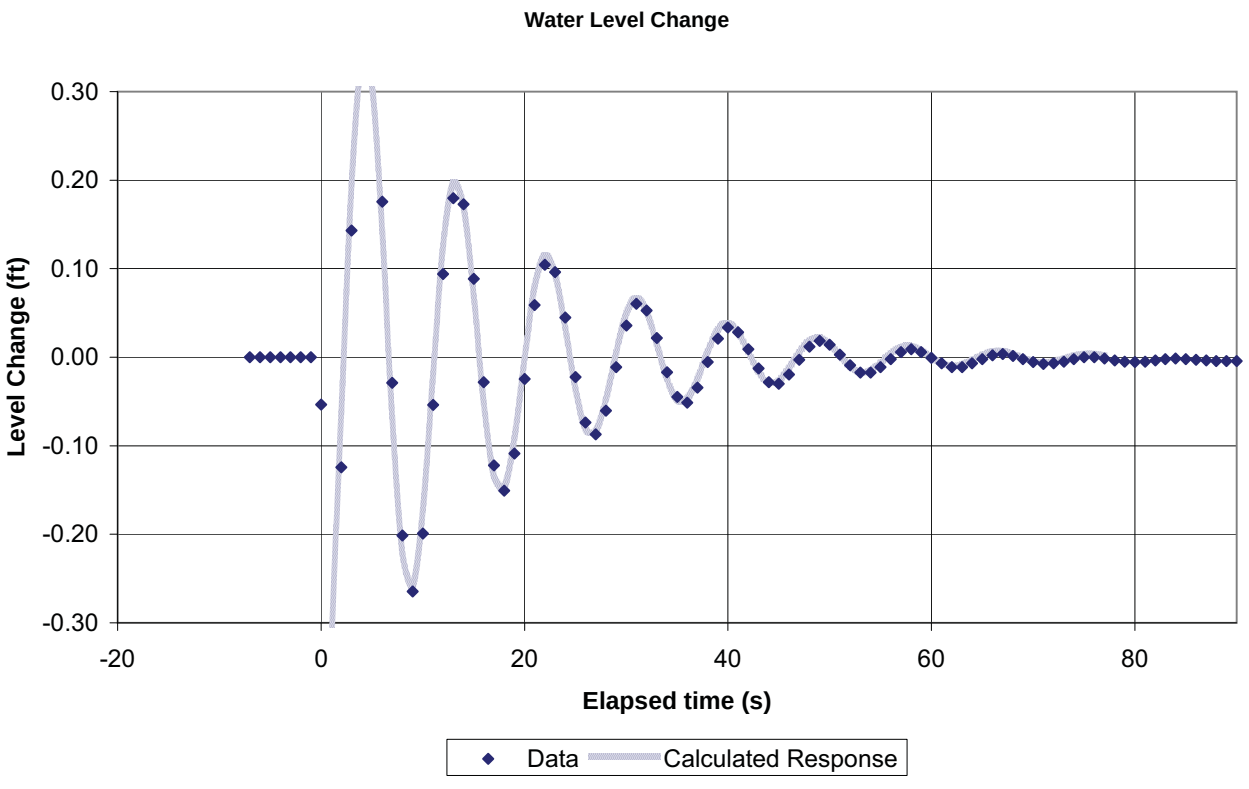
Borehole No:	MW8D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	14/08/2004
Test zone depth (m):	24.4-31.4	Test time:	1:11 PM
Test zone length (m):	7	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	28.00	d:	0.201
Depth to water (m):	2.80	angular frequency (per second):	0.63
Height of water predicted(m):	24.00	damping constant:	0.13
Height of water (m):	25.20	Initial amplitude:	-0.4
K (m/s):	3.2E-04	Transmissivity (m^2/s)	2.24E-03
Storage:	1.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

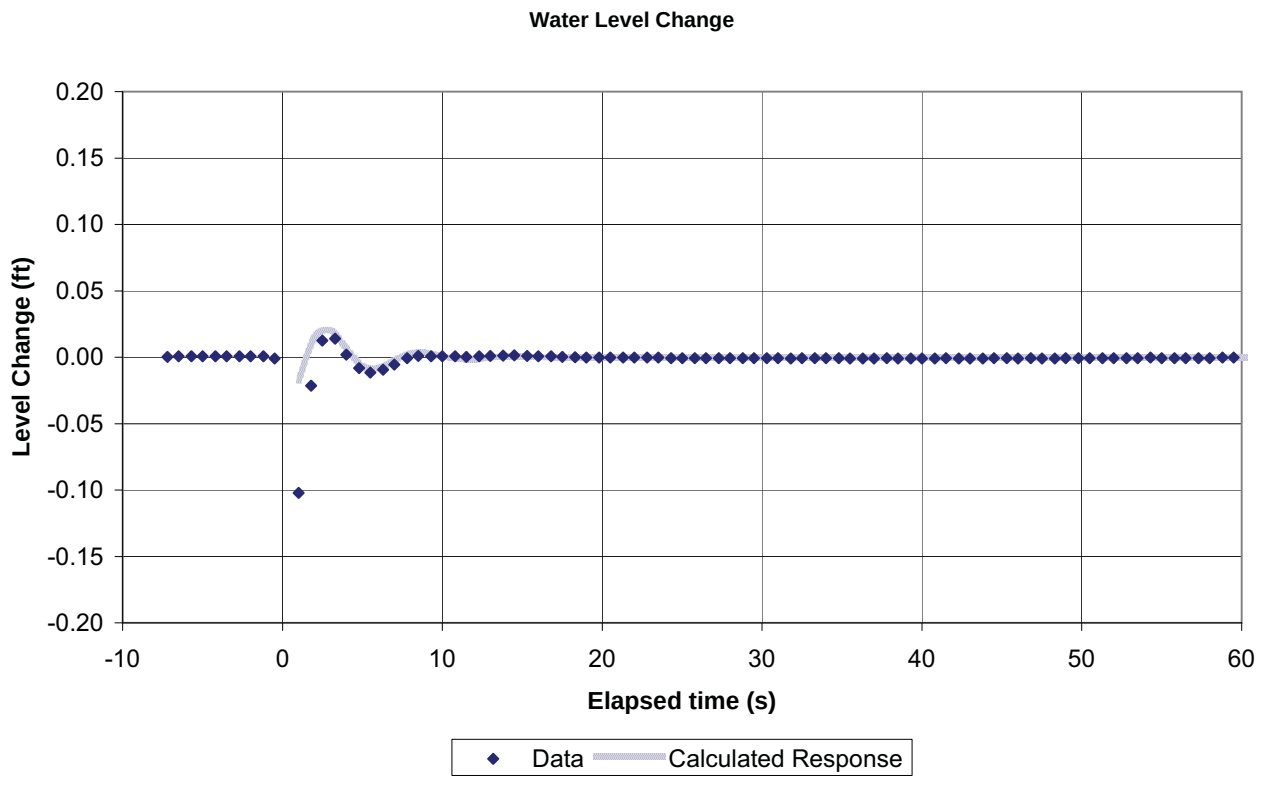
Borehole No:	MW9	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	16/08/2004
Test zone depth (m):	15.5-22.6	Test time:	5:15 PM
Test zone length (m):	7	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	
Riser inner diameter (m):	0.049	Analyst:	Alex Rosenberg
Depth of screen (m):	21.00	d:	0.087
Depth to water (m):	1.20	angular frequency (per second):	0.71
Height of water predicted(m):	19.50	damping constant:	0.06
Height of water (m):	19.80	Initial amplitude:	-0.45
K (m/s):	8.0E-04	Transmissivity (m^2/s)	5.60E-03
Storage:	3.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW11S	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	18/10/2004
Test zone depth (m):	14.3-25.6	Test time:	11:45 AM
Test zone length (m):	11	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inner diameter (m):	0.082	Analyst:	Alex Rosenberg
Depth of screen (m):	18.30	d:	0.270
Depth to water (m):	16.45	angular frequency (per second):	1.07
Height of water predicted(m):	8.00	damping constant:	0.30
Height of water (m):	9.14	Initial amplitude:	-0.05
K (m/s):	7.0E-04	Transmissivity (m^2/s)	7.70E-03
Storage:	3.00E-04		



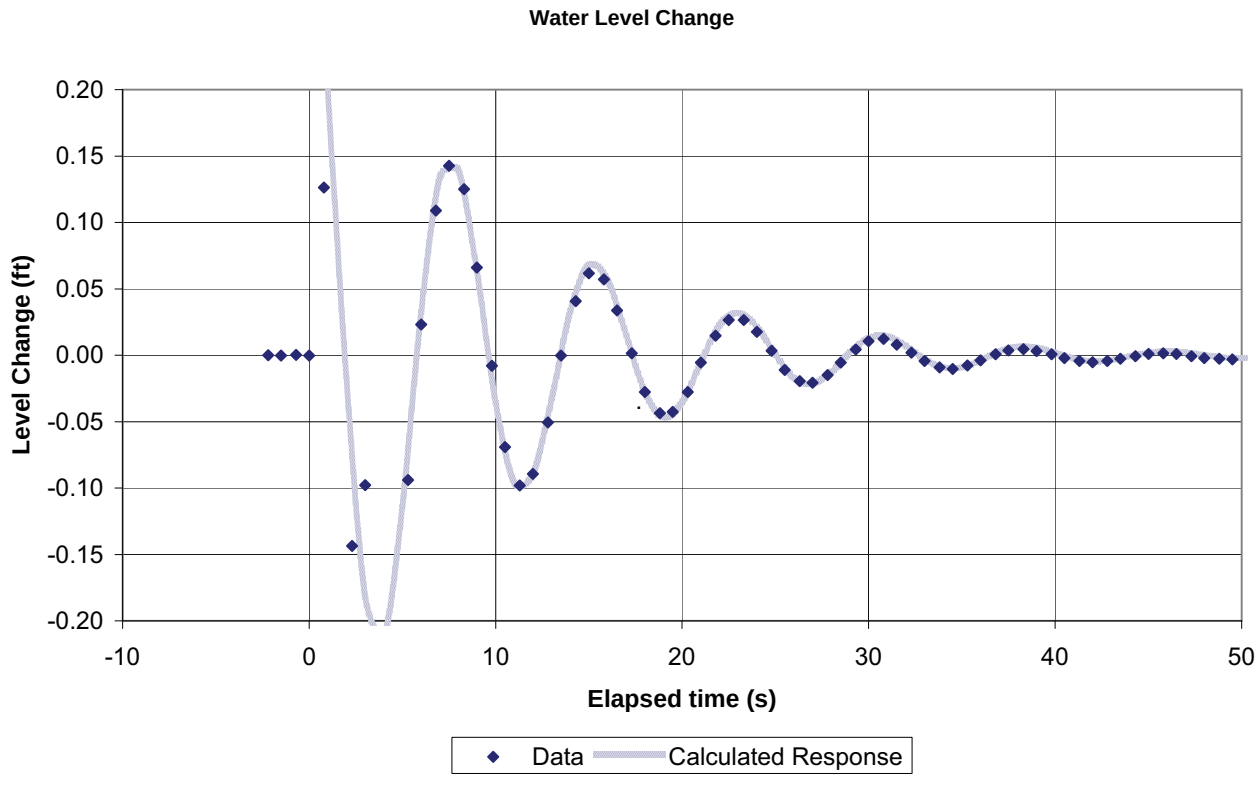
Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW11M insert	Test date:	18/10/2004
Instrument type:	In-situ transducer	Test time:	11:27 AM
Test zone depth (m):	30.2-34.4	Screen type:	2 " PVC - 20 slot
Test zone length (m):	4.2	Field technician:	Alex Rosenberg
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser inner diameter (m):	0.0459487		
		d:	1.22E-01
Depth of screen (m):	33.00	angular frequency (per second):	0.82
Depth to water (m):	15.70	damping constant:	0.10
Height of water predicted(m):	14.50	Initial amplitude:	0.32
Height of water (m):	17.30		
K (m/s):	9.0E-04	Transmissivity (m^2/s)	3.78E-03
Storage:	3.00E-04		

Water level within test zone: No

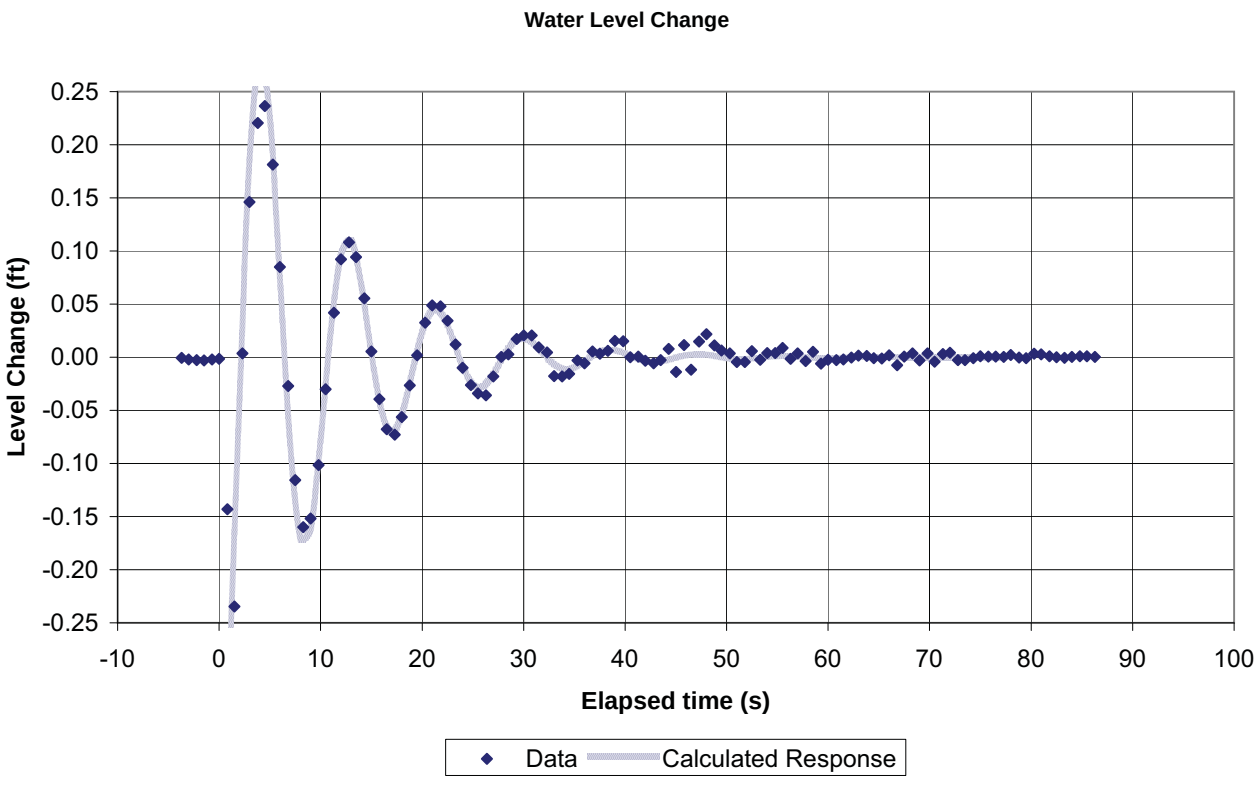
comment: effective diameter reduced because of waterra tubing inserted into riser pipe.



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW11M	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	18/10/2004
Test zone depth (m):	30.2-34.4	Test time:	11:27 AM
Test zone length (m):	4.2	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inner diameter (m):	0.053	Analyst:	Alex Rosenberg
Depth of screen (m):	33.00	d:	0.144
Depth to water (m):	15.70	angular frequency (per second):	0.73
Height of water predicted(m):	18.00	damping constant:	0.11
Height of water (m):	17.30	Initial amplitude:	-0.44
K (m/s):	9.0E-04	Transmissivity (m^2/s)	3.78E-03
Storage:	3.00E-04		



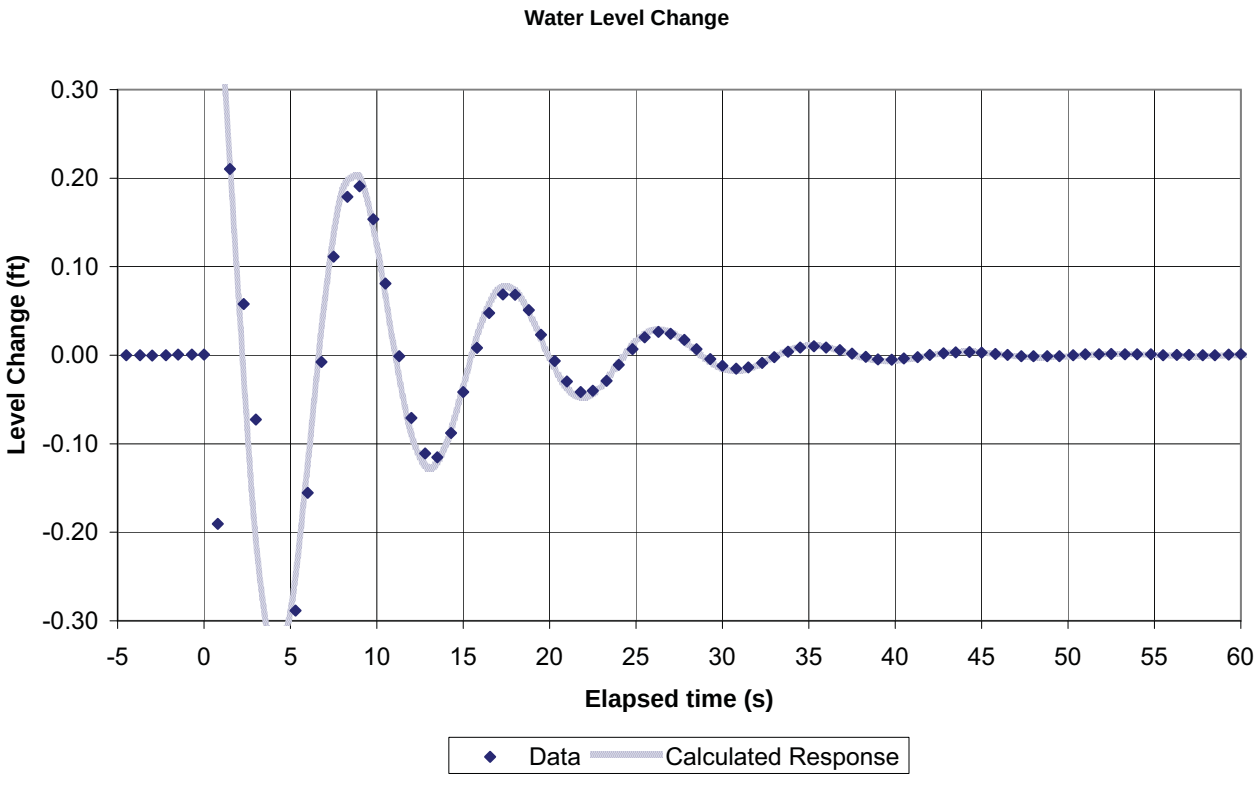
Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW11D insert	Test date:	18/10/2004
Instrument type:	In-situ transducer	Test time:	11:56 AM
Test zone depth (m):	38.4-42	Screen type:	2 " PVC - 20 slot
Test zone length (m):	3.6	Field technician:	Alex Rosenberg
Hole diameter (m):	0.127	Analyst:	Alex Rosenberg
Riser inner diameter (m):	0.046		
		d:	1.54E-01
Depth of screen (m):	40.00	angular frequency (per second):	0.71
Depth to water (m):	15.90	damping constant:	0.11
Height of water predicted(m):	19.00	Initial amplitude:	0.55
Height of water (m):	24.10		
K (m/s):	7.0E-04	Transmissivity (m^2/s)	2.52E-03
Storage:	3.00E-04		

Water level within test zone: No

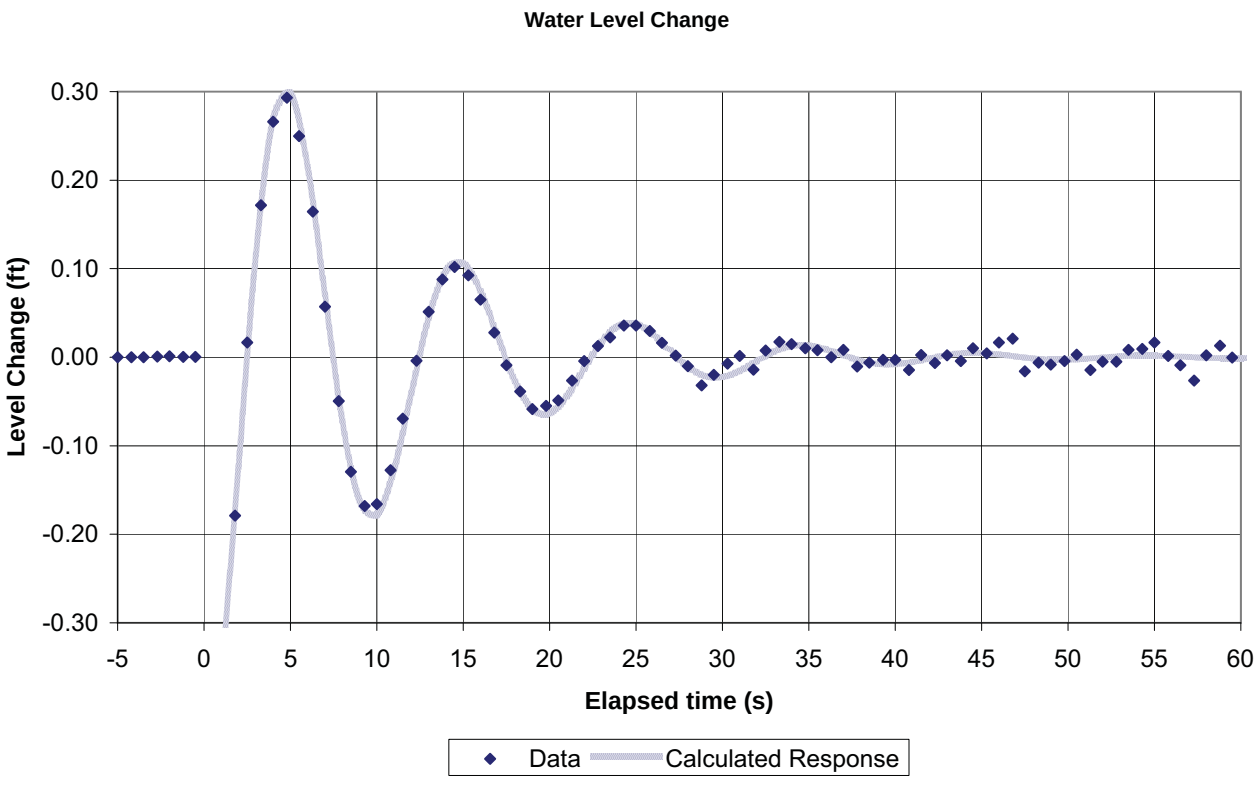
comment: effective diameter reduced because of waterra tubing inserted into riser pipe.



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW11D	Test type:	Rising head
Instrument type:	In-situ transducer	Test date:	18/10/2004
Test zone depth (m):	38.4-42	Test time:	11:56 AM
Test zone length (m):	3.6	Screen type:	2 " PVC - 20 slot
Hole diameter (m):	0.127	Field technician:	Alex Rosenberg
Riser inner diameter (m):	0.053	Analyst:	Alex Rosenberg
Depth of screen (m):	40.00	d:	0.162
Depth to water (m):	15.90	angular frequency (per second):	0.63
Height of water predicted(m):	24.00	damping constant:	0.10
Height of water (m):	24.10	Initial amplitude:	-0.5
K (m/s):	8.0E-04	Transmissivity (m^2/s)	2.88E-03
Storage:	3.00E-04		

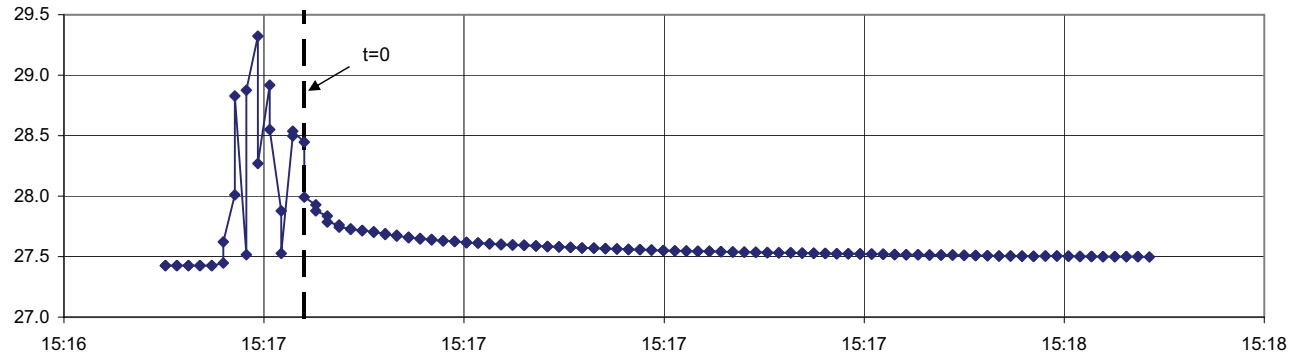


Borehole Response Test - Hvorslev Method

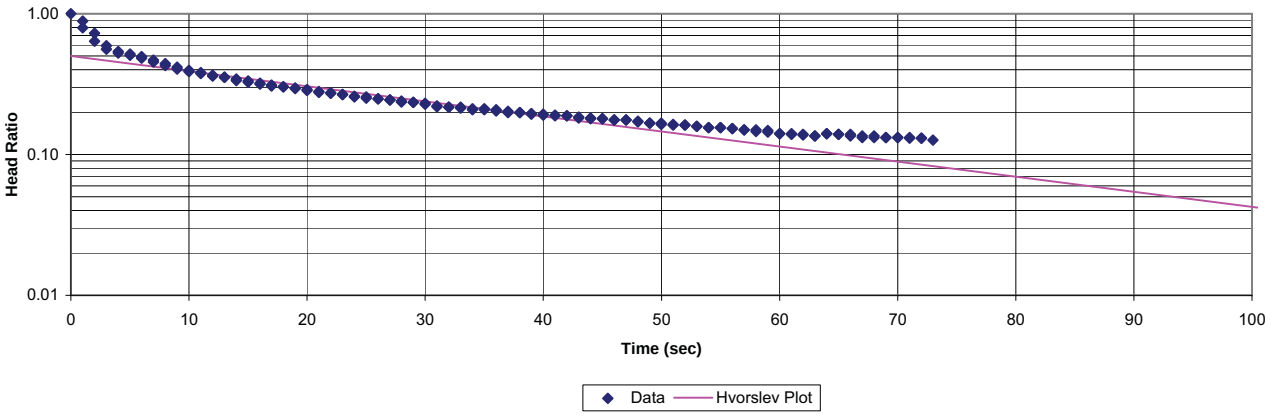
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-07S falling	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	3:17 PM
Zone depth (m):	22.9	Screen type:	2 " PVC - 20 slot
Test length (m):	6.4008	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.5		
K (m/s):	5.5E-06	Transmissivity (m^2/s)	3.52E-05

Water Level Change



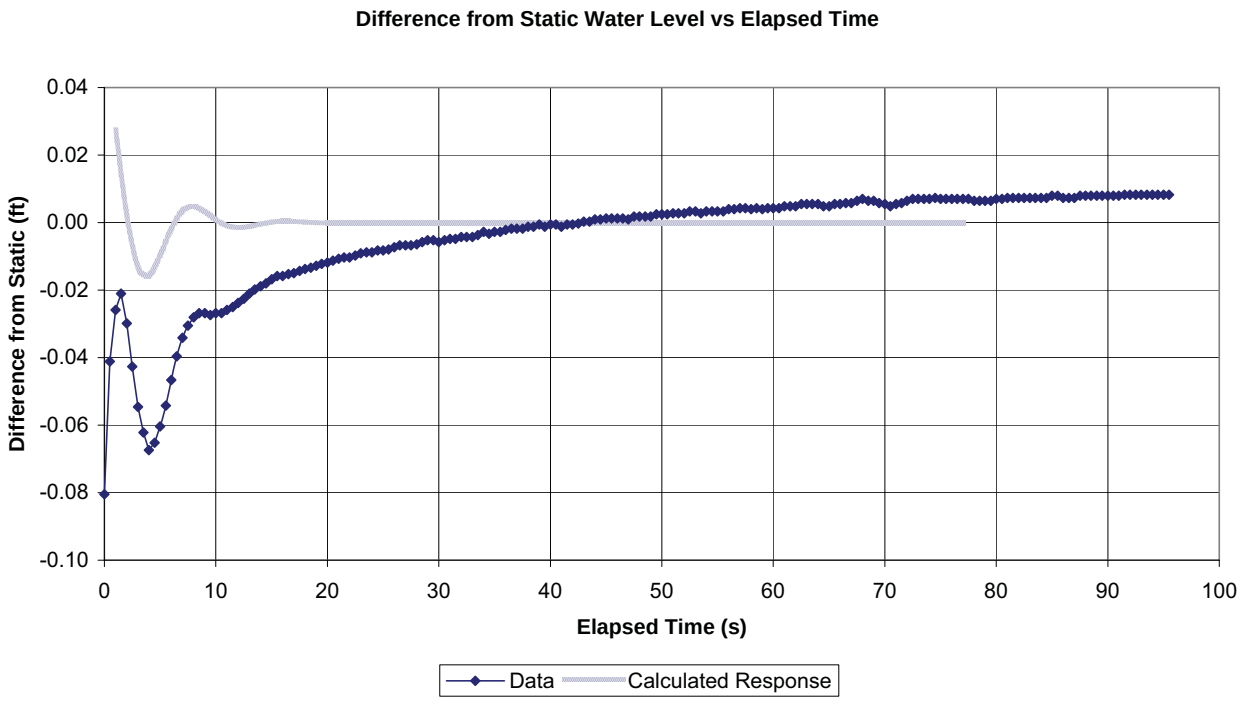
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-07S	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	2:07 PM
Zone depth (m):	22.86	Screen type:	2 " PVC - 20 slot
Test length (m):	6.4008	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.36
Depth of screen (m):	22.86	angular frequency (per second):	0.75
Depth to water (m):	7.72	damping constant:	0.29
Height of water predicted(m):	15.14	Initial amplitude:	0.05
Height of water (m):	15.14		
K (m/s):	2.0E-04	Transmissivity (m^2/s)	1.28E-03
Storage:	3.00E-04		



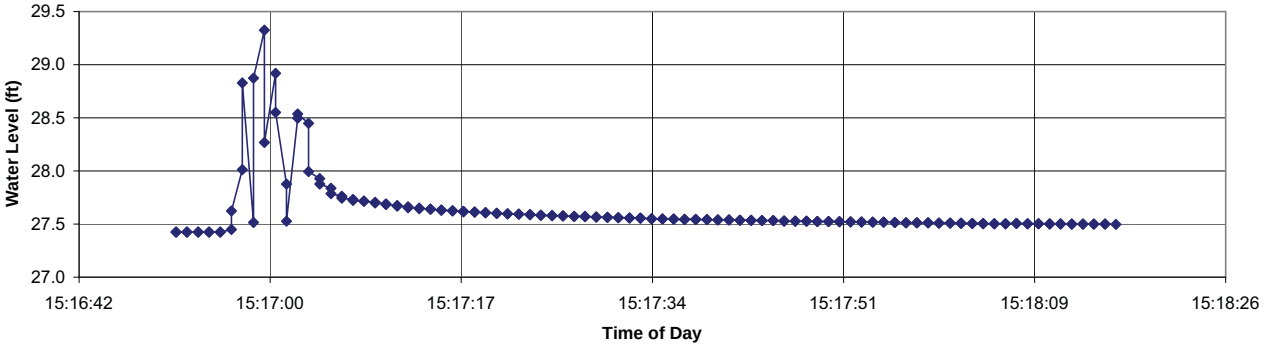
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

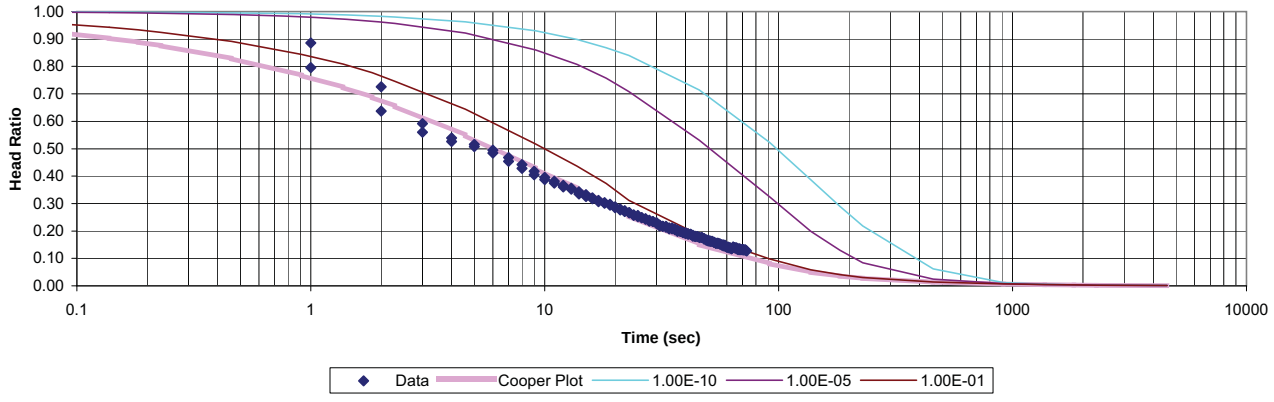
Borehole No:	P-05-07S	Test date:	########
Instrument type:	In-situ transducer	Test time:	3:19 PM
Zone depth (m):	23	Screen type:	2 " PVC - 10 slot
Test length (m):	6.40	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	4.4E-06	Transmissivity (m^2/s)	2.82E-05
Storage:	5.00E-02	Alpha	4.50E-01
		Δh_o (m)	0.568

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

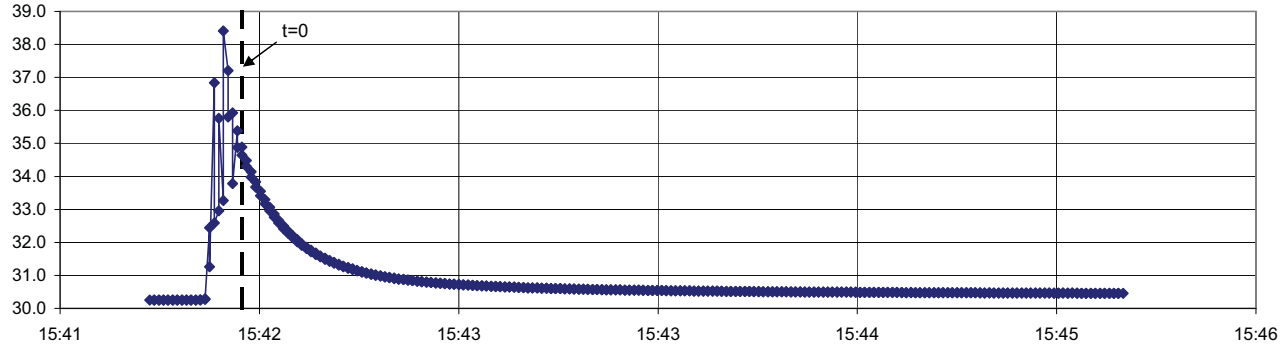
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-07D falling	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	3:42 PM
Zone depth (m):	61	Screen type:	2 " PVC - 20 slot
Test length (m):	8.2296	Field technician:	SLR Alaska
Hole diameter (m):	0.1397	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		

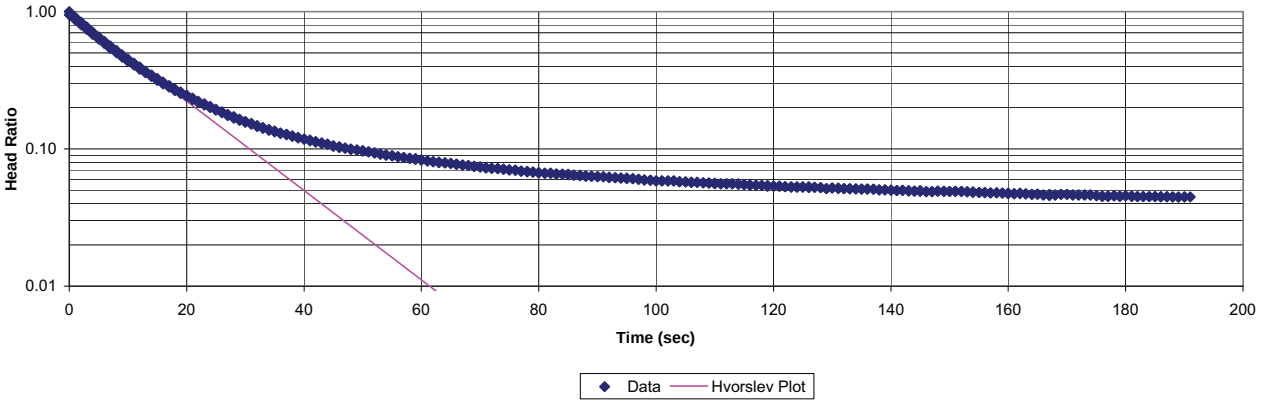
K (m/s): 1.4E-05

Transmissivity (m^2/s) 1.15E-04

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

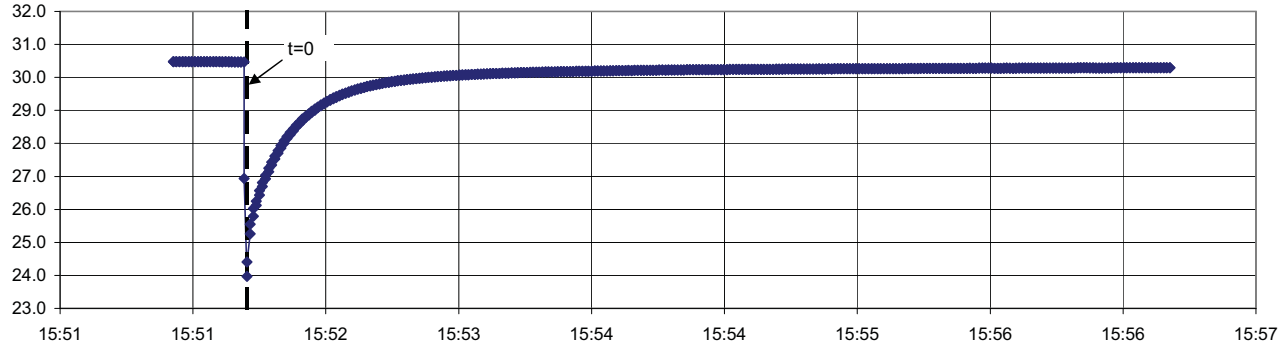
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-07D rising	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	3:52 PM
Zone depth (m):	61	Screen type:	2 " PVC - 20 slot
Test length (m):	8.2296	Field technician:	SLR Alaska
Hole diameter (m):	0.1397	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.75		

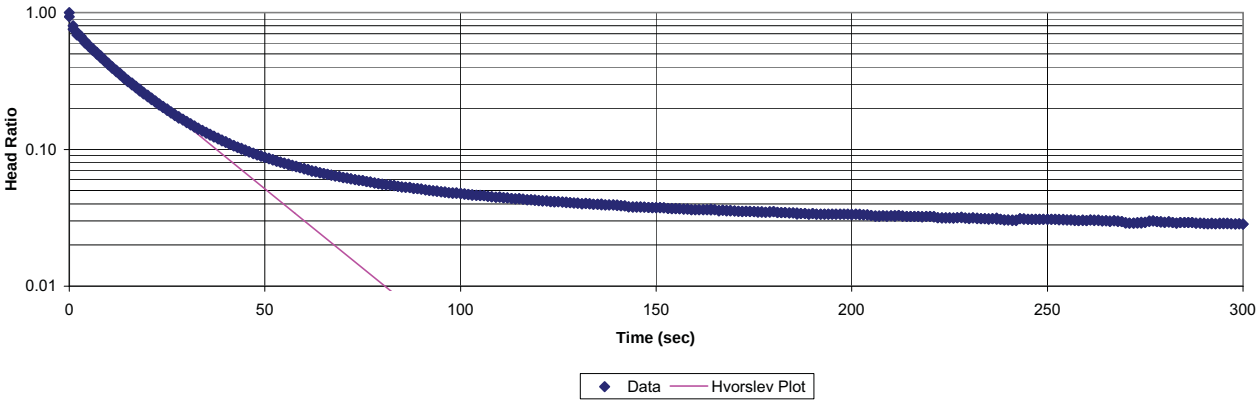
K (m/s): 1.0E-05

Transmissivity (m^2/s) 8.23E-05

Water Level Change



Head Ratio Plot



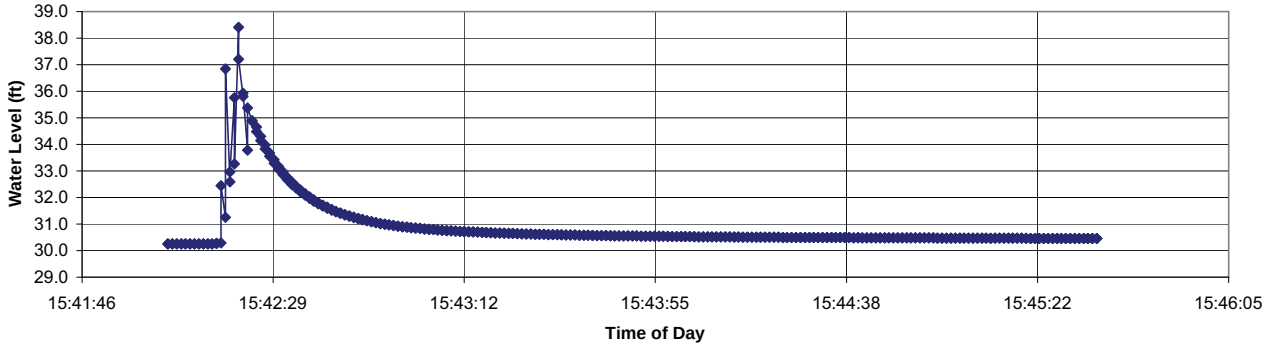
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

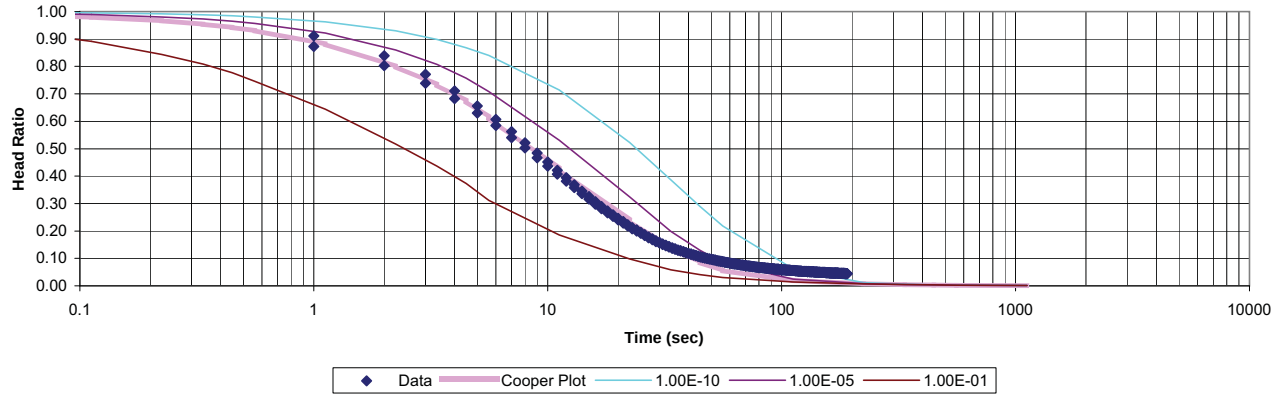
Borehole No:	P-05-07D	Test date:	########
Instrument type:	In-situ transducer	Test time:	3:42 PM
Zone depth (m):	61	Screen type:	2 " PVC - 10 slot
Test length (m):	8.23	Field technician:	SLR Alaska
Hole diameter (m):	0.140	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.4E-05	Transmissivity (m^2/s)	1.15E-04
Storage:	7.00E-05	Alpha	5.29E-04
		Δh_o (m)	4.64

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

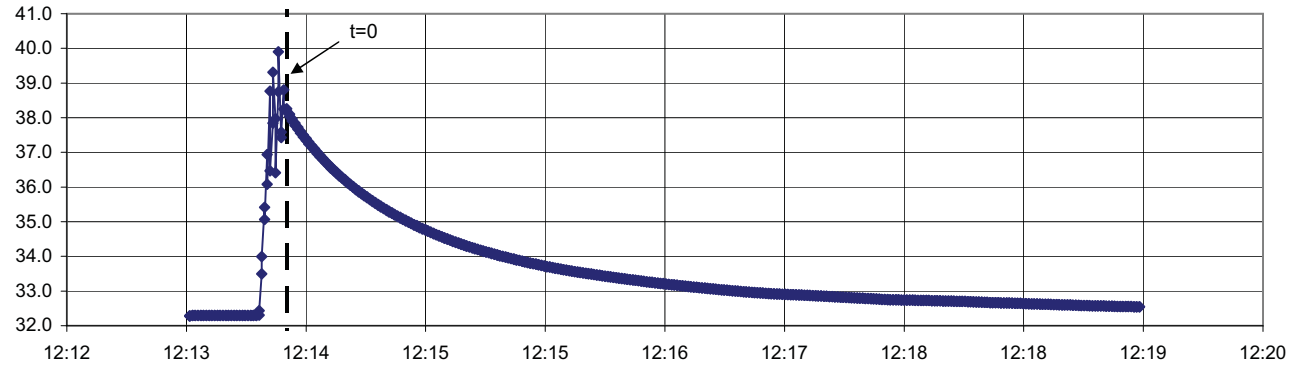
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-08 falling	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	12:14 PM
Zone depth (m):	22.6	Screen type:	2 " PVC - 20 slot
Test length (m):	5.4864	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.9		

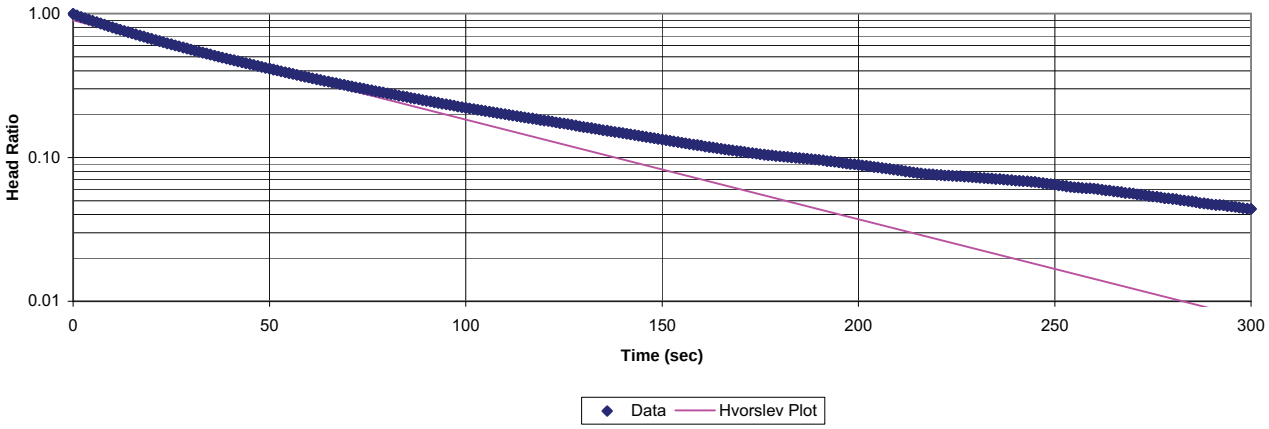
K (m/s): 4.0E-06

Transmissivity (m^2/s) 2.19E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

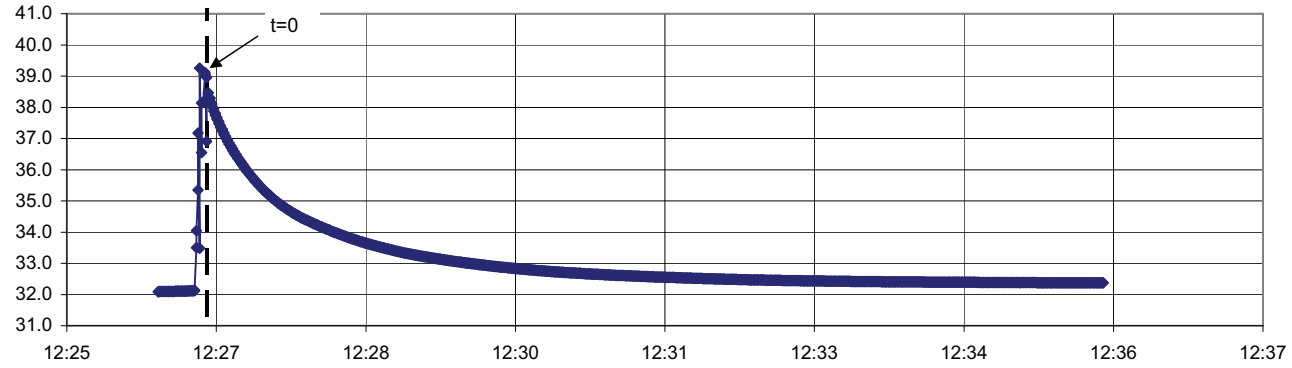
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-08 falling	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	12:27 PM
Zone depth (m):	22.6	Screen type:	2 " PVC - 20 slot
Test length (m):	5.4864	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.89		

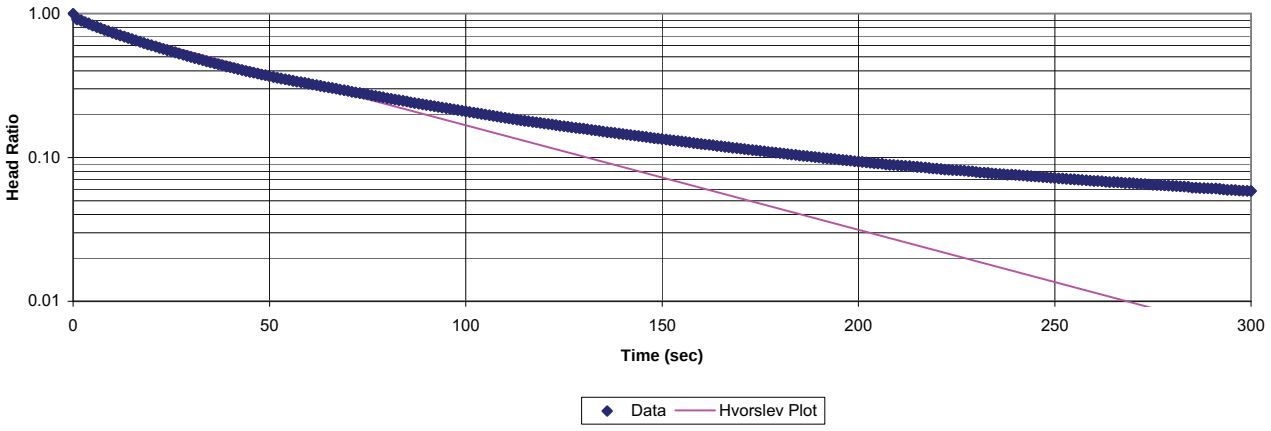
K (m/s): 4.2E-06

Transmissivity (m^2/s) 2.30E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

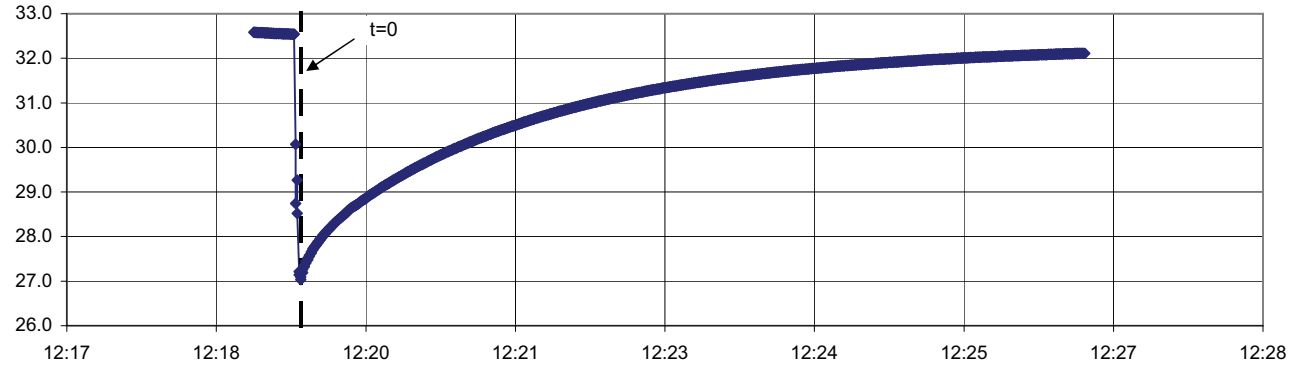
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-08 rising	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	12:19 PM
Zone depth (m):	22.6	Screen type:	2 " PVC - 20 slot
Test length (m):	5.4864	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		

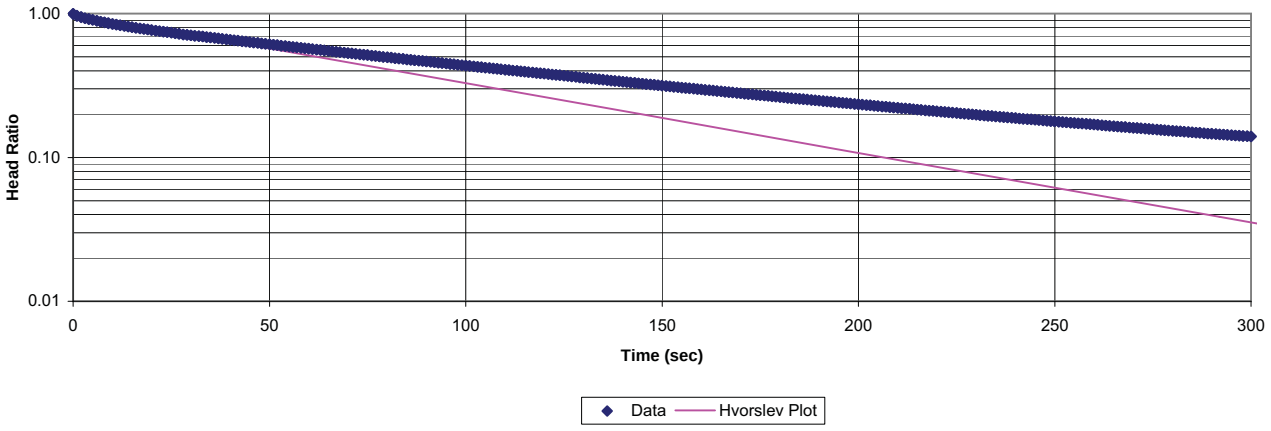
K (m/s): 2.8E-06

Transmissivity (m^2/s) 1.54E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

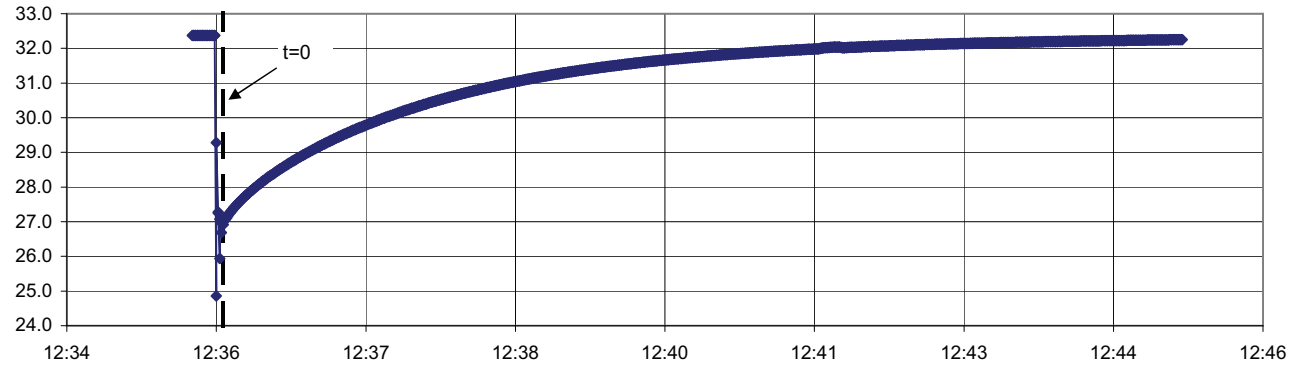
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-08 rising	Test date:	20-Sep-05
Instrument type:	In-situ transducer	Test time:	12:36 PM
Zone depth (m):	22.6	Screen type:	2 " PVC - 20 slot
Test length (m):	5.4864	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		

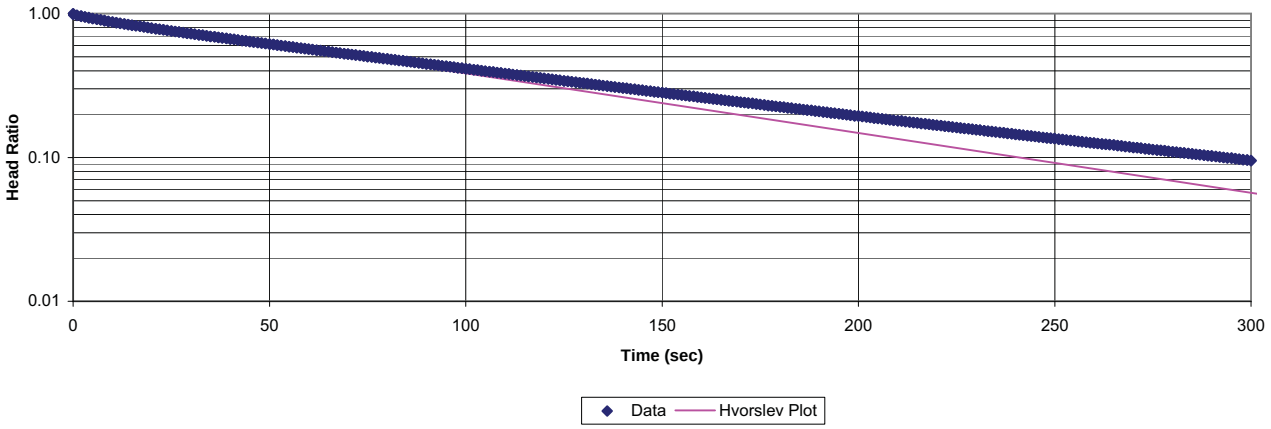
K (m/s): 2.4E-06

Transmissivity (m^2/s) 1.32E-05

Water Level Change



Head Ratio Plot



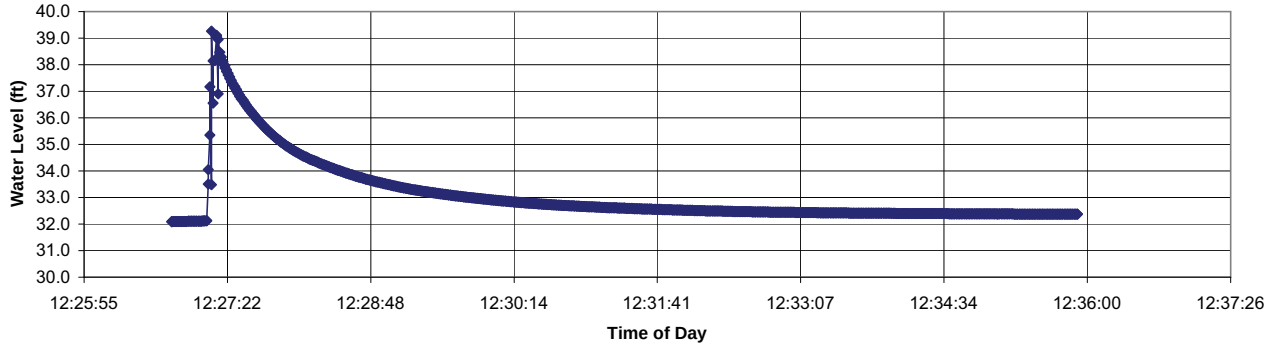
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

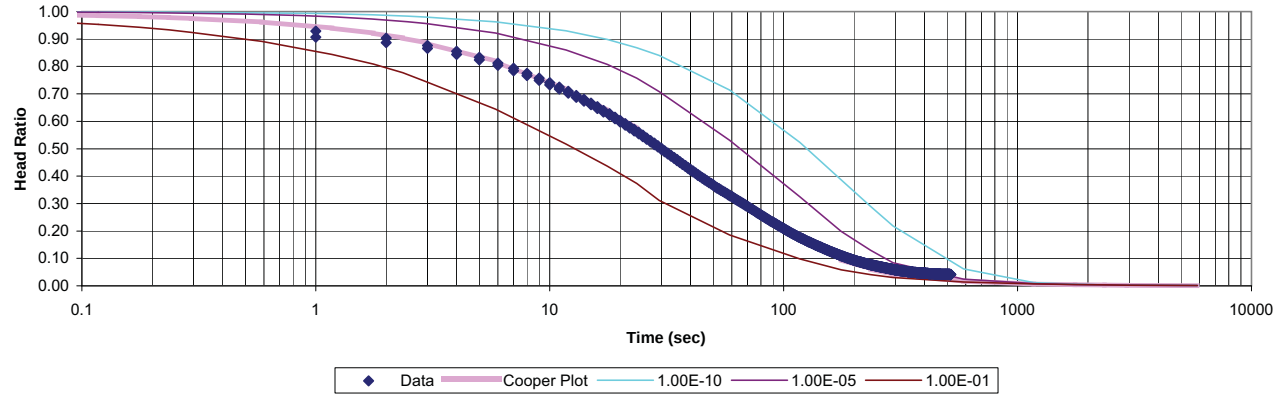
Borehole No:	P-05-08	Test date:	########
Instrument type:	In-situ transducer	Test time:	12:27 PM
Zone depth (m):	22.55	Screen type:	2 " PVC - 10 slot
Test length (m):	5.49	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	4.0E-06	Transmissivity (m^2/s)	2.19E-05
Storage:	7.00E-04	Alpha	6.30E-03
		Δh_o (m)	6.87

Water Level vs Time of Day



Head Ratio Plot

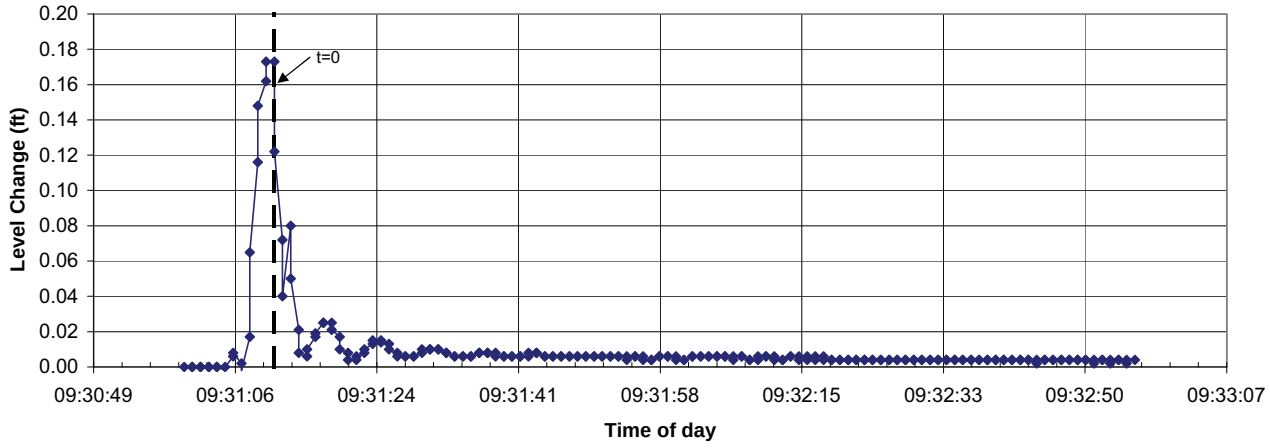


Borehole Response Test - Hvorslev Method

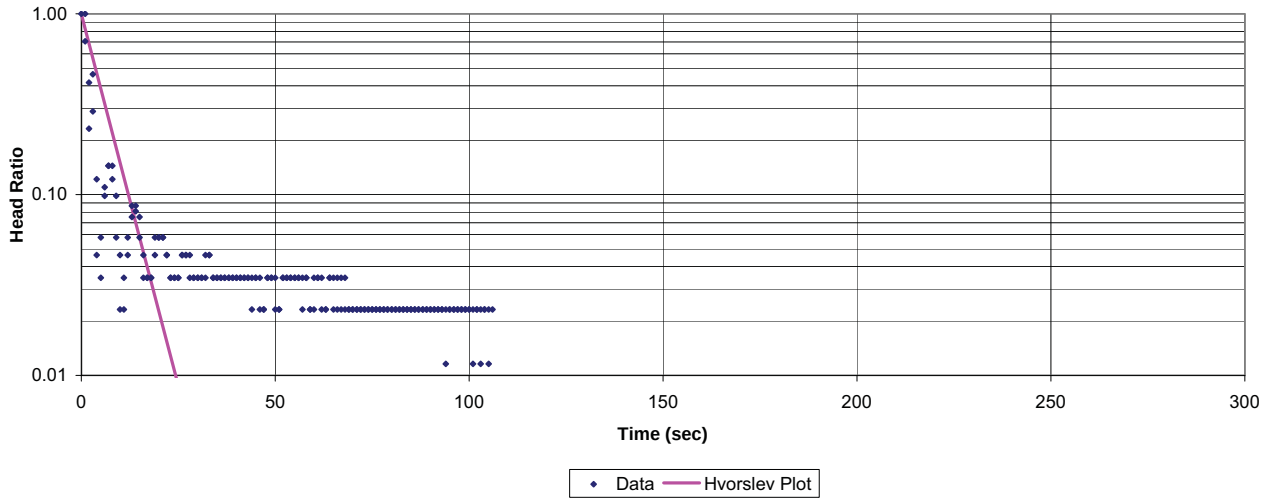
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-09D falling	Test date:	25-Sep-05
Instrument type:	In-situ transducer	Test time:	9:31:11 AM
Zone depth (m):	29.87	Screen type:	2 " PVC - 10 slot
Test length (m):	7.62	Field technician:	Jon
Hole diameter (m):	0.127	Analyst:	Hugh McCreadie
Riser diameter (m):	0.053		
Hvorslev intercept:	1		
K (m/s):	4.1E-05	Transmissivity (m^2/s)	3.12E-04

Water Level Change



Head Ratio Plot

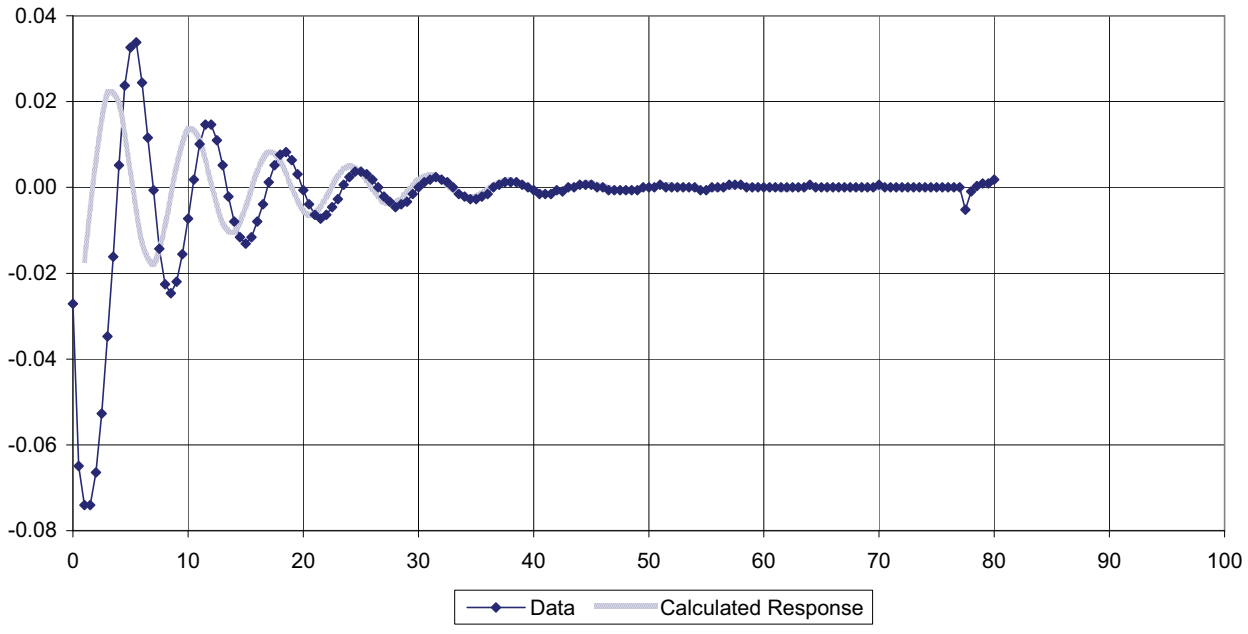


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-09D	Test date:	25/09/2005
Instrument type:	In-situ transducer	Test time:	9:37 AM
Zone depth (m):	29.8704	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.08
Depth of screen (m):	29.87	angular frequency (per second):	0.91
Depth to water (m):	15.91	damping constant:	0.07
Height of water predicted(m):	11.75	Initial amplitude:	-0.03
Height of water (m):	13.96		
K (m/s):	9.4E-04	Transmissivity (m^2/s)	7.16E-03
Storage:	6.00E-04		

Water Level Change

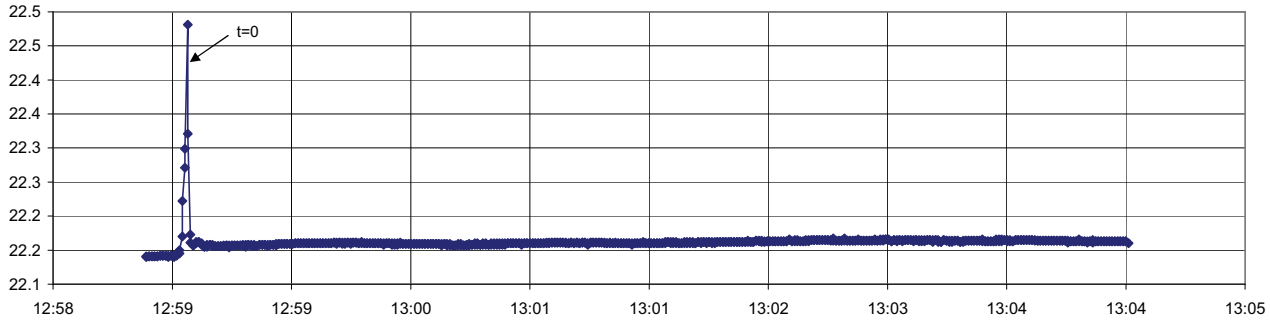


Borehole Response Test - Hvorslev Method

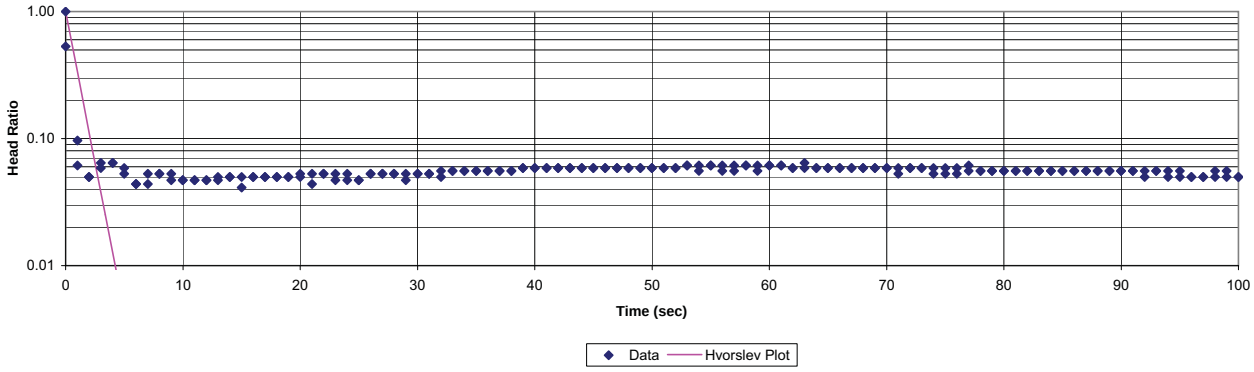
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-10S	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	12:59 PM
Zone depth (m):	8.8	Screen type:	2 " PVC - 20 slot
Test length (m):	4.8768	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		
K (m/s):	3.0E-04	Transmissivity (m^2/s)	1.46E-03

Water Level Change



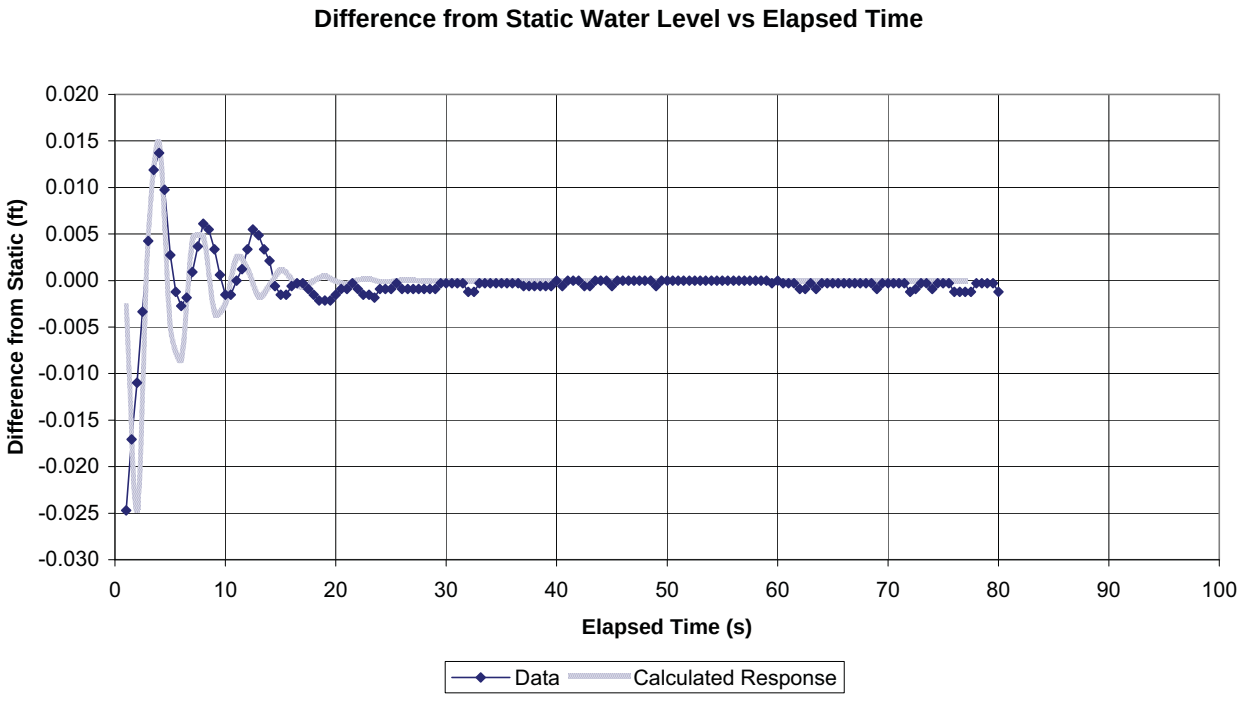
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-10S	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	12:35 PM
Zone depth (m):	8.9916	Screen type:	2 " PVC - 20 slot
Test length (m):	4.8768	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.14
Depth of screen (m):	8.99	angular frequency (per second):	1.66
Depth to water (m):	1.53	damping constant:	0.23
Height of water predicted(m):	3.50	Initial amplitude:	0.04
Height of water (m):	7.46		
K (m/s):	1.0E-03	Transmissivity (m^2/s)	4.88E-03
Storage:	4.00E-03		

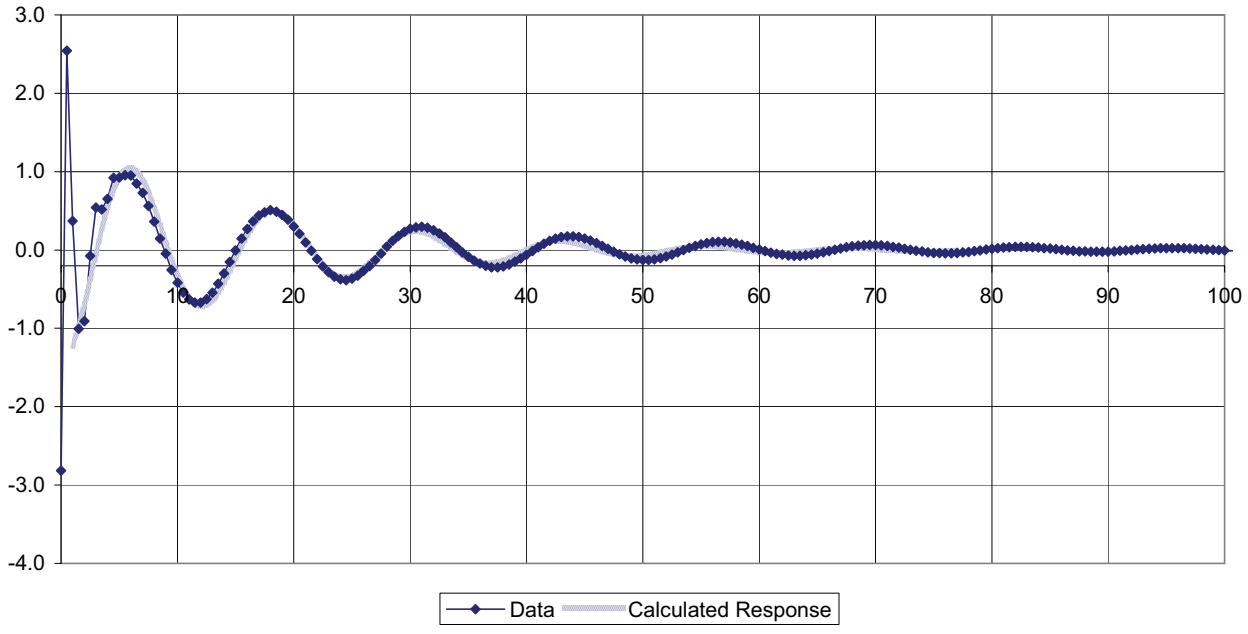


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-10D	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	12:35 PM
Zone depth (m):	42.0624	Screen type:	2 " PVC - 20 slot
Test length (m):	8.5344	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.12
Depth of screen (m):	42.06	angular frequency (per second):	0.51
Depth to water (m):	1.54	damping constant:	0.06
Height of water predicted(m):	37.00	Initial amplitude:	-1.5
Height of water (m):	40.52		
K (m/s):	4.0E-04	Transmissivity (m^2/s)	3.41E-03
Storage:	1.00E-04		

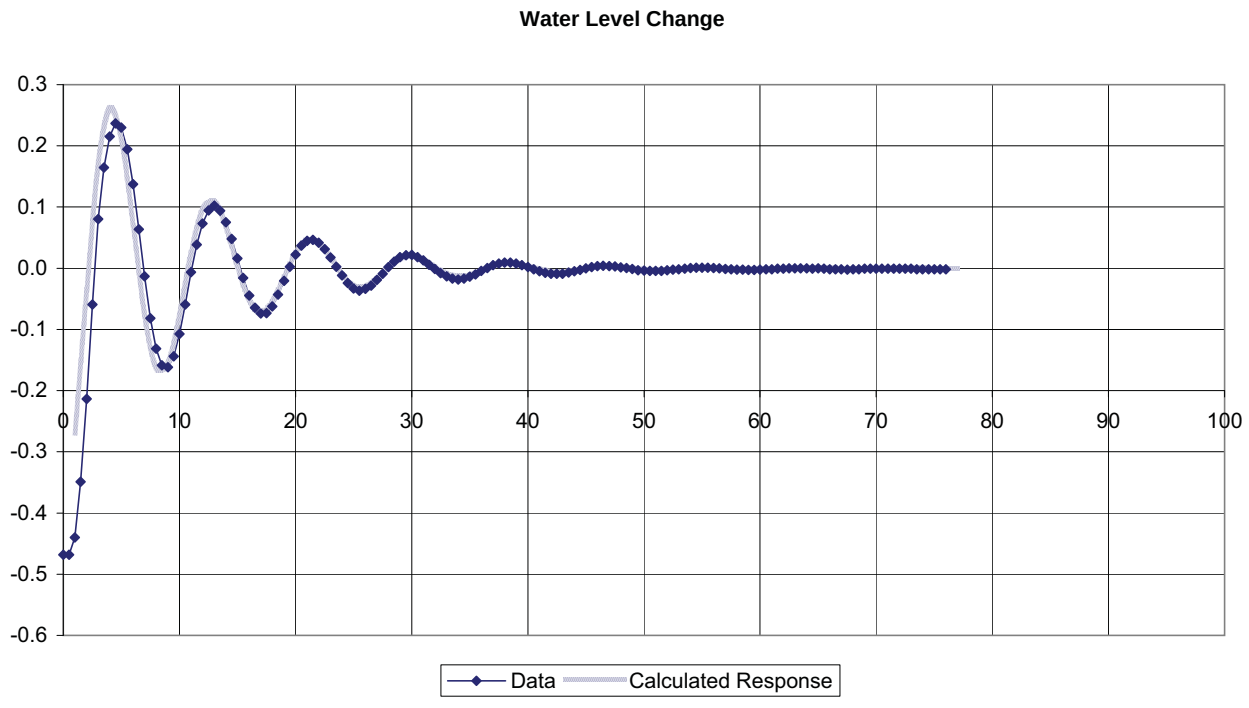
Water Level Change



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-11M	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	3:13 PM
Zone depth (m):	23.74392	Screen type:	2 " PVC - 20 slot
Test length (m):	7.0104	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.14
Depth of screen (m):	23.74	angular frequency (per second):	0.73
Depth to water (m):	2.43	damping constant:	0.10
Height of water predicted(m):	18.00	Initial amplitude:	-0.4
Height of water (m):	21.31		
K (m/s):	7.5E-04	Transmissivity (m^2/s)	5.26E-03
Storage:	1.00E-05		

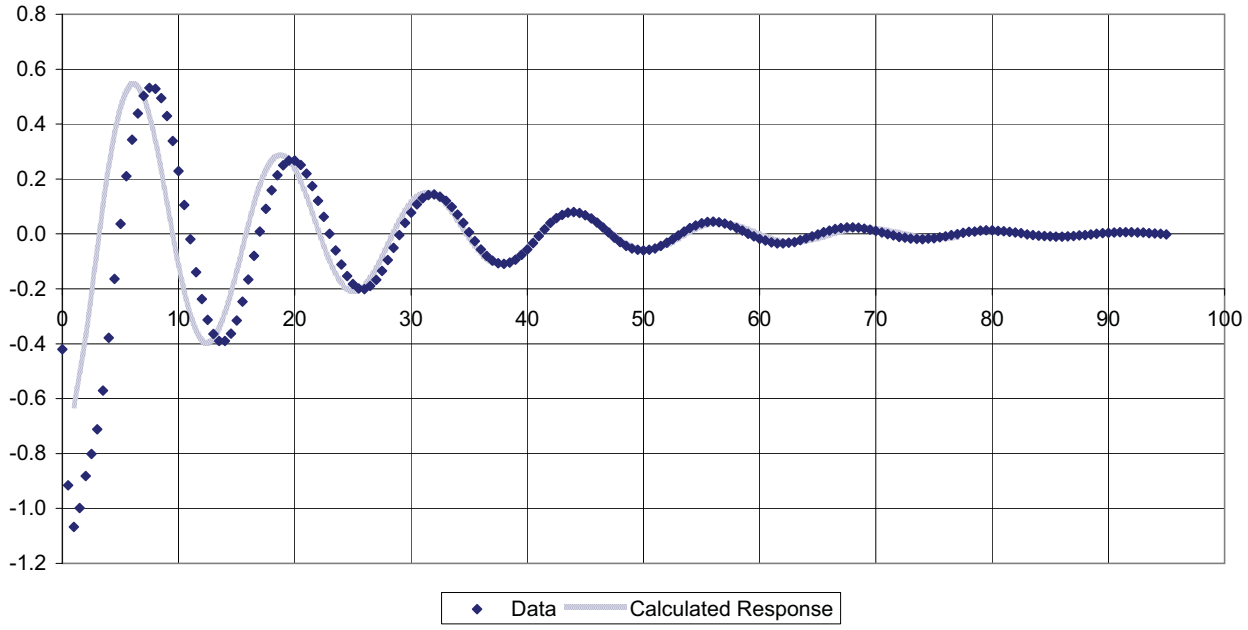


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-11D	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	2:45 PM
Zone depth (m):	50.5968	Screen type:	2 " PVC - 20 slot
Test length (m):	9.7536	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.10
Depth of screen (m):	50.60	angular frequency (per second):	0.50
Depth to water (m):	2.30	damping constant:	0.05
Height of water predicted(m):	39.25	Initial amplitude:	-0.75
Height of water (m):	48.30		
K (m/s):	3.0E-04	Transmissivity (m^2/s)	2.93E-03
Storage:	8.00E-04		

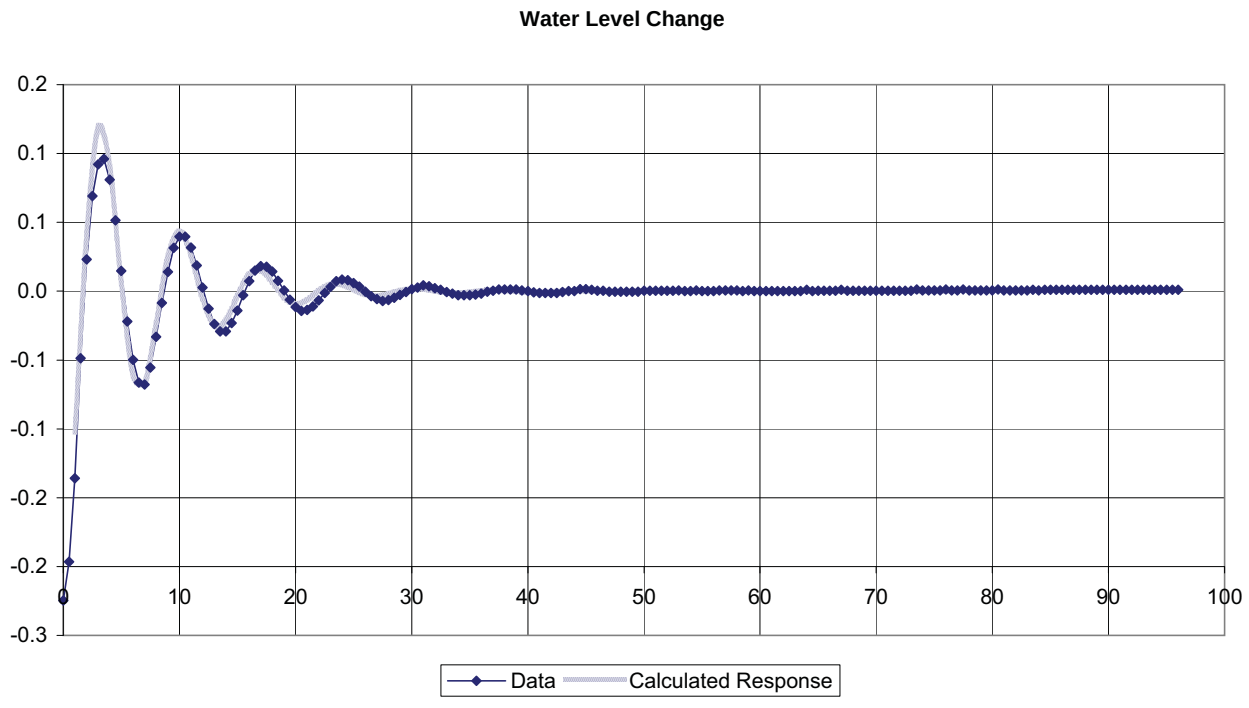
Water Level Change



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-12	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	1:42 PM
Zone depth (m):	25.4508	Screen type:	2 " PVC - 20 slot
Test length (m):	12.8016	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.16
Depth of screen (m):	25.45	angular frequency (per second):	0.93
Depth to water (m):	8.22	damping constant:	0.15
Height of water predicted(m):	11.00	Initial amplitude:	-0.2
Height of water (m):	17.23		
K (m/s):	3.5E-04	Transmissivity (m^2/s)	4.48E-03
Storage:	8.00E-05		

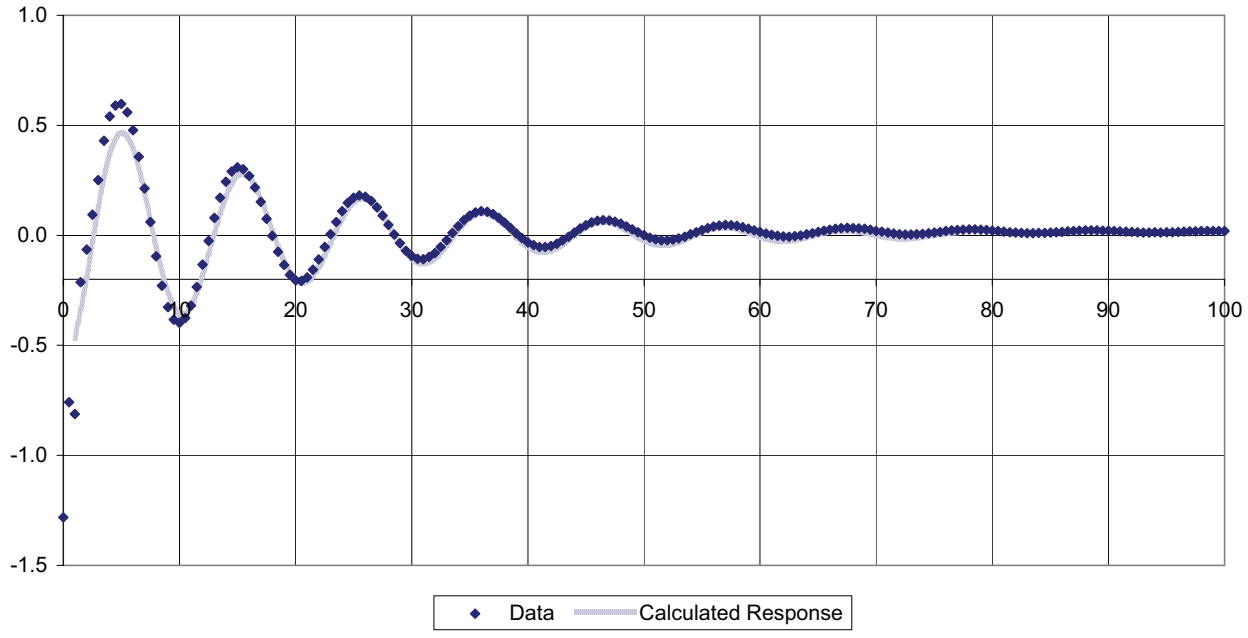


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-13	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	3:27 PM
Zone depth (m):	35.052	Screen type:	2 " PVC - 20 slot
Test length (m):	8.8392	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.08
Depth of screen (m):	35.05	angular frequency (per second):	0.61
Depth to water (m):	7.47	damping constant:	0.05
Height of water predicted(m):	26.50	Initial amplitude:	-0.6
Height of water (m):	27.58		
K (m/s):	6.0E-04	Transmissivity (m^2/s)	5.30E-03
Storage:	3.00E-04		

Water Level Change



Borehole Response Test - Hvorslev Method

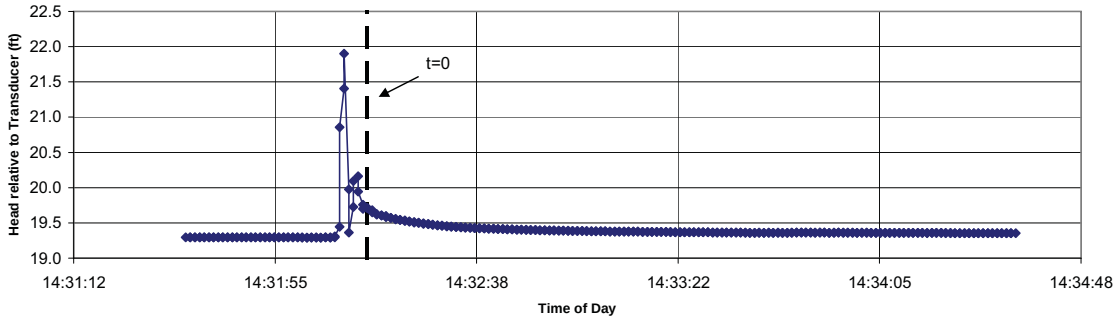
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-14S	
Instrument type:	In-situ transducer	
Zone depth:	11.58 m	38 ft
Test Zone Length:	6.4 m	21 ft
Hole diameter:	0.152 m	6. in
Riser diameter:	0.051 m	2. in
Transmissivity (m^2/s)	8.32E-05	
K (m/s):	1.3E-05	
Hvorslev intercept:	0.8	

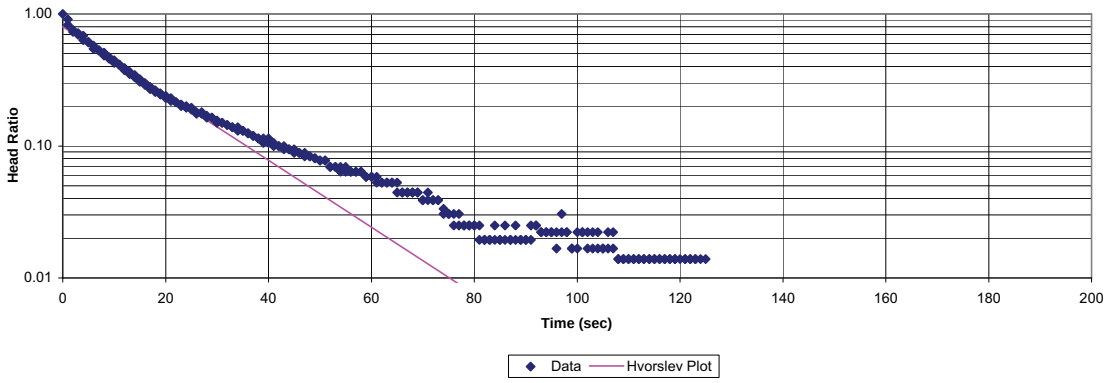
Test date:	14-Oct-05
Test time:	2:32 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	19.353
Head at t=0 relative to Transducer(ft)	19.713

Note: Static based on post test value

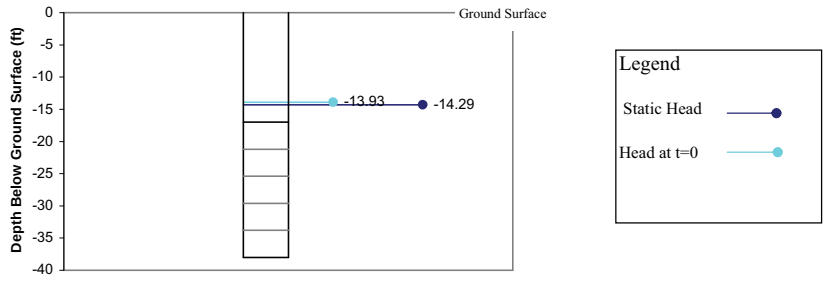
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



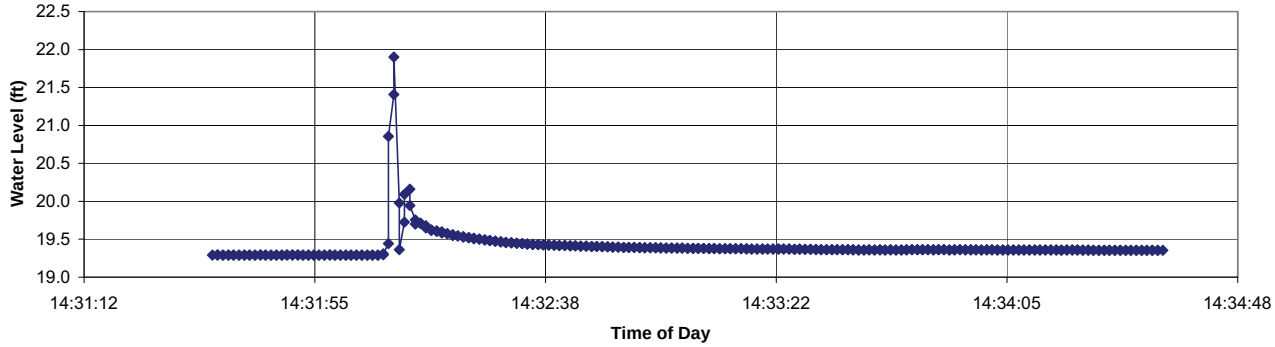
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

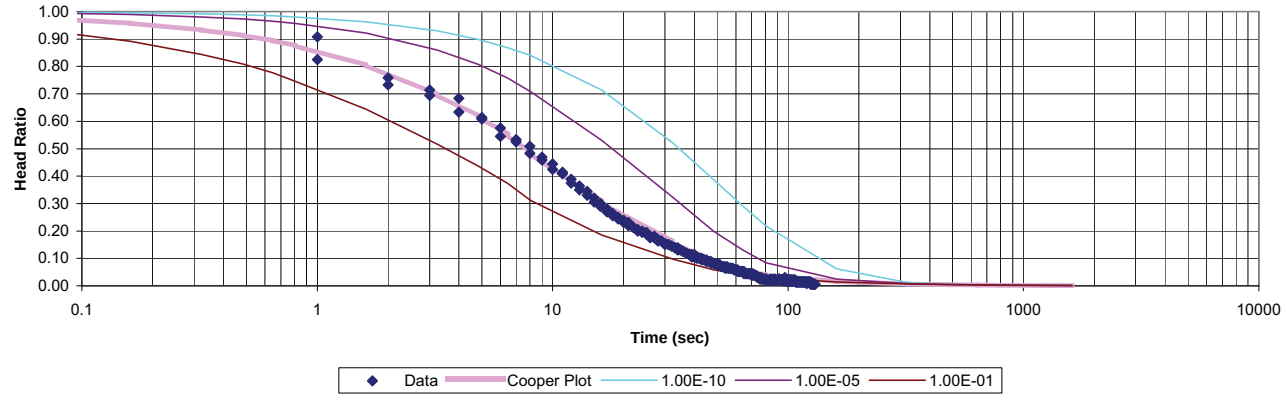
Borehole No:	P-05-14S	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	2:32 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	6.40	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.3E-05	Transmissivity (m^2/s)	8.00E-05
Storage:	9.00E-04	Alpha	8.10E-03
		Δh_o (m)	0.36

Water Level vs Time of Day



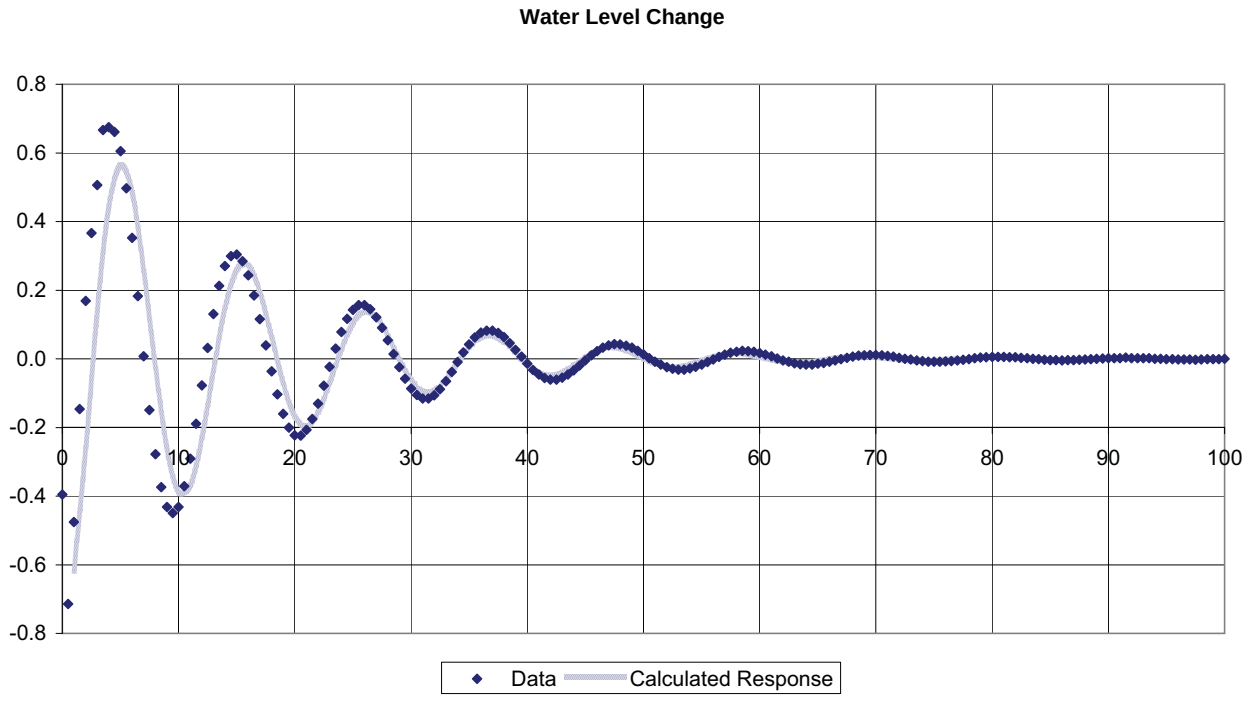
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-14D	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	2:07 PM
Zone depth (m):	35.51	Screen type:	2 " PVC - 20 slot
Test length (m):	8.2296	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.11
Depth of screen (m):	31.70	angular frequency (per second):	0.60
Depth to water (m):	6.33	damping constant:	0.07
Height of water predicted(m):	27.25	Initial amplitude:	-0.8
Height of water (m):	25.37		
K (m/s):	3.0E-04	Transmissivity (m^2/s)	2.47E-03
Storage:	3.00E-03		

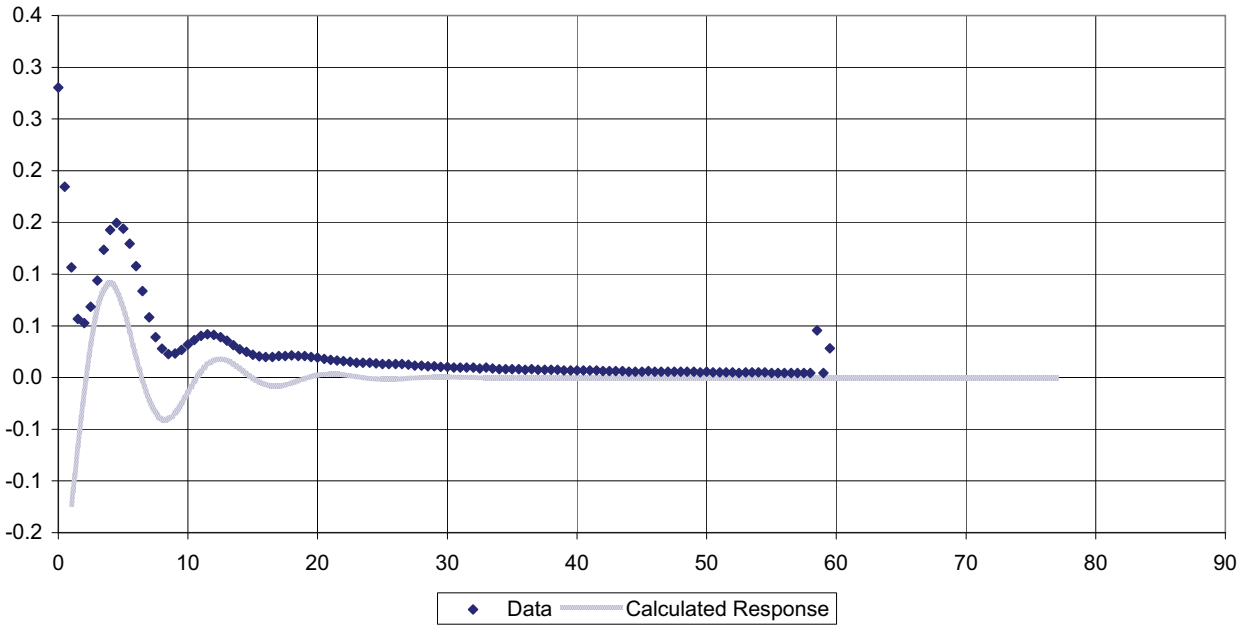


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-15S	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	4:50 PM
Zone depth (m):	24.17064	Screen type:	2 " PVC - 20 slot
Test length (m):	6.096	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.25
Depth of screen (m):	24.17	angular frequency (per second):	0.74
Depth to water (m):	4.09	damping constant:	0.19
Height of water predicted(m):	17.00	Initial amplitude:	-0.2
Height of water (m):	20.08		
K (m/s):	3.0E-04	Transmissivity (m^2/s)	1.83E-03
Storage:	3.00E-04		

Water Level Change

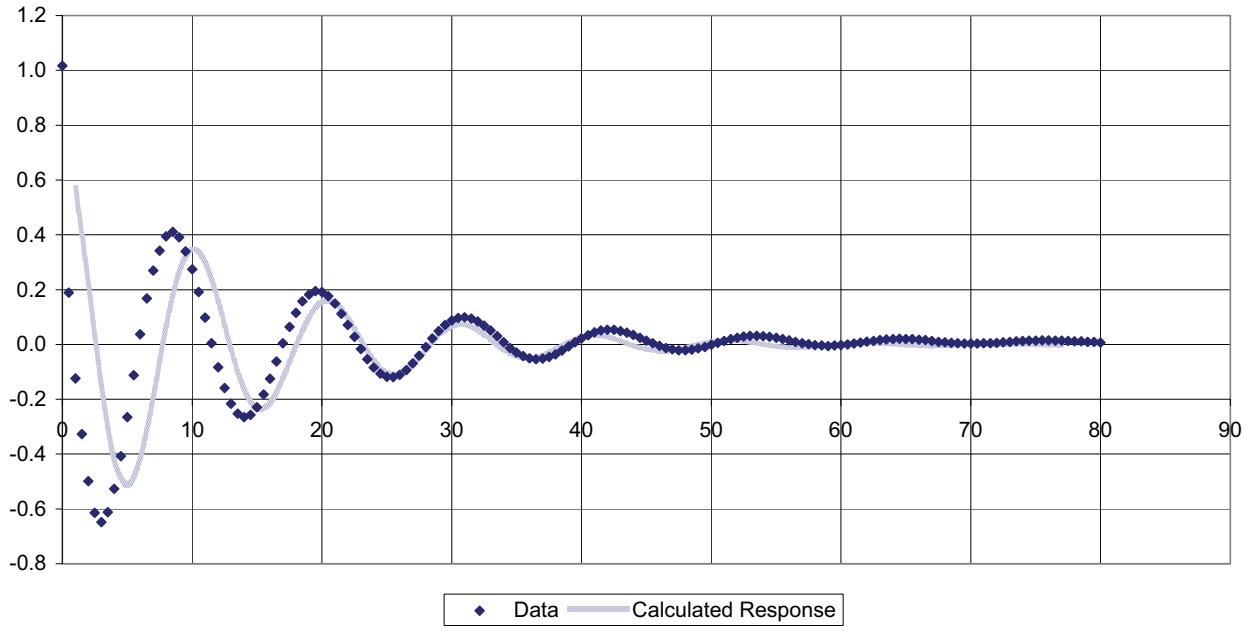


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-15D	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	4:22 PM
Zone depth (m):	38.61816	Screen type:	2 " PVC - 20 slot
Test length (m):	6.096	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.12
Depth of screen (m):	37.19	angular frequency (per second):	0.61
Depth to water (m):	1.32	damping constant:	0.08
Height of water predicted(m):	26.00	Initial amplitude:	0.75
Height of water (m):	35.87		
K (m/s):	5.5E-04	Transmissivity (m^2/s)	3.35E-03
Storage:	3.00E-04		

Water Level Change



Borehole Response Test - Hvorslev Method

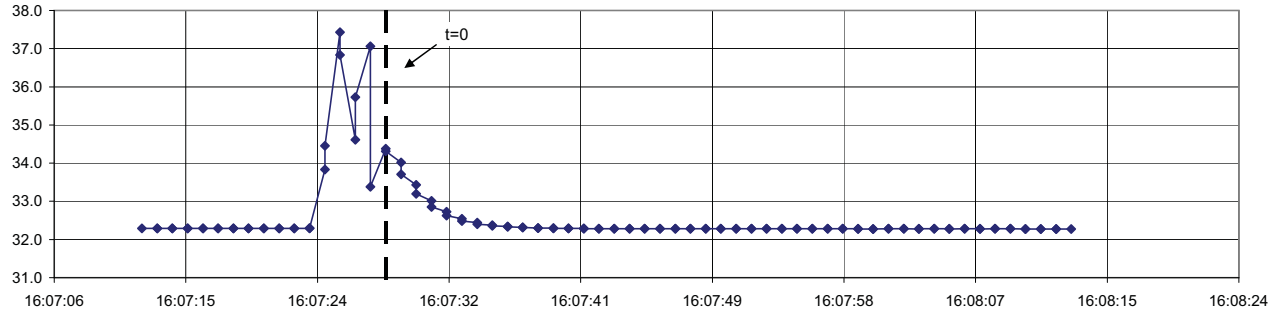
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16S	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	4:07 PM
Zone depth (m):	17	Screen type:	2 " PVC - 20 slot
Test length (m):	3.6576	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		

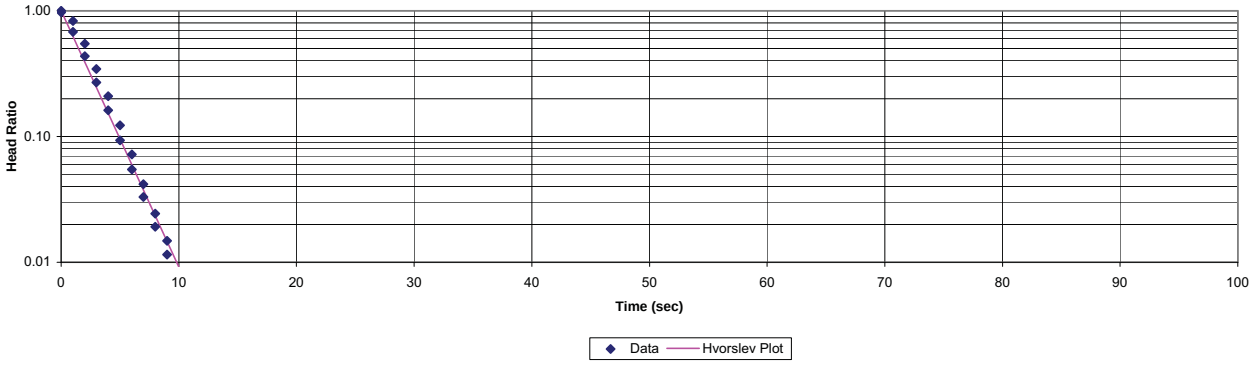
K (m/s): 1.6E-04

Transmissivity (m^2/s) 5.85E-04

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

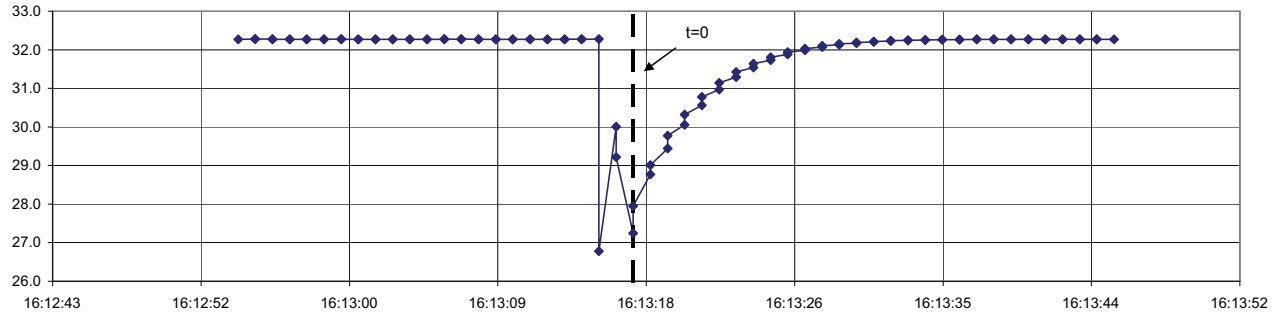
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16S
Instrument type:	In-situ transducer
Zone depth (m):	17
Test length (m):	3.6576
Hole diameter (m):	0.1524
Riser diameter (m):	0.051
Hvorslev intercept:	1
K (m/s):	1.6E-04

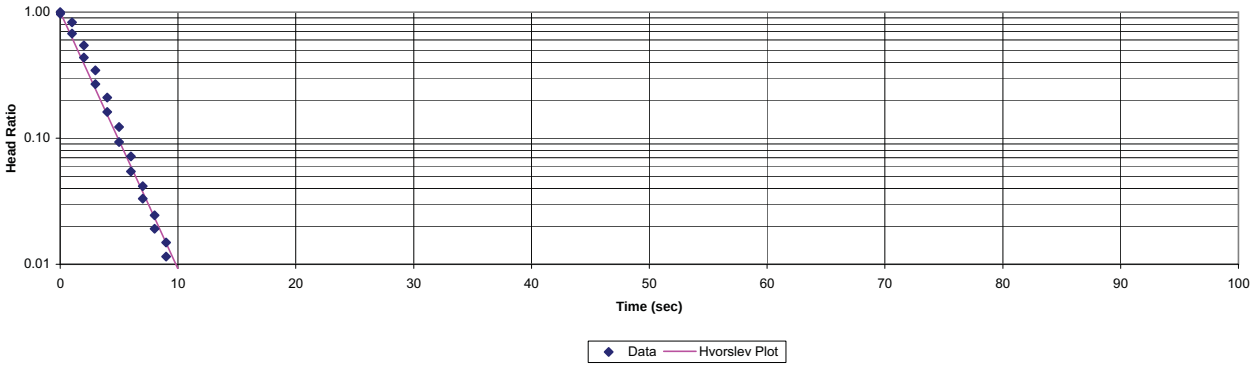
Test date:	30-Sep-05
Test time:	4:13 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 5.85E-04

Water Level Change



Head Ratio Plot



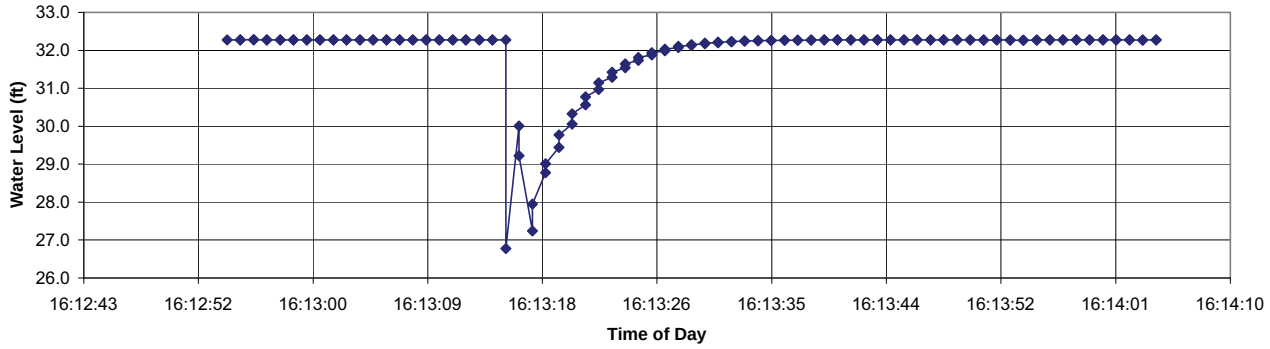
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

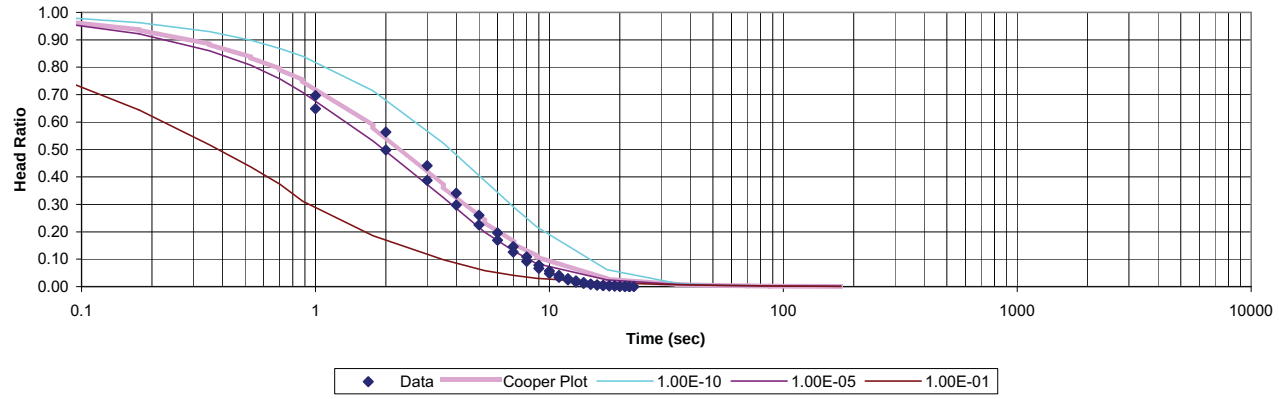
Borehole No:	P-05-16S	Test date:	########
Instrument type:	In-situ transducer	Test time:	4:13 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.66	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	2.0E-04	Transmissivity (m^2/s)	7.32E-04
Storage:	1.00E-07	Alpha	9.00E-07
		Δh_o (m)	-5.03

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

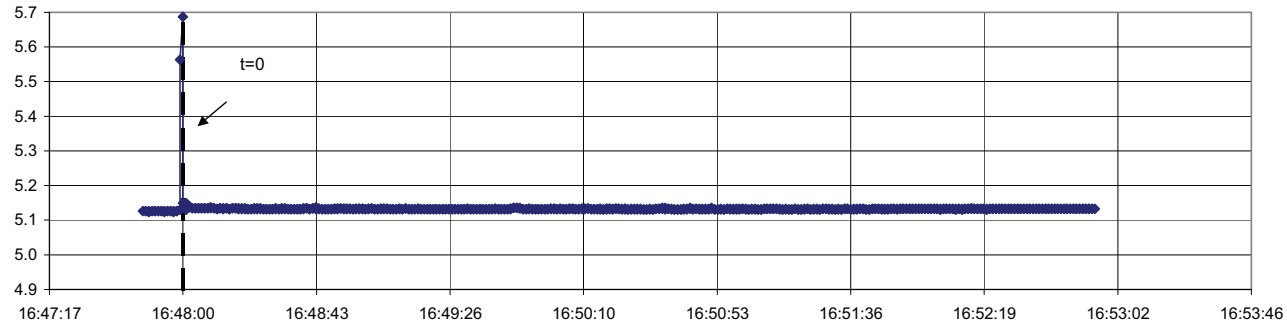
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16SS	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	4:48 PM
Zone depth (m):	5.5	Screen type:	2 " PVC - 20 slot
Test length (m):	2.7432	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		

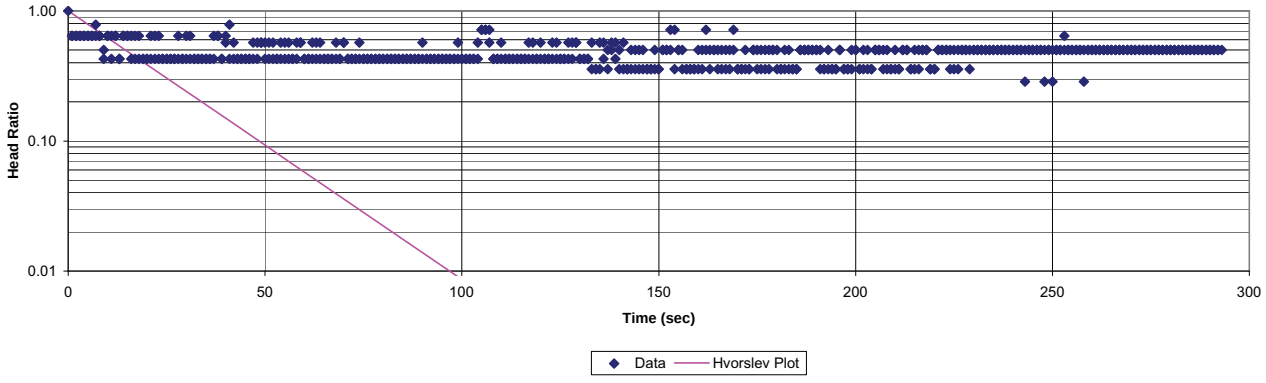
K (m/s): 2.0E-05

Transmissivity (m^2/s) 5.49E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

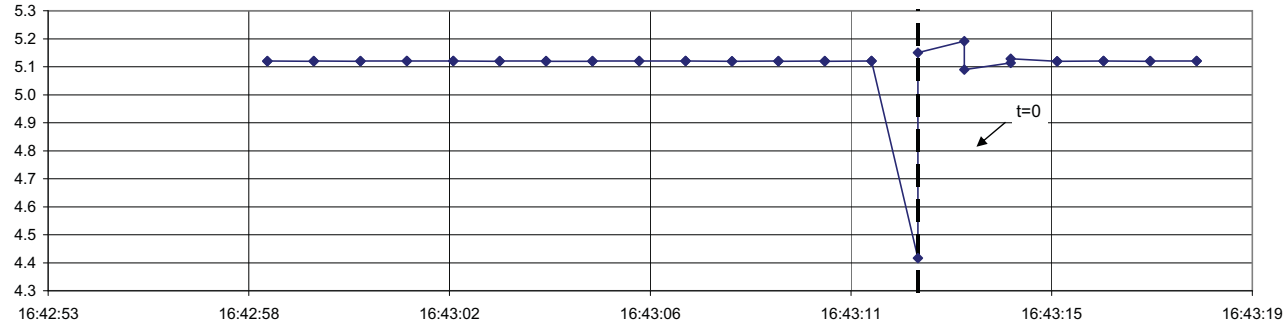
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16SS
Instrument type:	In-situ transducer
Zone depth (m):	5.5
Test length (m):	2.7432
Hole diameter (m):	0.1524
Riser diameter (m):	0.051
Hvorslev intercept:	1
K (m/s):	2.0E-03

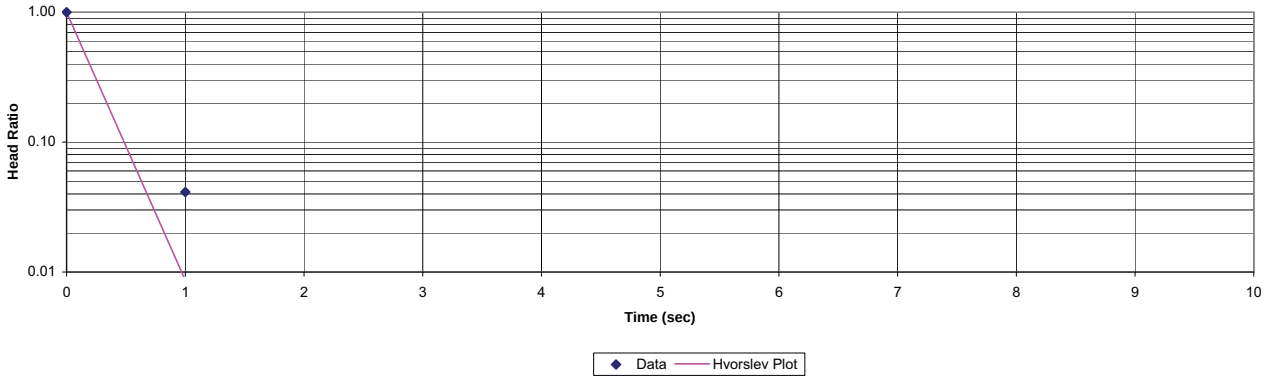
Test date:	30-Sep-05
Test time:	4:43 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 5.49E-03

Water Level Change



Head Ratio Plot



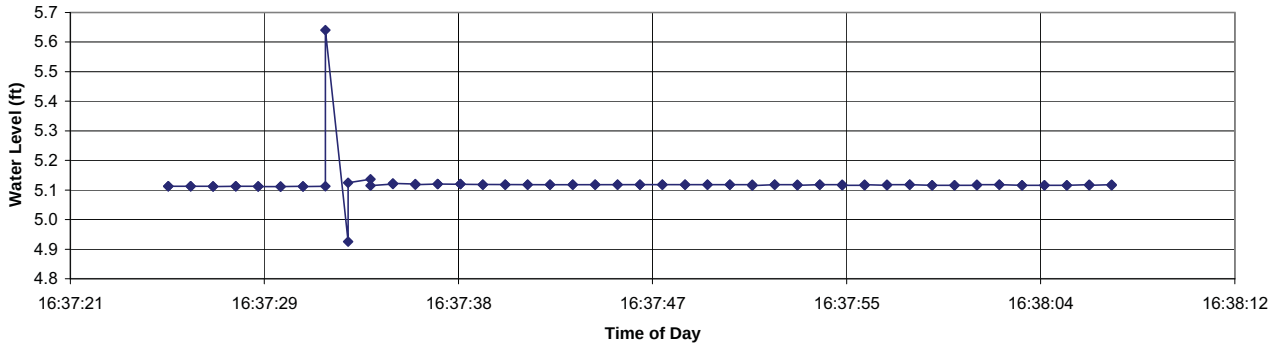
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

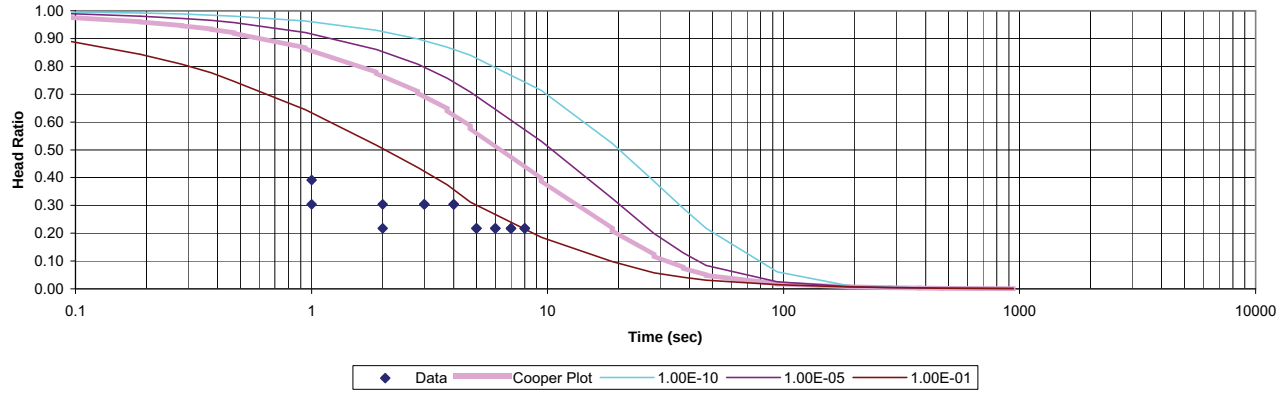
Borehole No:	P-05-16SS	Test date:	########
Instrument type:	In-situ transducer	Test time:	4:37 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	2.74	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	5.0E-05	Transmissivity (m^2/s)	1.37E-04
Storage:	1.00E-04	Alpha	9.00E-04
		Δh_o (m)	0.023

Water Level vs Time of Day



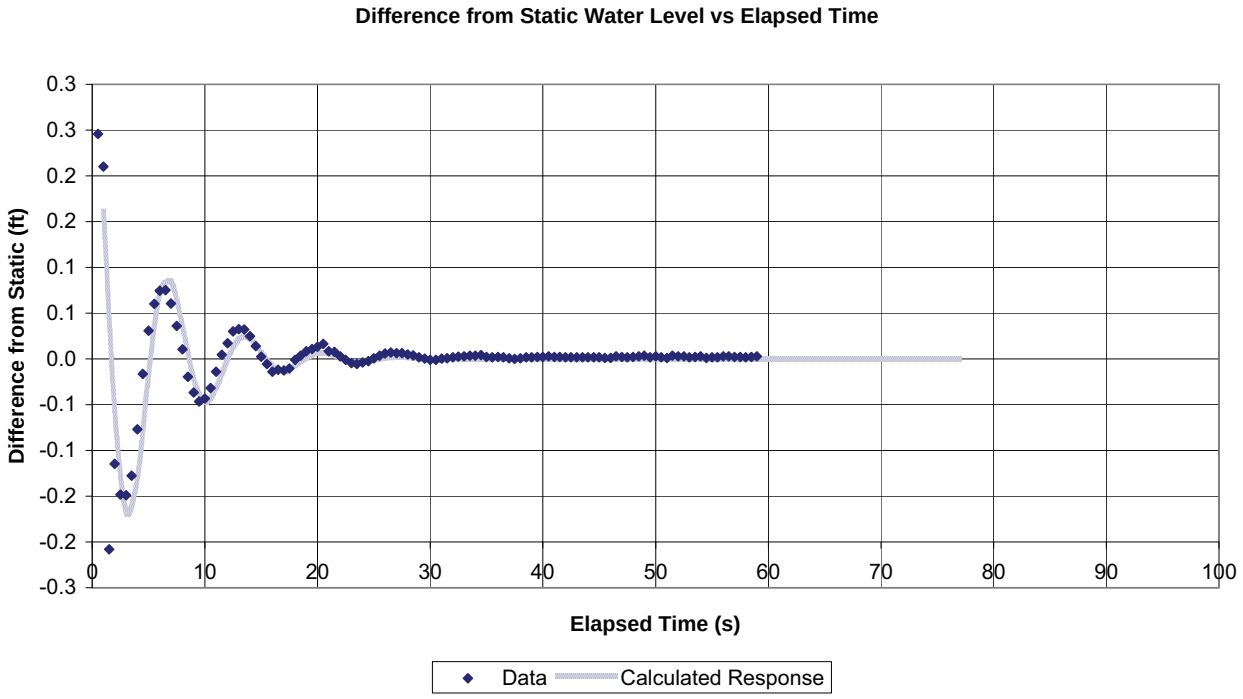
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

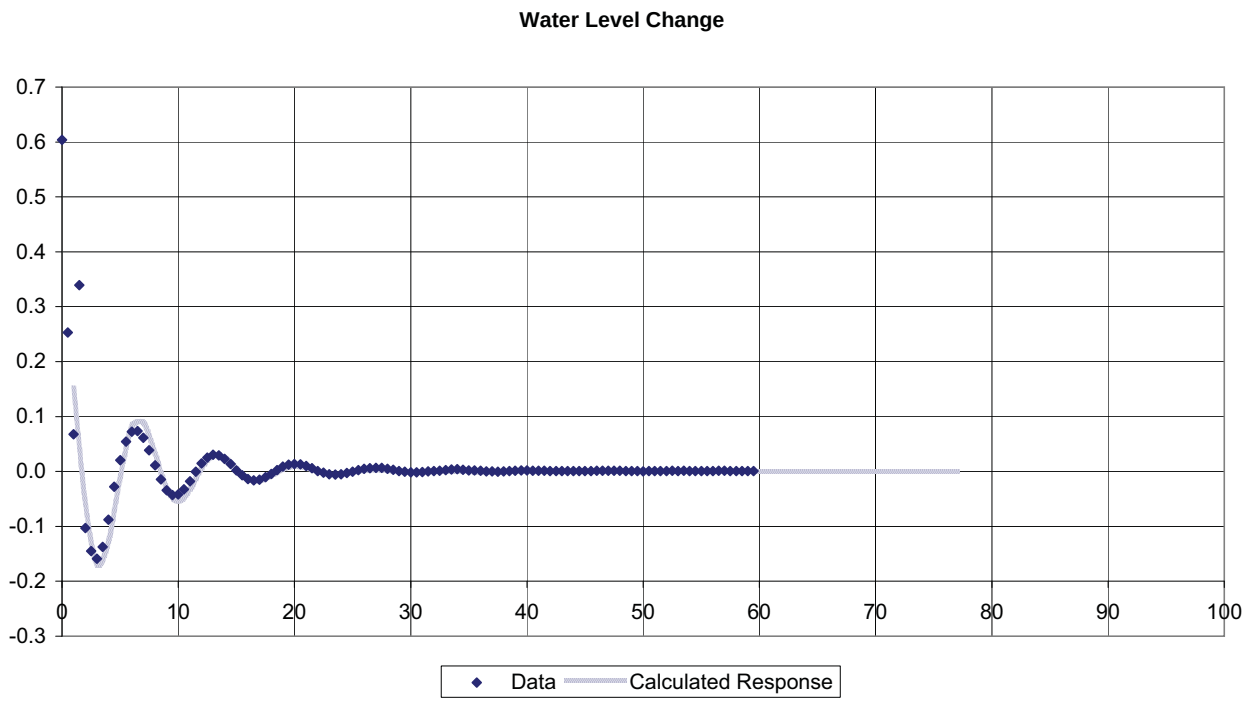
Borehole No:	P-05-16M		Test date:	13/07/2005
Instrument type:	In-situ transducer		Test time:	3:12 PM
Zone depth (m):	25.6032	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.62	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg & KG
Riser diameter (m):		0.0508		
			d:	0.20
Depth of screen (m):		25.60	angular frequency (per second):	0.92
Depth to water (m):		12.76	damping constant:	0.19
Height of water predicted(m):		11.20	Initial amplitude:	0.32
Height of water (m):		12.85		
K (m/s):		3.3E-04	Transmissivity (m^2/s)	2.51E-03
Storage:		7.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

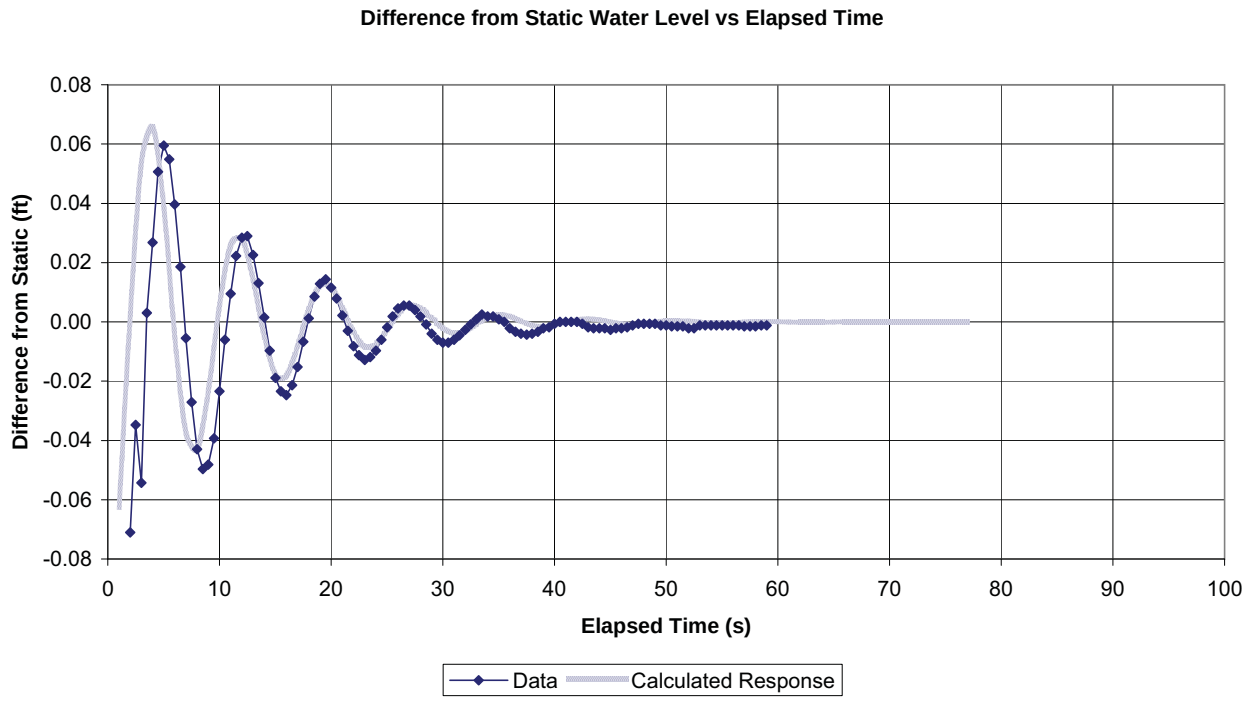
Borehole No:	P-05-16M		Test date:	13/07/2005
Instrument type:	In-situ transducer		Test time:	3:12 PM
Zone depth (m):	25.6032	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.62	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg
Riser diameter (m):		0.0508		
			d:	0.18
Depth of screen (m):		25.60	angular frequency (per second):	0.93
Depth to water (m):		12.76	damping constant:	0.17
Height of water predicted(m):		11.00	Initial amplitude:	0.3
Height of water (m):		12.85		
K (m/s):		3.8E-04	Transmissivity (m^2/s)	2.90E-03
Storage:		7.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

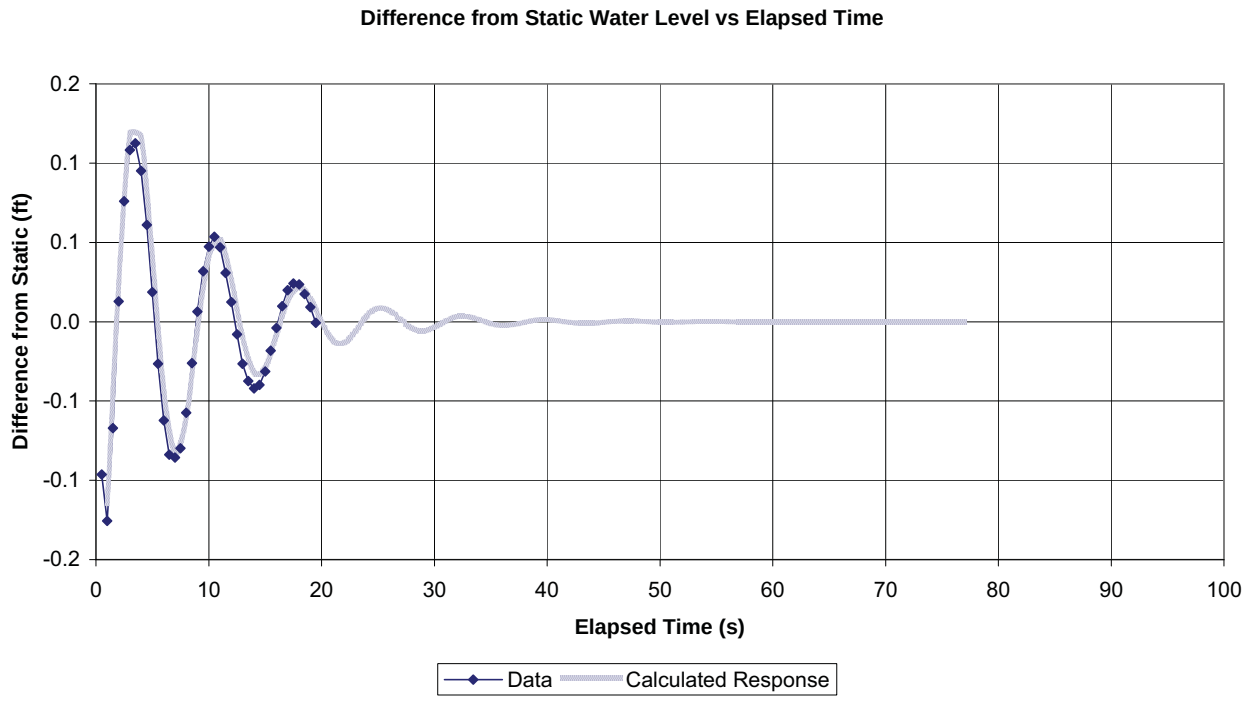
Borehole No:	P-05-16M		Test date:	13/07/2005
Instrument type:	In-situ transducer		Test time:	3:13 PM
Zone depth (m):	25.6032	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.62	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg & KG
Riser diameter (m):		0.0508		
			d:	0.13
Depth of screen (m):		25.60	angular frequency (per second):	0.80
Depth to water (m):		12.76	damping constant:	0.10
Height of water predicted(m):		15.00	Initial amplitude:	-0.1
Height of water (m):		12.85		
K (m/s):		4.8E-04	Transmissivity (m^2/s)	3.66E-03
Storage:		7.00E-04		



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16M		Test date:	13/07/2005
Instrument type:	In-situ transducer		Test time:	3:12 PM
Zone depth (m):	25.6032	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.62	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg & KG
Riser diameter (m):		0.0508		
			d:	0.14
Depth of screen (m):		25.60	angular frequency (per second):	0.87
Depth to water (m):		12.76	damping constant:	0.12
Height of water predicted(m):		12.85	Initial amplitude:	-0.2
Height of water (m):		12.85		
K (m/s):		4.7E-04	Transmissivity (m^2/s)	3.58E-03
Storage:		7.00E-04		

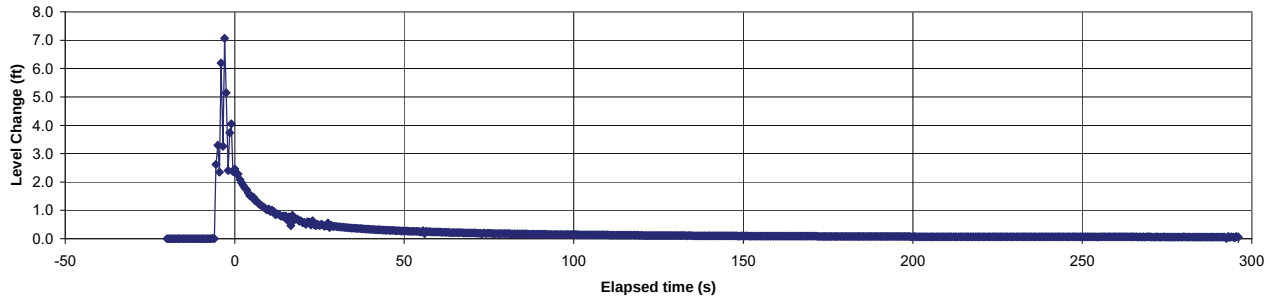


Borehole Response Test - Hvorslev Method

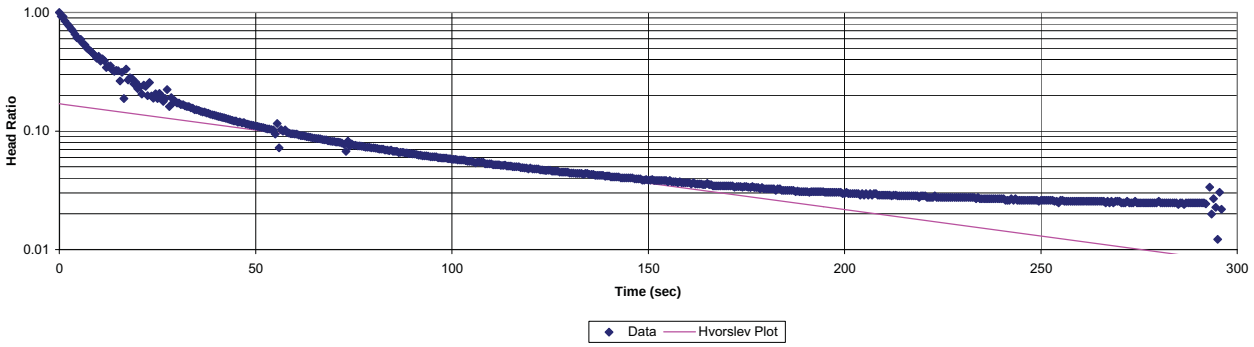
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16D	Test date:	13-Jul-05
Instrument type:	In-situ transducer	Test time:	11:05 AM
Zone depth (m):	41.57	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	Alex Rosenberg
Hole diameter (m):	0.1524	Analyst:	Alex Rosenberg
Riser diameter (m):	0.051		
Hvorslev intercept:	0.17		
K (m/s):	2.0E-06	Transmissivity (m²/s)	1.52E-05

Water Level Change



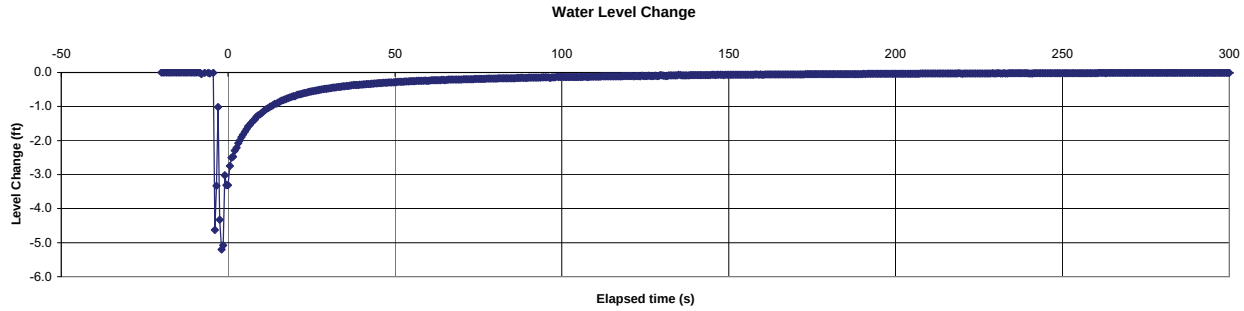
Head Ratio Plot

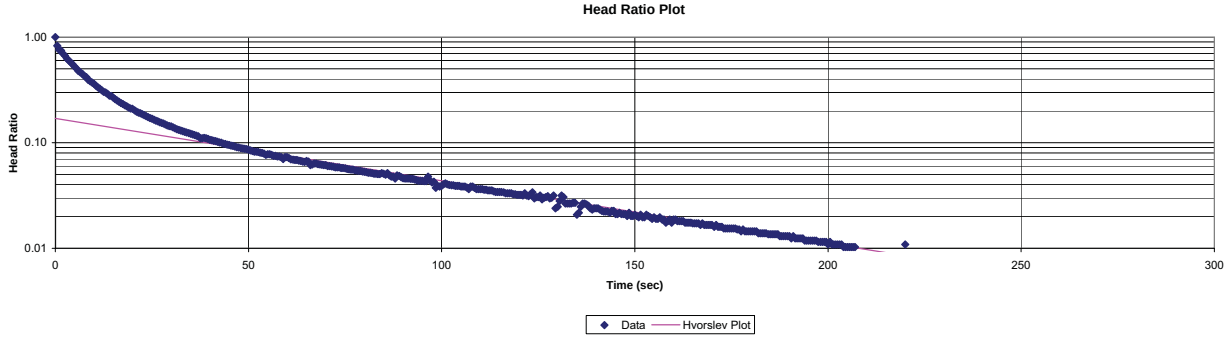


Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16D	Test date:	13-Jul-05
Instrument type:	In-situ transducer	Test time:	11:05 AM
Zone depth (m):	41.57	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	Alex Rosenberg
Hole diameter (m):	0.1524	Analyst:	Alex Rosenberg
Riser diameter (m):	0.051		
Hvorslev intercept:	0.17		
K (m/s):	2.7E-06	Transmissivity (m^2/s)	2.02E-05



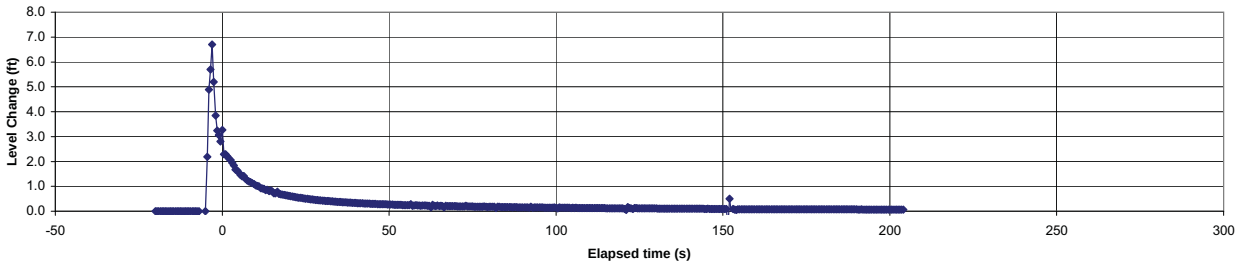


Borehole Response Test - Hvorslev Method

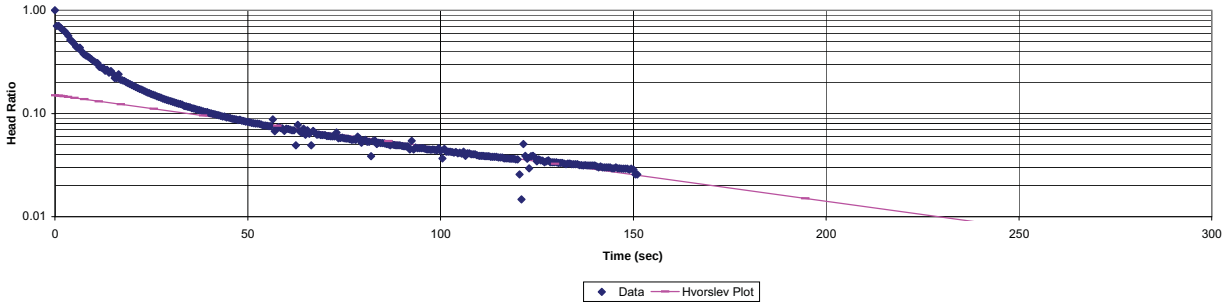
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16D	Test date:	13-Jul-05
Instrument type:	In-situ transducer	Test time:	11:05 AM
Zone depth (m):	41.57	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	Alex Rosenberg
Hole diameter (m):	0.1524	Analyst:	Alex Rosenberg
Riser diameter (m):	0.051		
Hvorslev intercept:	0.15		
K (m/s):	2.3E-06	Transmissivity (m^2/s)	1.75E-05

Water Level Change



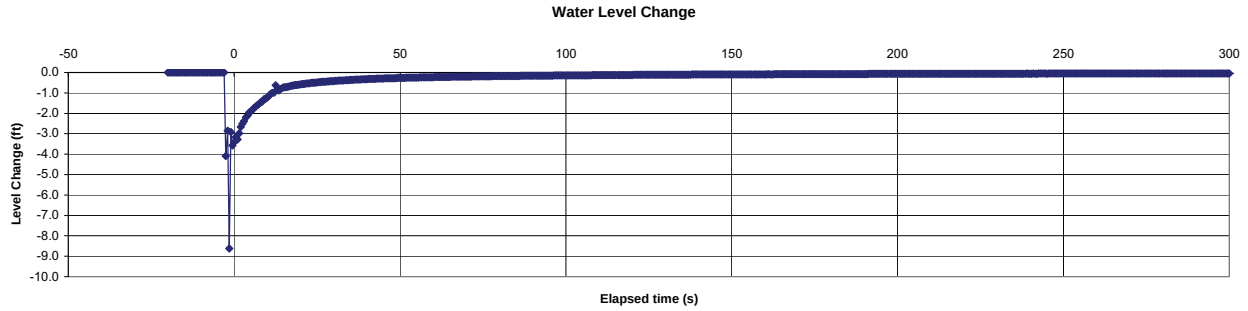
Head Ratio Plot

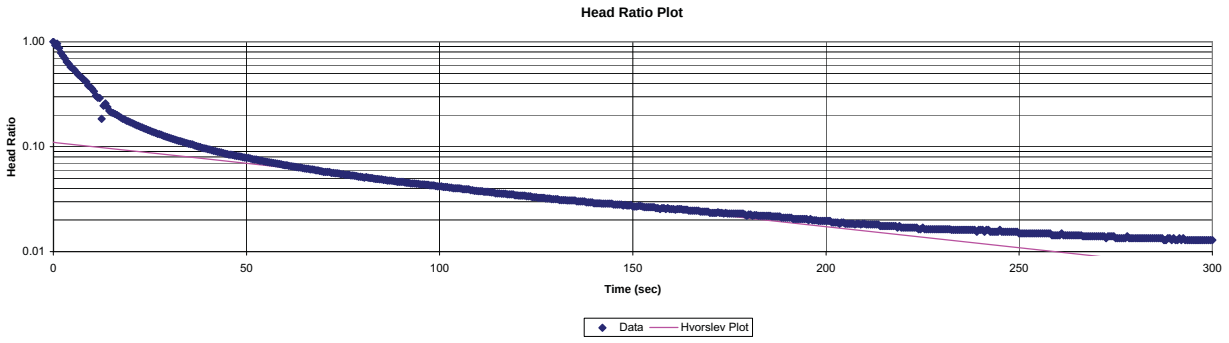


Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-16D	Test date:	13-Jul-05
Instrument type:	In-situ transducer	Test time:	11:05 AM
Zone depth (m):	41.57	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	Alex Rosenberg
Hole diameter (m):	0.1524	Analyst:	Alex Rosenberg
Riser diameter (m):	0.051		
Hvorslev intercept:	0.11		
K (m/s):	1.8E-06	Transmissivity (m^2/s)	1.37E-05





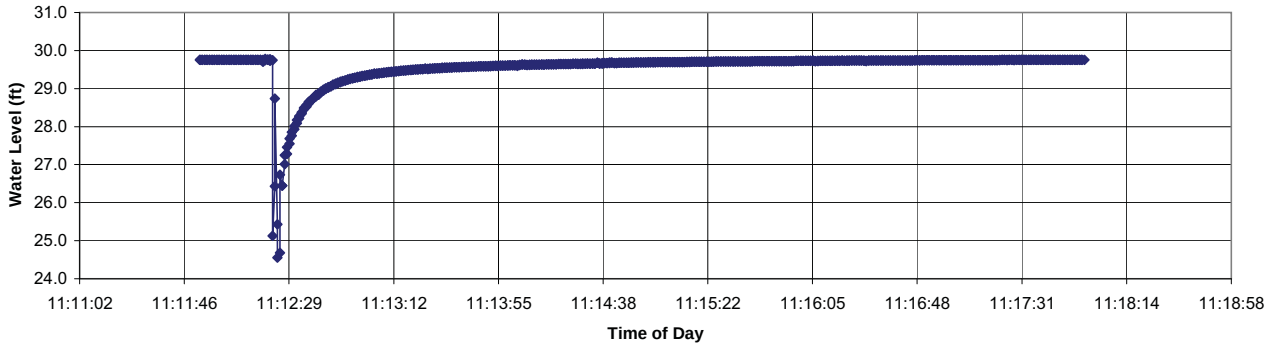
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

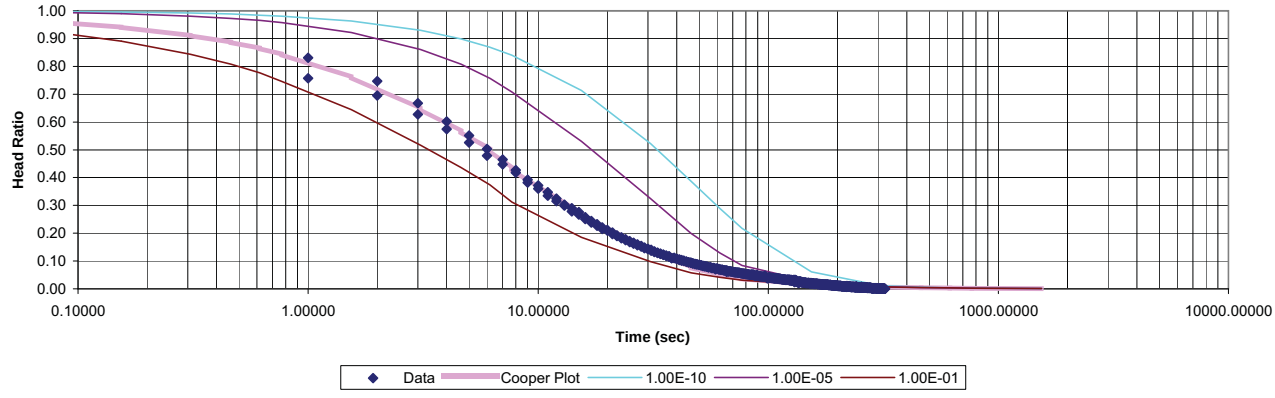
Borehole No:	P-05-16D	Test date:	########
Instrument type:	In-situ transducer	Test time:	11:12 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	7.62	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.1E-05	Transmissivity (m^2/s)	8.38E-05
Storage:	3.00E-03	Alpha	2.70E-02
		Δh_o (m)	-3.31

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

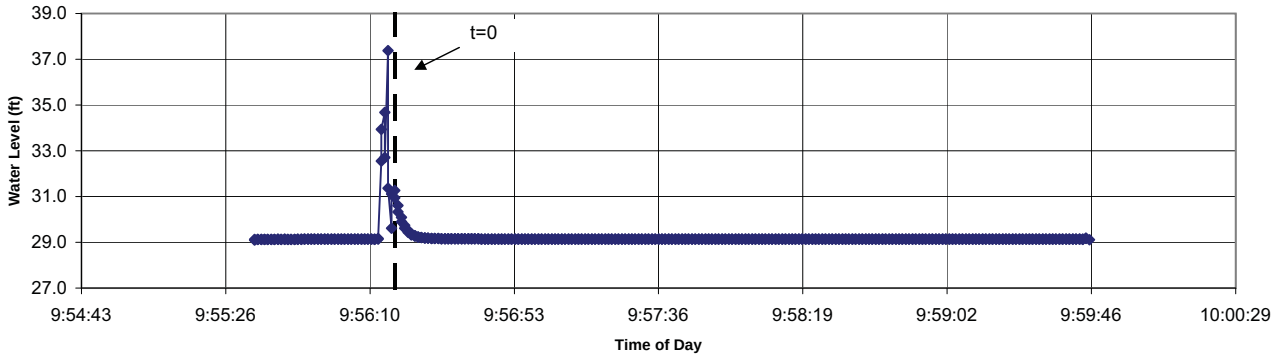
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-17S	Test date:	14-Jul-05
Instrument type:	In-situ transducer	Test time:	9:56 AM
Zone depth (m):	18.29	Screen type:	2 " PVC - 20 slot
Test length (m):	4.88	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		

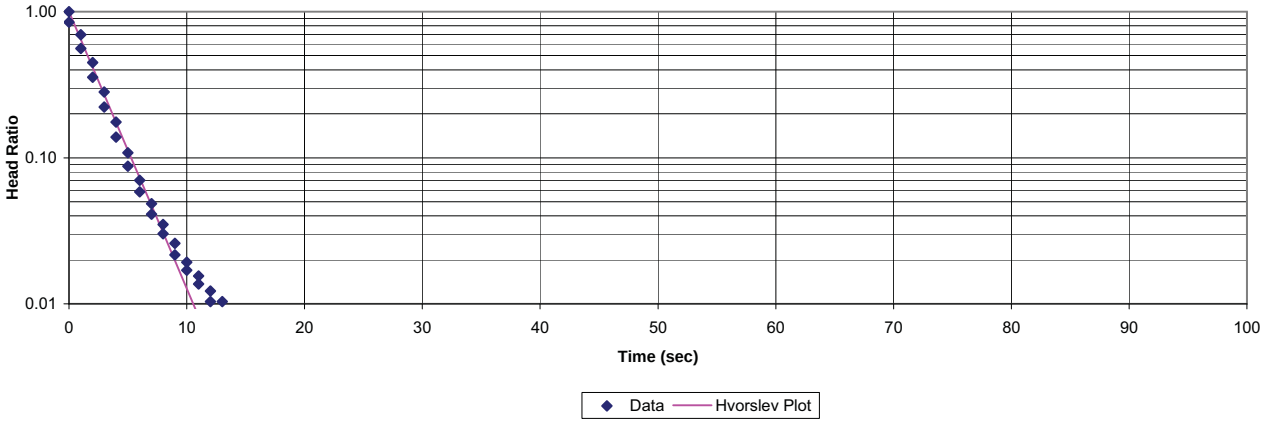
K (m/s): 1.2E-04

Transmissivity (m^2/s) 5.85E-04

Water Level Change



Head Ratio Plot

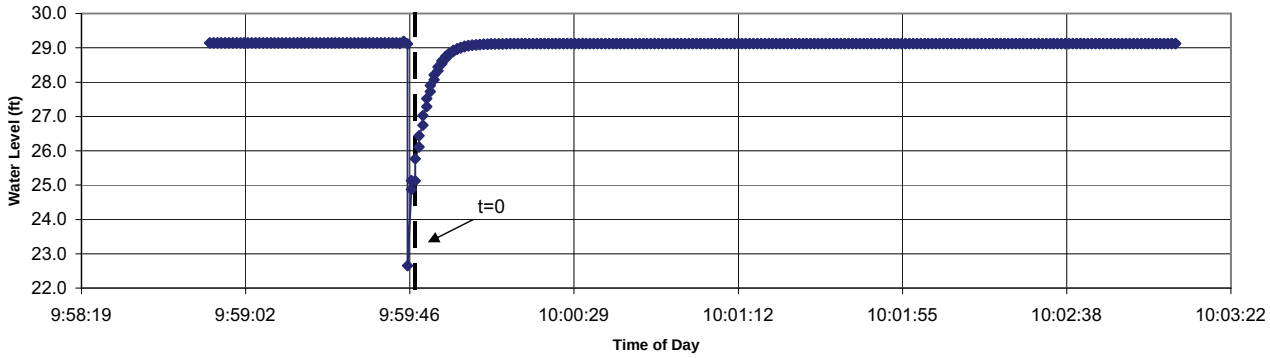


Borehole Response Test - Hvorslev Method

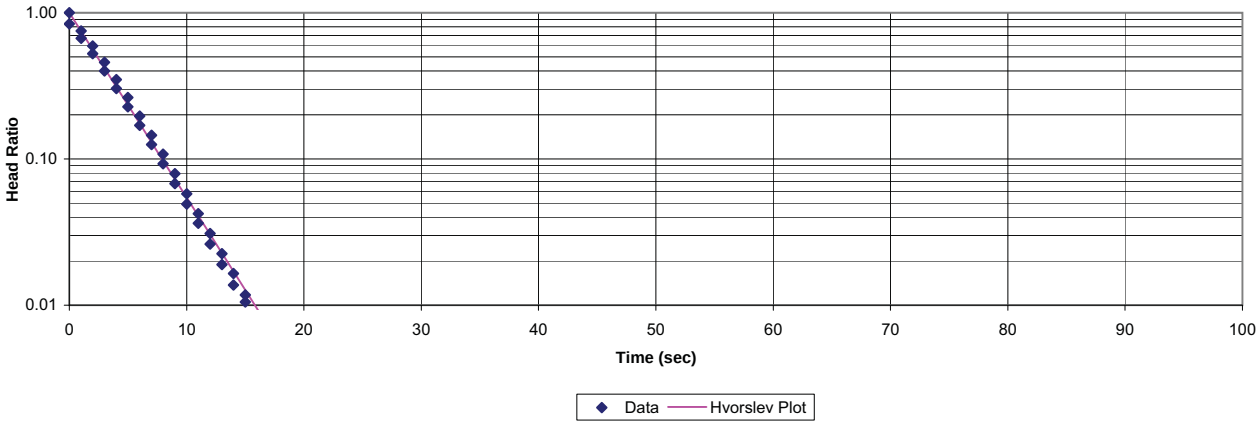
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-17S	Test date:	14-Jul-05
Instrument type:	In-situ transducer	Test time:	9:59 AM
Zone depth (m):	18.29	Screen type:	2 " PVC - 20 slot
Test length (m):	4.88	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		
K (m/s):	8.0E-05	Transmissivity (m^2/s)	3.90E-04

Water Level Change



Head Ratio Plot



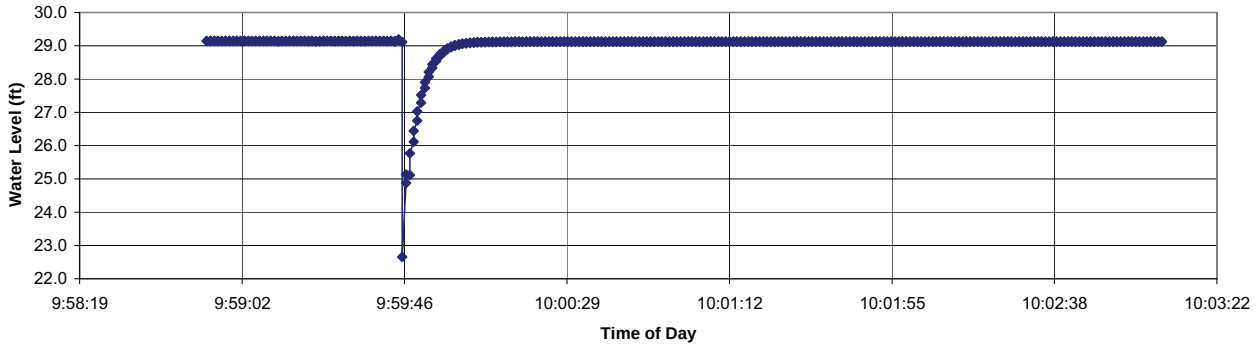
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

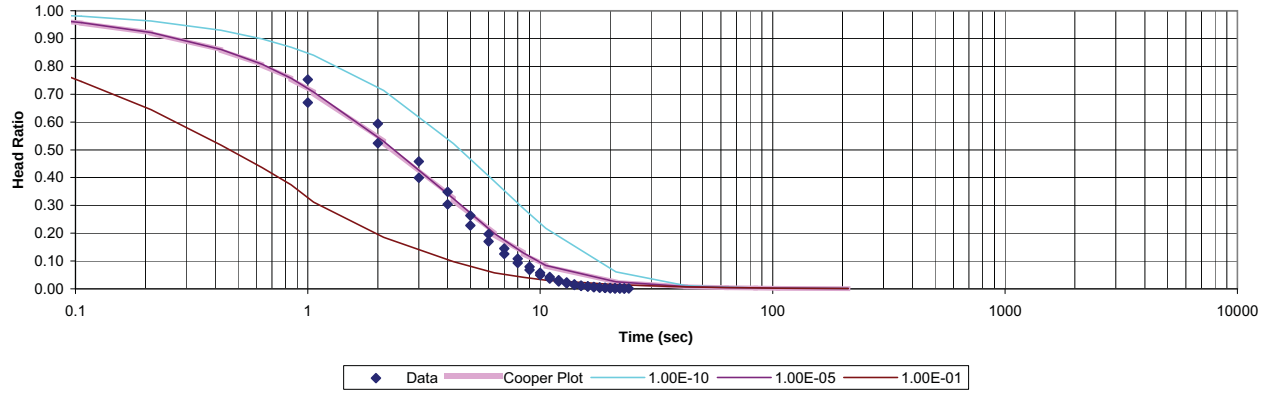
Borehole No:	P-05-17S	Test date:	14/07/2005
Instrument type:	In-situ transducer	Test time:	9:59 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	4.88	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.3E-04	Transmissivity (m^2/s)	6.10E-04
Storage:	1.50E-06	Alpha	1.35E-05
		Δh_o (m)	-4.00

Water Level vs Time of Day



Head Ratio Plot

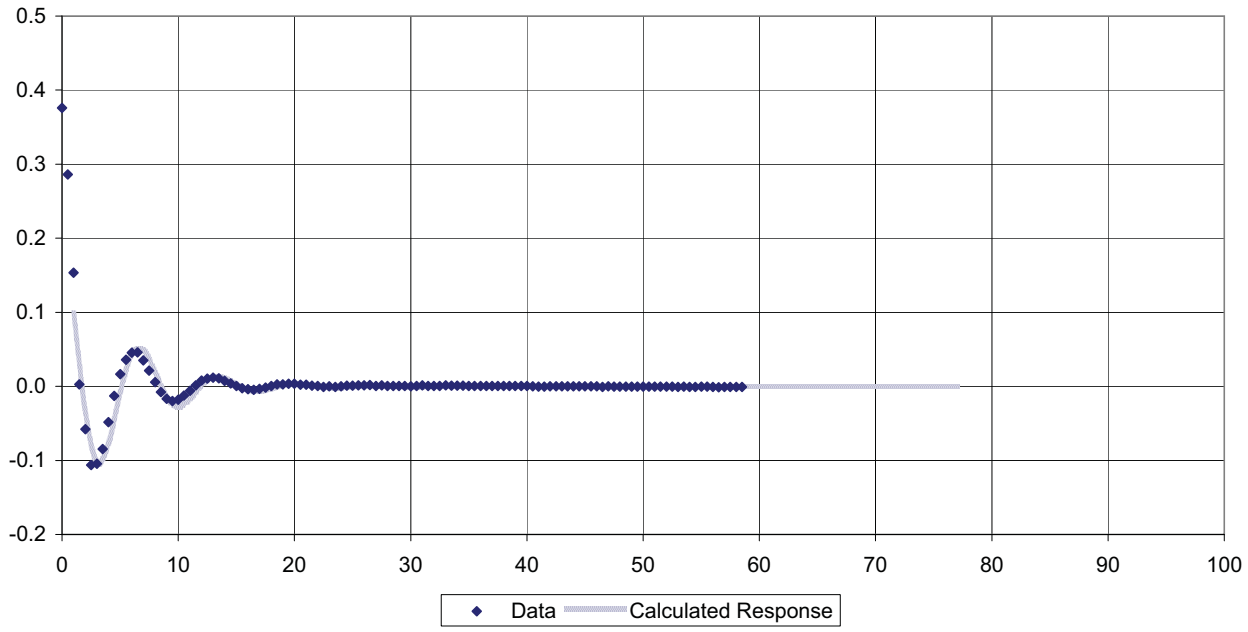


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-17D		Test date:	11/07/2005
Instrument type:	In-situ transducer		Test time:	11:31 AM
Zone depth (m):	41.4528	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.9248	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg &KG
Riser diameter (m):		0.0508		
			d:	0.21
Depth of screen (m):		40.84	angular frequency (per second):	0.92
Depth to water (m):		29.51	damping constant:	0.20
Height of water predicted(m):		11.00	Initial amplitude:	0.2
Height of water (m):		11.33		
K (m/s):		3.0E-04	Transmissivity (m^2/s)	2.38E-03
Storage:		8.00E-04		

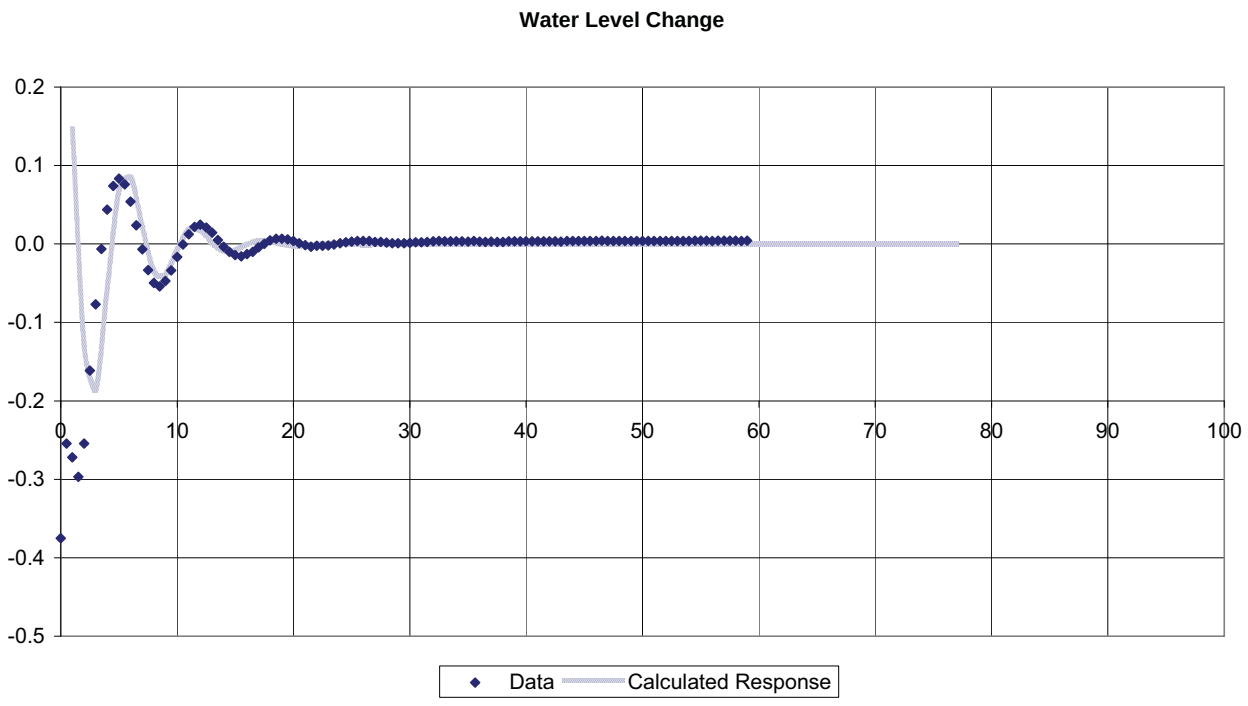
Water Level Change



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-17D		Test date:	11/07/2005
Instrument type:	In-situ transducer		Test time:	11:31 AM
Zone depth (m):	41.4528	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.9248	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg &KG
Riser diameter (m):		0.0508		
			d:	0.23
Depth of screen (m):		40.84	angular frequency (per second):	1.08
Depth to water (m):		29.51	damping constant:	0.26
Height of water predicted(m):		8.00	Initial amplitude:	0.4
Height of water (m):		11.33		
K (m/s):		3.0E-04	Transmissivity (m^2/s)	2.38E-03
Storage:		1.00E-03		

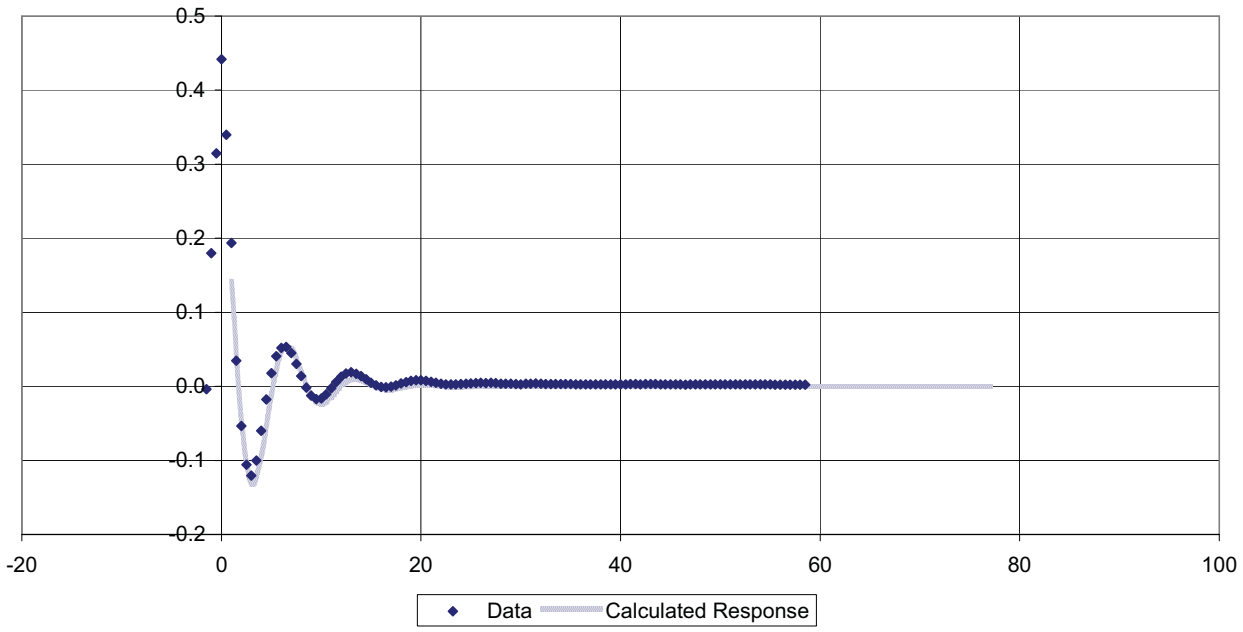


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:		P-05-17D	Test date:		11/07/2005
Instrument type:		In-situ transducer	Test time:		11:31 AM
Zone depth (m):	41.4528	19.2024	Screen type:		2 " PVC - 20 slot
Test length (m):		7.9248	Field technician:		
Hole diameter (m):		0.1524	Analyst:		Alex Rosenberg &KG
Riser diameter (m):		0.0508			
			d:		0.26
Depth of screen (m):		40.84	angular frequency (per second):		0.92
Depth to water (m):		29.51	damping constant:		0.25
Height of water predicted(m):		10.80	Initial amplitude:		0.3
Height of water (m):		11.33			
K (m/s):		2.5E-04	Transmissivity (m^2/s)		1.98E-03
Storage:		5.00E-04			

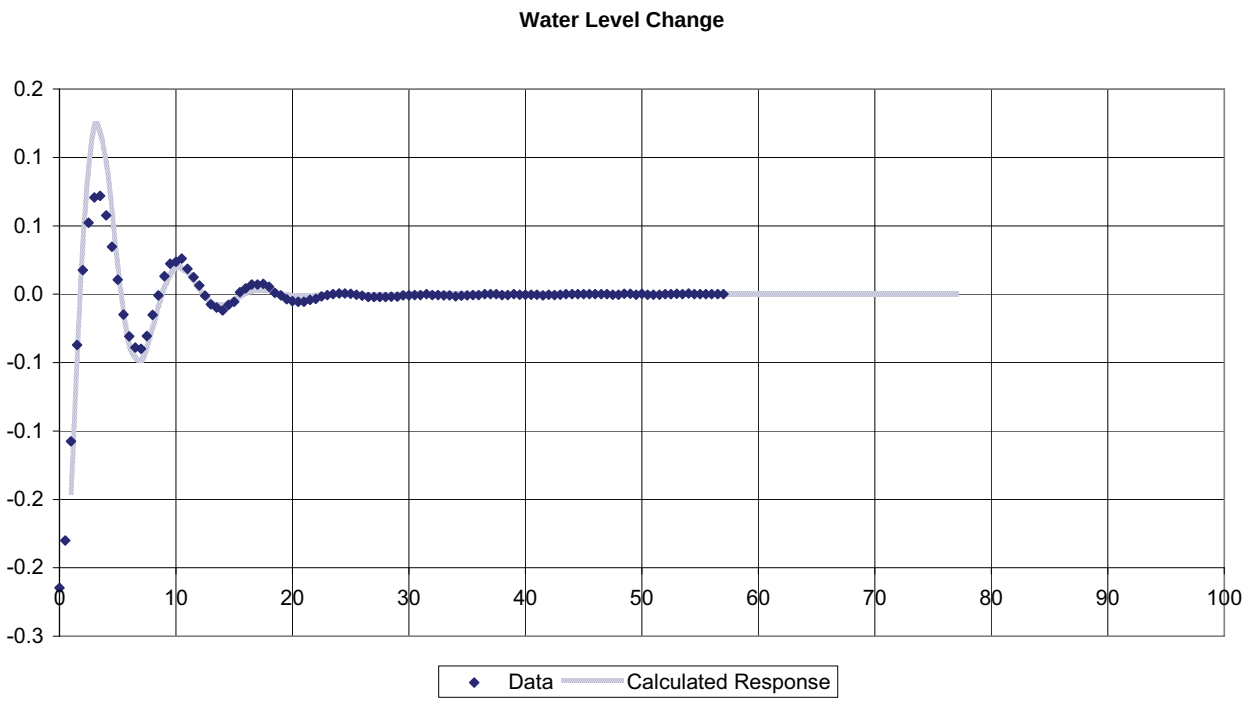
Water Level Change



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-17D		Test date:	11/07/2005
Instrument type:	In-situ transducer		Test time:	11:31 AM
Zone depth (m):	41.4528	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):		7.9248	Field technician:	
Hole diameter (m):		0.1524	Analyst:	Alex Rosenberg
Riser diameter (m):		0.0508		
			d:	0.28
Depth of screen (m):		40.84	angular frequency (per second):	0.89
Depth to water (m):		29.51	damping constant:	0.26
Height of water predicted(m):		11.33	Initial amplitude:	-0.3
Height of water (m):		11.33		
K (m/s):		2.0E-04	Transmissivity (m^2/s)	1.58E-03
Storage:		1.00E-03		

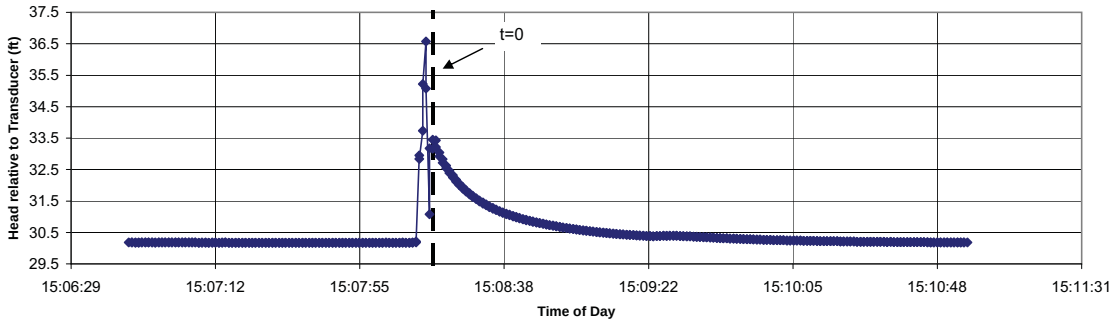


Borehole Response Test - Hvorslev Method

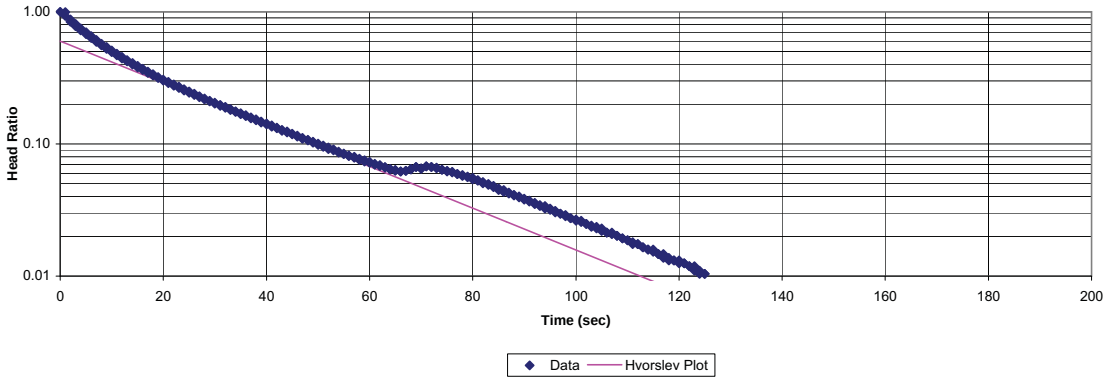
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-19D		Test date:	16-Oct-05
Instrument type:	In-situ transducer		Test time:	3:08 PM
Zone depth:	26.52 m	87 ft	Screen type:	2 " PVC - 20 slot
Test Zone Length:	4.88 m	16 ft	Field technician:	SLR Alaska
Hole diameter:	0.152 m	6. in	Analyst:	K Gibson
Riser diameter:	0.051 m	2. in		
Transmissivity (m^2/s)	4.88E-05		Static Head relative to Transducer(ft)	30.177
K (m/s):	1.0E-05		Head at t=0 relative to Transducer(ft)	33.449
Hvorslev intercept:	0.6			

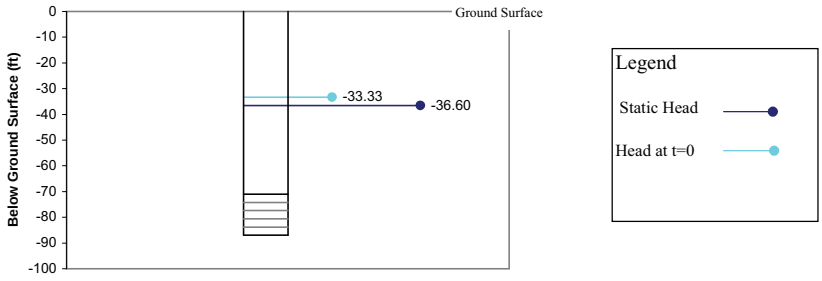
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



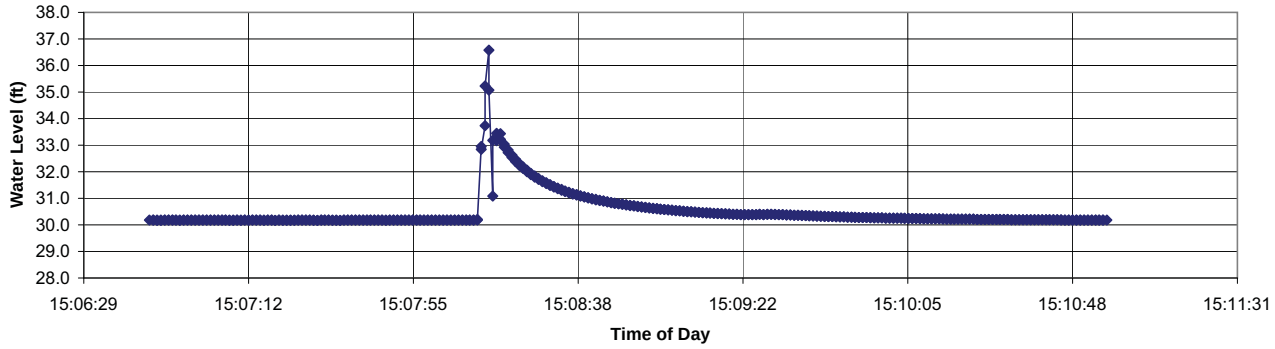
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

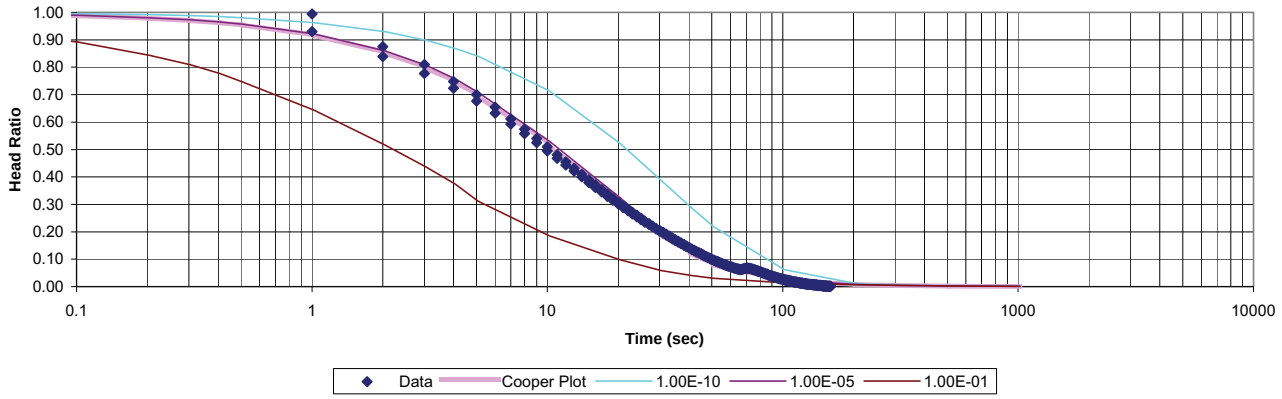
Borehole No:	P-05-19D	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	3:08 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	4.88	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	2.6E-05	Transmissivity (m^2/s)	1.27E-04
Storage:	3.00E-06	Alpha	2.70E-05
		Δh_o (m)	3.27

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

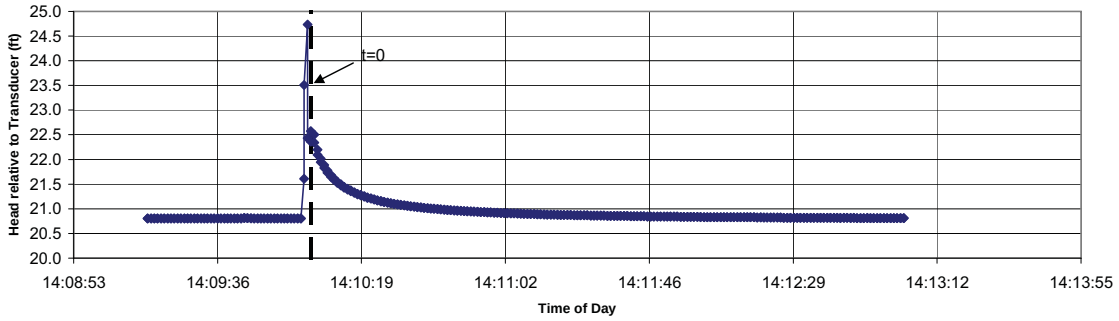
Borehole No:	P-05-20S	
Instrument type:	In-situ transducer	
Zone depth:	8.38 m	28 ft
Test Zone Length:	3.35 m	11 ft
Hole diameter:	0.121 m	4.75 in
Riser diameter:	0.051 m	2. in

Test date:	16-Oct-05
Test time:	2:10 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

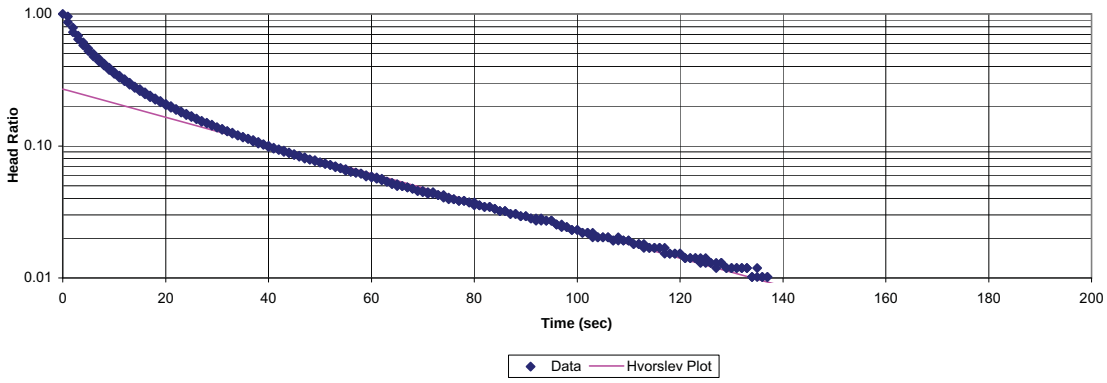
Transmissivity (m^2/s)	3.19E-05
K (m/s):	9.5E-06
Hvorslev intercept:	0.27

Static Head relative to Transducer(ft)	20.806
Head at t=0 relative to Transducer(ft)	22.577

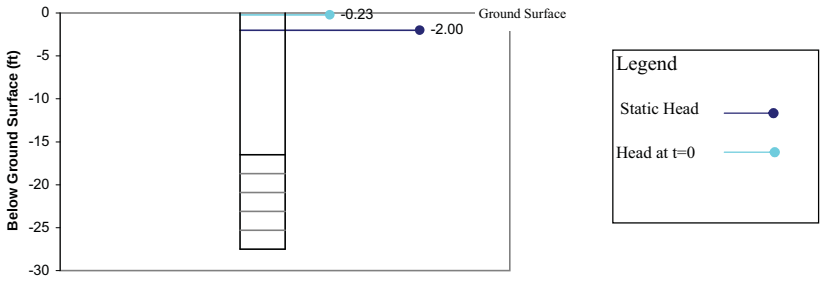
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



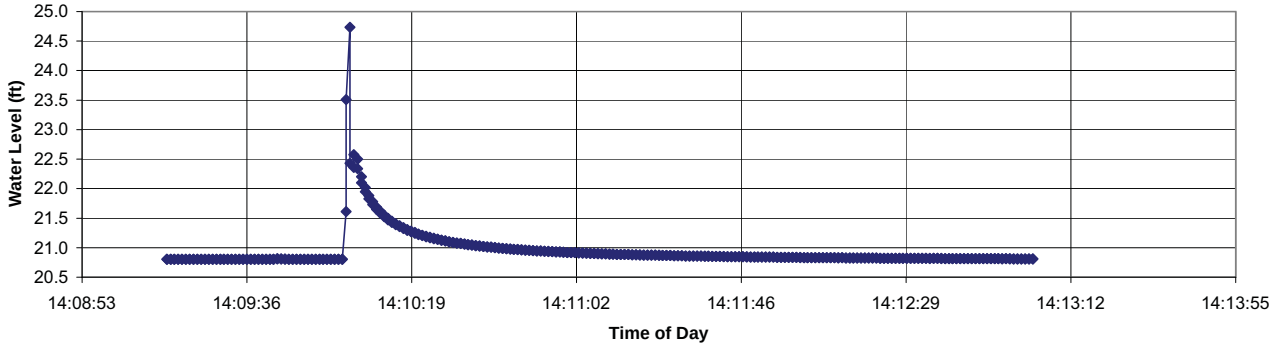
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

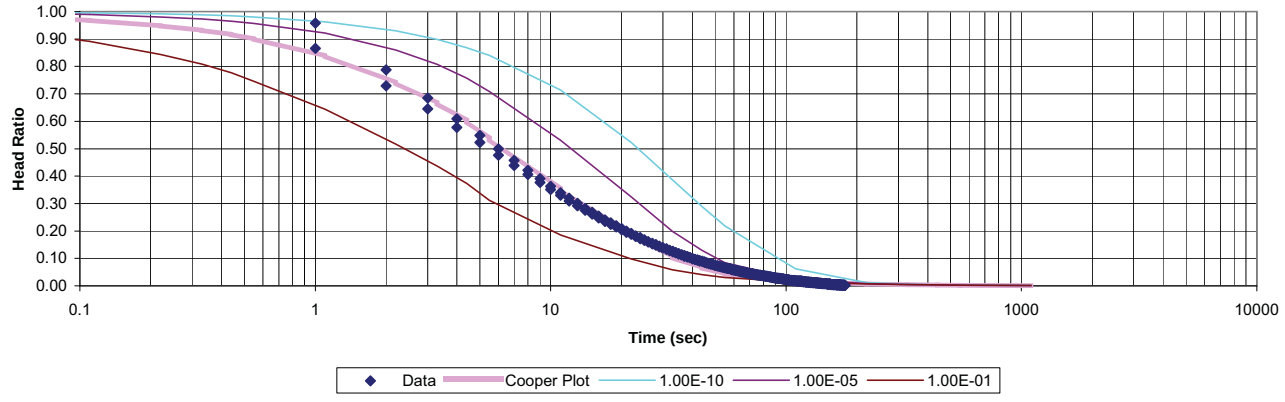
Borehole No:	P-05-20S	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	2:10 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.35	Field technician:	SLR Alaska
Hole diameter (m):	0.121	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	3.5E-05	Transmissivity (m^2/s)	1.17E-04
Storage:	7.00E-04	Alpha	3.95E-03
		Δh_o (m)	1.77

Water Level vs Time of Day



Head Ratio Plot

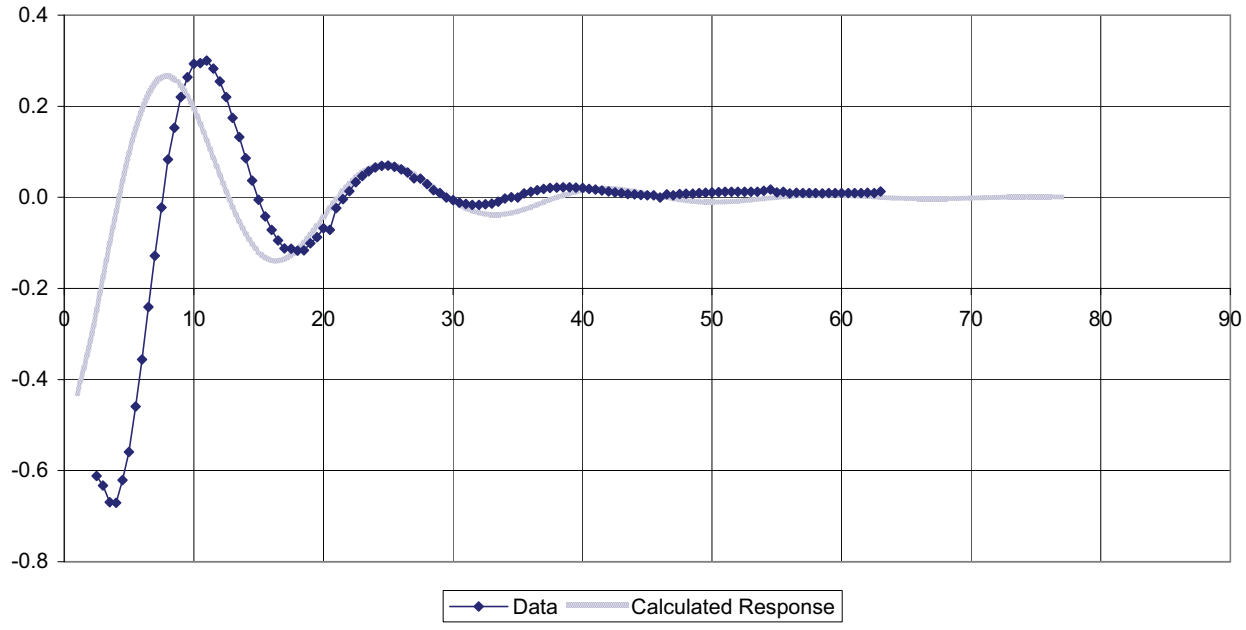


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-22	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	11:28 AM
Zone depth (m):	70.866	Screen type:	2 " PVC - 20 slot
Test length (m):	14.6304	Field technician:	SLR Alaska
Hole diameter (m):	0.12065	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.20
Depth of screen (m):	70.87	angular frequency (per second):	0.37
Depth to water (m):	7.84	damping constant:	0.08
Height of water predicted(m):	68.00	Initial amplitude:	-0.5
Height of water (m):	63.02		
K (m/s):	1.5E-04	Transmissivity (m^2/s)	2.19E-03
Storage:	1.00E-06		

Water Level Change



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-23	
Instrument type:	In-situ transducer	
Zone depth:	17.68 m	58 ft
Test Zone Length:	3.66 m	12 ft
Hole diameter:	0.146 m	5.75 in
Riser diameter:	0.051 m	2. in

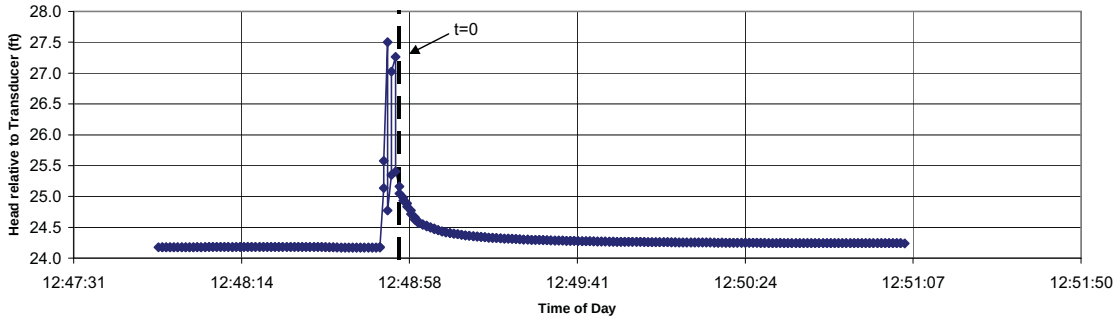
Test date:	14-Oct-05
Test time:	12:48 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m²/s)	4.75E-05
K (m/s):	1.3E-05
Hvorslev intercept:	0.25

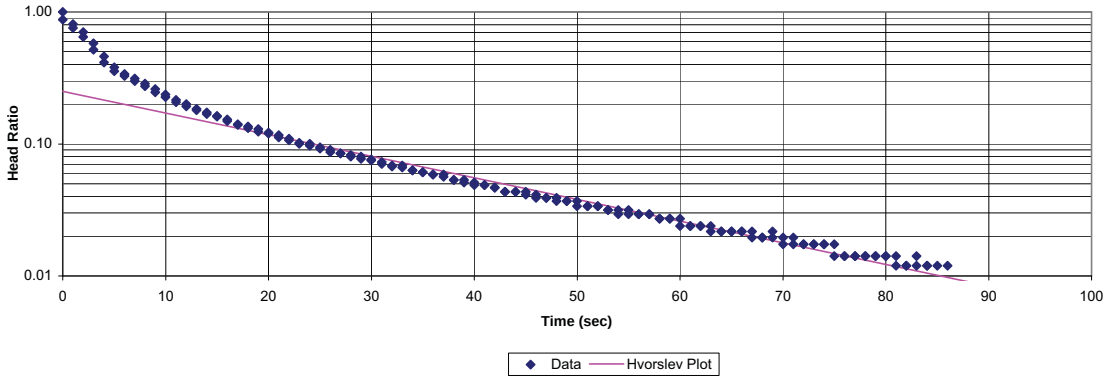
Static Head relative to Transducer(ft)	24.24
Head at t=0 relative to Transducer(ft)	25.16

Note: Static based on post test value

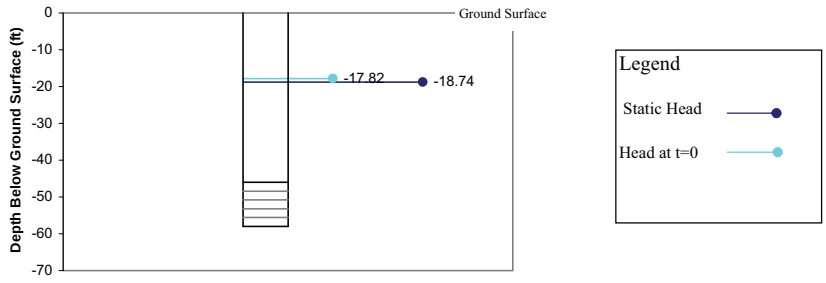
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



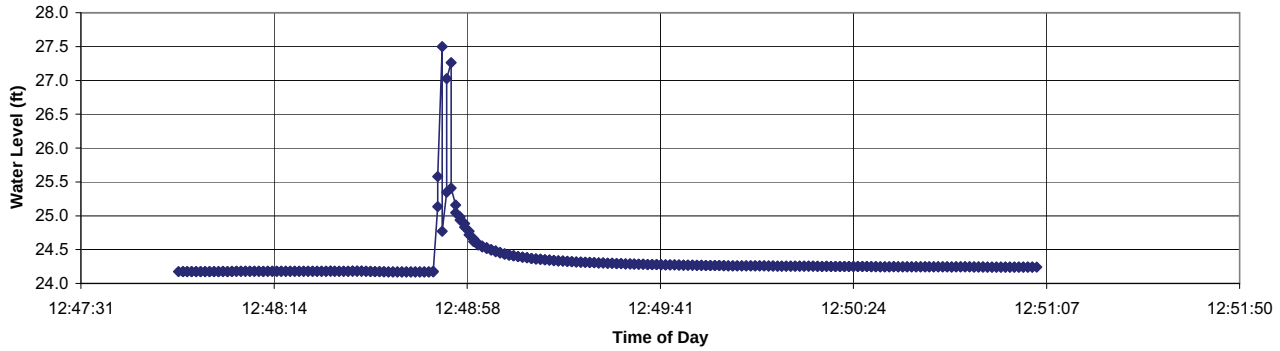
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

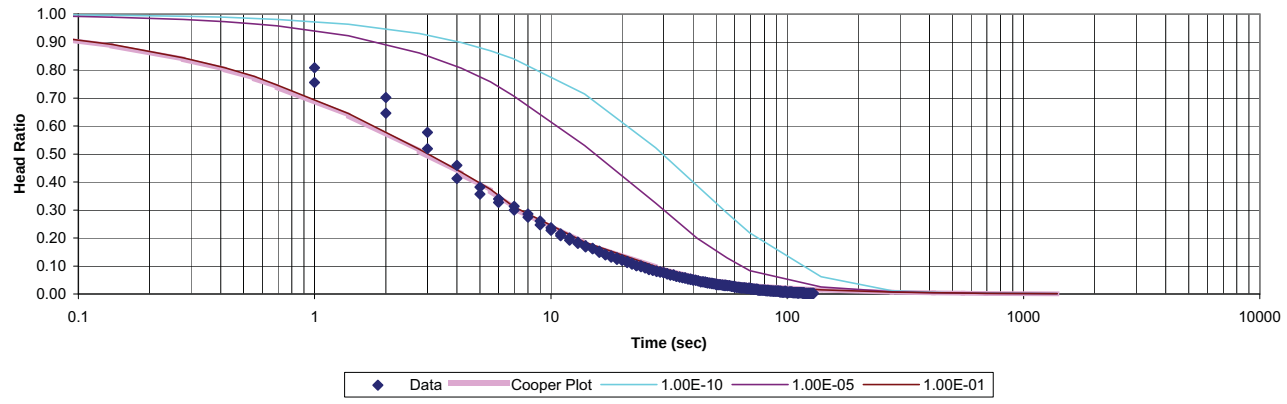
Borehole No:	P-05-23	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	12:48 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.66	Field technician:	SLR Alaska
Hole diameter (m):	0.063	Analyst:	K Gibson
Riser diameter (m):	0.025		

K (m/s):	6.3E-06	Transmissivity (m^2/s)	2.30E-05
Storage:	2.00E-02	Alpha	1.26E-01
		Δh_o (m)	0.92

Water Level vs Time of Day



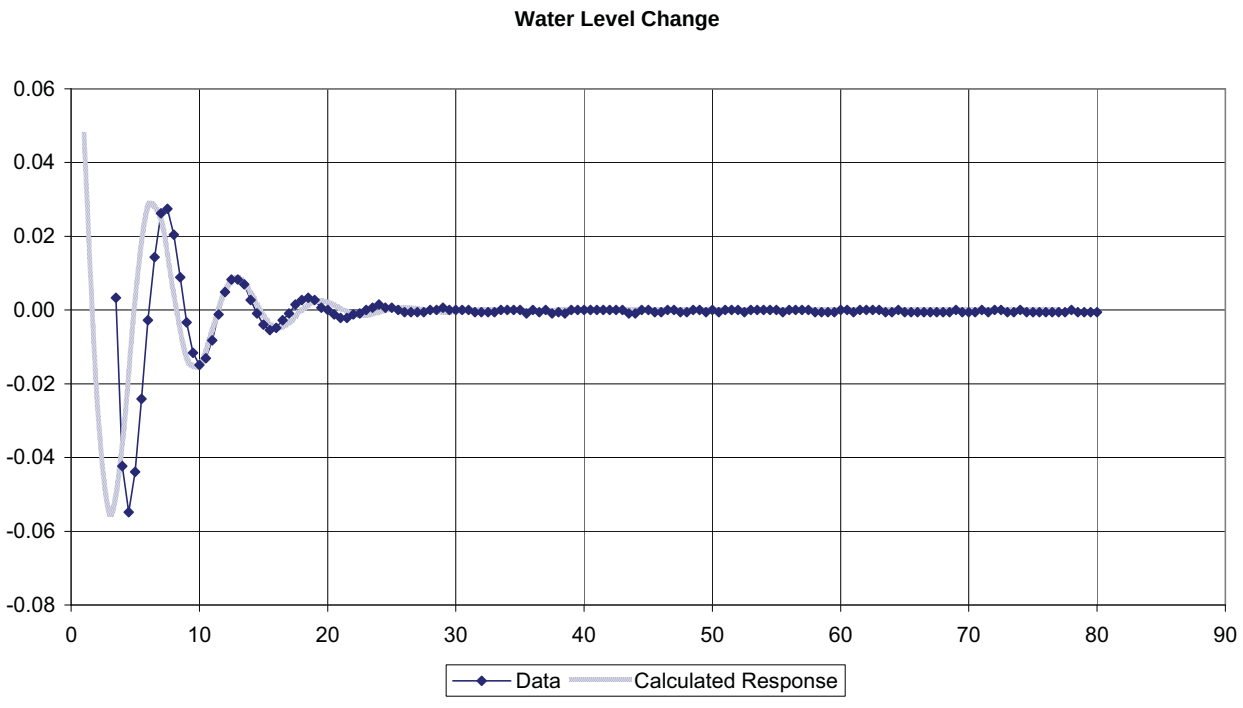
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-24S	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	10:13 AM
Zone depth (m):	11.43	Screen type:	2 " PVC - 20 slot
Test length (m):	2.4384	Field technician:	SLR Alaska
Hole diameter (m):	0.14605	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.19
Depth of screen (m):	11.28	angular frequency (per second):	0.96
Depth to water (m):	3.87	damping constant:	0.19
Height of water predicted(m):	10.25	Initial amplitude:	0.1
Height of water (m):	7.41		
K (m/s):	8.7E-04	Transmissivity (m^2/s)	2.12E-03
Storage:	3.00E-03		

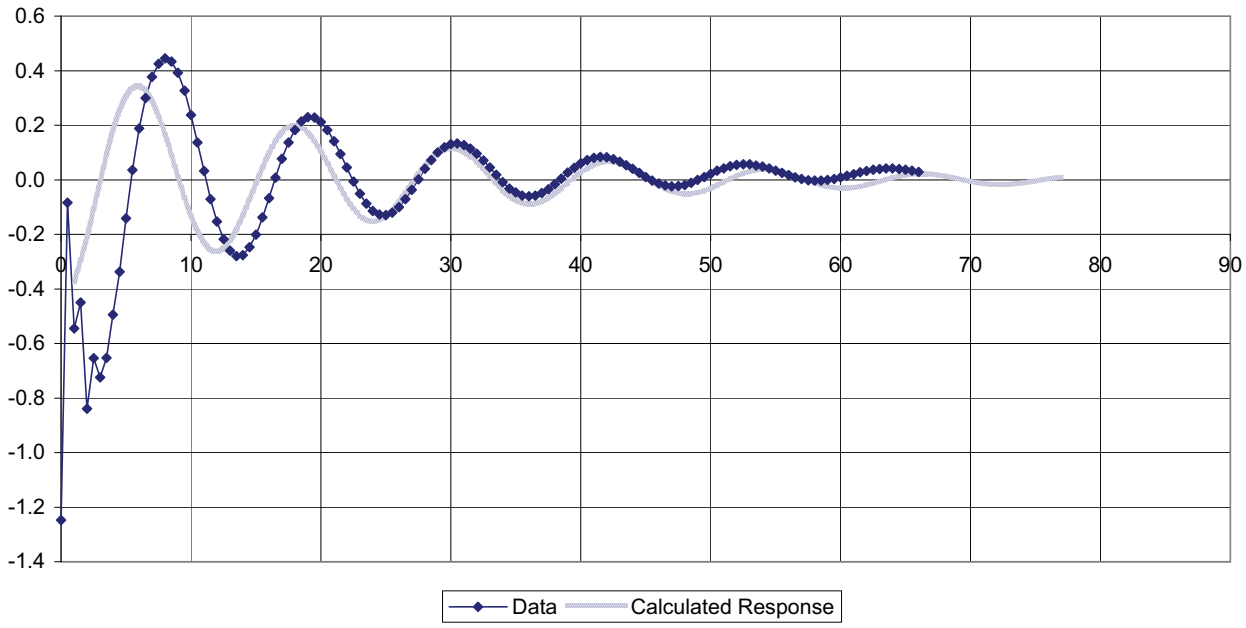


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-24D	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	9:42 AM
Zone depth (m):	43.2816	Screen type:	2 " PVC - 20 slot
Test length (m):	4.2672	Field technician:	SLR Alaska
Hole diameter (m):	0.14605	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.09
Depth of screen (m):	43.28	angular frequency (per second):	0.52
Depth to water (m):	3.40	damping constant:	0.04
Height of water predicted(m):	36.00	Initial amplitude:	-0.45
Height of water (m):	39.88		
K (m/s):	2.0E-03	Transmissivity (m^2/s)	8.53E-03
Storage:	1.00E-07		

Water Level Change



Borehole Response Test - Hvorslev Method

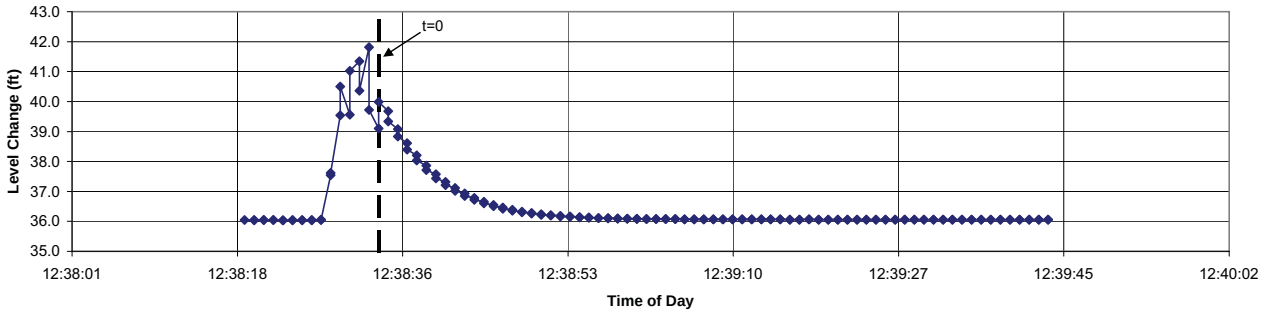
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-25
Instrument type:	In-situ transducer
Zone depth (m):	18.90
Test length (m):	4.88
Hole diameter (m):	0.14605
Riser diameter (m):	0.051
Hvorslev intercept:	1
K (m/s):	4.9E-05

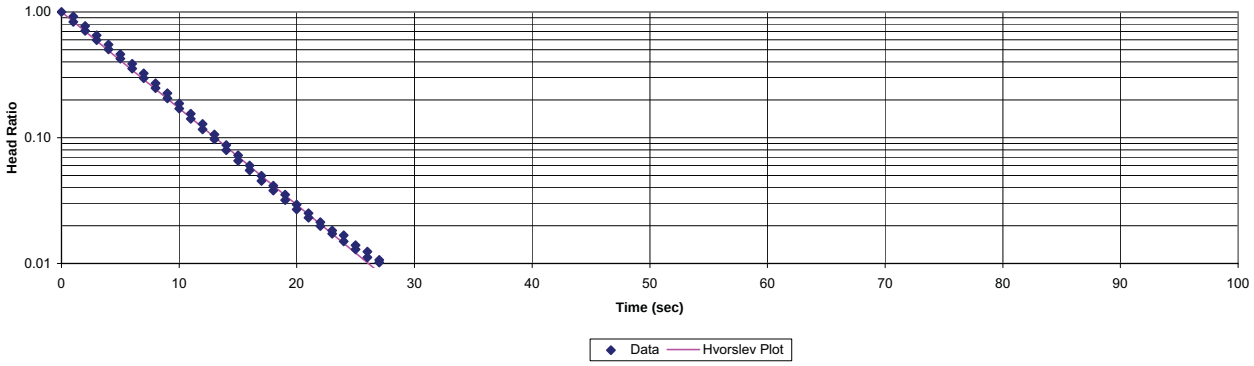
Test date:	25-Sep-05
Test time:	12:38 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 2.39E-04

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

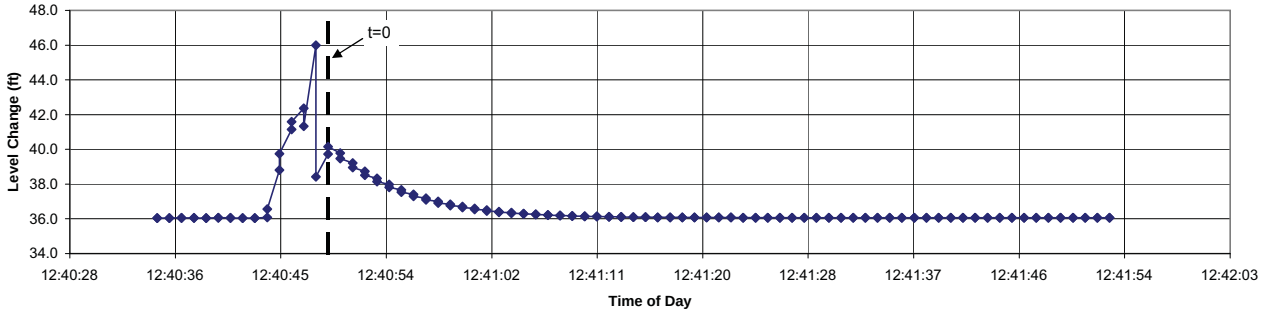
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-25
Instrument type:	In-situ transducer
Zone depth (m):	18.90
Test length (m):	4.88
Hole diameter (m):	0.001693
Riser diameter (m):	0.051
Hvorslev intercept:	1
K (m/s):	1.0E-04

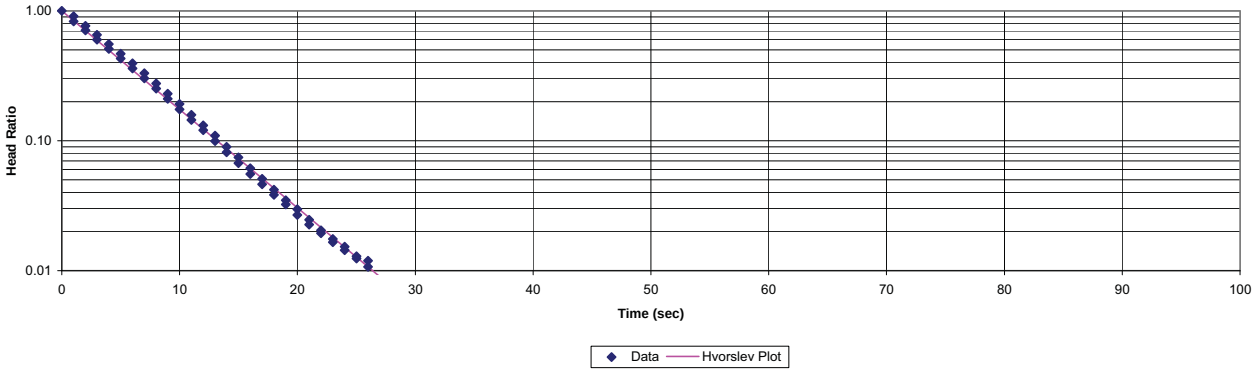
Test date:	25-Sep-05
Test time:	12:40 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 4.87E-04

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

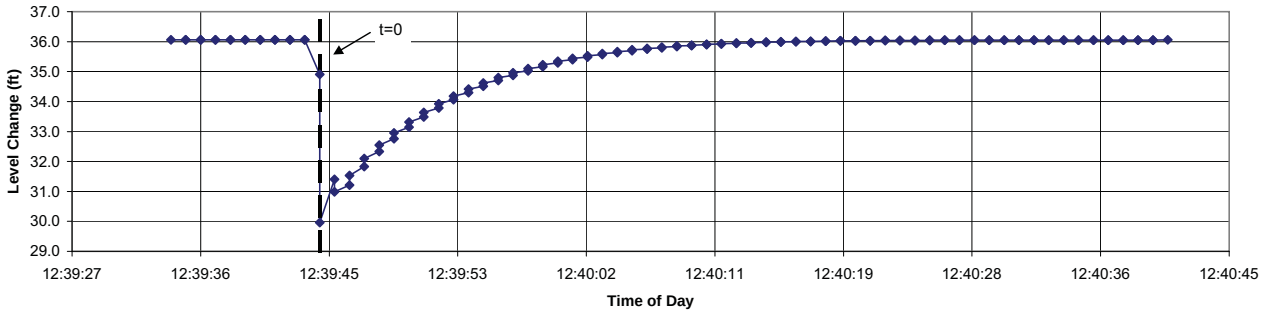
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-25
Instrument type:	In-situ transducer
Zone depth (m):	18.90
Test length (m):	4.88
Hole diameter (m):	0.14605
Riser diameter (m):	0.051
Hvorslev intercept:	1
K (m/s):	3.9E-05

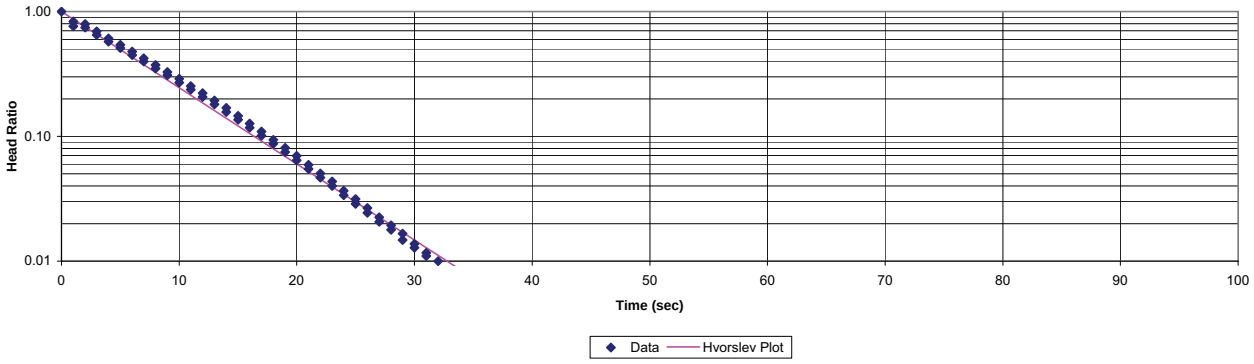
Test date:	25-Sep-05
Test time:	12:39 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 1.90E-04

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

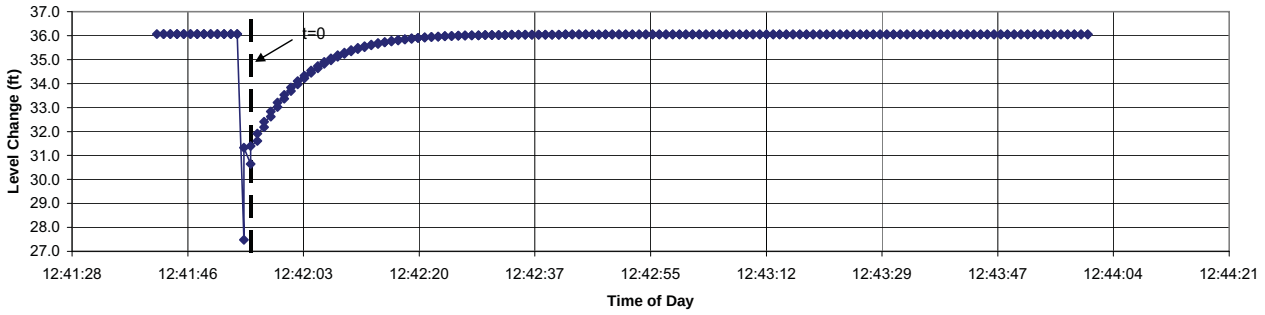
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-25
Instrument type:	In-situ transducer
Zone depth (m):	18.90
Test length (m):	4.88
Hole diameter (m):	0.14605
Riser diameter (m):	0.051
Hvorslev intercept:	1
K (m/s):	3.8E-05

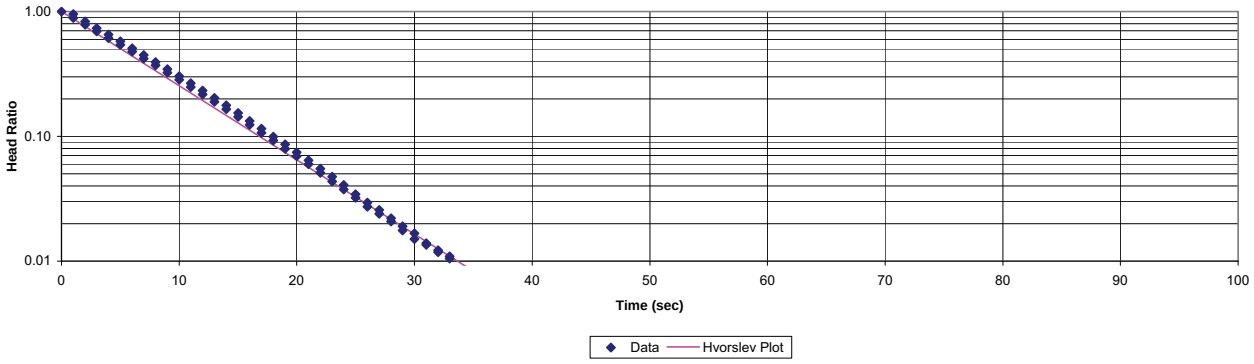
Test date:	25-Sep-05
Test time:	12:41 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 1.85E-04

Water Level Change



Head Ratio Plot



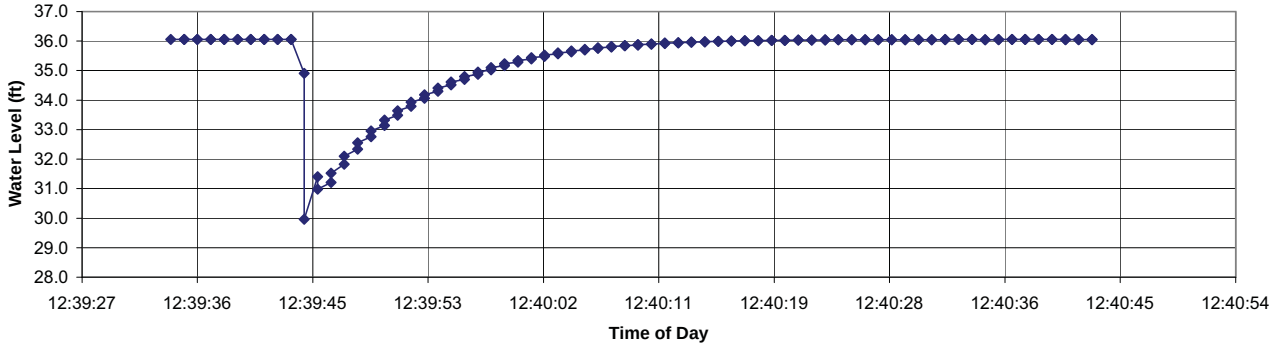
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

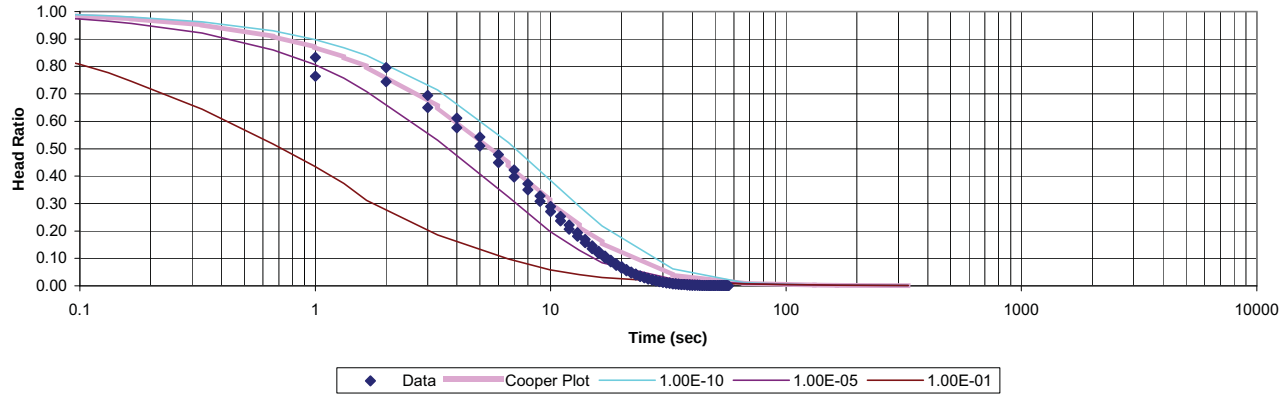
Borehole No:	P-05-25	Test date:	25/09/2005
Instrument type:	In-situ transducer	Test time:	12:39 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	4.88	Field technician:	SLR Alaska
Hole diameter (m):	0.146	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	8.0E-05	Transmissivity (m^2/s)	3.90E-04
Storage:	3.00E-09	Alpha	2.48E-08
		Δh_o (m)	-6.09

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

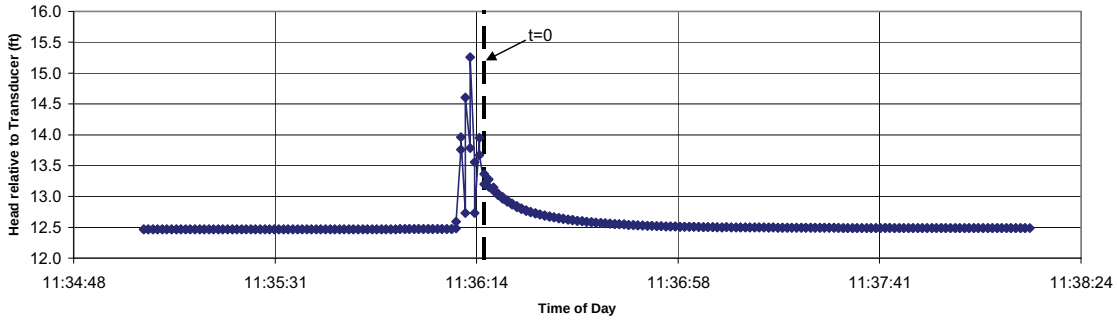
Borehole No:	P-05-26S	
Instrument type:	In-situ transducer	
Zone depth:	8.99 m	30 ft
Test Zone Length:	3.96 m	13 ft
Hole diameter:	0.127 m	5. in
Riser diameter:	0.051 m	2. in

Test date:	14-Oct-05
Test time:	11:36 AM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

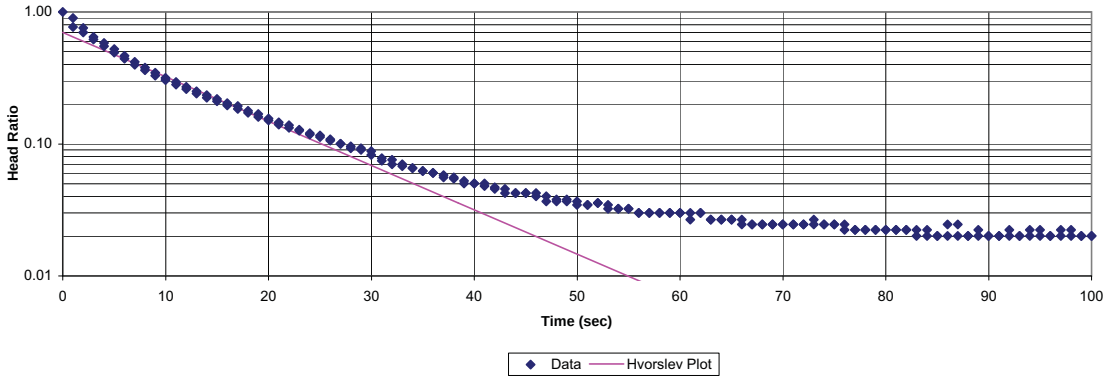
Transmissivity (m²/s)	1.03E-04
K (m/s):	2.6E-05
Hvorslev intercept:	0.7

Static Head relative to Transducer(ft)	12.467
Head at t=0 relative to Transducer(ft)	13.366

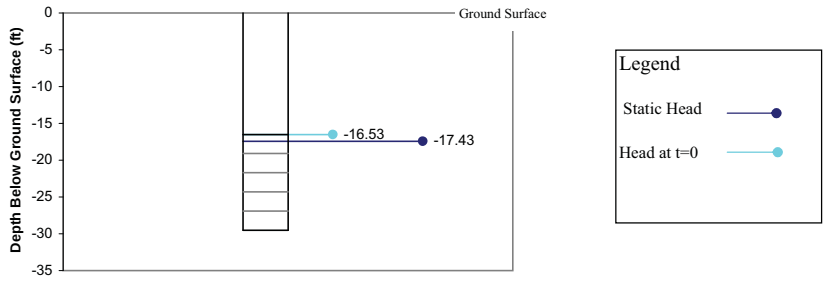
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval

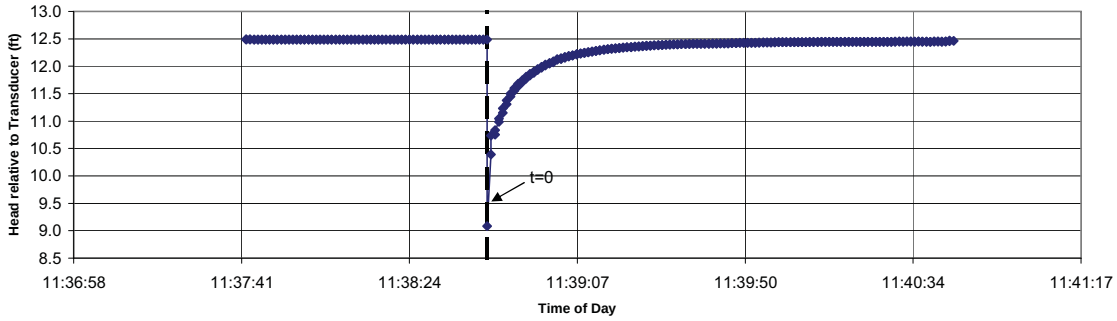


Borehole Response Test - Hvorslev Method

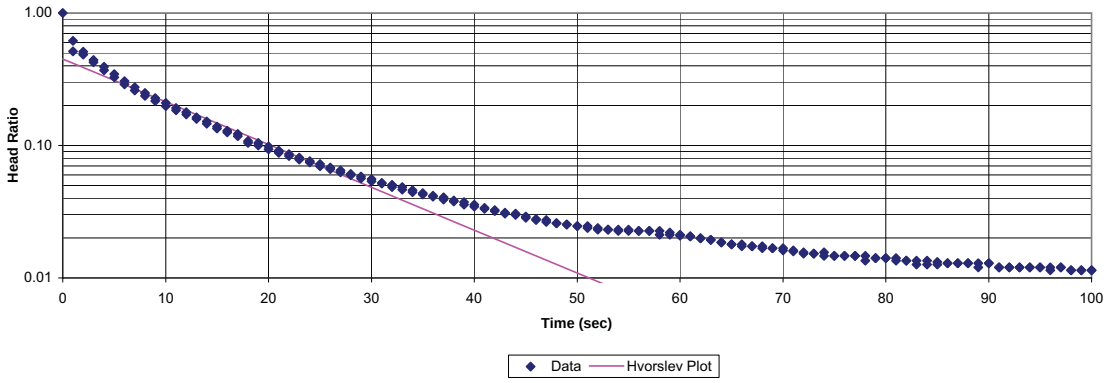
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-26S		Test date:	14-Oct-05
Instrument type:	In-situ transducer		Test time:	11:38 AM
Zone depth:	9.14 m	30 ft	Screen type:	2 " PVC - 20 slot
Test Zone Length:	3.96 m	13 ft	Field technician:	SLR Alaska
Hole diameter:	0.127 m	5. in	Analyst:	K Gibson
Riser diameter:	0.051 m	2. in		
Transmissivity (m²/s)	9.91E-05		Static Head relative to Transducer(ft)	12.487
K (m/s):	2.5E-05		Head at t=0 relative to Transducer(ft)	9.082
Hvorslev intercept:	0.45			

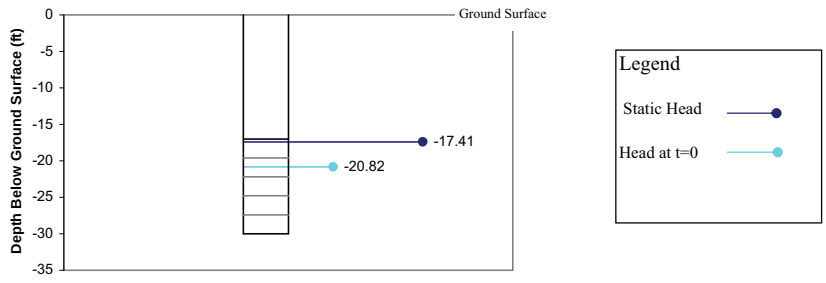
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



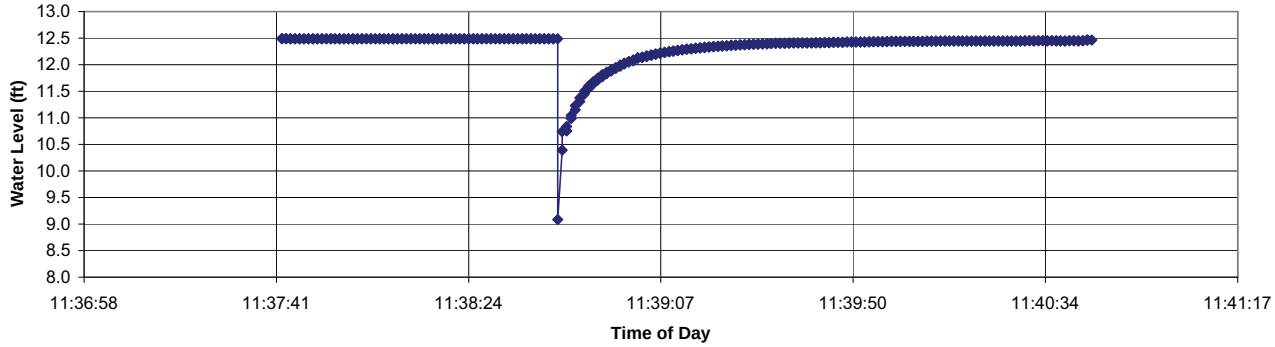
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

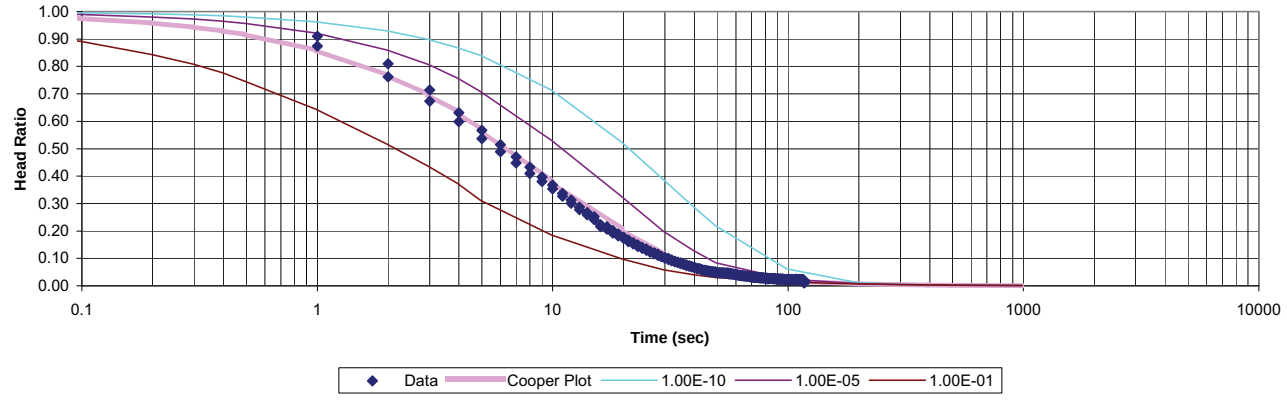
Borehole No:	P-05-26S	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	11:38 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.96	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	3.3E-05	Transmissivity (m^2/s)	1.31E-04
Storage:	2.00E-04	Alpha	1.25E-03
		Δh_o (m)	-1.65

Water Level vs Time of Day



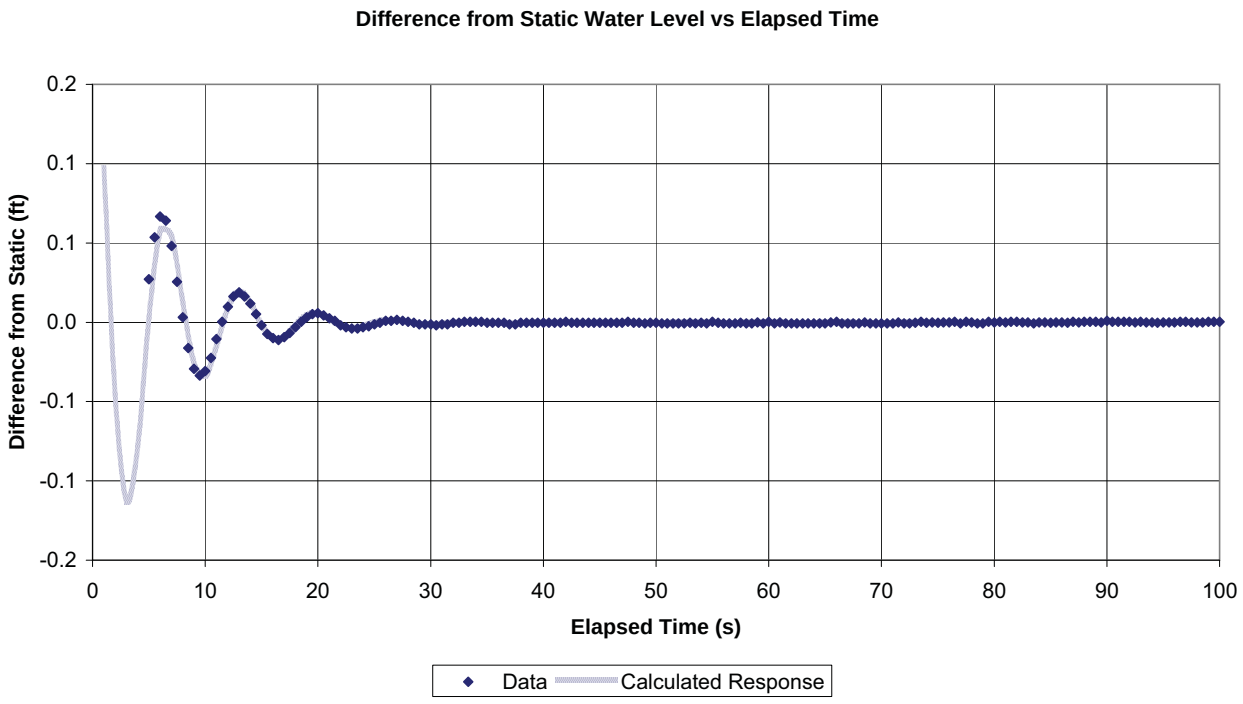
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-26D	Test date:	14/10/2005
Instrument type:	In-situ transducer	Test time:	10:52 AM
Zone depth (m):	54.864	Screen type:	2 " PVC - 20 slot
Test length (m):	7.0104	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.18
Depth of screen (m):	54.86	angular frequency (per second):	0.95
Depth to water (m):	39.51	damping constant:	0.18
Height of water predicted(m):	10.50	Initial amplitude:	0.2
Height of water (m):	15.36		
K (m/s):	5.0E-04	Transmissivity (m^2/s)	3.51E-03
Storage:	3.00E-04		

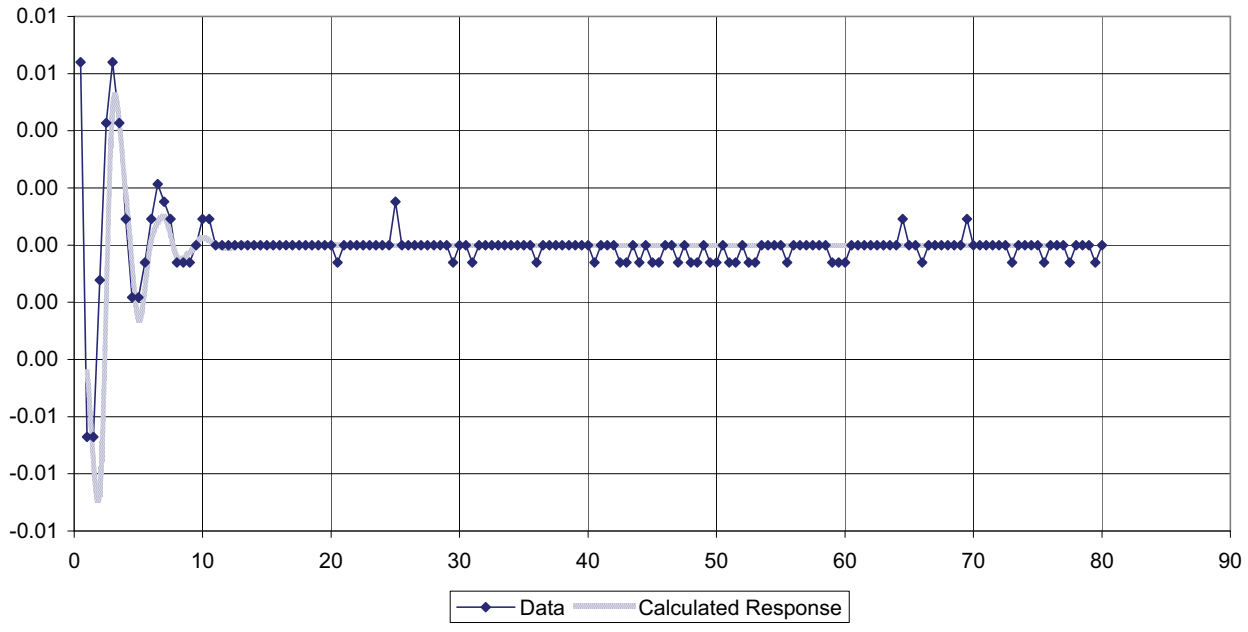


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-27S	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	4:10 PM
Zone depth (m):	11.5824	Screen type:	2 " PVC - 20 slot
Test length (m):	5.1816	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.24
Depth of screen (m):	11.28	angular frequency (per second):	1.85
Depth to water (m):	7.27	damping constant:	0.45
Height of water predicted(m):	2.70	Initial amplitude:	0.025
Height of water (m):	4.01		
K (m/s):	9.0E-04	Transmissivity (m^2/s)	4.66E-03
Storage:	6.00E-04		

Water Level Change



Borehole Response Test - Hvorslev Method

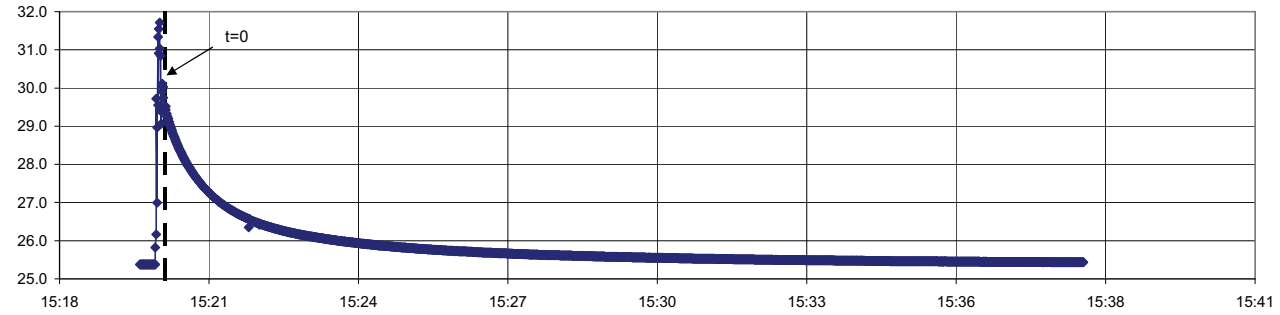
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-27M
Instrument type:	In-situ transducer
Zone depth (m):	21.34
Test length (m):	3.35
Hole diameter (m):	0.127
Riser diameter (m):	0.051
Hvorslev intercept:	0.5
K (m/s):	2.2E-06

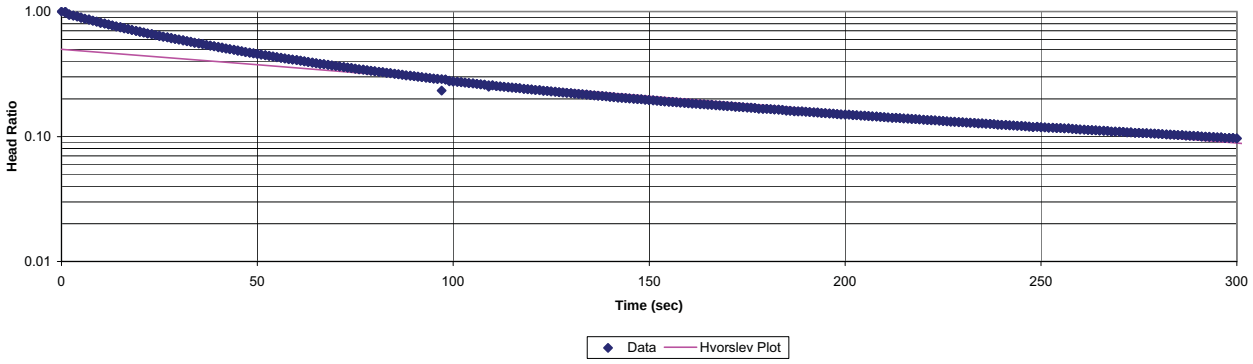
Test date:	27-Sep-05
Test time:	3:20 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 7.38E-06

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

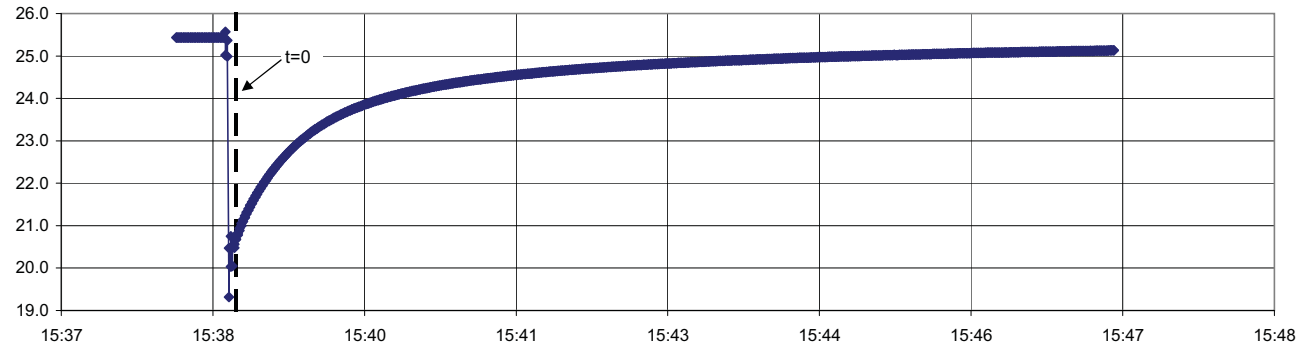
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-27M	Test date:	27-Sep-05
Instrument type:	In-situ transducer	Test time:	3:39 PM
Zone depth (m):	21.34	Screen type:	2 " PVC - 20 slot
Test length (m):	3.35	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.48		

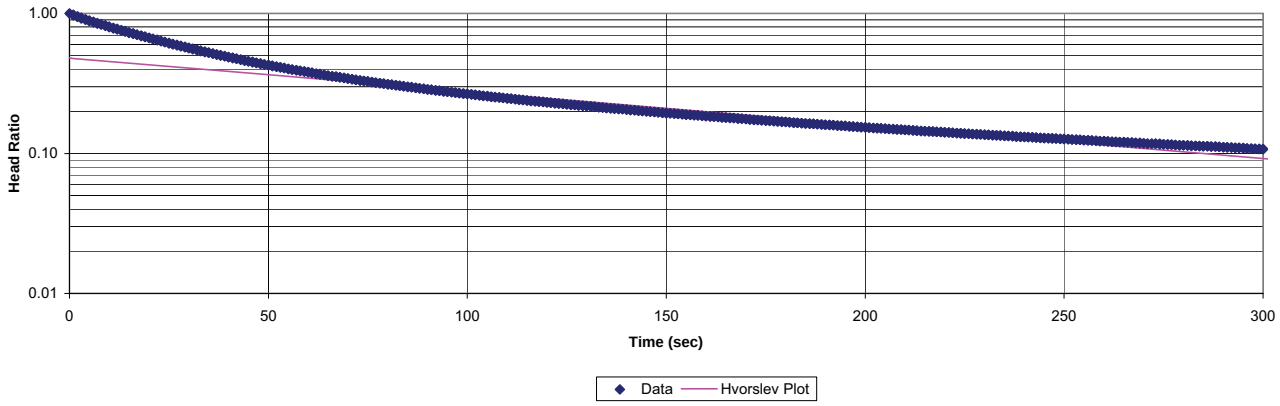
K (m/s): 2.1E-06

Transmissivity (m^2/s) 7.04E-06

Water Level Change



Head Ratio Plot



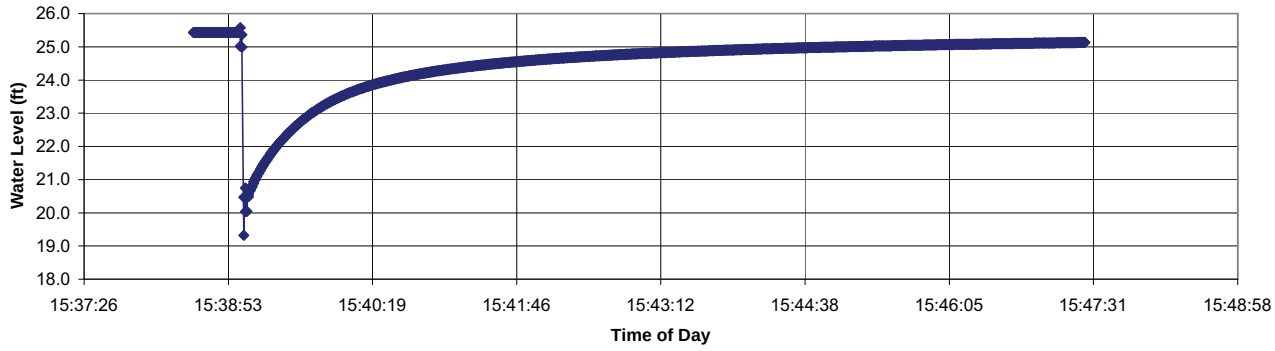
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

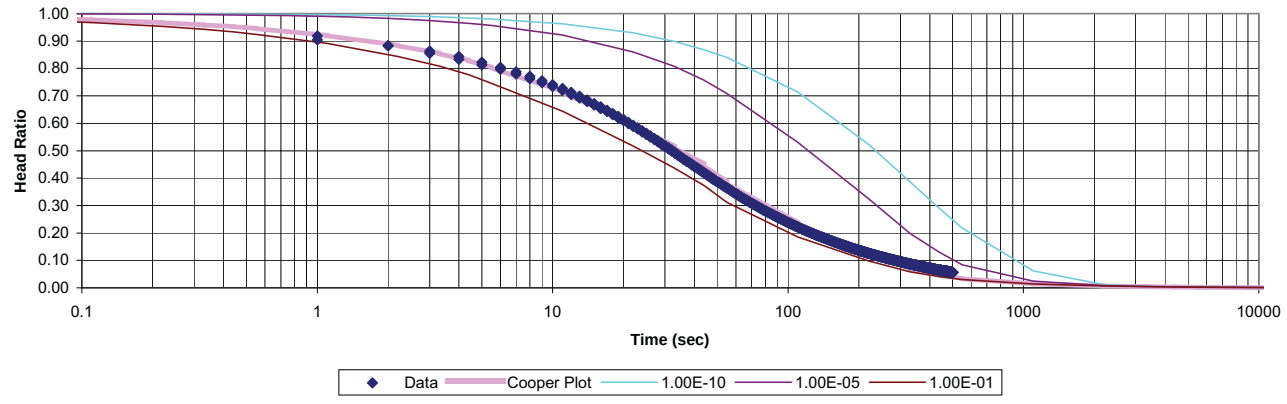
Borehole No:	P-05-27M	Test date:	27/09/2005
Instrument type:	In-situ transducer	Test time:	3:39 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.35	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	3.5E-06	Transmissivity (m^2/s)	1.17E-05
Storage:	9.00E-03	Alpha	5.63E-02
		Δh_o (m)	-5.39

Water Level vs Time of Day



Head Ratio Plot

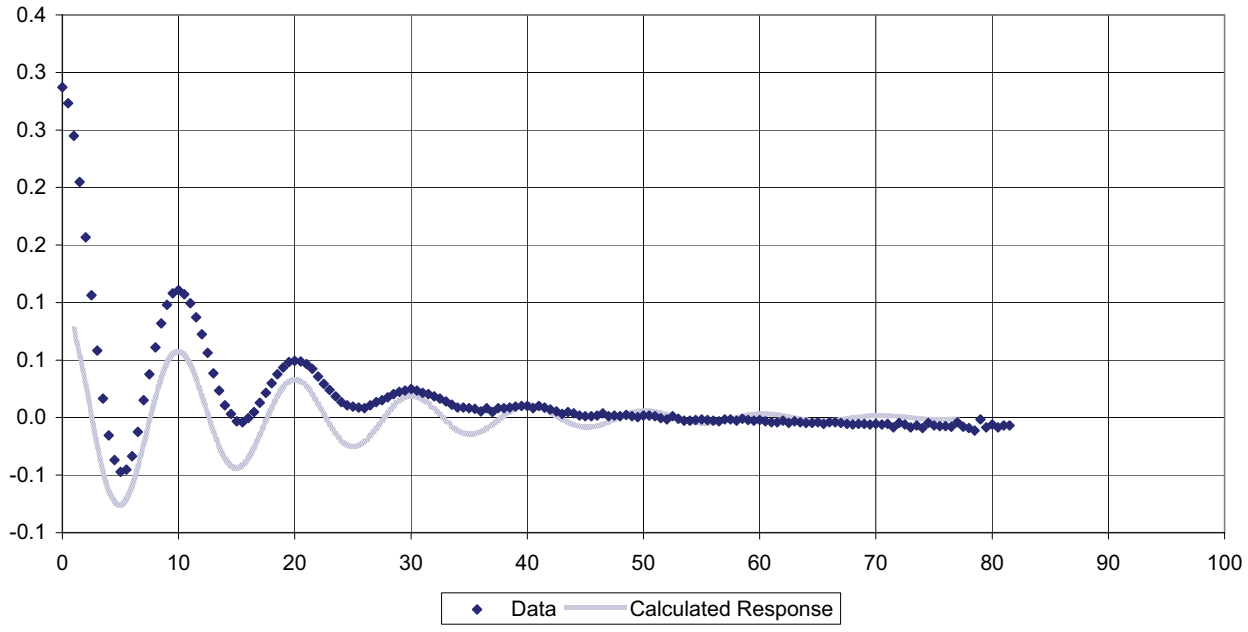


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-28D		Test date:	25/09/2005
Instrument type:	In-situ transducer		Test time:	11:19 AM
Zone depth (m):	49.6824	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):	8.382		Field technician:	SLR Alaska
Hole diameter (m):	0.14605		Analyst:	K Gibson
Riser diameter (m):	0.0508			
			d:	0.09
Depth of screen (m):	48.92		angular frequency (per second):	0.62
Depth to water (m):	11.00		damping constant:	0.06
Height of water predicted(m):	25.00		Initial amplitude:	0.1
Height of water (m):	37.92			
K (m/s):	6.0E-04		Transmissivity (m^2/s)	5.03E-03
Storage:	3.00E-04			

Water Level Change

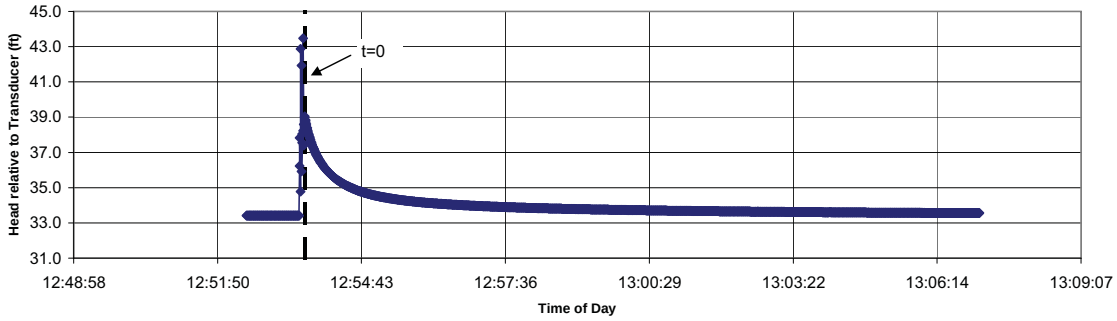


Borehole Response Test - Hvorslev Method

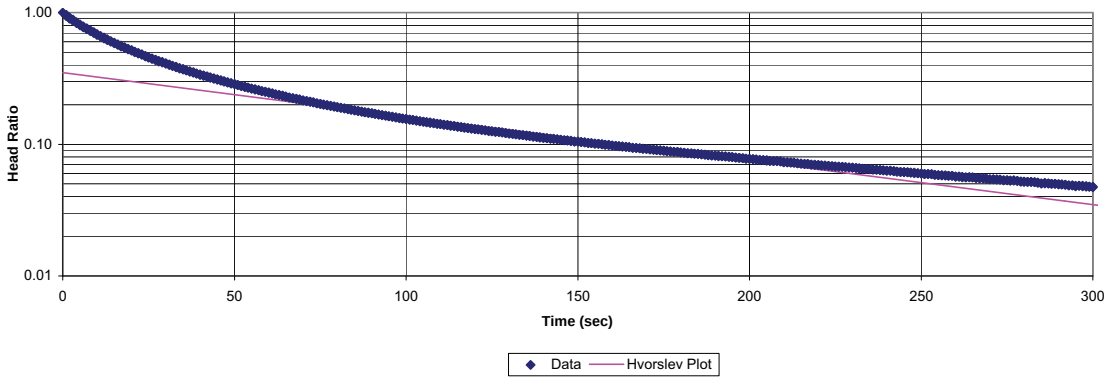
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-30S		Test date:	16-Oct-05
Instrument type:	In-situ transducer		Test time:	12:53 PM
Zone depth:	22.25 m	73 ft	Screen type:	2 " PVC - 20 slot
Test Zone Length:	3.05 m	10 ft	Field technician:	SLR Alaska
Hole diameter:	0.152 m	6. in	Analyst:	K Gibson
Riser diameter:	0.051 m	2. in		
Transmissivity (m²/s)	9.14E-06		Static Head relative to Transducer(ft)	33.555
K (m/s):	3.0E-06		Head at t=0 relative to Transducer(ft)	39.043
Hvorslev intercept:	0.35			

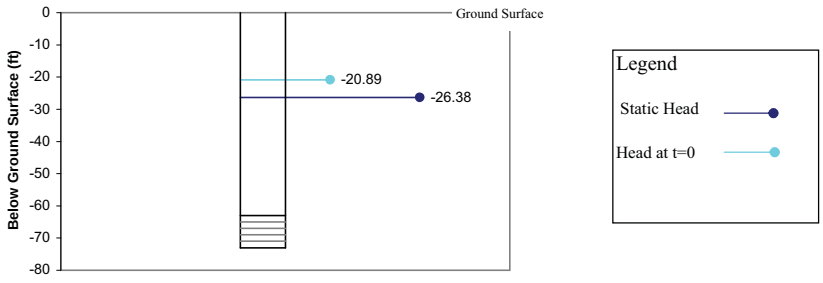
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



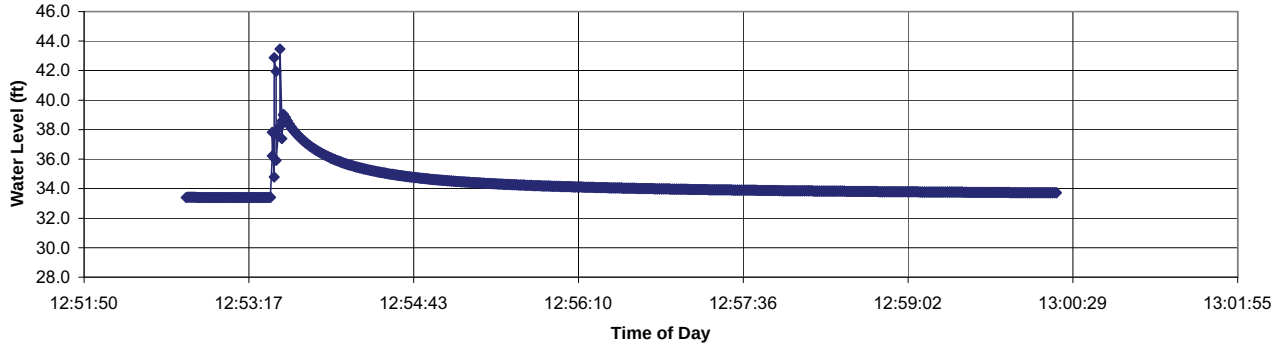
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

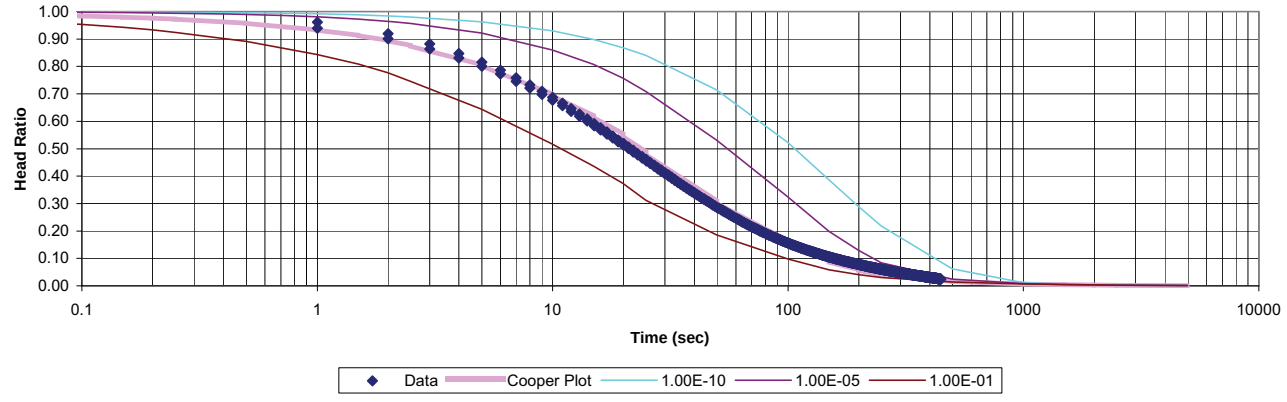
Borehole No:	P-05-30S	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	12:53 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.05	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	8.5E-06	Transmissivity (m^2/s)	2.59E-05
Storage:	9.00E-04	Alpha	8.10E-03
		Δh_o (m)	5.49

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

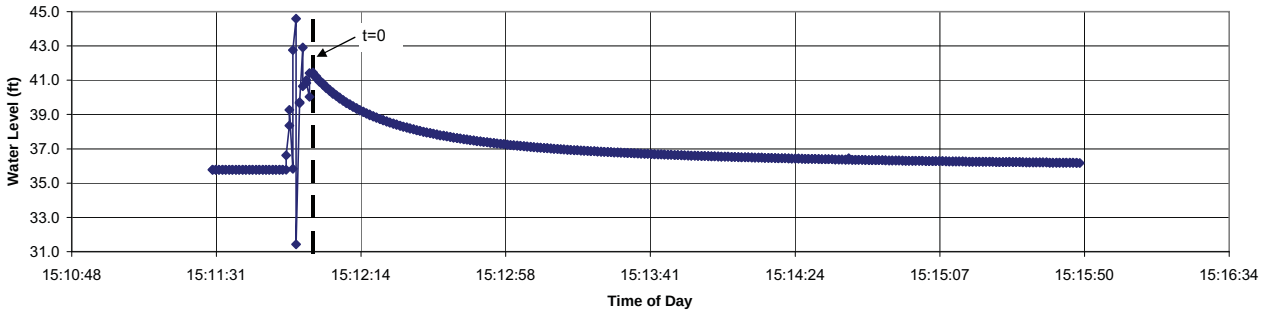
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-30D
Instrument type:	In-situ transducer
Zone depth (m):	32.92
Test length (m):	5.49
Hole diameter (m):	0.1524
Riser diameter (m):	0.051
Hvorslev intercept:	0.8
K (m/s):	5.5E-06

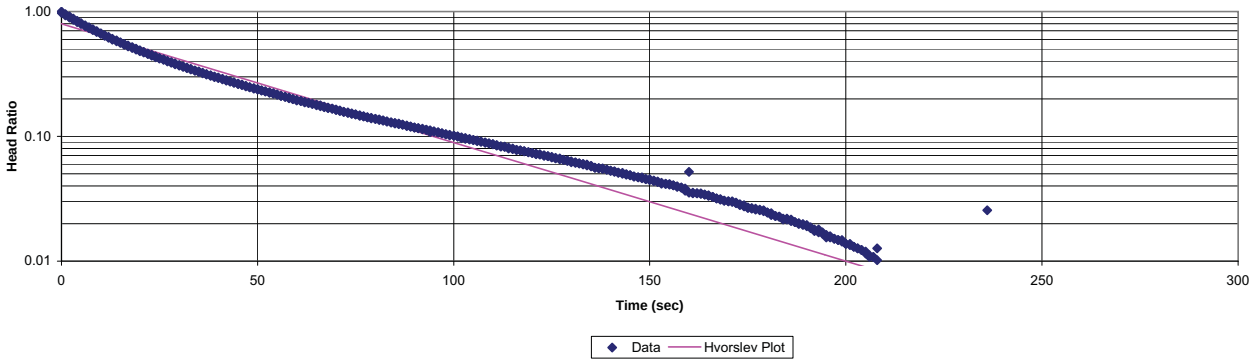
Test date:	24-Sep-05
Test time:	3:12 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 3.02E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

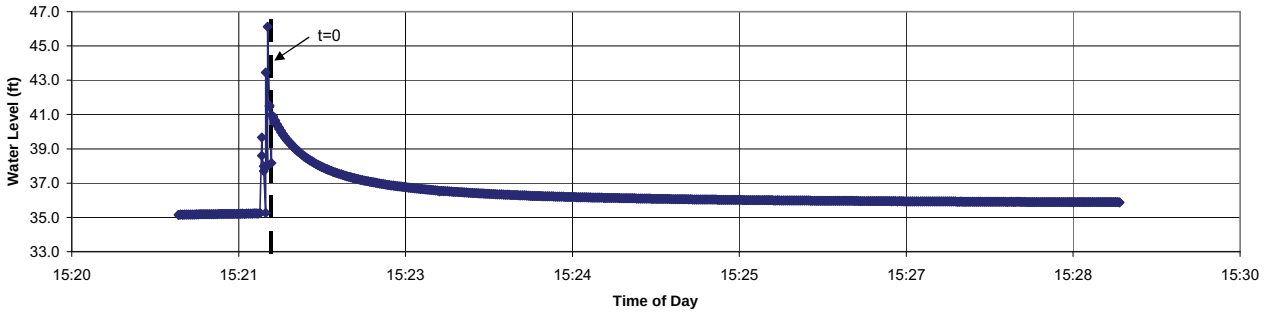
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-30D
Instrument type:	In-situ transducer
Zone depth (m):	32.92
Test length (m):	5.49
Hole diameter (m):	0.1524
Riser diameter (m):	0.051
Hvorslev intercept:	0.45
K (m/s):	3.0E-06

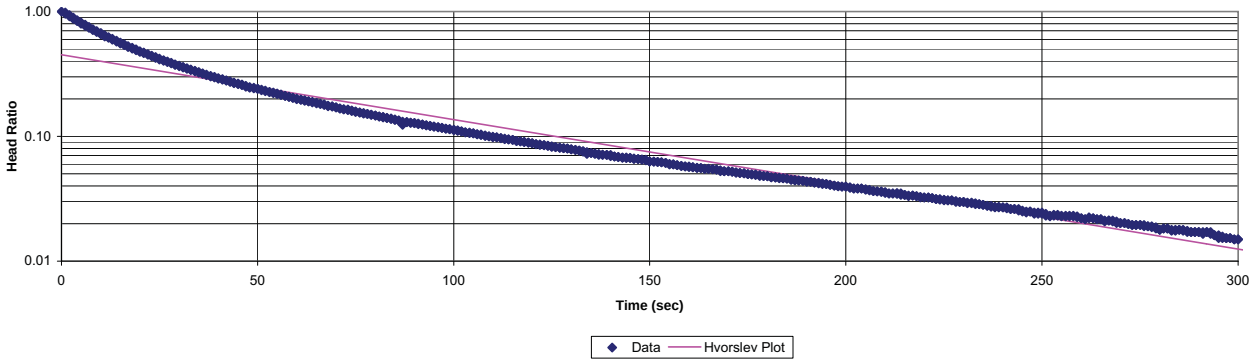
Test date:	24-Sep-05
Test time:	3:21 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 1.65E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

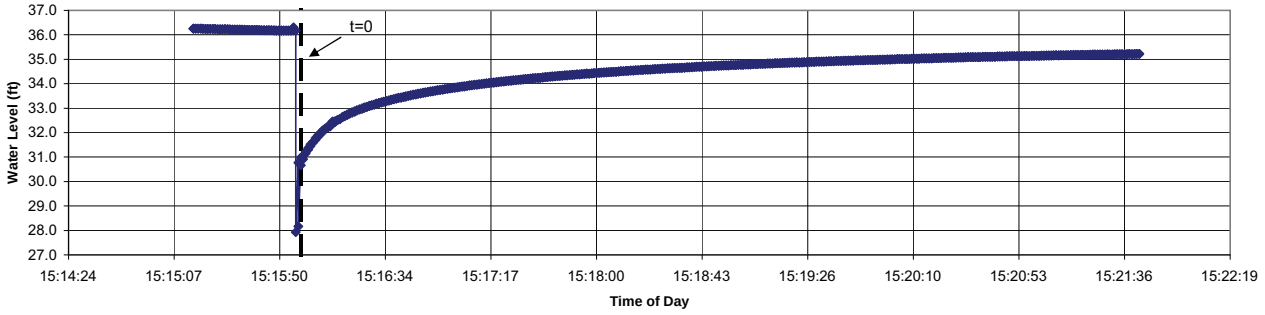
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-30D
Instrument type:	In-situ transducer
Zone depth (m):	32.92
Test length (m):	5.49
Hole diameter (m):	0.1524
Riser diameter (m):	0.051
Hvorslev intercept:	0.63
K (m/s):	2.5E-06

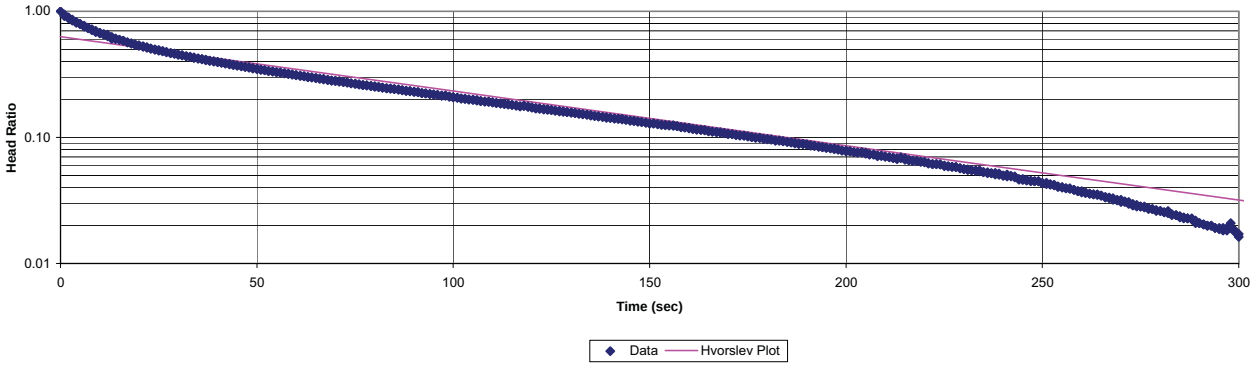
Test date:	24-Sep-05
Test time:	3:15 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

Transmissivity (m^2/s) 1.37E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

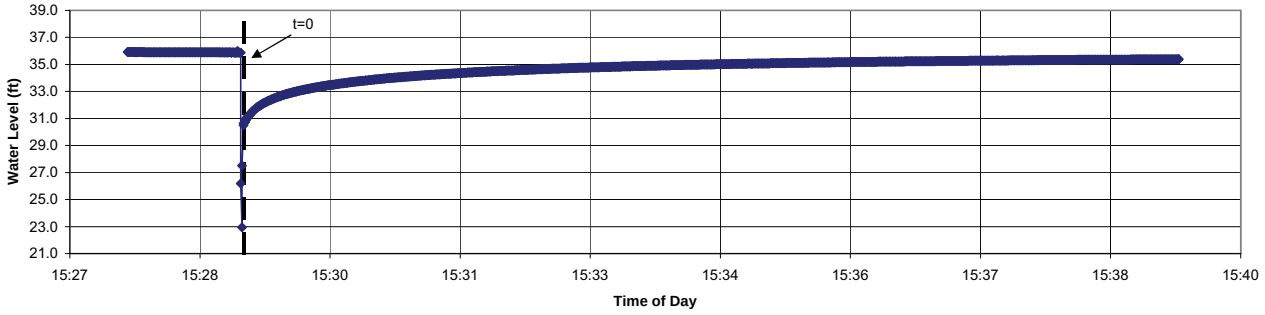
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-30D
Instrument type:	In-situ transducer
Zone depth (m):	32.92
Test length (m):	5.49
Hole diameter (m):	0.1524
Riser diameter (m):	0.051
Hvorslev intercept:	0.65
K (m/s):	1.8E-06

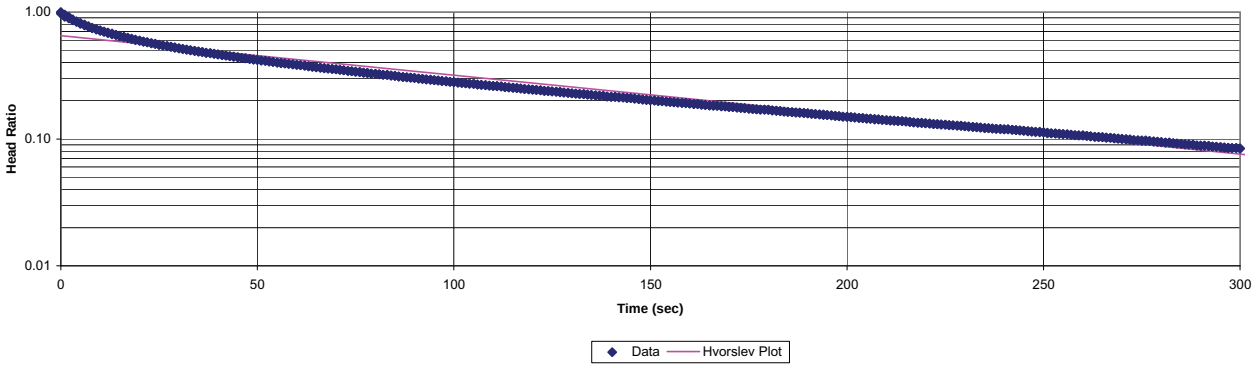
Test date:	24-Sep-05
Test time:	3:29 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K. Gibson

Transmissivity (m^2/s) 9.88E-06

Water Level Change



Head Ratio Plot



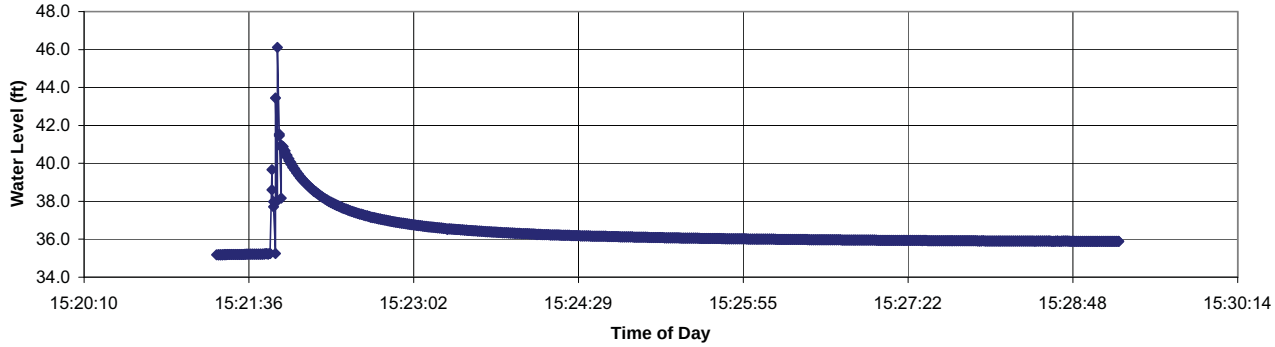
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

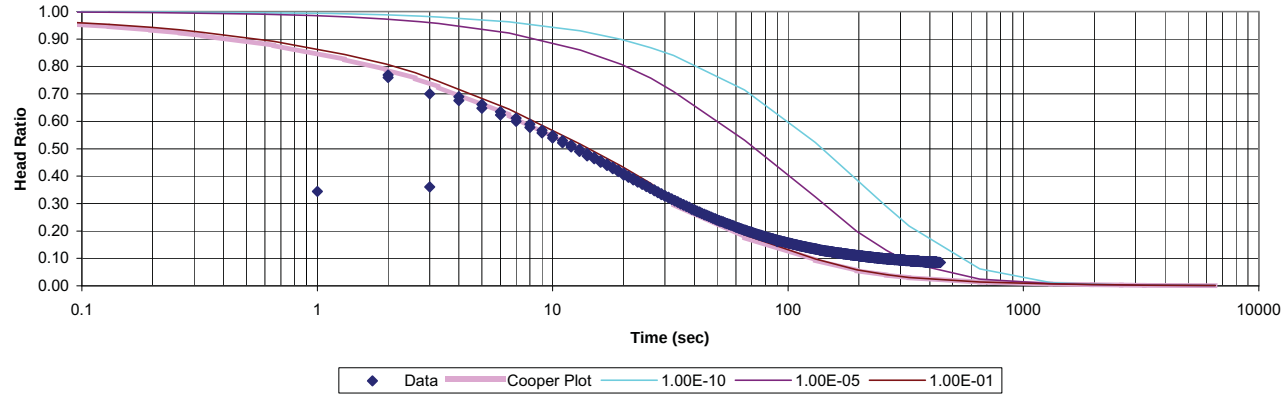
Borehole No:	P-05-30D	Test date:	24/09/2005
Instrument type:	In-situ transducer	Test time:	3:21 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	5.49	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	3.6E-06	Transmissivity (m^2/s)	1.98E-05
Storage:	2.00E-02	Alpha	1.80E-01
		Δh_o (m)	8.27

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

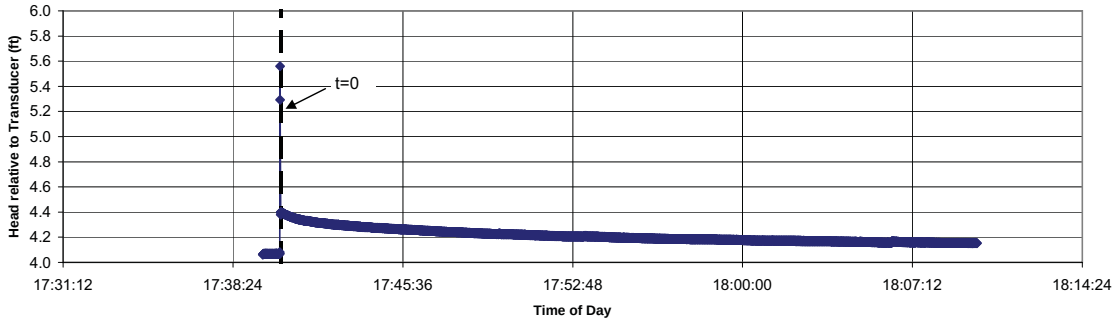
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-31S	
Instrument type:	In-situ transducer	
Zone depth:	7.65 m	25 ft
Test Zone Length:	3.05 m	10 ft
Hole diameter:	0.146 m	5.75 in
Riser diameter:	0.051 m	2. in
Transmissivity (m²/s)	1.83E-06	
K (m/s):	6.0E-07	
Hvorslev intercept:	0.7	

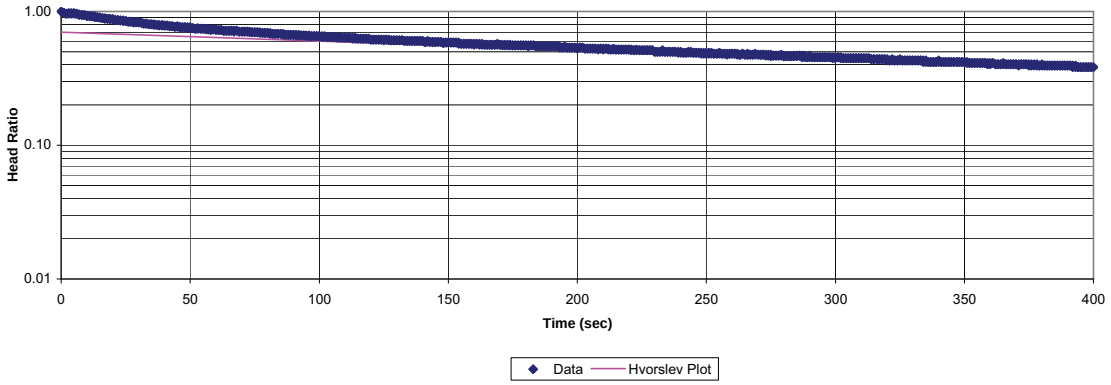
Test date:	15-Oct-05
Test time:	5:40 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	4.152
Head at t=0 relative to Transducer(ft)	4.4

Note: Static from post test used

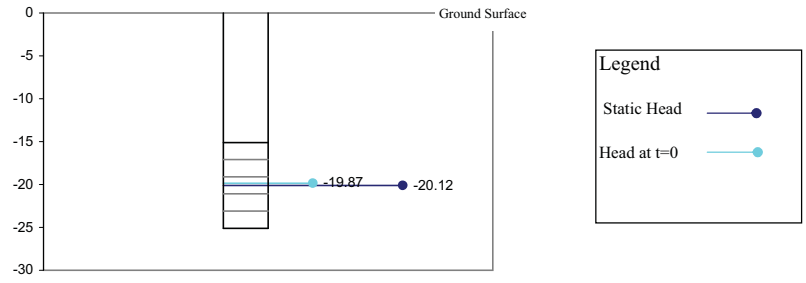
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



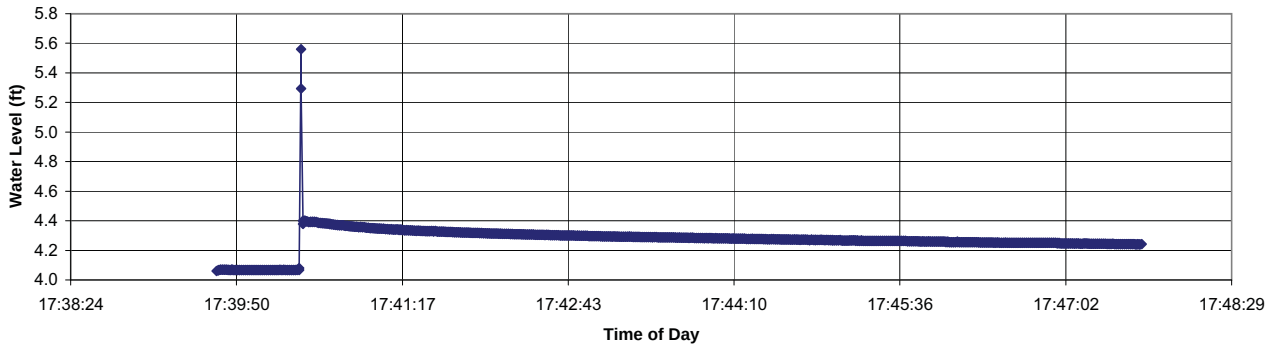
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

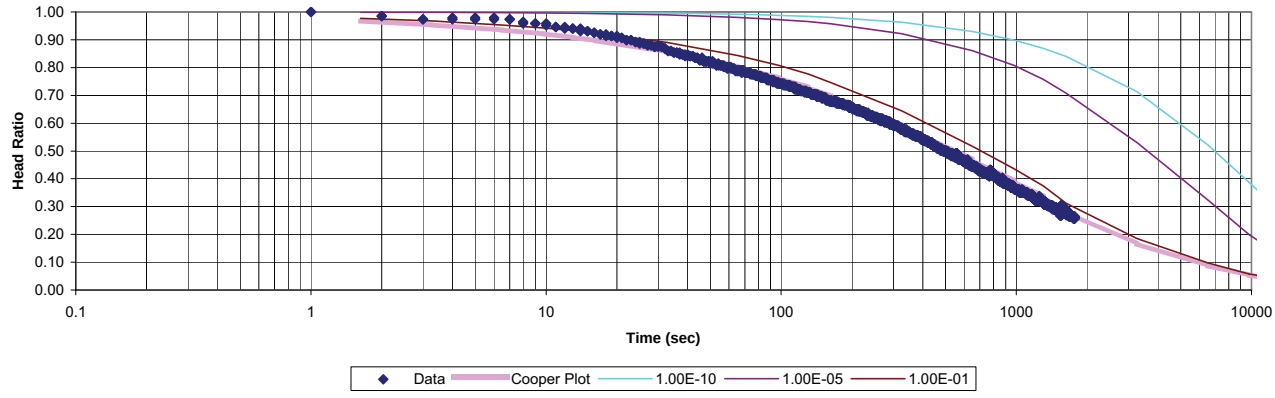
Borehole No:	P-05-31S	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	5:40 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.05	Field technician:	SLR Alaska
Hole diameter (m):	0.146	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.3E-07	Transmissivity (m^2/s)	3.96E-07
Storage:	3.50E-02	Alpha	2.89E-01
		Δh_o (m)	0.33

Water Level vs Time of Day



Head Ratio Plot



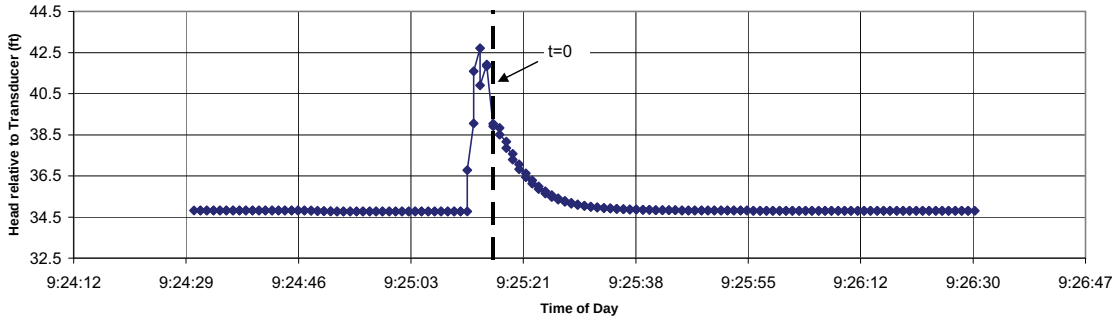
Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

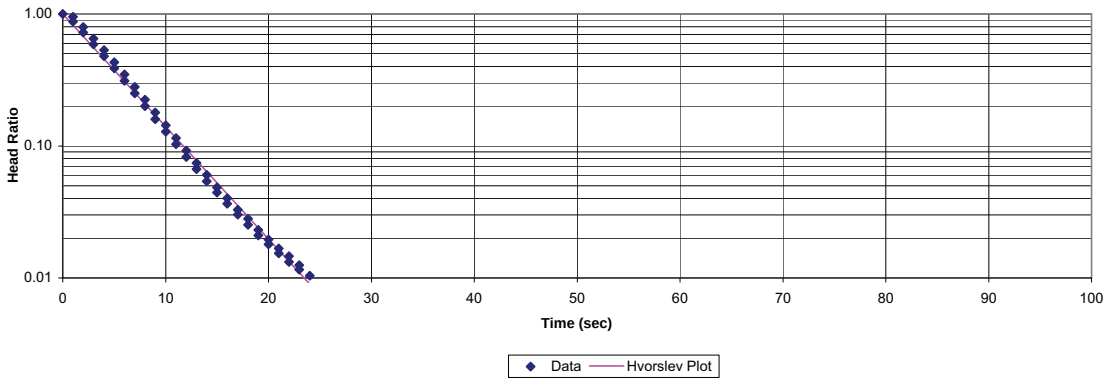
Borehole No:	P-05-31D	
Instrument type:	In-situ transducer	
Zone depth:	46.02 m	151 ft
Test Zone Length:	10.97 m	36 ft
Hole diameter:	0.121 m	4.75 in
Riser diameter:	0.051 m	2. in
Transmissivity (m²/s)	3.29E-04	
K (m/s):	3.0E-05	
Hvorslev intercept:	1	

Test date:	16-Oct-05
Test time:	9:25 AM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	34.802
Head at t=0 relative to Transducer(ft)	39.04

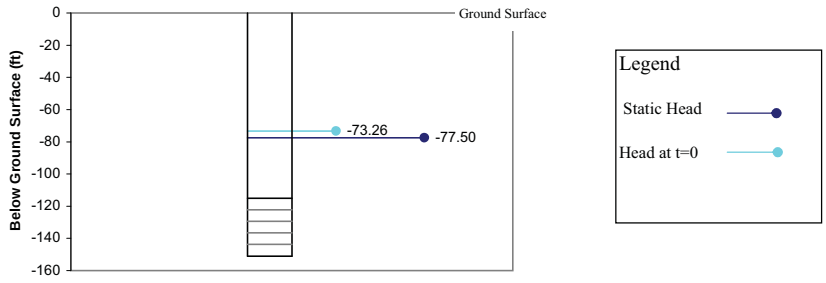
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



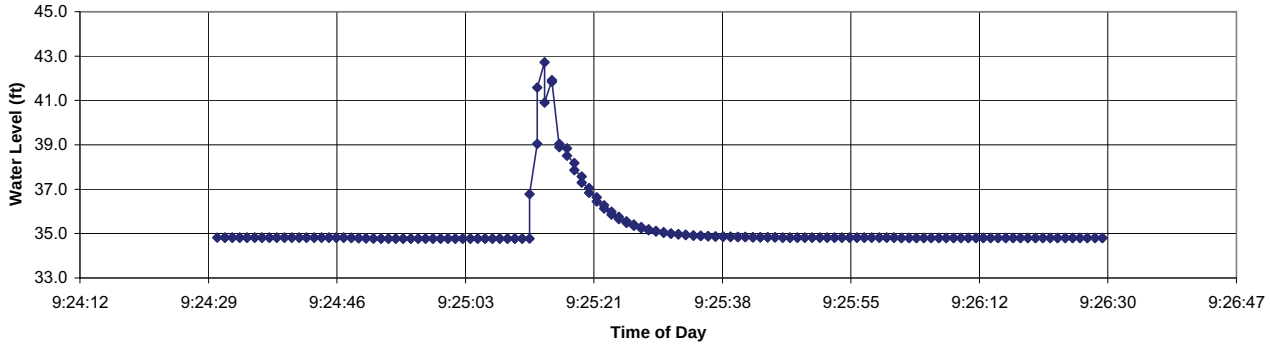
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

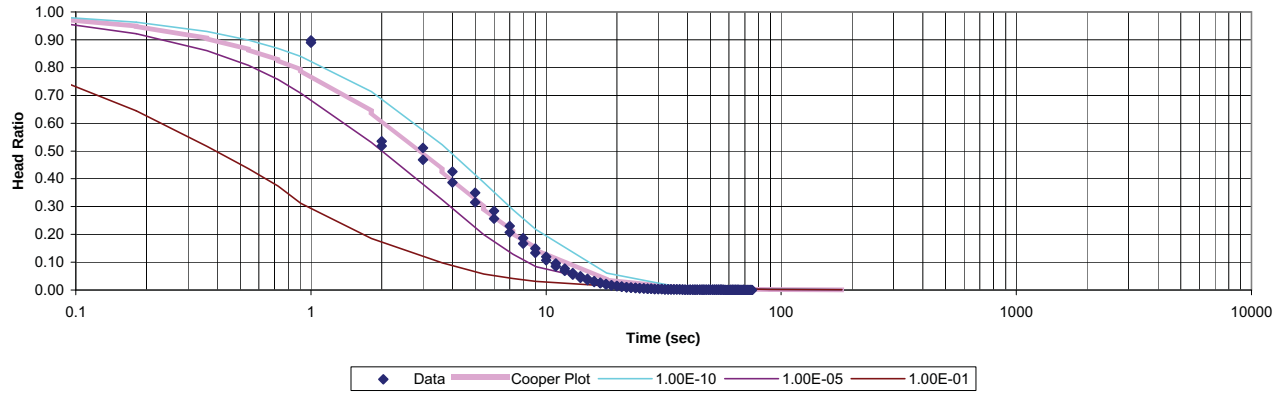
Borehole No:	P-05-31D	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	9:25 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	10.97	Field technician:	SLR Alaska
Hole diameter (m):	0.121	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	6.5E-05	Transmissivity (m^2/s)	7.13E-04
Storage:	1.00E-08	Alpha	5.64E-08
		Δh_o (m)	7.9

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

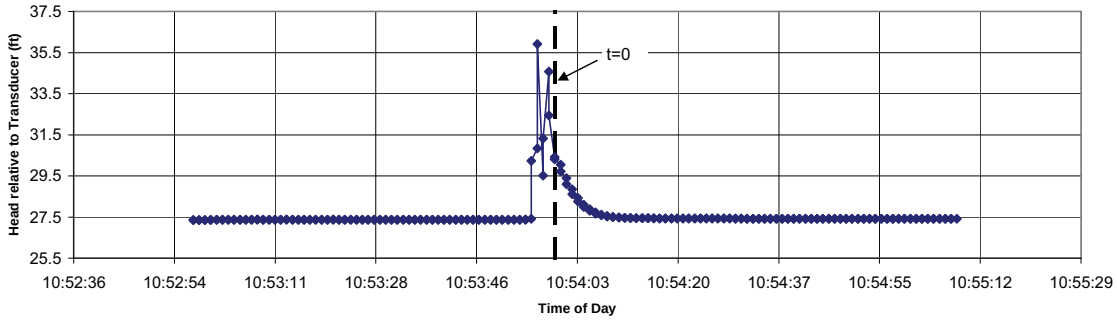
Borehole No:	P-05-32	
Instrument type:	In-situ transducer	
Zone depth:	30.48 m	100 ft
Test Zone Length:	6.71 m	22 ft
Hole diameter:	0.098 m	3.875 in
Riser diameter:	0.051 m	2. in

Test date:	16-Oct-05
Test time:	10:53 AM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

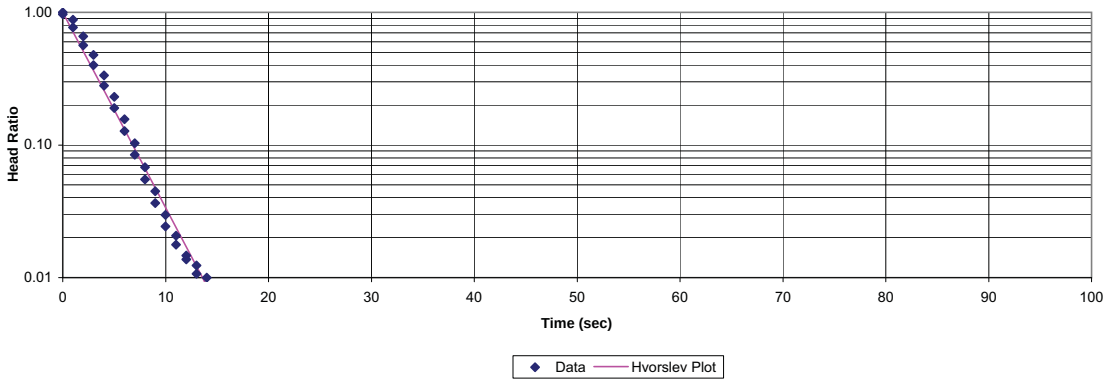
Transmissivity (m²/s)	5.36E-04
K (m/s):	8.0E-05
Hvorslev intercept:	1

Static Head relative to Transducer(ft)	27.417
Head at t=0 relative to Transducer(ft)	30.411

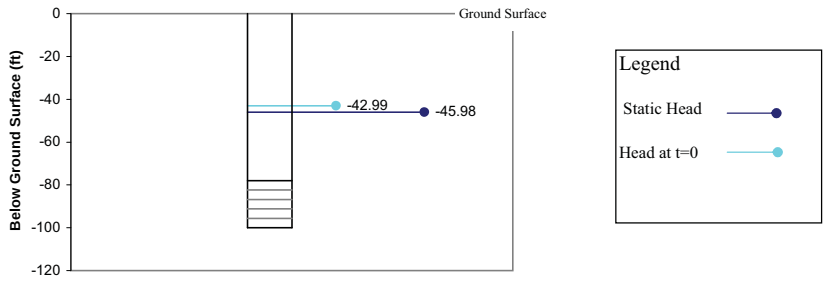
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



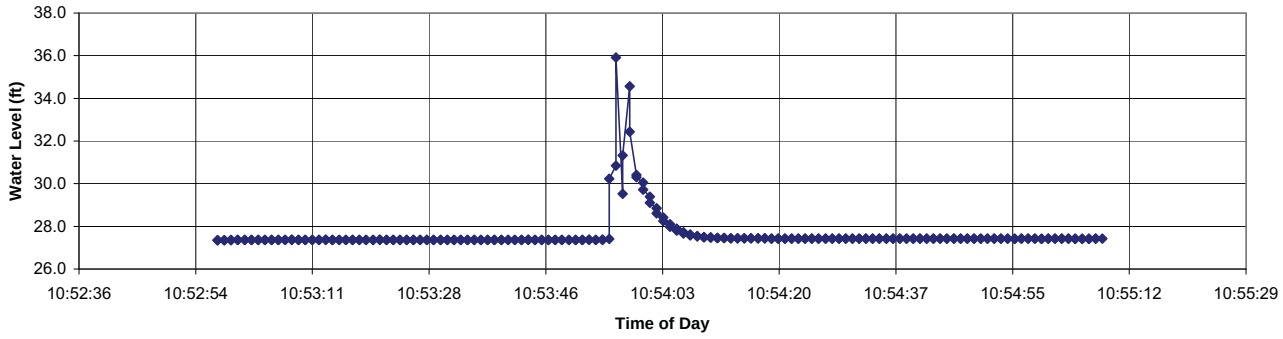
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

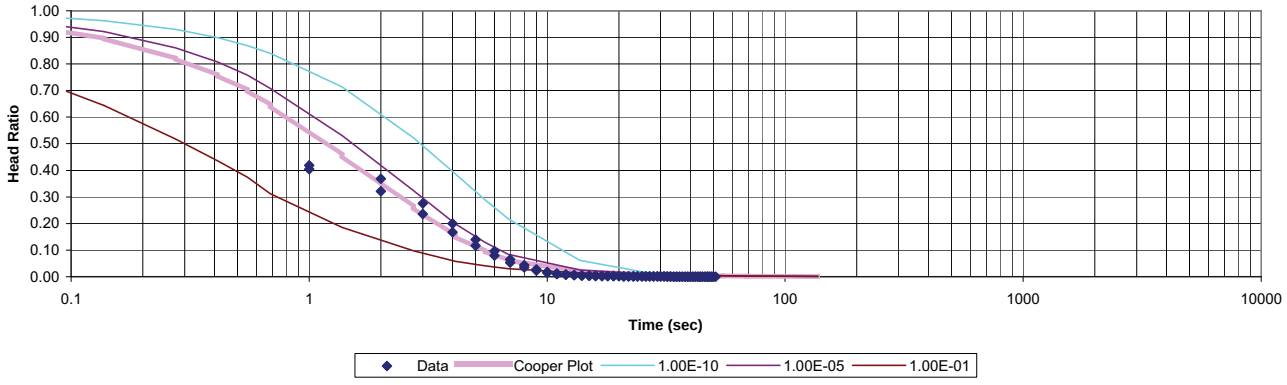
Borehole No:	P-05-32	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	10:53 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	6.71	Field technician:	SLR Alaska
Hole diameter (m):	0.098	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.4E-04	Transmissivity (m^2/s)	9.39E-04
Storage:	5.00E-05	Alpha	1.88E-04
		Δh_o (m)	7.1

Water Level vs Time of Day



Head Ratio Plot



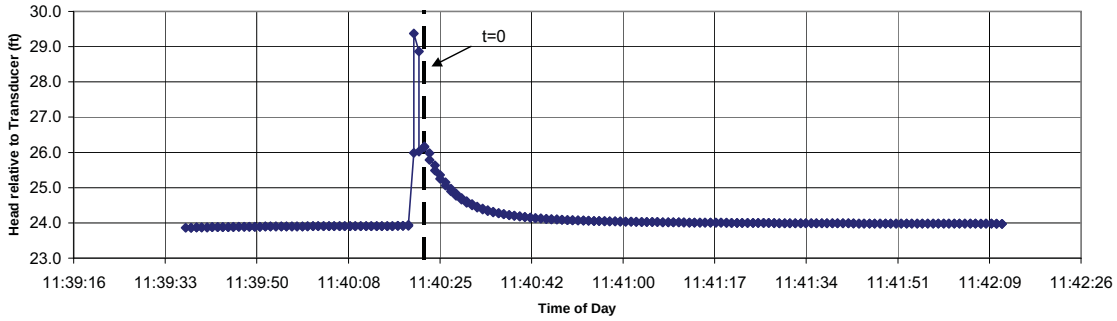
Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

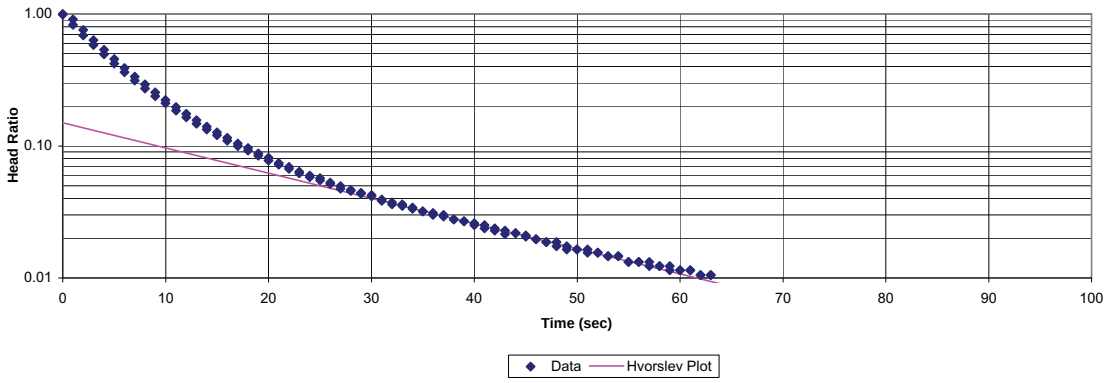
Borehole No:	P-05-33	
Instrument type:	In-situ transducer	
Zone depth:	13.87 m	46 ft
Test Zone Length:	3.66 m	12 ft
Hole diameter:	0.152 m	6. in
Riser diameter:	0.051 m	2. in
Transmissivity (m²/s)	5.49E-05	
K (m/s):	1.5E-05	
Hvorslev intercept:	0.15	

Test date:	16-Oct-05
Test time:	11:40 AM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	23.975
Head at t=0 relative to Transducer(ft)	26.167

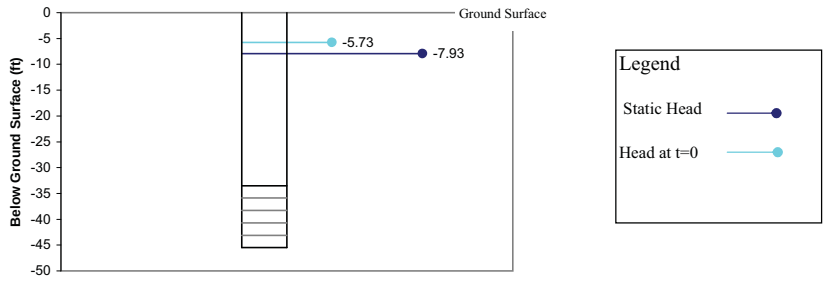
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



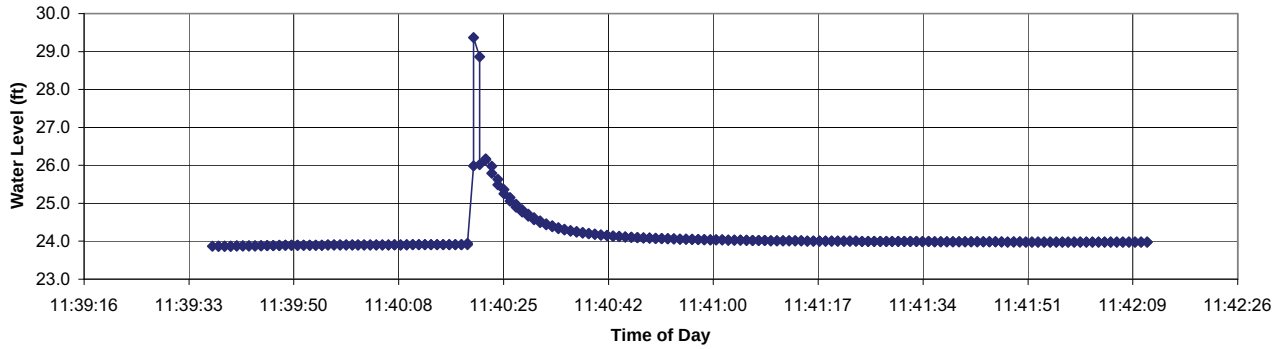
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

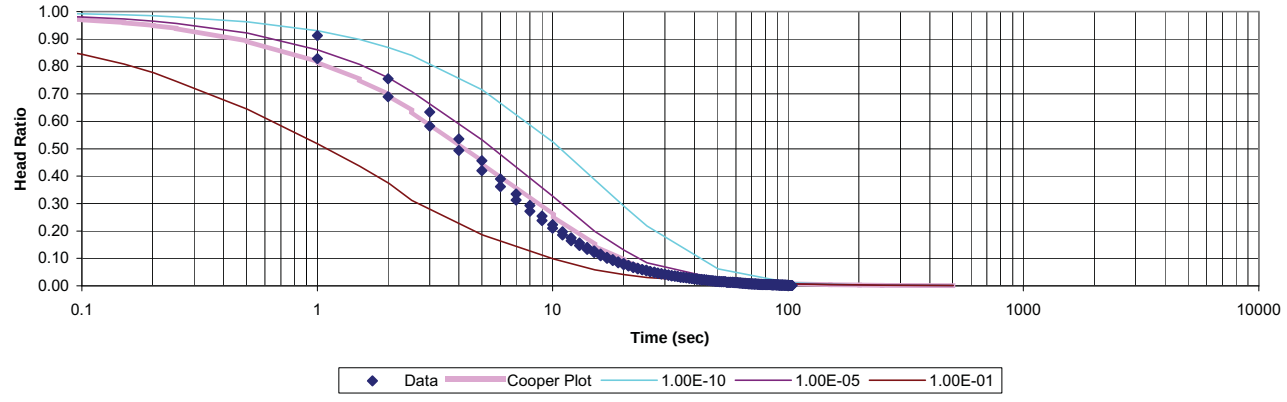
Borehole No:	P-05-33D	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	11:40 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.66	Field technician:	SLR Alaska
Hole diameter (m):	0.087	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	7.0E-05	Transmissivity (m^2/s)	2.56E-04
Storage:	9.00E-05	Alpha	2.64E-04
		Δh_o (m)	2.2

Water Level vs Time of Day



Head Ratio Plot

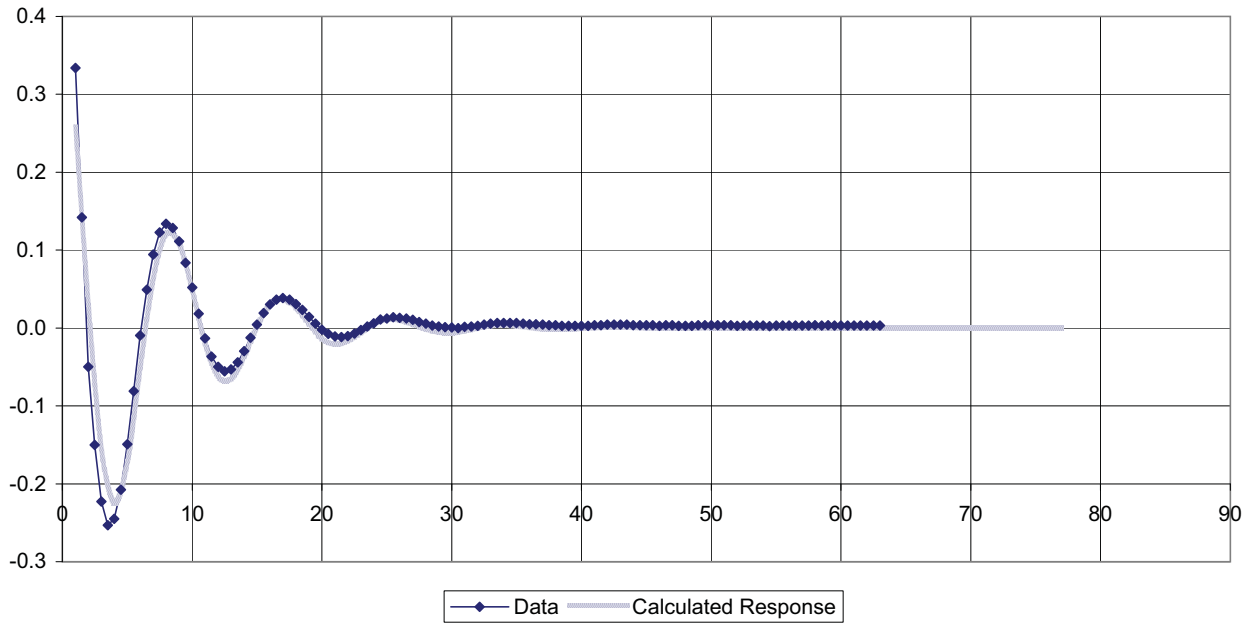


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-34	Test date:	16/10/2005
Instrument type:	In-situ transducer	Test time:	12:15 PM
Zone depth (m):	28.956	Screen type:	2 " PVC - 20 slot
Test length (m):	14.9352	Field technician:	SLR Alaska
Hole diameter (m):	0.1016	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.19
Depth of screen (m):	28.96	angular frequency (per second):	0.74
Depth to water (m):	1.77	damping constant:	0.14
Height of water predicted(m):	17.50	Initial amplitude:	0.4
Height of water (m):	27.19		
K (m/s):	2.0E-04	Transmissivity (m^2/s)	2.99E-03
Storage:	2.00E-04		

Water Level Change



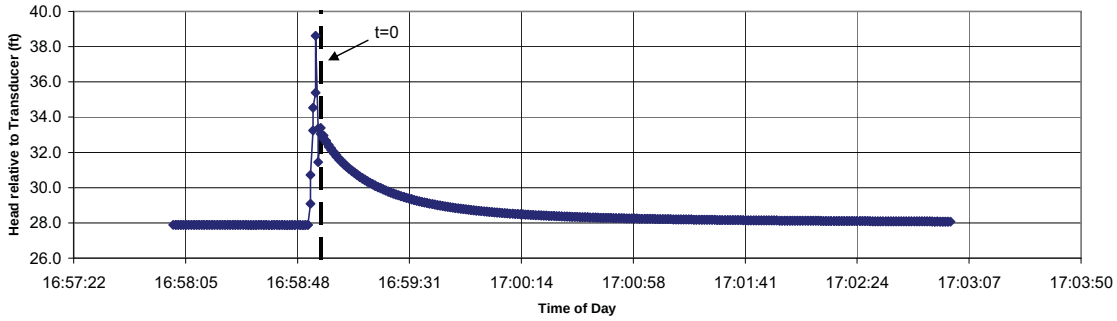
Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

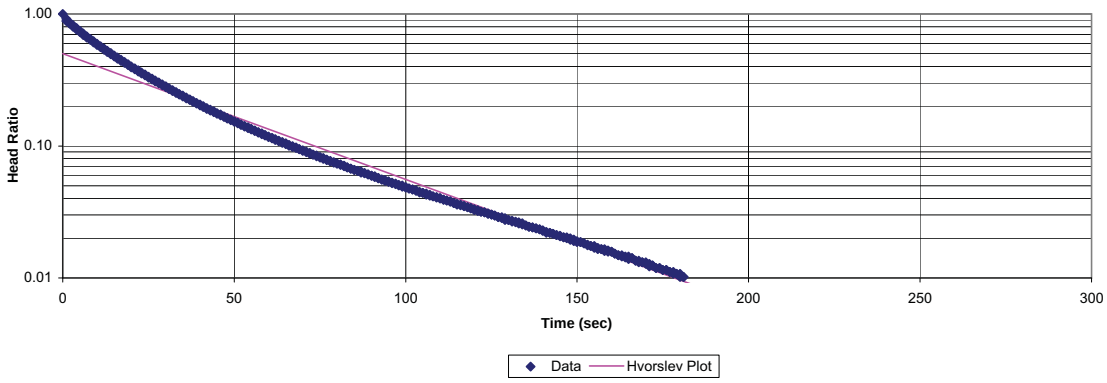
Borehole No:	P-05-35	
Instrument type:	In-situ transducer	
Zone depth:	17.98 m	59 ft
Test Zone Length:	3.05 m	10 ft
Hole diameter:	0.102 m	4. in
Riser diameter:	0.051 m	2. in
Transmissivity (m²/s)	2.90E-05	
K (m/s):	9.5E-06	
Hvorslev intercept:	0.5	

Test date:	15-Oct-05
Test time:	4:58 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	28.074
Head at t=0 relative to Transducer(ft)	33.386

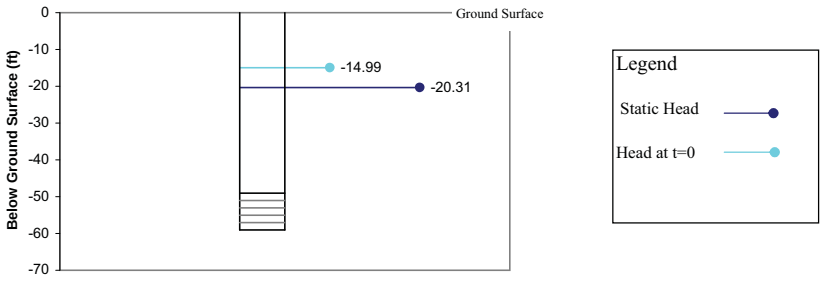
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



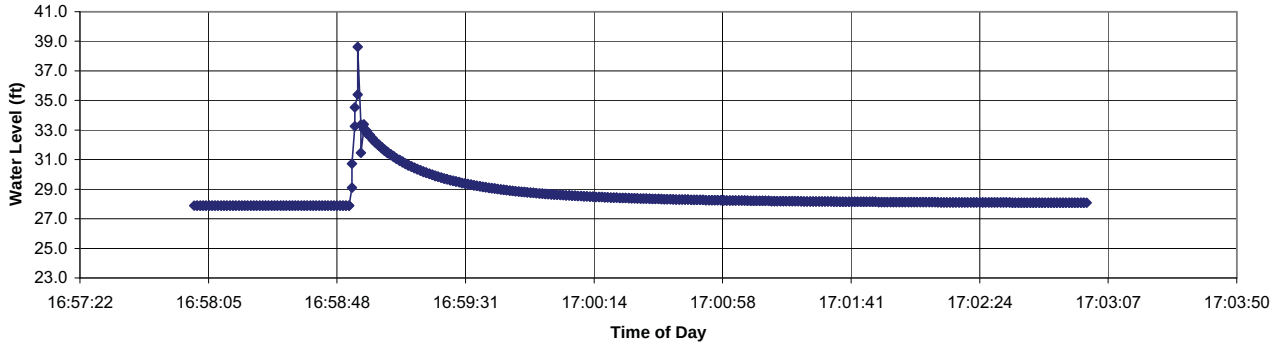
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

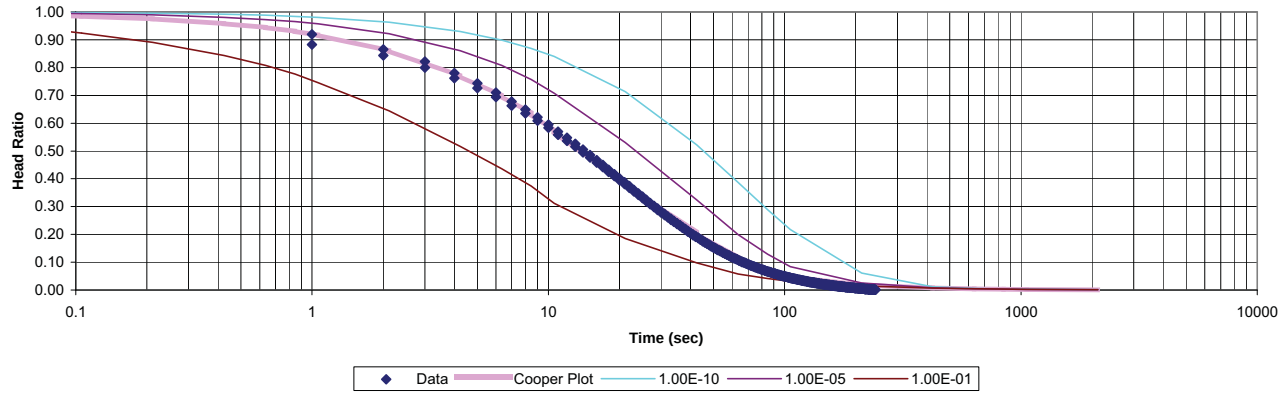
Borehole No:	P-05-35	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	4:58 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	3.05	Field technician:	SLR Alaska
Hole diameter (m):	0.102	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	2.0E-05	Transmissivity (m^2/s)	6.10E-05
Storage:	3.00E-04	Alpha	1.20E-03
		Δh_o (m)	5.3

Water Level vs Time of Day



Head Ratio Plot

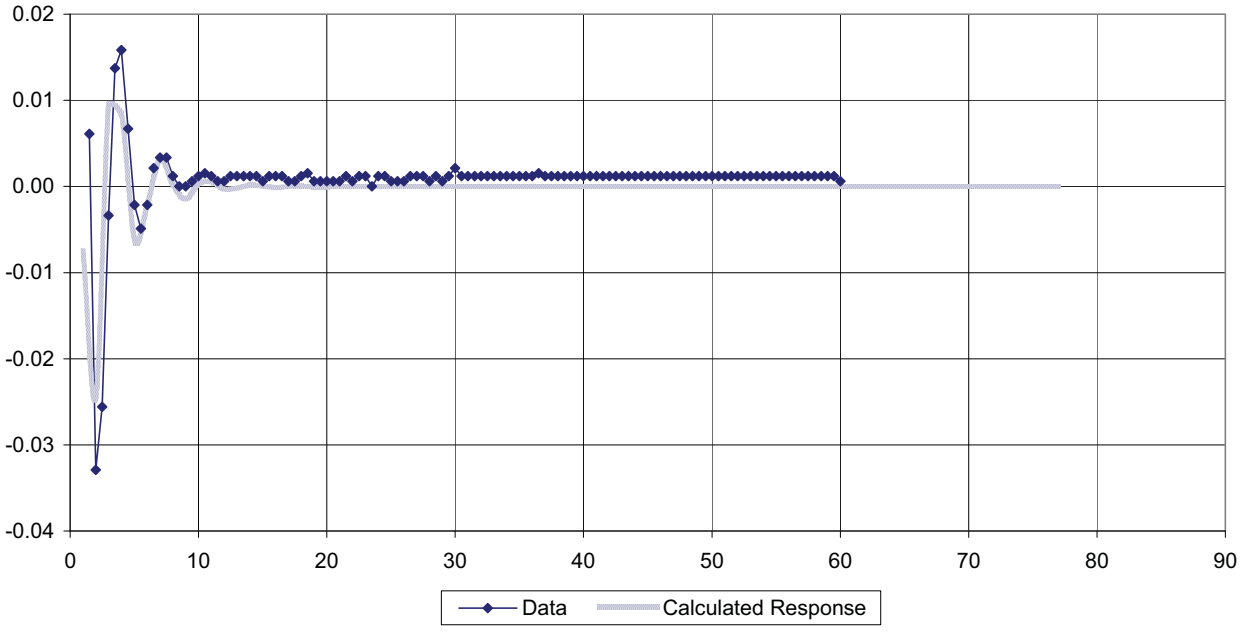


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-36S	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	2:20 PM
Zone depth (m):	10.3632	Screen type:	2 " PVC - 20 slot
Test length (m):	4.2672	Field technician:	SLR Alaska
Hole diameter (m):	0.13335	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.23
Depth of screen (m):	10.21	angular frequency (per second):	1.76
Depth to water (m):	5.76	damping constant:	0.41
Height of water predicted(m):	3.00	Initial amplitude:	0.06
Height of water (m):	4.45		
K (m/s):	1.3E-03	Transmissivity (m^2/s)	5.33E-03
Storage:	2.00E-04		

Water Level Change



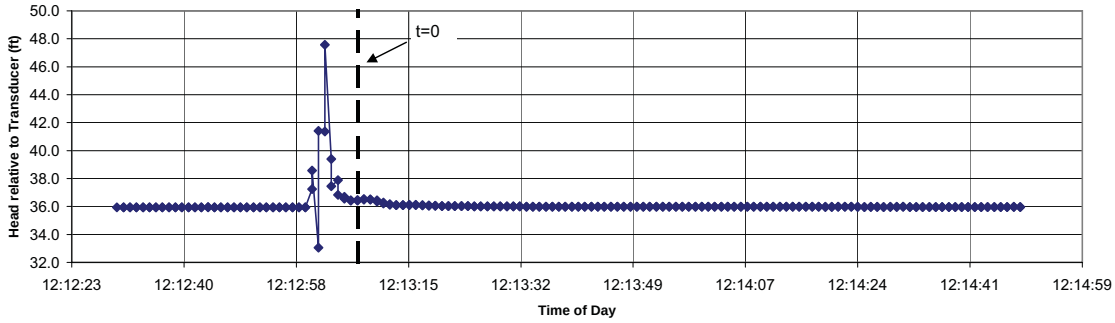
Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

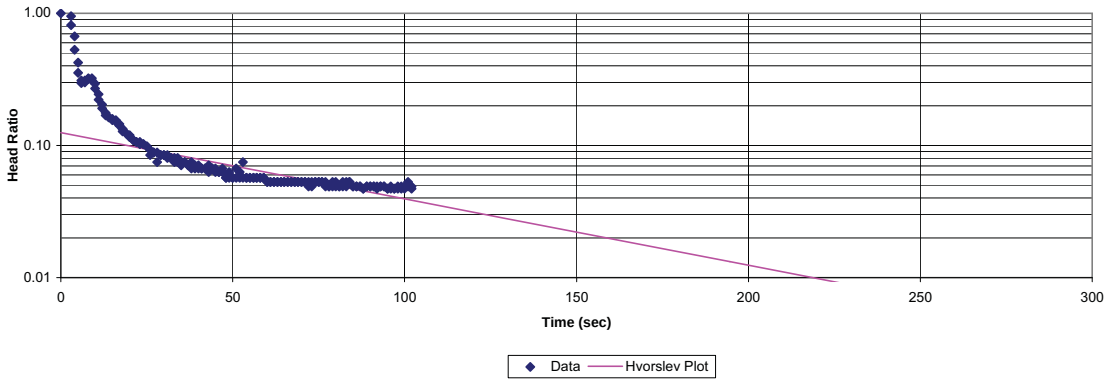
Borehole No:	P-05-36M	
Instrument type:	In-situ transducer	
Zone depth:	27.43 m	90 ft
Test Zone Length:	5.49 m	18 ft
Hole diameter:	0.152 m	6. in
Riser diameter:	0.051 m	2. in
Transmissivity (m²/s)	1.59E-05	
K (m/s):	2.9E-06	
Hvorslev intercept:	0.125	

Test date:	15-Oct-05
Test time:	12:13 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	35.948
Head at t=0 relative to Transducer(ft)	36.457

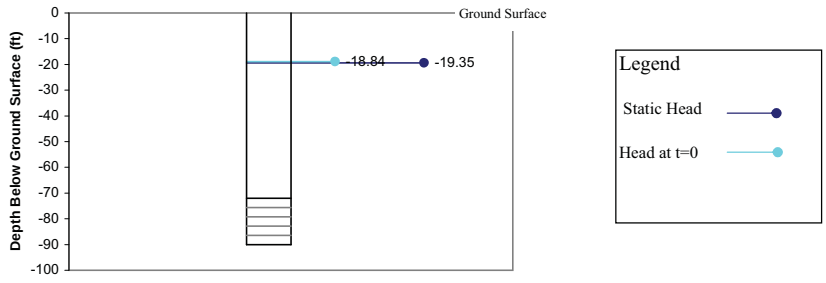
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval

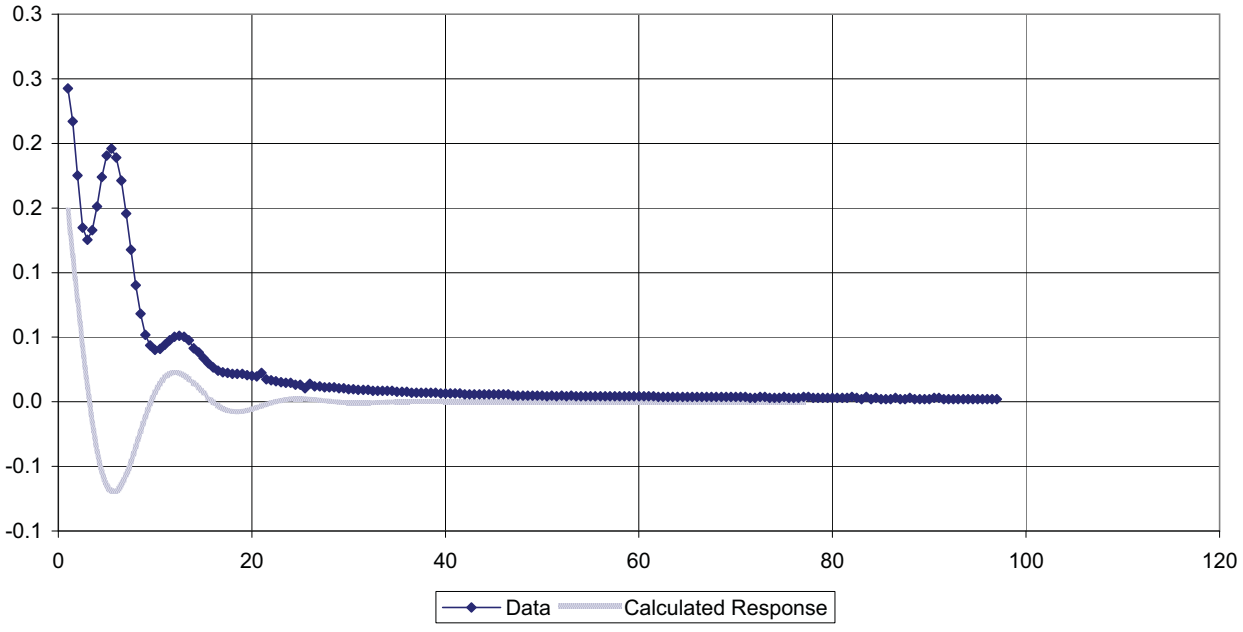


Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	P-05-36M	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	12:18 PM
Zone depth (m):	27.432	Screen type:	2 " PVC - 20 slot
Test length (m):	5.4864	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.33
Depth of screen (m):	27.43	angular frequency (per second):	0.49
Depth to water (m):	5.90	damping constant:	0.17
Height of water predicted(m):	36.00	Initial amplitude:	0.2
Height of water (m):	21.53		
K (m/s):	1.5E-04	Transmissivity (m^2/s)	8.23E-04
Storage:	5.00E-04		

Water Level Change



Borehole Response Test - Hvorslev Method

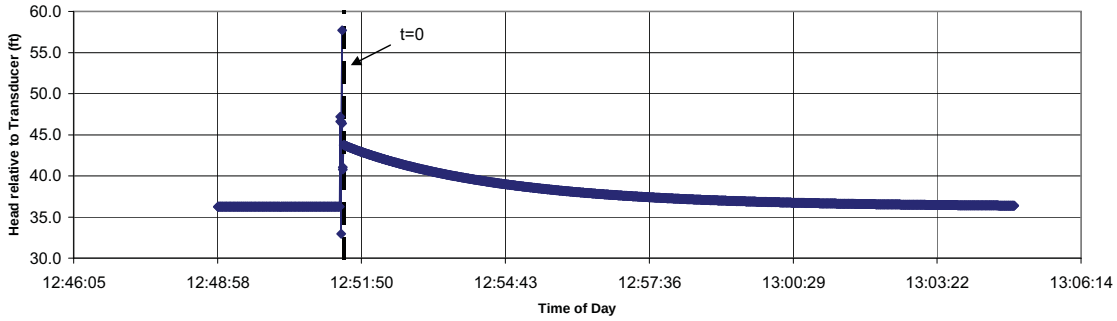
THE PEBBLE PARTNERSHIP

Borehole No:	P-05-36D	
Instrument type:	In-situ transducer	
Zone depth:	46.33 m	152 ft
Test Zone Length:	5.79 m	19 ft
Hole diameter:	0.102 m	4. in
Riser diameter:	0.051 m	2. in
Transmissivity (m²/s)	8.40E-06	
K (m/s):	1.5E-06	
Hvorslev intercept:	1	

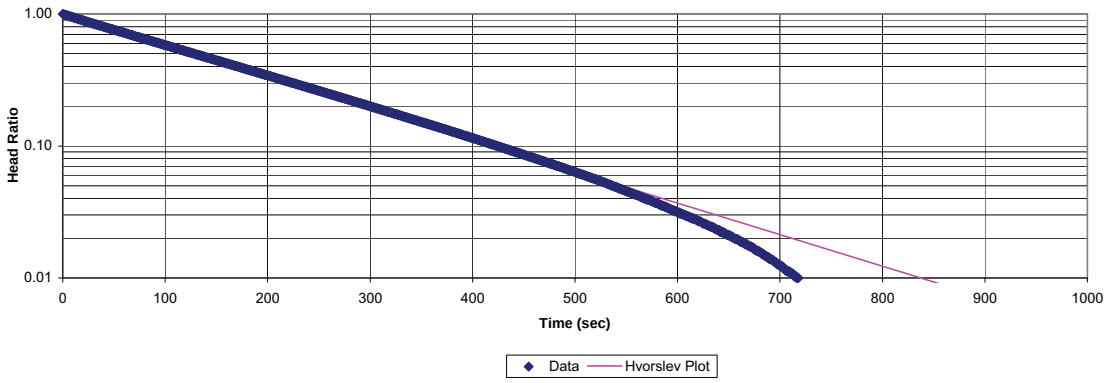
Test date:	15-Oct-05
Test time:	12:51 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson
Static Head relative to Transducer(ft)	36.385
Head at t=0 relative to Transducer(ft)	43.771

Note: static level taken post test

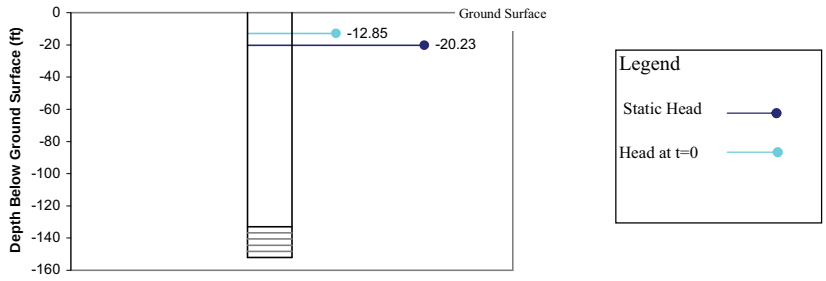
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



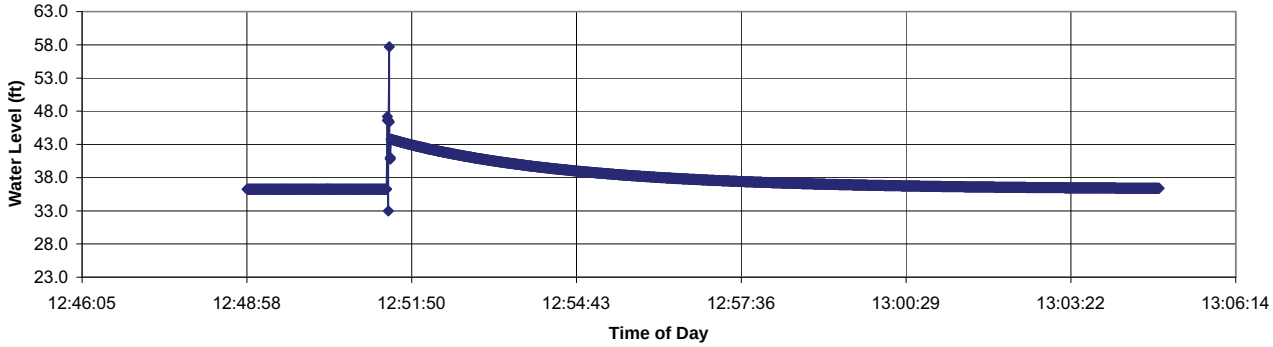
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

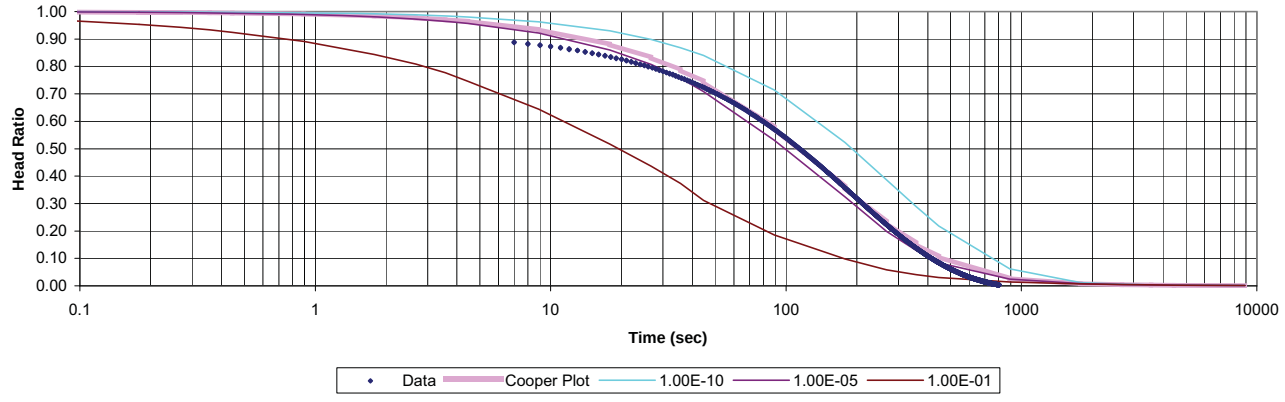
Borehole No:	P-05-36D	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	4:58 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	5.79	Field technician:	SLR Alaska
Hole diameter (m):	0.102	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	2.5E-06	Transmissivity (m^2/s)	1.45E-05
Storage:	4.00E-07	Alpha	1.60E-06
		Δh_o (m)	8.0

Water Level vs Time of Day



Head Ratio Plot

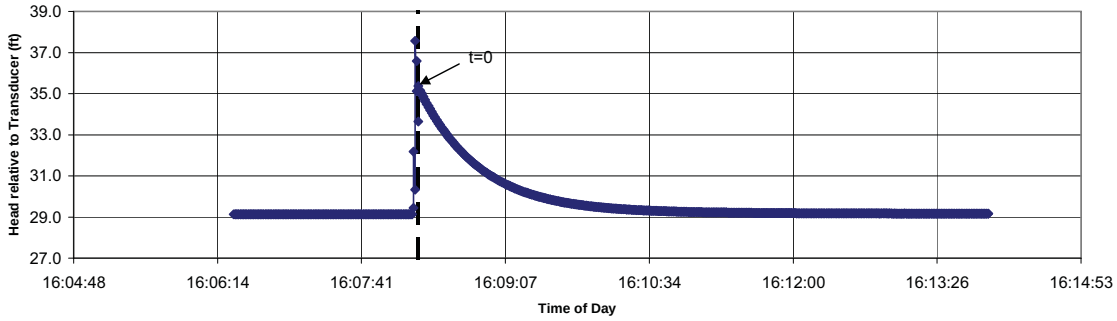


Borehole Response Test - Hvorslev Method

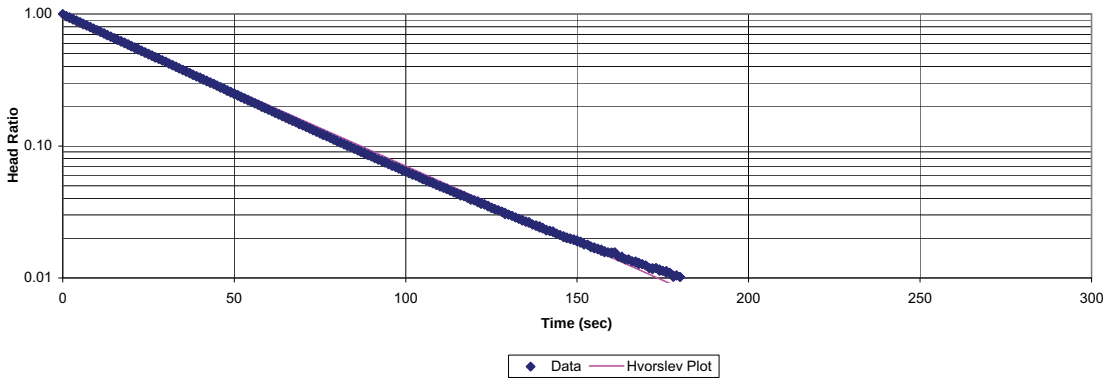
THE PEBBLE PARTNERSHIP

Borehole No:	PQ-4		Test date:	15-Oct-05
Instrument type:	In-situ transducer		Test time:	4:08 PM
Zone depth:	42.06 m	138 ft	Screen type:	2 " PVC - 20 slot
Test Zone Length:	6.1 m	20 ft	Field technician:	SLR Alaska
Hole diameter:	0.123 m	4.84 in	Analyst:	K Gibson
Riser diameter:	0.051 m	2. in		
Transmissivity (m^2/s)	3.93E-05		Static Head relative to Transducer(ft)	29.159
K (m/s):	6.5E-06		Head at t=0 relative to Transducer(ft)	35.366
Hvorslev intercept:	1			

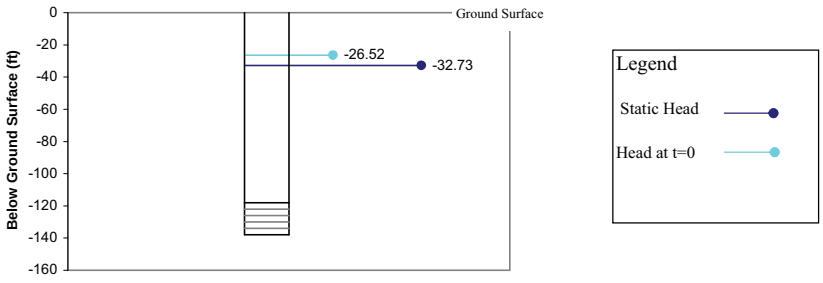
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



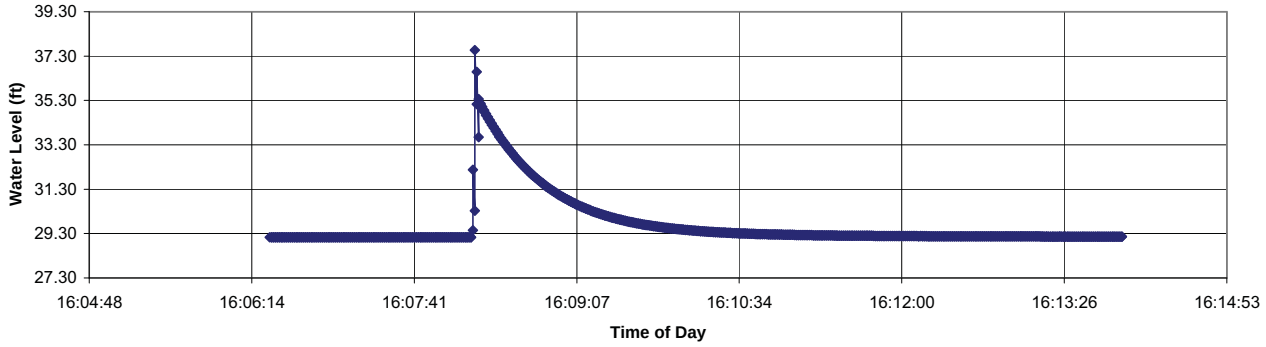
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

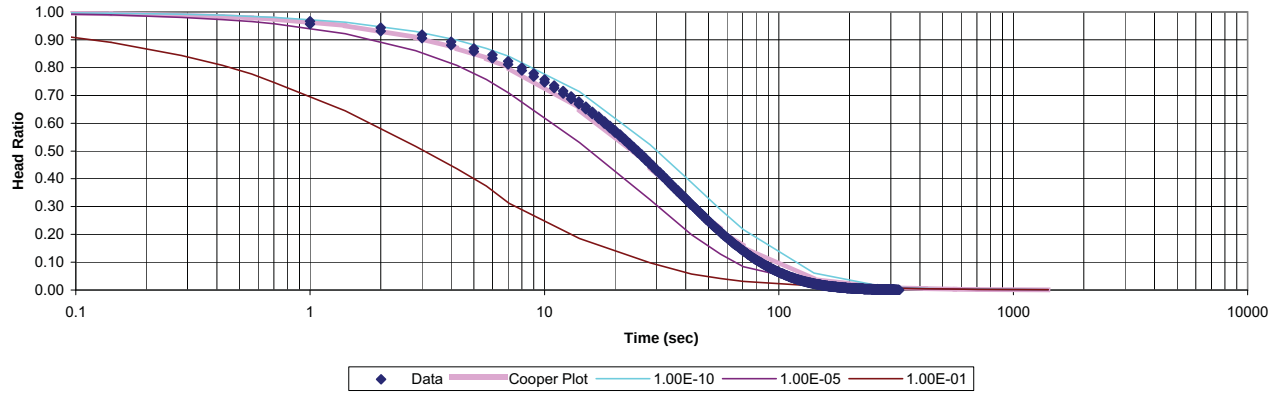
Borehole No:	PQ-4	Test date:	15/10/2005
Instrument type:	In-situ transducer	Test time:	4:08 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	6.10	Field technician:	SLR Alaska
Hole diameter (m):	0.123	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.5E-05	Transmissivity (m^2/s)	9.14E-05
Storage:	5.00E-09	Alpha	2.93E-08
		Δh_o (m)	6.205

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

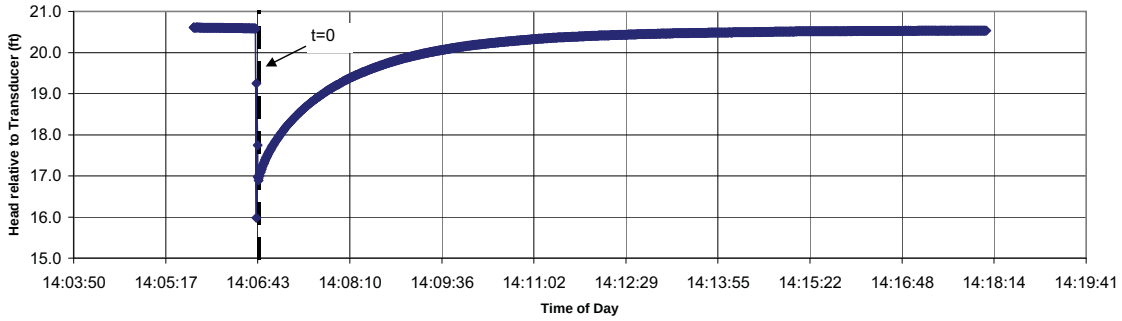
Borehole No:	MW-05-12S	
Instrument type:	In-situ transducer	
Zone depth:	13.44 m	44 ft
Test Zone Length:	4.27 m	14 ft
Hole diameter:	0.152 m	6. in
Riser diameter:	0.051 m	2. in

Test date:	20-Sep-05
Test time:	2:06 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

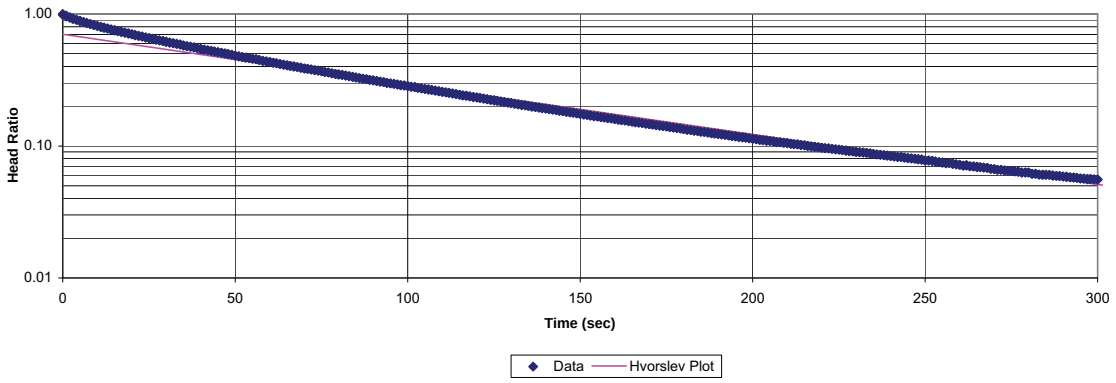
Transmissivity (m²/s)	1.13E-05
K (m/s):	2.7E-06
Hvorslev intercept:	0.7

Static Head relative to Transducer(ft)	20.595
Head at t=0 relative to Transducer(ft)	16.891

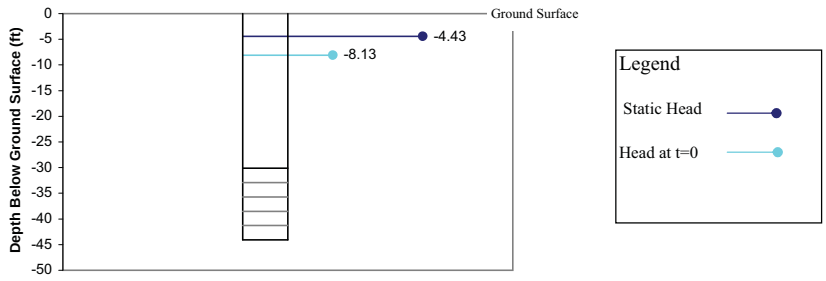
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

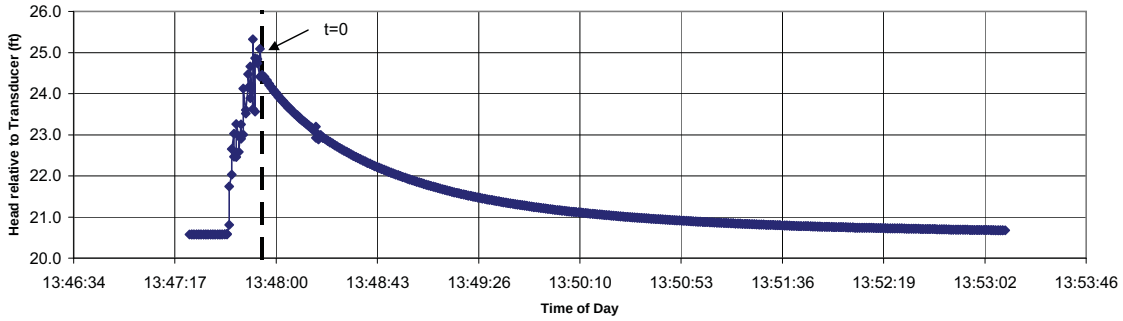
Borehole No:	MW-05-12S	
Instrument type:	In-situ transducer	
Zone depth:	13.44 m	44 ft
Test Zone Length:	4.27 m	14 ft
Hole diameter:	0.152 m	6. in
Riser diameter:	0.051 m	2. in

Test date:	20-Sep-05
Test time:	1:47 PM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

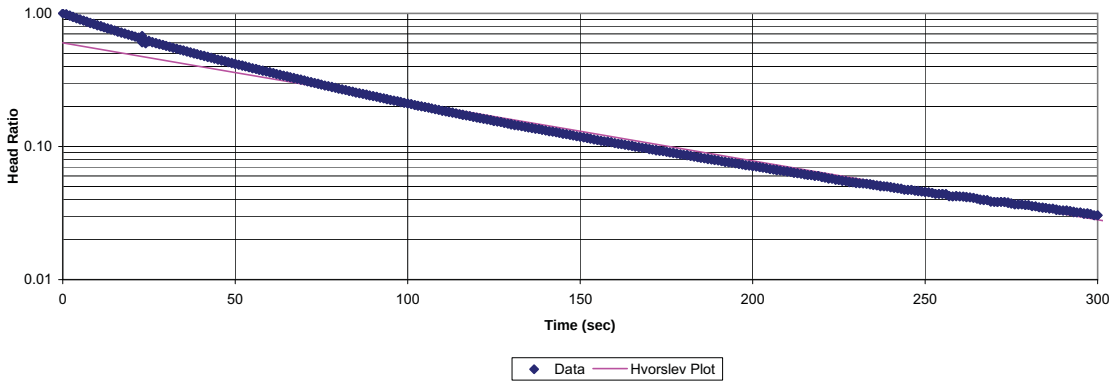
Transmissivity (m^2/s)	1.32E-05
K (m/s):	3.1E-06
Hvorslev intercept:	0.6

Static Head relative to Transducer(ft)	20.572
Head at t=0 relative to Transducer(ft)	24.457

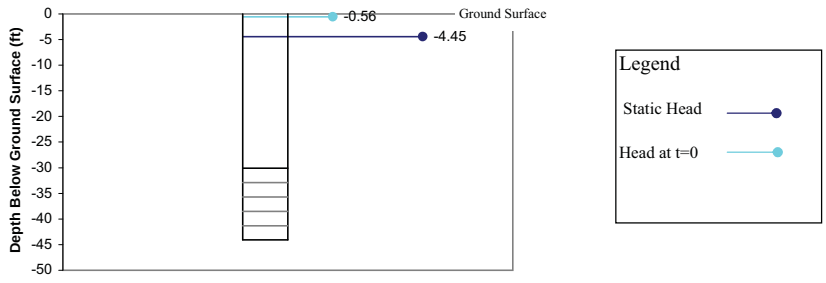
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



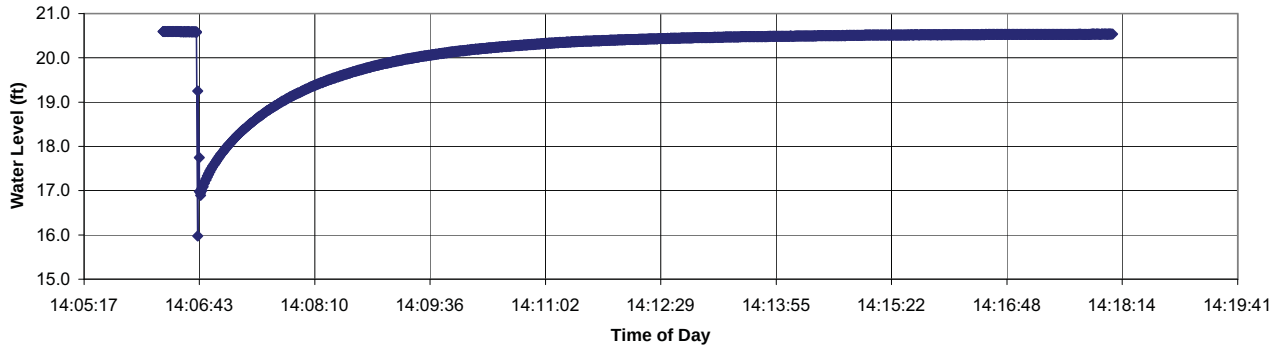
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

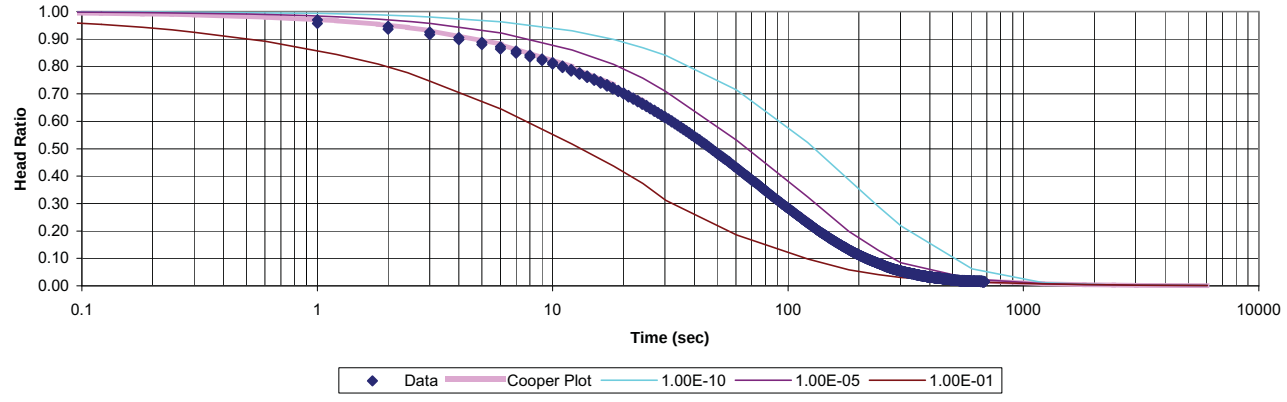
Borehole No:	MW-05-12S	Test date:	20/09/2005
Instrument type:	In-situ transducer	Test time:	2:06 PM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	4.27	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	5.0E-06	Transmissivity (m^2/s)	2.13E-05
Storage:	6.00E-05	Alpha	5.40E-04
		Δh_o (m)	-3.7

Water Level vs Time of Day



Head Ratio Plot

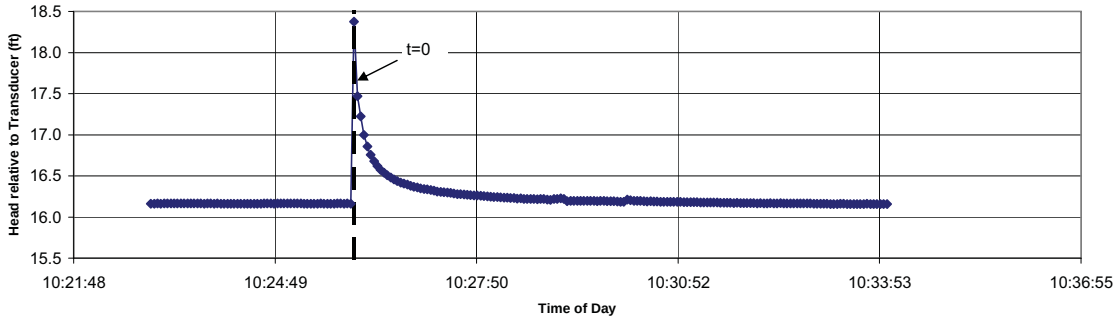


Borehole Response Test - Hvorslev Method

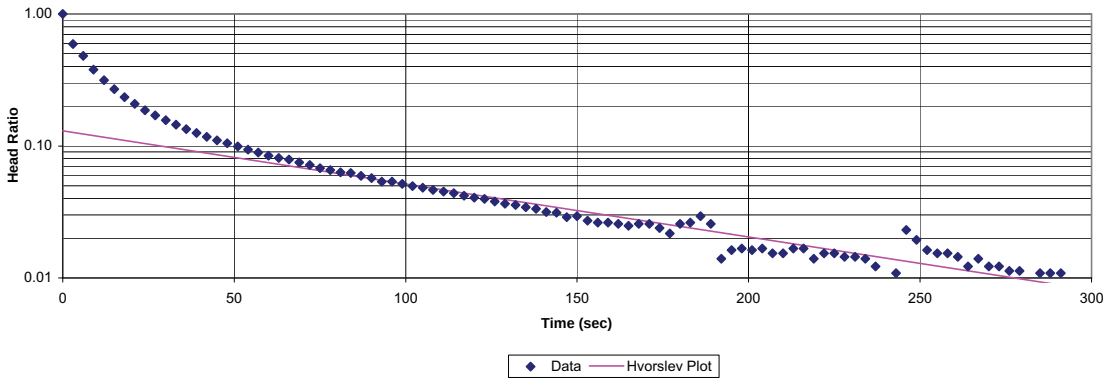
THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-12D		Test date:	13-Jun-05
Instrument type:	In-situ transducer		Test time:	10:26 AM
Zone depth:	38.1 m	125 ft	Screen type:	2 " PVC - 20 slot
Test Zone Length:	10.97 m	36 ft	Field technician:	SLR Alaska
Hole diameter:	0.152 m	6. in	Analyst:	K Gibson
Riser diameter:	0.051 m	2. in		
Transmissivity (m^2/s)	1.48E-05		Static Head relative to Transducer(ft)	16.161
K (m/s):	1.4E-06		Head at t=0 relative to Transducer(ft)	18.374
Hvorslev intercept:	0.13			

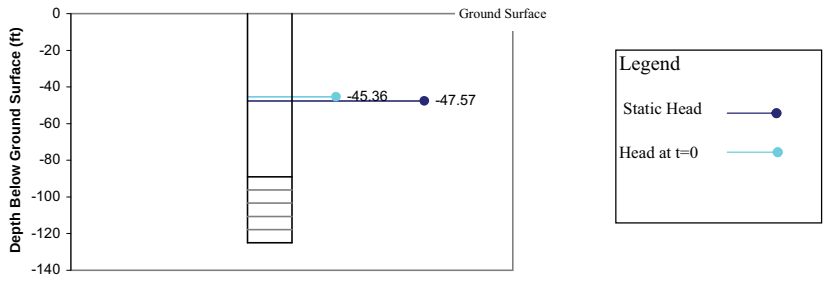
Water Level Change



Head Ratio Plot



Test Water Level Relative to Screen Interval



Borehole Response Test - Hvorslev Method

THE PEBBLE PARTNERSHIP

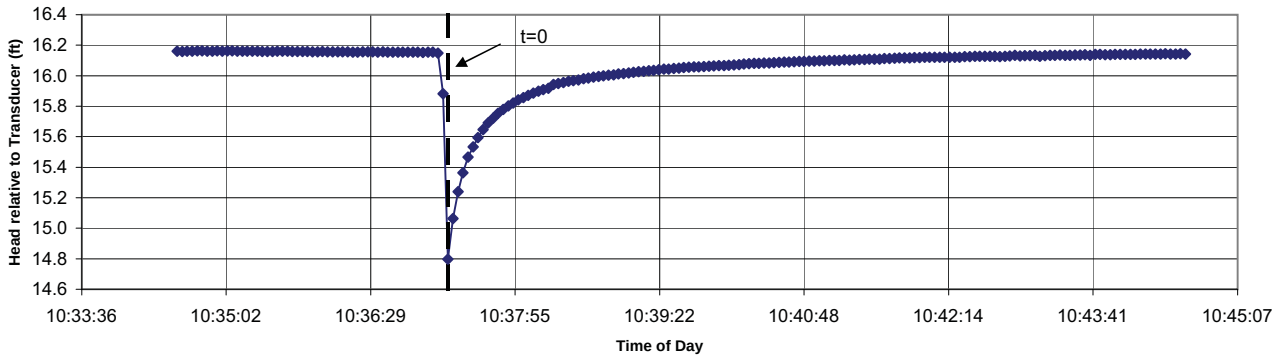
Borehole No:	MW-05-12D	
Instrument type:	In-situ transducer	
Zone depth:	38.1 m	125 ft
Test Zone Length:	10.97 m	36 ft
Hole diameter:	0.152 m	0.5 ft
Riser diameter:	0.051 m	0.167 ft

Test date:	13-Jun-05
Test time:	10:37 AM
Screen type:	2 " PVC - 20 slot
Field technician:	SLR Alaska
Analyst:	K Gibson

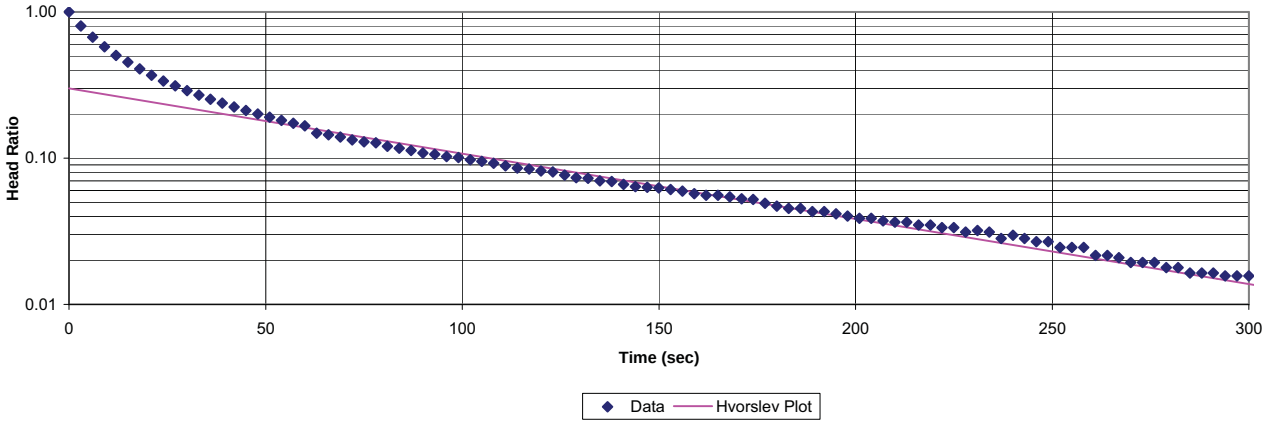
Transmissivity (m^2/s)	1.65E-05
Hvorslev intercept:	0.3
K (m/s):	1.5E-06

Static Head relative to Transducer(ft)	16.142
Head at t=0 relative to Transducer(ft)	14.798

Water Level Change



Head Ratio Plot



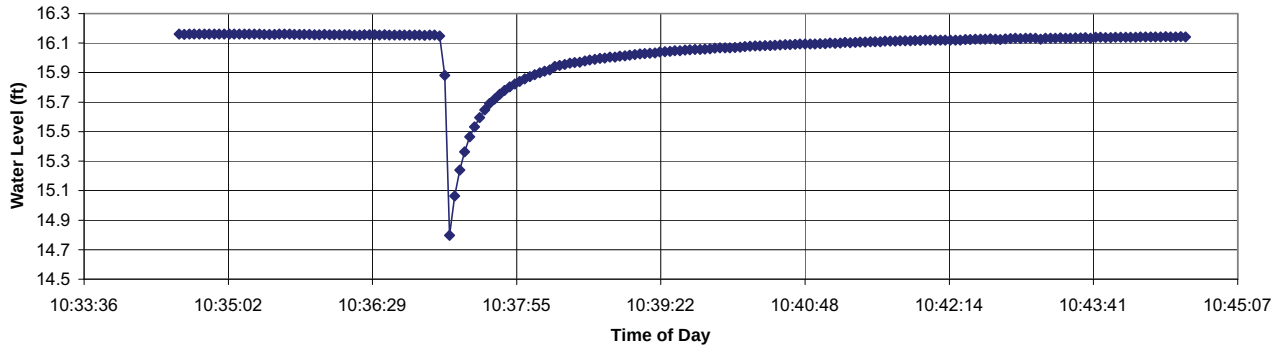
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

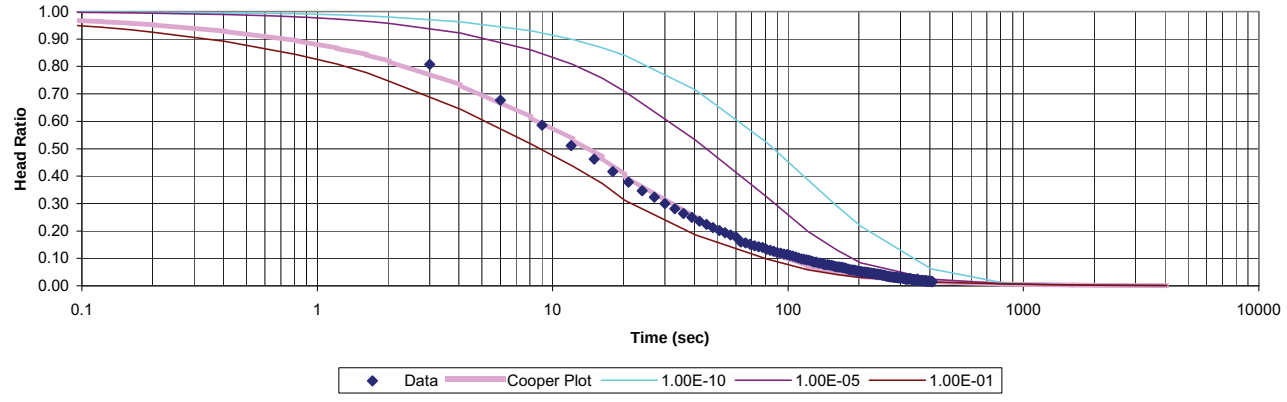
Borehole No:	MW-05-12D	Test date:	13/06/2005
Instrument type:	In-situ transducer	Test time:	10:37 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	10.97	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	2.9E-06	Transmissivity (m^2/s)	3.18E-05
Storage:	5.00E-03	Alpha	4.50E-02
		Δh_o (m)	-1.36

Water Level vs Time of Day



Head Ratio Plot

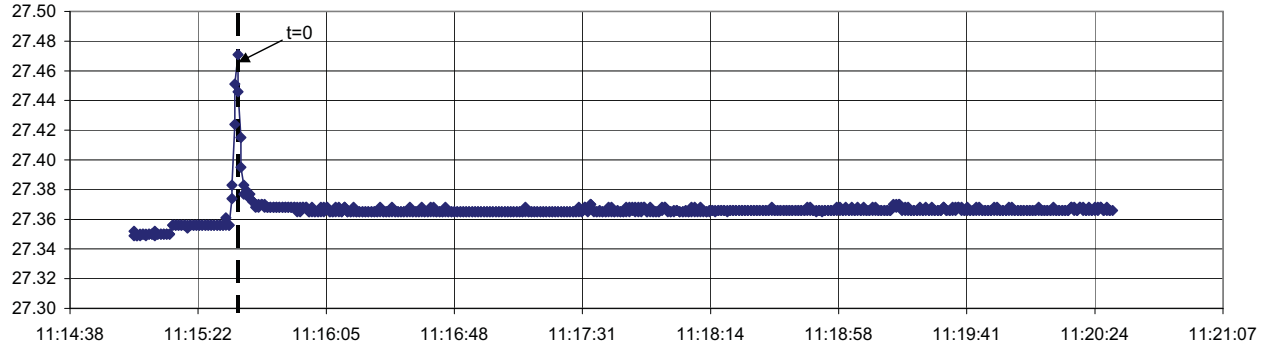


Borehole Response Test - Hvorslev Method

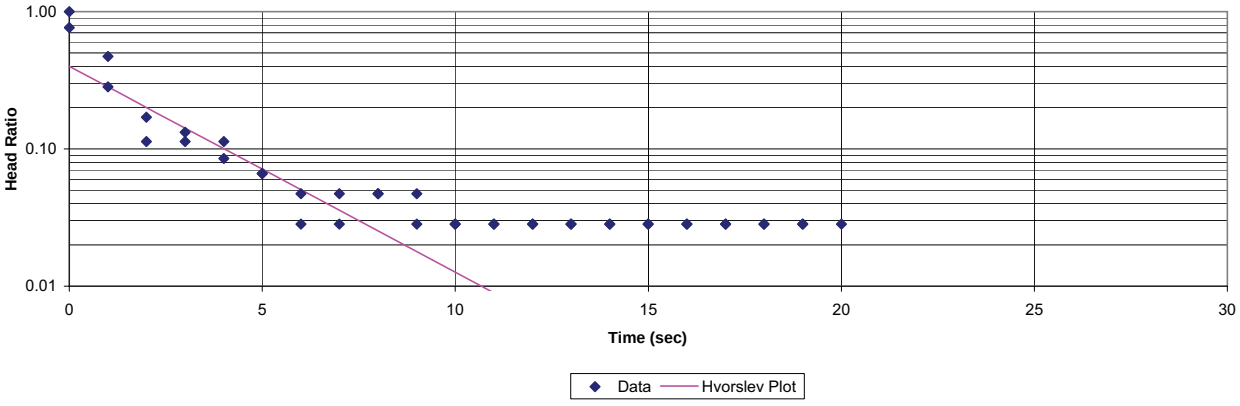
THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-13S	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	11:15 AM
Zone depth (m):	9.94	Screen type:	2 " PVC - 20 slot
Test length (m):	6.10	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.4		
K (m/s):	8.0E-05	Transmissivity (m^2/s)	4.88E-04

Water Level Change



Head Ratio Plot

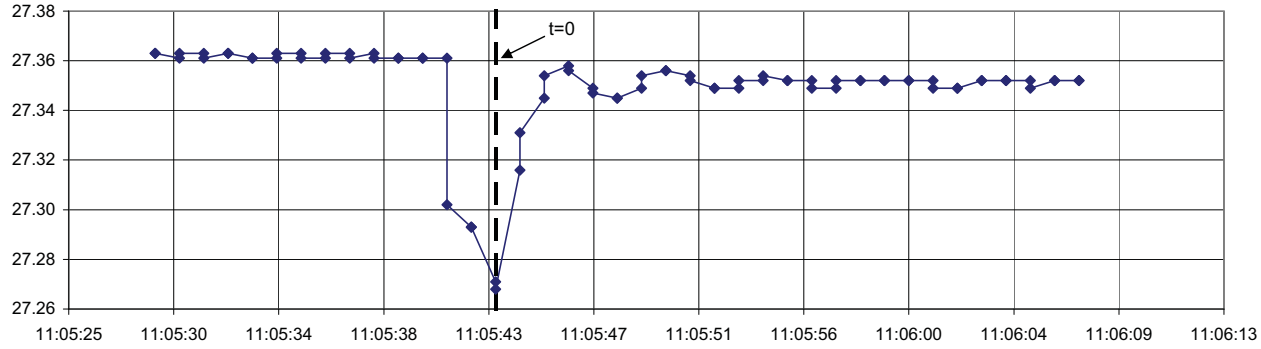


Borehole Response Test - Hvorslev Method

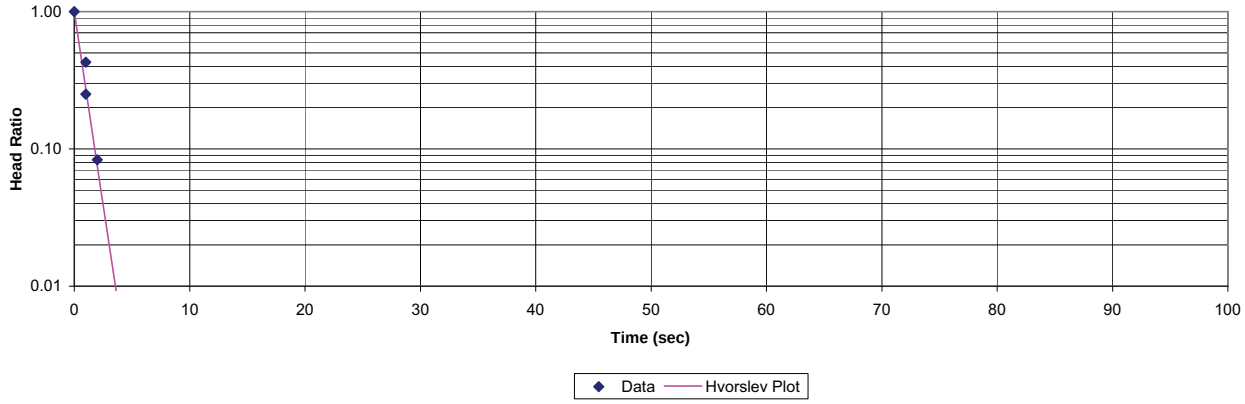
THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-13S	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	11:05 AM
Zone depth (m):	9.94	Screen type:	2 " PVC - 20 slot
Test length (m):	6.10	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	1		
K (m/s):	3.0E-04	Transmissivity (m^2/s)	1.83E-03

Water Level Change



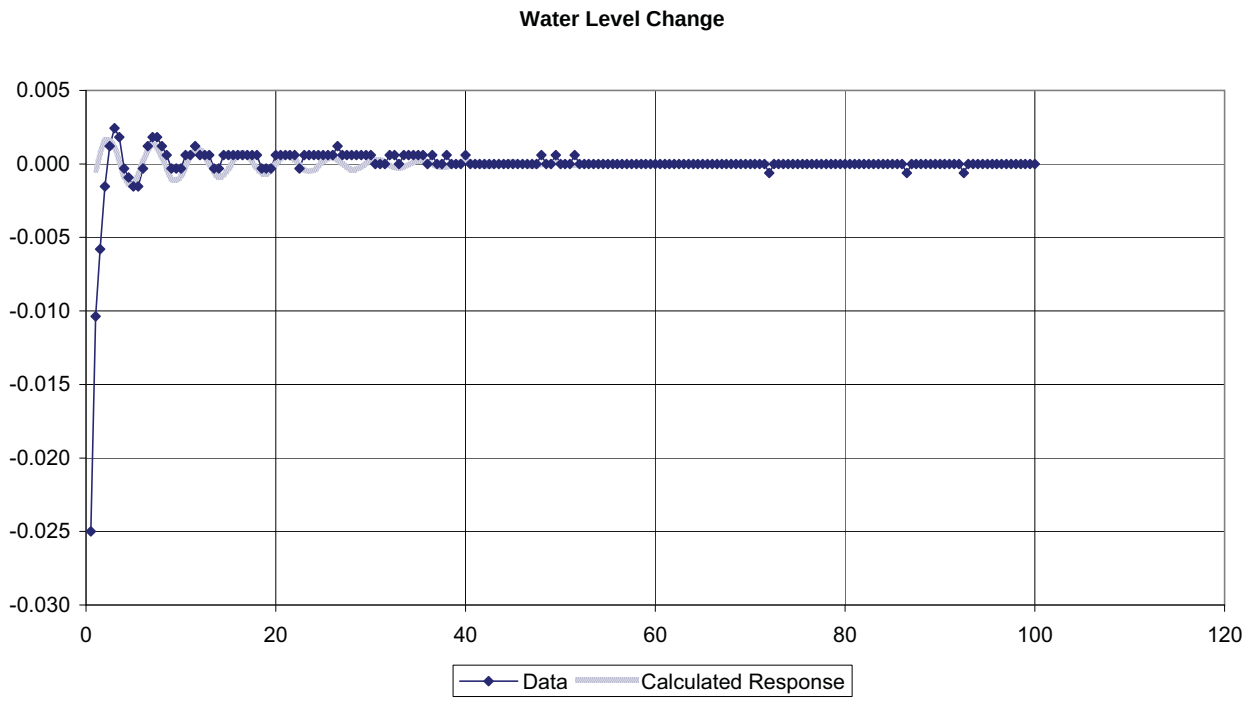
Head Ratio Plot



Borehole Response Test - Van der Kamp Method

THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-13S	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	11:05 AM
Zone depth (m):	9.93648	Screen type:	2 " PVC - 20 slot
Test length (m):	6.096	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	K Gibson
Riser diameter (m):	0.0508		
		d:	0.04
Depth of screen (m):	9.94	angular frequency (per second):	1.33
Depth to water (m):	1.06	damping constant:	0.06
Height of water predicted(m):	5.50	Initial amplitude:	-0.002
Height of water (m):	8.88		
K (m/s):	9.0E-04	Transmissivity (m^2/s)	5.49E-03
Storage:	1.00E-01		



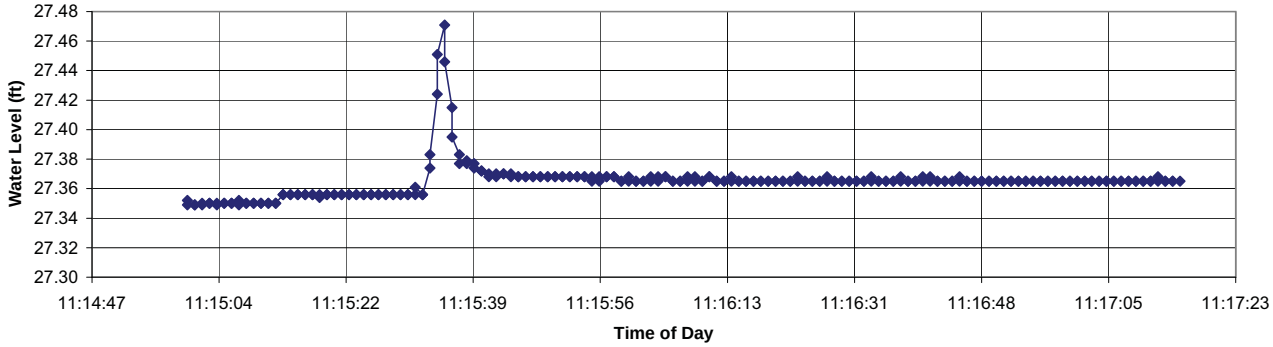
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

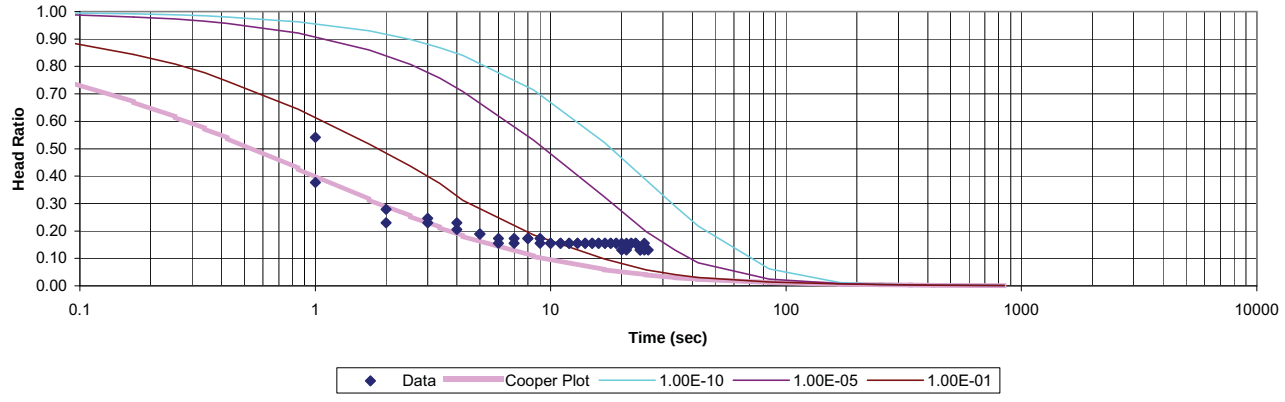
Borehole No:	MW-05-13S	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	11:15 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	6.10	Field technician:	SLR Alaska
Hole diameter (m):	0.152	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	2.5E-05	Transmissivity (m^2/s)	1.52E-04
Storage:	1.00E-01	Alpha	9.00E-01
		Δh_o (m)	0.122

Water Level vs Time of Day



Head Ratio Plot



Borehole Response Test - Hvorslev Method

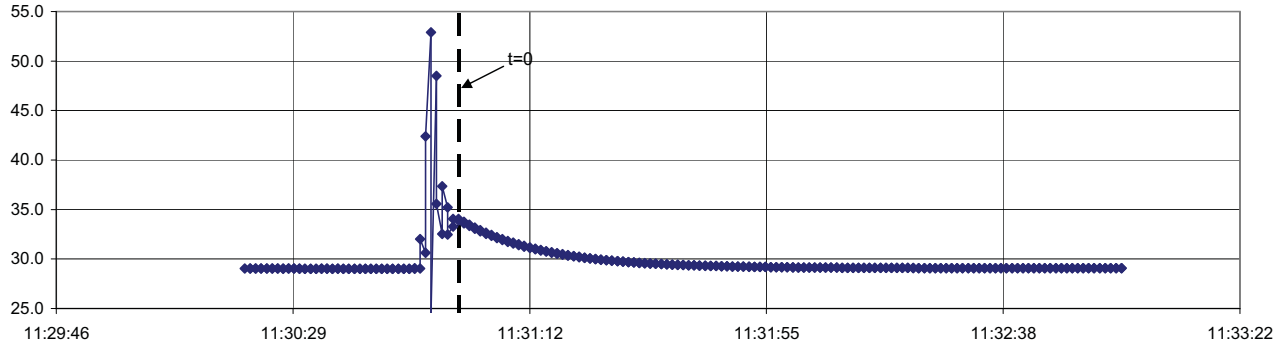
THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-13D	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	11:30 AM
Zone depth (m):	34.44	Screen type:	2 " PVC - 20 slot
Test length (m):	7.01	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.8		

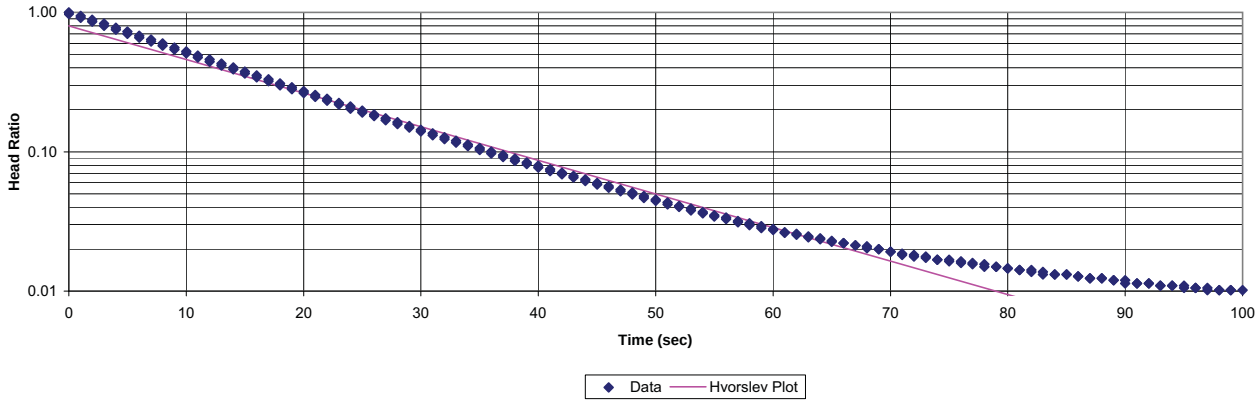
K (m/s): 1.2E-05

Transmissivity (m^2/s) 8.41E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

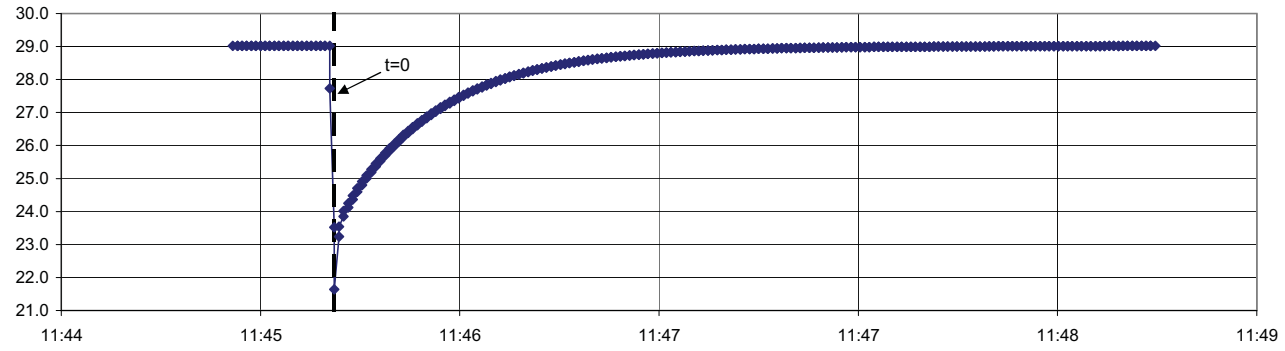
THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-13D	Test date:	30-Sep-05
Instrument type:	In-situ transducer	Test time:	11:45 AM
Zone depth (m):	34.44	Screen type:	2 " PVC - 20 slot
Test length (m):	7.01	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.8		

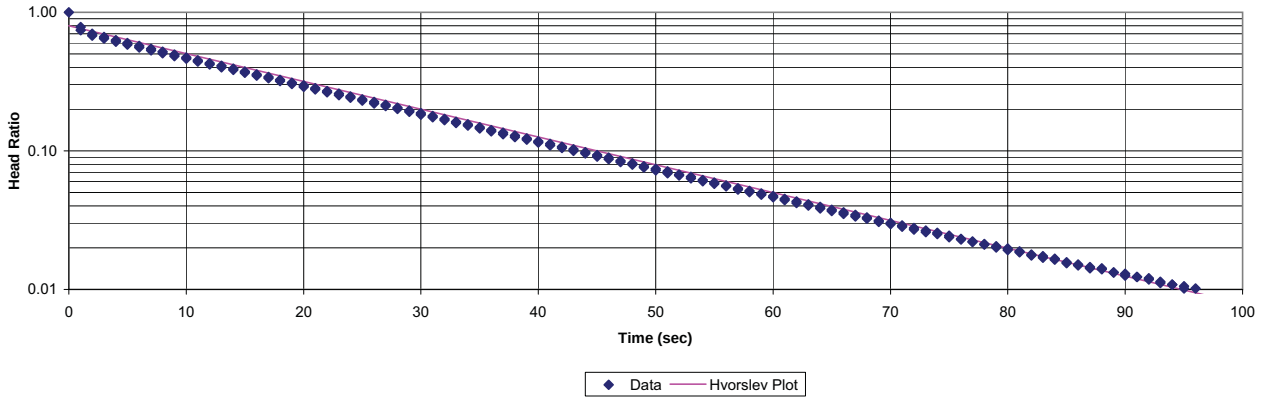
K (m/s): 1.0E-05

Transmissivity (m^2/s) 7.01E-05

Water Level Change



Head Ratio Plot



Borehole Response Test - Hvorslev Method

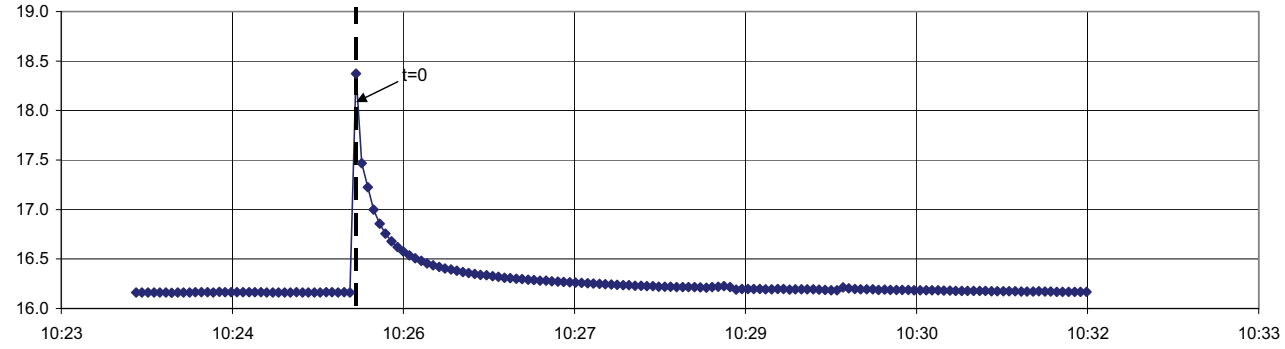
THE PEBBLE PARTNERSHIP

Borehole No:	MW-05-13D	Test date:	13-Jun-05
Instrument type:	In-situ transducer	Test time:	10:26 AM
Zone depth (m):	34.44	Screen type:	2 " PVC - 20 slot
Test length (m):	7.01	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.3		

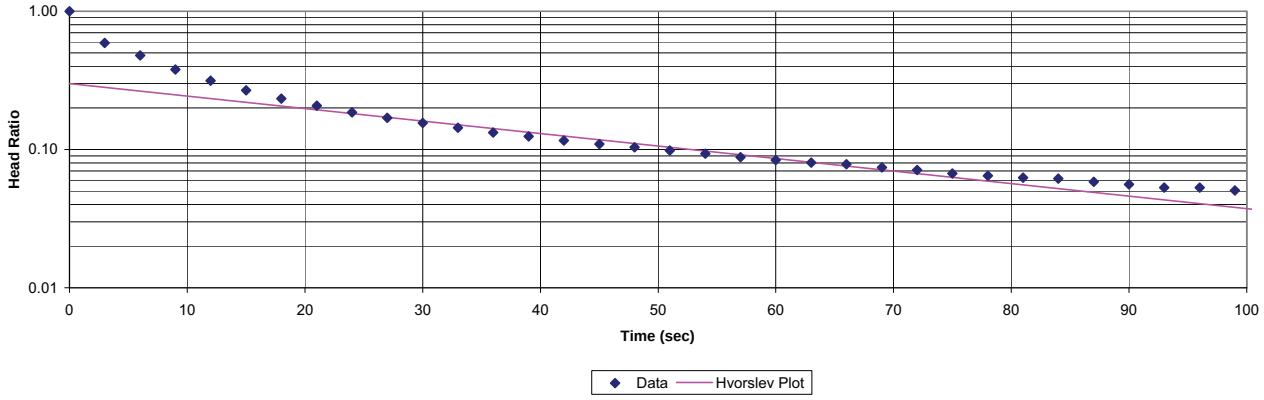
K (m/s): 4.5E-06

Transmissivity (m^2/s) 3.15E-05

Water Level Change



Head Ratio Plot



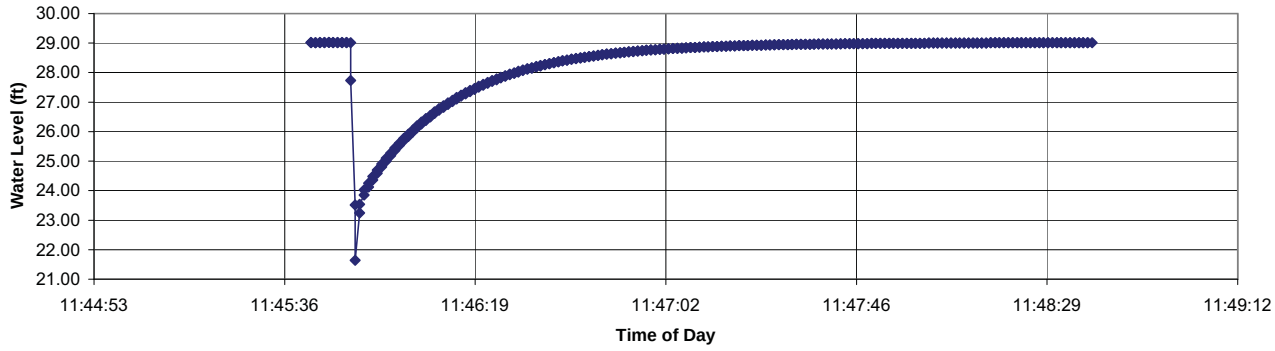
Borehole Response Test - Cooper Papadopulos Method

THE PEBBLE PARTNERSHIP

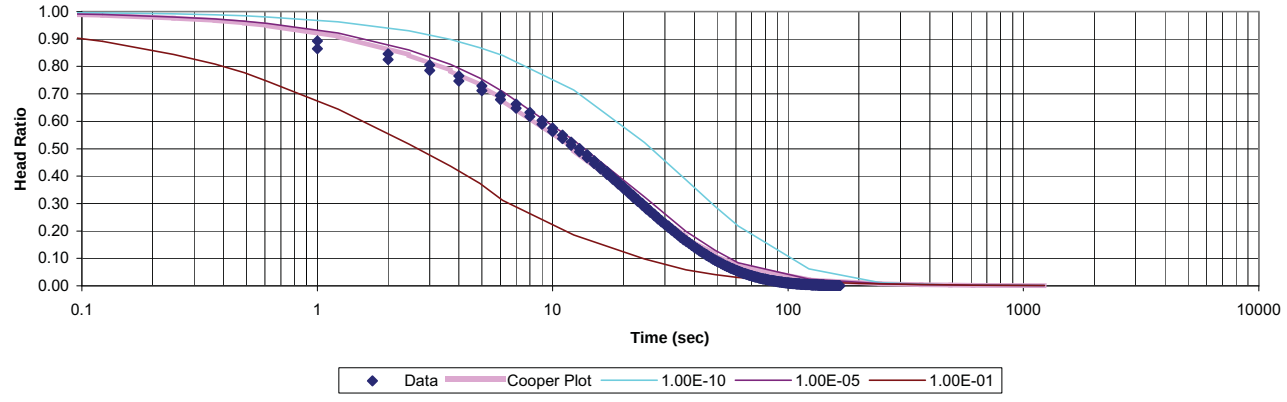
Borehole No:	MW-05-13D	Test date:	30/09/2005
Instrument type:	In-situ transducer	Test time:	11:45 AM
Zone depth (m):		Screen type:	2 " PVC - 10 slot
Test length (m):	7.01	Field technician:	SLR Alaska
Hole diameter (m):	0.127	Analyst:	K Gibson
Riser diameter (m):	0.051		

K (m/s):	1.5E-05	Transmissivity (m^2/s)	1.05E-04
Storage:	9.00E-06	Alpha	5.63E-05
		Δh_o (m)	-5.78

Water Level vs Time of Day

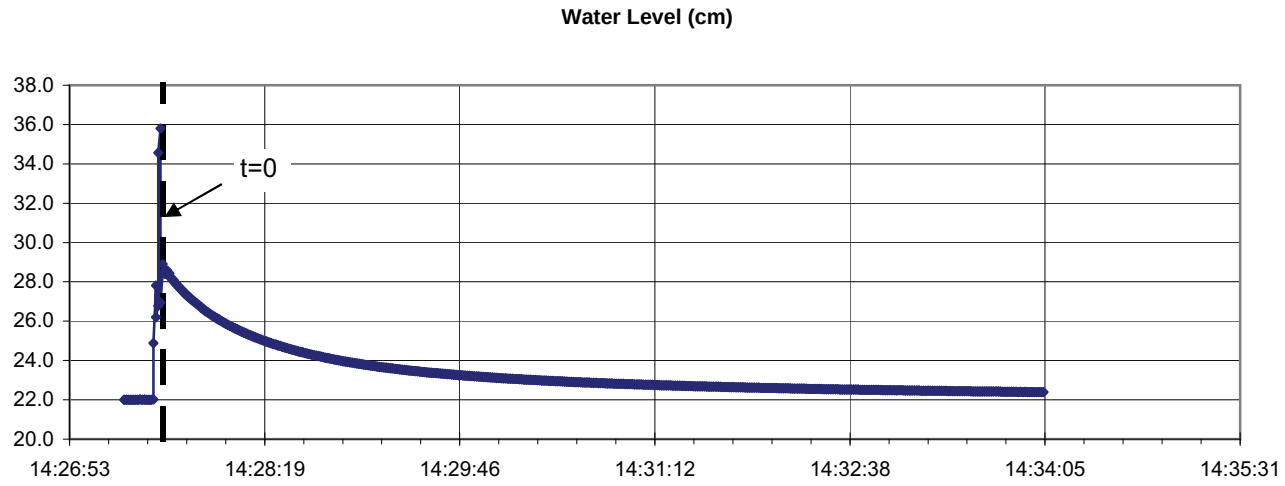


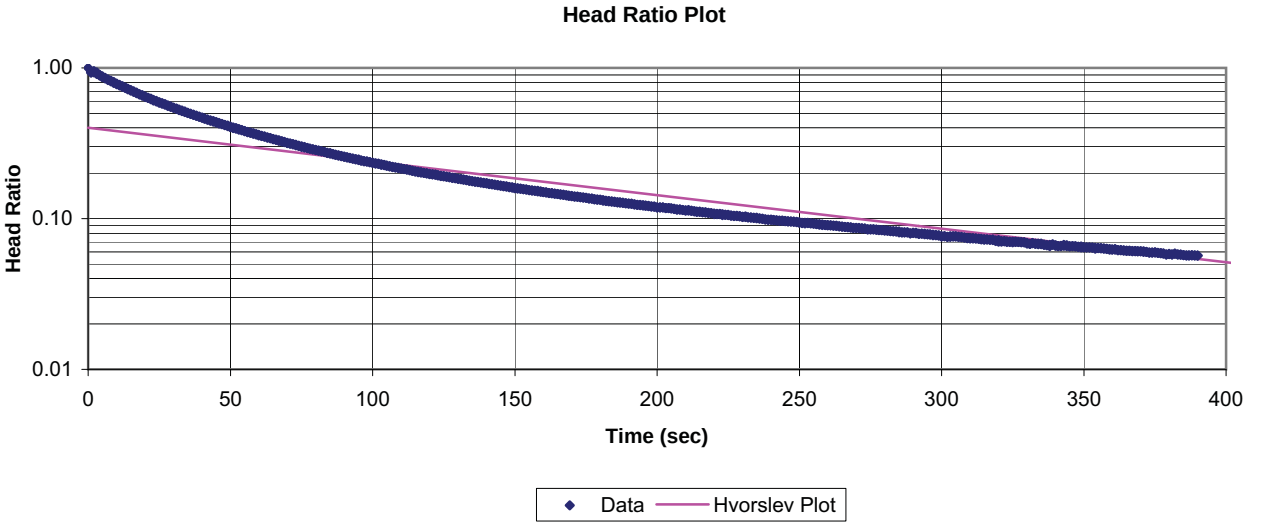
Head Ratio Plot



BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-06-37M falling	Test date:	15-Sep-06
Instrument type:	In-situ transducer	Test time:	2:27 PM
Zone depth (m):	22.9	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.4		
K (m/s):	1.0E-06	Transmissivity (m^2/s)	7.62E-06







Legend

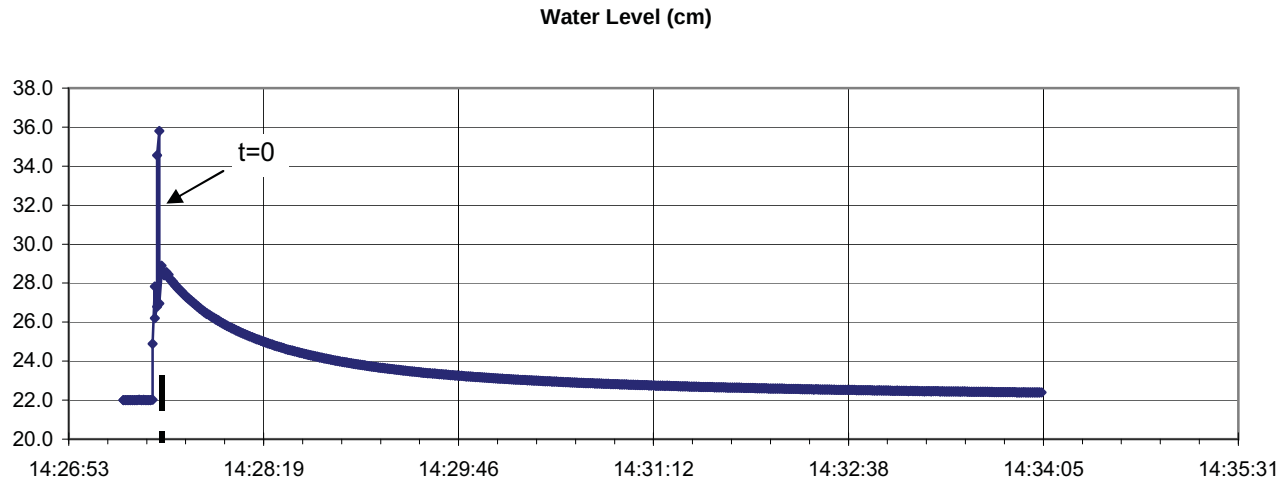
- Data
- Hvorslev Plot

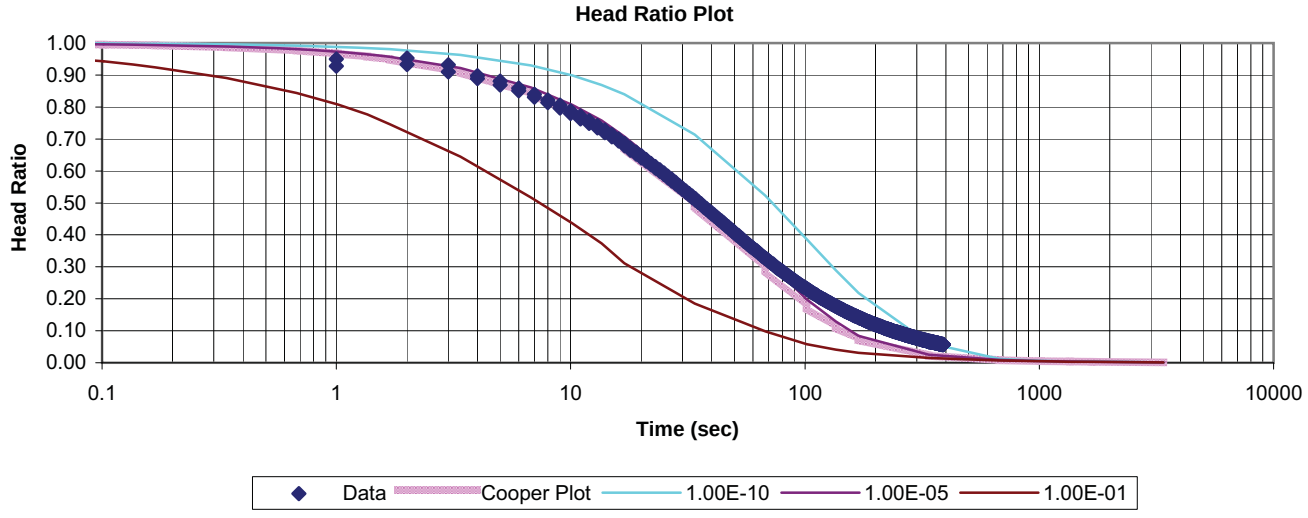
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Cooper Papadopulos Method

Borehole No:	P-06-37M	Test date:	15-Sep-06
Instrument type:	In-situ transducer	Test time:	2:27 PM
Zone depth (m):	28.956	Screen type:	2 " PVC - 20 slot
Test length (m):	7.62	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
		Transmissivity (m^2/s):	3.81E-05
K (m/s):	5.0E-06	Alpha:	6.30E-05
Storage:	7.00E-06	Δho (m):	5.58







Legend

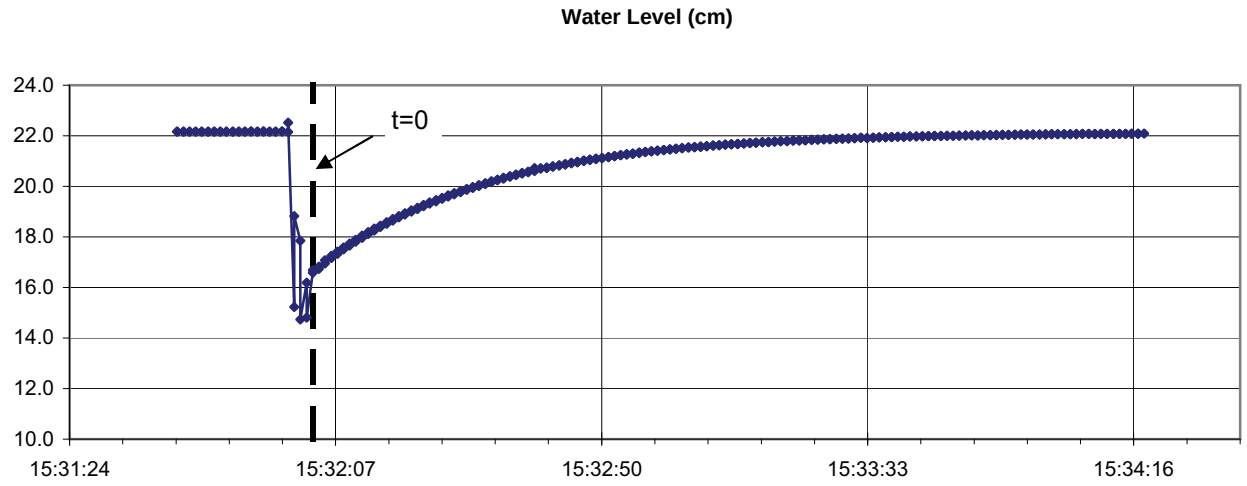
- Data
- Cooper Plot
- 1.00E-10
- 1.00E-05
- 1.00E-01

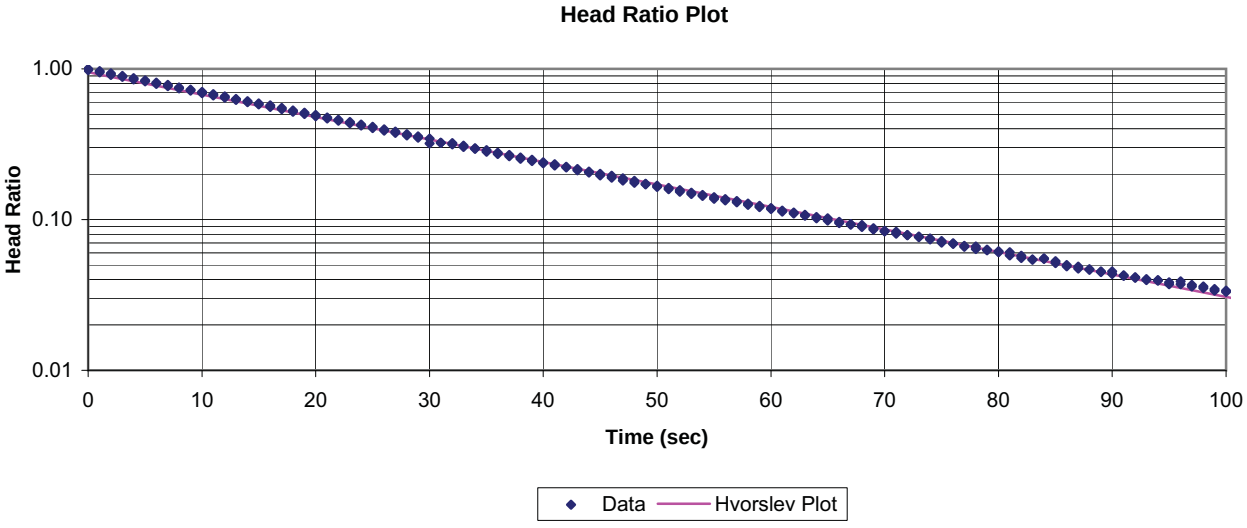
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-06-37D rising	Test date:	15-Sep-06
Instrument type:	In-situ transducer	Test time:	3:32 PM
Zone depth (m):	22.9	Screen type:	2 " PVC - 20 slot
Test length (m):	9.7536	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.95		
K (m/s):	5.5E-06	Transmissivity (m^2/s)	5.36E-05







Legend

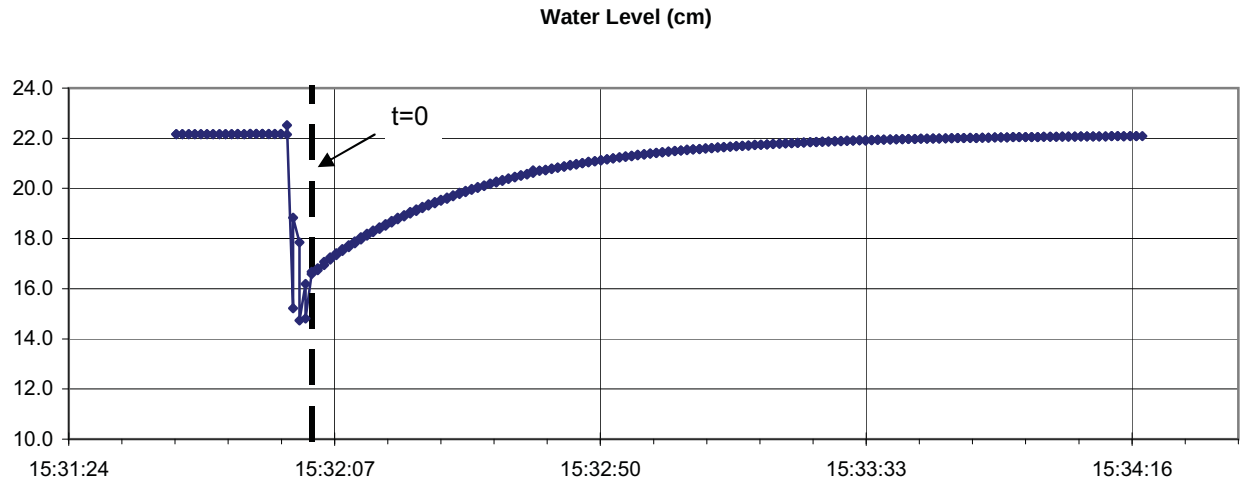
- Data
- Hvorslev Plot

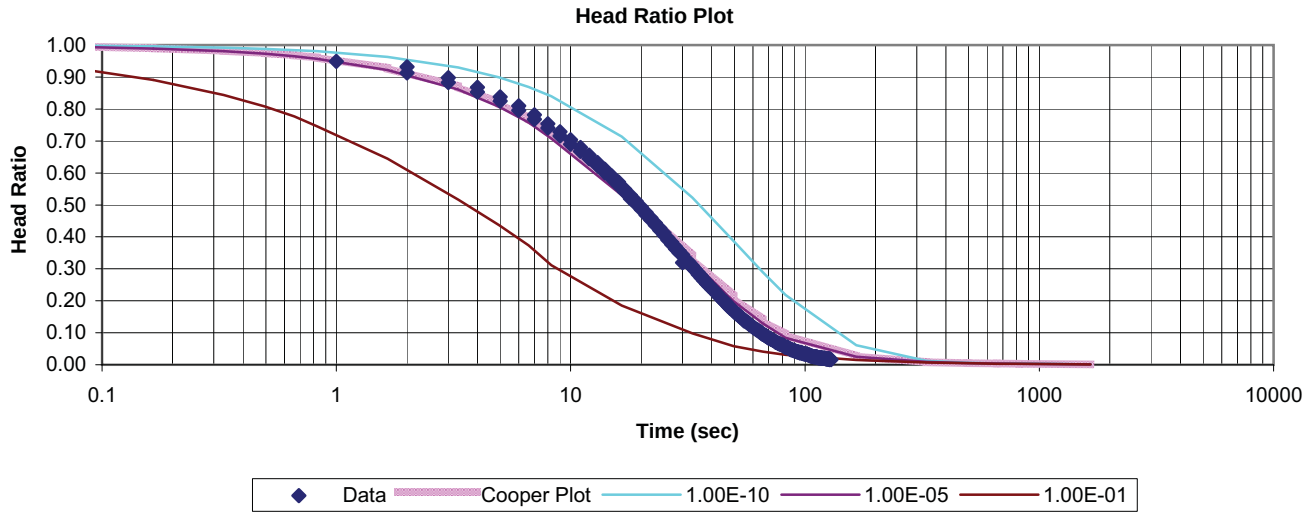
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Cooper Papadopulos Method

Borehole No:	P-06-37D	Test date:	15-Sep-06
Instrument type:	In-situ transducer	Test time:	3:32 PM
Zone depth (m):	62.484	Screen type:	2 " PVC - 20 slot
Test length (m):	9.7536	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
		Transmissivity (m^2/s):	7.80E-05
K (m/s):	8.0E-06	Alpha:	6.30E-06
Storage:	7.00E-07	Δho (m):	5.58







Legend

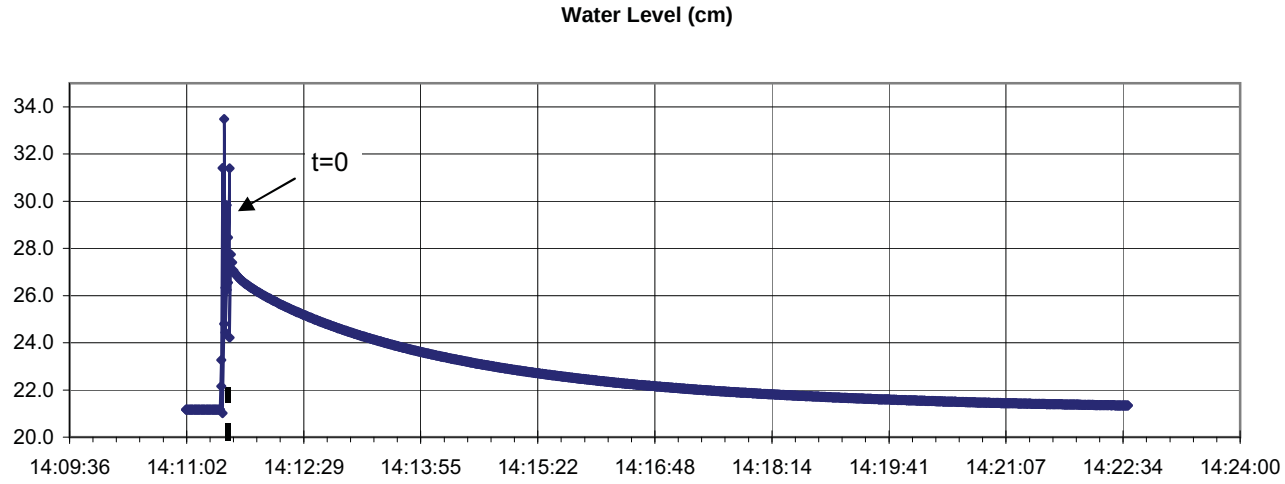
- Data
- Cooper Plot
- 1.00E-10
- 1.00E-05
- 1.00E-01

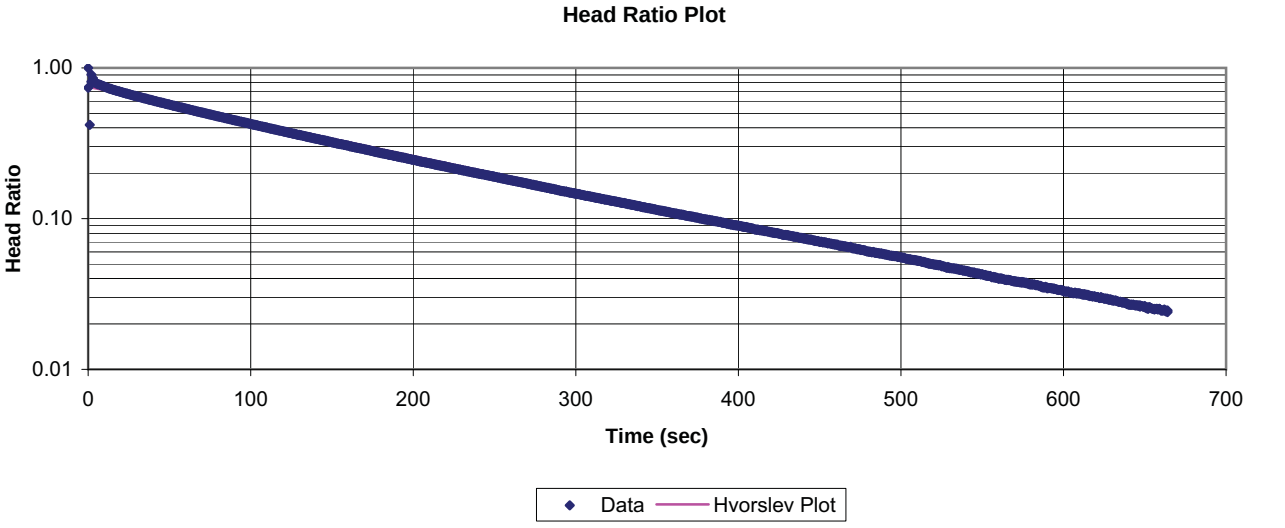
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-06-39S falling	Test date:	16-Sep-06
Instrument type:	In-situ transducer	Test time:	2:11 PM
Zone depth (m):	10.9728	Screen type:	2 " PVC - 20 slot
Test length (m):	4.2672	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.75		
K (m/s):	1.6E-06	Transmissivity (m^2/s)	6.87E-06







Legend

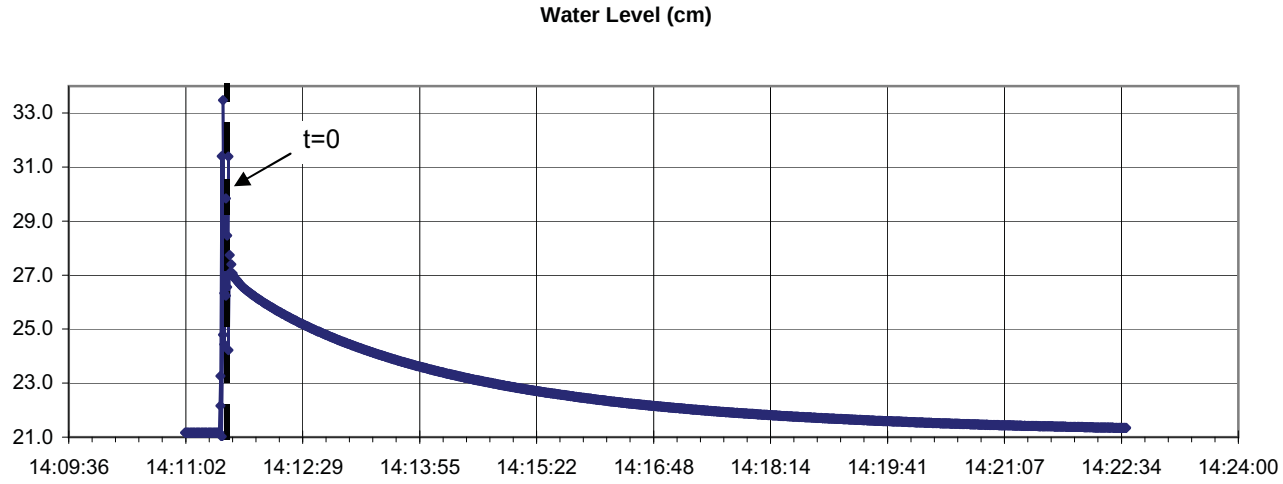
- Data
- Hvorslev Plot

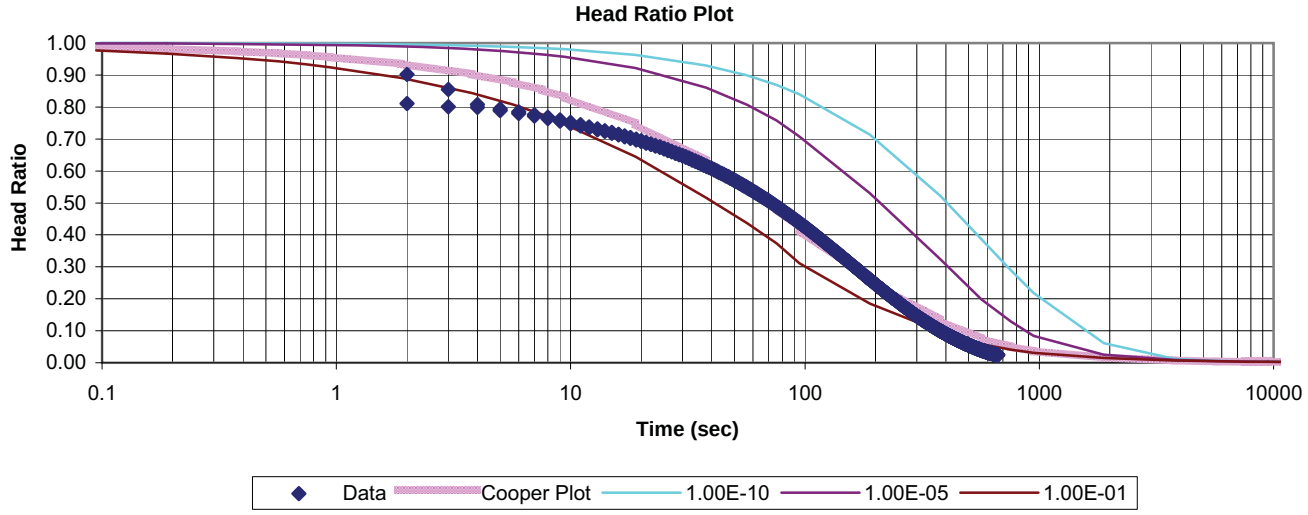
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Cooper Papadopulos Method

Borehole No:	P-06-39S	Test date:	16-Sep-06
Instrument type:	In-situ transducer	Test time:	2:11 PM
Zone depth (m):	10.9728	Screen type:	2 " PVC - 20 slot
Test length (m):	4.2672	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
		Transmissivity (m^2/s):	6.83E-06
K (m/s):	1.6E-06	Alpha:	3.60E-02
Storage:	4.00E-03	Δho (m):	7.3







Legend

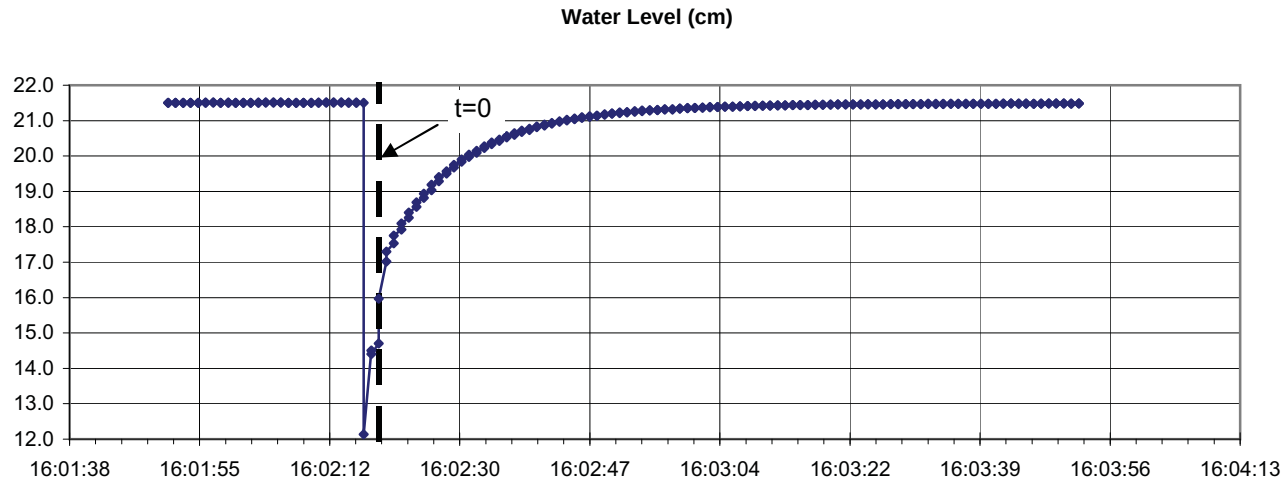
- Data
- Cooper Plot
- 1.00E-10
- 1.00E-05
- 1.00E-01

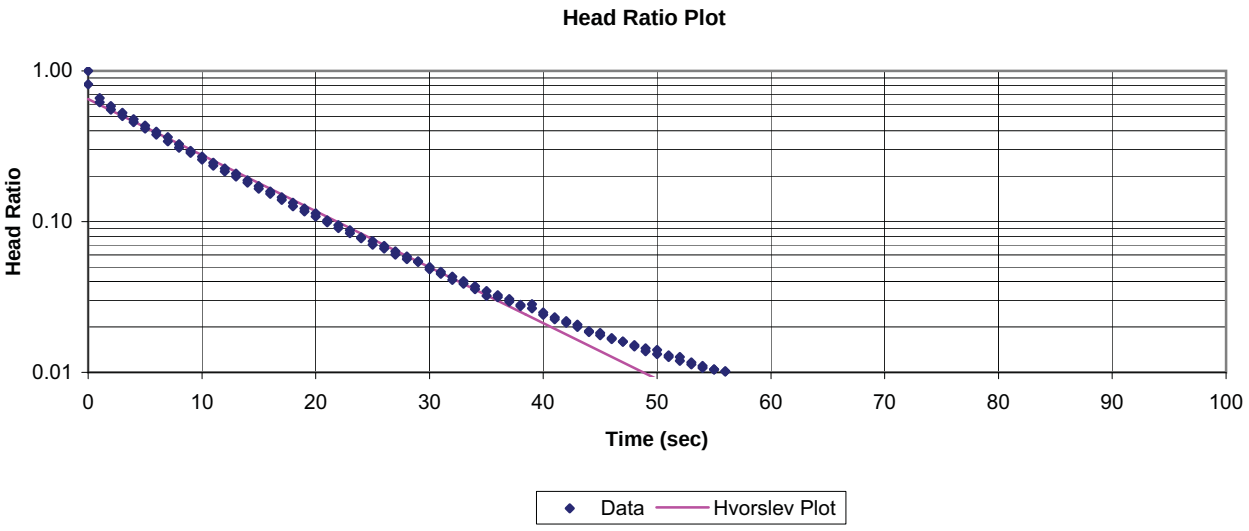
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-06-39D rising	Test date:	16-Sep-06
Instrument type:	In-situ transducer	Test time:	4:02 PM
Zone depth (m):	22.9	Screen type:	2 " PVC - 20 slot
Test length (m):	22.4028	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.65		
K (m/s):	7.0E-06	Transmissivity (m^2/s)	1.57E-04







Legend

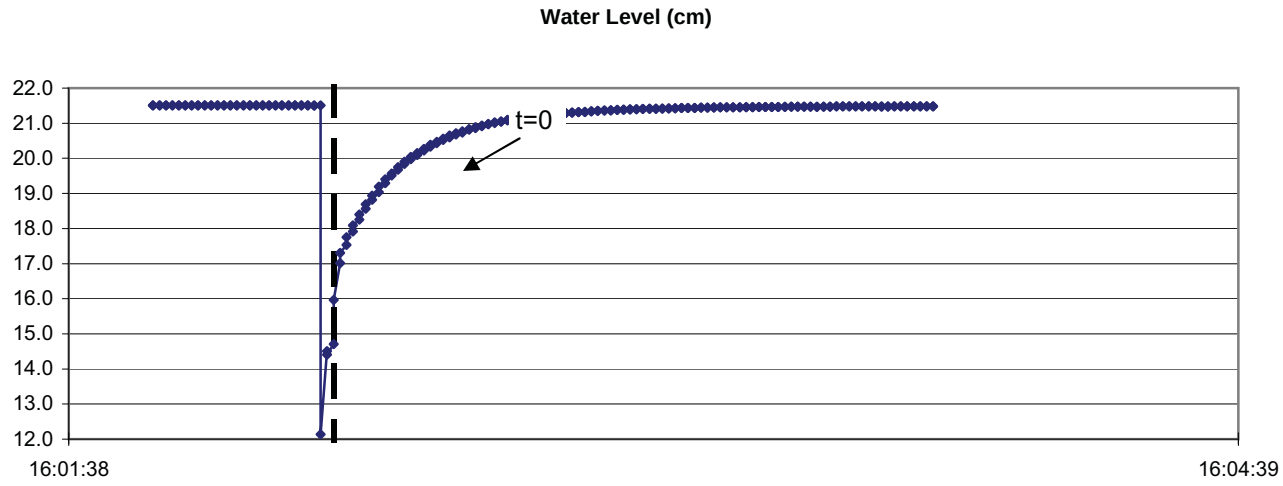
- Data
- Hvorslev Plot

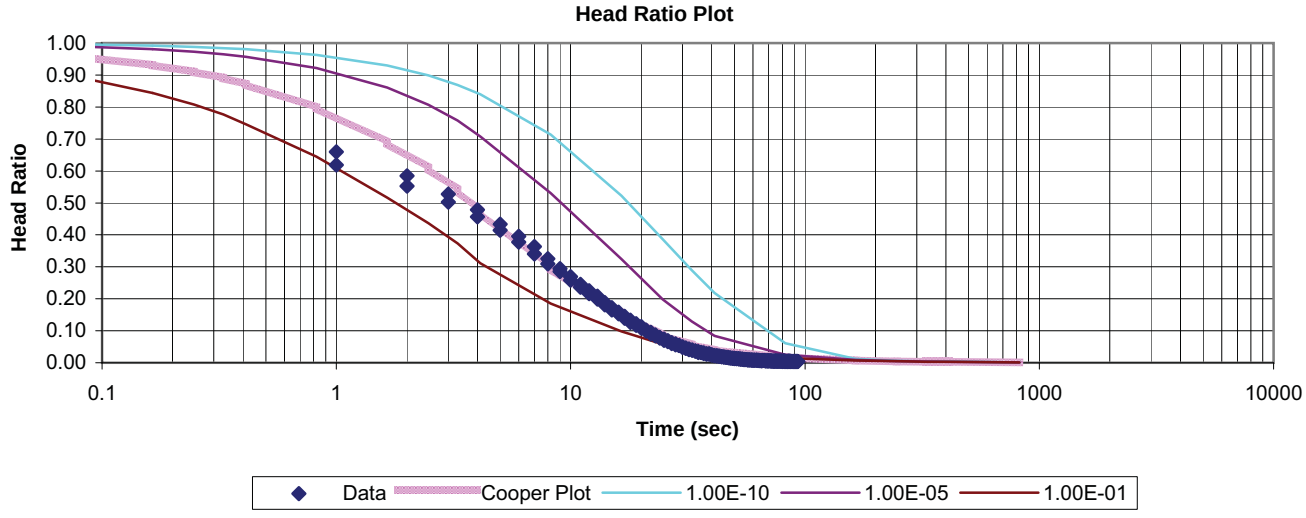
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Cooper Papadopulos Method

Borehole No:	P-06-39D rising	Test date:	16-Sep-06
Instrument type:	In-situ transducer	Test time:	4:02 PM
Zone depth (m):	34.29	Screen type:	2 " PVC - 20 slot
Test length (m):	22.4028	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
		Transmissivity (m^2/s):	1.57E-04
K (m/s):	7.0E-06	Alpha:	9.00E-03
Storage:	1.00E-03	Δho (m):	6.8







Legend

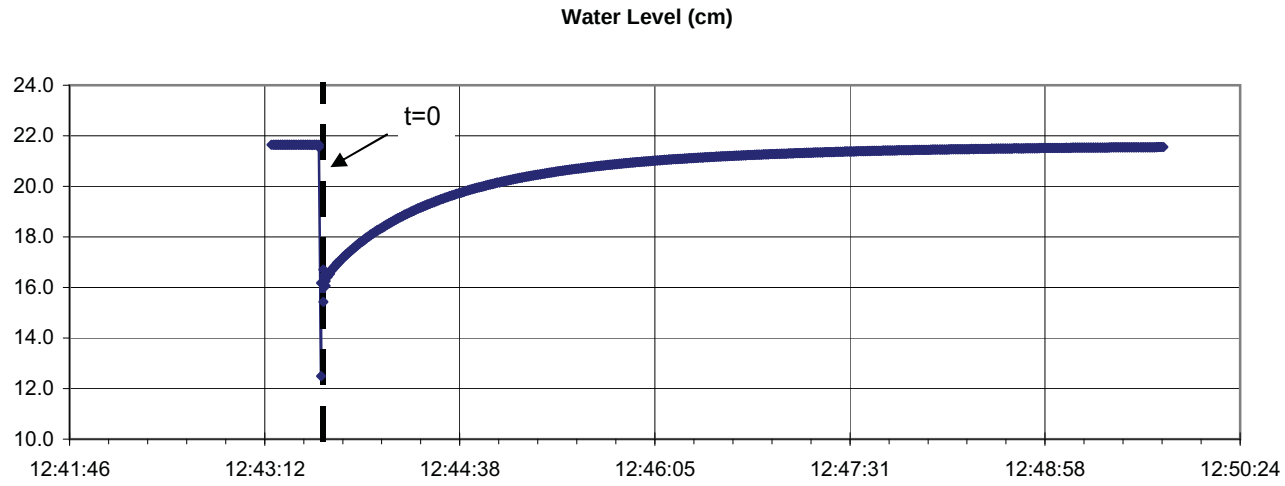
- Data
- Cooper Plot
- 1.00E-10
- 1.00E-05
- 1.00E-01

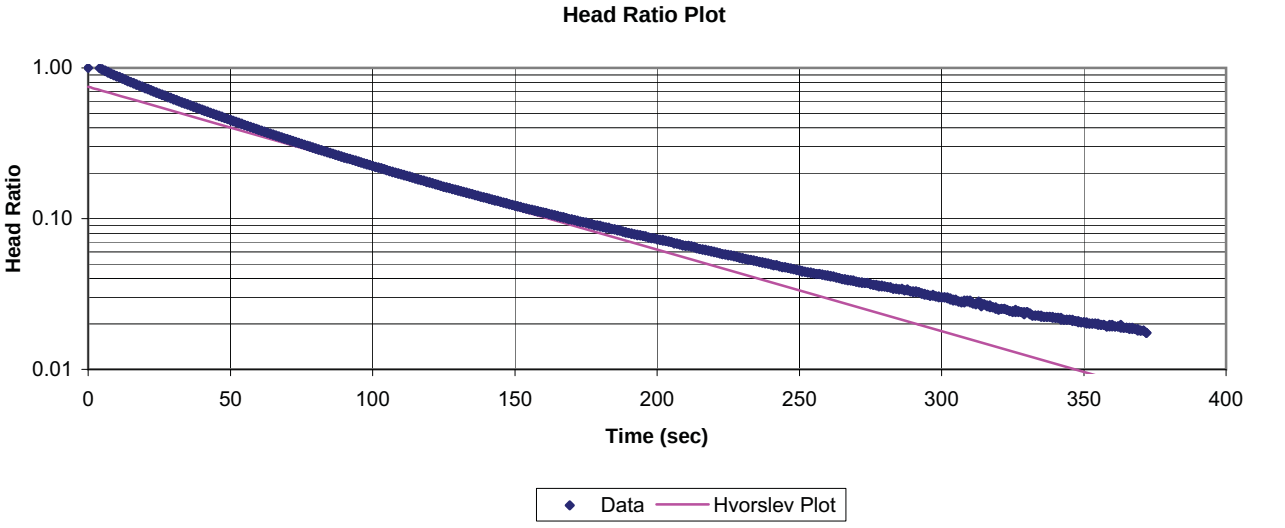
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-06-41M rising	Test date:	16-Sep-06
Instrument type:	In-situ transducer	Test time:	12:43 PM
Zone depth (m):	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):	3.9624	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
Hvorslev intercept:	0.75		
K (m/s):	4.0E-06	Transmissivity (m^2/s)	1.58E-05







Legend

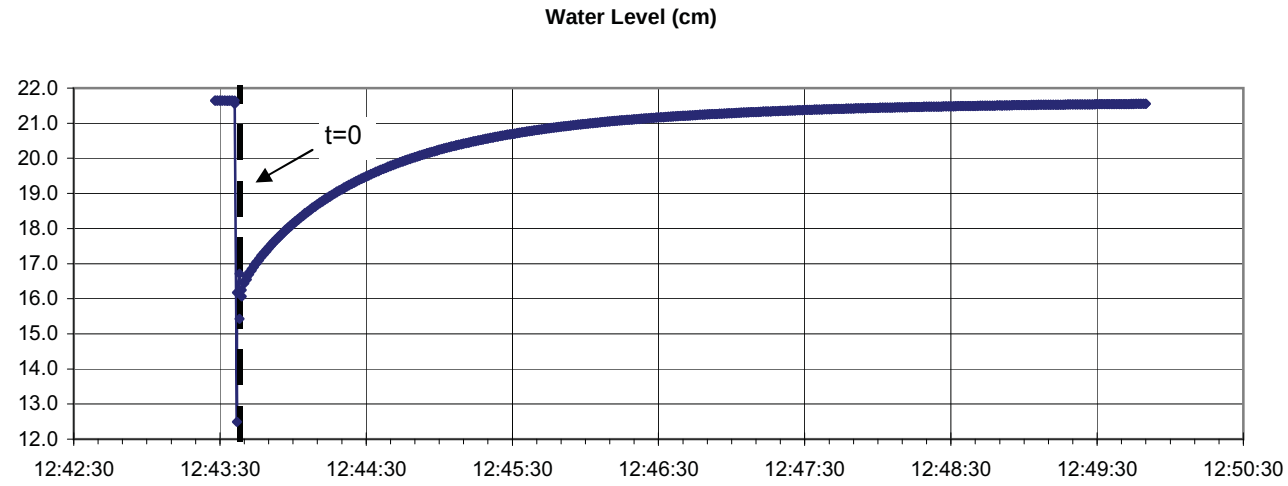
- Data
- Hvorslev Plot

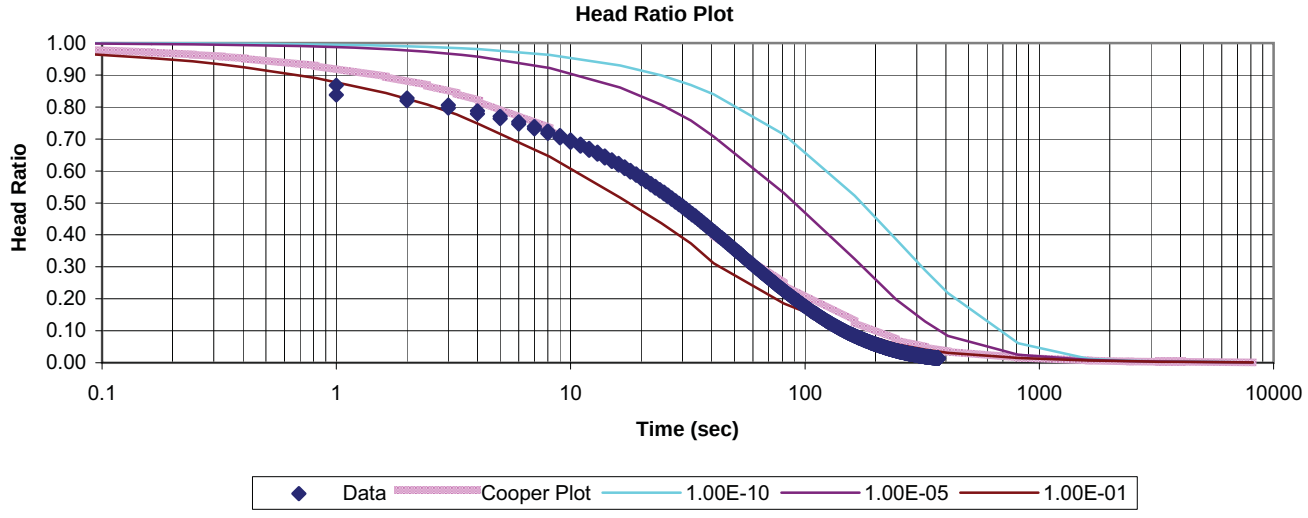
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Cooper Papadopulos Method

Borehole No:	P-06-41M	Test date:	16-Sep-06
Instrument type:	In-situ transducer	Test time:	12:43 PM
Zone depth (m):	19.2024	Screen type:	2 " PVC - 20 slot
Test length (m):	3.9624	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
		Transmissivity (m^2/s):	1.58E-05
K (m/s):	4.0E-06	Alpha:	4.50E-02
Storage:	5.00E-03	Δho (m):	6.21







Legend

- Data
- Cooper Plot
- 1.00E-10
- 1.00E-05
- 1.00E-01

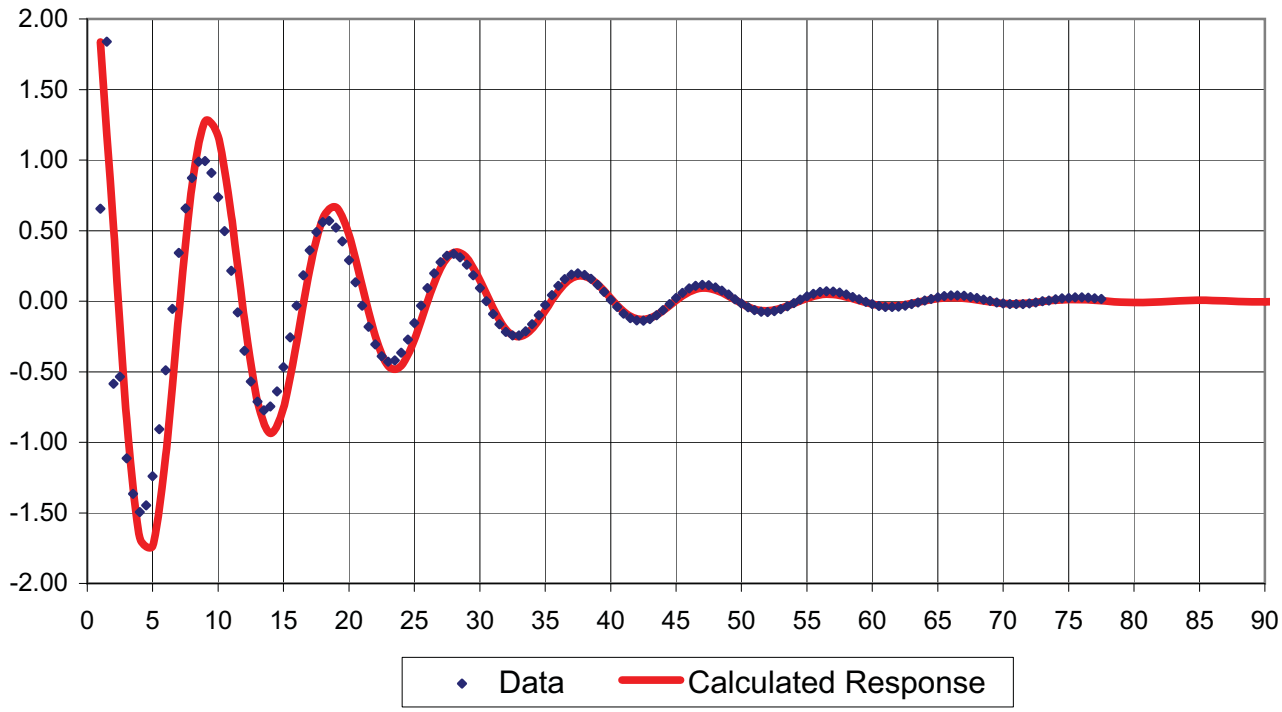
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-07-50D	Test date:	23-Oct-07
Instrument type:	In-situ transducer	Test time:	2:06 AM
Zone depth (m):	45.72	Screen type:	2 " PVC - 20 slot
Test length (m):	3.048	Field technician:	R. Klieforth
Hole diameter (m):	0.1524	Analyst:	H. McCreadie
Riser diameter (m):	0.051		
Depth of screen (m):	45.72	d:	0.10
Depth to water (m):	18.29	angular frequency (per second):	0.66
Height of water predicted(m):	22.00	damping constant:	0.07
Height of water (m):	27.43	Initial amplitude:	2.5
K (m/s):	4.0E-06	Transmissivity (m2/s):	7.62E-03
Storage:	1.00E-06	Time Shift (s):	0.25

Water Level Change





Legend

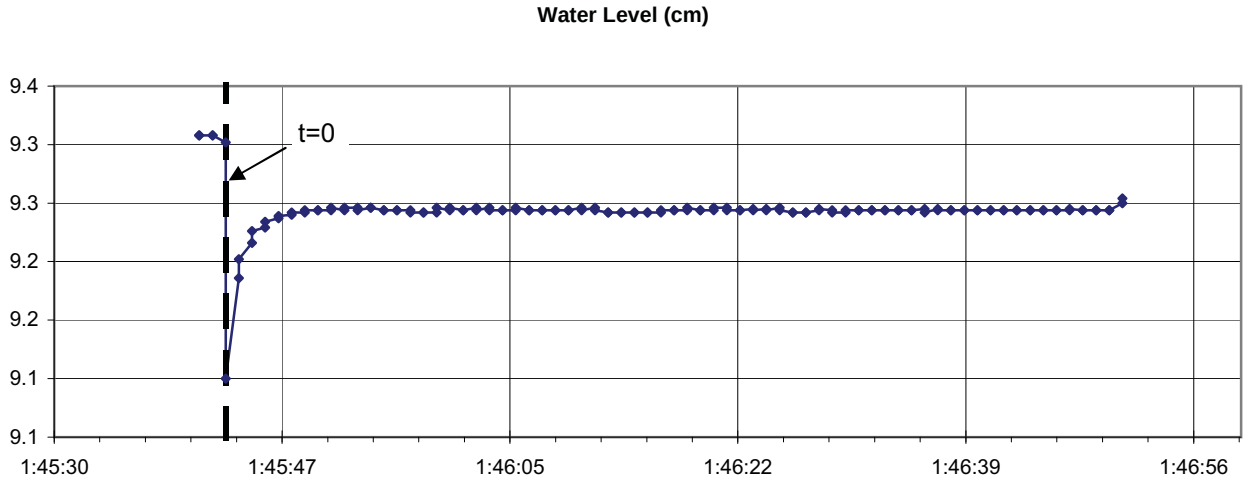
- Data
- Calculated Response

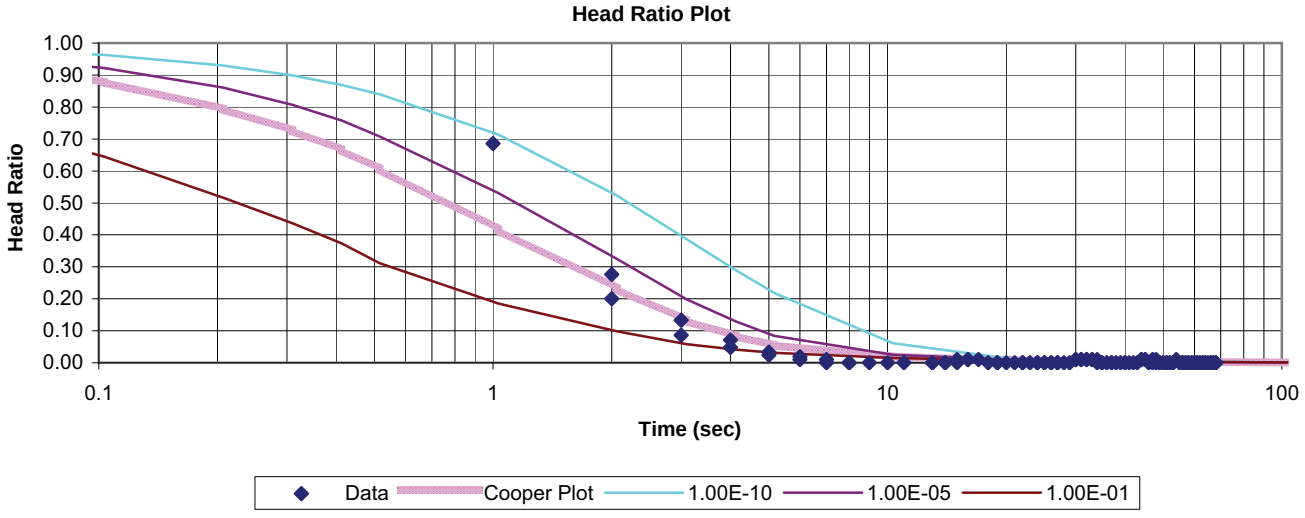
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Cooper Papadopulos Method

Borehole No:	P-07-50S	Test date:	09-Sep-07
Instrument type:	In-situ transducer	Test time:	1:45 AM
Zone depth (m):	21.9456	Screen type:	2 " PVC - 20 slot
Test length (m):	6.2484	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	L. Carson
Riser diameter (m):	0.051		
		Transmissivity (m^2/s):	1.25E-03
K (m/s):	2.0E-04	Alpha:	6.30E-04
Storage:	7.00E-05	Δho (m):	-0.21







Legend

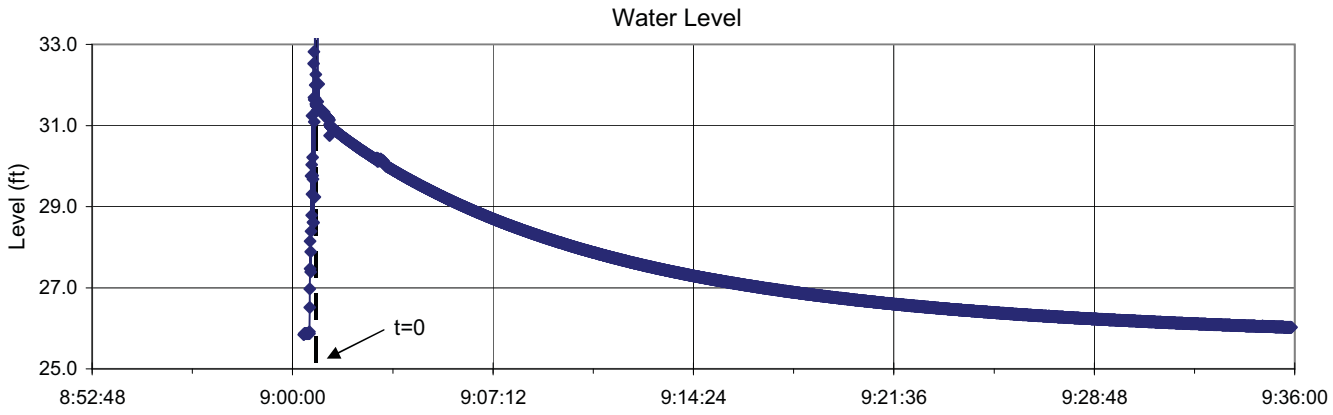
- Data
- Cooper Plot
- 1.00E-10
- 1.00E-05
- 1.00E-01

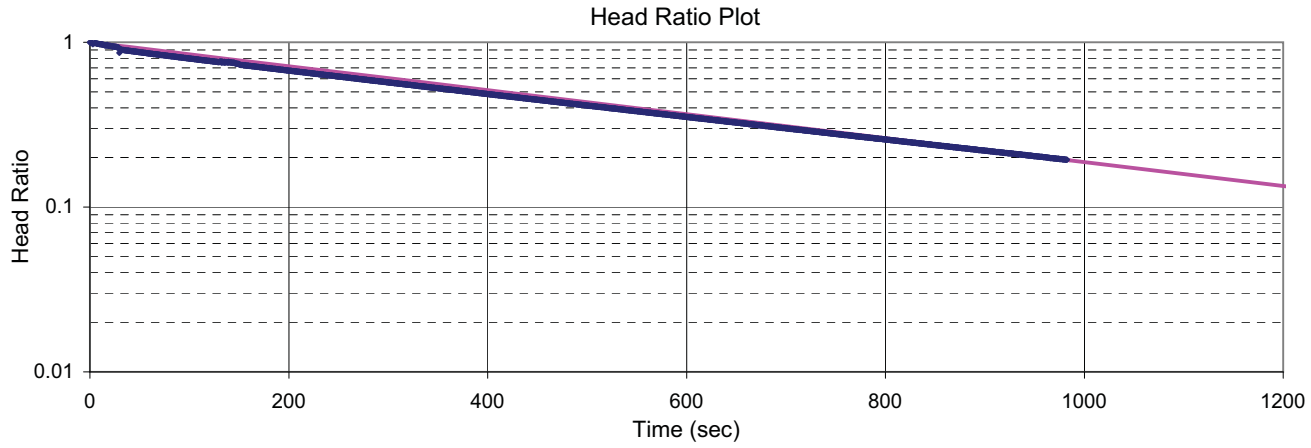
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-07-47D	Test date:	7/4/2008
Instrument type:	In-situ transducer	Test time:	9:00:50
Zone depth (m):	24.23	Screen type:	2 " PVC - 20 slot
Test length (m):	3.84	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	5.50E-07	Transmissivity (m^2/s)	2.11E-06







Legend

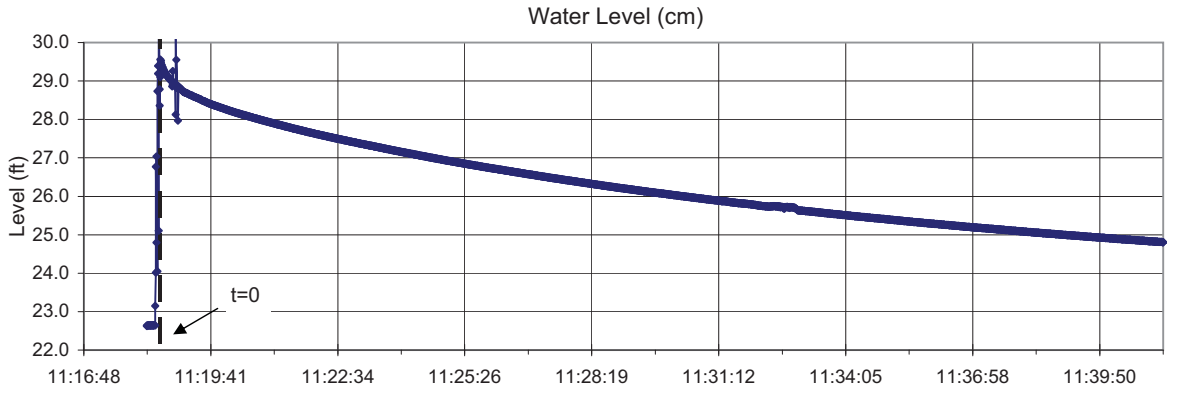
◆ Data — Hvorslev Plot

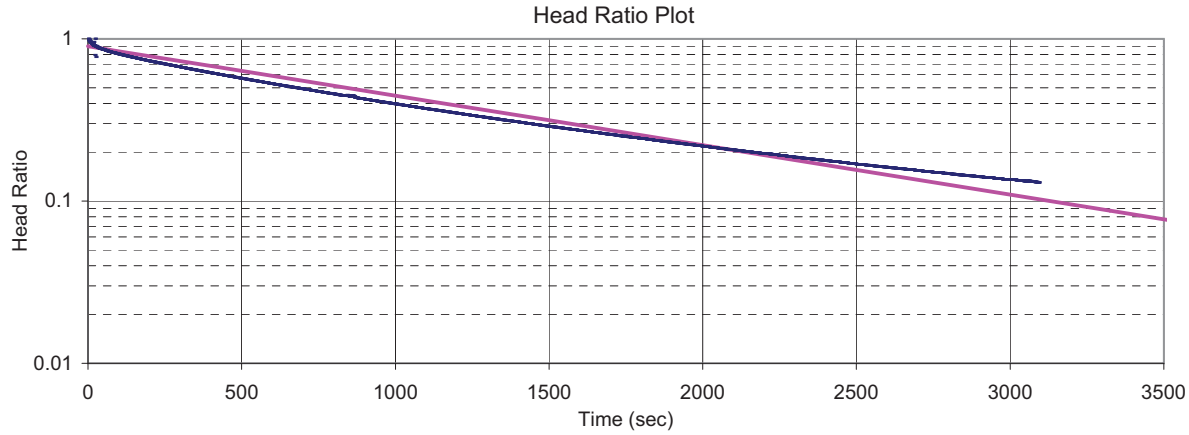
THE pebble PARTNERSHIP

Project No: 7126	Date: Apr 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-07-51D	Test date:	7/5/2008
Instrument type:	In-situ transducer	Test time:	11:18:32
Zone depth (m):	15.36	Screen type:	2 " PVC - 20 slot
Test length (m):	6.22	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.90		
K (m/s):	1.60E-07	Transmissivity (m^2/s)	9.95E-07







Legend

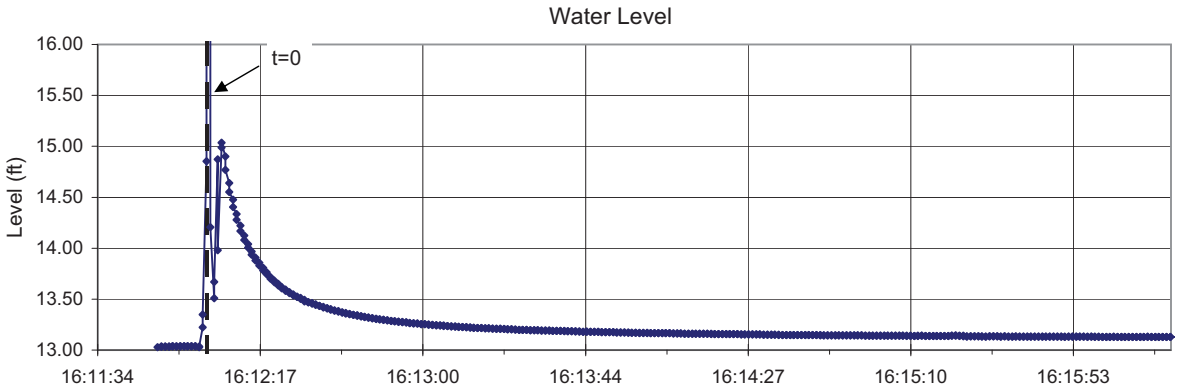
- Data
- Hvorslev Plot

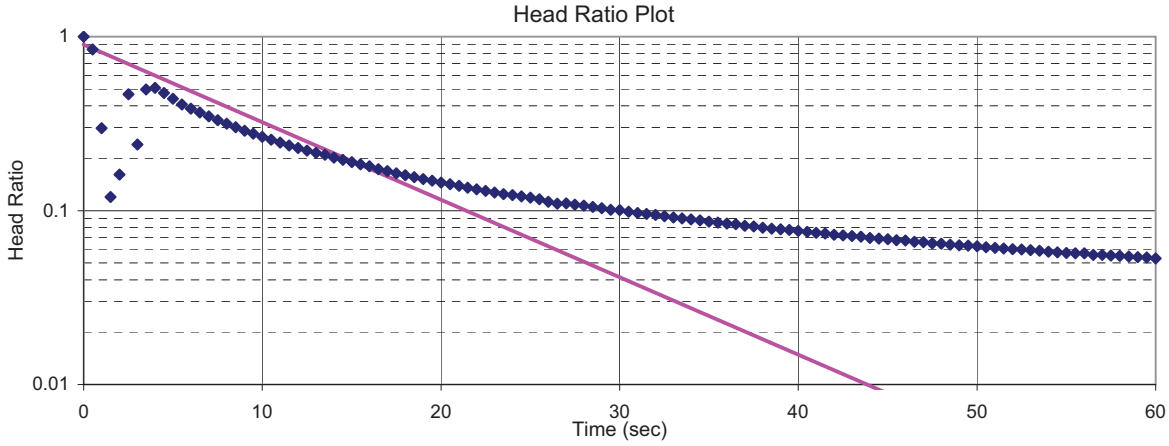
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-07-51S	Test date:	7/4/2008
Instrument type:	In-situ transducer	Test time:	16:12:03
Zone depth (m):	6.10	Screen type:	2 " PVC - 20 slot
Test length (m):	3.66	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.90		
K (m/s):	3.50E-05	Transmissivity (m^2/s)	1.28E-04







Legend

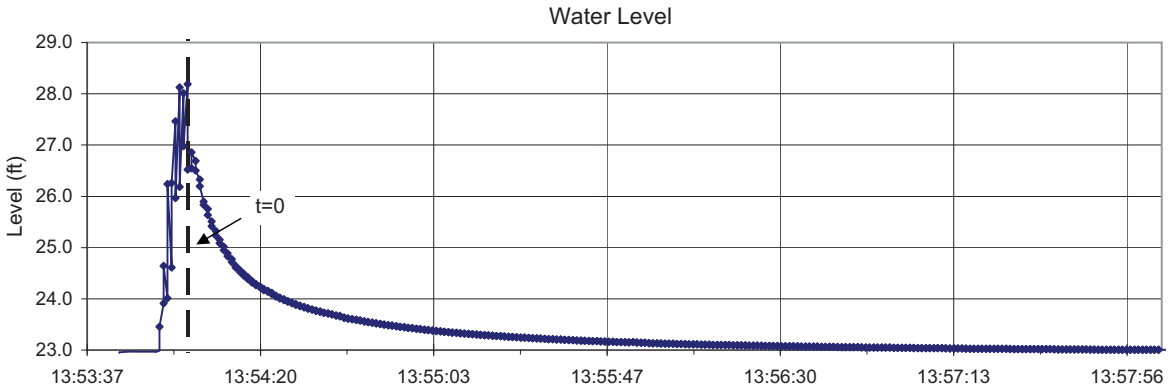
◆ Data — Hvorslev Plot

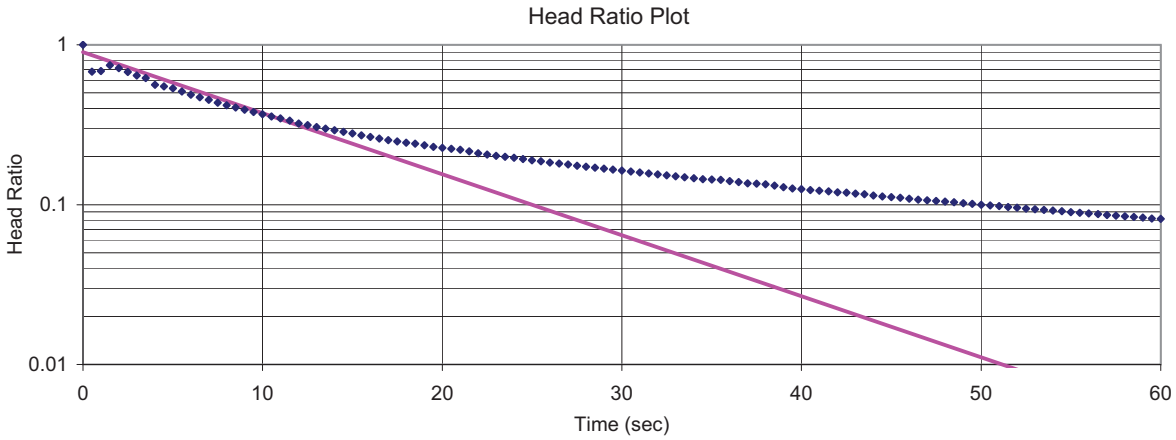
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-07-52D	Test date:	7/5/2008
Instrument type:	In-situ transducer	Test time:	13:54:02
Zone depth (m):	18.29	Screen type:	2 " PVC - 20 slot
Test length (m):	4.66	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.90		
K (m/s):	2.50E-05	Transmissivity (m^2/s)	1.17E-04







Legend

◆ Data

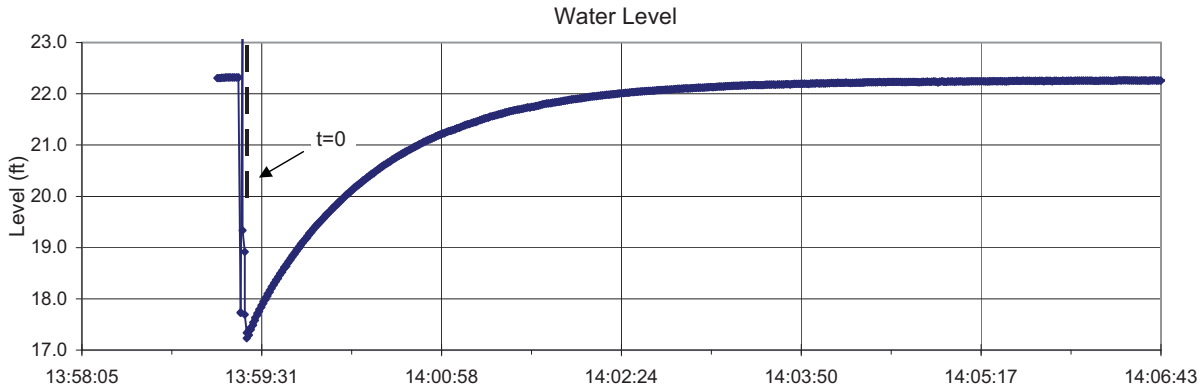
— Hvorslev Plot

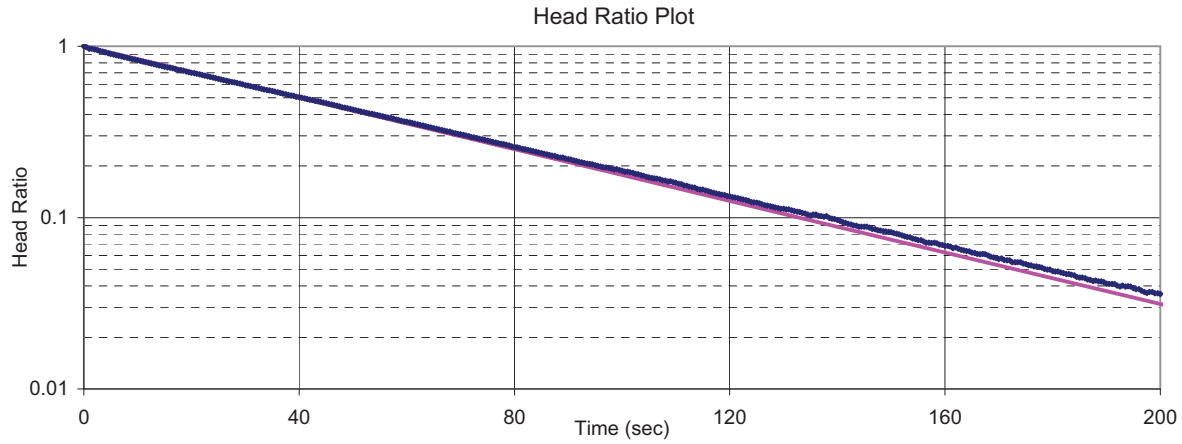
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-55D	Test date:	7/2/2008
Instrument type:	In-situ transducer	Test time:	13:59:24
Zone depth (m):	35.15	Screen type:	2 " PVC - 20 slot
Test length (m):	3.58	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	6.00E-06	Transmissivity (m^2/s)	2.15E-05







Legend

◆ Data

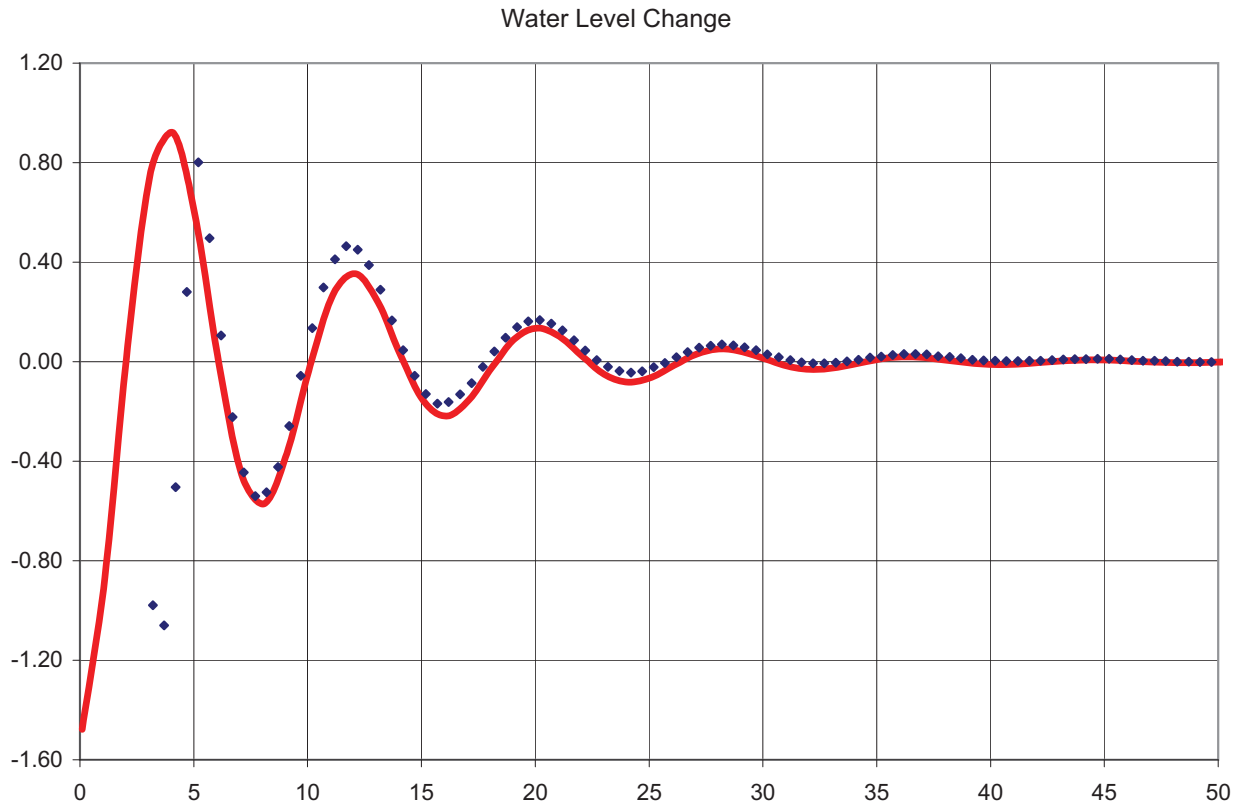
— Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-55S	Test date:	7/2/2008
Instrument type:	In-situ transducer	Test time:	12:40:28
Zone depth (m):	19.81	Screen type:	2 " PVC - 20 slot
Test length (m):	6.86	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	13.88	d:	0.15
Depth to water (m):	7.18	angular frequency (per second):	0.77
Height of water predicted(m):	16.00	damping constant:	0.12
Height of water (m):	6.70	Initial amplitude:	-1.5
K (m/s):	3.0E-04	Transmissivity (m2/s):	2.06E-03
Storage:	4.00E-03	Time Shift (s):	3.20





Legend

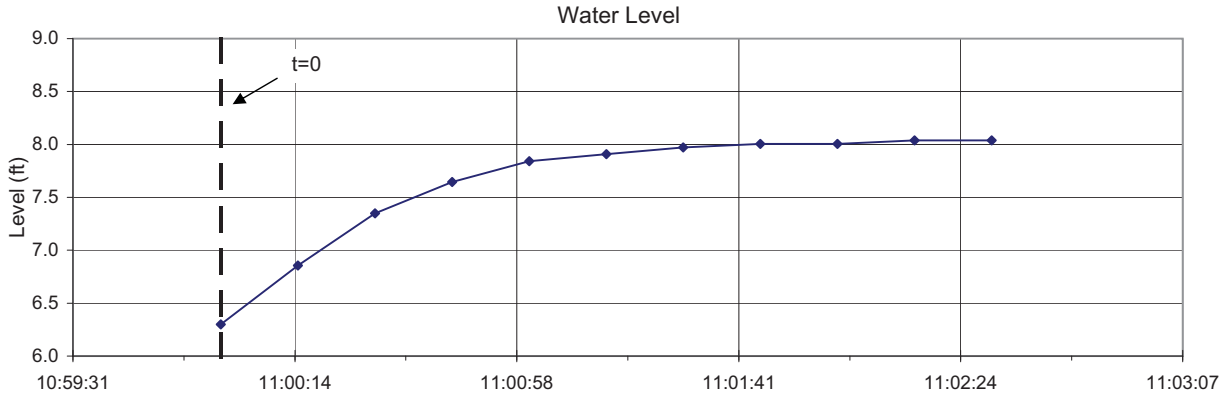
- Data
- Calculated Response

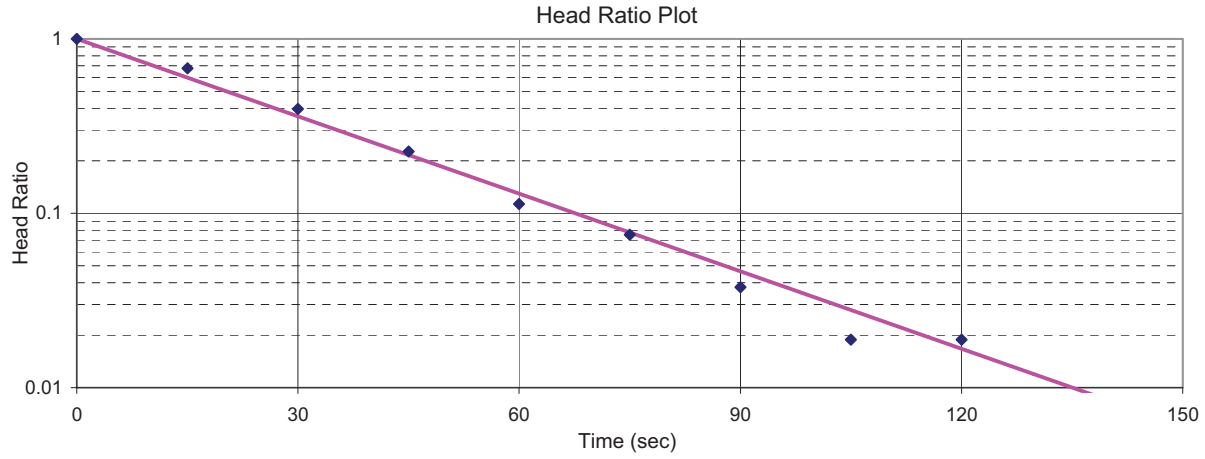
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-56D	Test date:	6/28/2008
Instrument type:	In-situ transducer	Test time:	11:00:00
Zone depth (m):	42.67	Screen type:	2 " PVC - 20 slot
Test length (m):	3.51	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	1.20E-05	Transmissivity (m^2/s)	4.21E-05







Legend

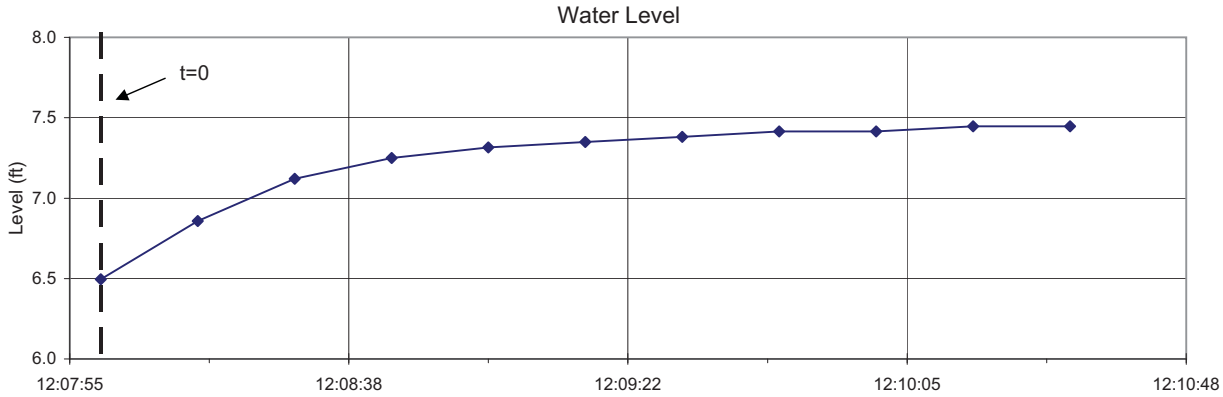
- Data
- Hvorslev Plot

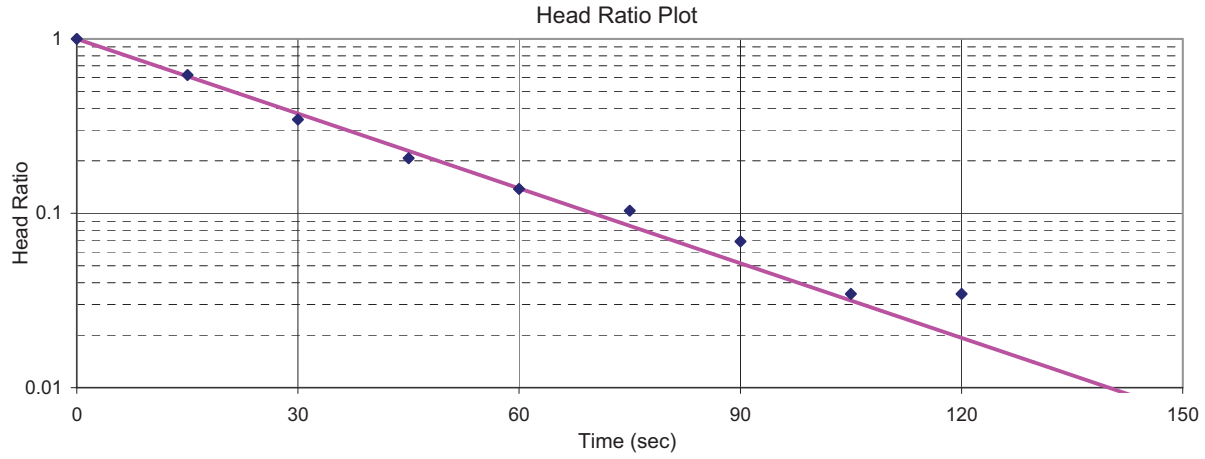
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-56M	Test date:	6/28/2008
Instrument type:	In-situ transducer	Test time:	12:08:00
Zone depth (m):	29.78	Screen type:	2 " PVC - 20 slot
Test length (m):	4.27	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	1.00E-05	Transmissivity (m^2/s)	4.27E-05







Legend

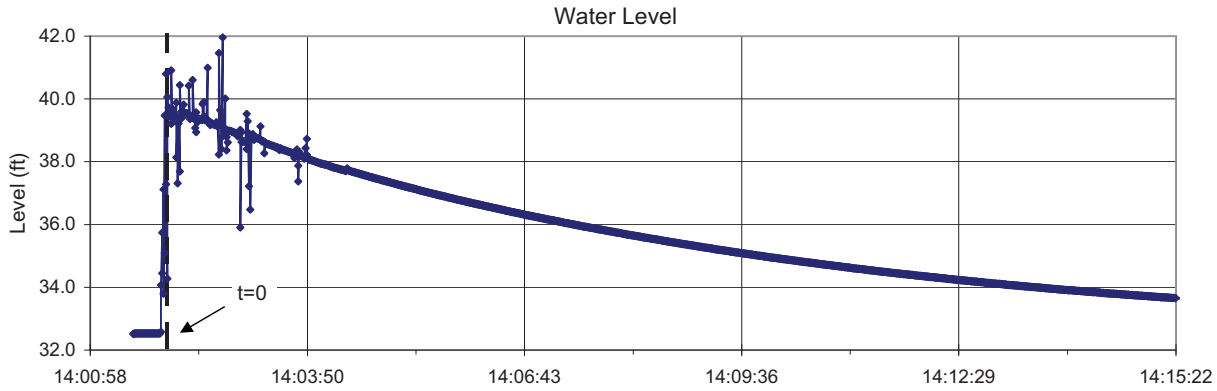
- Data
- Hvorslev Plot

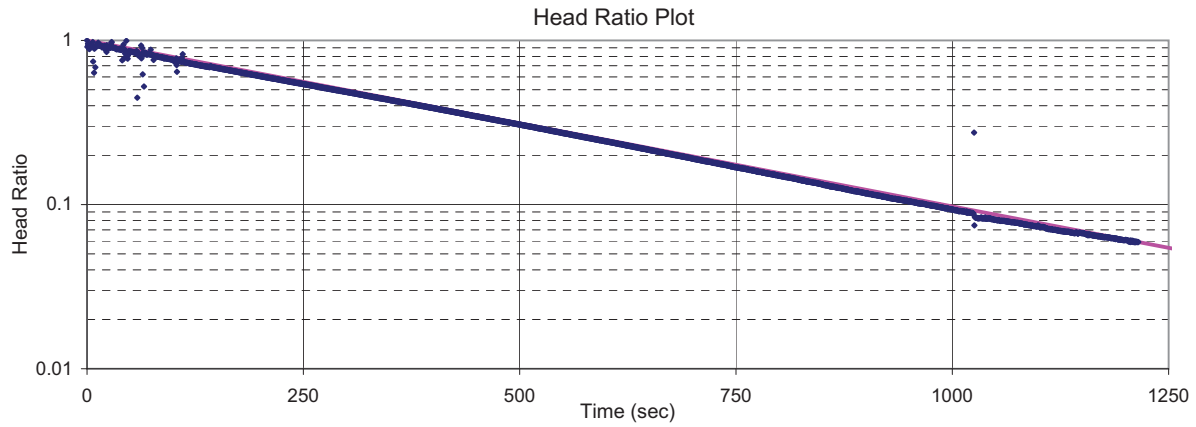
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-57D	Test date:	6/29/2008
Instrument type:	In-situ transducer	Test time:	14:01:59
Zone depth (m):	73.66	Screen type:	2 " PVC - 20 slot
Test length (m):	4.17	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	7.20E-07	Transmissivity (m^2/s)	3.00E-06







Legend

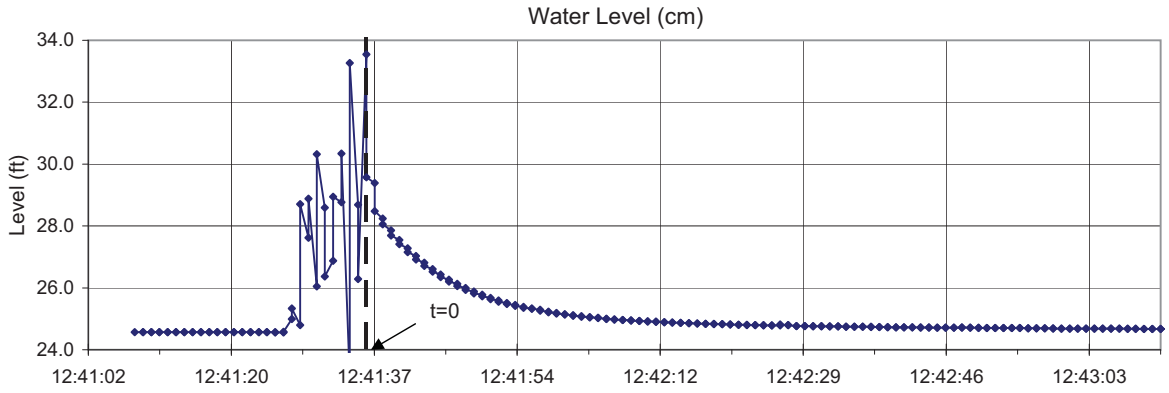
- Data
- Hvorslev Plot

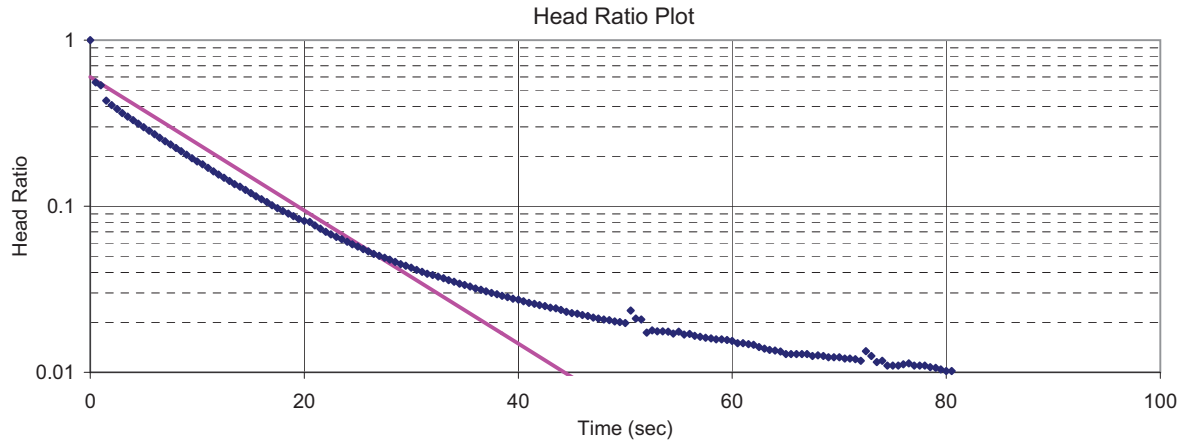
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-58D	Test date:	7/3/2008
Instrument type:	In-situ transducer	Test time:	12:41:36
Zone depth (m):	32.10	Screen type:	2 " PVC - 20 slot
Test length (m):	3.91	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.60		
K (m/s):	3.00E-05	Transmissivity (m^2/s)	1.17E-04







Legend

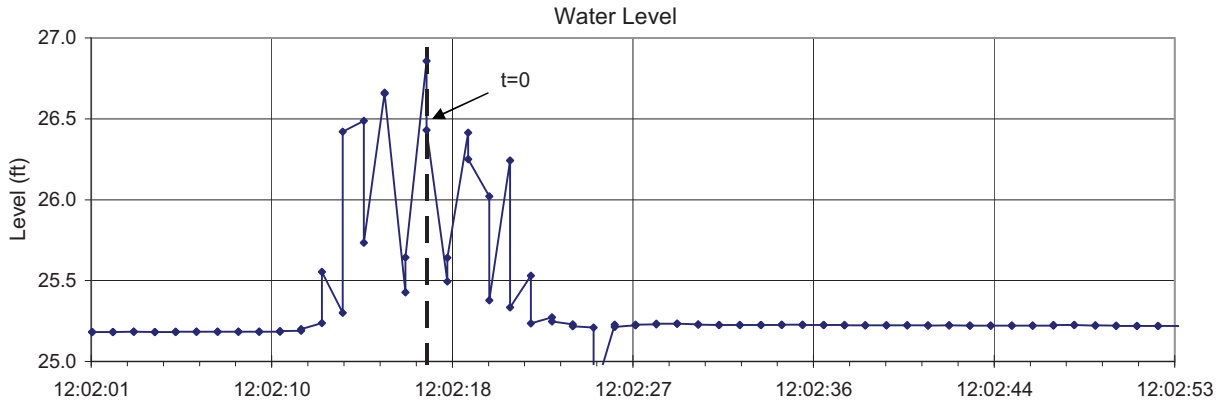
- Data
- Hvorslev Plot

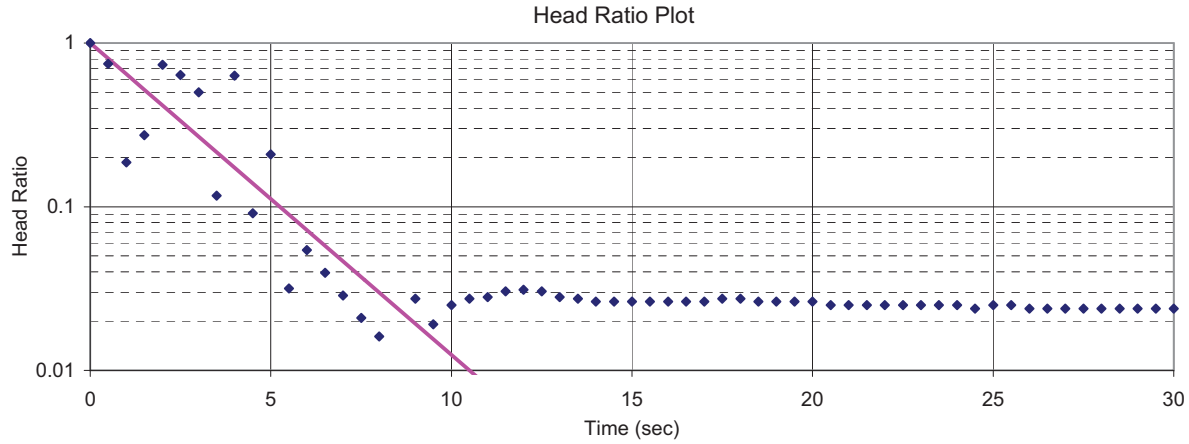
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-58M	Test date:	7/3/2008
Instrument type:	In-situ transducer	Test time:	12:02:17
Zone depth (m):	18.29	Screen type:	2 " PVC - 20 slot
Test length (m):	8.28	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	8.00E-05	Transmissivity (m^2/s)	6.63E-04







Legend

- Data
- Hvorslev Plot

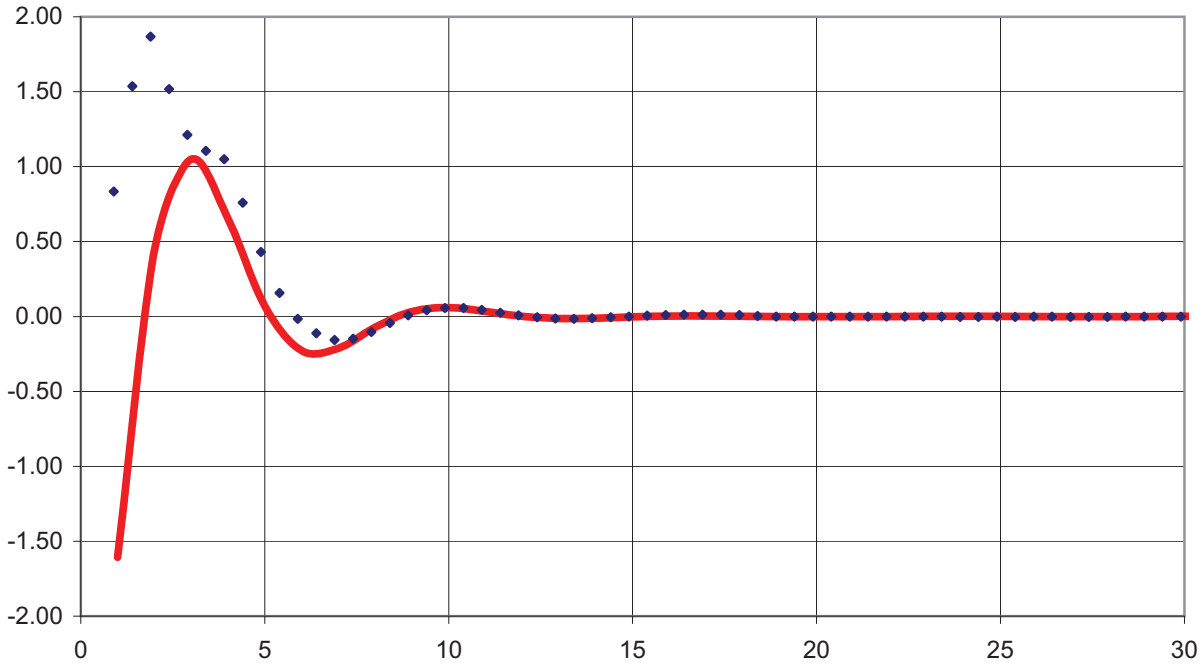
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-59D	Test date:	29-Jun-08
Instrument type:	In-situ transducer	Test time:	10:54 AM
Zone depth (m):	32.028	Screen type:	2 " PVC - 20 slot
Test length (m):	7.696	Field technician:	
Hole diameter (m):	0.102	Analyst:	A.U.B
Riser diameter (m):	0.051		
Depth of screen (m):	25.09	d:	0.42
Depth to water (m):	6.98	angular frequency (per second):	0.91
Height of water predicted(m):	9.70	damping constant:	0.42
Height of water (m):	18.11	Initial amplitude:	-4
K (m/s):	1.5E-04	Transmissivity (m2/s):	1.15E-03
Storage:	1.50E-03	Time Shift (s):	0.90

Water Level Change





Legend

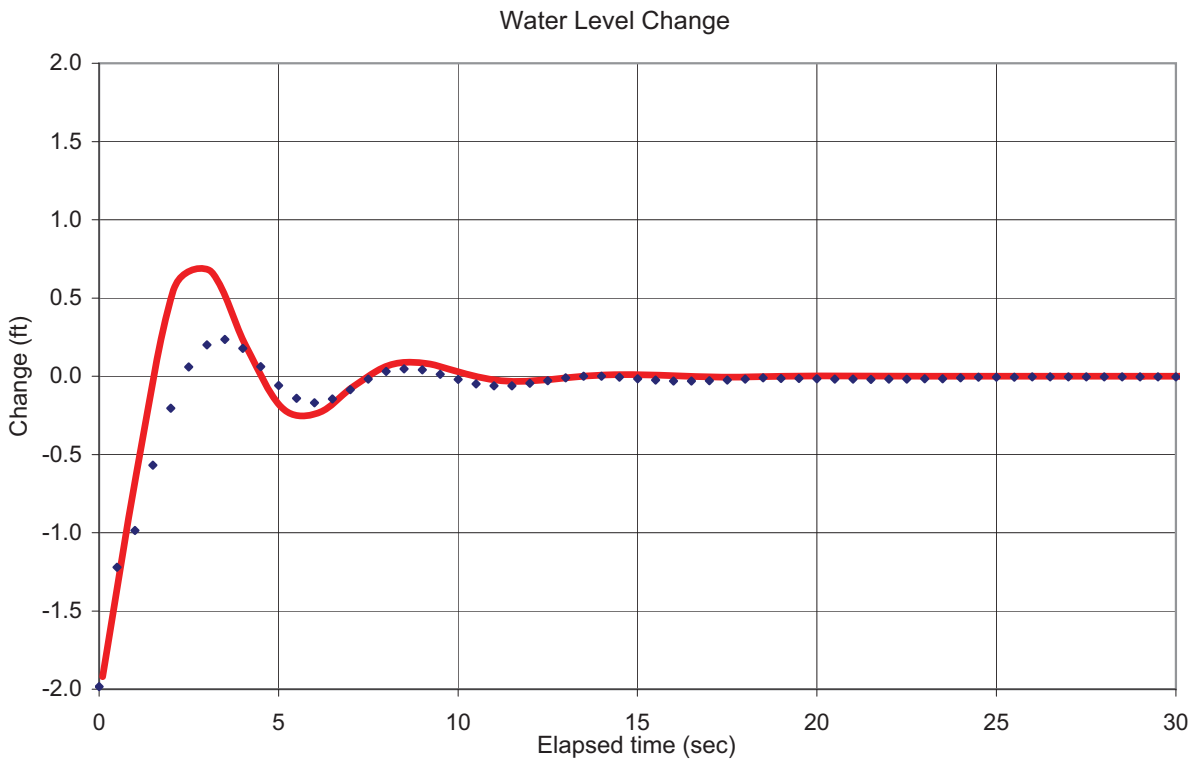
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-59S	Test date:	29-Jun-08
Instrument type:	In-situ transducer	Test time:	10:19:44
Zone depth (m):	14.54	Screen type:	2 " PVC - 20 slot
Test length (m):	2.04	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	12.65	d:	0.32
Depth to water (m):	4.89	angular frequency (per second):	1.05
Theoretrical height of w. (m):	8.00	damping constant:	0.35
Actual height of water (m):	7.75	Initial amplitude:	-2
K (m/s):	8.0E-04	Transmissivity (m2/s):	1.63E-03
Storage:	1.00E-03	Time Shift (s):	0.00





Legend

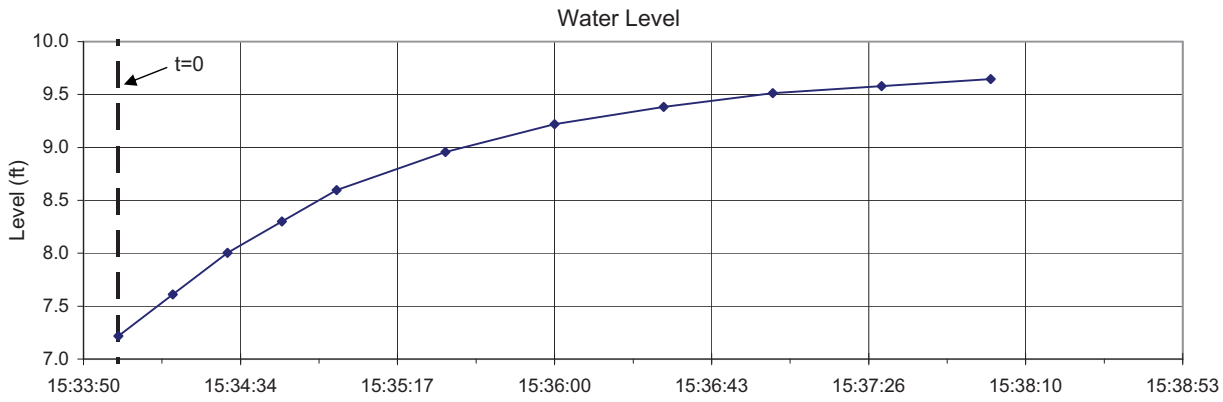
- Data
- Calculated Response

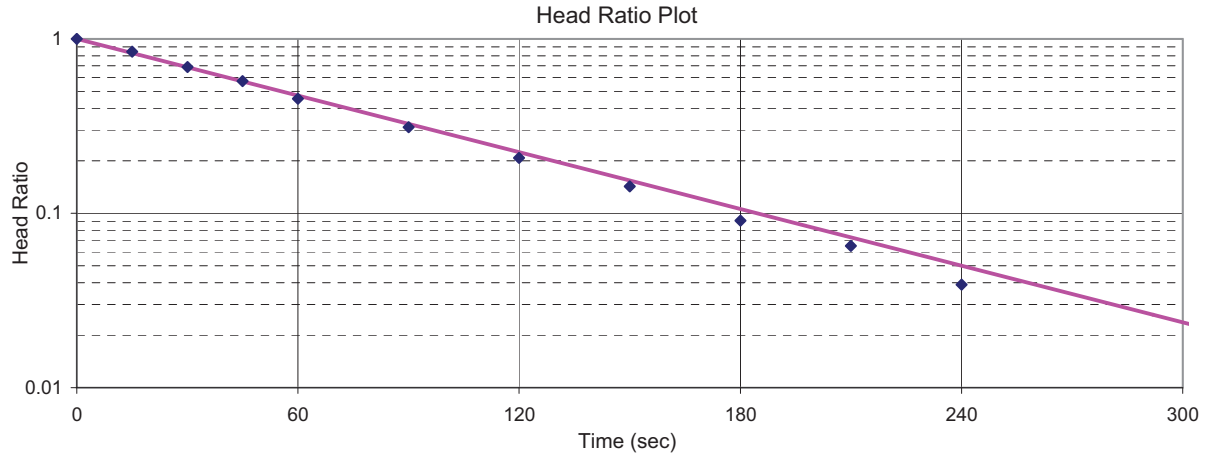
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-60D	Test date:	6/28/2008
Instrument type:	In-situ transducer	Test time:	15:34:00
Zone depth (m):	25.60	Screen type:	2 " PVC - 20 slot
Test length (m):	9.75	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	2.00E-06	Transmissivity (m^2/s)	1.95E-05







Legend

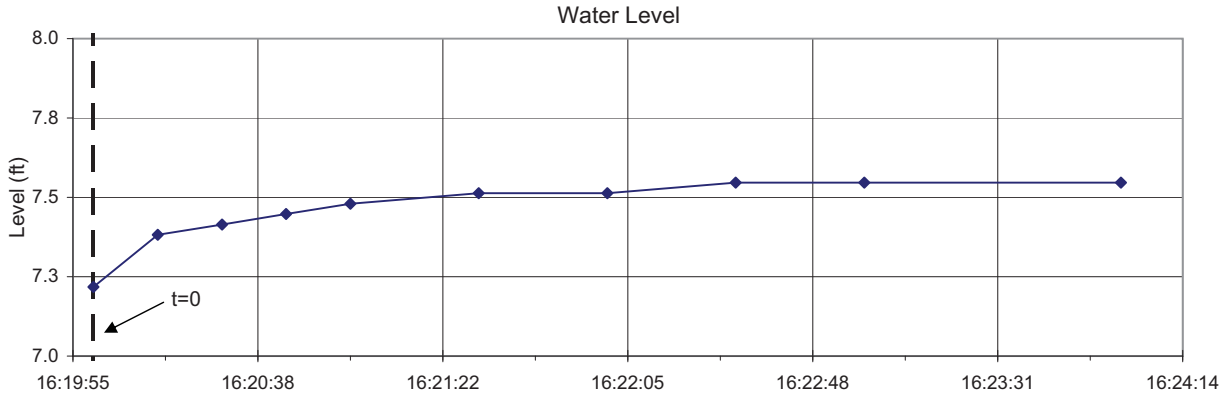
- Data
- Hvorslev Plot

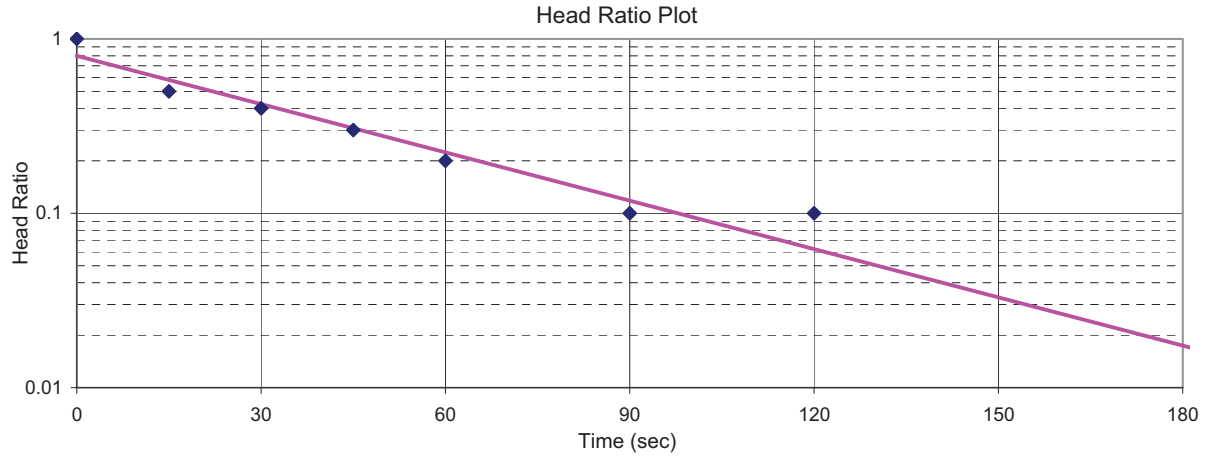
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-60S	Test date:	6/28/2008
Instrument type:	In-situ transducer	Test time:	16:20:00
Zone depth (m):	9.91	Screen type:	2 " PVC - 20 slot
Test length (m):	3.20	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.80		
K (m/s):	8.00E-06	Transmissivity (m^2/s)	2.56E-05







Legend

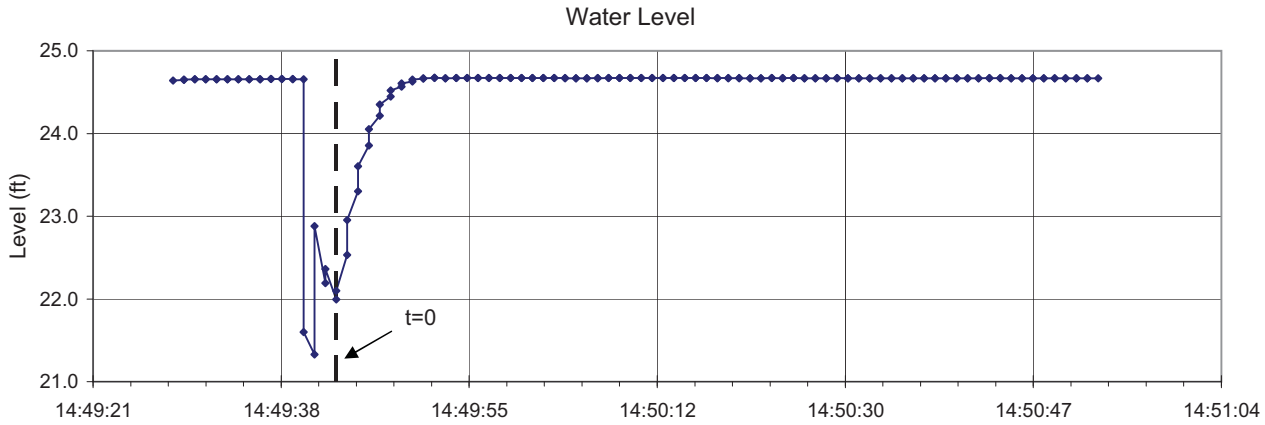
- Data
- Hvorslev Plot

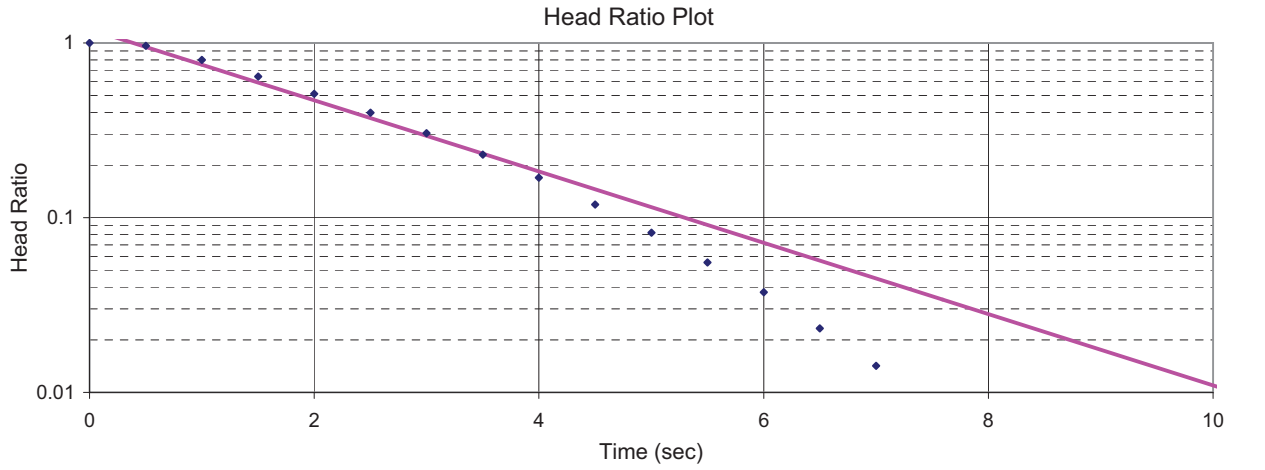
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-61D	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	2:49 PM
Zone depth (m):	27.89	Screen type:	2 " PVC - 20 slot
Test length (m):	6.00	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.2		
K (m/s):	1.10E-04	Transmissivity (m^2/s)	6.61E-04







Legend

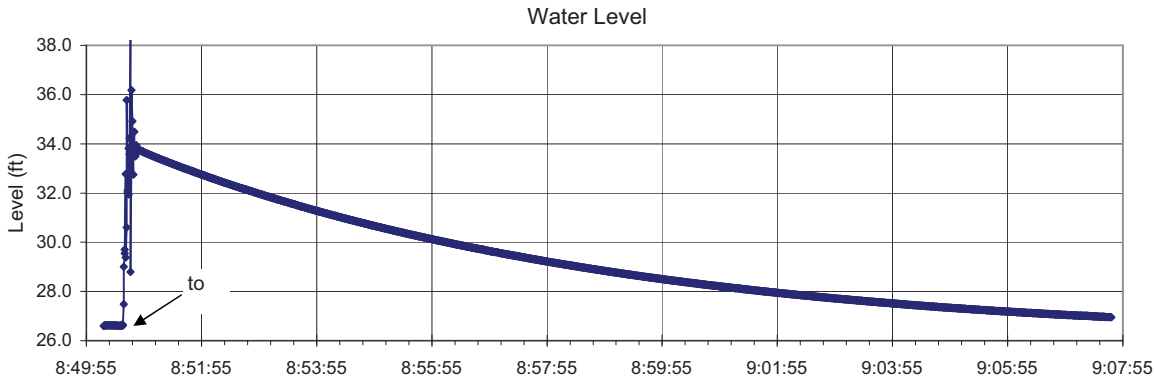
- Data
- Hvorslev Plot

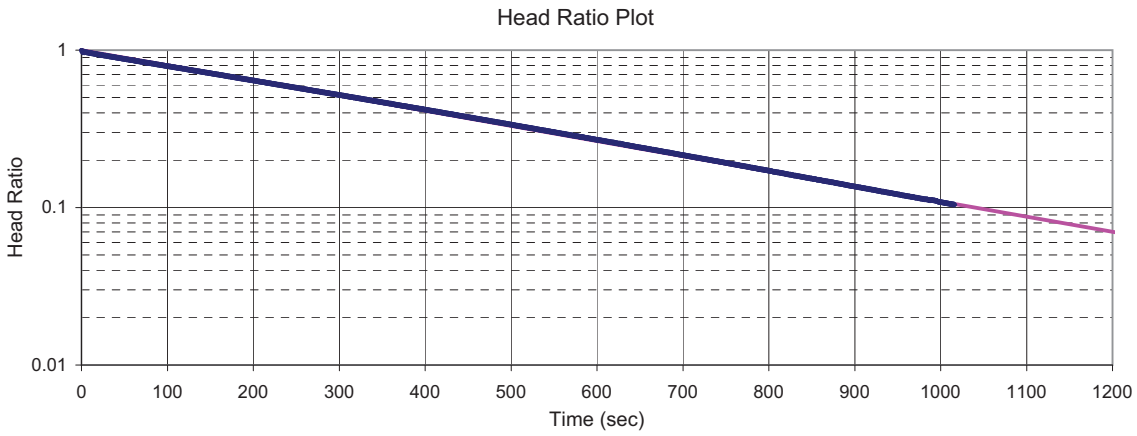
THE pebble PARTNERSHIP

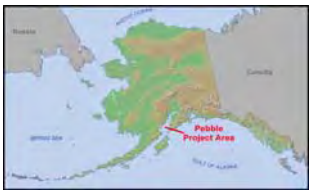
Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-62D	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	8:50:47
Zone depth (m):	93.60	Screen type:	2 " PVC - 20 slot
Test length (m):	3.76	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	A.U.B.
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	7.40E-07	Transmissivity (m^2/s)	2.78E-06







Legend

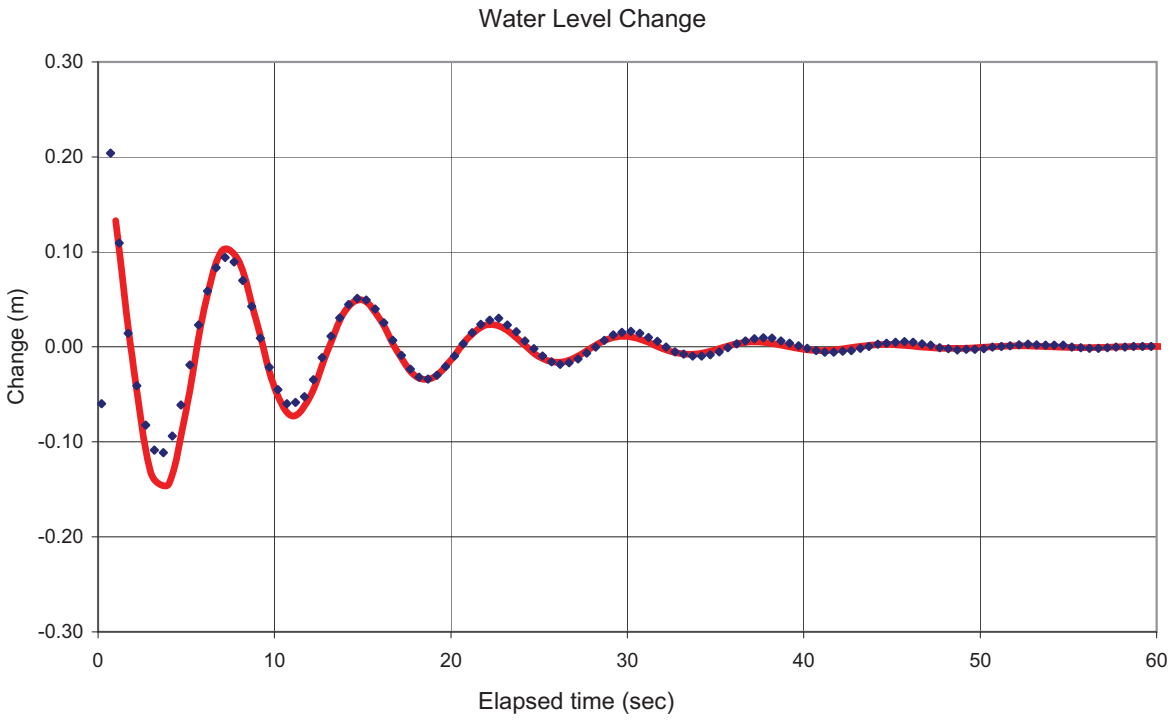
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-62M	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	9:50 AM
Zone depth (m):	24.38	Screen type:	2 " PVC - 20 slot
Test length (m):	4.48	Field technician:	SLB
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	20.48	d:	0.12
Depth to water (m):	9.86	angular frequency (per second):	0.84
Height of water theoretical (m):	13.70	damping constant:	0.10
Height of water actual (m):	10.62	Initial amplitude:	0.22
K (m/s):	9.0E-04	Transmissivity (m2/s):	4.03E-03
Storage:	1.00E-03	Time Shift (s):	-1.30





Legend

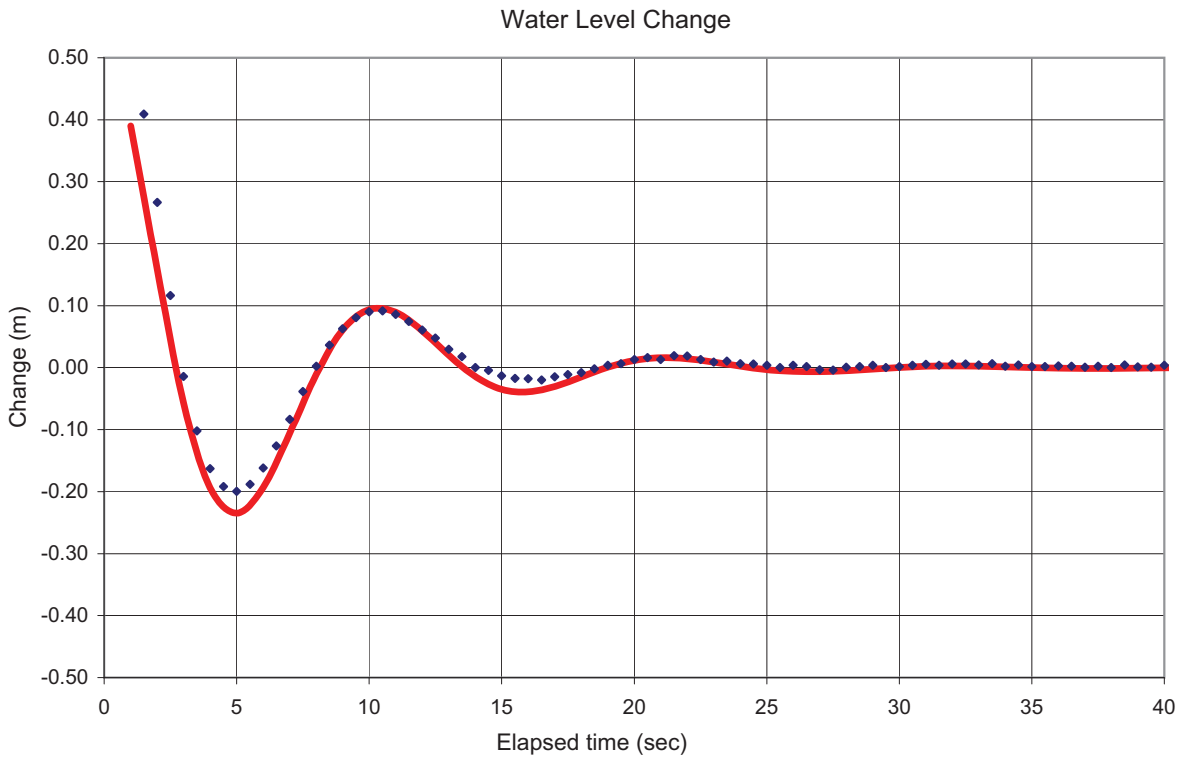
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date: april 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-63D	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	14:07:00 PM
Zone depth (m):	39.62	Screen type:	2 " PVC - 20 slot
Test length (m):	9.30	Field technician:	SLB
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	32.00	d:	0.27
Depth to water (m):	7.53	angular frequency (per second):	0.58
Height of w. theoretical (m):	27.00	damping constant:	0.16
Height of water actual (m):	24.47	Initial amplitude:	0.55
K (m/s):	1.80E-04	Transmissivity (m2/s):	1.67E-03
Storage:	5.00E-05	Time Shift (s):	-2.50





Legend

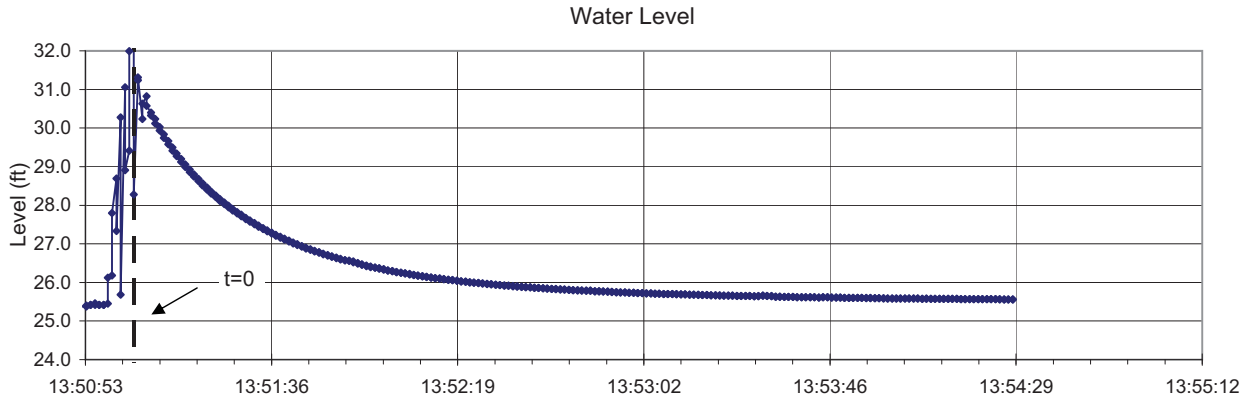
- Data
- Calculated Response

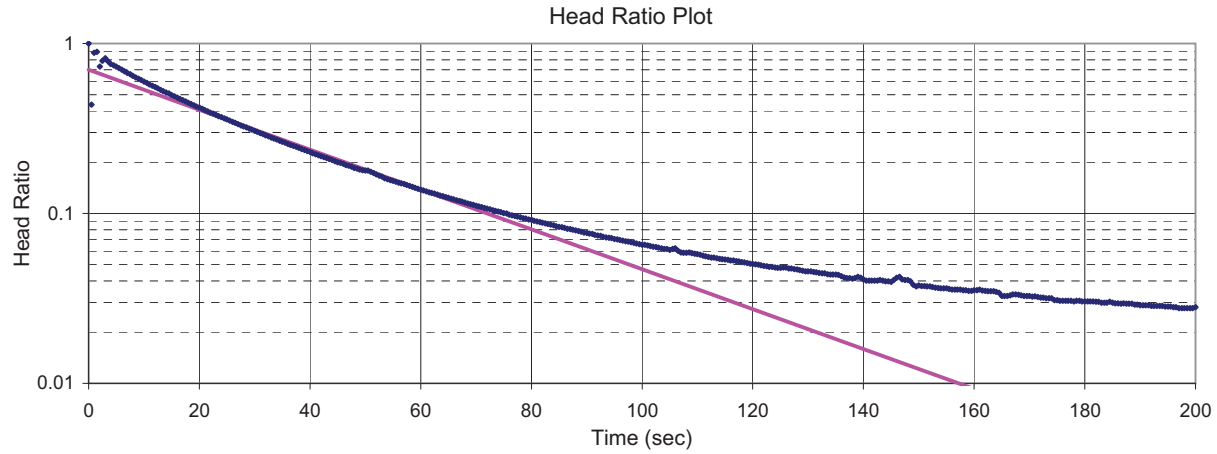
THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-63M	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	13:51:04
Zone depth (m):	25.30	Screen type:	2 " PVC - 20 slot
Test length (m):	4.42	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.70		
K (m/s):	8.00E-06	Transmissivity (m^2/s)	3.54E-05







Legend

◆ Data

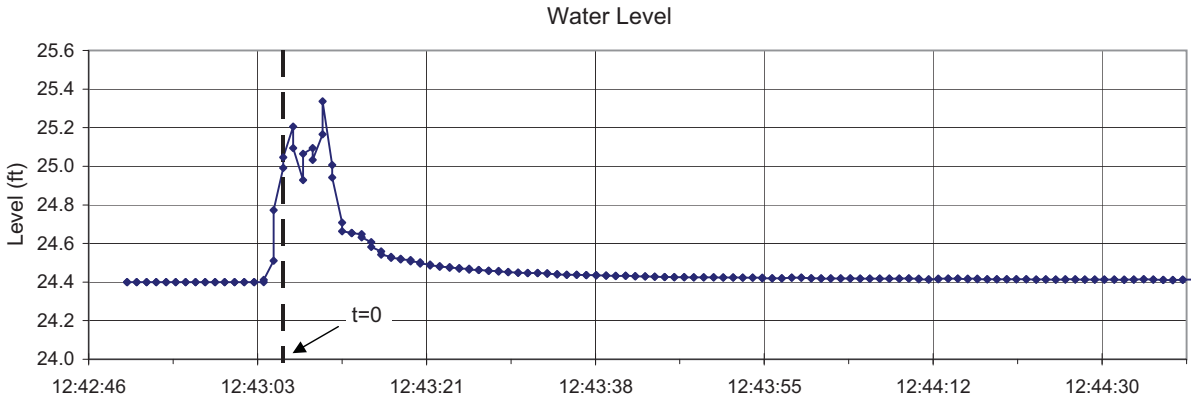
— Hvorslev Plot

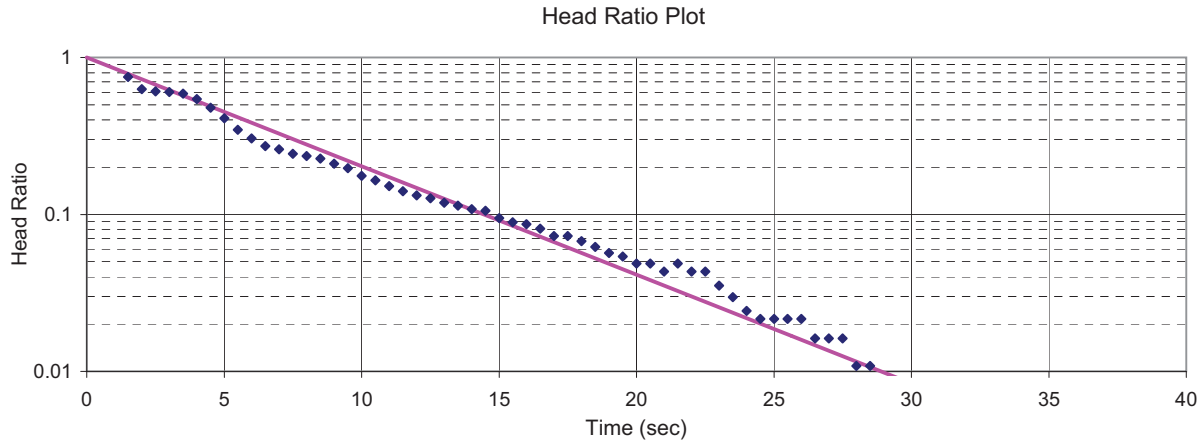
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-63S	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	12:43:06
Zone depth (m):	13.72	Screen type:	2 " PVC - 20 slot
Test length (m):	3.20	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	6.00E-05	Transmissivity (m^2/s)	1.92E-04







Legend

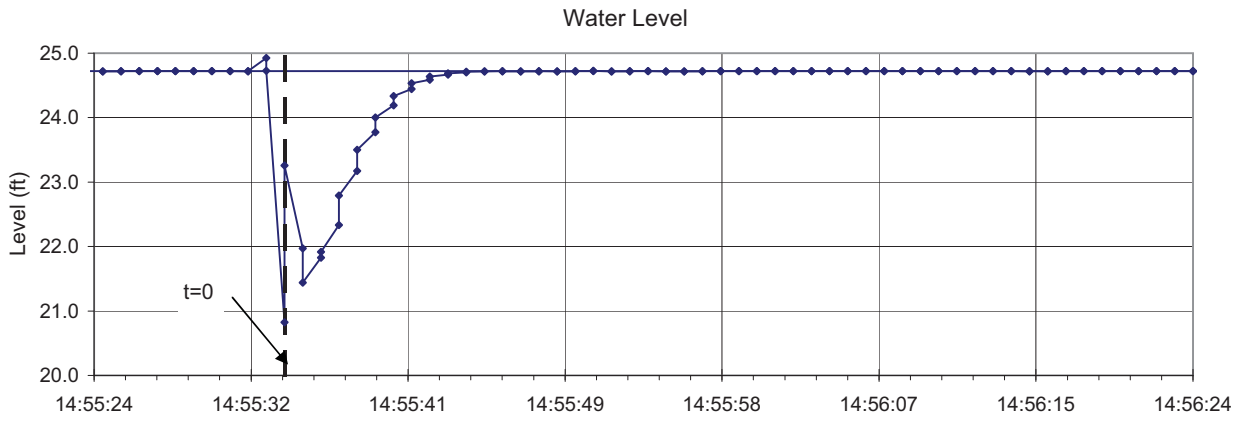
- Data
- Hvorslev Plot

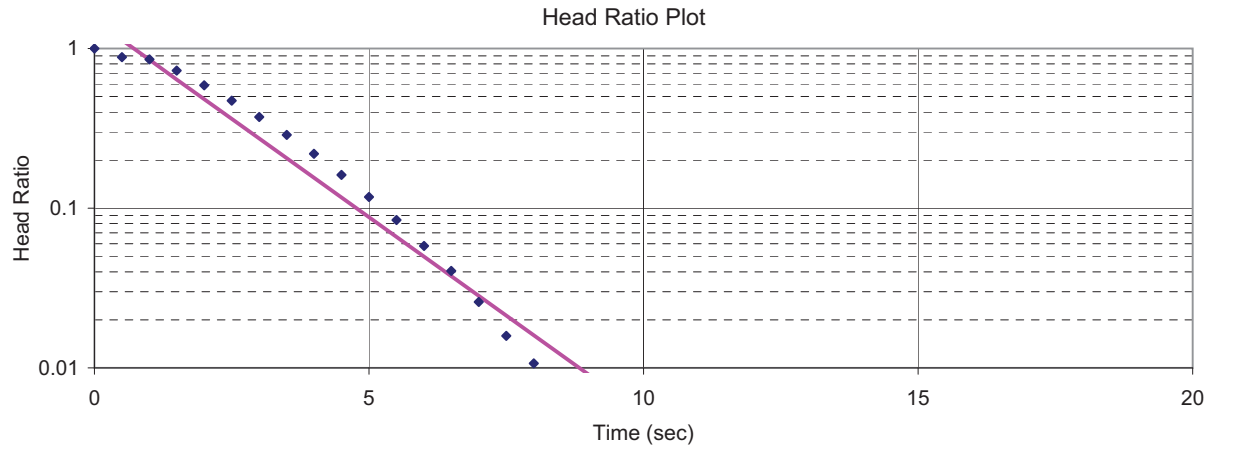
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-64D	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	14:55:34
Zone depth (m):	21.18	Screen type:	2 " PVC - 20 slot
Test length (m):	6.86	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RV
Hvorslev intercept:	1.5		
K (m/s):	1.20E-04	Transmissivity (m^2/s)	8.23E-04







Legend

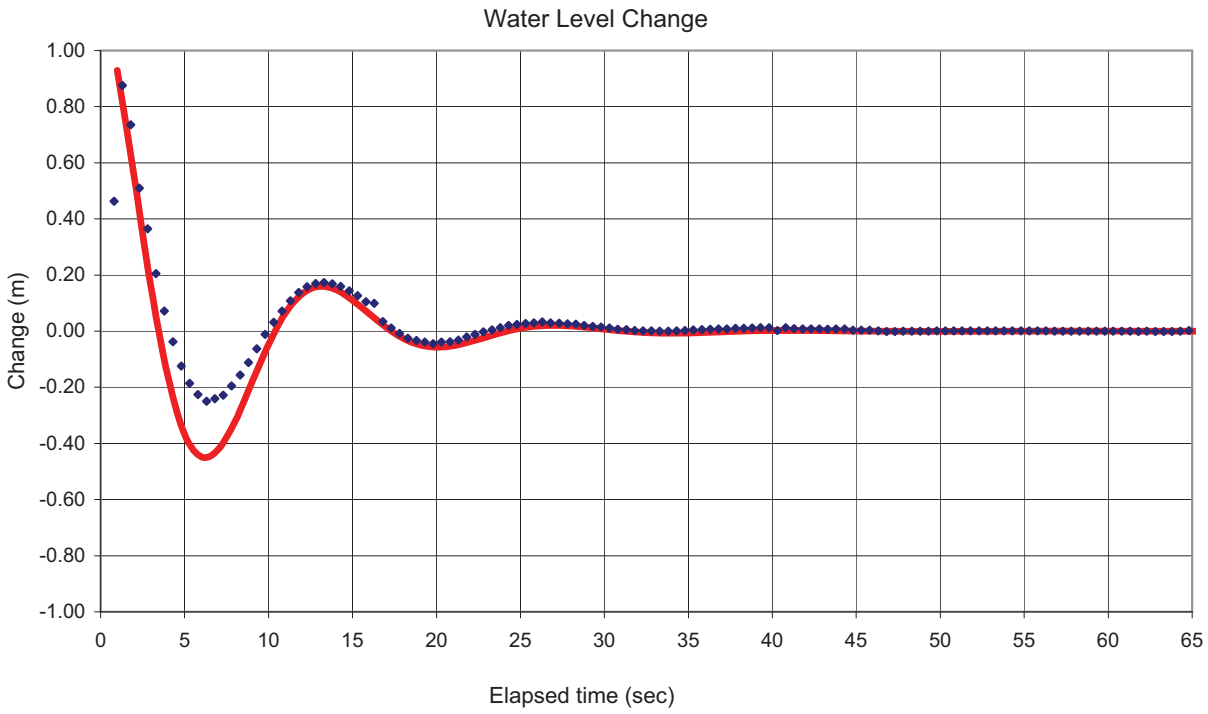
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-65D	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	9:50 AM
Zone depth (m):	57.91	Screen type:	2 " PVC - 20 slot
Test length (m):	5.74	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	52.93	d:	0.31
Depth to water (m):	9.39	angular frequency (per second):	0.45
Height of water predicted(m):	43.00	damping constant:	0.15
Height of water (m):	43.54	Initial amplitude:	1.2
K (m/s):	1.30E-04	Transmissivity (m2/s):	7.46E-04
Storage:	8.00E-04	Time Shift (s):	-1.20





Legend

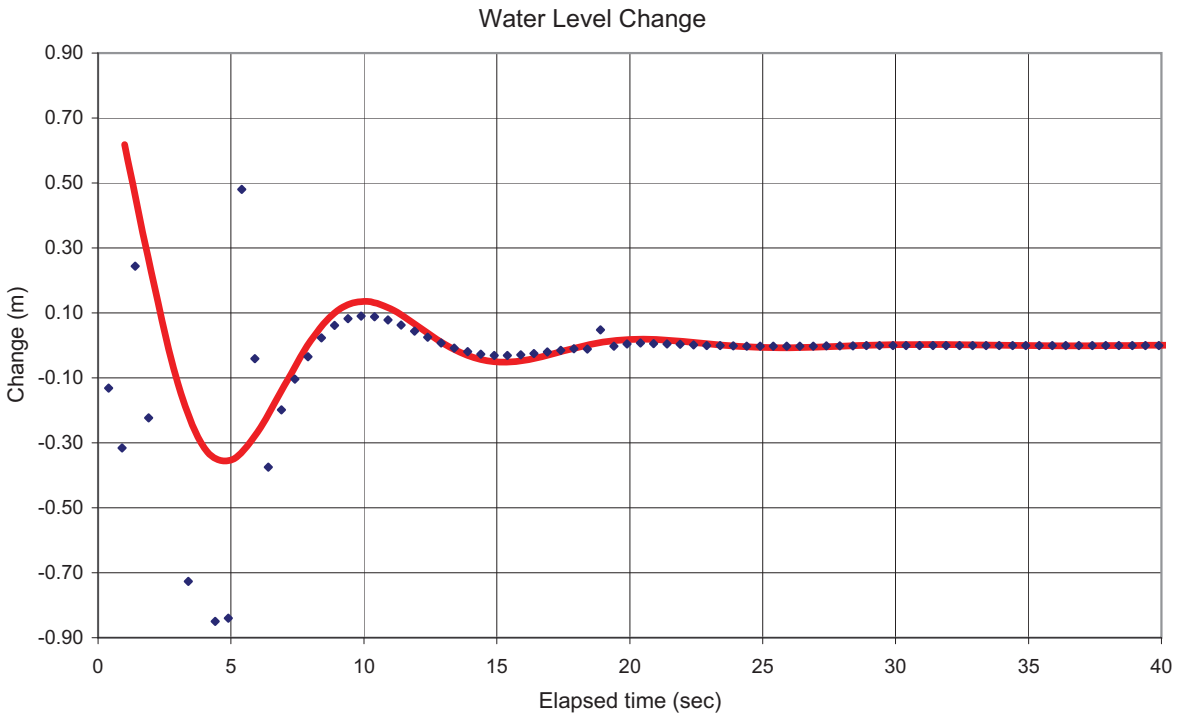
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date: June 30, 2008
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-65M	Test date:	6/30/2008
Instrument type:	In-situ transducer	Test time:	9:50 AM
Zone depth (m):	44.50	Screen type:	2 " PVC - 20 slot
Test length (m):	3.66	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	41.45	d:	0.29
Depth to water (m):	9.14	angular frequency (per second):	0.60
Height of water predicted(m):	25.00	damping constant:	0.18
Height of water (m):	32.32	Initial amplitude:	0.9
K (m/s):	4.00E-04	Transmissivity (m2/s):	1.46E-03
Storage:	1.00E-04	Time Shift (s):	0.40





Legend

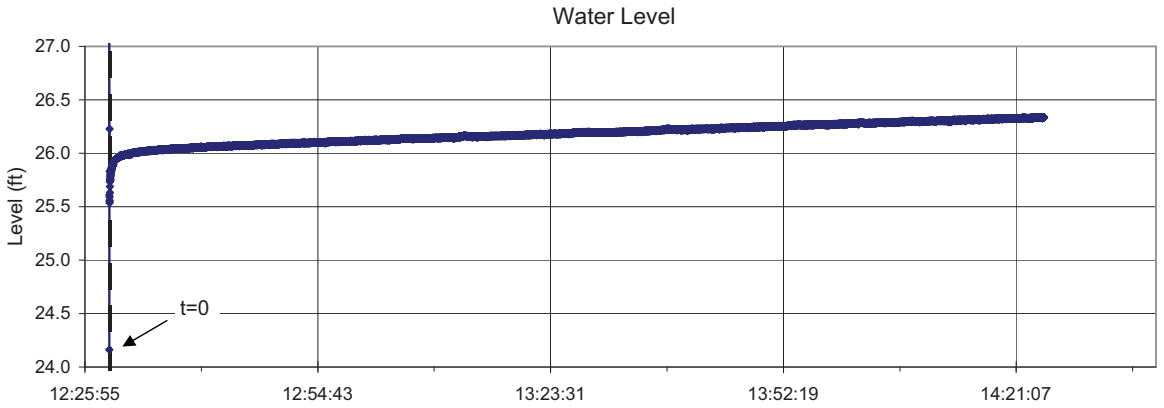
- Data
- Calculated Response

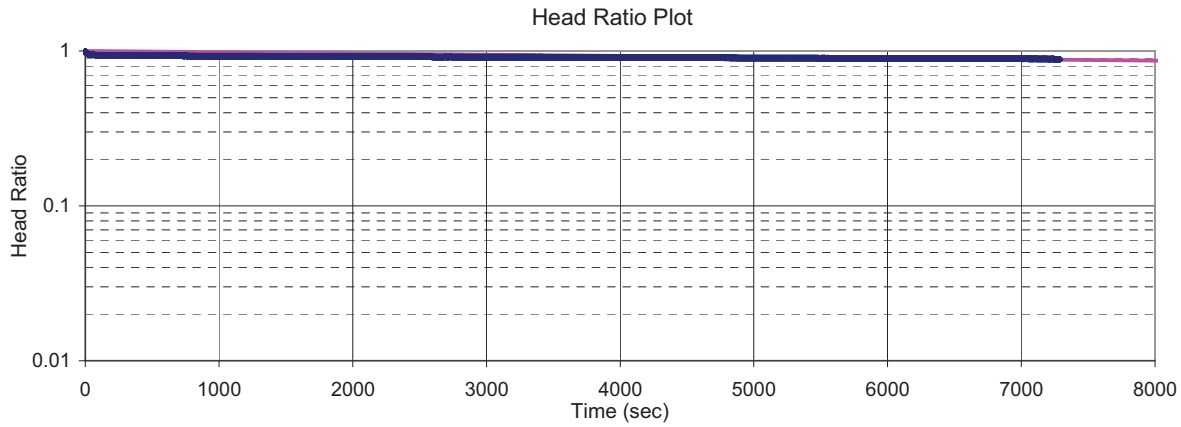
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author:SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-66D	Test date:	7/1/2008
Instrument type:	In-situ transducer	Test time:	12:28:58
Zone depth (m):	18.17	Screen type:	2 " PVC - 20 slot
Test length (m):	4.82	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	5.00E-09	Transmissivity (m^2/s)	2.41E-08







Legend

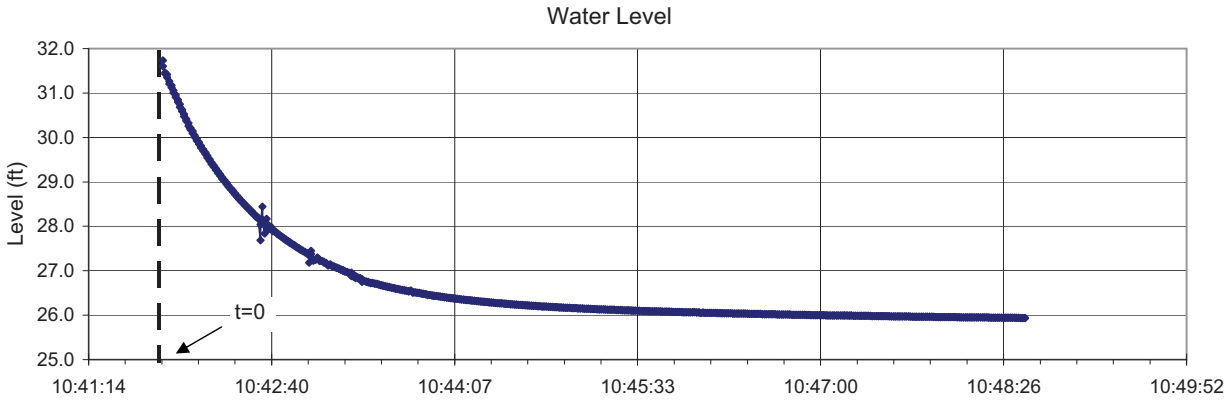
- Data
- Hvorslev Plot

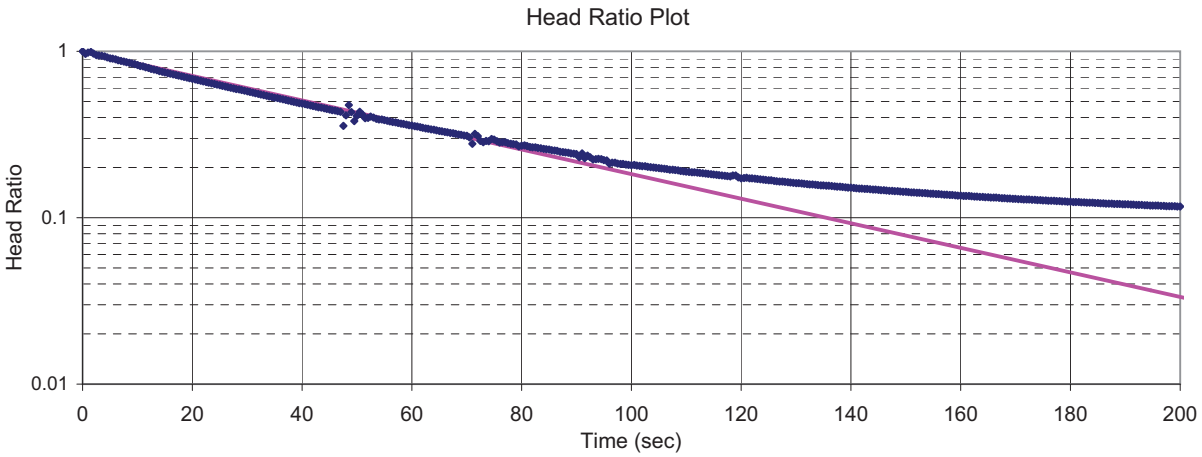
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-67D	Test date:	8/14/2008
Instrument type:	In-situ transducer	Test time:	10:41:47
Zone depth (m):	18.07	Screen type:	2 " PVC - 20 slot
Test length (m):	4.45	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	5.00E-06	Transmissivity (m^2/s)	2.23E-05







Legend

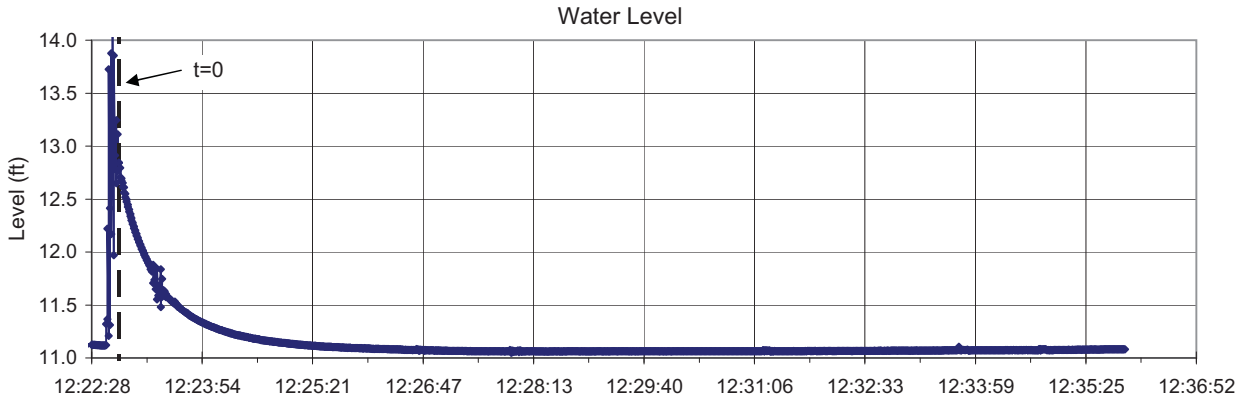
- Data
- Hvorslev Plot

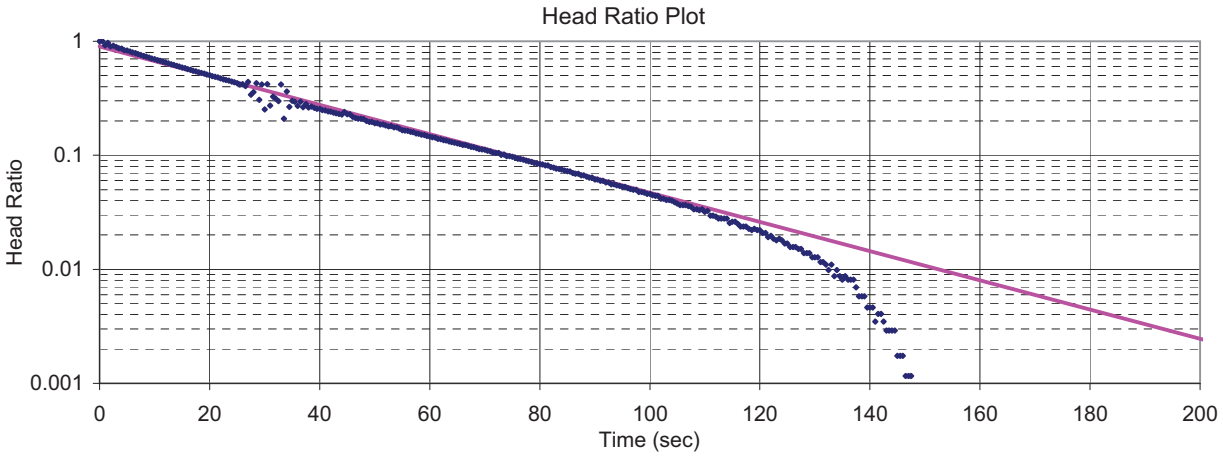
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-67S	Test date:	8/14/2008
Instrument type:	In-situ transducer	Test time:	12:22:49
Zone depth (m):	8.35	Screen type:	2 " PVC - 20 slot
Test length (m):	3.69	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.9		
K (m/s):	1.00E-05	Transmissivity (m^2/s)	3.69E-05







Legend

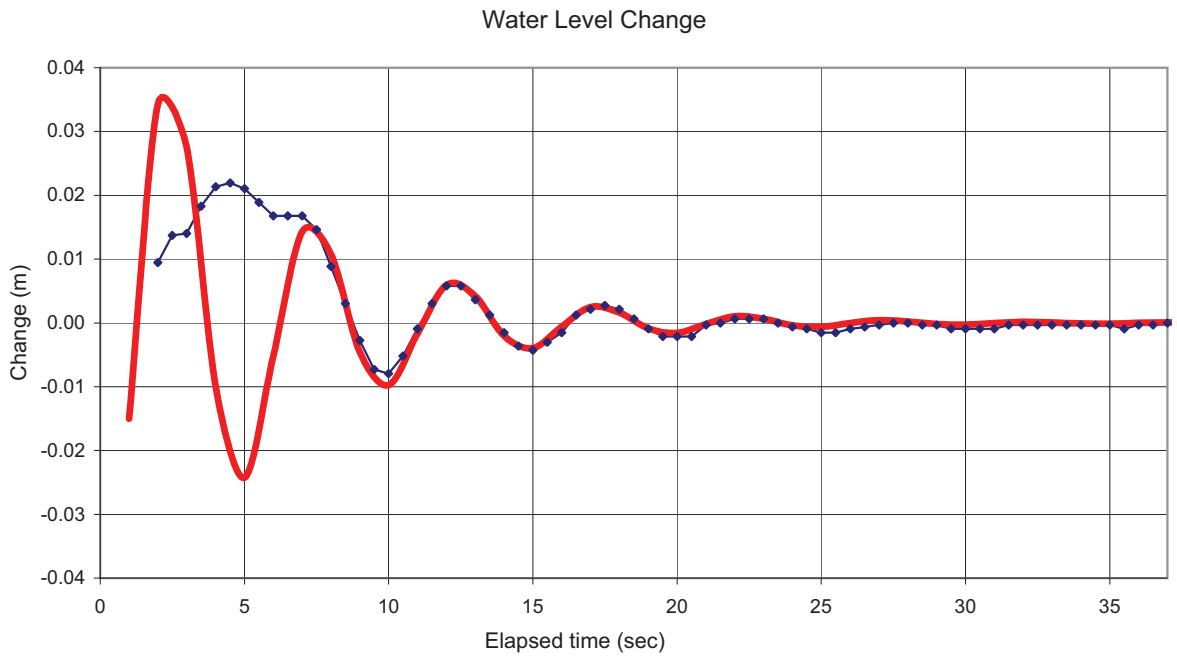
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-68D	Test date:	7/4/2008
Instrument type:	In-situ transducer	Test time:	14:20:37
Zone depth (m):	26.52	Screen type:	2 " PVC - 20 slot
Test length (m):	4.57	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	22.59	d:	0.14
Depth to water (m):	7.42	angular frequency (per second):	1.27
Height of w. theoretical (m):	6.00	damping constant:	0.18
Height of water actual (m):	15.17	Initial amplitude:	-0.06
K (m/s):	1.20E-03	Transmissivity (m2/s):	5.49E-03
Storage:	5.00E-04	Time Shift (s):	2.00





Legend

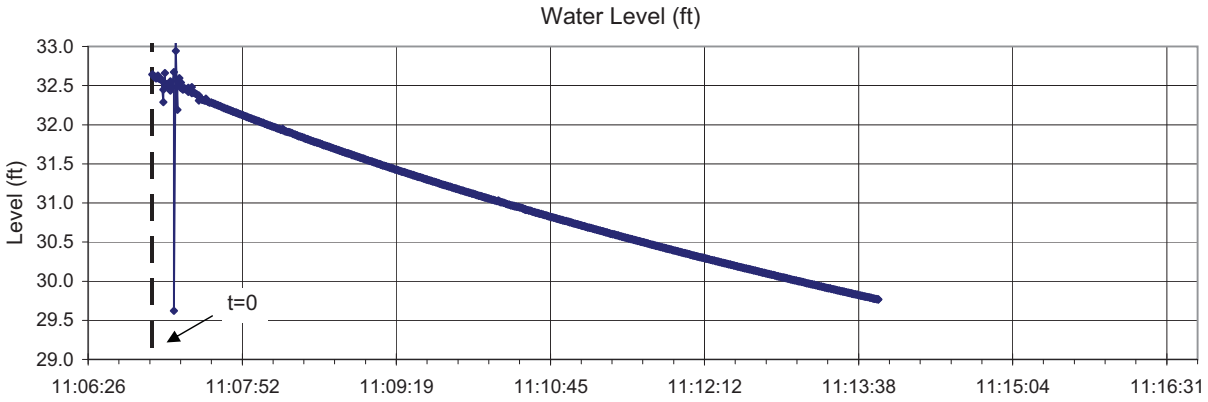
- Data
- Calculated Response

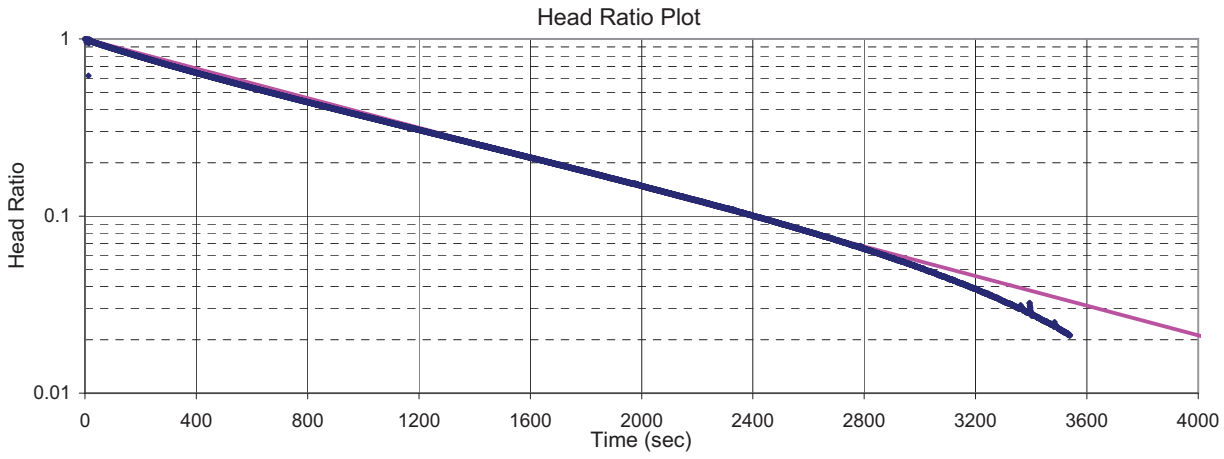
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-69D	Test date:	9/5/2008
Instrument type:	In-situ transducer	Test time:	11:07:02
Zone depth (m):	18.32	Screen type:	2 " PVC - 20 slot
Test length (m):	5.55	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	2.40E-07	Transmissivity (m^2/s)	1.33E-06







Legend

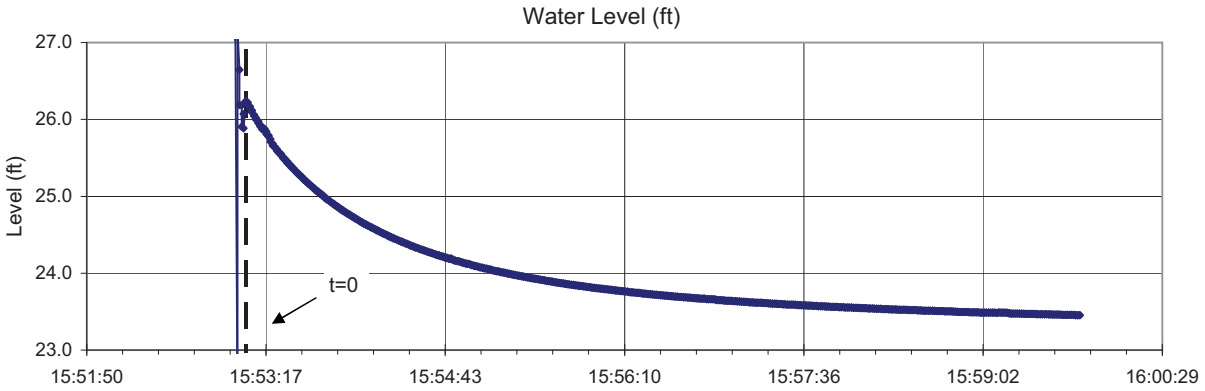
- Data
- Hvorslev Plot

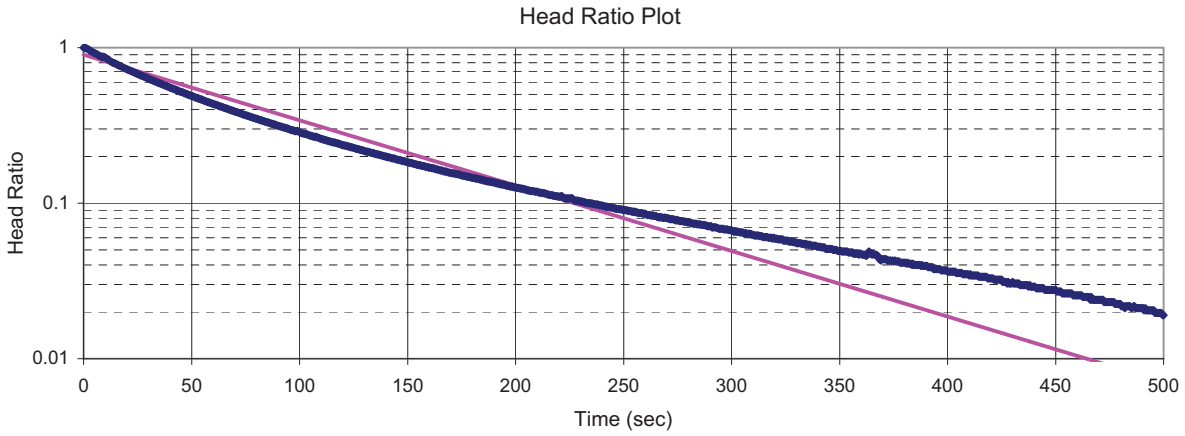
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-70D	Test date:	9/5/2008
Instrument type:	In-situ transducer	Test time:	15:53:07
Zone depth (m):	16.76	Screen type:	2 " PVC - 20 slot
Test length (m):	7.07	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.9		
K (m/s):	2.00E-06	Transmissivity (m^2/s)	1.41E-05







Legend

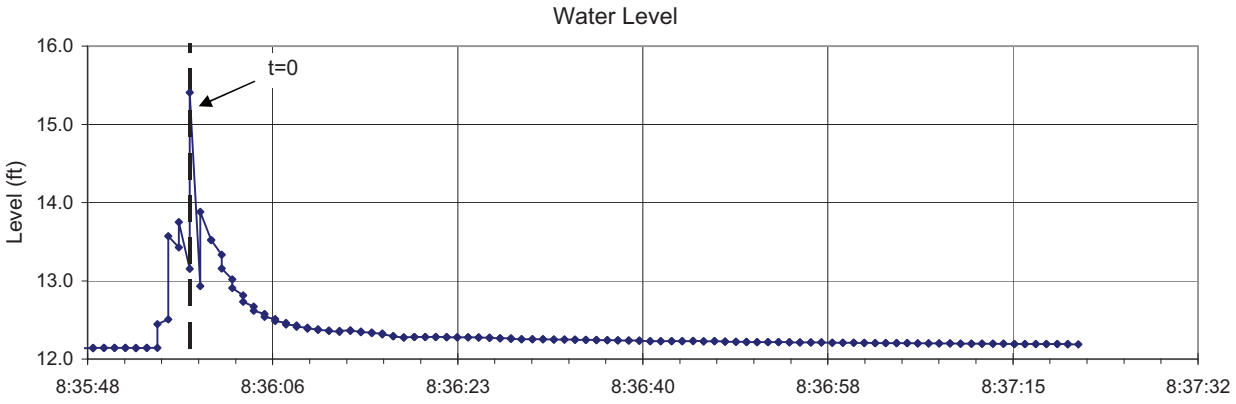
- Data
- Hvorslev Plot

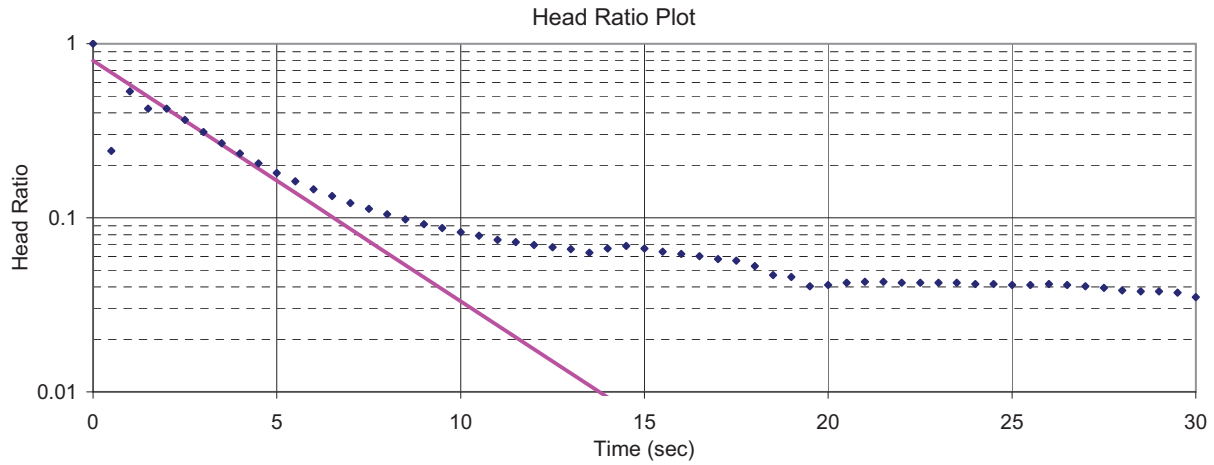
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-70S	Test date:	9/6/2008
Instrument type:	In-situ transducer	Test time:	8:35:58
Zone depth (m):	6.06	Screen type:	2 " PVC - 20 slot
Test length (m):	2.34	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.8		
K (m/s):	1.50E-04	Transmissivity (m^2/s)	3.51E-04







Legend

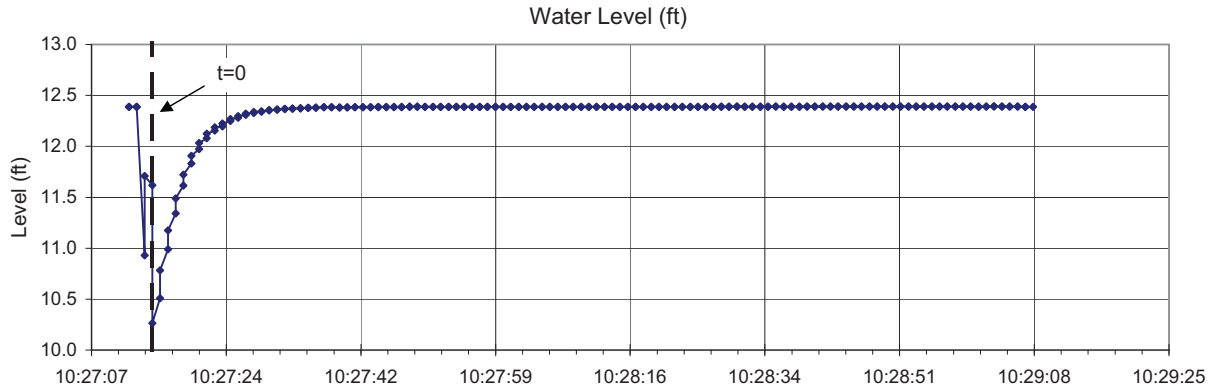
◆ Data — Hvorslev Plot

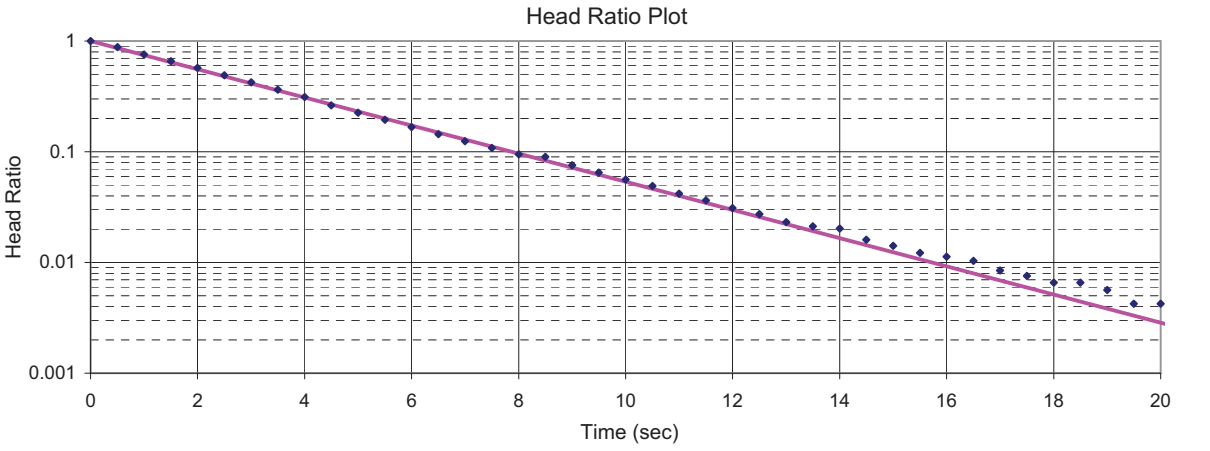
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-71D	Test date:	9/6/2008
Instrument type:	In-situ transducer	Test time:	10:27:15
Zone depth (m):	11.25	Screen type:	2 " PVC - 20 slot
Test length (m):	4.21	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	9.00E-05	Transmissivity (m^2/s)	3.79E-04







Legend

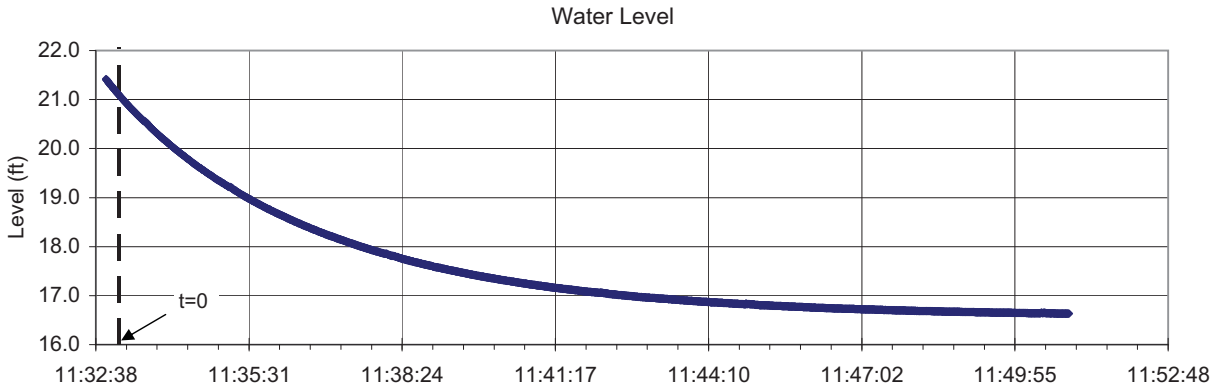
- Data
- Hvorslev Plot

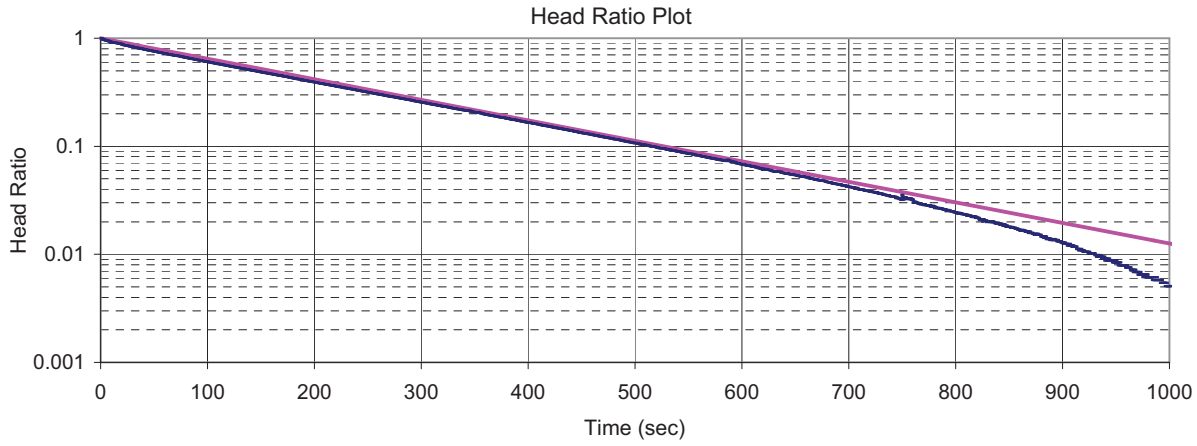
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-72D	Test date:	9/6/2008
Instrument type:	In-situ transducer	Test time:	11:33:04
Zone depth (m):	17.74	Screen type:	2 " PVC - 20 slot
Test length (m):	7.10	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1		
K (m/s):	9.00E-07	Transmissivity (m^2/s)	6.39E-06







Legend

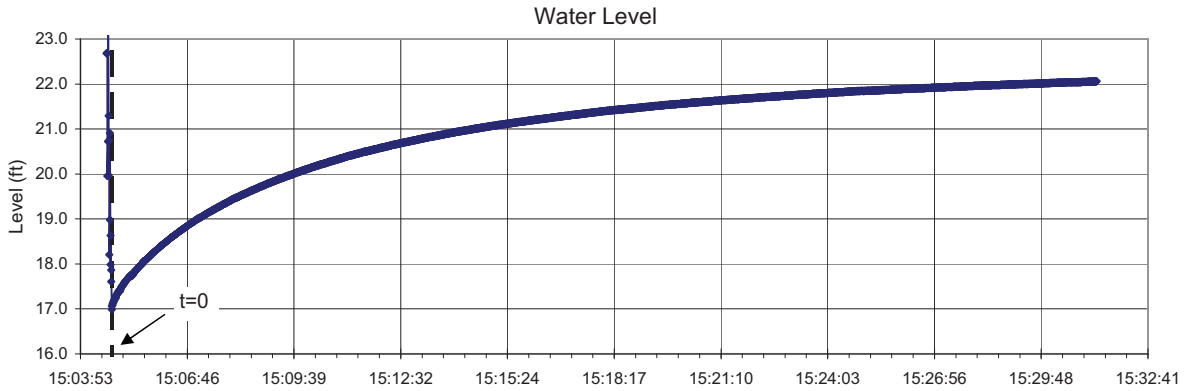
- Data
- Hvorslev Plot

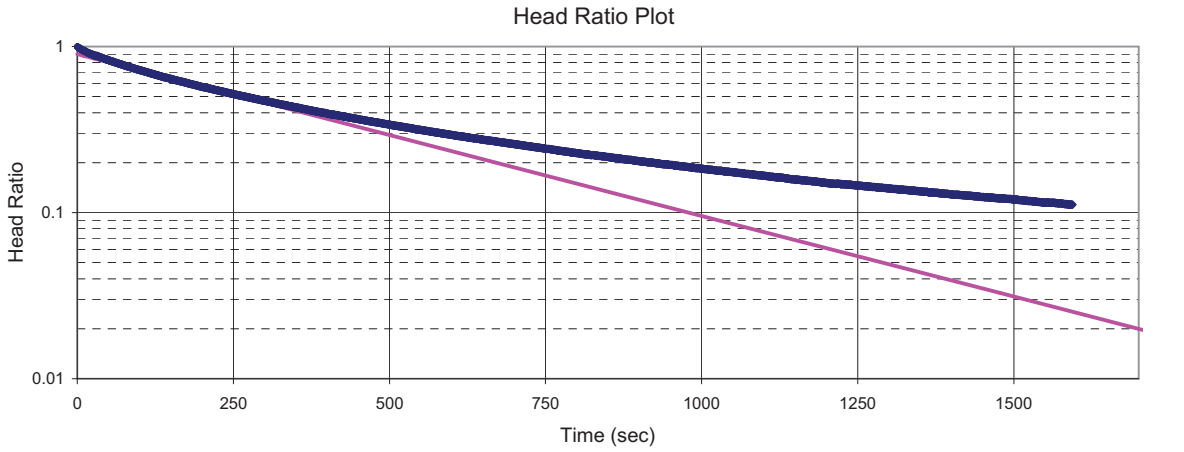
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-73D	Test date:	9/6/2008
Instrument type:	In-situ transducer	Test time:	15:04:44
Zone depth (m):	34.75	Screen type:	2 " PVC - 20 slot
Test length (m):	6.40	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.90		
K (m/s):	5.00E-07	Transmissivity (m^2/s)	3.20E-06







Legend

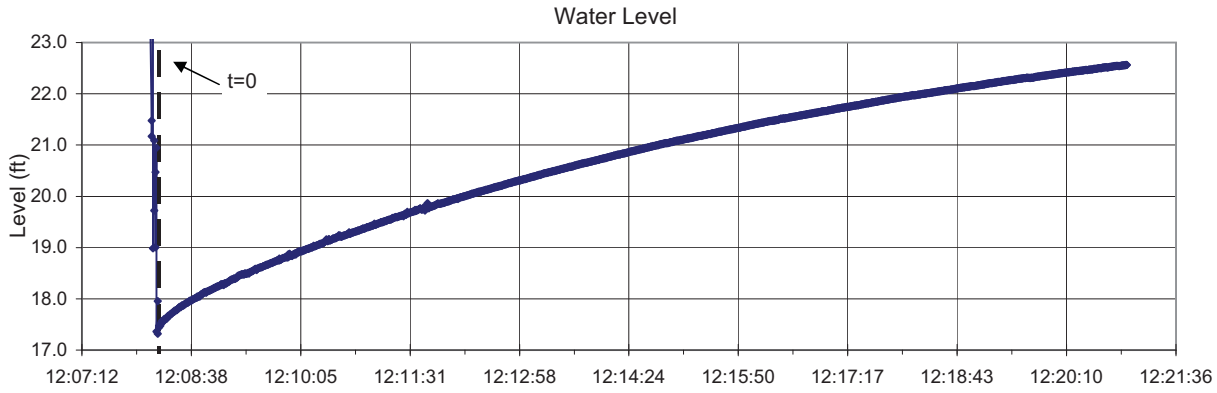
- Data
- Hvorslev Plot

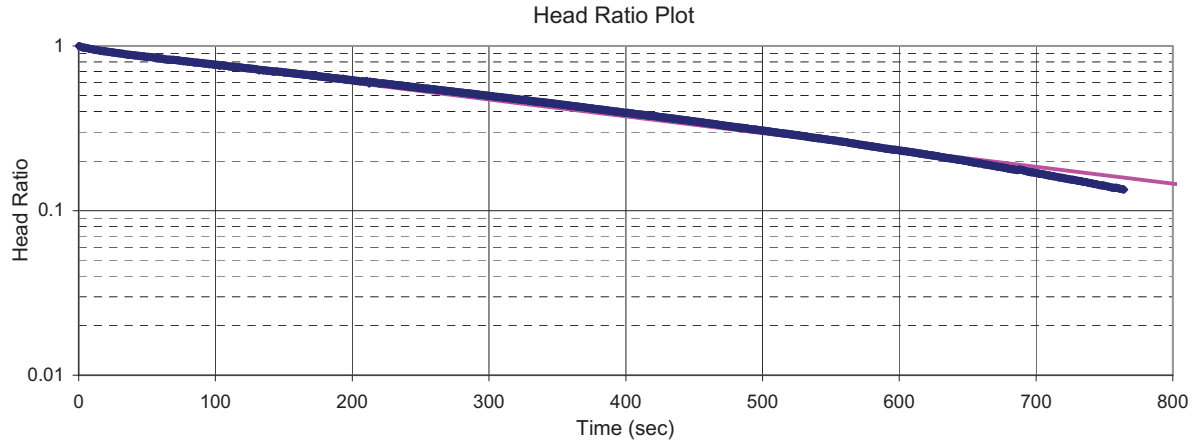
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-74D	Test date:	9/7/2008
Instrument type:	In-situ transducer	Test time:	12:08:13
Zone depth (m):	28.86	Screen type:	2 " PVC - 20 slot
Test length (m):	6.83	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.96		
K (m/s):	5.00E-07	Transmissivity (m^2/s)	3.41E-06







Legend

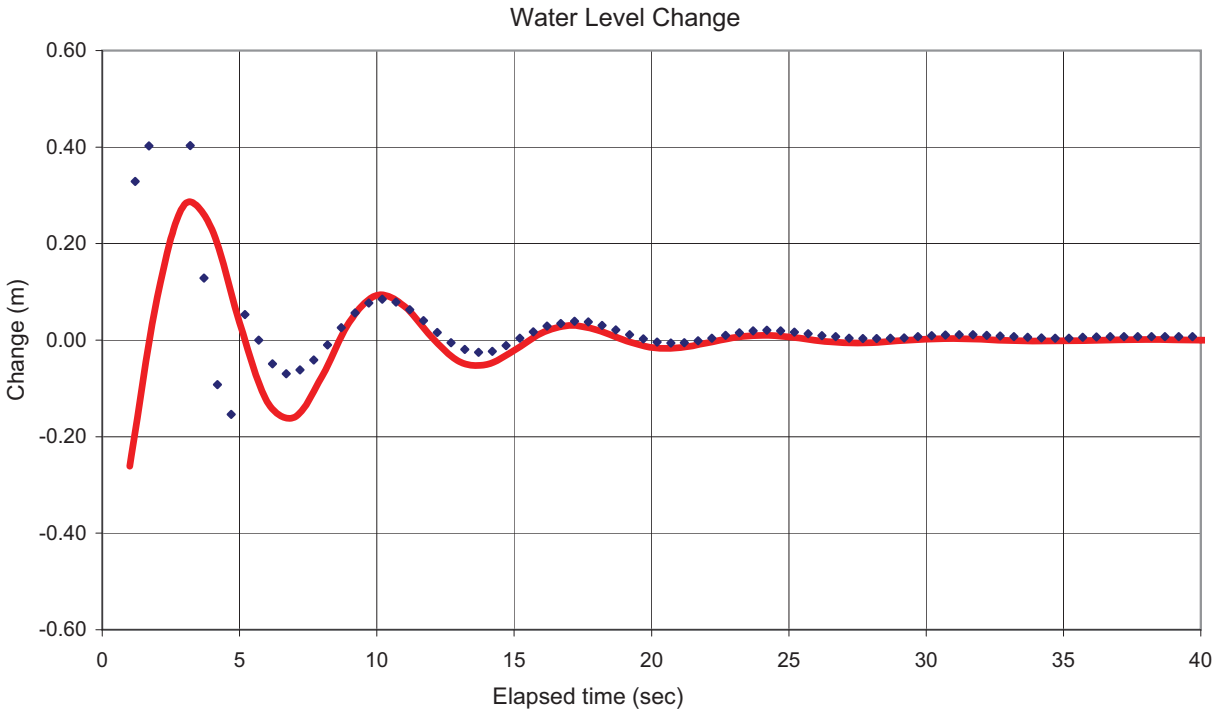
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: april 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-74S	Test date:	9/7/2008
Instrument type:	In-situ transducer	Test time:	11:07:46
Zone depth (m):	15.67	Screen type:	2 " PVC - 20 slot
Test length (m):	4.11	Field technician:	SLB
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	12.50	d:	0.18
Depth to water (m):	6.86	angular frequency (per second):	0.91
Height of w. theoretical(m):	11.50	damping constant:	0.16
Height of water actual (m):	5.64	Initial amplitude:	-0.5
K (m/s):	1.20E-03	Transmissivity (m2/s):	4.94E-03
Storage:	1.00E-05	Time Shift (s):	1.20





Legend

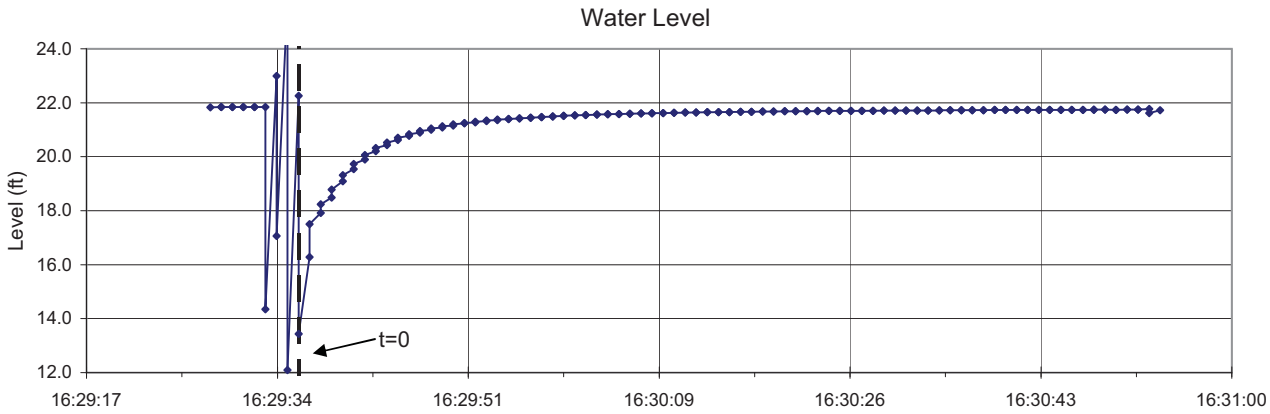
- Data
- Calculated Response

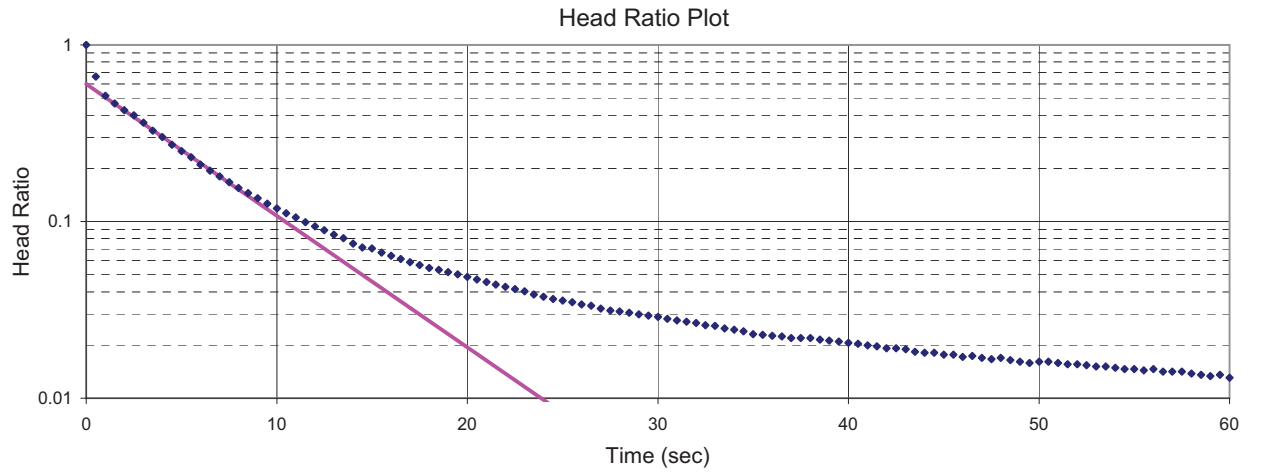
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-75D	Test date:	9/7/2008
Instrument type:	In-situ transducer	Test time:	16:29:36
Zone depth (m):	53.34	Screen type:	2 " PVC - 20 slot
Test length (m):	5.18	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.60		
K (m/s):	4.50E-05	Transmissivity (m^2/s)	2.33E-04







Legend

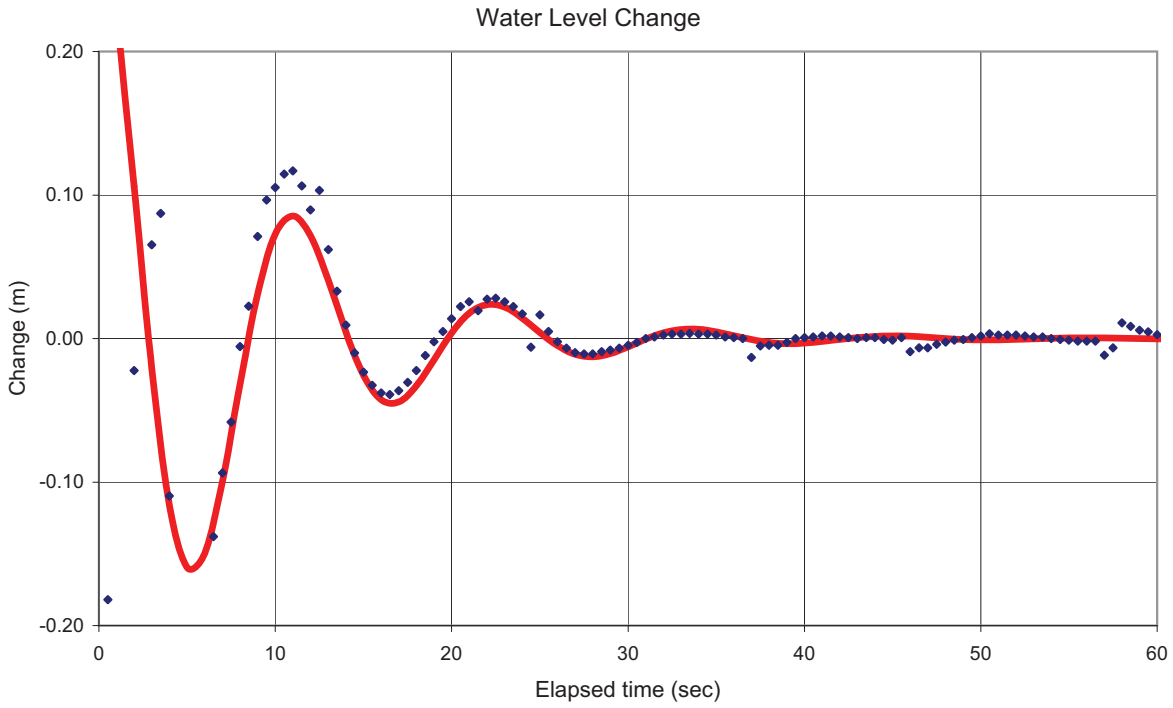
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date:April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-75M	Test date:	9/7/2008
Instrument type:	In-situ transducer	Test time:	15:29:25
Zone depth (m):	41.76	Screen type:	2 " PVC - 20 slot
Test length (m):	9.45	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	33.62	d:	0.20
Depth to water (m):	6.72	angular frequency (per second):	0.56
Height of w. theoretical (m):	30.50	damping constant:	0.11
Height of water actual (m):	26.90	Initial amplitude:	0.3
K (m/s):	1.80E-04	Transmissivity (m2/s):	1.70E-03
Storage:	4.00E-04	Time Shift (s):	-1.00





Legend

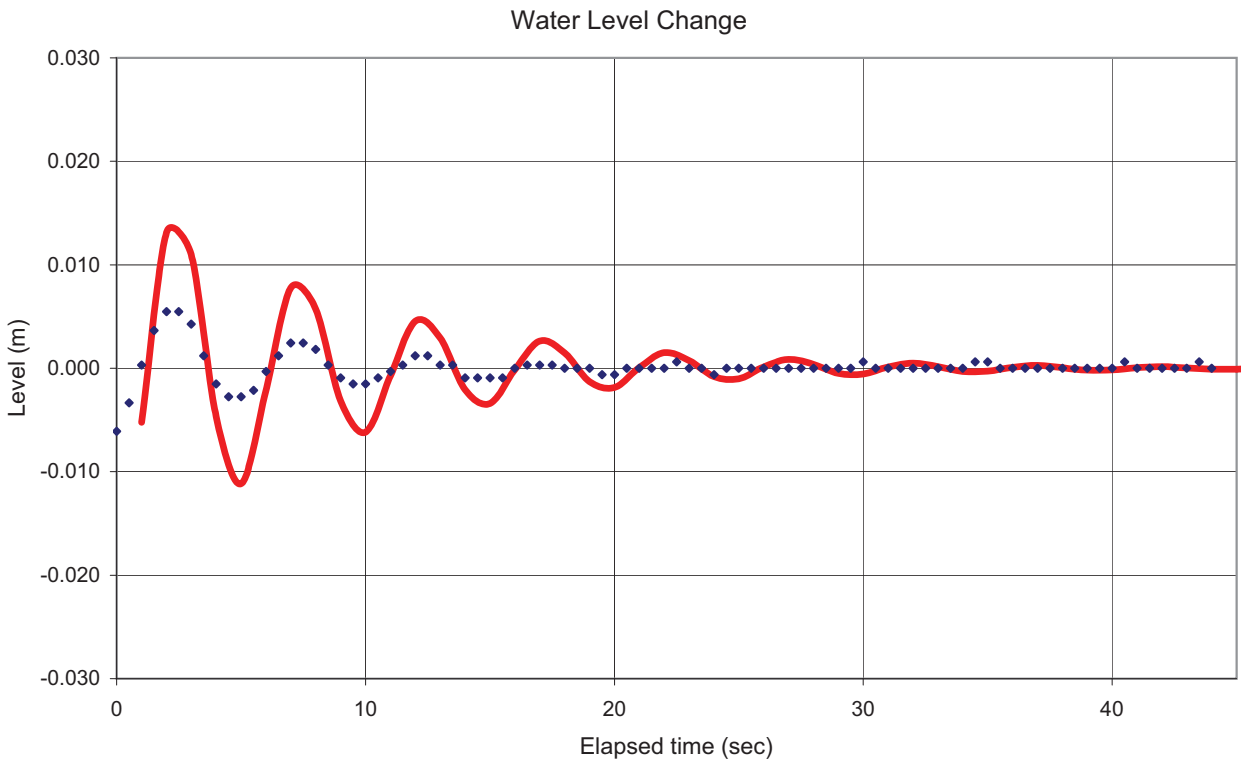
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date:April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-75S	Test date:	9/7/2008
Instrument type:	In-situ transducer	Test time:	15:59:16
Zone depth (m):	12.80	Screen type:	2 " PVC - 20 slot
Test length (m):	3.93	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	9.48	d:	0.09
Depth to water (m):	6.47	angular frequency (per second):	1.27
Height of water predicted(m):	6.00	damping constant:	0.12
Height of water (m):	3.01	Initial amplitude:	-0.02
K (m/s):	2.10E-03	Transmissivity (m2/s):	8.26E-03
Storage:	1.00E-03	Time Shift (s):	-0.50





Legend

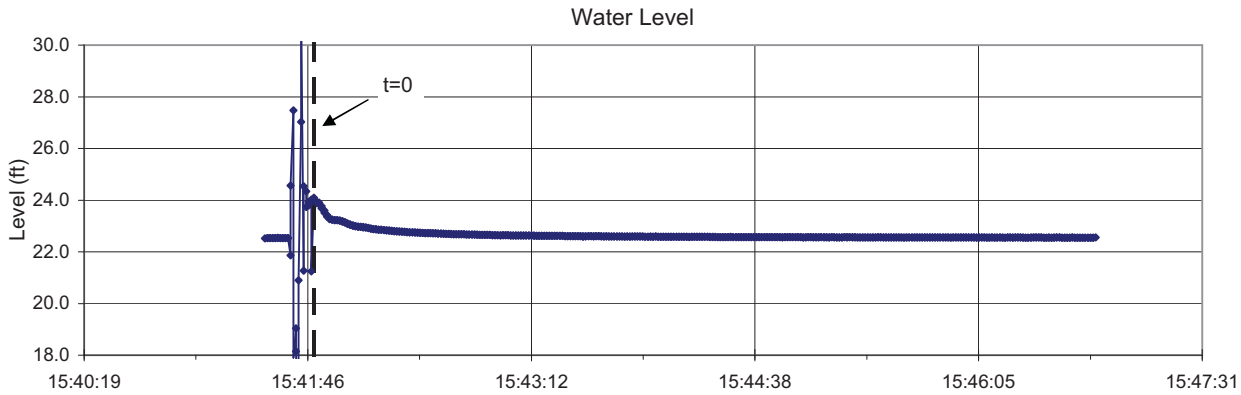
- Data
- Calculated Response

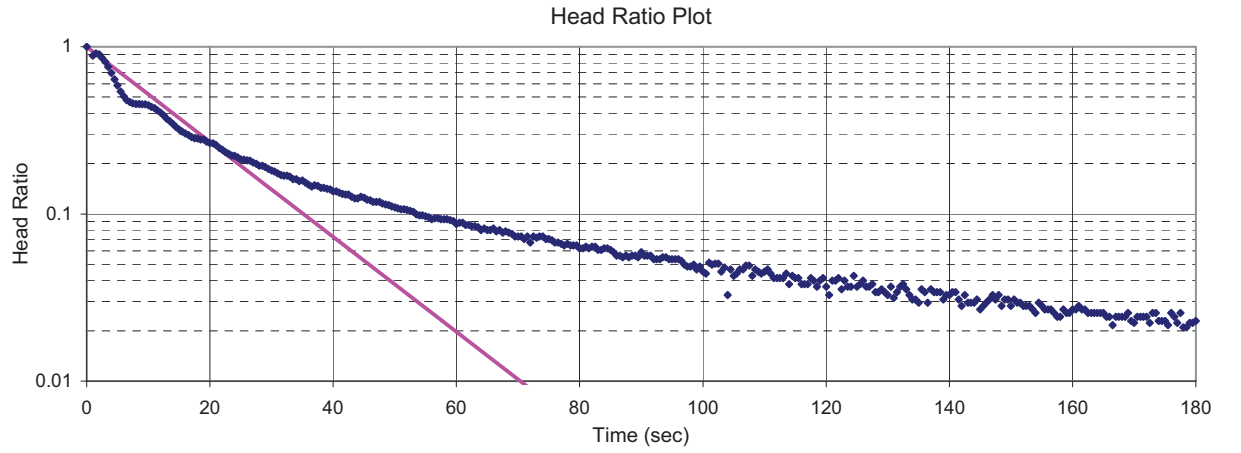
THE pebble PARTNERSHIP

Project No: 7126	Date: April 25, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-76D	Test date:	9/8/2008
Instrument type:	In-situ transducer	Test time:	15:41:48
Zone depth (m):	42.06	Screen type:	2 " PVC - 20 slot
Test length (m):	4.24	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	2.00E-05	Transmissivity (m^2/s)	8.47E-05







Legend

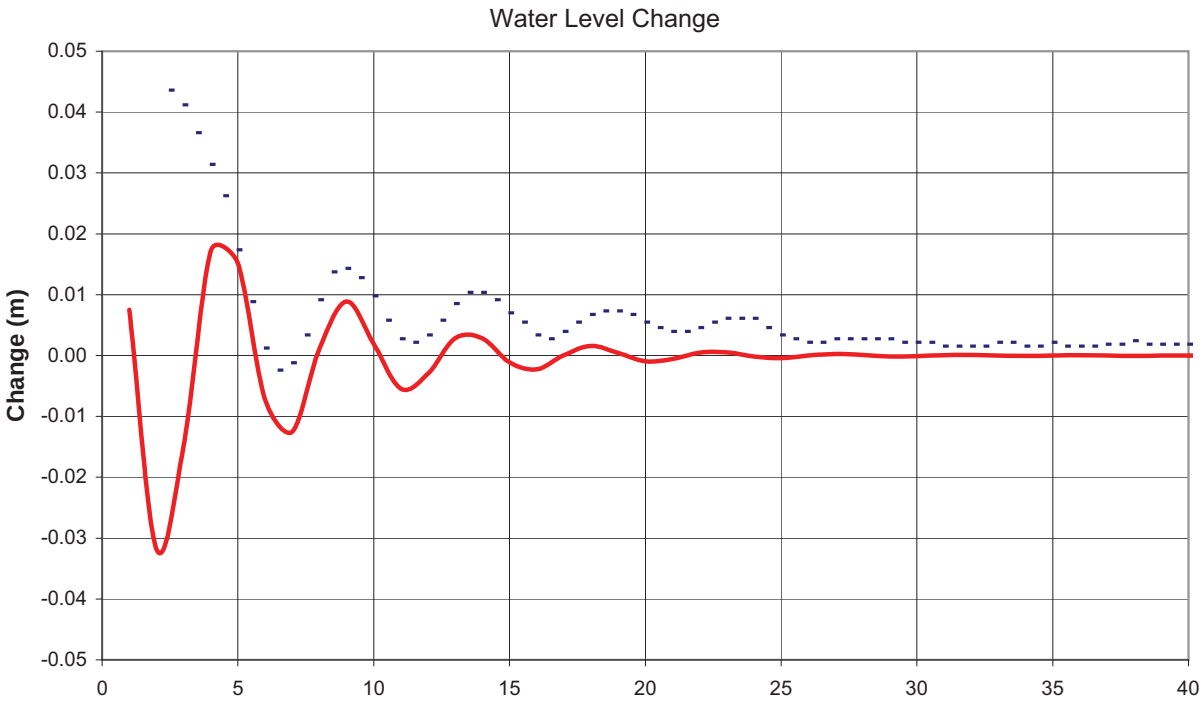
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-76S	Test date:	9/8/2008
Instrument type:	In-situ transducer	Test time:	14:25:22
Zone depth (m):	11.58	Screen type:	2 " PVC - 20 slot
Test length (m):	4.91	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	7.62	d:	0.14
Depth to water (m):	6.77	angular frequency (per second):	1.39
Height of w. theoretical (m):	5.00	damping constant:	0.19
Height of water actual (m):	0.85	Initial amplitude:	0.05
K (m/s):	1.00E-03	Transmissivity (m2/s):	4.91E-03
Storage:	2.00E-03	Time Shift (s):	1.50





Legend

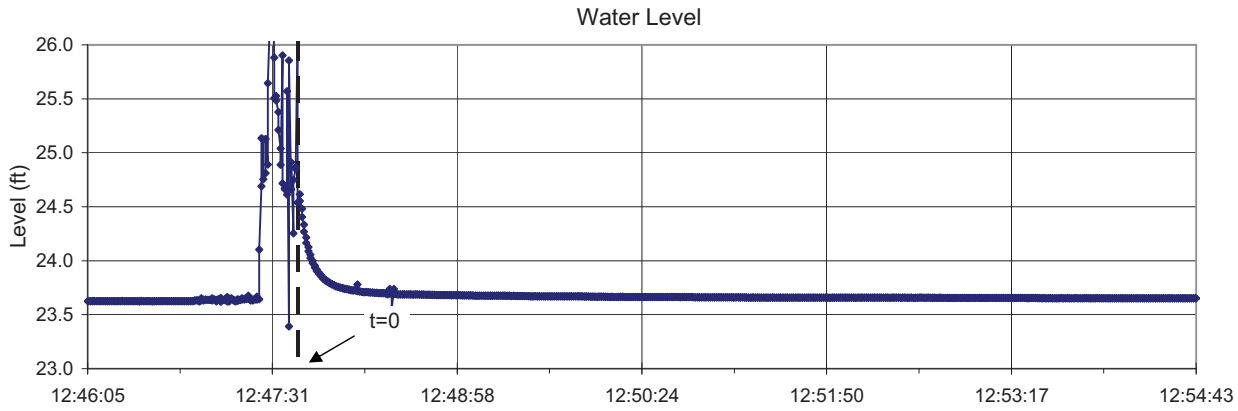
- Data
- Calculated Response

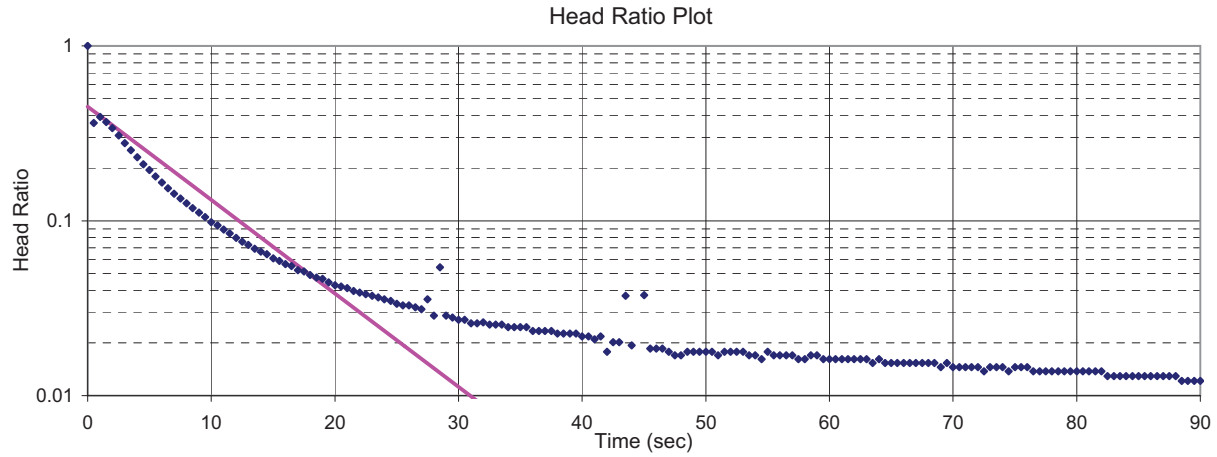
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-78D	Test date:	10/2/2008
Instrument type:	In-situ transducer	Test time:	12:47:43
Zone depth (m):	28.19	Screen type:	2 " PVC - 20 slot
Test length (m):	3.90	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.45		
K (m/s):	4.00E-05	Transmissivity (m^2/s)	1.56E-04







Legend

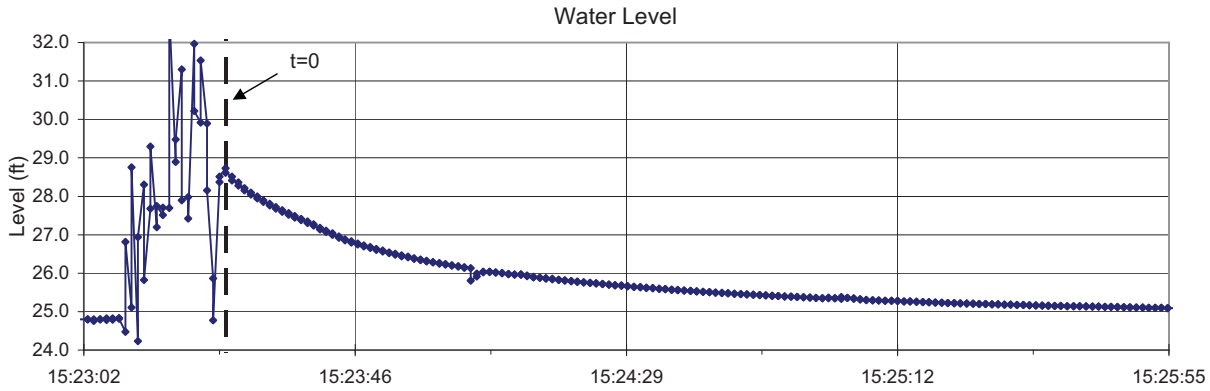
- Data
- Hvorslev Plot

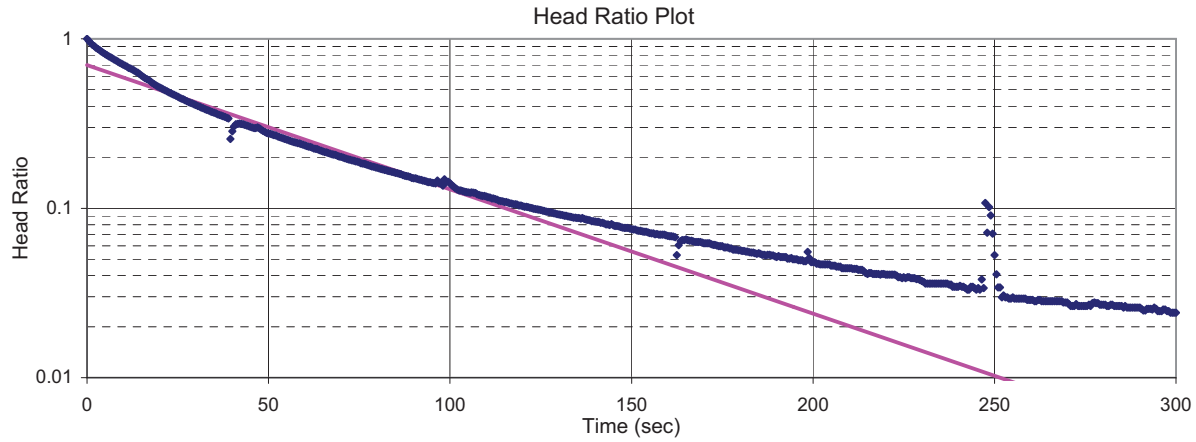
THE pebble PARTNERSHIP

Project No: 7126	Date: Japril 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-79D	Test date:	10/1/2008
Instrument type:	In-situ transducer	Test time:	15:23:25
Zone depth (m):	46.79	Screen type:	2 " PVC - 20 slot
Test length (m):	4.42	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.70		
K (m/s):	5.00E-06	Transmissivity (m^2/s)	2.21E-05







Legend

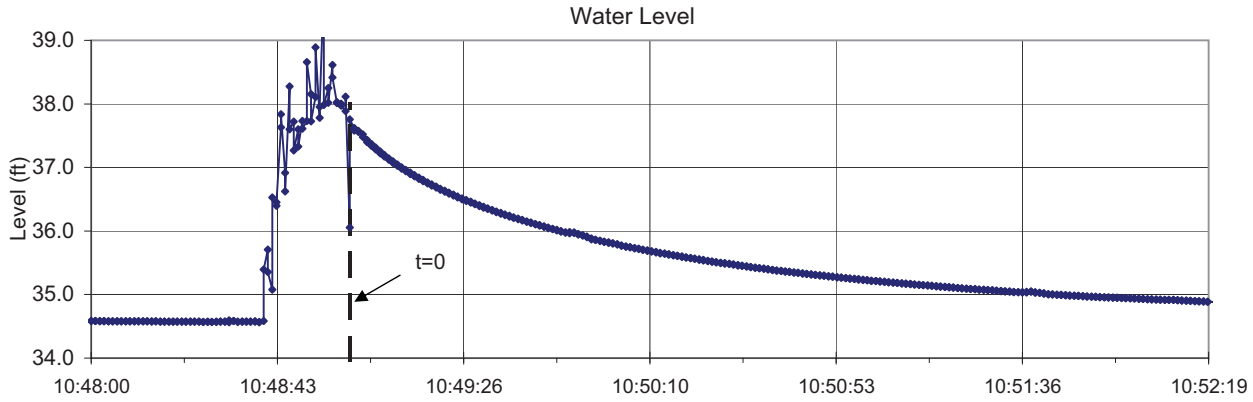
- Data
- Hvorslev Plot

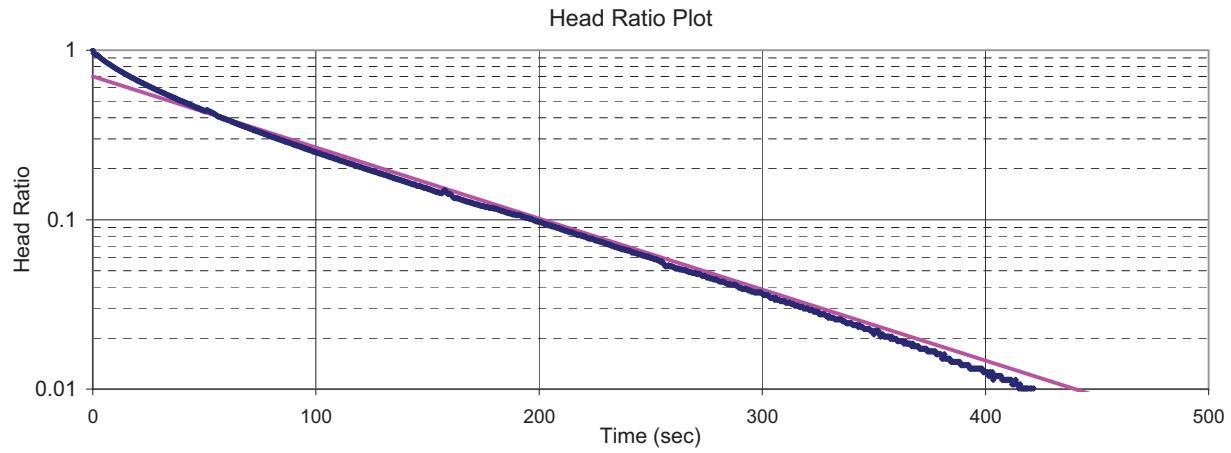
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-79M	Test date:	10/2/2008
Instrument type:	In-situ transducer	Test time:	10:49:00
Zone depth (m):	21.34	Screen type:	2 " PVC - 20 slot
Test length (m):	3.96	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.70		
K (m/s):	3.10E-06	Transmissivity (m^2/s)	1.23E-05







Legend

- Data
- Hvorslev Plot

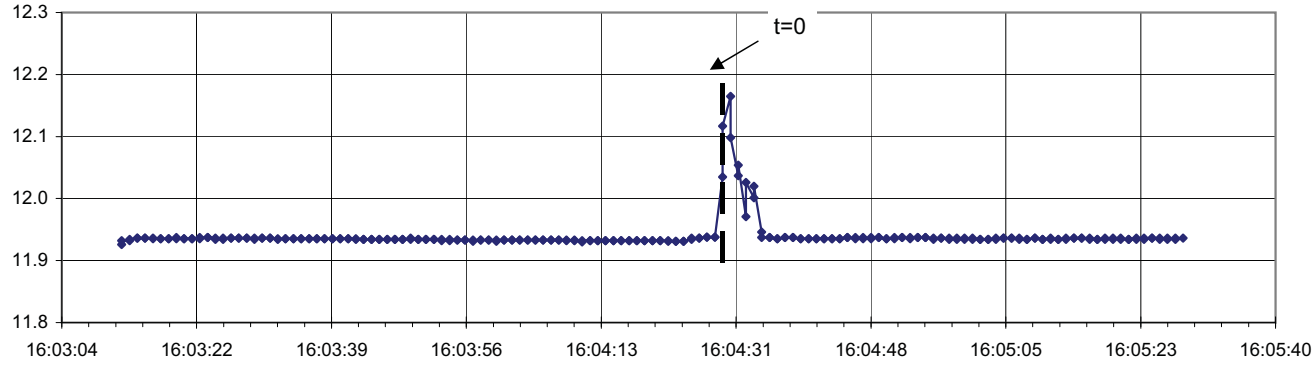
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

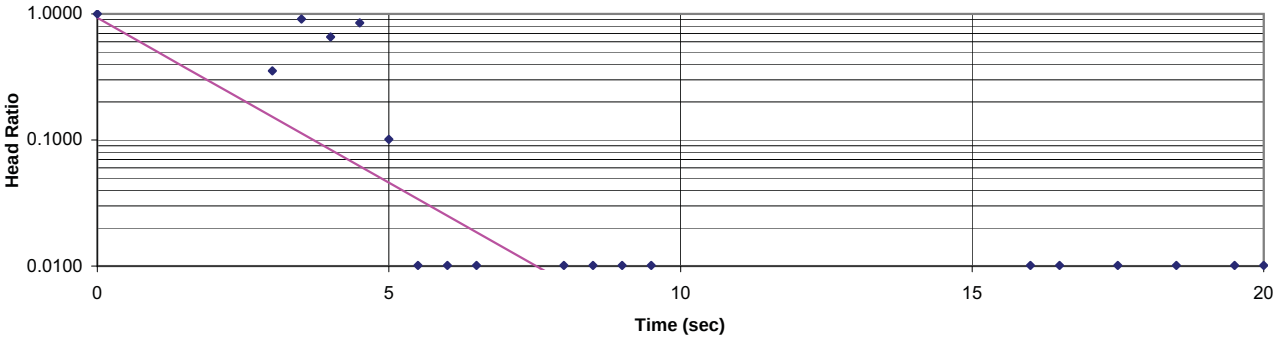
BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-79S	Test date:	10/1/2008
Instrument type:	In-situ transducer	Test time:	16:04:29
Zone depth (m):	4.8768	Screen type:	2 " PVC - 20 slot
Test length (m):	2.16408	Field technician:	SLR Alaska
Hole diameter (m):	0.1524	Analyst:	A.U.B.
Riser diameter (m):	0.051		
Hvorslev intercept:	0.93		
K (m/s):	3.00E-04	Transmissivity (m^2/s)	6.49E-04

Water Level (cm)



Head Ratio Plot





Legend

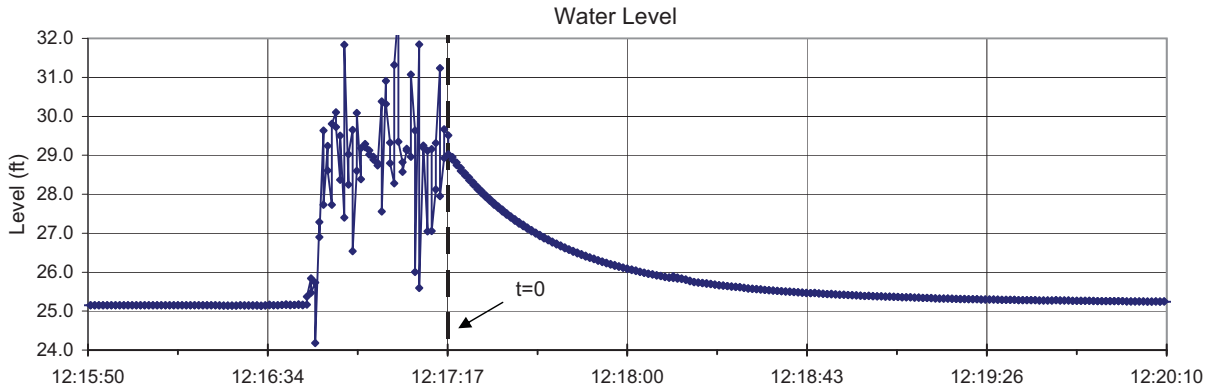
- Data
- Hvorslev Plot

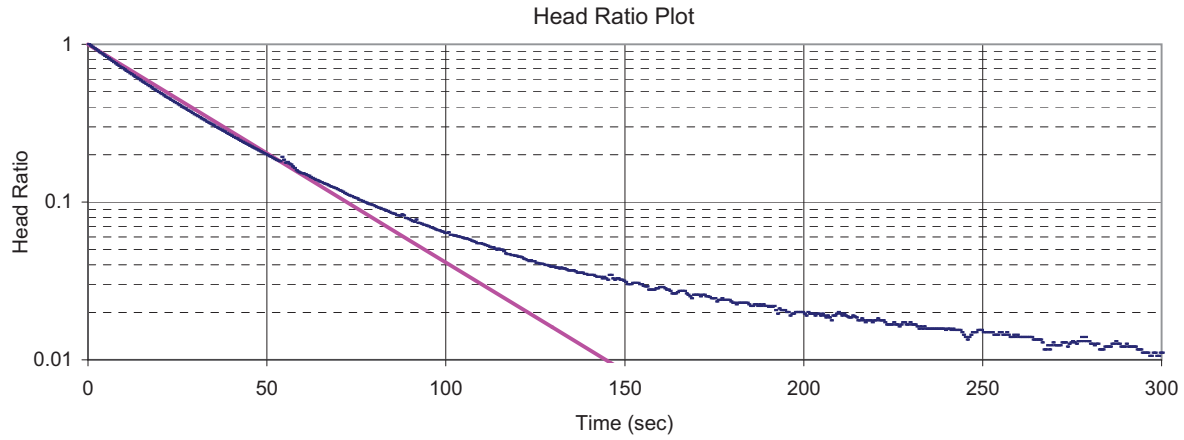
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: WMC-LC

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-80D	Test date:	10/1/2008
Instrument type:	In-situ transducer	Test time:	12:17:17
Zone depth (m):	38.72	Screen type:	2 " PVC - 20 slot
Test length (m):	4.08	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	1.00E-05	Transmissivity (m^2/s)	4.08E-05







Legend

◆ Data

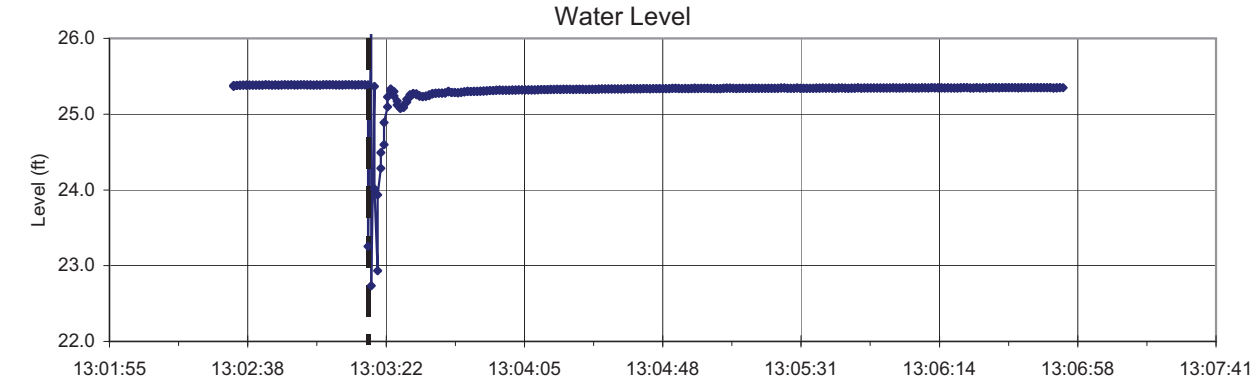
— Hvorslev Plot

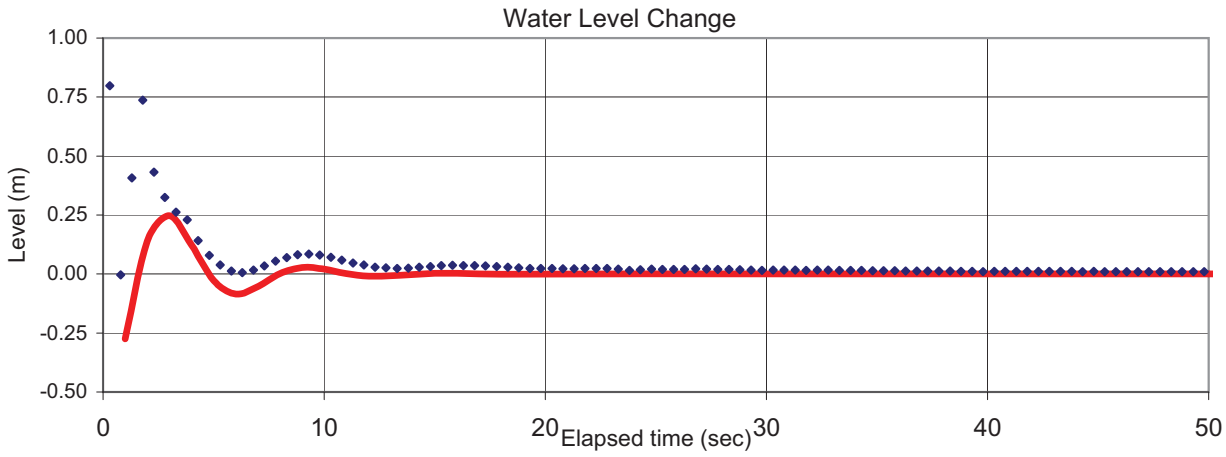
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-80M	Test date:	10/1/2008
Instrument type:	In-situ transducer	Test time:	13:03:16
Zone depth (m):	19.11	Screen type:	2 " PVC - 20 slot
Test length (m):	3.61	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	RS
Riser diameter (m):	0.05	Checked by:	VS
Depth of screen (m):	16.11	d:	0.33
Depth to water (m):	7.73	angular frequency (per second):	0.99
Height of water predicted(m):	9.00	damping constant:	0.34
Height of water (m):	8.38	Initial amplitude:	-0.7
K (m/s):	6.00E-04	Transmissivity (m2/s):	2.17E-03
Storage:	1.00E-04	Time Shift (s):	-0.70







Legend

- Data
- Calculated Response

THE pebble PARTNERSHIP

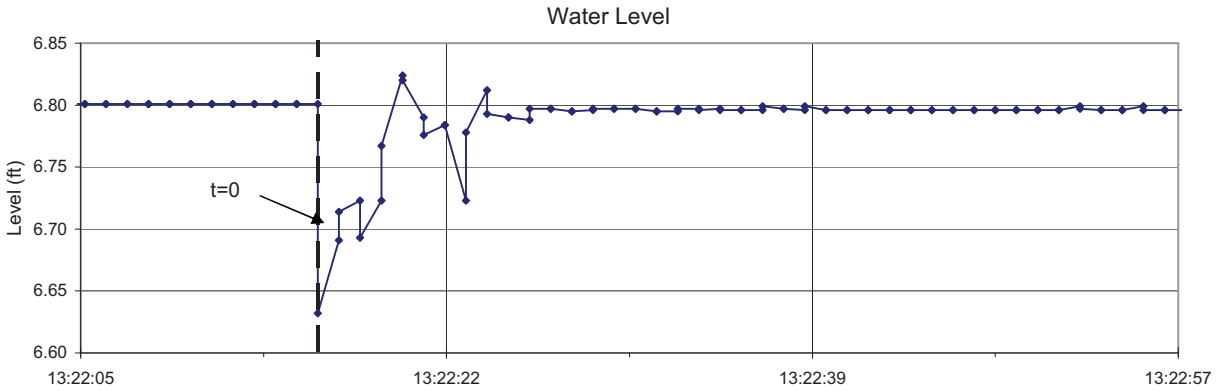
Project No: 7126	Date: April 25, 2010
Version: 1	Author: SWS

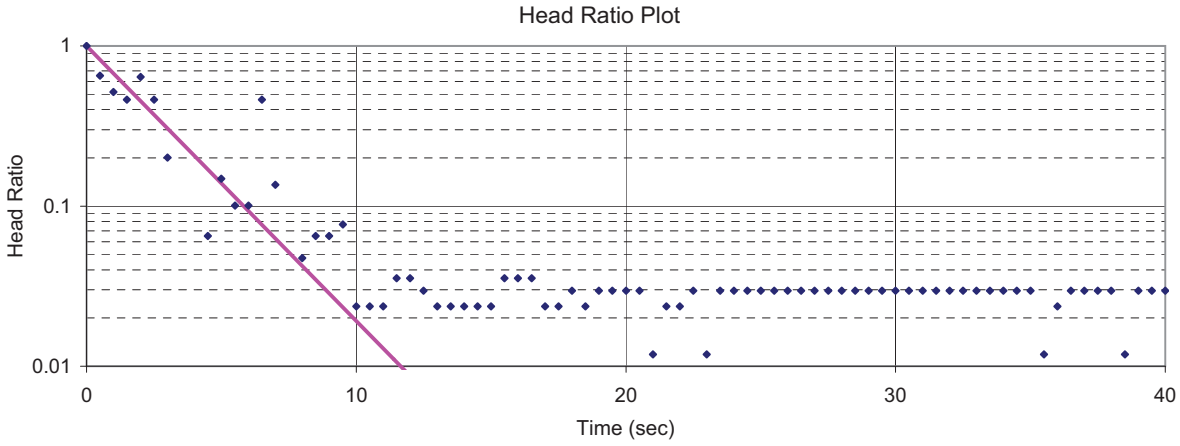
BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-80S	Test date:	10/1/2008
Instrument type:	In-situ transducer	Test time:	13:22:16
Zone depth (m):	5.17	Screen type:	2 " PVC - 20 slot
Test length (m):	2.12	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		

K (m/s): 2.00E-04 (GREATER THAN)

Transmissivity (m^2/s) 4.24E-04







Legend

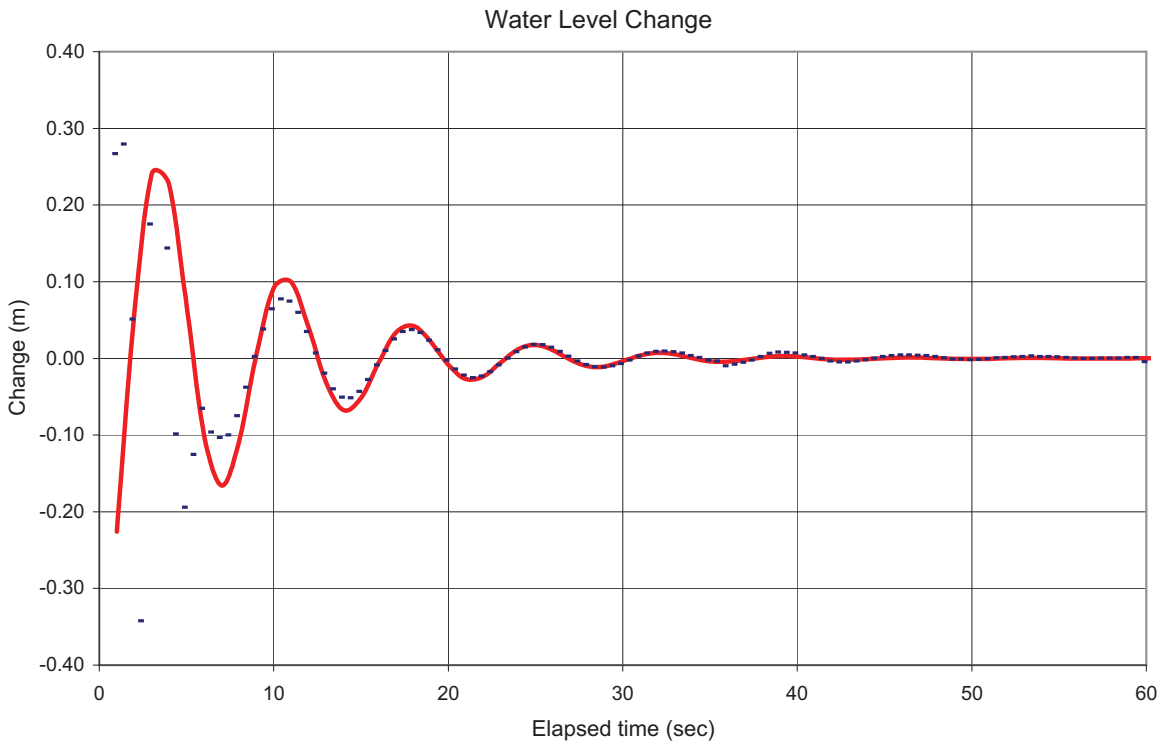
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-81D	Test date:	9/30/2008
Instrument type:	In-situ transducer	Test time:	16:38:17
Zone depth (m):	16.86	Screen type:	2 " PVC - 20 slot
Test length (m):	3.84	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	13.81	d:	0.14
Depth to water (m):	6.40	angular frequency (per second):	0.88
Height of w. theoretical (m):	12.50	damping constant:	0.12
Height of water actual (m):	7.41	Initial amplitude:	-0.4
K (m/s):	1.00E-03	Transmissivity (m2/s):	3.84E-03
Storage:	5.00E-04	Time Shift (s):	0.80





Legend

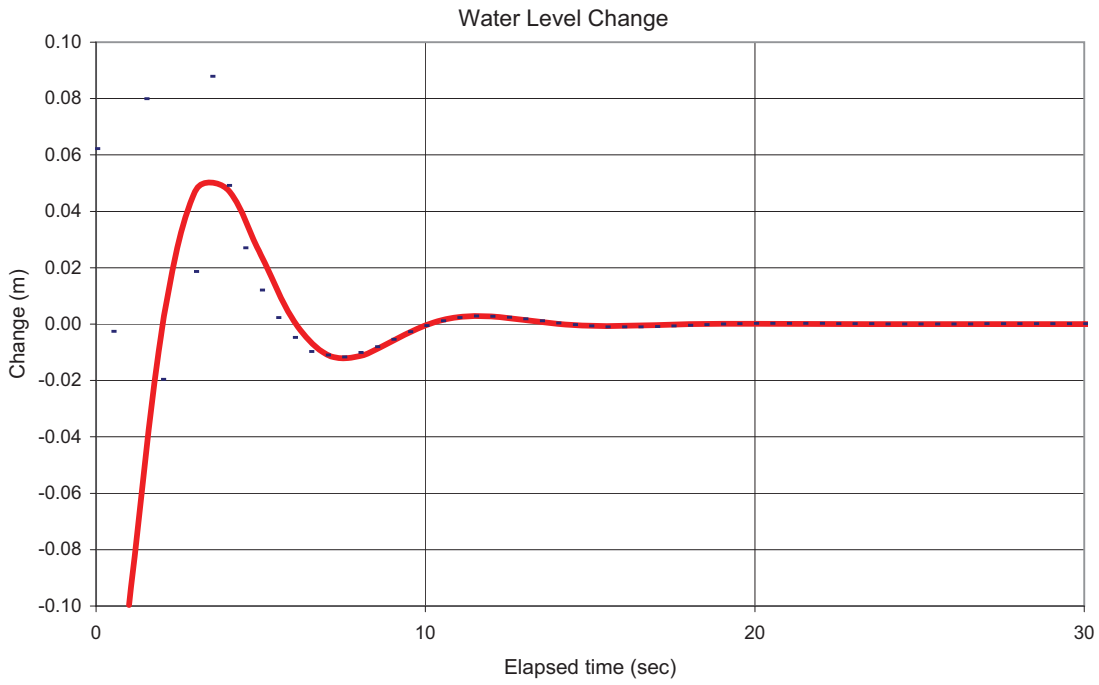
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date:April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-82D	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	16:16:26
Zone depth (m):	22.25	Screen type:	2 " PVC - 20 slot
Test length (m):	4.48	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.051	Checked by:	RS
Depth of screen (m):	19.04	d:	0.42
Depth to water (m):	7.42	angular frequency (per second):	0.78
Height of water predicted(m):	13.40	damping constant:	0.36
Height of water (m):	11.62	Initial amplitude:	-0.2
K (m/s):	2.40E-04	Transmissivity (m2/s):	1.08E-03
Storage:	4.00E-04	Time Shift (s):	0.00





Legend

Data

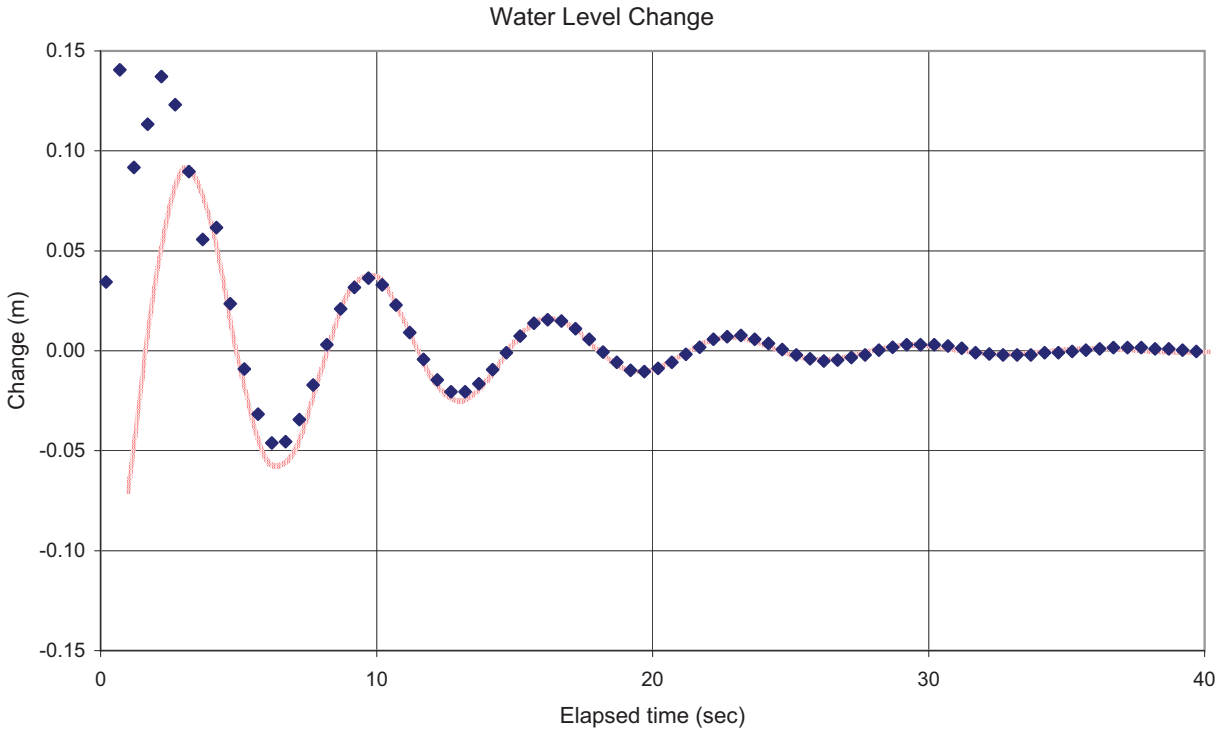
Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-82M	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	16:29:59
Zone depth (m):	15.30	Screen type:	2 " PVC - 20 slot
Test length (m):	3.47	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	12.24	d:	0.14
Depth to water (m):	9.15	angular frequency (per second):	0.96
Height of water predicted(m):	10.50	damping constant:	0.13
Height of water (m):	3.09	Initial amplitude:	-0.14
K (m/s):	9.00E-04	Transmissivity (m2/s):	3.13E-03
Storage:	3.00E-03	Time Shift (s):	0.20





Legend

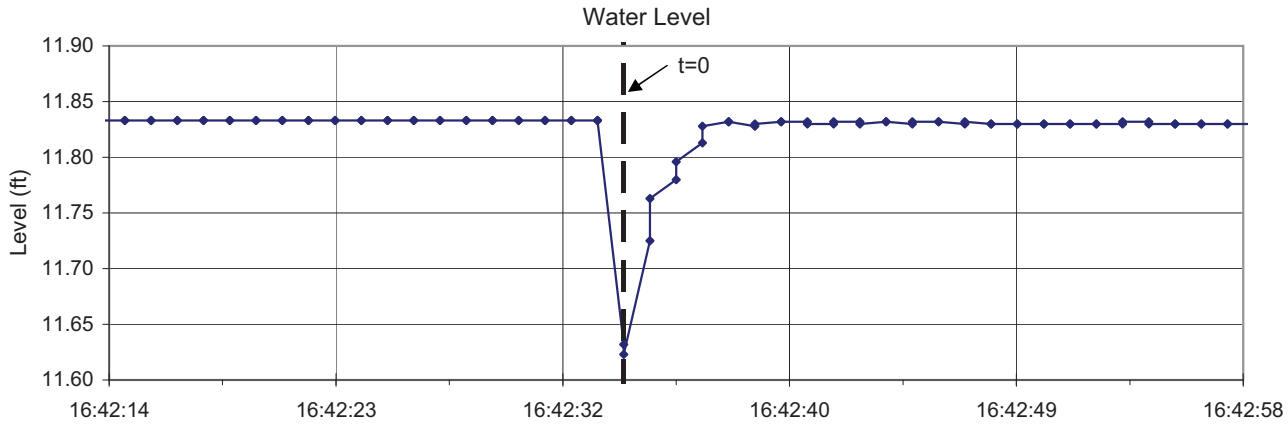
- Data
- Calculated Response

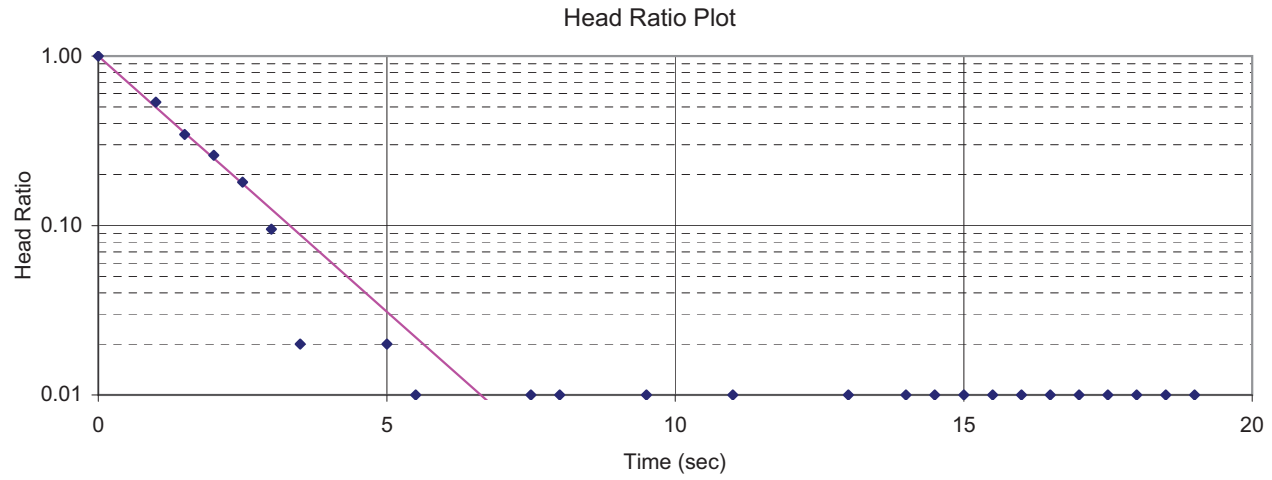
THE pebble PARTNERSHIP

Project No: 7126	Date: april 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-82S	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	16:42:34
Zone depth (m):	6.71	Screen type:	2 " PVC - 20 slot
Test length (m):	3.84	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.08	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	6.00E-04	Transmissivity (m^2/s)	2.30E-03







Legend

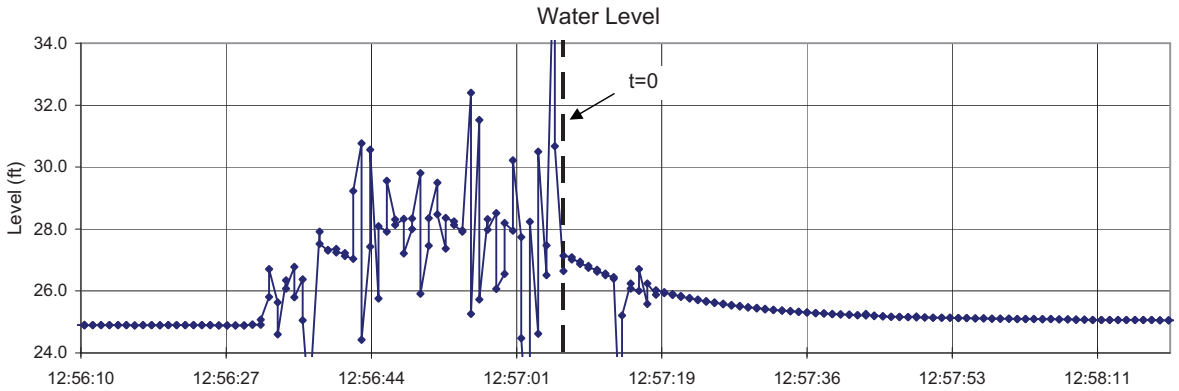
- Data
- Calculated Response

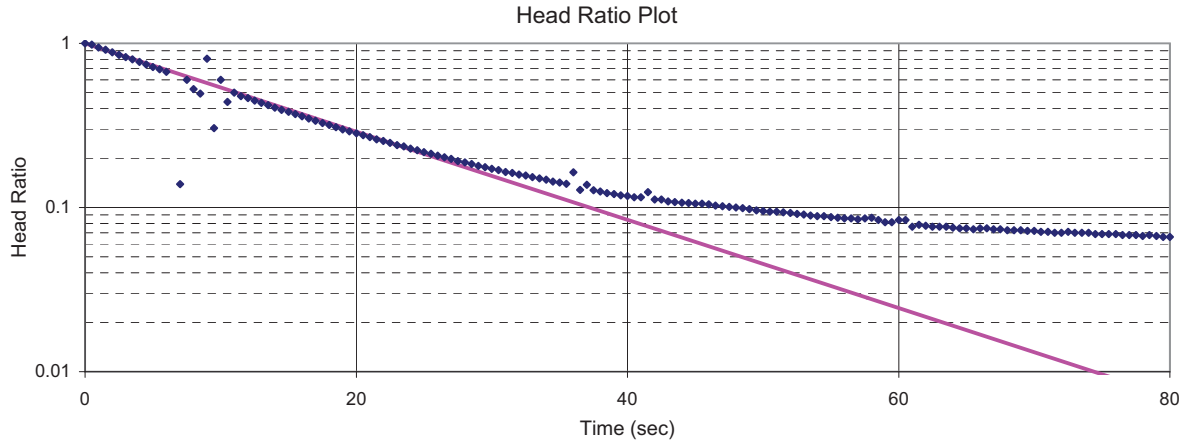
THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-83D	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	12:57:07
Zone depth (m):	57.82	Screen type:	2 " PVC - 20 slot
Test length (m):	6.92	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	1.30E-05	Transmissivity (m^2/s)	8.99E-05







Legend

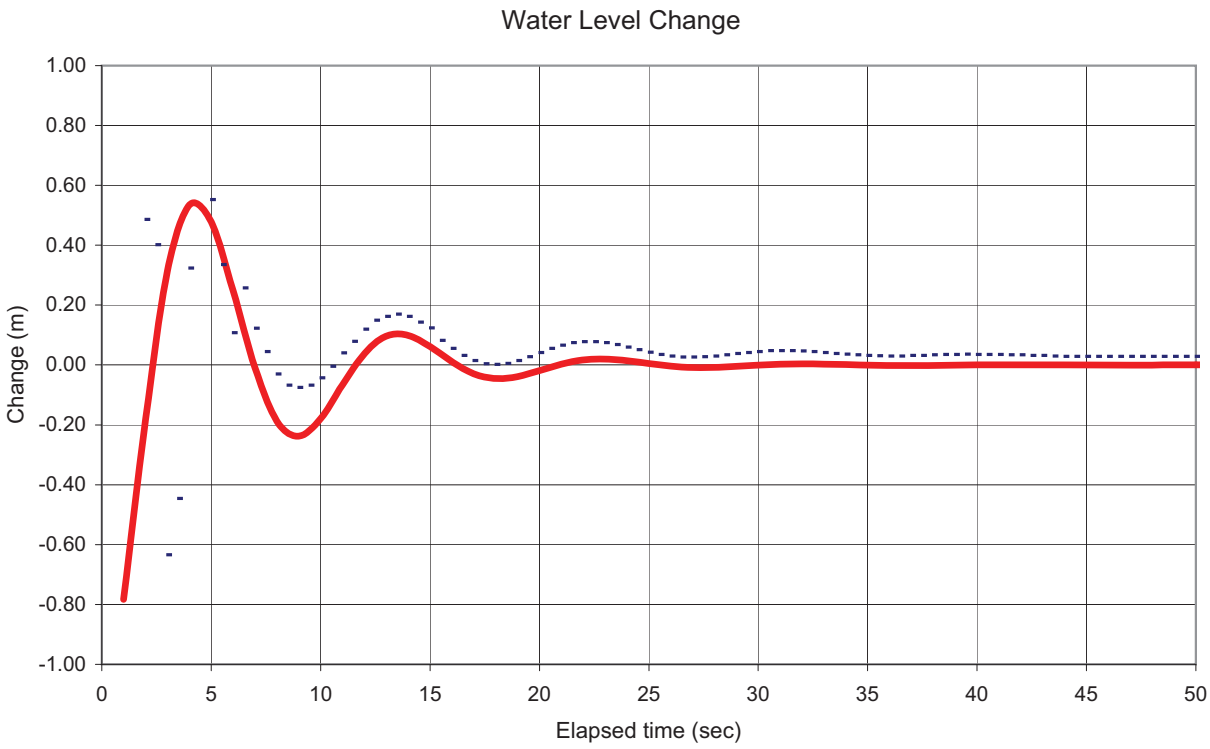
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-83M	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	14:00:05
Zone depth (m):	31.09	Screen type:	2 " PVC - 20 slot
Test length (m):	3.81	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	27.86	d:	0.25
Depth to water (m):	7.27	angular frequency (per second):	0.68
Height of water predicted(m):	20.00	damping constant:	0.18
Height of water (m):	20.59	Initial amplitude:	-1.2
K (m/s):	4.00E-04	Transmissivity (m2/s):	1.52E-03
Storage:	5.00E-04	Time Shift (s):	2.00





Legend

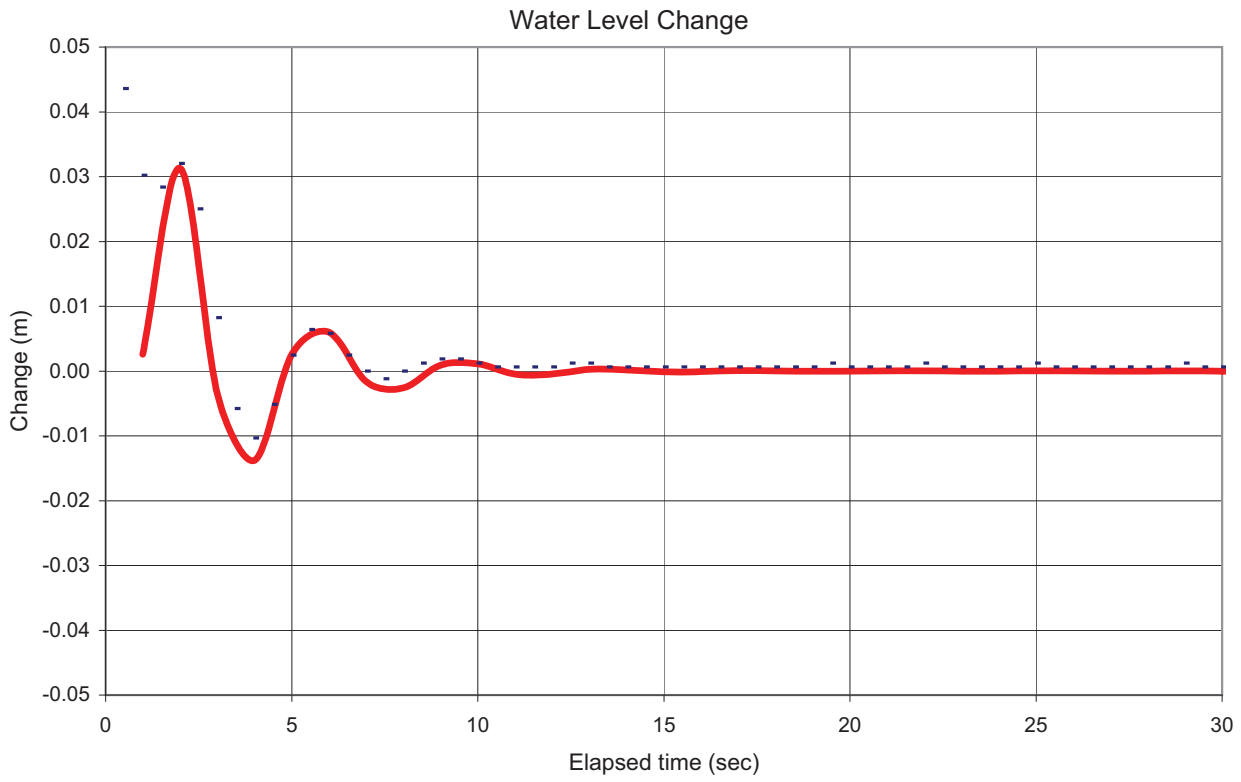
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-83S	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	14:37:59
Zone depth (m):	12.80	Screen type:	2 " PVC - 20 slot
Test length (m):	3.84	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	9.88	d:	0.24
Depth to water (m):	3.95	angular frequency (per second):	1.63
Height of water predicted(m):	3.50	damping constant:	0.40
Height of water (m):	5.92	Initial amplitude:	-0.07
K (m/s):	9.00E-04	Transmissivity (m2/s):	3.46E-03
Storage:	1.00E-03	Time Shift (s):	-2.00





Legend

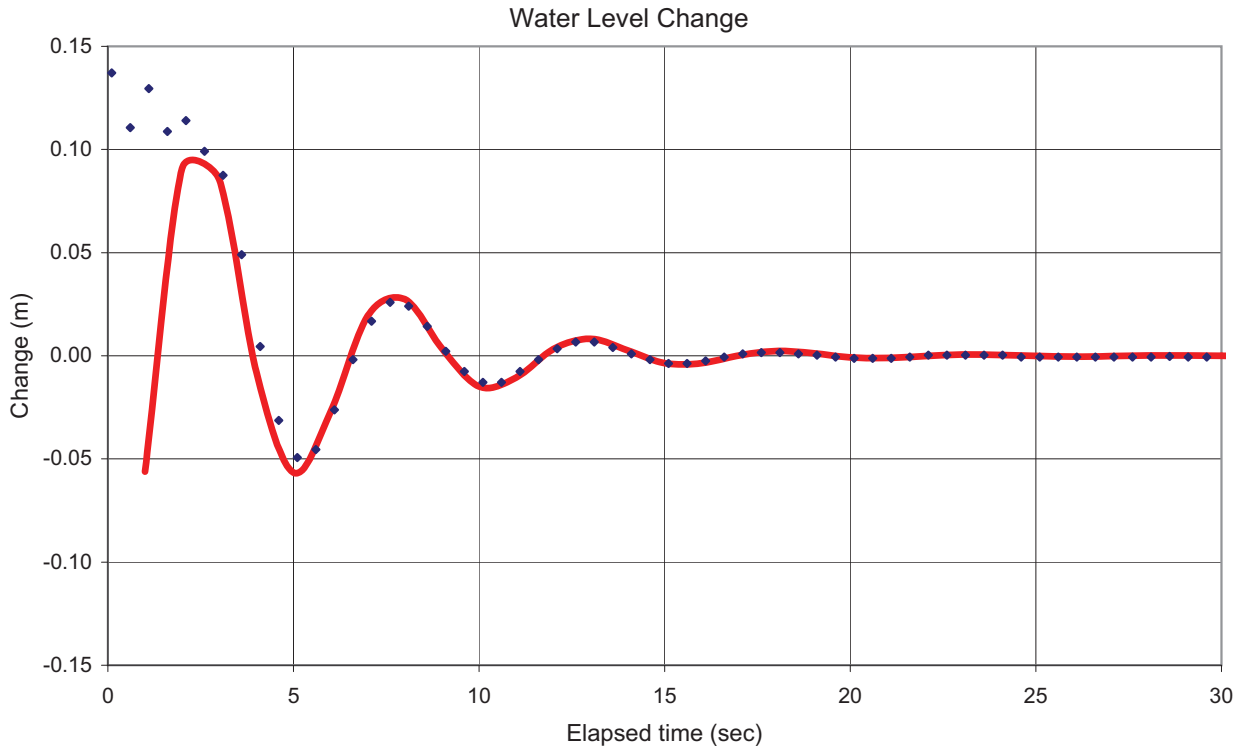
- Data
- Calculated Response

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-84D	Test date:	9/30/2008
Instrument type:	In-situ transducer	Test time:	11:32:40
Zone depth (m):	23.10	Screen type:	2 " PVC - 20 slot
Test length (m):	4.48	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	19.84	d:	0.20
Depth to water (m):	7.11	angular frequency (per second):	1.20
Height of w. theoretical (m):	6.50	damping constant:	0.25
Height of water actual (m):	12.73	Initial amplitude:	-0.2
K (m/s):	7.00E-04	Transmissivity (m2/s):	3.14E-03
Storage:	1.00E-03	Time Shift (s):	-0.90





Legend

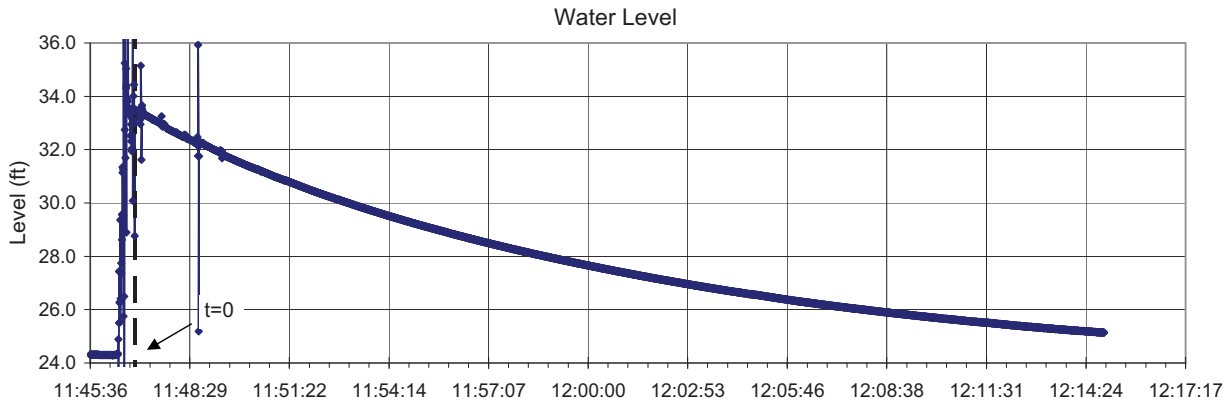
- Data
- Calculated Response

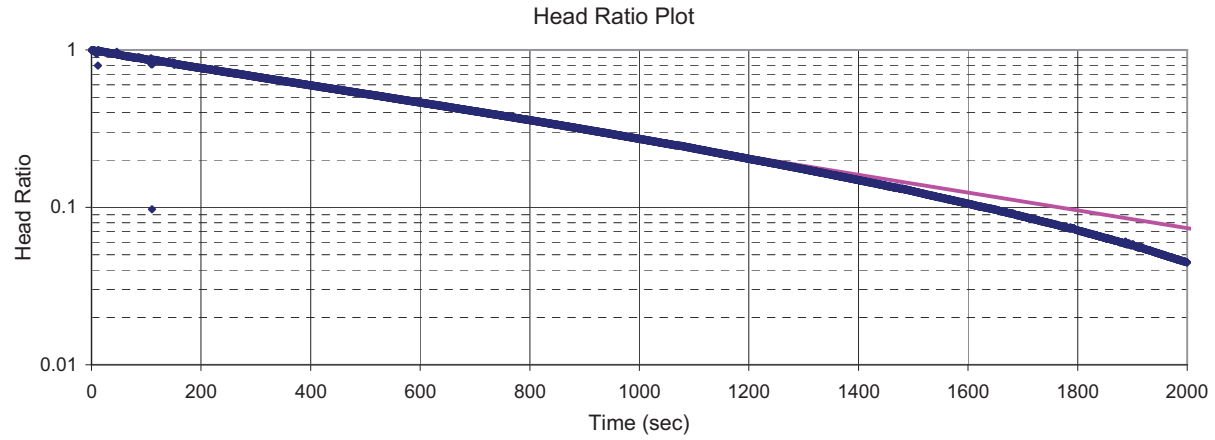
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-84S	Test date:	9/30/2008
Instrument type:	In-situ transducer	Test time:	11:46:54
Zone depth (m):	10.00	Screen type:	2 " PVC - 20 slot
Test length (m):	3.60	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	4.50E-07	Transmissivity (m^2/s)	1.62E-06







Legend

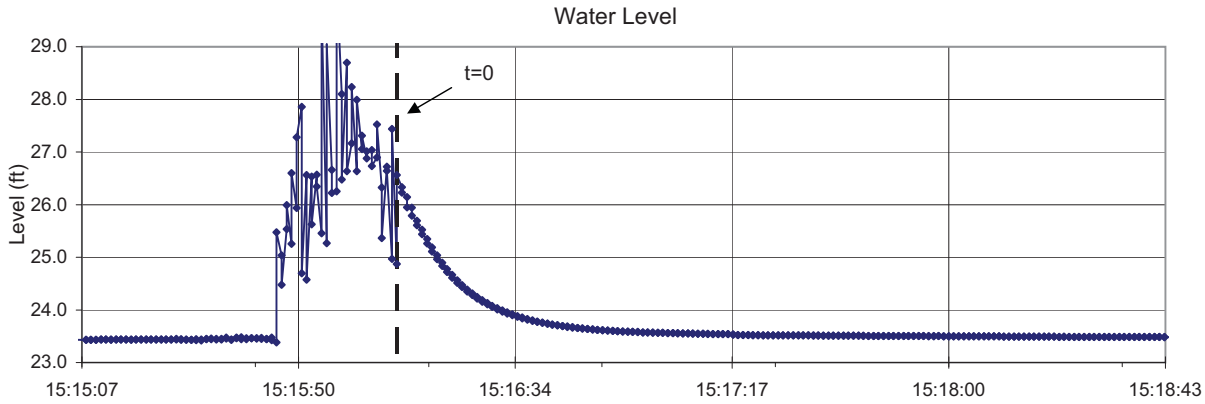
- Data
- Hvorslev Plot

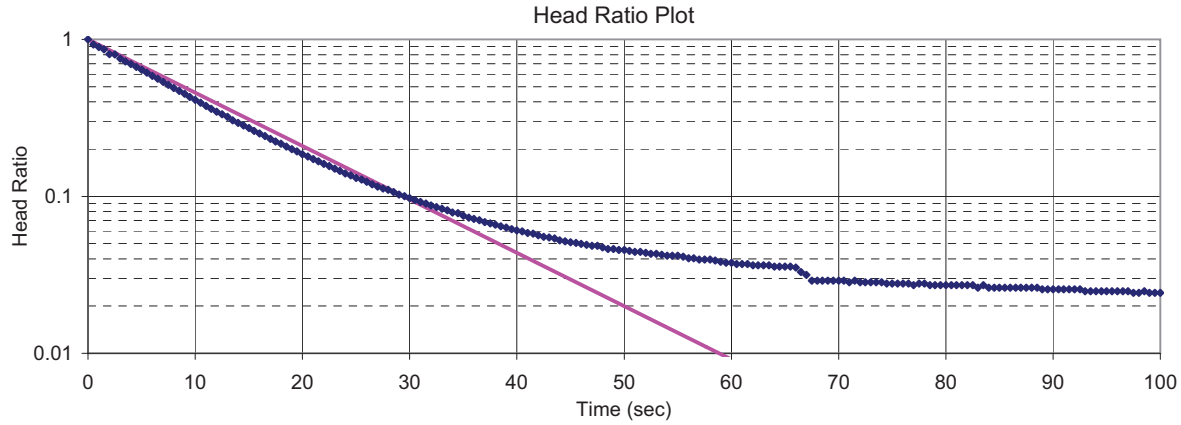
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-86D	Test date:	10/2/2008
Instrument type:	In-situ transducer	Test time:	15:16:10
Zone depth (m):	22.89	Screen type:	2 " PVC - 20 slot
Test length (m):	3.99	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	2.50E-05	Transmissivity (m^2/s)	9.98E-05







Legend

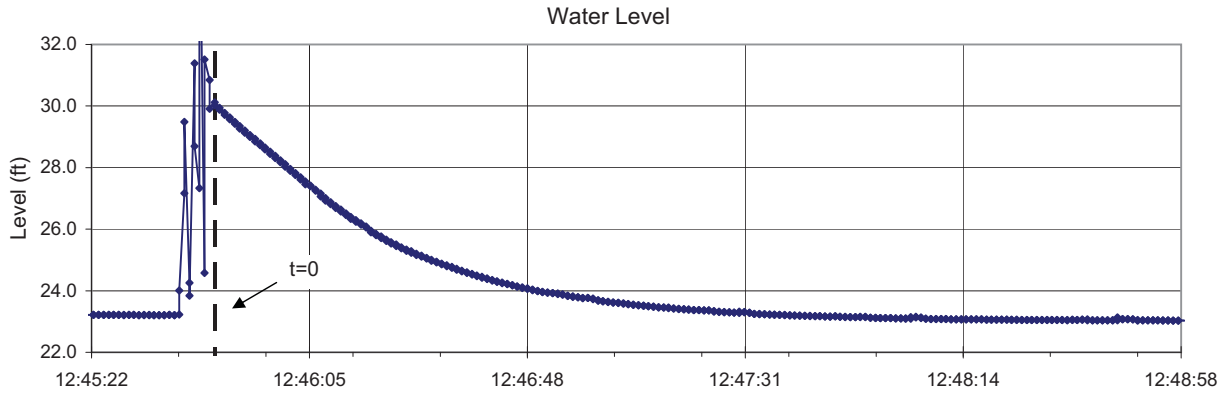
- Data
- Hvorslev Plot

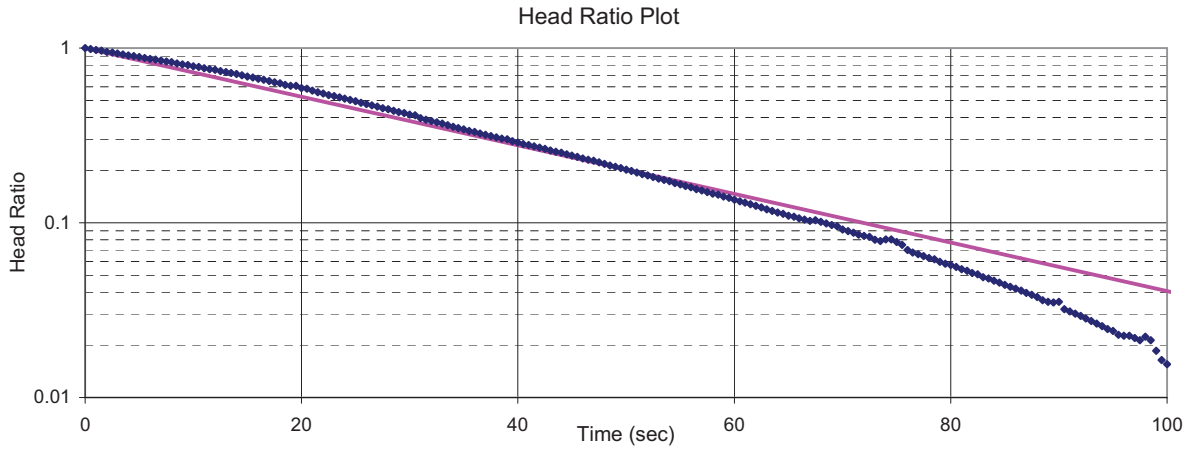
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-87D	Test date:	10/3/2008
Instrument type:	In-situ transducer	Test time:	12:45:46
Zone depth (m):	21.46	Screen type:	2 " PVC - 20 slot
Test length (m):	4.12	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	1.00E-05	Transmissivity (m^2/s)	4.12E-05







Legend

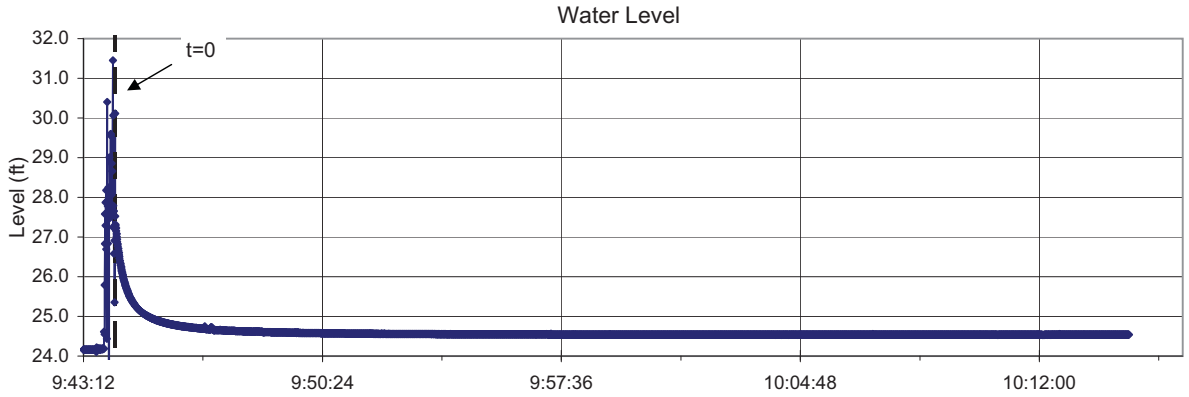
- Data
- Hvorslev Plot

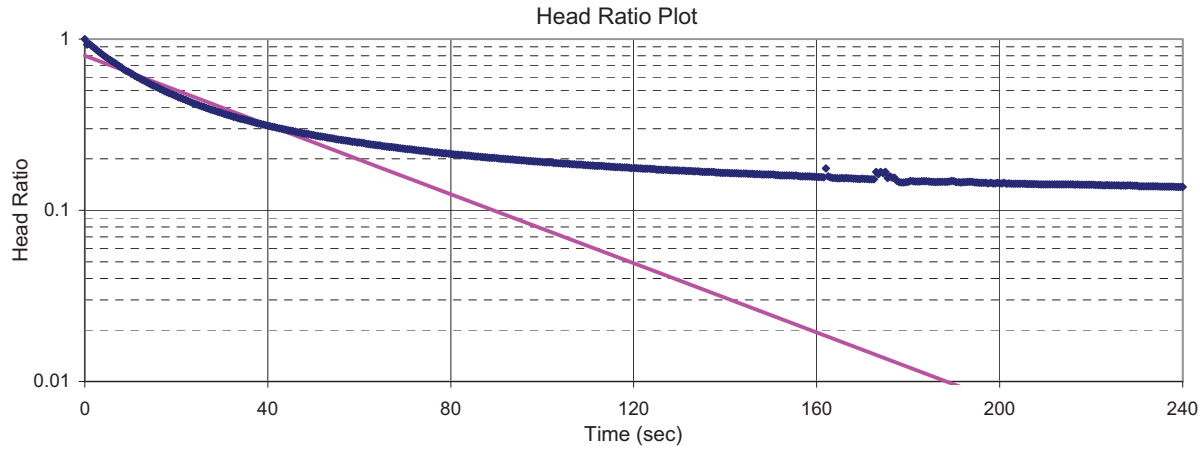
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-88D	Test date:	9/29/2008
Instrument type:	In-situ transducer	Test time:	9:44:09
Zone depth (m):	32.36	Screen type:	2 " PVC - 20 slot
Test length (m):	3.62	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.80		
K (m/s):	8.00E-06	Transmissivity (m^2/s)	2.89E-05







Legend

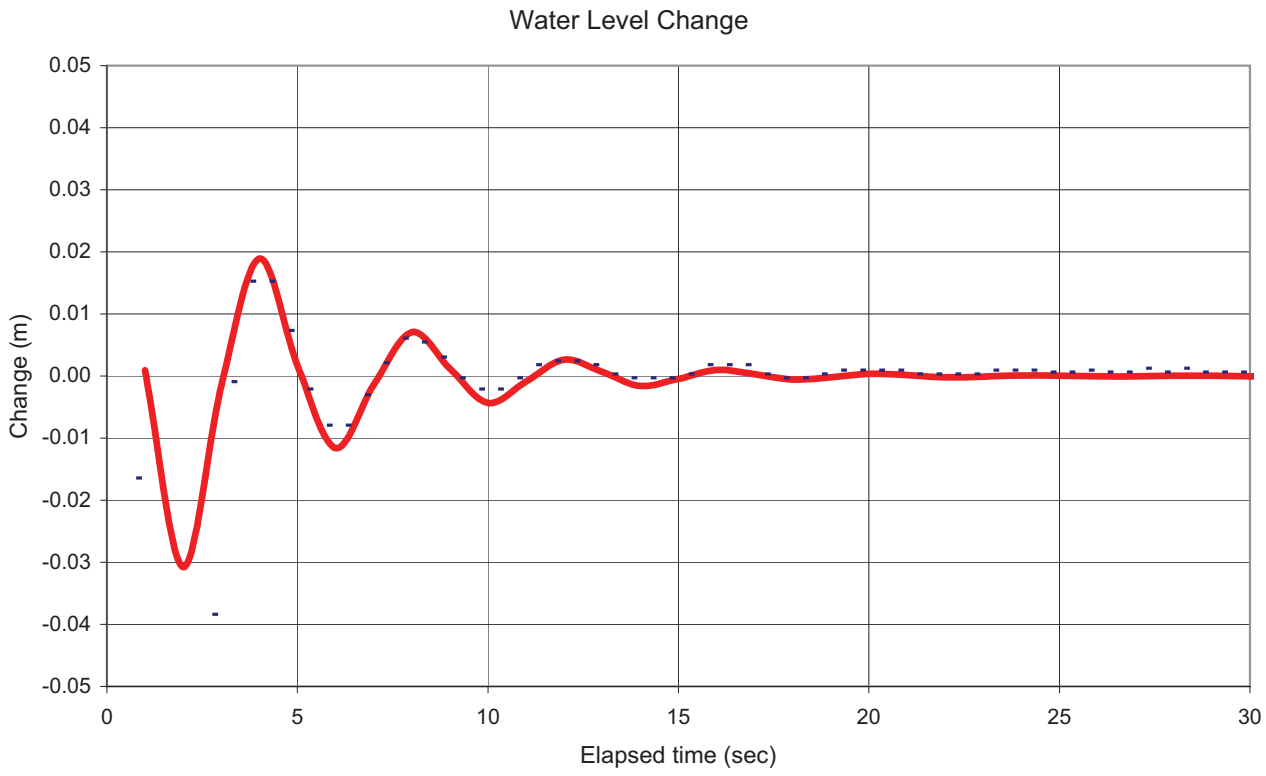
- Data
- Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 21, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - van der Kamp Analysis

Borehole No:	P-08-87S	Test date:	10/3/2008
Instrument type:	In-situ transducer	Test time:	12:17:44
Zone depth (m):	15.88	Screen type:	2 " PVC - 20 slot
Test length (m):	3.75	Field technician:	SLR
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Depth of screen (m):	12.95	d:	0.15
Depth to water (m):	3.95	angular frequency (per second):	1.55
Height of water predicted(m):	4.00	damping constant:	0.24
Height of water (m):	9.00	Initial amplitude:	0.05
K (m/s):	1.50E-03	Transmissivity (m2/s):	5.62E-03
Storage:	8.00E-04	Time Shift (s):	0.80





Legend

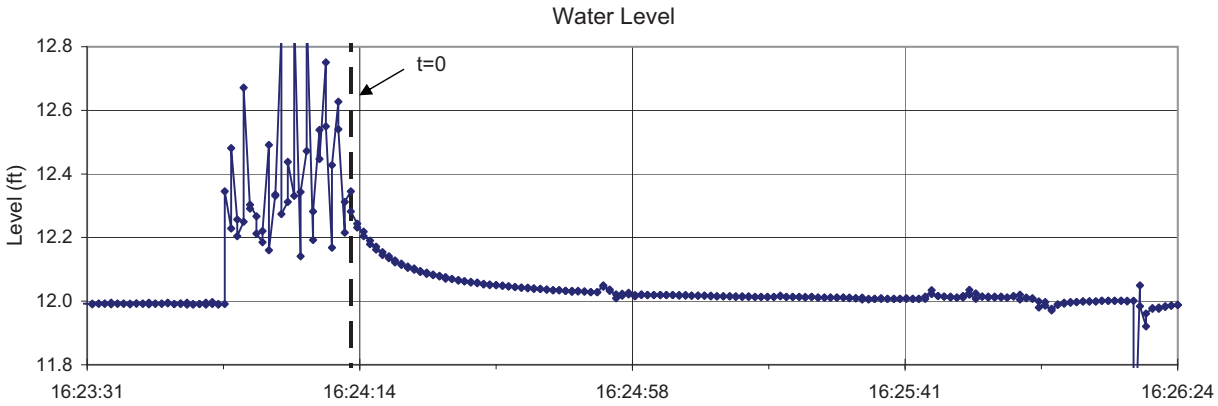
- Data
- Calculated Response

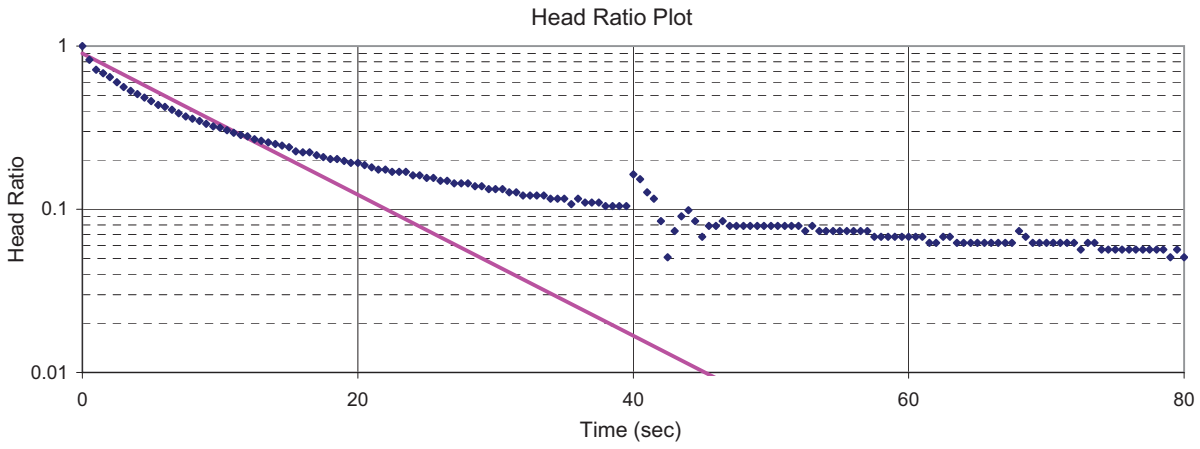
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-88S	Test date:	9/28/2008
Instrument type:	In-situ transducer	Test time:	16:24:13
Zone depth (m):	9.75	Screen type:	2 " PVC - 20 slot
Test length (m):	4.32	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.90		
K (m/s):	3.00E-05	Transmissivity (m^2/s)	1.30E-04







Legend

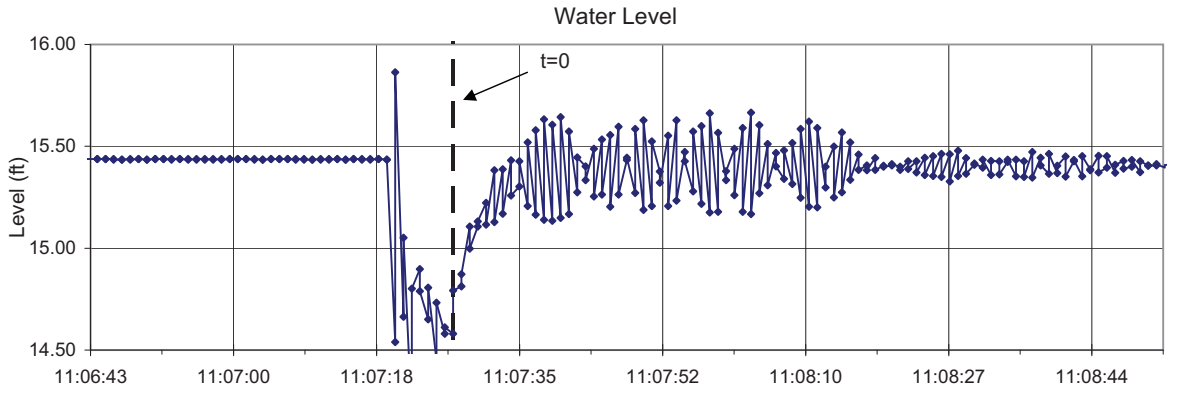
- Data
- Hvorslev Plot

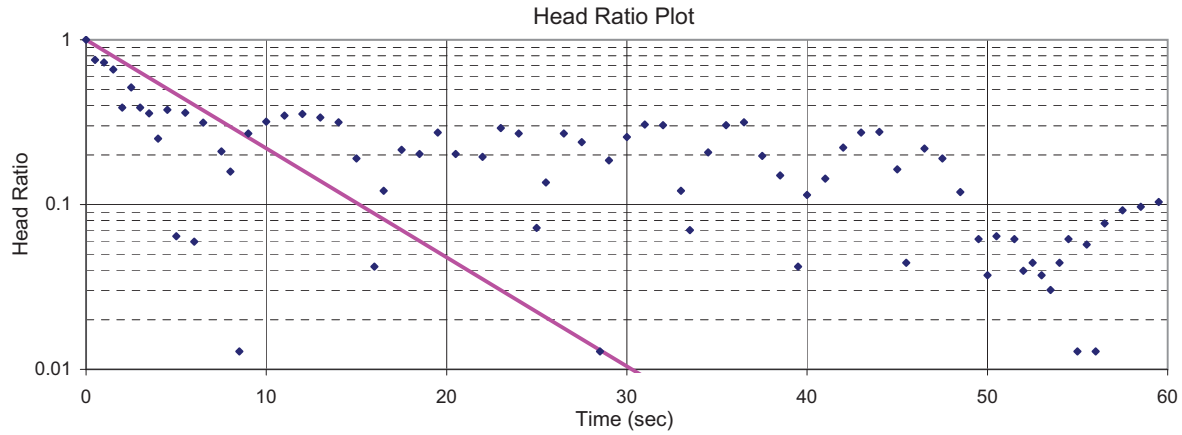
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-89D	Test date:	9/28/2008
Instrument type:	In-situ transducer	Test time:	11:07:27
Zone depth (m):	74.98	Screen type:	2 " PVC - 20 slot
Test length (m):	12.50	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	1.00		
K (m/s):	2.00E-05	Transmissivity (m^2/s)	2.50E-04







Legend

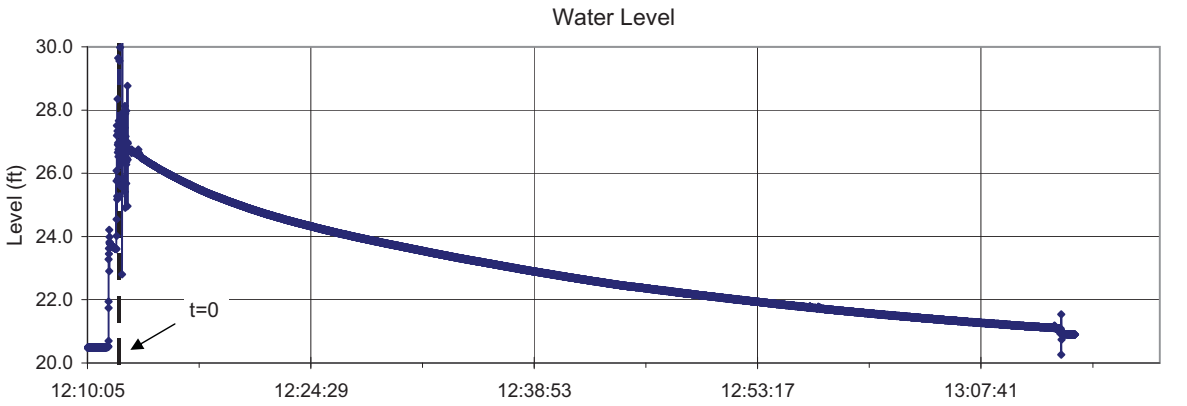
- Data
- Hvorslev Plot

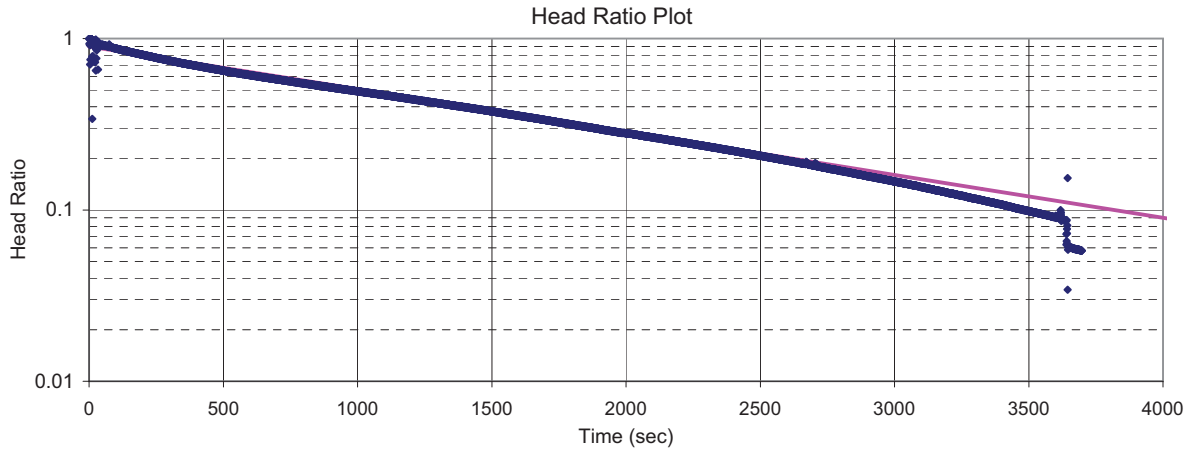
THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

BOREHOLE RESPONSE TEST - Hvorslev Analysis

Borehole No:	P-08-89S	Test date:	9/28/2008
Instrument type:	In-situ transducer	Test time:	12:12:07
Zone depth (m):	26.33	Screen type:	2 " PVC - 20 slot
Test length (m):	3.57	Field technician:	SLR Alaska
Hole diameter (m):	0.15	Analyst:	VS
Riser diameter (m):	0.05	Checked by:	RS
Hvorslev intercept:	0.90		
K (m/s):	2.00E-07	Transmissivity (m^2/s)	7.13E-07







Legend

◆ Data

— Hvorslev Plot

THE pebble PARTNERSHIP

Project No: 7126	Date: April 15, 2010
Version: 1	Author: SWS

APPENDIX 8.1D

Pumping Test Results

TABLE OF CONTENTS

TABLE OF CONTENTS i

LIST OF FIGURES (following Section 1.5) ii

ACRONYMS AND ABBREVIATIONS iii

1. North Fork Koktuli 1

    1.1 PW-08-10 1

2. PEBBLE Deposit Area 1

    2.1 PW-1 1

    2.2 PW-8 2

    2.3 PW-08-09 3

3. South Fork Koktuli River Near Frying Pan Lake 4

    3.1 PW-5 4

    3.2 PW-6 4

    3.3 PW-7 5

4. South Fork Koktuli River Downstream of Frying Pan Lake 6

    4.1 PW-3 6

    4.2 PW-4 6

5. References 7

LIST OF FIGURES (following Section 1.5)

Figure 8.1D-1, Pumping Test Locations
Figure 8.1D-2, Site Plan of PW-08-10 Pumping Test
Figure 8.1D-3, Cross Section for Pumping Well PW-08-10
Figure 8.1D-4, PW-08-10 Pumping Test P07-50D Analysis
Figure 8.1D-5, PW-08-10 Pumping Test P-07-53D Analysis
Figure 8.1D-6, Site Plan of PW-1 Pumping Test
Figure 8.1D-7, Cross Section for Pumping Well PW-1
Figure 8.1D-8, PW-1 Pumping Test P-6D Analysis
Figure 8.1D-9, Site Plan of PW-8 Pumping Test
Figure 8.1D-10, Cross Section for Pumping Well PW-8
Figure 8.1D-11, PW-8 Pumping Test P-05-29D Analysis
Figure 8.1D-12, PW-8 Pumping Test P-05-29D2 Analysis
Figure 8.1D-13, Site Plan of PW-08-09 Pumping Test
Figure 8.1D-14, Cross Section for Pumping Well PW-08-09
Figure 8.1D-15, PW-08-09 Pumping Test P-05-28D Analysis
Figure 8.1D-16, PW-08-09 Pumping Test GH-05-64 Analysis
Figure 8.1D-17, Site Plan of PW-5 and PW-6 Pumping Test
Figure 8.1D-18, Cross Section for Pumping Well PW-5
Figure 8.1D-19, PW-5 Pumping Test MW-05-14D Analysis
Figure 8.1D-20, Cross-Section for Pumping Well PW-6
Figure 8.1D-21, PW-6 Pumping Test, MW-05-14S Analysis
Figure 8.1D-22, Site Plan of PW-7 Pumping Test
Figure 8.1D-23, Cross-Section for Pumping Well PW-7
Figure 8.1D-24, PW-7 Pumping Test P-05-26D Analysis
Figure 8.1D-25, Site Plan of PW-3 Pumping Test
Figure 8.1D-26, Cross-Section for Pumping Well PW-3
Figure 8.1D-27, PW-3 Pumping Test MW11-M Analysis
Figure 8.1D-28, Site Plan of PW-4 Pumping Test
Figure 8.1D-29, Cross-Section for Pumping Well PW-4
Figure 8.1D-30, PW-4 Pumping Test MW-1M Analysis

ACRONYMS AND ABBREVIATIONS

gpm	gallon(s) per minute
m/s	meter(s) per second
m^2/s	meter(s) per second

PUMPING TEST RESULTS

1. NORTH FORK KOKTULI

1.1 PW-08-10

Pumping well PW-08-10 was located in the North Fork Koktuli River watershed northwest of the Pebble Deposit area (Figures 8.1D-1 and 8.1D-2) and was completed within the upper 14 feet of bedrock, which was weathered. The pumping well was cased to the overburden-bedrock contact. Borehole logs from nearby drill holes indicated the overburden in the area was a fairly homogeneous, unconfined sand and gravel aquifer overlying the weathered bedrock (Figure 8.1D-3; Appendix 8.1A).

Transducers were installed in two nearby bedrock wells, which were screened within the upper 15 feet of bedrock, and two overburden wells, which were screened above the bedrock contact at depths of 68 to 83 feet. All four wells were within 50 feet of the pumping well (Figure 8.1D-3). Pre-pumping water levels in the overburden wells were slightly higher than those in the bedrock wells prior to pumping.

The pumping well was tested at a rate of 84 gallons per minute (gpm) for 24 hours. Drawdown was observed in both bedrock wells, P-07-53D and P-07-50D, which were 47 and 33 feet away from the pumping well, respectively. The drawdown in the observation wells screened near the water table (P-07-53S and P-08-68D) was very small, indicating that water discharged during the test was drawn primarily from specific storage.

The weathered bedrock and the overlying overburden likely act as a single aquifer with an aquifer thickness of about 100 feet (33 meters). The recovery data gave the best results because the effects of variable pumping rates were averaged out. These data were analyzed with the Neuman method (Neuman, 1972) for unconfined aquifers, including the effect of partial penetration, using the Agarwal approach (1980) for recovery data (Figures 8.1D-4 and 8.1D-5). The calculated transmissivity was $5x10^{-3}$ square meters per second (m^2/s) at both P-07-50D and P-07-53D. Assuming an aquifer thickness of 100 feet, the calculated hydraulic conductivity of the aquifer was $1.5x10^{-4}$ meters per second (m/s).

2. PEBBLE DEPOSIT AREA

2.1 PW-1

Pumping well PW-1 was located near the middle of the Pebble Deposit Area in the South Fork Koktuli watershed (Figures 8.1D-1 and 8.1D-6) and was completed in upper bedrock (Figure 8.1D-7). Lithology from nearby borehole logs indicated a thin sand and gravel unit immediately overlying the weathered bedrock. The sand and gravel unit was overlain by a series of clay rich aquitards, and thin sand and gravel units (Figure 8.1D-7).

The well was tested at a rate of 11.2 to 8.7 gpm for 21 hours. During the test, water levels were monitored by two nests of piezometers: P-4AS and P-4AD; and P-6S, P-6M, and P-6D. These piezometers were

installed in both bedrock and overburden. Piezometers P-4AS and P-4AD were located 71 and 79 feet southwest of the pumping well, and piezometers P-6S, P-6M, and P-6D were located 248 to 263 feet northeast of the pumping well (Figure 8.1D-6). Pre-pumping water levels in wells completed beneath the confining units were slightly lower than shallow wells, indicating downward hydraulic gradients in the area. Piezometer P-4AS was screened in shallow sediments above the clayey units (Figure 8.1D-7) and did not respond to pumping. Piezometer P-6D was screened within the aquifer and had a maximum of 8.2 feet of drawdown. Piezometer P-6M was screened in silty material above a clay leaky confining unit and had a maximum drawdown of 2.3 feet. P-6S, similar to P-4AS, was screened above a clayey aquitard unit and did not respond to pumping. At the low pumping rate and limited duration of the test, measurable response would not necessarily be expected in the shallow wells, which were completed near the water table.

The data were analyzed using the Hantush method (Hantush, 1960) for vertical leakage from an upper unit accounting for storage, and a barrier boundary at 100 meters. The calculated transmissivity was about 8×10^{-5} m^2/s (Figure 8.1D-8). The transmissivity calculated using the Theis method (Theis, 1935) was very similar. Assuming an aquifer thickness of 16 feet (5 meters), representing the combined weathered bedrock and thin sand and gravel unit, the average horizontal hydraulic conductivity was about 1.6×10^{-5} m/s.

This result was about one order of magnitude lower than the average hydraulic conductivity of the response tests, which was 2×10^{-4} m/s. The test results suggest that the typical local hydraulic conductivity in the study area is greater than the larger scale hydraulic conductivity at this location. This difference may be due to the discontinuous and anisotropic[1] nature of fractured bedrock and overlying sand and gravel sediments or the natural variation in properties over a large area.

2.2 PW-8

Pumping well PW-8, which was located southeast of PW-1 in the Pebble Deposit area (Figures 8.1D-1 and 8.1D-9), was cased through the overburden and a few feet into bedrock, and then completed as an open hole 40 feet into bedrock. Borehole logs in the area indicate that a silt layer is the uppermost unit underlain by a gravel unit, a silty sand unit, another gravel unit, a second silt unit, a confined sand and gravel unit, and finally the bedrock (Figure 8.1D-10). A nest of four piezometers (P-05-29) completed at four depths (S, M, D, D2) were within 50 feet of the pumping well and were monitored throughout the test. Pre-pumping water levels in P-05-29S and P-05-29M were similar to each other and 1.0 to 1.5 feet higher than the two deeper bedrock monitoring intervals (P-05-29D and P-05-29D2), indicating a slight downward gradient.

The data were analyzed using the Hantush method (Hantush, 1960) for vertical leakage from an overlying unit accounting for storage within the leaky unit (Figures 8.1D-11 and 8.1D-12). The calculated transmissivity was about 3×10^{-4} m^2/s, which was very similar to the transmissivity calculated using the Theis method (Theis, 1935).

The transmissivity for PW-8 was about four times greater than the results from PW-1. Assuming an aquifer thickness of 42 feet (13 meters), which represented the bedrock thickness, the estimated average

[1] Anisotropic means that the fractures have a definite orientation and alignment. This means that water will flow preferably in the direction of the fractures.

horizontal hydraulic conductivity was about 2.3×10^{-5} m/s, which was very similar to the hydraulic conductivity calculated at PW-1.

2.3 PW-08-09

Pumping well PW-08-09 was located in Upper Talarik Creek watershed at the southeast boundary of the Pebble Deposit (Figures 8.1D-1 and 8.1D-13). Two clayey silt layers acted as aquitards and created a system of aquifers: a shallow unconfined overburden aquifer; an intermediate semi-confined overburden aquifer; and a deep, semi-confined fractured-bedrock aquifer (Figure 8.1D-14). A 6- to 8-feet-thick confining layer separated the shallow aquifer from the intermediate aquifer and a 15-feet-thick confining layer separated the intermediate aquifer from the bedrock aquifer. The pumping well was screened in the intermediate aquifer. A series of small lakes located about 330 feet to the west were identified as potential recharge boundaries during pumping.

Transducers were installed in four nearby piezometers, three of which were screened in overburden and one in bedrock. Pre-pumping water levels from wells screened below the confining layer were above the confining layer and higher than levels in the shallow aquifer, as shown in the cross-section (Figure 8.1D-14).

The pumping well was tested at a rate of 50 to 54 gpm for 24 hours. The closest piezometer to the pumping well was P-08-57D, which was about 48 feet away and was screened in the semi-confined fractured rock aquifer. The water level in P-08-57D varied only slightly during the test due to natural fluctuation and did not respond to pumping. Piezometer P-05-28S was screened in the shallow aquifer above the shallow silt layer 59 feet from the pumping well and also did not respond to pumping. These two observations indicated that the silt layers above and below the aquifer may have hydraulically confining properties. Piezometer P-05-28D was screened in the intermediate aquifer and was located about 41 feet from the pumping well. The maximum drawdown in this piezometer was about 8.5 feet. Piezometer GH-05-64 was located 756 feet from the pumping well, was also screened within the intermediate aquifer and had a maximum drawdown of 1.1 feet. Water levels in the pumped intermediate aquifer stayed above the confining layer throughout the pumping test.

Transducer data were collected for a few days before pumping began and one to two days after the system had recovered to assess water level trends that were unrelated to pumping. Rising trends in water level were noted in both P-05-28D and GH-05-64. These background trends were subtracted from the data prior to pumping test analysis.

The recovery data from piezometers P-05-28D and GH-05-64 were analyzed using both the Theis method (Theis, 1935) for confined aquifers and the Hantush method (Hantush, 1960) for leaky confined aquifers. The Agarwal (1980) approach was used for analyzing recovery data. The estimated aquifer thickness was 133 feet, corresponding to the thickness between the silt layers. For piezometer P-05-28D, the Theis model fit the early-time data. For piezometer GH-05-64, the Theis model fit the early and late-time data but not the intermediate-time data. These results suggested leakage from aquitards in some areas or recharge from the proximal lakes. When the leaky aquifer model (Hantush, 1960) was applied to each of the data sets, the drawdown at each piezometer was approximated but reached steady state earlier than the measured data. Therefore, the Theis analysis for piezometer P-05-28D was repeated with image wells to

simulate recharge from the nearby water bodies because this piezometer was relatively close to proximal ponds. This model resulted in a better fit to the data (Figure 8.1D-15).

In summary, the best fit to the data was obtained using a Theis analysis with a recharge boundary for piezometer P-05-28D, and an early-time Theis analysis for piezometer GH-05-64. The estimated transmissivity for the aquifer was $5.0x10^{-4}$ m^2/s from P-05-28D and $3.0x10^{-3}$ m^2/s from GH-05-64 (Figures 8.1D-15 and 8.1D-16). Based on the assumed thickness of 133 feet, the estimated hydraulic conductivity was $1.2x10^{-5}$ m/s and $7.4x10^{-5}$ m/s from P-05-28D and GH-05-64, respectively. The order of magnitude difference between the conductivity estimates was attributed to heterogeneity in the aquifer.

3. SOUTH FORK KOKTULI RIVER NEAR FRYING PAN LAKE

3.1 PW-5

Pumping well PW-5 was completed in upper bedrock near the South Fork Koktuli River about halfway between gauging stations SK110D and SK100F (Figures 8.1D-1 and 8.1D-17). Lithology in the area consisted of sand and gravel overburden sediments with a thin silty gravel unit followed by another unit of sand and gravel directly overlying the bedrock (Figure 8.1D-18). Bedrock was generally encountered at a depth of 45 to 50 feet except at MW-05-14D where the bedrock surface was considerably lower, which indicated a possible buried bedrock valley. Alternatively, the cuttings from this drill hole might have been mis-logged. The pre-pumping water levels were just within or just below the silty gravel unit (Figure 8.1D-18). This silty unit extends as far as P-05-25 and pinches out towards MW-05-14S, but it was absent in well MW-05-14D, where the shallow bedrock is overlain by sand and gravel.

Monitoring well MW-05-14S was screened in the sand and gravel just above the bedrock surface while MW-05-14D and P-05-25 were screened within the shallow bedrock. The pumping well was tested at a rate of 83 to 100 gpm for 24 hours. All three monitoring wells responded to pumping. The drawdown trend in MW-14S, which was installed in overburden, indicated that the sand and gravel unit and the underlying bedrock behaved as a single unconfined aquifer.

Using the Moench method (Moench, 1993) (Figure 8.1D-19), the calculated transmissivity was $1.4x10^{-2}$ m^2/s. The Moench method considered the response of an unconfined aquifer. Thus, assuming an aquifer thickness of 30 meters, which included the bedrock and the overlying overburden, the estimated hydraulic conductivity was about 4.6×10^{-4} m/s.

3.2 PW-6

Pumping well PW-6 was located 22 feet from PW-5 near the South Fork Koktuli River about halfway between gauging stations SK110D and SK100F (Figures 8.1D-1 and 8.1D-17). Borehole logs indicated that sediments in the overburden primarily consisted of sand and gravel with two silty gravel units (Figure 8.1D-20). The pumping well was screened in a sand and gravel unit just above the bedrock surface. Bedrock in the area was generally encountered at a depth of 45 to 50 feet except at MW-05-14D where bedrock surface was considerably lower, which indicated a possible buried bedrock valley. The pre-pumping water table was just above the bottom of the deeper silty gravel unit before pumping began.

The 9.5-hour pumping test at this well was operated at a relatively constant rate of 43 to 48 gpm. All four wells monitored during the test responded with maximum drawdown of 0.26 to 0.41 feet, including three wells completed in the bedrock. These results indicated that the shallow bedrock and overlying sand and gravel unit behaved hydraulically as a single aquifer.

The Hantush method (Hantush, 1960) was used to analyze the drawdown data from MW-05-14S (Figure 8.1D-21). This method considers vertical leakage and aquitard storage. The calculated transmissivity aquifer was about 1.8×10^{-2} m^2/s. Assuming an aquifer thickness of 98 feet (30 meters) representing the sand and gravel unit as well as the upper 85 feet of bedrock, the estimated horizontal hydraulic conductivity was about 6.0×10^{-4} m/s.

Results from the pumping test in PW-6 suggest that the shallow bedrock aquifer together with the sand and gravel overburden aquifer constitute a confined aquifer with leakage from the overlying silty aquitard. This interpretation contrasts with the interpretation for pumping test PW-5 because the piezometric levels were below the confining layer for PW-5 and above the confining layer for PW-6.

3.3 PW-7

Pumping well PW-7 was completed in overburden (sand and gravel) south of Frying Pan Lake and west of the South Fork Koktuli River (Figures 8.1D-1 and 8.1D-22). Lithology derived from borehole logs indicated a thick sequence of overburden sediments consisting primarily of sand and gravel but containing two silty sand units within the upper 60 feet of overburden (Figure 8.1D-23). Below these units was a thick sand and gravel aquifer that extended to a total depth of 185 feet. The pumping well was screened in the deep sand and gravel unit. A cluster of piezometers, all within 20 feet of the pumping well (P-05-26), were completed at three depths (S, M, and D) and were monitored during pumping.

Water levels were recorded for a few days before and two days after the pumping test to evaluate water level changes that were unrelated to pumping. The water levels in the responding well, P-05-26D, clearly trended upward before and after the test. This trend was subtracted from the drawdown data used for pumping test analysis.

The well was tested at a rate of 50 gpm for 24 hours. Piezometer P-05-26M remained dry throughout the pumping test, and P-05-26S did not respond to pumping. The adjusted maximum drawdown of piezometer P-05-26D was 0.15 feet.

The Neuman method (Neuman, 1974) was used to analyze the drawdown data from P-05-26D (Figure 8.1D-24). This method considers a delayed gravity response in an unconfined aquifer. It was used because the drawdown followed a typical response trend in unconfined aquifers subject to gravity drainage. The calculated transmissivity of the sand and gravel aquifer was about 0.11 m^2/s. Assuming a saturated aquifer thickness of 45 feet (13.7 meters), the estimated horizontal hydraulic conductivity was about 8.0×10^{-3} m/s.

4. SOUTH FORK KOKTULI RIVER DOWNSTREAM OF FRYING PAN LAKE

4.1 PW-3

Pumping well PW-3 was completed in overburden just south of the South Fork Koktuli River and just north of the surface water divide separating the South Fork Koktuli River watershed from the tributary UT1.190 watershed (Figures 8.1D-1 and 8.1D-25). Borehole logs in the area indicated the overburden consisted of a fairly homogeneous sand and gravel aquifer (Figure 8.1D-26). A nest of three piezometers (MW-11S, MW-11M, and MW-11D) contained transducers that monitored water level response prior to and during pumping within the sand and gravel aquifer. These piezometers were located 26 to 35 feet from the pumping well. Pre-pumping water levels were similar within the two deeper piezometers (MW-11M and MW-11D) but about 2 feet lower in MW-11S, indicating an upward gradient in the area.

The well was tested for 26 hours at a constant flow rate of 49.5 gpm. The drawdown response within piezometer MW-11M flattened out over time with a maximum drawdown of 0.44 feet. The flattening of the drawdown curve was likely due to delayed yield. The data were analyzed using the Neuman method. The close proximity of the observation wells to the pumping well and short screen lengths indicate vertical flow components probably influenced the measured response. Therefore, partial penetration of the wells was considered in the analysis. The calculated transmissivity of the aquifer was about 6.0×10^{-3} m^2/s (Figure 8.1D-27). Assuming an aquifer thickness of 85 feet (25.9 meters), the estimated horizontal hydraulic conductivity was about 2.3×10^{-4} m/s.

Response tests in the immediate area were completed in the three MW-11 wells. Well MW-11M was completed within the pumped horizon and the response test for this well indicated a hydraulic conductivity of 9×10^{-4} m/s. This higher value was most likely the result of natural variation of aquifer materials.

4.2 PW-4

Pumping well PW-4 was completed in overburden just south of the South Fork Koktuli River at the western end of the study area (Figures 8.1D-1 and 8.1D-28). Borehole logs in the area indicated a fairly homogeneous unit of sand and gravel over bedrock. The sand and gravel unit was about 128 feet thick (Figure 8.1D-29). A nest of wells (MW-1S, MW-1M, and MW-1D) located nearby were equipped with transducers to monitor water-level response prior to and during pumping at 3 depth intervals. Pre-pumping water levels in the two deeper monitoring wells were about 3.5 feet higher than in MW-1S prior to pumping.

The well was tested for 3 hours 38 minutes at a pumping rate of 357 gpm. Drawdown was observed in MW-1D and MW-1M but not in MW-1S. Measured drawdown in MW-1D was insufficient for pumping test analysis. Therefore, the data from well MW-11M were used to calculate aquifer transmissivity (Figure 8.1D-30). The drawdown curve for MW-11M gradually flattened during the intermediate part of the test, then steepened again during late time. This type of response likely indicated delayed yield. Therefore, the Neuman method (1974) was used to analyze the data. The effects of partial penetration were included in the analysis. The data collected during the first 30 seconds were not included in the

analysis because they appear to represent time lag in the observation well. The calculated transmissivity of the sand and gravel aquifer was about 5.3×10^{-1} m^2/s. Assuming an aquifer thickness of 128 feet (39 meters), the estimated horizontal hydraulic conductivity was about 1.3×10^{-2} m/s. This horizontal hydraulic conductivity was the highest value measured at the site.

Response tests in the immediate area were completed in the three MW-1 wells. Well MW-1M was screened within the pumped horizon and the response test indicated a hydraulic conductivity of about 1×10^{-5} m/s. The other two wells had response test results of about 6×10^{-4} m/s and 2×10^{-4} m/s. These values were all less than the pumping test value, which may indicate the limitation of the slug test method (permeability of filter and screen) and/or the natural variation of material properties.

5. REFERENCES

Agarwal, R.G. 1980. "A new method to account for producing time effects when drawdown type curves are used to analyze pressure buildup and other test data." *Proceedings of the 55th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers.* Dallas, TX, Sept. 21-24. Paper SPE 9289.

Hantush, M.S. 1960. "Modification of the Theory of Leaky Aquifers." *Journal of Geophysical Research.* Vol. 65: 1960. pp 3713-3725.

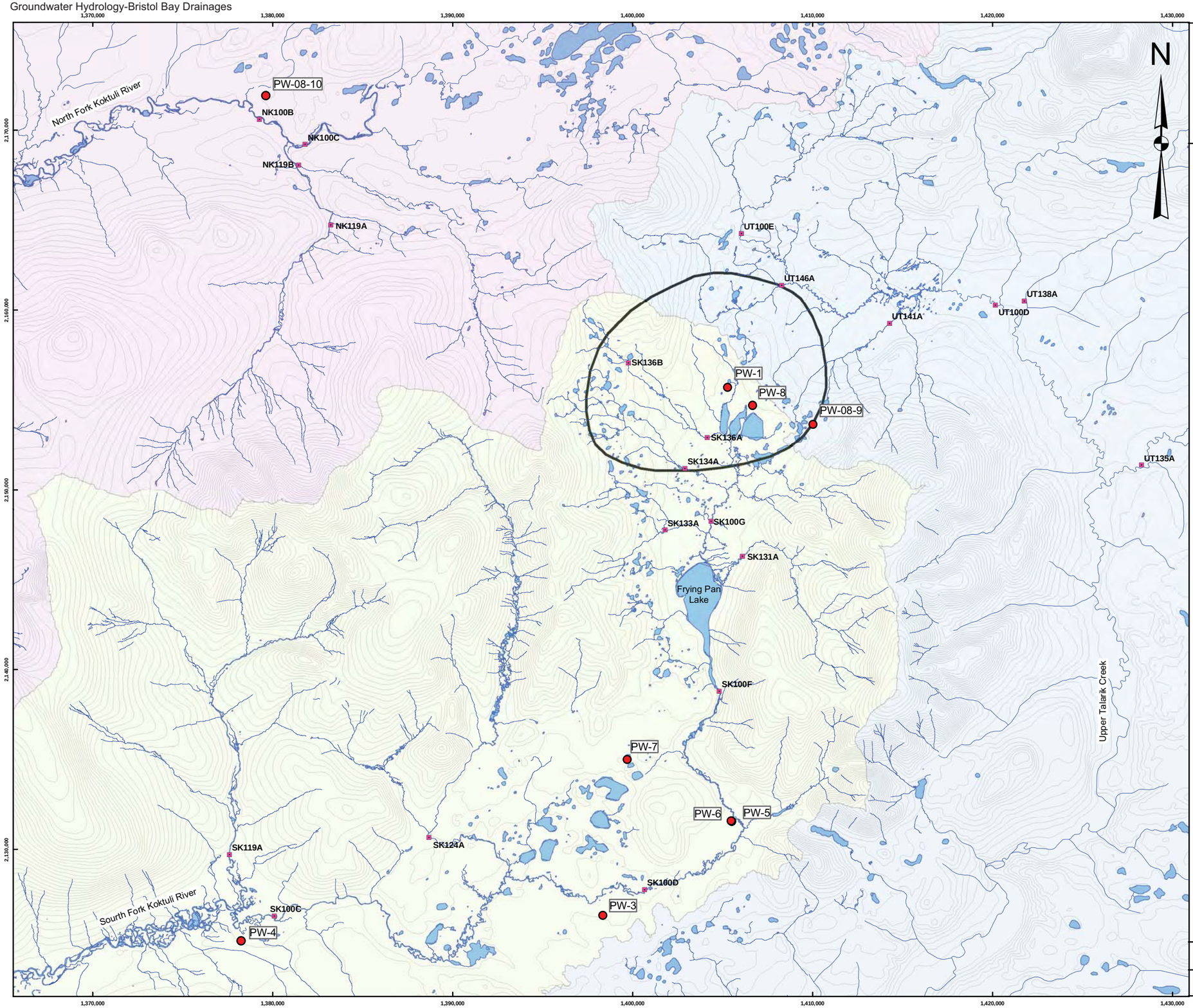
Moench, Allen F. 1993. "Computation of Type Curves for Flow to Partially Penetrating Wells in Water Table Aquifers." *Groundwater*, 31(6).

Neuman, Shlomo P. 1972. "Theory of Flow in Unconfined Aquifers Considering Delayed Response of the Water Table." *Water Resources Research*, 8(4). 1972.

Neuman, S. P. 1974 "Effect of partial penetration on flow in unconfined aquifers considering delayed gravity response." *Water Resources Research*, 10(2). 1974. pp 303-312.

Theis, C.V. 1935. The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage. *Transactions American Geophysical Union,* 2: 1935. pp 519-524.

FIGURES



THE pebble PARTNERSHIP

Figure 8.1D-1
Pumping Test Locations

Appendix 8.1D
Pumping Test Results

Legend

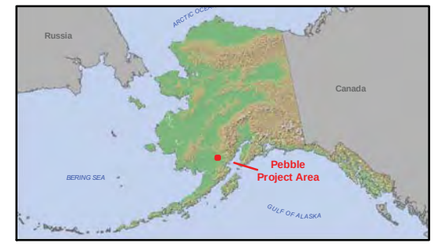
- Pumping Well (PW)
- Stream Gaging Station
- Rivers
- Lakes
- General Deposit Location
- 50-ft Contour Interval

Watershed

- North Fork Koktuli River
- South Fork Koktuli River
- Upper Talarik Creek

Notes:

1. Piezometer layout for each pumping test is shown on the respective plans within this appendix



0 4,000 8,000 12,000 16,000 Feet

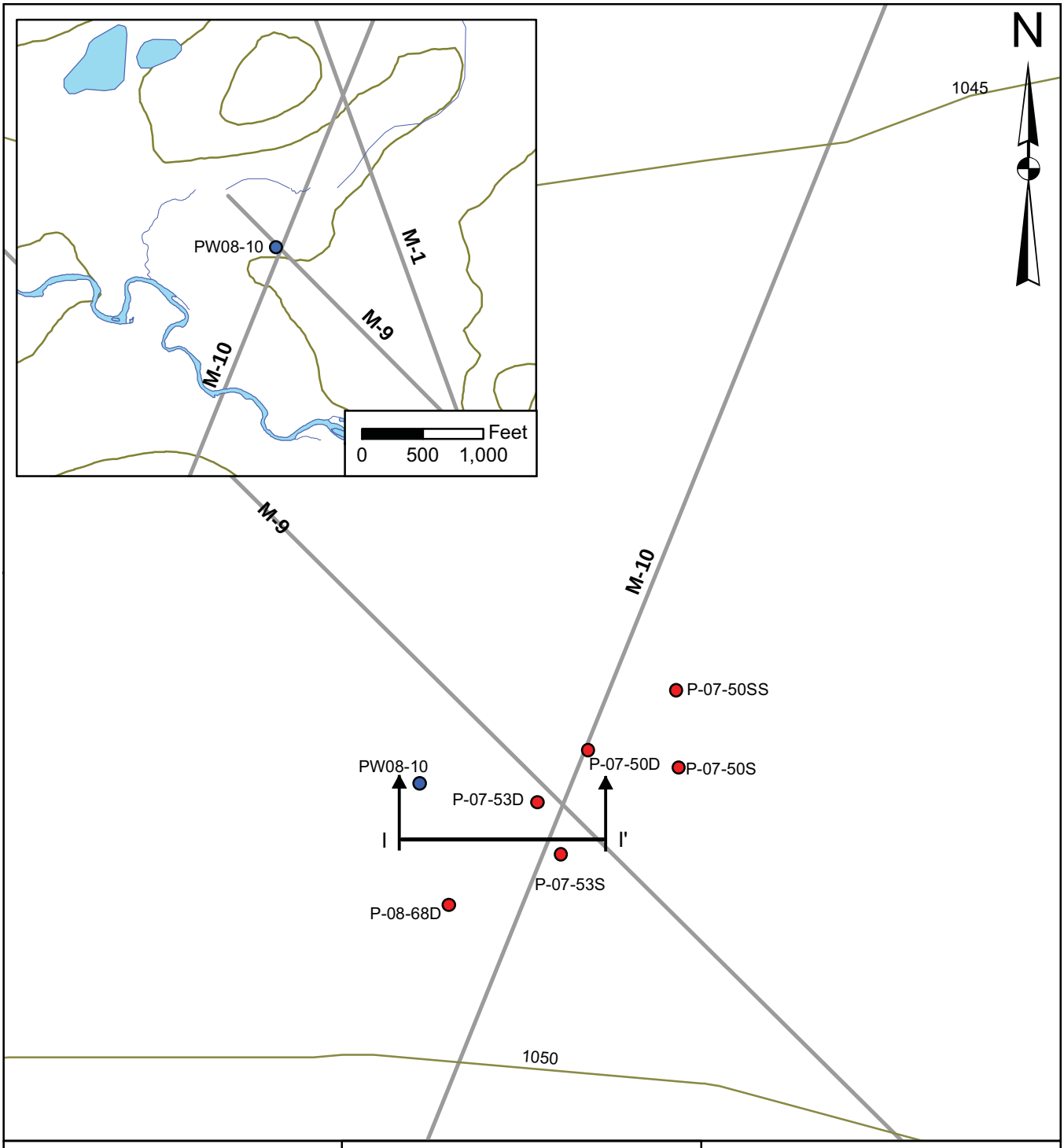
0 1,000 2,000 3,000 4,000 Meters

Scale 1:65,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 1 - Pumping Test Locations.mxd



Refer to Figure 8.1D-17
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Regional Cross Section
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet
0 10 20 30 40

Meters
0 4 8 12 16

Scale 1:500

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

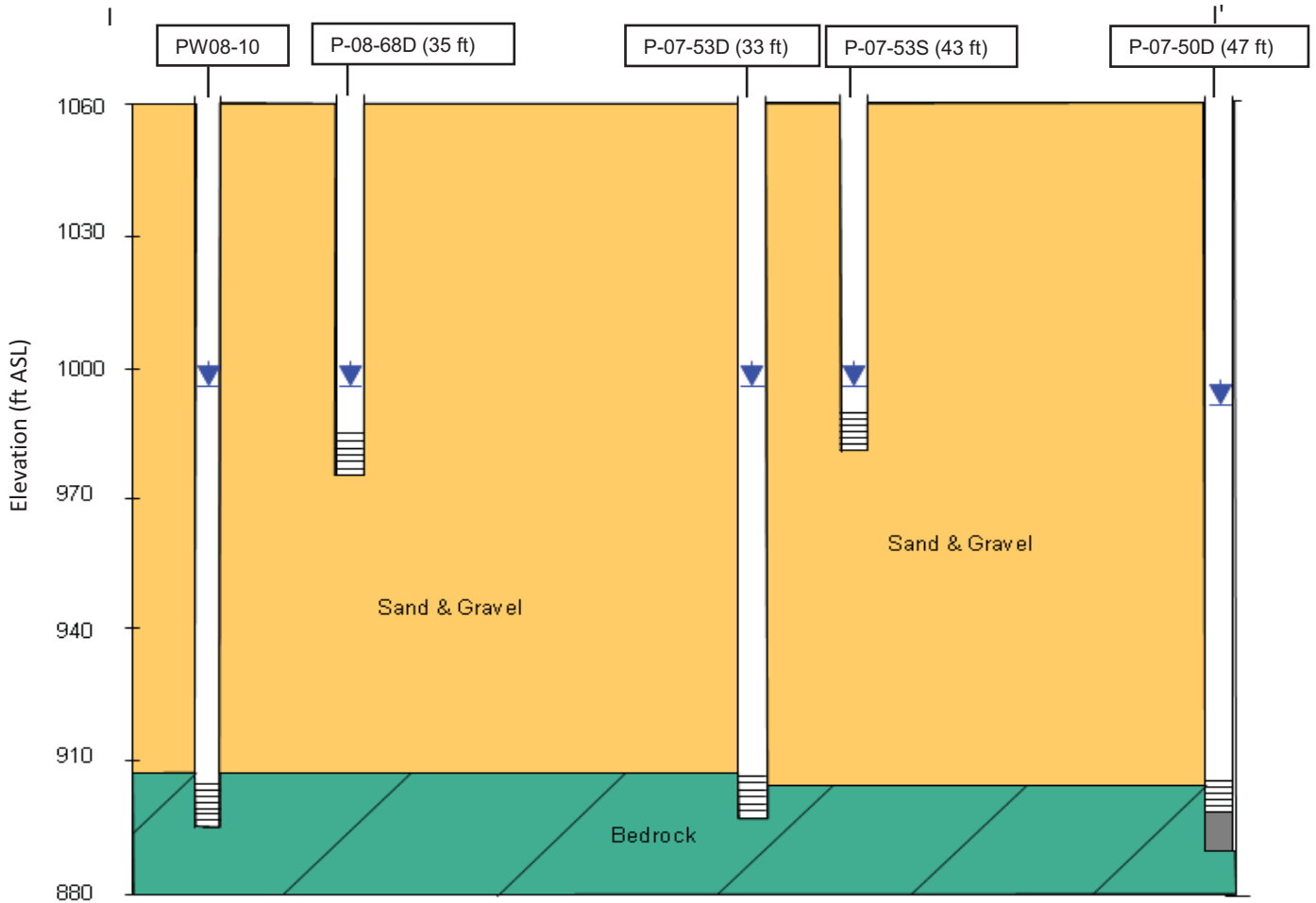
Figure 8.1D - 2
Site Plan of PW-08-10
Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 8 - Site Plan of P2-08-10.mxd

Looking North
Section Location on Figure 8.1D-2



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 3
Cross Section for
Pumping Well PW-08-10

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-08-10)

- Well Riser
- Well Screen
- Sealed Zone
- Water Level Elevation Before Pumping
- Sand & Gravel
- Bedrock

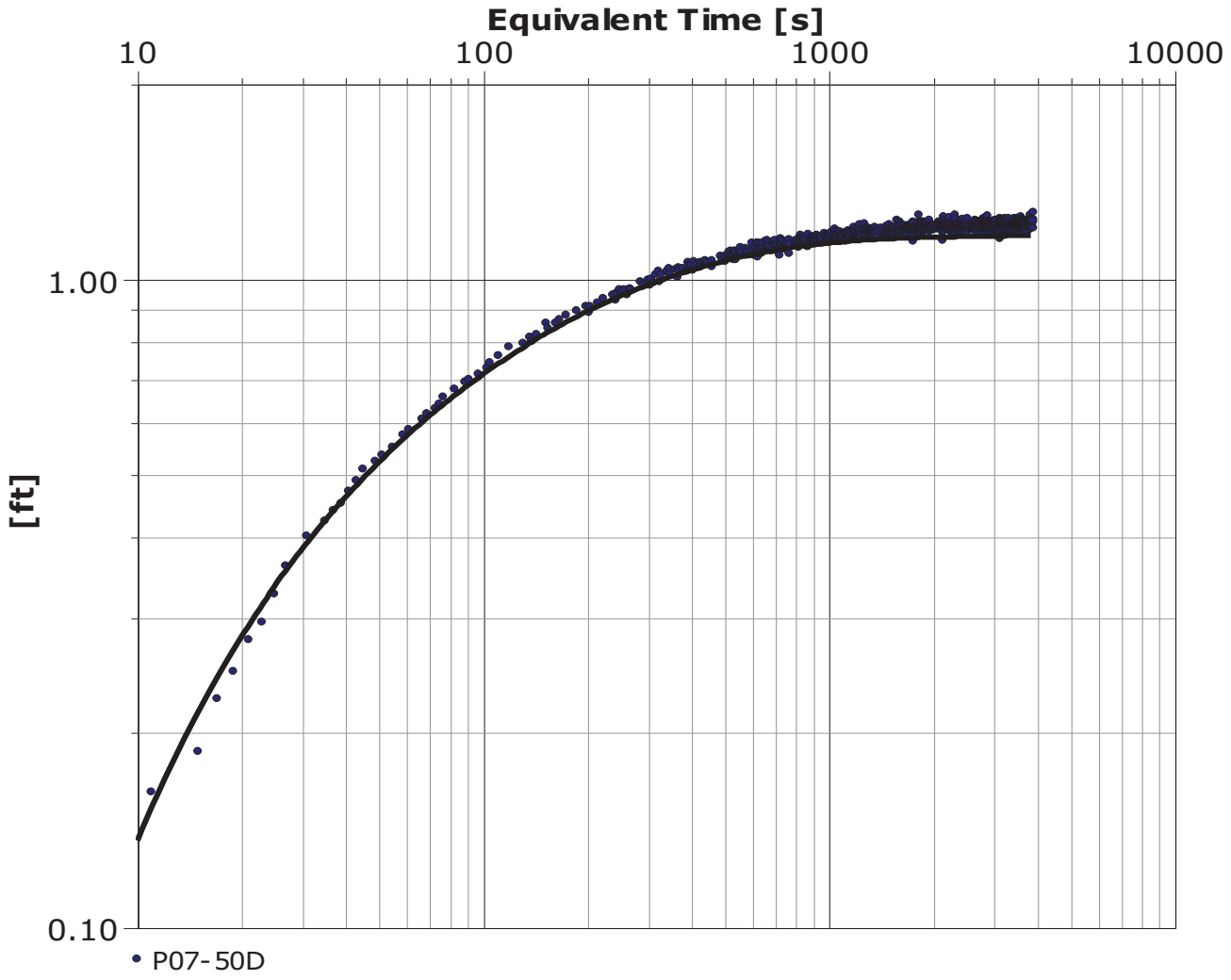
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



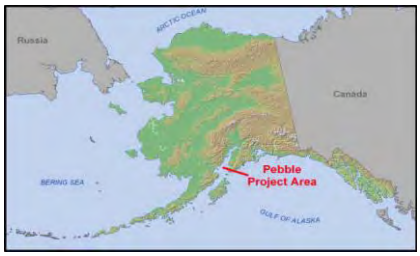
Refer to Appendix 8.1B for
Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-08-10	**Transmissivity (m^2/s):**	$5.0x10^{-3}$
Observation Well:	P07-50D	**Aquifer Thickness (m):**	33
Test Date:	7/15/2008	**Aquifer K (m/s):**	$1.5x10^{-4}$
Pumping Rate (m^3/s):	$5.3x10^{-3}$	**Aquifer K_v/K_h:**	$2x10^{-3}$
Pumping Method:	Airlift	**Aquifer S:**	$6.7x10^{-4}$
Analysis Method:	Neuman	**Aquifer S_y:**	0.1



Legend

Field Data

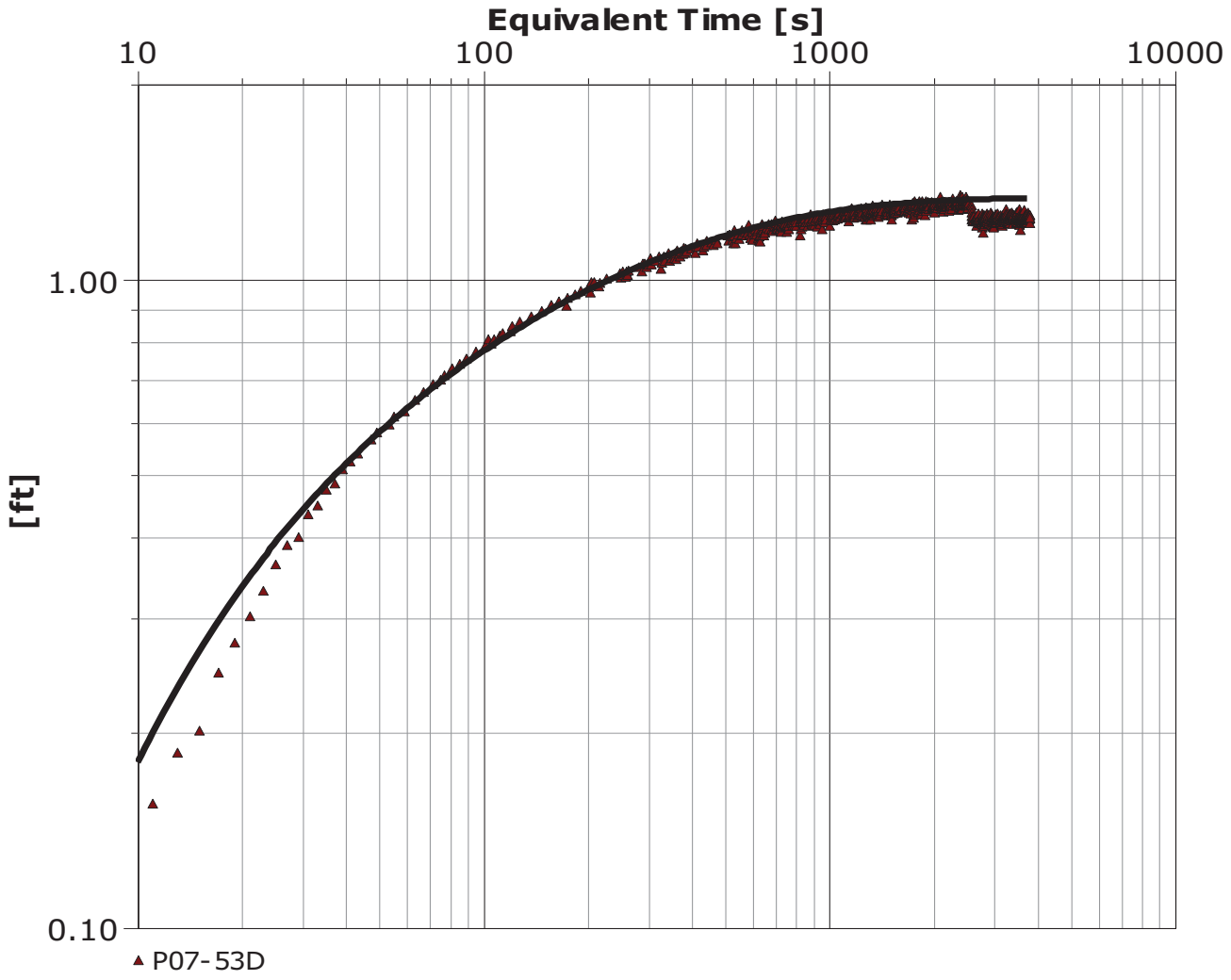
Type Curve

THE pebble PARTNERSHIP

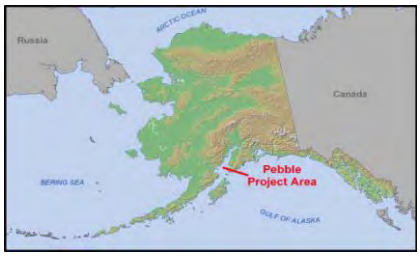
Figure 8.1D-4
PW-08-10 Pumping Test
P07-50D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

\\Manu\projects\Pebble_7-075\reporting\WMC 2009 EBD\Appendix_8.1D_Pumping_Test_Results\Pumping Test Results.xls



Pumping Well:	PW-08-10	**Transmissivity (m^2/s):**	$5.3x10^{-3}$
Observation Well:	P-07-53D	**Aquifer Thickness (m):**	33
Test Date:	7/15/2008	**Aquifer K (m/s):**	$1.6x10^{-4}$
Pumping Rate (m^3/s):	$5.3x10^{-3}$	**Aquifer K_v/K_h:**	$2x10^{-3}$
Pumping Method:	Airlift	**Aquifer S:**	$2.7x10^{-4}$
Analysis Method:	Neuman	**Aquifer S_y:**	4.00E-02



Legend

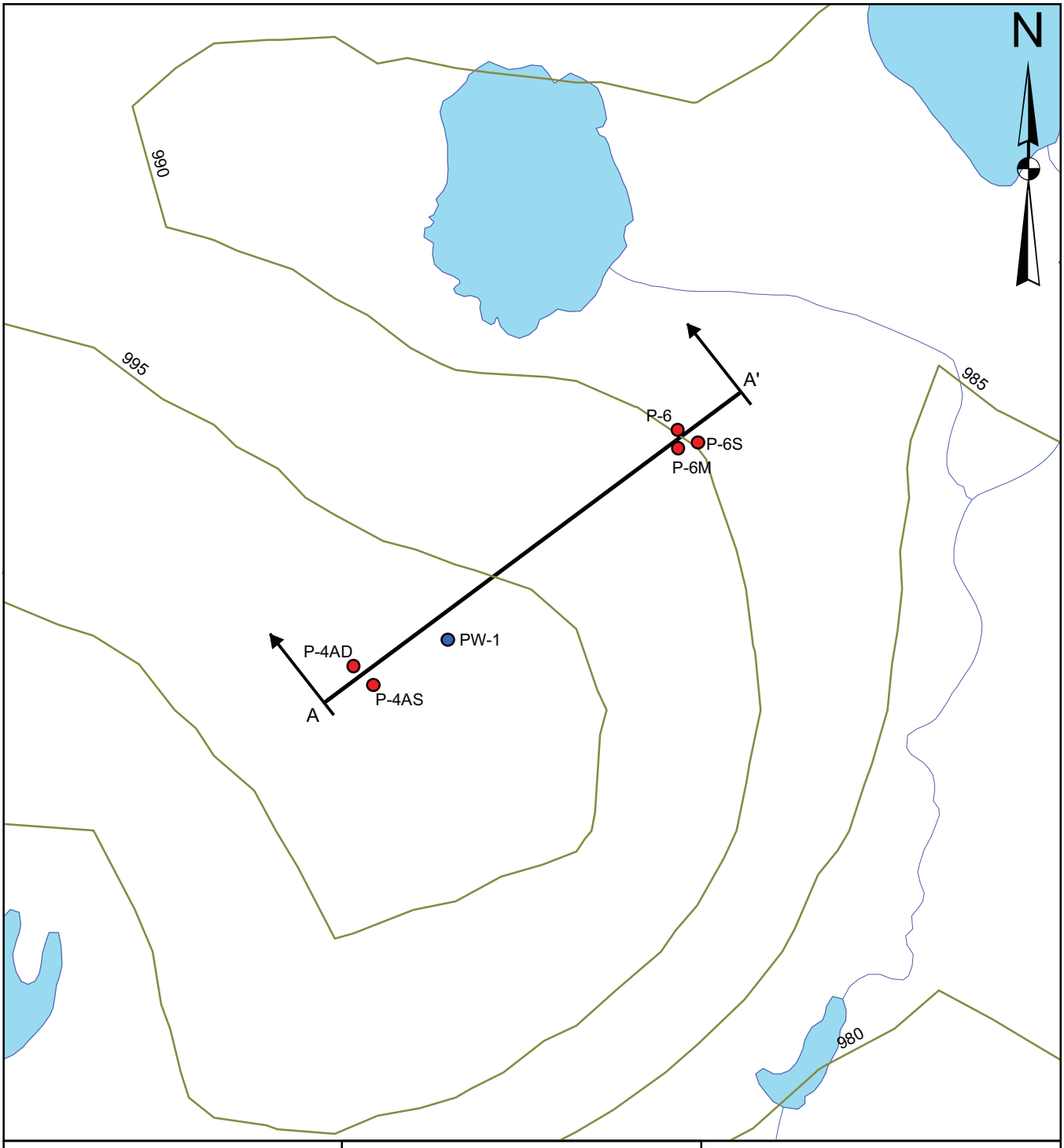
▲ Field Data

— Type Curve

Figure 8.1D-5
PW-08-10 Pumping Test
P-07-53D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

\\Manu\projects\Pebble_7-075\reporting\WMC 2009 EBD\Appendix_8.1D_Pumping_Test_Results\Pumping Test Results.xls



Refer to Figure 8.1D-9
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet: 0 40 80 120 160
Meters: 0 10 20 30 40

Scale 1:1,500

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

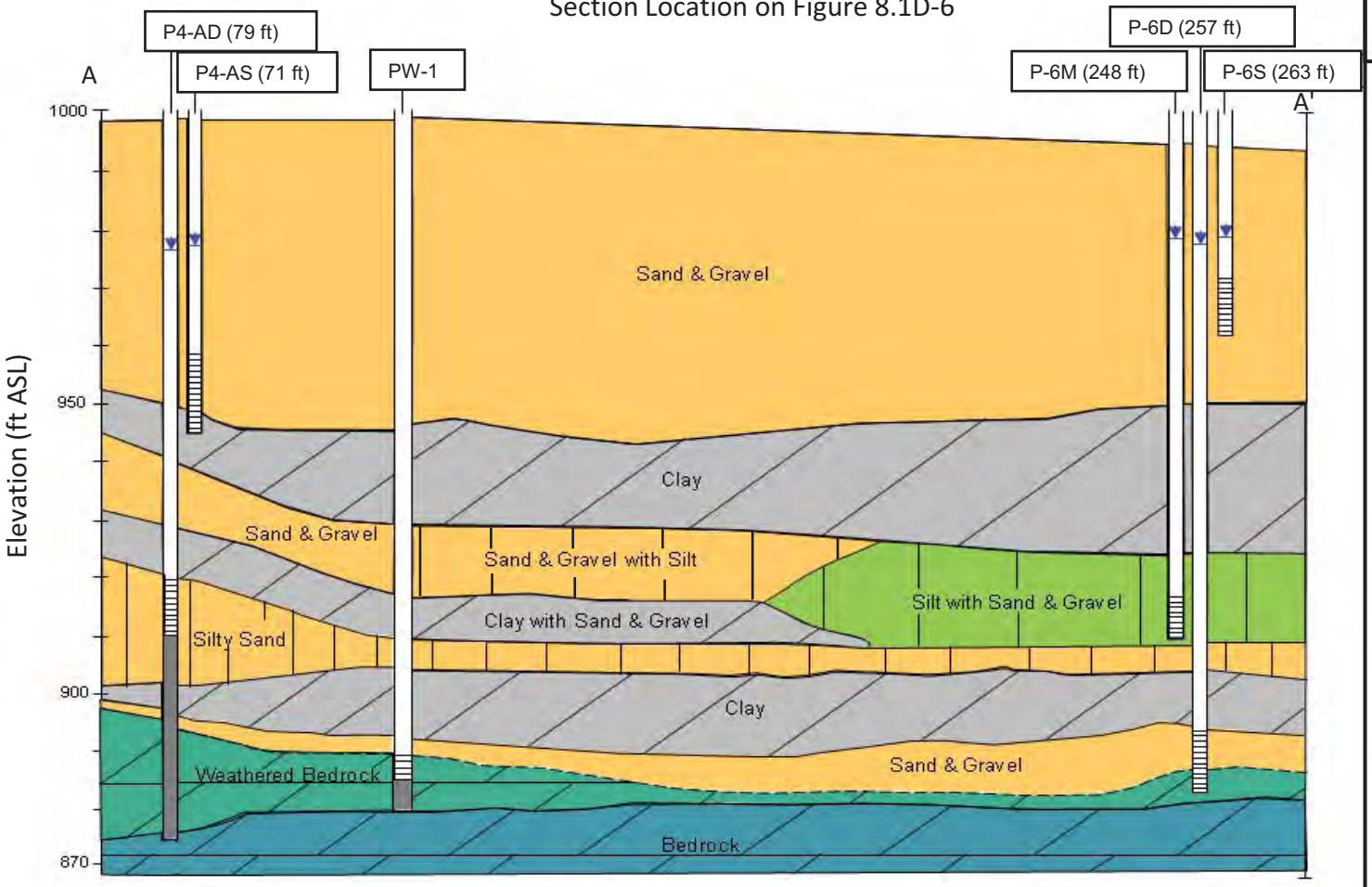
Figure 8.1D - 6
Site Plan of PW-1 Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 1 - Site Plan of PW-1.mxd

Looking Northwest
Section Location on Figure 8.1D-6



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 7
Cross Section for
Pumping Well PW-1

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-1)
Well Riser
Well Screen
Sealed Zone
Water Level Elevation Before Pumping
Sand & Gravel
Silty Sand
Clay
Silt
Weathered Bedrock
Bedrock

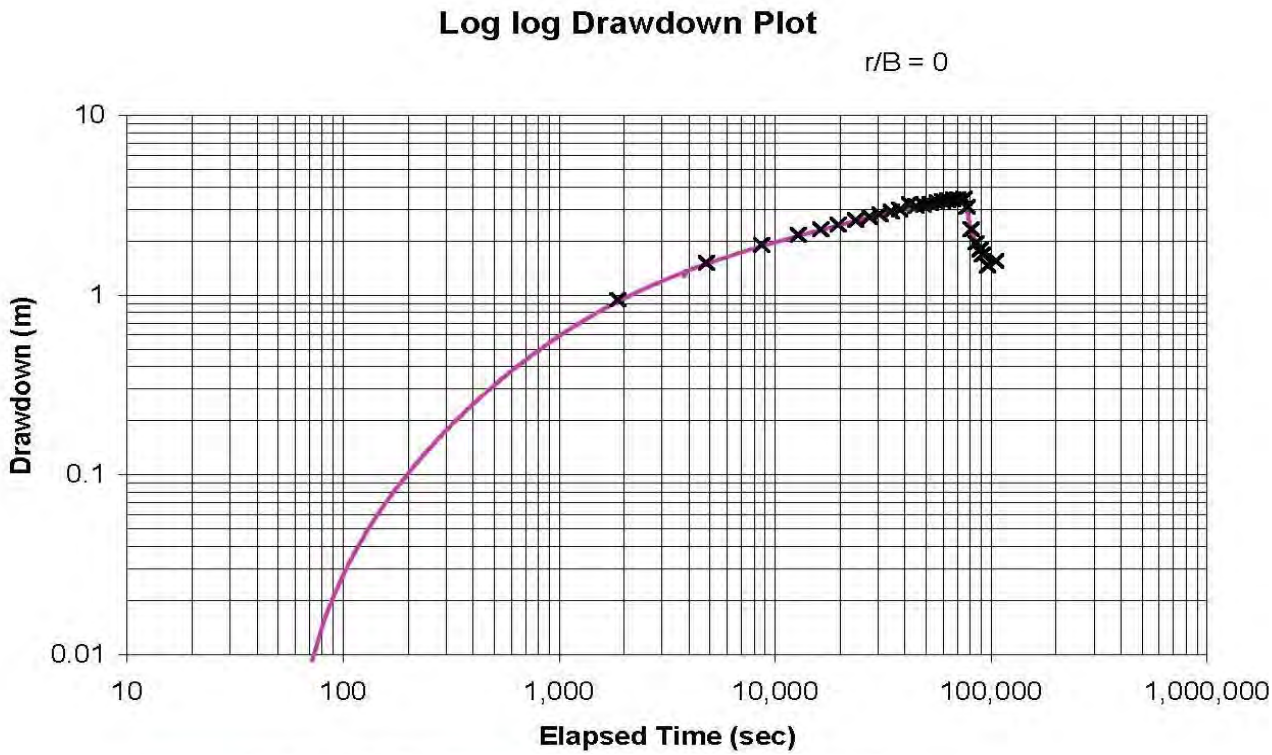
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



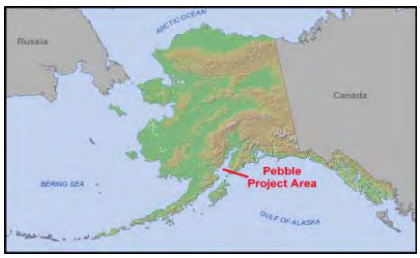
Refer to Appendix 8.1B for Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-1	**Transmissivity (m^2/s):**	8.0×10^{-5}
Observation Well:	P-6D	**Aquifer Thickness (m):**	5
Test Date:	9/21/2004	**Aquifer K (m/s):**	1.6×10^{-5}
Pumping Rate (m^3/s):	6.6×10^{-4}	**Aquifer S:**	1.3×10^{-5}
Pumping Method:	Airlift	**Aquifer S_y:**	
Analysis Method:	Hantush		



Legend

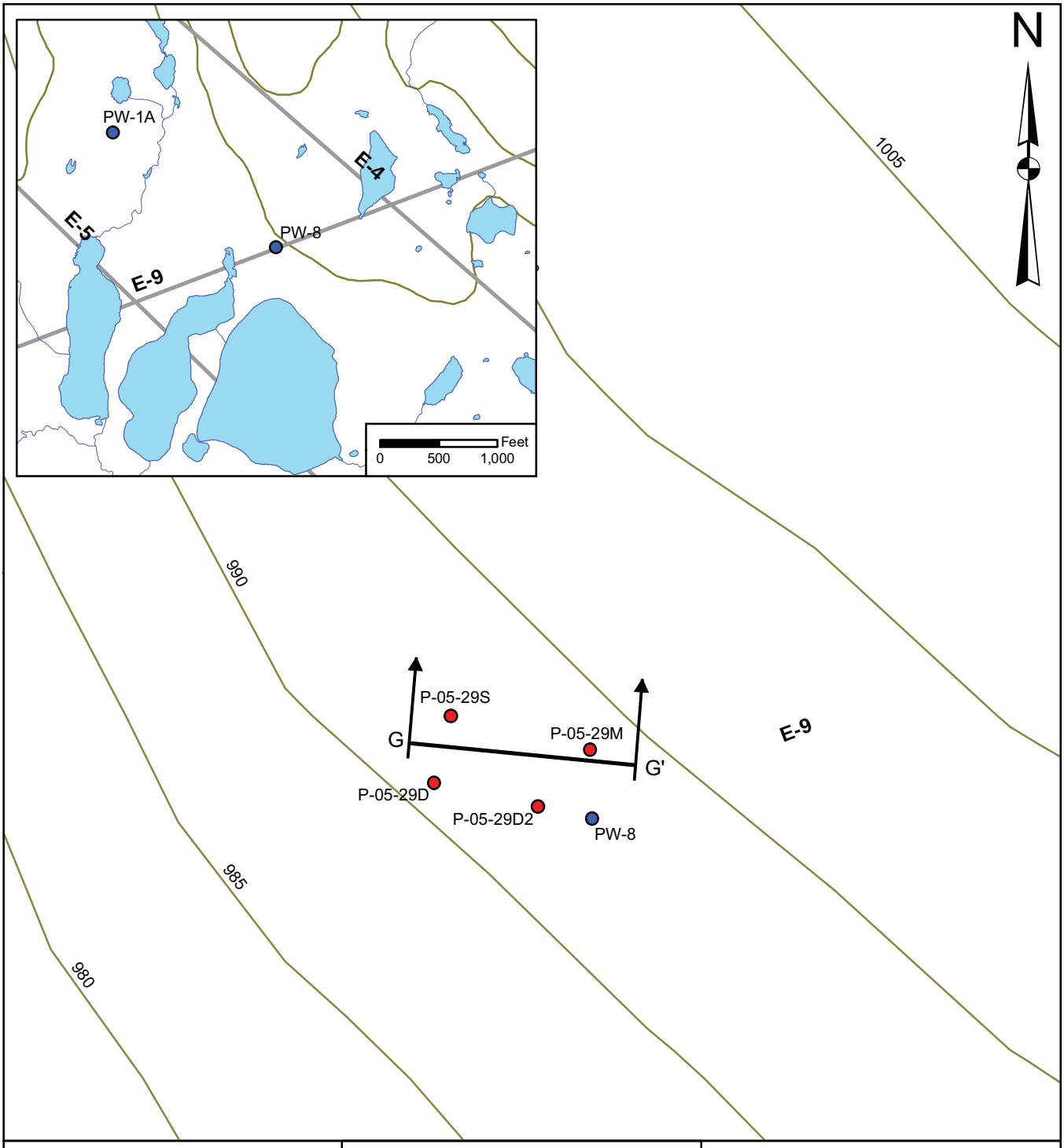
✕ Field Data

— Type Curve

THE pebble PARTNERSHIP

Figure 8.1D-8
PW-1 Pumping Test
P-6D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010



Refer to Figure 8.1D-15
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Regional Cross Section
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet
0 20 40 60 80

Meters
0 4 8 12 16

Scale 1:500

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

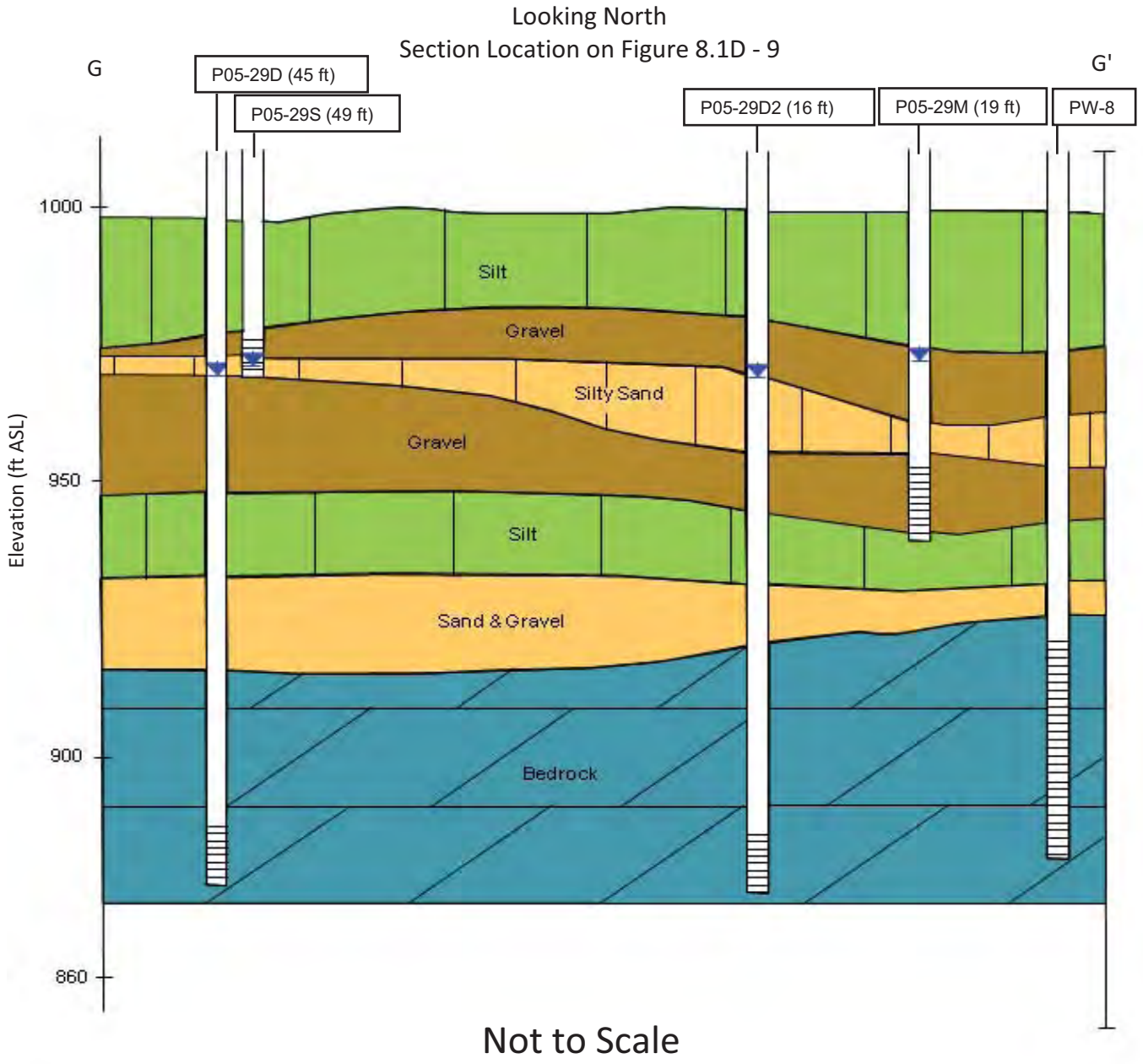
THE pebble PARTNERSHIP

Figure 8.1D - 9
Site Plan of PW-8 Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 6 - Site Plan of PW-8.mxd



THE pebble PARTNERSHIP

Figure 8.1D - 10
Cross Section for
Pumping Well PW-8

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-8)

Well Riser

Well Screen

Sealed Zone

Water Level Elevation Before Pumping

Silt

Bedrock

Gravel

Silty Sand

Sand & Gravel

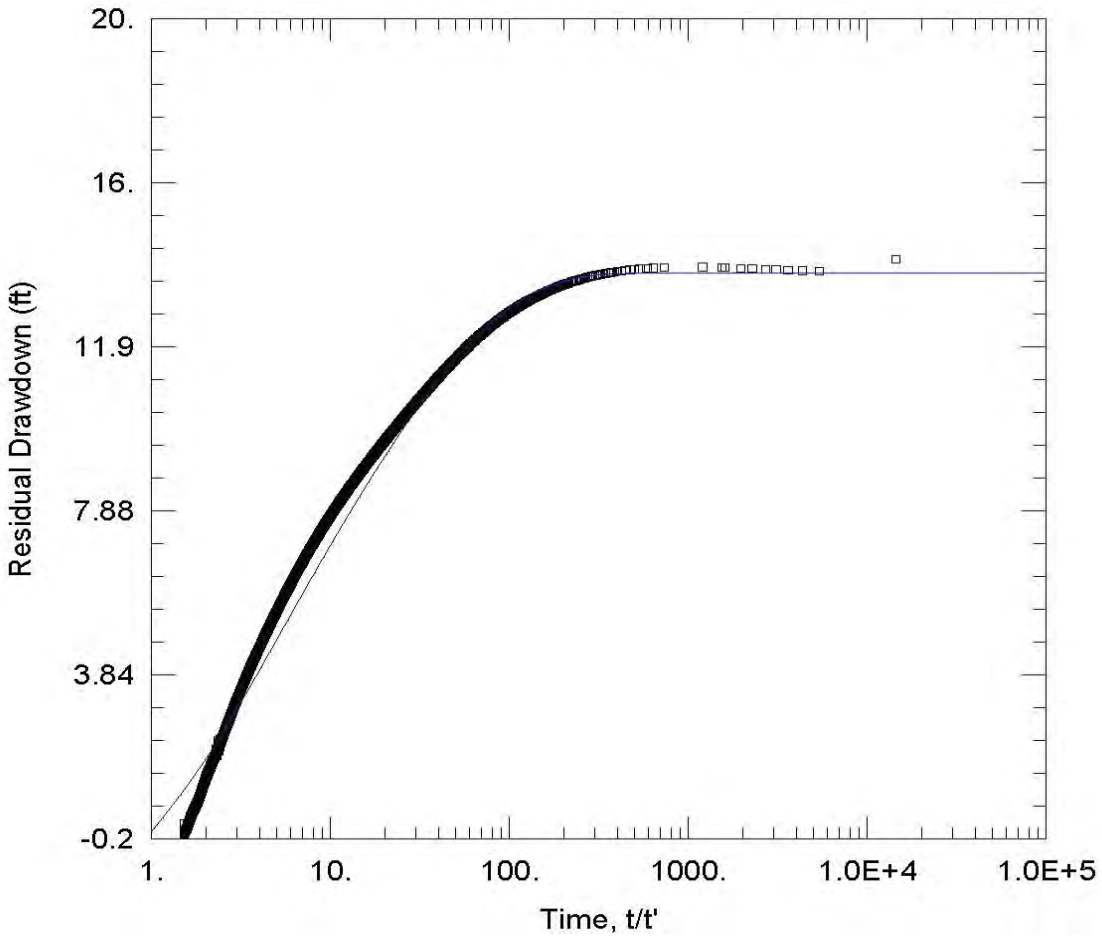
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



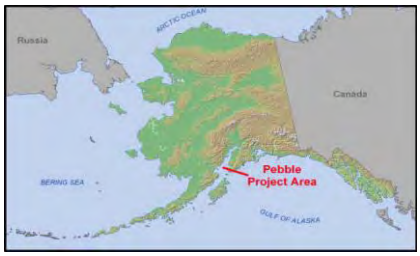
Refer to Appendix 8.1B for Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-8	**Transmissivity (m^2/s):**	$3.0x10^{-4}$
Observation Well:	P-05-29D	**Aquifer Thickness (m):**	13
Test Date:	5/9/2007	**Aquifer K (m/s):**	$2.3x10^{-5}$
Pumping Rate (m^3/s):		**Aquifer S:**	$5.0x10^{-3}$
Pumping Method:	Airlift	**Aquifer S_y:**	
Analysis Method:	Hantush	**β:**	$7.8x10^{-3}$
		Kz/Kr	$1.25x10^{-2}$



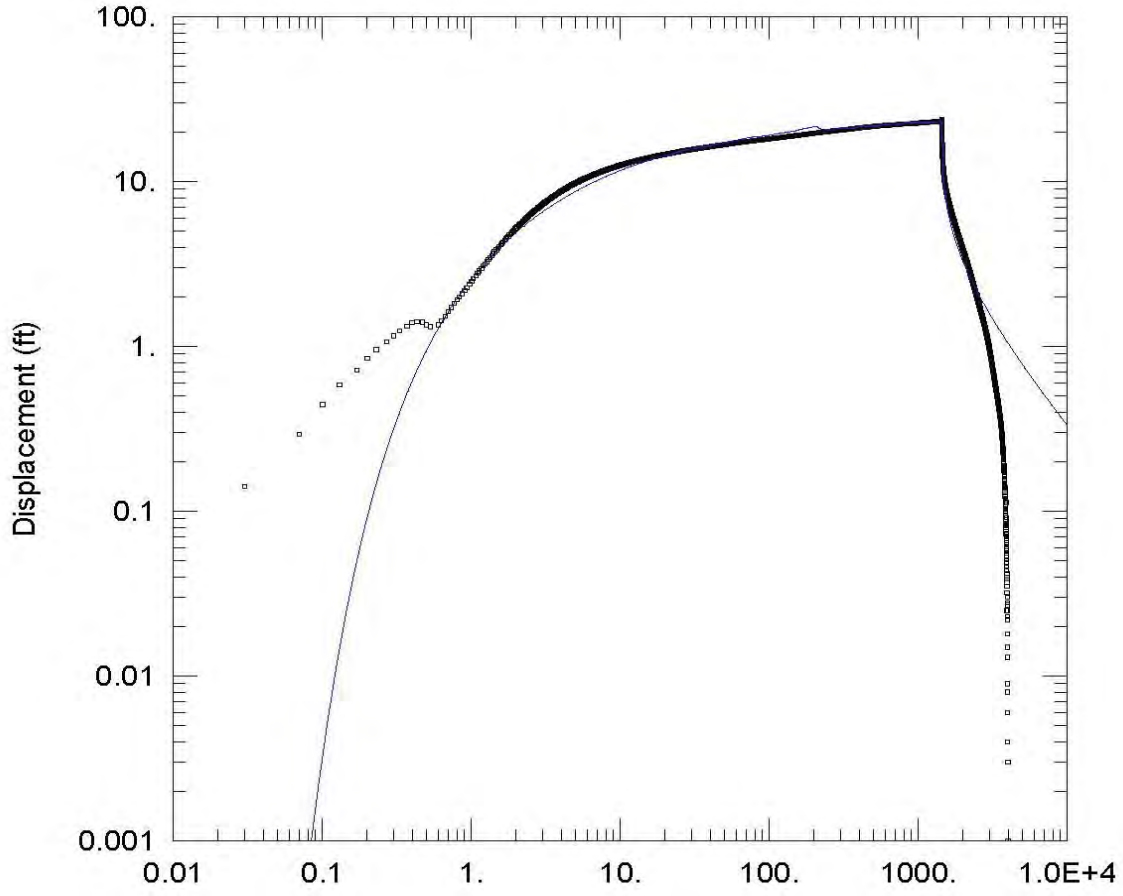
Legend

- Field Data
- Type Curve

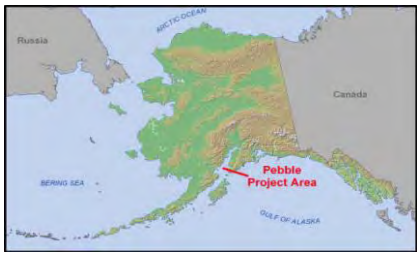
Figure 8.1D-11
PW-8 Pumping Test
P-05-29D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

\\Manu\projects\Pebble_7-075\reporting\WMC 2009 EBD\Appendix_8.1D_Pumping_Test_Results\Pumping Test Results.xls



Pumping Well:	PW-8	**Transmissivity (m^2/s):**	$2.6x10^{-4}$
Observation Well:	P-05-29D2	**Aquifer Thickness (m):**	13
Test Date:	5/9/2007	**Aquifer K (m/s):**	2.0x10-5
Pumping Rate (m^3/s):		**Aquifer S:**	$1.3x10^{-3}$
Pumping Method:	Airlift	**Aquifer S_y:**	
Analysis Method:	Hantush	**β:**	$5.0x10^{-3}$
		Kz/Kr	$2.7x10^{-1}$



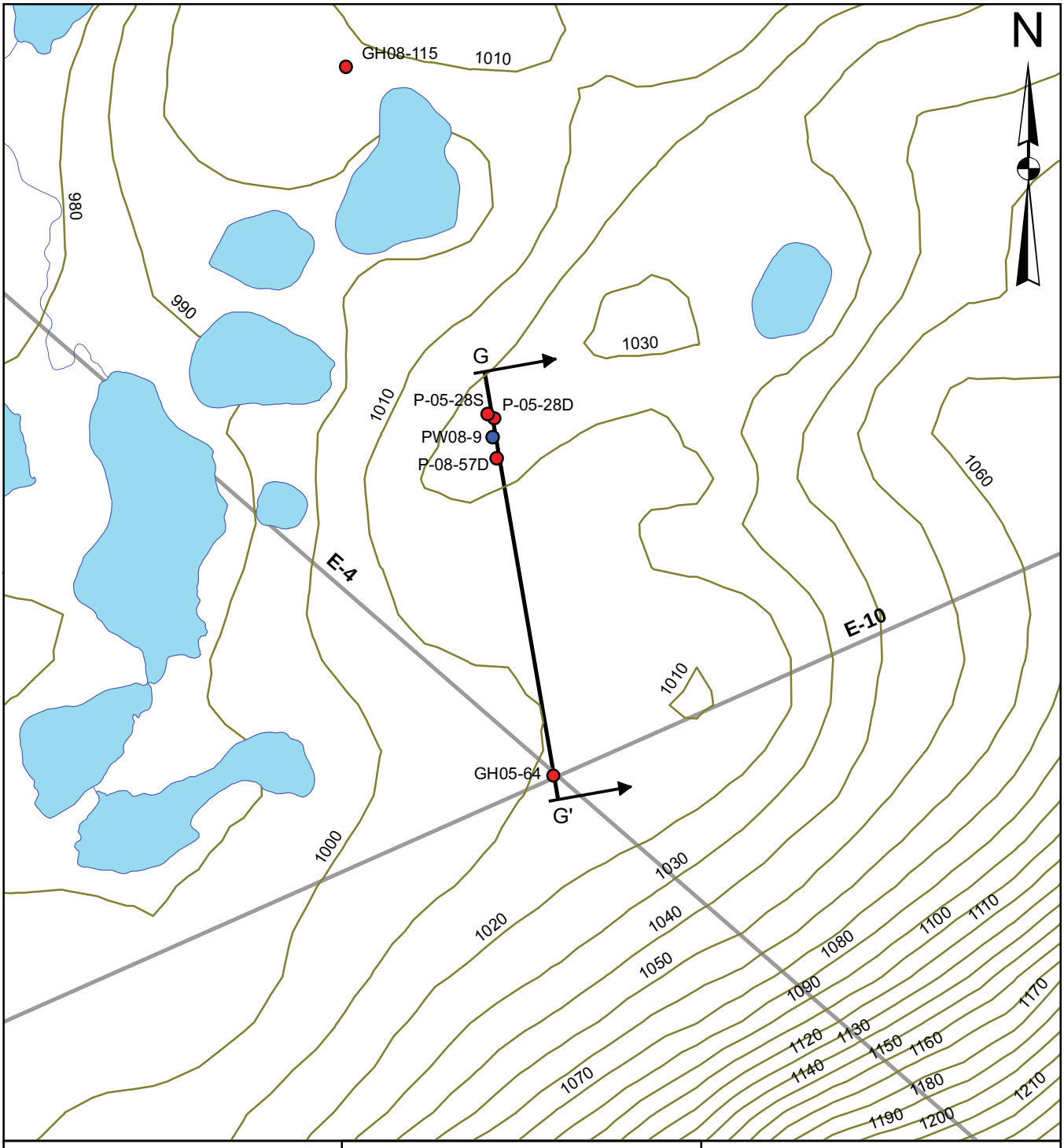
Legend

- Field Data
- Type Curve

THE pebble PARTNERSHIP

Figure 8.1D-12
PW-8 Pumping Test
P-05-29D2 Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010



Refer to Figure 8.1D-16
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Rivers
- Lakes
- Elevation Contour (ft)
- Regional Cross Section
- Local Cross Section
- Direction of Looking for Cross-Section

Feet
0 125 250 375 500

Meters
0 40 80 120 160

Scale 1:4,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

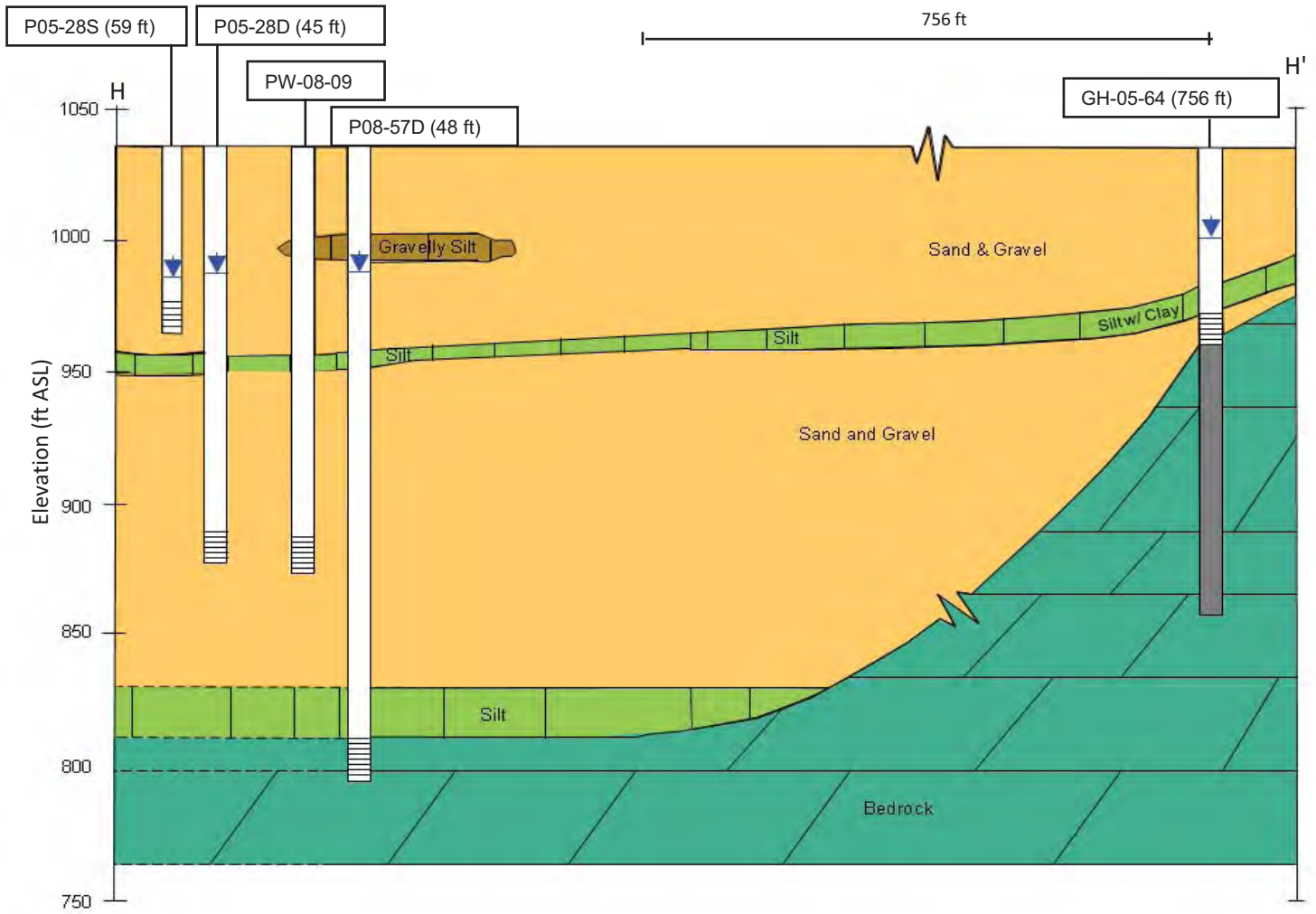
Figure 8.1D - 13
Site Plan of PW-08-09
Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 7 - Site Plan of PW-08-09.mxd

Looking East
Section Location on Figure 8.1D - 13



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 14
Cross Section for
Pumping Well PW-08-09

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-08-09)
Well Riser
Well Screen
Sealed Zone
Water Level Elevation Before Pumping
Sand & Gravel
Silt
Bedrock
Gravely Silt

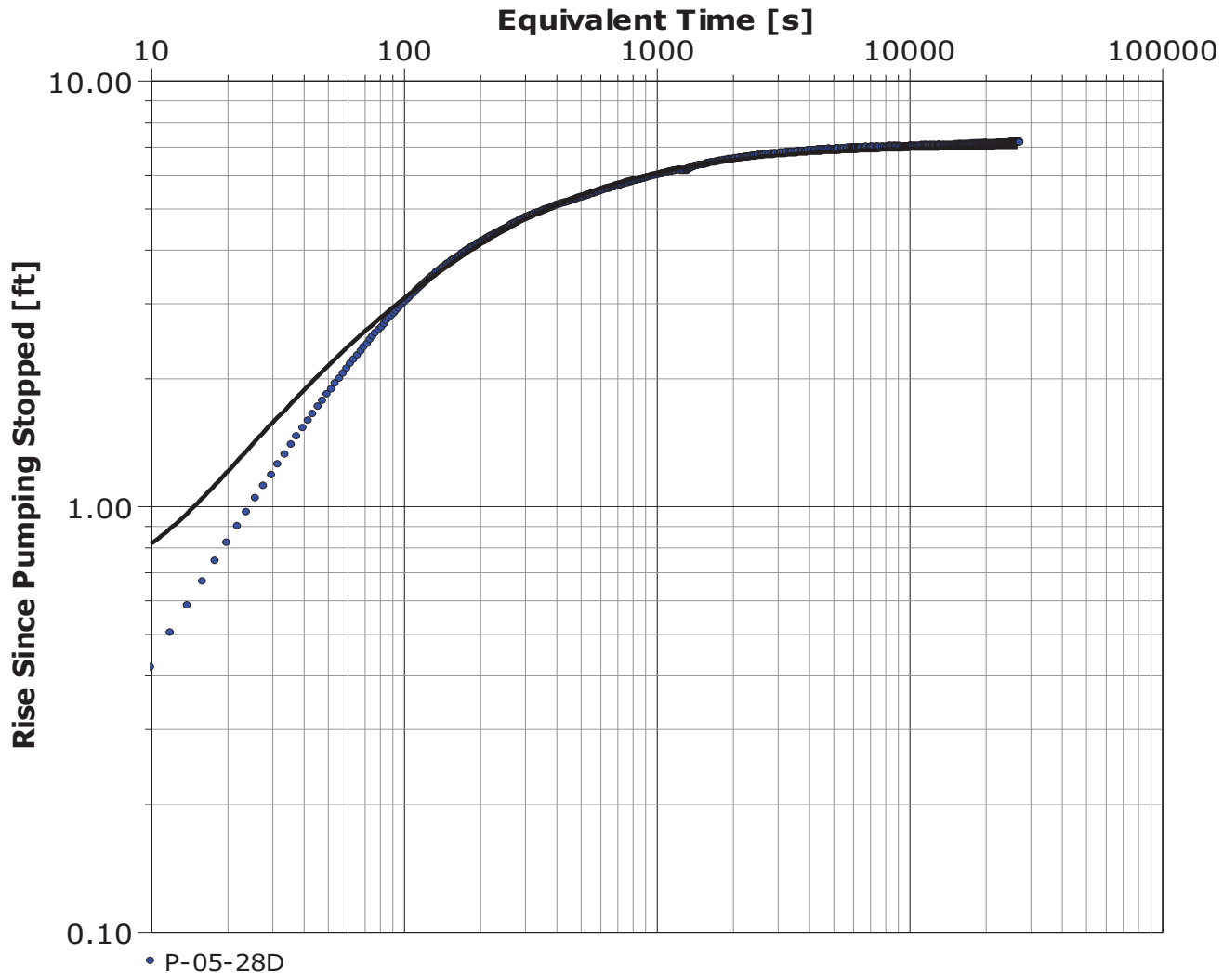
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



Refer to Appendix 8.1B for Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-08-09	**Transmissivity (m^2/s):**	5.0×10^{-4}
Observation Well:	P-05-28D	**Aquifer Thickness (m):**	40.5
Test Date:	5/21/2008	**Aquifer K (m/s):**	1.2×10^{-5}
Pumping Rate (m^3/s):	3.3×10^{-3}	**Aquifer S:**	2.0×10^{-4}
Pumping Method:	Airlift	**Aquifer S_y:**	
Analysis Method:	Theis with recharge boundary	**$P = r_i/r_r$**	6.5



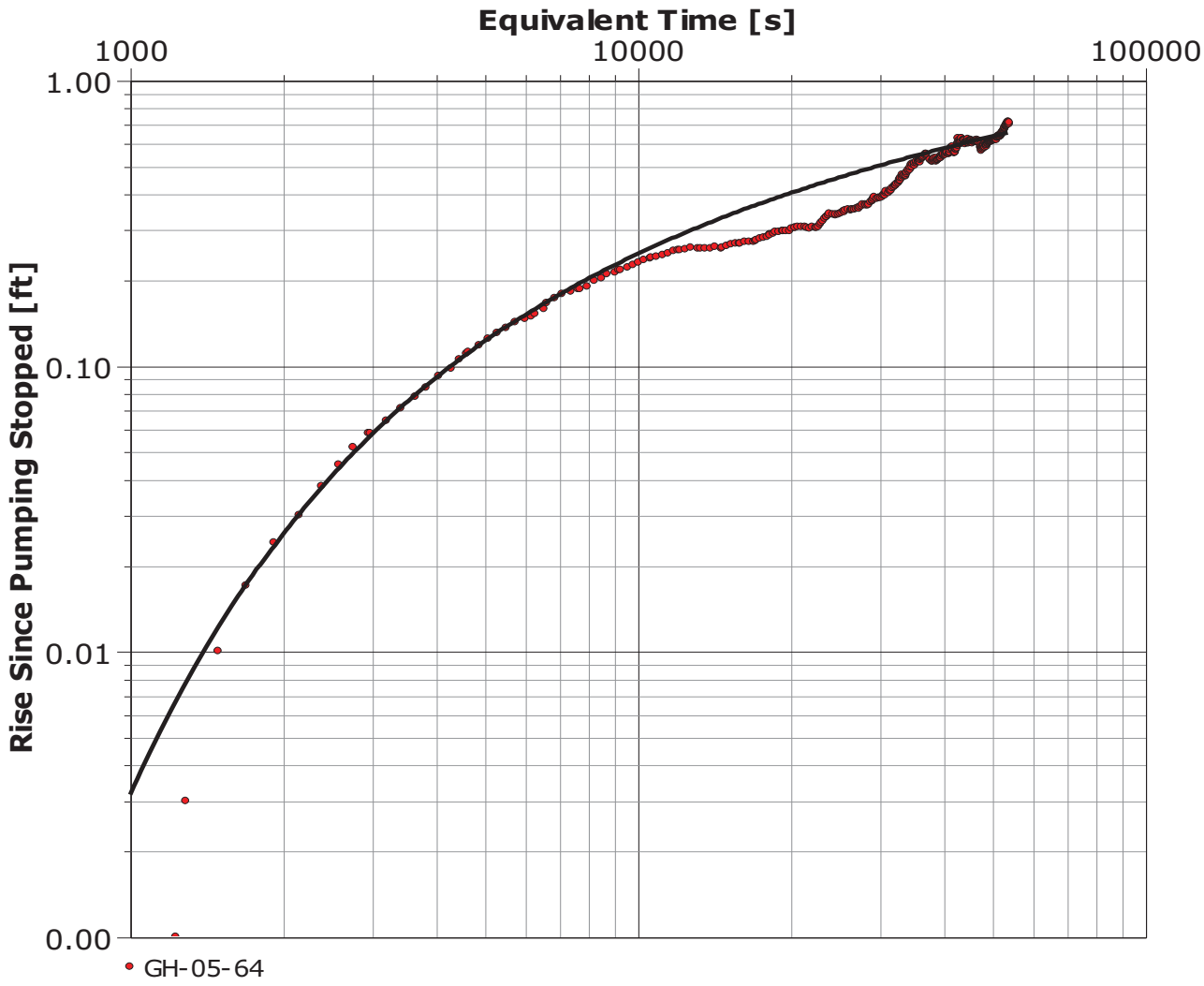
Legend

Field Data

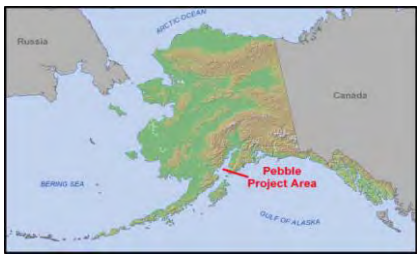
Type Curve

Figure 8.1D-15
PW-08-09 Pumping Test
P-05-28D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010



Pumping Well:	PW-08-09	**Transmissivity (m^2/s):**	$3.0x10^{-3}$
Observation Well:	GH-05-64	**Aquifer Thickness (m):**	40.5
Test Date:	5/21/2008	**Aquifer K (m/s):**	$7.4x10^{-5}$
Pumping Rate (m^3/s):	$3.3x10^{-3}$	**Aquifer S:**	$7.0x10^{-4}$
Pumping Method:	Airlift	**Aquifer S_y:**	
Analysis Method:	Theis		



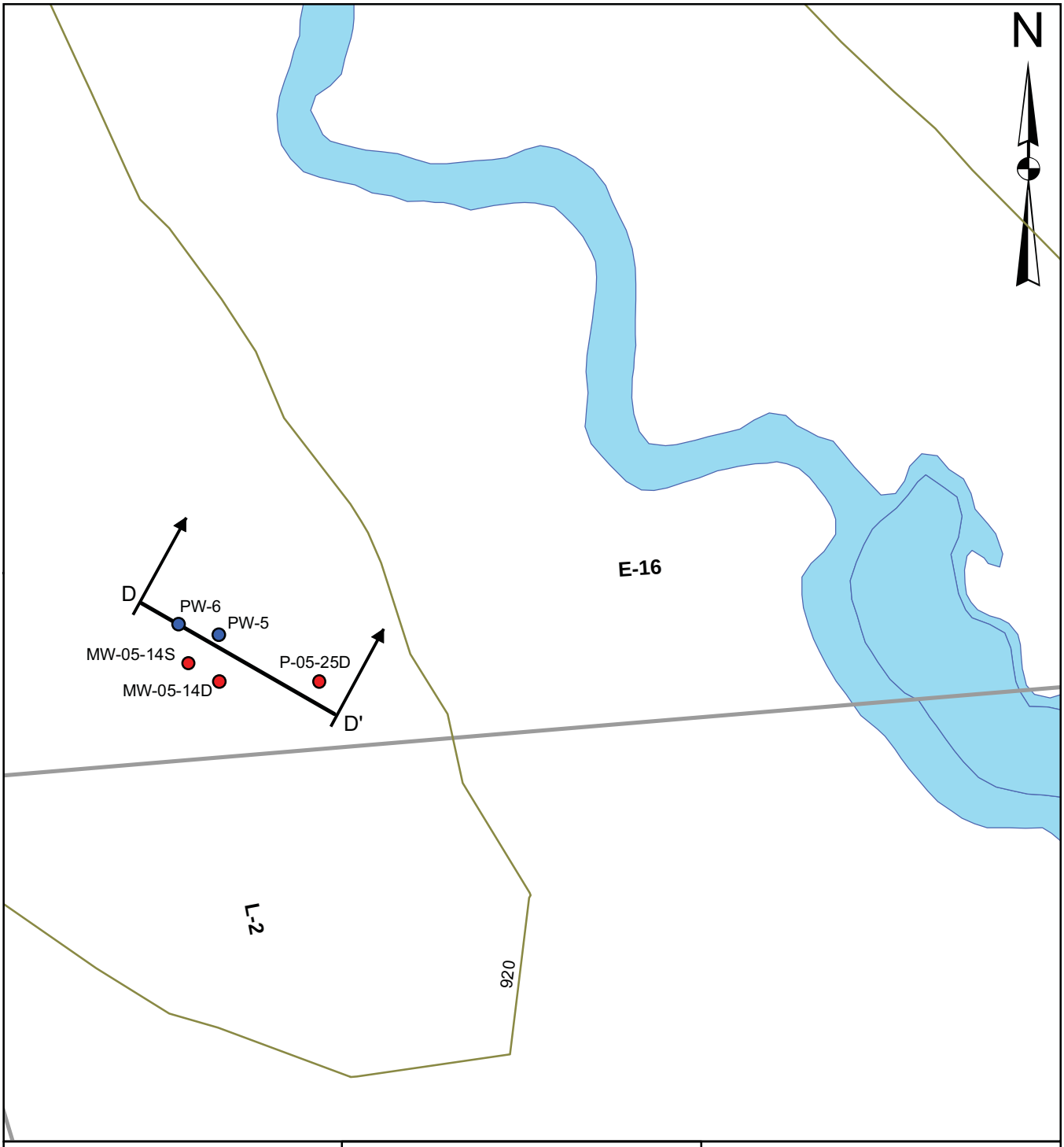
Legend

Field Data

Type Curve

Figure 8.1D-16
PW-08-09 Pumping Test
GH-05-64 Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010



Refer to Figure 8.1D-12 and 13 for the local cross-section



Refer to Appendix 8.1B for Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Regional Cross Section
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet: 0 25 50 75 100

Meters: 0 7.5 15 22.5 30

Scale 1:1,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

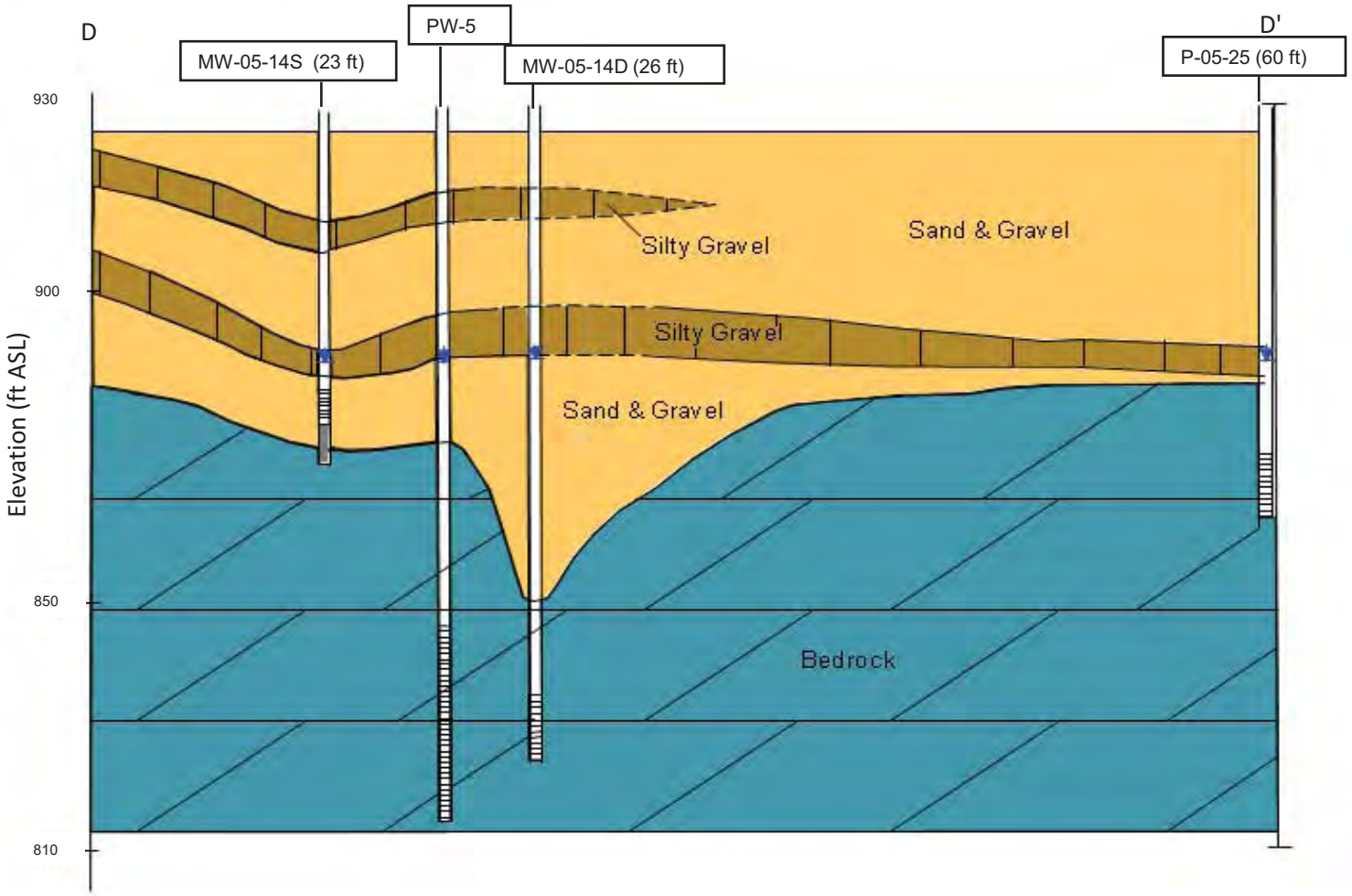
Figure 8.1D - 17
Site Plan of PW-5 and PW-6 Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 4 - Site Plan of PW-5 and PW-6.mxd

Looking Northeast
Section Location on Figure 8.1D-17



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 18
Cross Section for
Pumping Well PW-5

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-5)
Well Riser
Well Screen
Sealed Zone
Water Level Elevation Before Pumping
Sand & Gravel
Silty Gravel
Bedrock

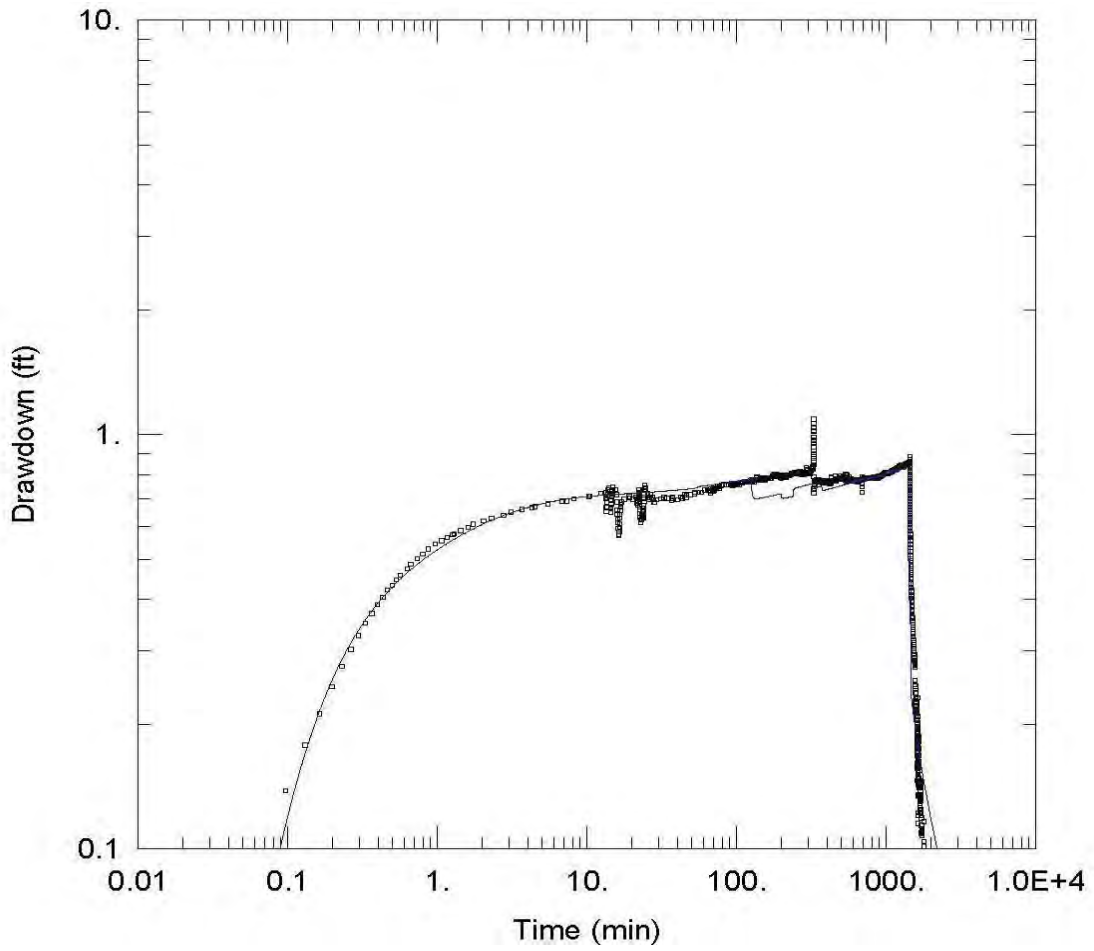
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



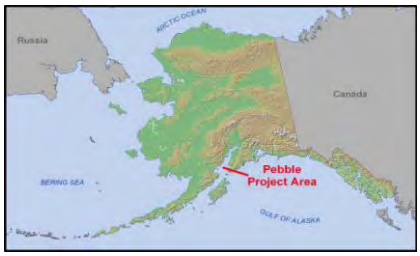
Refer to Appendix 8.1B for Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-5	**Transmissivity (m^2/s):**	$1.4x10^{-2}$
Observation Well:	MW-05-14D	**Aquifer Thickness (m):**	30.5
Test Date:	5/8/2007	**Aquifer K (m/s):**	$4.6x10^{-4}$
Pumping Rate (m^3/s):		**Aquifer S:**	$2.8x10^{-3}$
Pumping Method:	Airlift	**Aquifer S_y:**	$7.4x10^{-2}$
Analysis Method:	Moench	**β:**	$1.7x10^{-2}$
		Kz/Kr	$2.5x10^{-1}$



Legend

- Field Data
- Type Curve

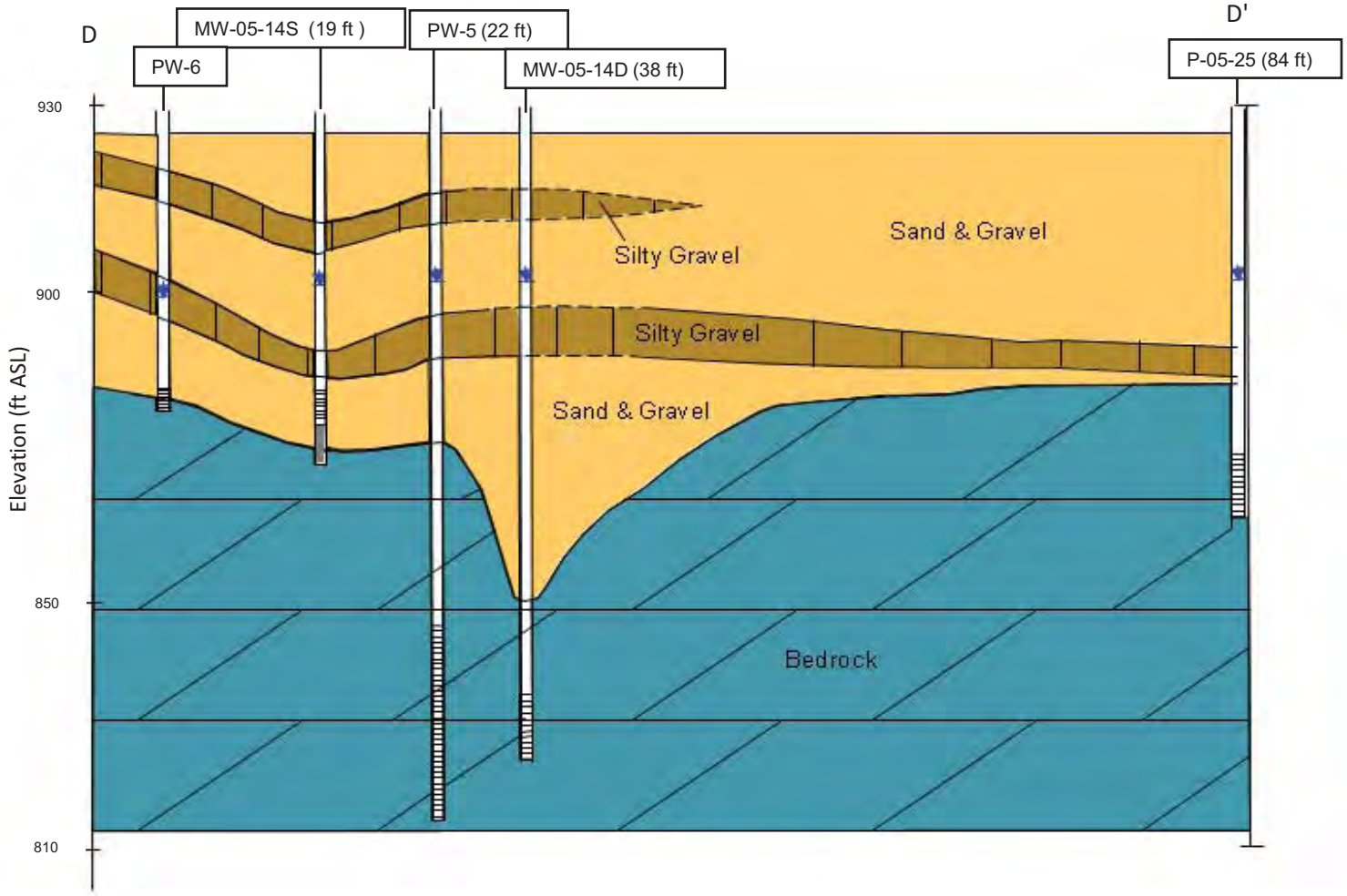
THE pebble PARTNERSHIP

Figure 8.1D-19
PW-5 Pumping Test
MW-05-14D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

\\Manu\projects\Pebble_7-075\reporting\WMC 2009 EBD\Appendix_8.1D_Pumping_Test_Results\Pumping Test Results.xls

Looking Northeast
Section Location on Figure 8.1D-17



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 20
Cross-Section for
Pumping Well PW-6

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-6)
Well Riser
Well Screen
Sealed Zone
Water Level Elevation Before Pumping
Sand & Gravel
Silty Gravel
Bedrock

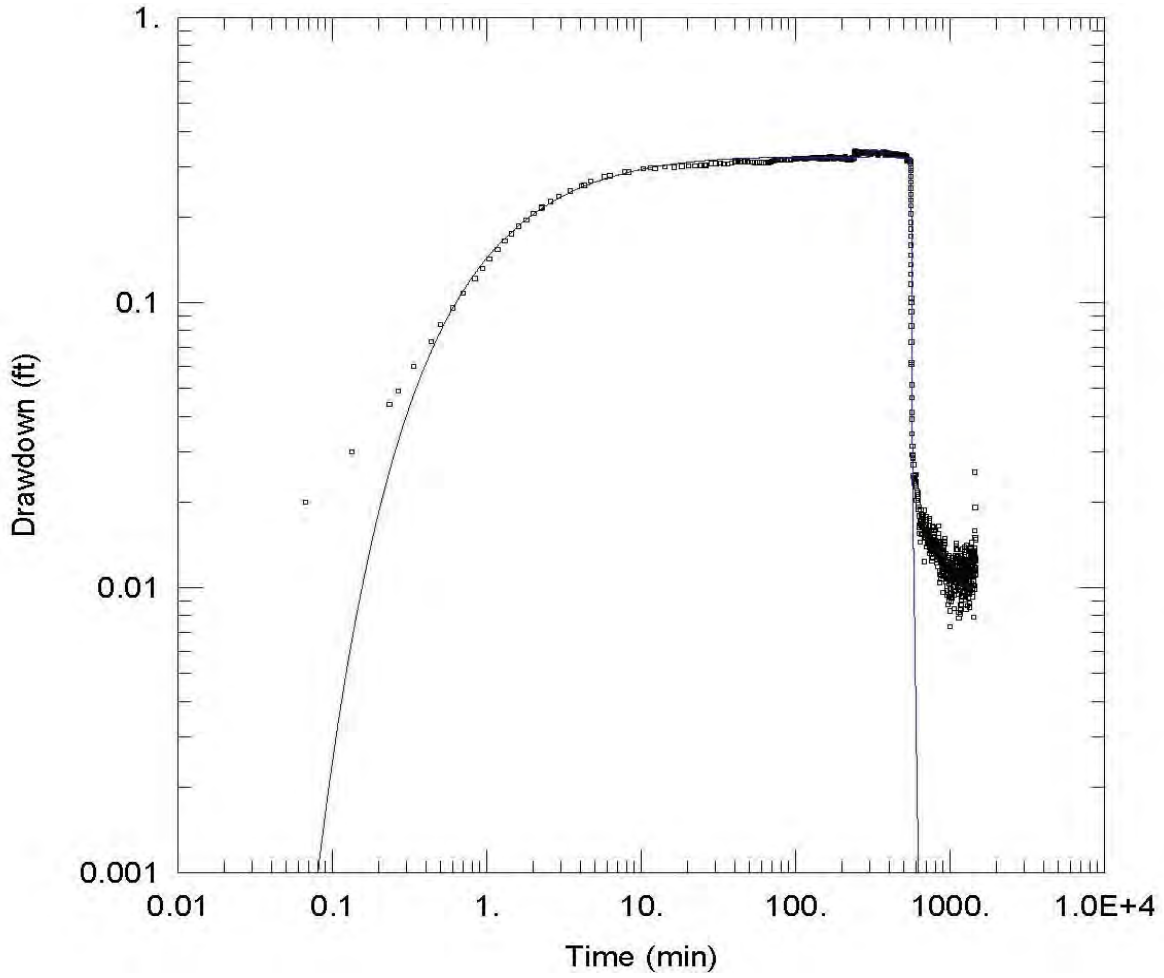
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



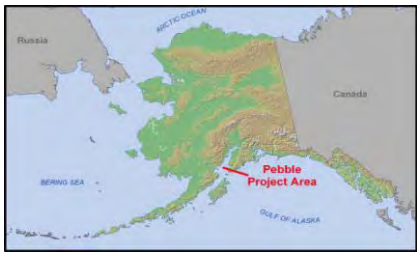
Refer to Appendix 8.1B for Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-6	**Transmissivity (m^2/s):**	$1.8x10^{-2}$
Observation Well:	MW-05-14S	**Aquifer Thickness (m):**	30
Test Date:	5/8/2007	**Aquifer K (m/s):**	$6.0x10^{-4}$
Pumping Rate (m^3/s):		**Aquifer S:**	$2.5x10^{-2}$
Pumping Method:	Airlift	**Aquifer S_y:**	
Analysis Method:	Hantush-Jacob	**r/B:**	$2.0x10^{-1}$
		Kz/Kr:	$5.0x10^{-1}$



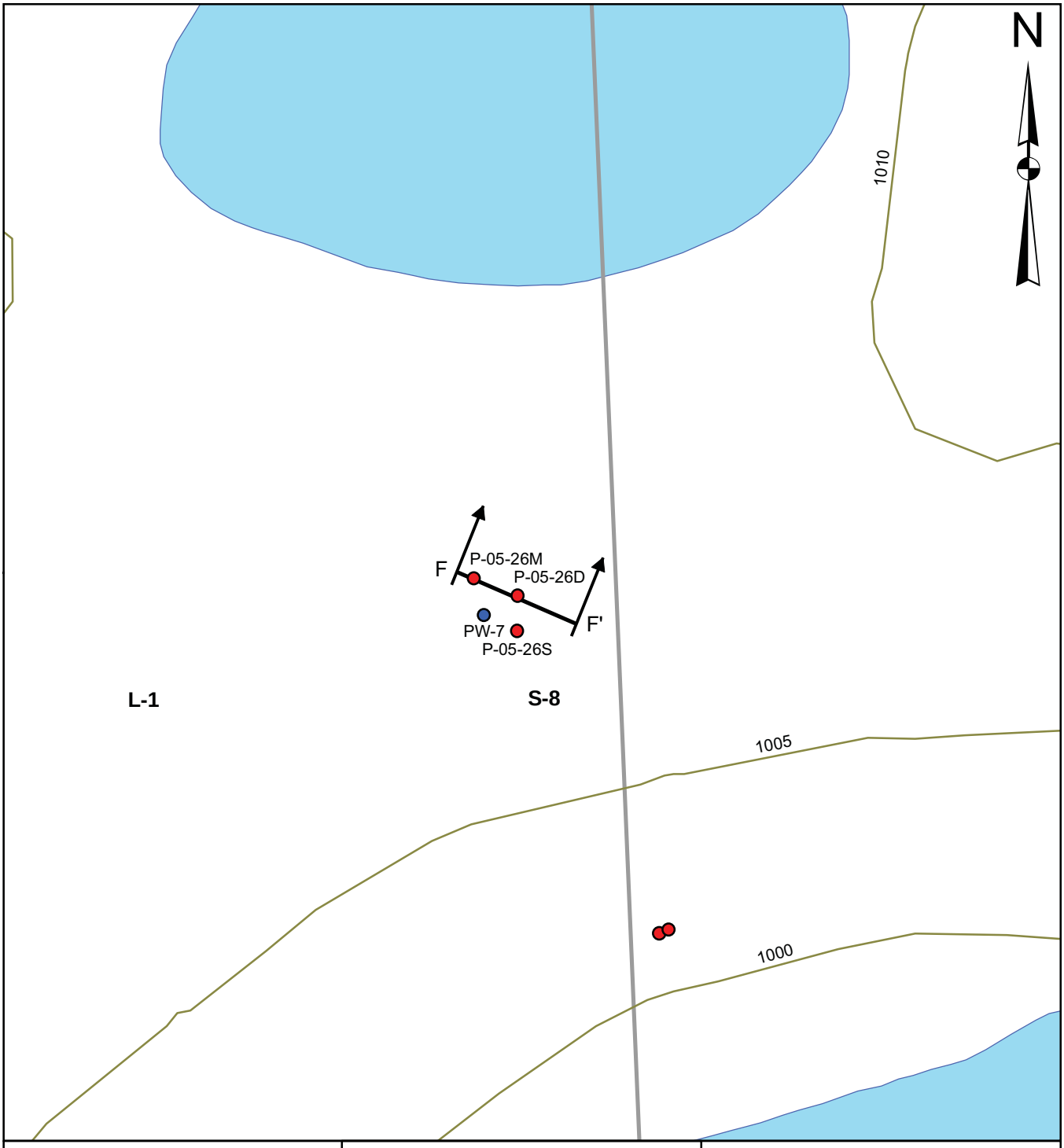
Legend

- Field Data
- Type Curve

Figure 8.1D-21
PW-6 Pumping Test
MW-05-14S Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

\\Manu\projects\Pebble_7-075\reporting\WMC 2009 EBD\Appendix_8.1D_Pumping_Test_Results\Pumping Test Results.xls



Refer to Figure 8.1D-14
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

Well_Locations_Apr_28_fromDB

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Regional Cross Section
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet
0 20 40 60 80
Meters
0 5 10 15 20
Scale 1:750

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

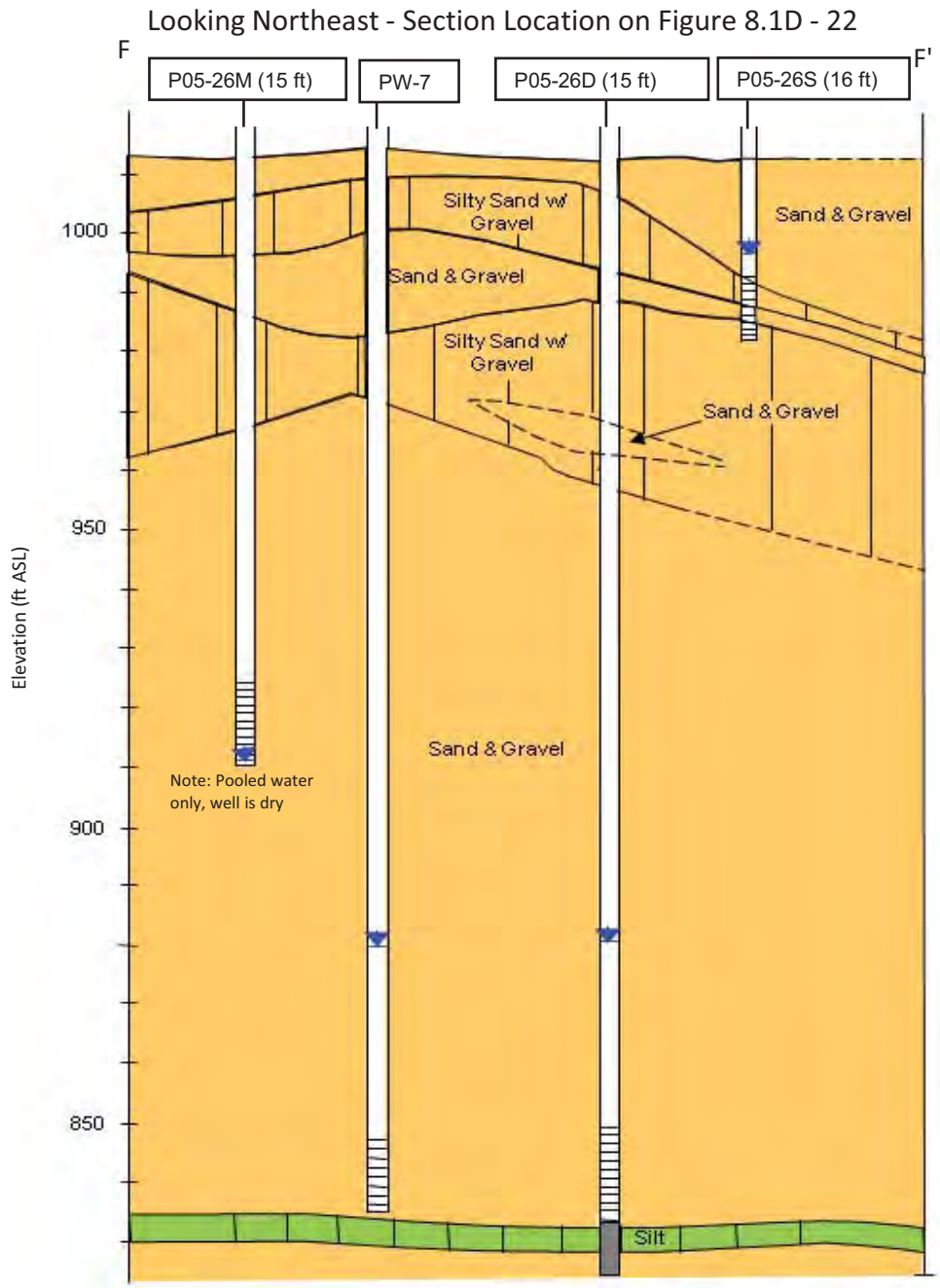
THE pebble PARTNERSHIP

Figure 8.1D - 22
Site Plan of PW-7 Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 5 - Site Plan of PW-7.mxd



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 23
Cross-Section for
Pumping Well PW-7

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-7)

Well Riser

Well Screen

Water Level Elevation Before Pumping

Sand & Gravel

Silty Sand

Silt

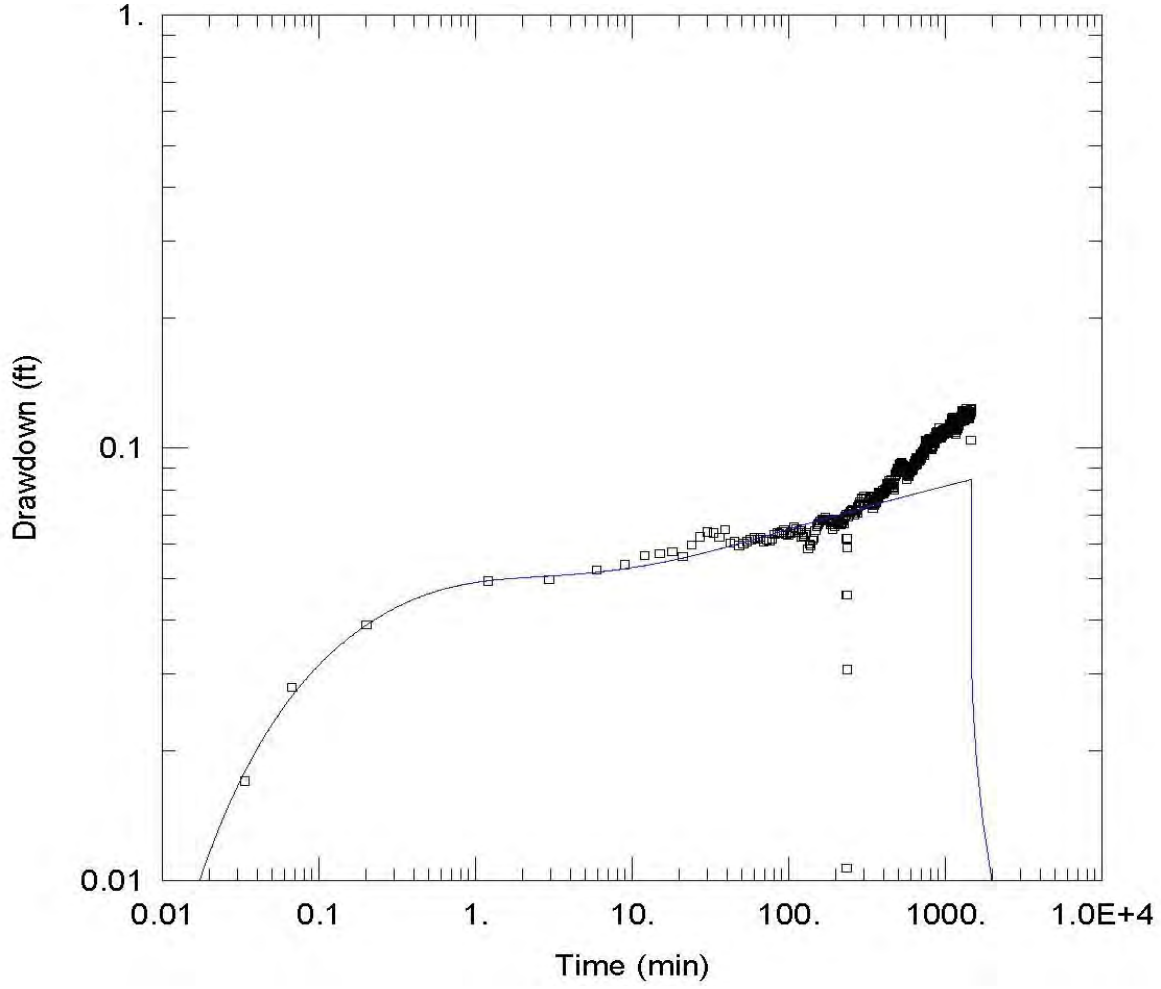
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



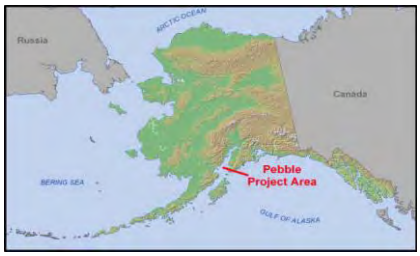
Refer to Appendix 8.1B for Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-7	**Transmissivity (m^2/s):**	$1.1x10^{-1}$
Observation Well:	P-05-26D	**Aquifer Thickness (m):**	13.7
Test Date:	5/8/2007	**Aquifer K (m/s):**	$8.0x10^{-3}$
Pumping Rate (m^3/s):		**Aquifer S:**	$1.1x10^{-2}$
Pumping Method:	Airlift	**Aquifer S_y:**	$2.0x10^{-1}$
Analysis Method:	Neuman	**β:**	$2.6x10^{-2}$



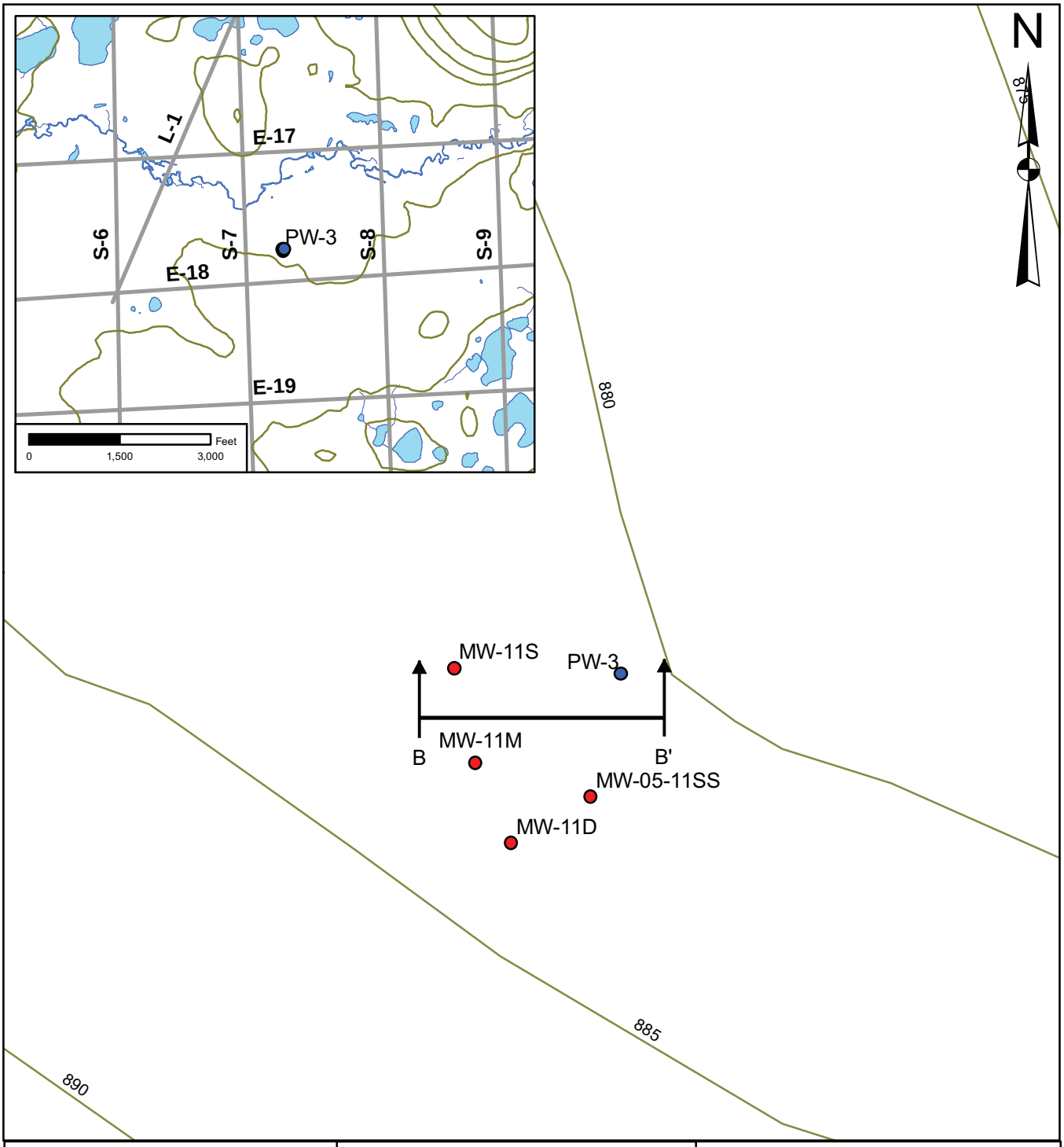
Legend

- Field Data
- Type Curve

Figure 8.1D-24
PW-7 Pumping Test
P-05-26D Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

\\Manu\projects\Pebble_7-075\reporting\WMC 2009 EBD\Appendix_8.1D_Pumping_Test_Results\Pumping Test Results.xls



Refer to Figure 8.1D-10
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Regional Cross Section
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet
0 10 20 30 40

Meters
0 3 6 9 12

Scale 1:300

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

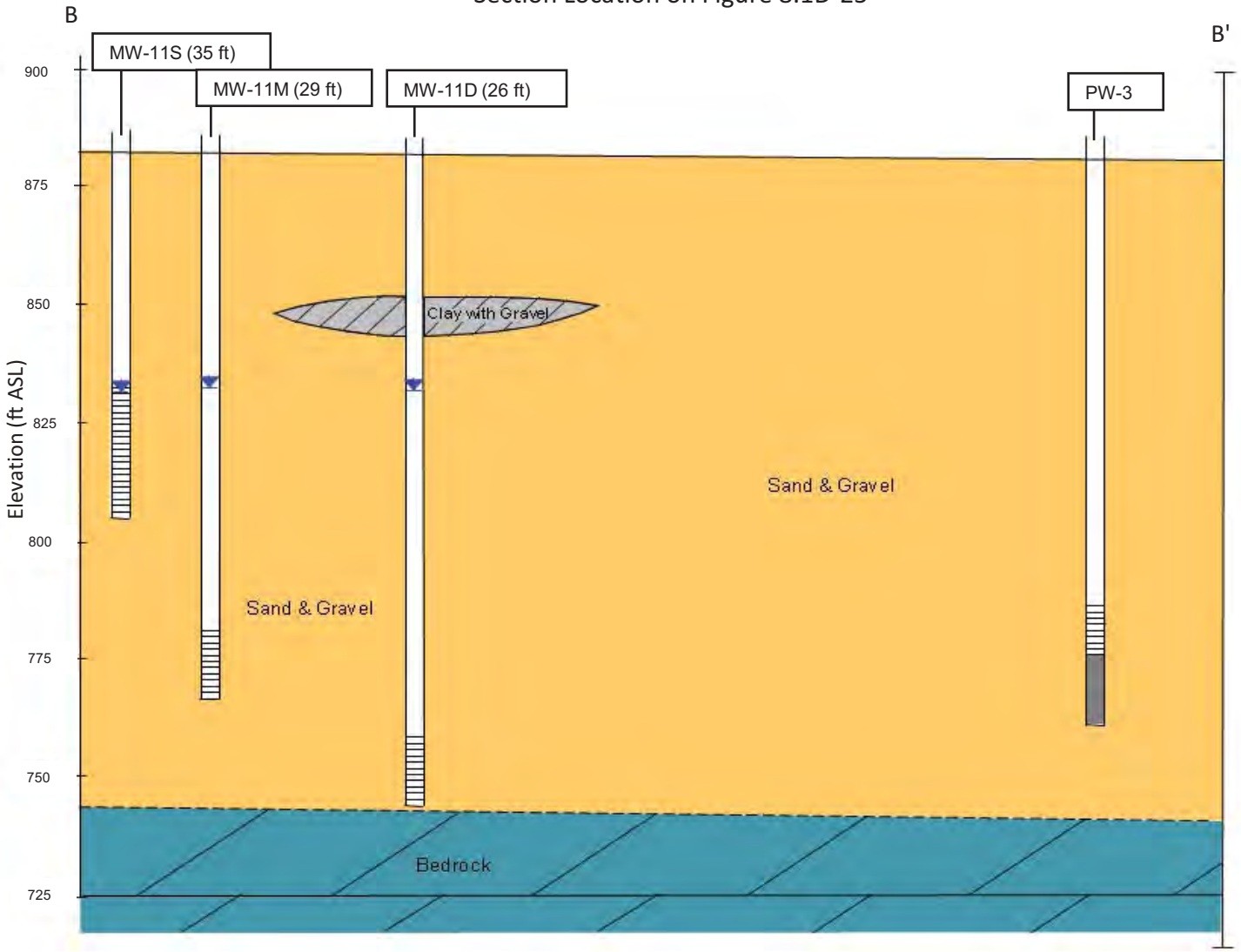
Figure 8.1D - 25
Site Plan of PW-3 Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 2 - Site Plan of PW-3.mxd

Looking Northwest
Section Location on Figure 8.1D-25



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 26
Cross-Section for
Pumping Well PW-3

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-3)

- Well Riser
- Well Screen
- Sealed Zone
- Water Level Elevation Before Pumping
- Sand & Gravel
- Clay
- Bedrock

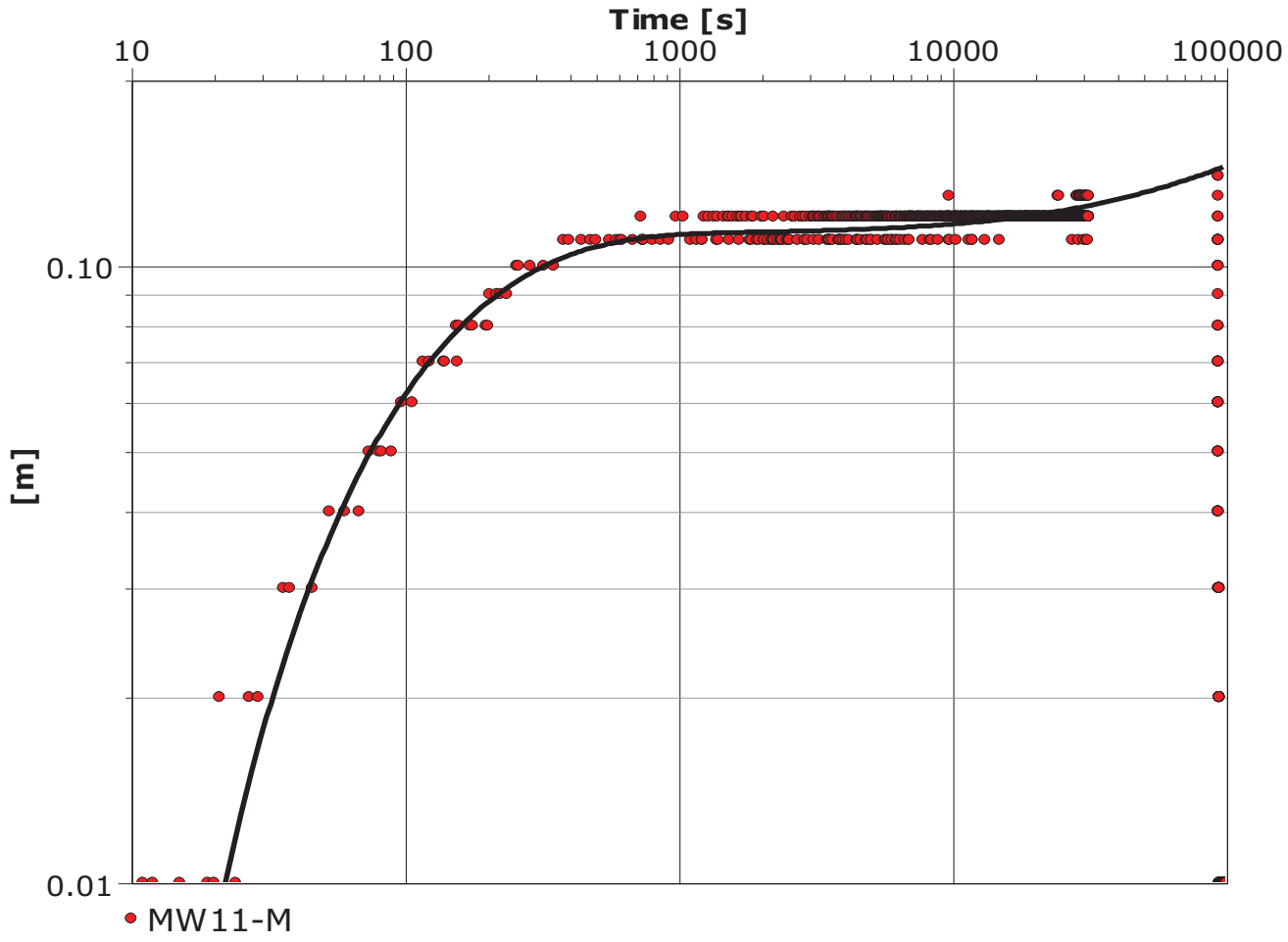
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



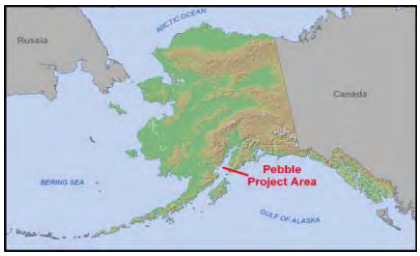
Refer to Appendix 8.1B for
Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-3	**Transmissivity (m^2/s):**	6.0×10^{-3}
Observation Well:	MW11-M	**Aquifer Thickness (m):**	26
Test Date:	10/8/2004	**Aquifer K (m/s):**	2.3×10^{-4}
Pumping Rate (m^3/s):	3.1×10^{-3}	**Aquifer K_v/K_h:**	0.1
Pumping Method:	Airlift	**Aquifer S:**	7.0×10^{-4}
Analysis Method:	Neuman	**Aquifer S_y:**	0.14



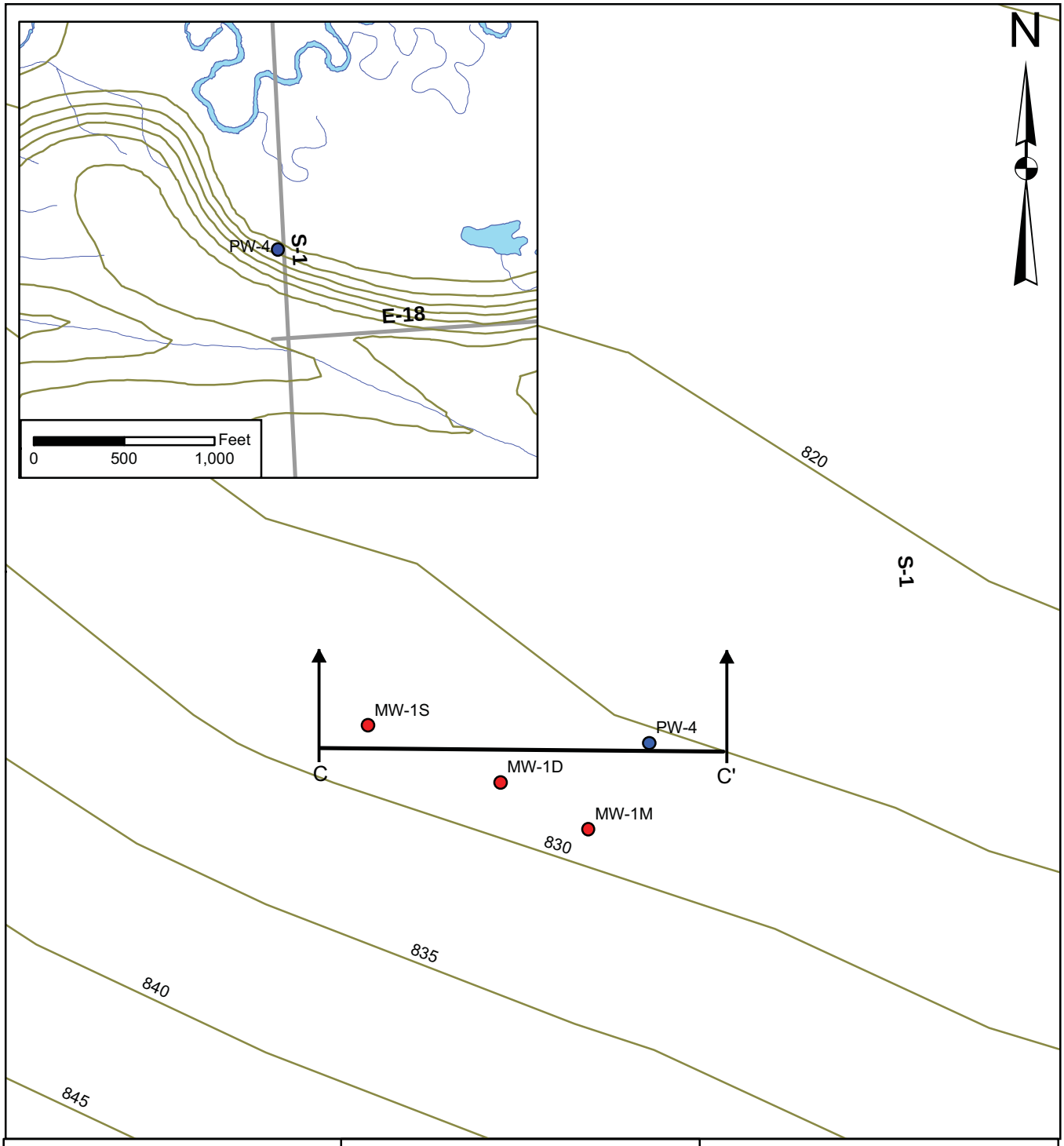
Legend

Field Data

Type Curve

Figure 8.1D-27
PW-3 Pumping Test
MW11-M Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010



Refer to Figure 8.1D-11
for the local cross-section



Refer to Appendix 8.1B for
Regional Cross Sections

Legend

- Monitoring Well
- Pumping Well (PW)
- Elevation Contour (ft)
- Regional Cross Section
- Lakes
- Rivers
- Local Cross Section
- Direction of Looking for Cross-Section

Feet
0 10 20 30 40

Meters
0 2.5 5 7.5 10

Scale 1:250

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

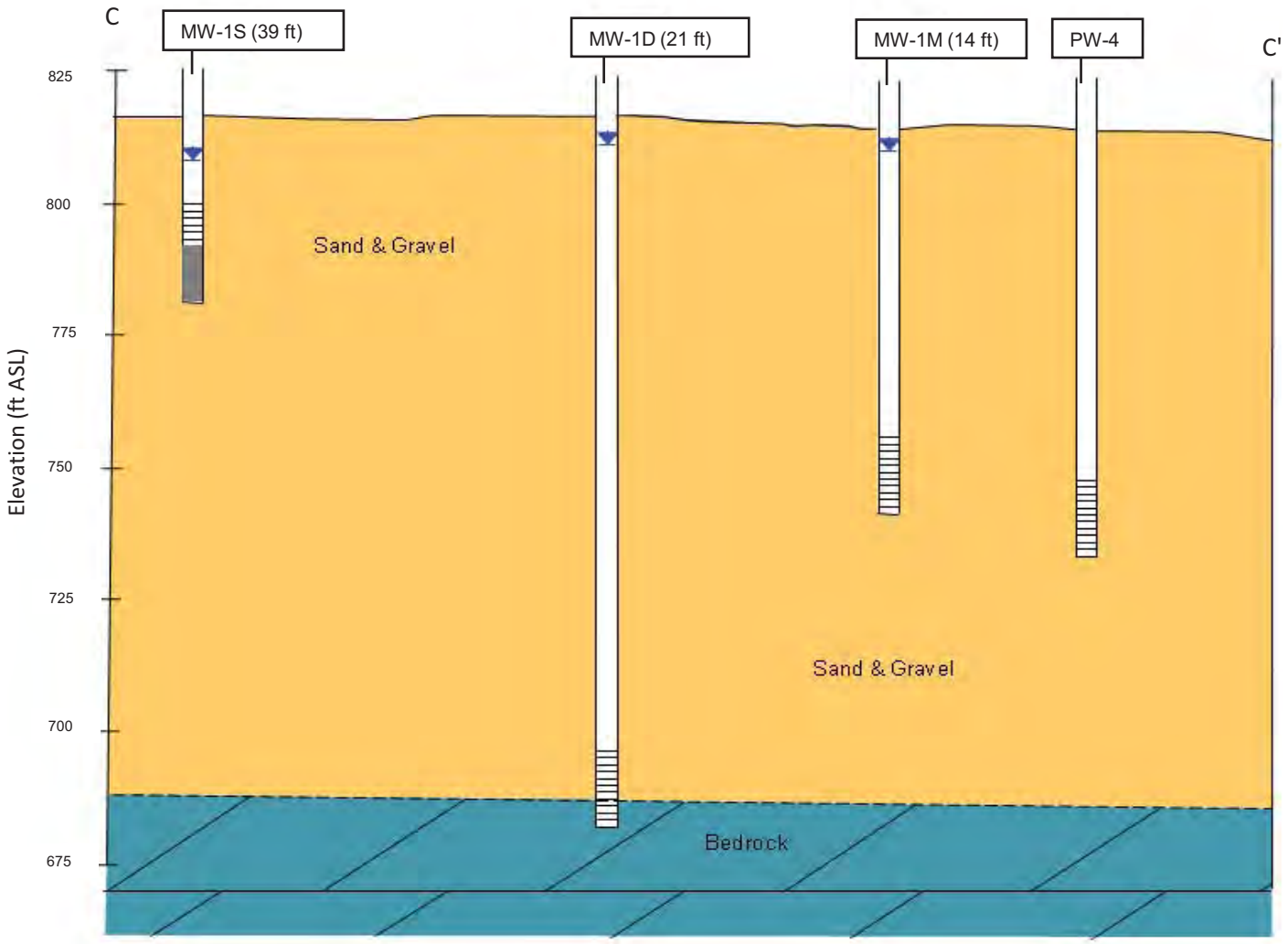
Figure 8.1D - 28
Site Plan of PW-4 Pumping Test

Appendix 8.1D
Pumping Test Results

Project No: 7126	Date: April 06, 2010
Version: 1	Author: SWS-PP

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\Figure 3 - Site Plan of PW-4.mxd

Looking North
Section Location on Figure 8.1D-28



Not to Scale

THE pebble PARTNERSHIP

Figure 8.1D - 29
Cross-Section for
Pumping Well PW-4

Appendix 8.1D
Pumping Test Results

Legend

Well Name (Distance from PW-4)

- Well Riser
- Well Screen
- Sealed Zone
- Water Level Elevation Before Pumping
- Sand & Gravel
- Bedrock

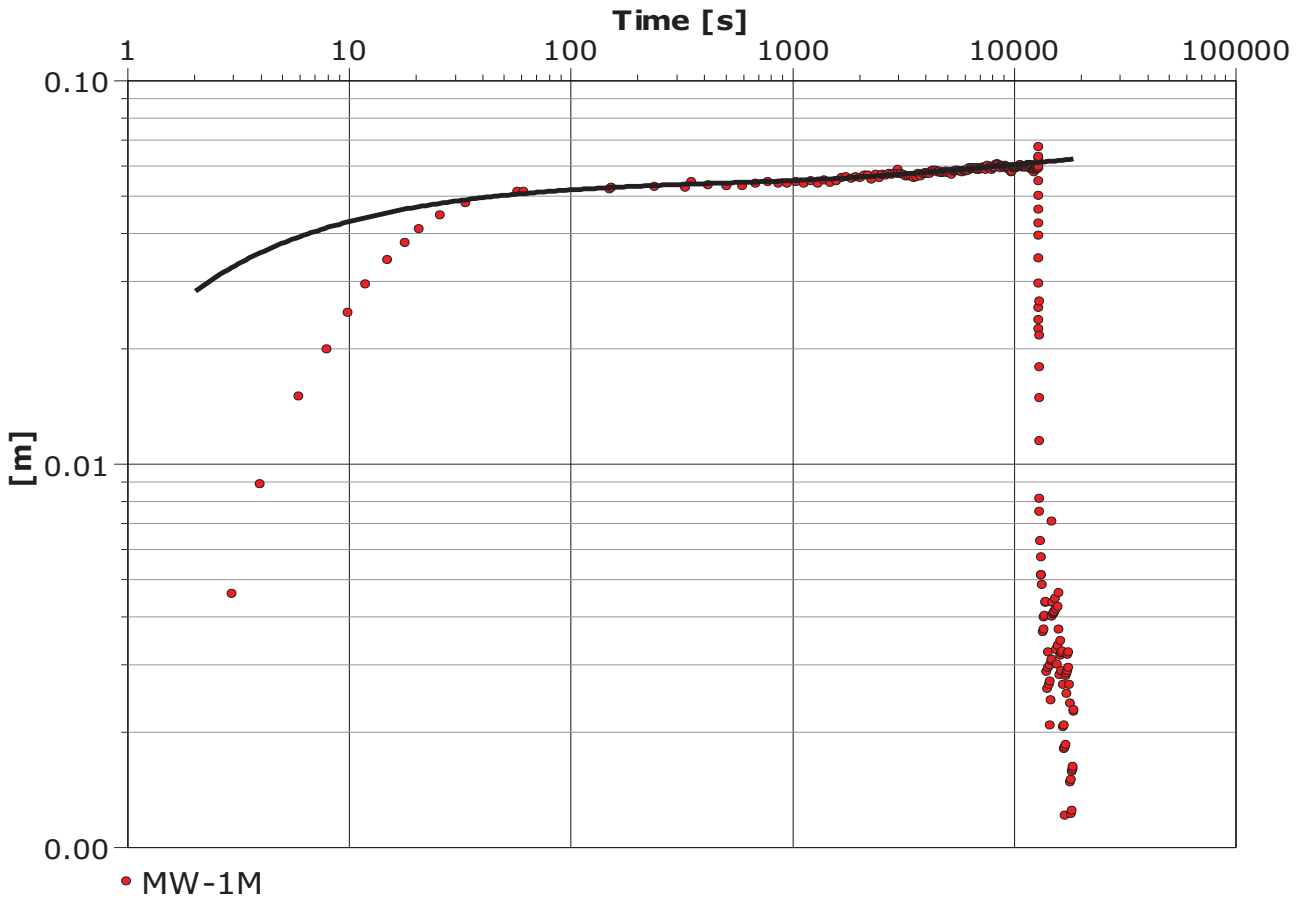
Note: This radial cross-section was developed to show the radial distance from the pumping well to each observation well and does not represent a true cross-section



Refer to Appendix 8.1B for
Regional Cross-Sections

Project No: 7126	Author: SWS-PP
Version: 1	Date: April 9, 2010

\\Srv008wtl\projects\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1D_Pumping_Test_Results\8.1D - Local Cross Sections.xls



Pumping Well:	PW-4	**Transmissivity (m^2/s):**	$5.3x10^{-1}$
Observation Well:	MW-1M	**Aquifer Thickness (m):**	39
Test Data:	10/19/2004	**Aquifer K (m/s)**	$1.3x10^{-2}$
Pumping Rate (m^3/s):	$2.3x10^{-2}$	**Aquifer K_v/K_h:**	0.1
Pumping Method:	Airlift	**Aquifer S:**	0.01
Analysis Method	Neuman	**Aquifer S_y:**	0.1

Note: Early response of observation well likely influenced by time lag



Legend

Field Data

Type Curve

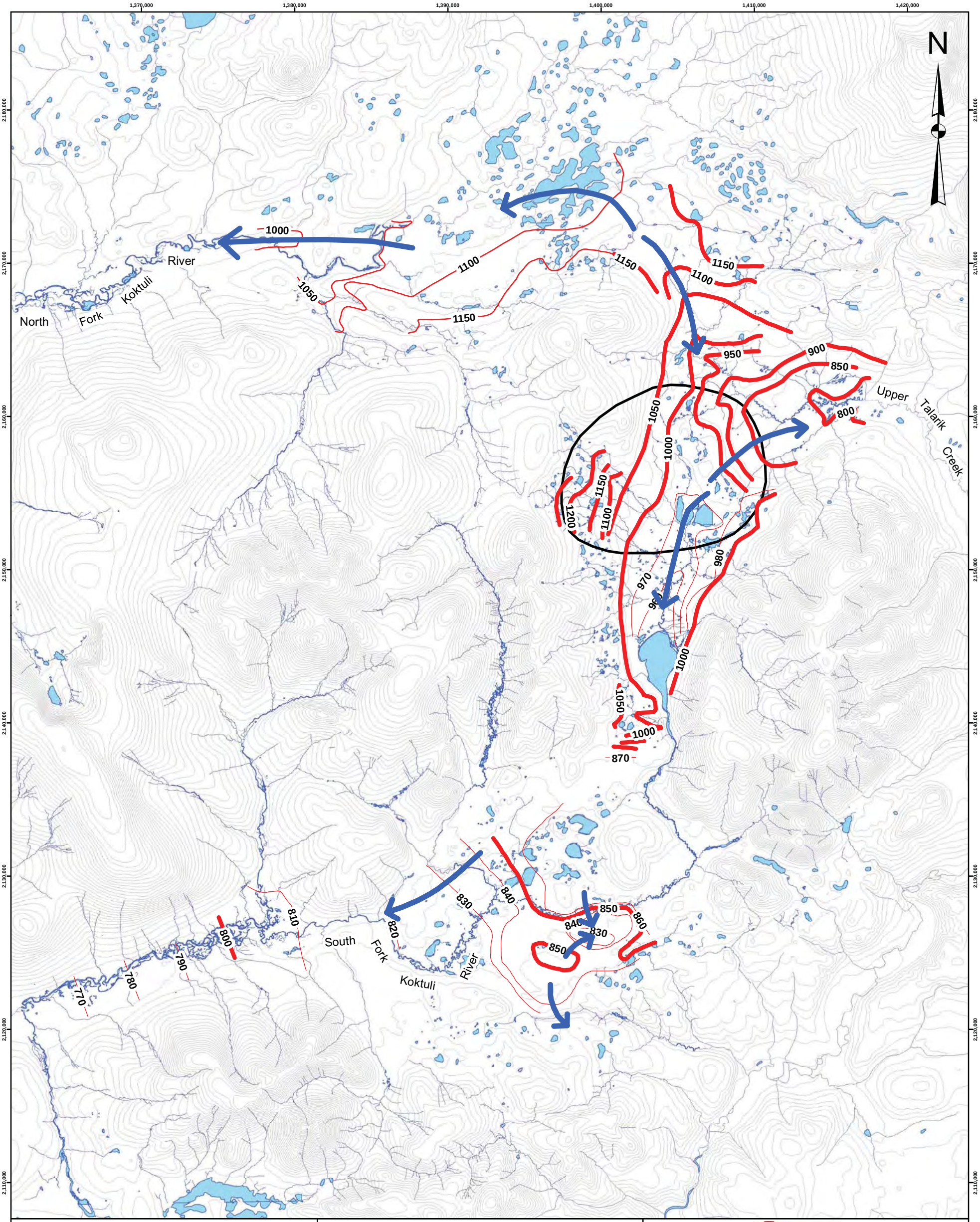
THE pebble PARTNERSHIP

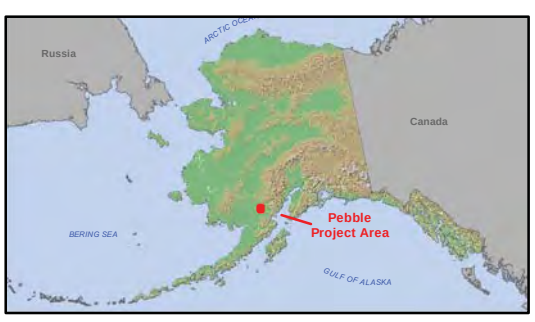
Figure 8.1D-30
PW-4 Pumping Test
MW-1M Analysis
Appendix 8.1D
Pumping Test Results

Project: 7126	Author: SWS-PP
Version: 1	Date: May 06, 2010

APPENDIX 8.1E

Snapshots of Water Levels





Legend

Shallow GWE Contours
- 10 ft
- 100 & 50 ft
- General Deposit Location
- Lakes
- Rivers
- 50-ft Contour Interval
- Groundwater Flow Direction

Feet: 0, 4,000, 8,000, 12,000, 16,000

Meters: 0, 1,000, 2,000, 3,000, 4,000

Scale 1:75,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1E - 1
Shallow Groundwater Elevation
May, 2008
Seasonal Low Water

Appendix 8.1E
Snapshots of Water Levels

Project No: 7126	Date: April, 2011
Version: 2	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3993\Figure 1 - Shallow Ground Water Elevation May 2008.mxd

1,370,000 1,380,000 1,390,000 1,400,000 1,410,000 1,420,000

2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000 2,110,000

N

1000 1050 1100 1150

North Fork Koktuli River

1050 950 900 800

Upper Talarik Creek

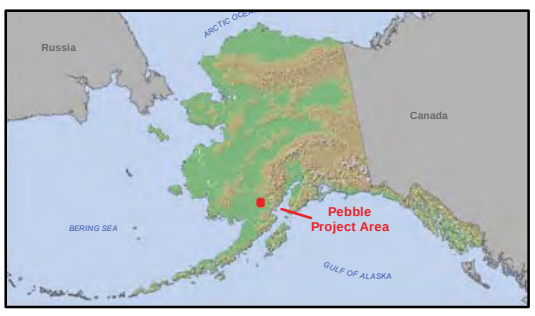
1100 1150 1200 1000 990 980 850 1000 990 980 960 970

880

870 860 840 850 850 850 840

South Fork Koktuli River

830 820 810 800 790 780 770



Legend

Shallow GWE Contours
- 10 ft
- 100 & 50 ft

General Deposit Location
Lakes
Rivers
50-ft Contour Interval
Groundwater Flow Direction

0 4,000 8,000 12,000 16,000 Feet

0 1,000 2,000 3,000 4,000 Meters

Scale 1:75,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1E - 2
Shallow Groundwater Elevation
June, 2008
Seasonal High Water

Appendix 8.1E
Snapshots of Water Levels

Project No: 7126	Date: April, 2011
Version: 2	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3994\Figure 2 - Shallow Ground Water Elevation June 2008.mxd

1,370,000 1,380,000 1,390,000 1,400,000 1,410,000 1,420,000

2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000 2,110,000

N

North Fork Koktuli River

South Fork Koktuli River

Upper Talarik Creek

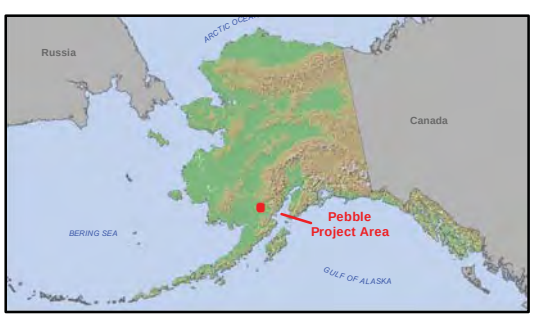
1000 1050 1100 1150 1200

1100 1150

1050 950 850 800

1450 1400 1500 1350 1300 1250 1200 1000 900 1000

960 950 900 880 870 860 850 840 830 820 810 800 790 780 770 760



Legend

Deep GWE Contours
- 10 ft
- 100 & 50 ft
- General Deposit Location
- Lakes
- Rivers
- 50-ft Contour Interval
- Groundwater Flow Direction

0 4,000 8,000 12,000 16,000 Feet

0 1,000 2,000 3,000 4,000 Meters

Scale 1:75,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1E - 3
Deep Groundwater Elevation
May, 2008
Seasonal Low Water

Appendix 8.1E
Snapshots of Water Levels

Project No: 7126	Date: April, 2011
Version: 2	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3995\Figure 3 - Deep Ground Water Elevation May 2008.mxd

1,370,000 1,380,000 1,390,000 1,400,000 1,410,000 1,420,000

2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000 2,110,000

N

1100 1000 1150 1100 1150

North Fork Koktuli River

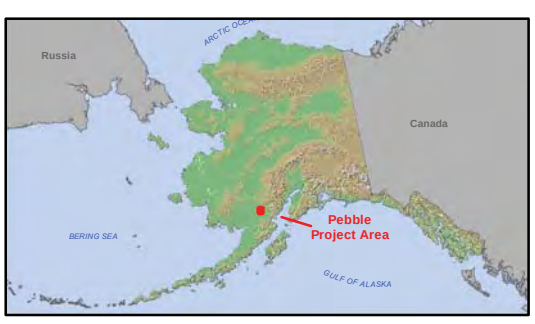
1450 1400 1350 1200 1150 1100 1250 1050 1000 950 900 850 800 1000 980 990 1000 970

Upper Talarik Creek

880 870 860 890 840 830 820 810 800 850 750

South Fork Koktuli River

800 810 820 830 780 790 770



Legend

Deep GWE Contours
- 10 ft
- 100 & 50 ft
- General Deposit Location
- Lakes
- Rivers
- 50-ft Contour Interval
- Groundwater Flow Direction

0 4,100 8,200 12,300 16,400 Feet

0 1,000 2,000 3,000 4,000 Meters

Scale 1:75,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Appendix 8.1E - 4
Deep Groundwater Elevations
June, 2008
Seasonal High Water

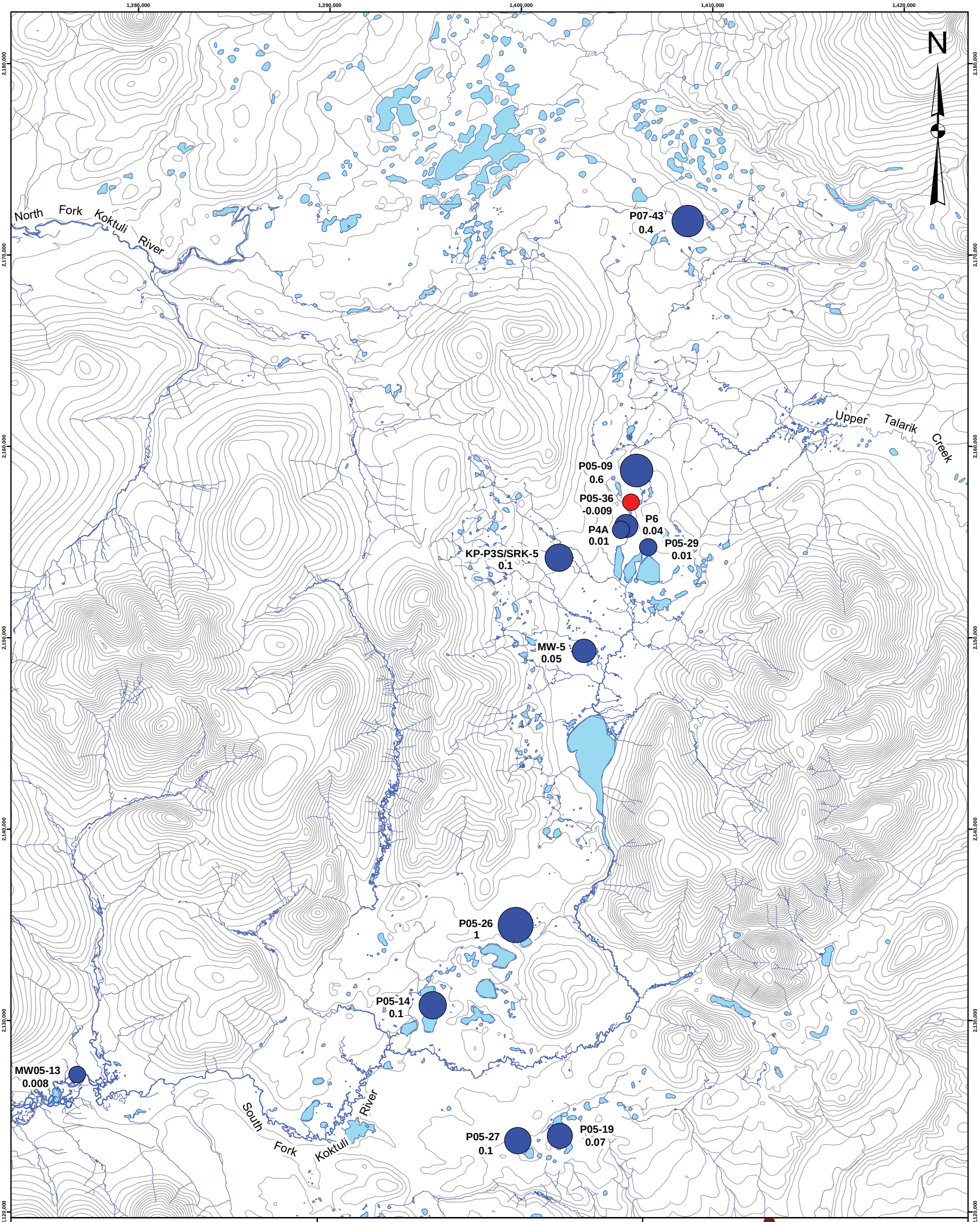
Appendix 8.1E
Snapshots of Water Levels

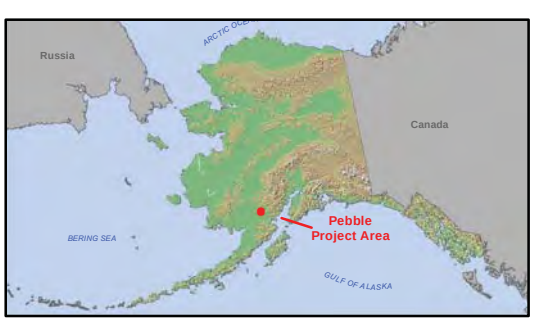
Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3996\Figure 4 - Deep Groundwater Elevation June 2008.mxd

APPENDIX 8.1F

Snapshots of Vertical Gradients





Legend

- SO-DO Upward Gradient
- SO-DO Downward Gradient
- 50-ft Contour Interval
- Rivers
- Lakes

DO = Deep Overburden
SO = Shallow Overburden
P = Piezometer
KP-P = Knight-Piesold Piezometer
MW = Monitoring Well
SRK = Steffan Robertson Kirsten

Notes: 1. Gradient = Head Difference / Distance Between Screen Midpoints

2. Diameter of circle is logarithmically proportional to the magnitude of the gradient

0 2,500 5,000 7,500 10,000 Feet

0 1,000 2,000 3,000 4,000 Meters

Scale 1:60,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1F - 1
Vertical Gradients between
Shallow Overburden and Deep Overburden
during Seasonal Low
May, 2008

Appendix 8.1F
Vertical Gradients

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3997\Figure 1 - Vertical Gradients between Shallow Overburden and Deep Overburden May 2008.mxd

1,380,000 1,390,000 1,400,000 1,410,000 1,420,000

2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000

N

North Fork Koktuli River

P07-43
0.3

Upper Talarik Creek

P05-09
0.6

P05-36
-0.002

P4A
-0.02

P6
-0.02

P05-29
0.003

KP-P3S/SRK-5
0.2

P08-56
0.02

MW-5
0.006

P08-67
0.03

P05-26
1

P05-14
0.05

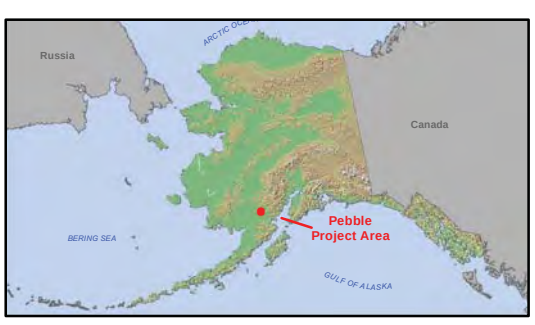
MW05-13
0.008

South Fork Koktuli River

MW05-11
0.3

P05-19
0.02

P05-16
0.4



Legend

- SO-DO Upward Gradient
- SO-DO Downward Gradient
- 50-ft Contour Interval
- Rivers
- Lakes

DO = Deep Overburden
SO = Shallow Overburden
P = Piezometer
KP-P = Knight-Piesold Piezometer
MW = Monitoring Well
SRK = Steffan Robertson Kirsten

Notes: 1. Gradient = $\frac{\text{Head Difference}}{\text{Distance Between Screen Midpoints}}$

2. Diameter of circle is logarithmically proportional to the magnitude of the gradient

Feet
0 2,500 5,000 7,500 10,000

Meters
0 1,000 2,000 3,000 4,000

Scale 1:60,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

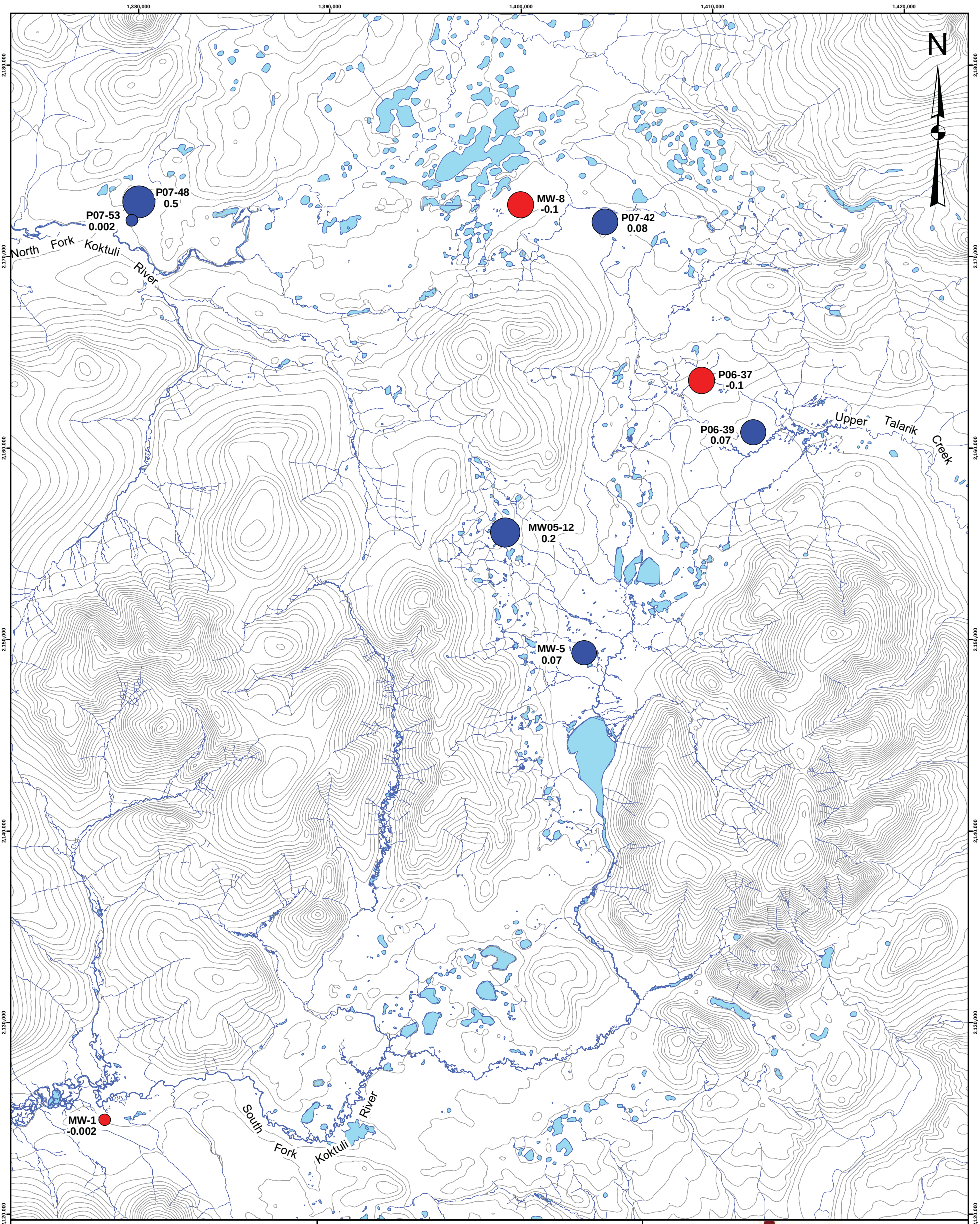
THE pebble PARTNERSHIP

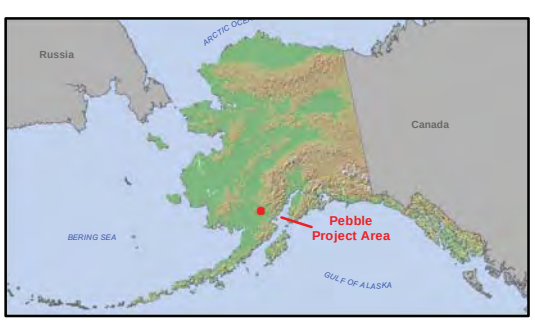
Figure 8.1F - 2
Vertical Gradients between
Shallow Overburden and Deep Overburden
during Seasonal High
June, 2008

Appendix 8.1F
Vertical Gradients

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7-126\GIS\MXDs\EBD_2009_Appendix_8.1F_vertical_gradients\Vertical Gradients for SO-DO June 2008.mxd





Legend

- SO-CZ/BR Upward Gradient
- SO-CZ/BR Downward Gradient
- 50-ft Contour Interval
- Rivers
- Lakes

DO = Deep Overburden
SO = Shallow Overburden
P = Piezometer
KP-P = Knight-Piesold Piezometer
MW = Monitoring Well
SRK = Steffan Robertson Kirsten

Notes: 1. Gradient = $\frac{\text{Head Difference}}{\text{Distance Between Screen Midpoints}}$

2. Diameter of circle is logarithmically proportional to the magnitude of the gradient

3. Contact Zone: zone immediately above and below the bedrock contact that is penetrated by the well screen and sand pack

Feet: 0 — 2,500 — 5,000 — 7,500 — 10,000

Meters: 0 — 890 — 1,780 — 2,670 — 3,560

Scale 1:60,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1F - 3
Vertical Gradients between Shallow Overburden and Bedrock during Seasonal Low
May, 2008

Appendix 8.1F
Vertical Gradients

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T4001\Figure 3 - Vertical Gradients between Shallow Overburden and Bedrock May 2008.mxd

1,380,000 1,390,000 1,400,000 1,410,000 1,420,000

2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000

N

P07-48
0.3

P07-53
0.004

North Fork Koktuli River

MW-8
-0.08

P07-42
0.06

P06-37
-0.09

P06-39
0.09

P06-41
0.02

Upper Talarik Creek

GH07-96
-0.005

GH07-98
-0.004

MW-7
-0.004

MW05-12
0.2

P08-55
0.001

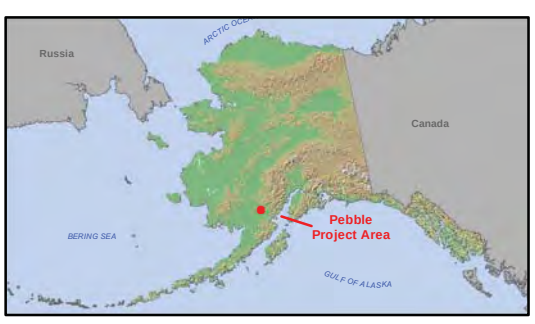
MW-5
-0.08

P08-60
0.1

P08-63
0.02

MW-1
-0.003

South Fork Koktuli River



Legend

- SO-CZ/BR Upward Gradient
- SO-CZ/BR Downward Gradient
- 50-ft Contour Interval
- Rivers
- Lakes

DO = Deep Overburden
SO = Shallow Overburden
P = Piezometer
KP-P = Knight-Piesold Piezometer
MW = Monitoring Well
SRK = Steffan Robertson Kirsten

Notes: 1. Gradient = Head Difference / Distance Between Screen Midpoints

2. Diameter of circle is logarithmically proportional to the magnitude of the gradient

3. Contact Zone: zone immediately above and below the bedrock contact that is penetrated by the well screen and sand pack

Feet
0 2,500 5,000 7,500 10,000

Meters
0 1,000 2,000 3,000 4,000

Scale 1:60,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1F - 4
Vertical Gradients between Shallow Overburden and Bedrock during Seasonal High June, 2008

Appendix 8.1F
Vertical Gradients

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T4002\Figure 4 - Vertical Gradients between Shallow Overburden and Bedrock June 2008.mxd

1,380,000 1,390,000 1,400,000 1,410,000 1,420,000

2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000

N

North Fork Koktuli River

P07-43
0.001

P05-30
-0.3

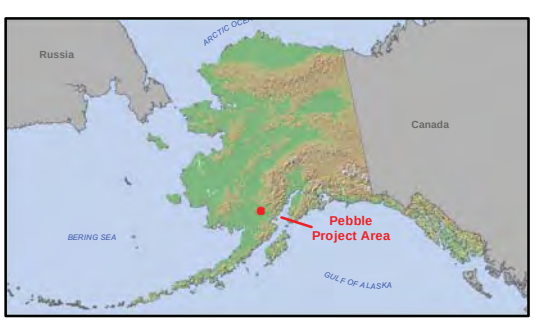
Upper Talarik Creek

P05-36
0.006

P05-07
-0.1

MW-5
0.08

South Fork Koktuli River



Legend

- DO-CZ/BR Upward Gradient
- DO-CZ/BR Downward Gradient
- 50-ft Contour Interval
- Rivers
- Lakes

DO = Deep Overburden
SO = Shallow Overburden
P = Piezometer
KP-P = Knight-Piesold Piezometer
MW = Monitoring Well
SRK = Steffan Robertson Kirsten

Notes: 1. Gradient = $\frac{\text{Head Difference}}{\text{Distance Between Screen Midpoints}}$

2. Diameter of circle is logarithmically proportional to the magnitude of the gradient

3. Contact Zone: zone immediately above and below the bedrock contact that is penetrated by the well screen and sand pack

Feet
0 2,500 5,000 7,500 10,000

Meters
0 1,000 2,000 3,000 4,000

Scale 1:60,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

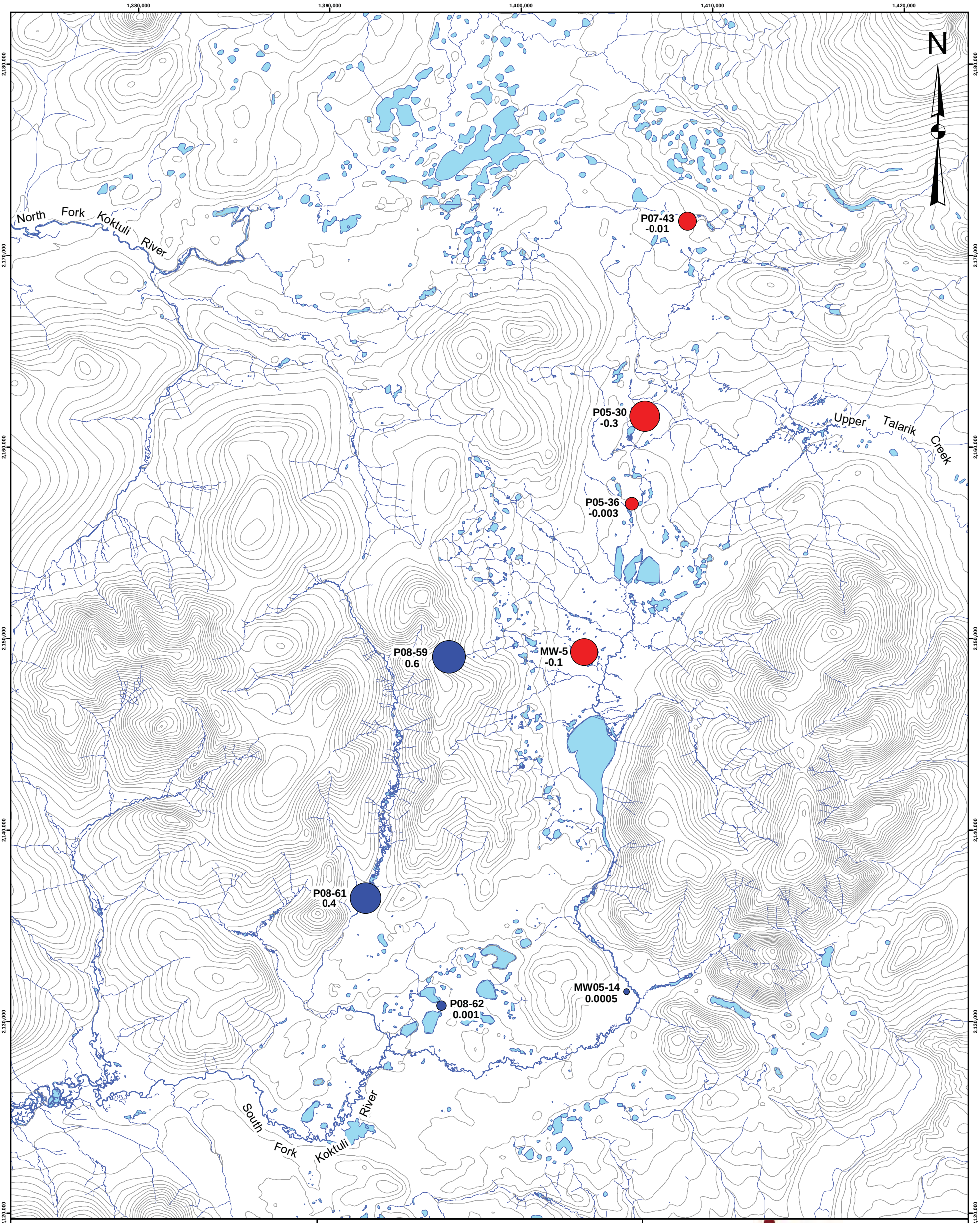
THE pebble PARTNERSHIP

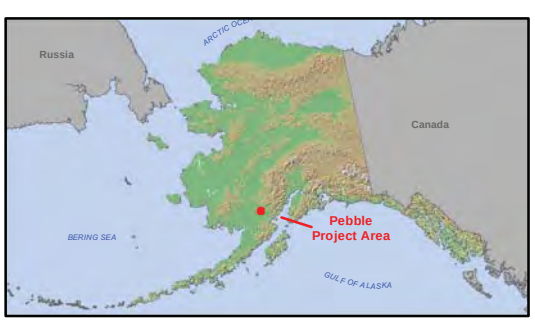
Figure 8.1F - 5
Vertical Gradients between Deep Overburden and Bedrock during Seasonal Low May, 2008

Appendix 8.1F
Vertical Gradients

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T4003\Figure 5 - Vertical Gradients between Deep Overburden and Bedrock May 2008.mxd





Legend

- DO-CZ/BR Upward Gradient
- DO-CZ/BR Downward Gradient
- 50-ft Contour Interval
- Rivers
- Lakes

DO = Deep Overburden
SO = Shallow Overburden
P = Piezometer
KP-P = Knight-Piesold Piezometer
MW = Monitoring Well
SRK = Steffan Robertson Kirsten

Notes: 1. Gradient = $\frac{\text{Head Difference}}{\text{Distance Between Screen Midpoints}}$

2. Diameter of circle is logarithmically proportional to the magnitude of the gradient

3. Contact Zone: zone immediately above and below the bedrock contact that is penetrated by the well screen and sand pack

Feet
0 2,500 5,000 7,500 10,000

Meters
0 1,000 2,000 3,000 4,000

Scale 1:60,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Figure 8.1F - 6
Vertical Gradients between
Deep Overburden and Bedrock
during Seasonal High
June, 2008

Appendix 8.1F
Vertical Gradients

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T4004\Figure 6 - Vertical Gradients between Deep Overburden and Bedrock June 2008.mxd

APPENDIX 8.1G

Time Series of Piezometric Elevations (Uniform Scale)

Pebble Project Environmental Baseline Document 2004 through 2008
Appendix 8.1G Time Series of Piezometric Elevations (uniform scale)

Table of Contents

DH-5324C, DH-5324B, DH-5324A 1
DH-5326B, DH-5326A 2
GH04-02 3
GH04-05 4
GH04-06 5
GH04-08 6
GH04-12A 7
GH04-14 8
GH04-16 9
GH04-17 10
GH04-18 11
GH04-19 12
GH04-20 13
GH04-22 14
GH04-23 15
GH04-25 16
GH04-27 17
GH04-28 18
GH04-30 19
GH04-31 20
GH04-33 21
GH04-35 22
GH04-37 23
GH04-38 24
GH04-43 25
GH04-45A 26
GH04-46 27
GH04-47 28
GH04-48 29
GH05-53 30
GH05-55 31
GH05-56 32
GH05-57 33
GH05-58, GH05-58 (Transducer) 34
GH05-59 35
GH05-61 36
GH05-63 37
GH05-64 38
GH06-65 39
GH06-66 40

Pebble Project Environmental Baseline Document 2004 through 2008
Appendix 8.1G Time Series of Piezometric Elevations (uniform scale)

Table of Contents (cont'd.)

GH06-67 41
GH06-68 42
GH06-74 43
GH06-75 44
GH06-76 45
GH06-80 46
GH07-101 47
GH07-102S, GH07-102D 48
GH07-103S, GH07-103D 49
GH07-104 50
GH07-105 51
GH07-82S, GH07-82D 52
GH07-83S, GH07-83D 53
GH07-84 54
GH07-85 55
GH07-86 56
GH07-87S, GH07-87D 57
GH07-88 58
GH07-89S, GH07-89D 59
GH07-90S, GH07-90D 60
GH07-91 61
GH07-92S, GH07-92D 62
GH07-93 63
GH07-94 64
GH07-95 65
GH07-96S, GH07-96D 66
GH07-97S, GH07-97D 67
GH07-98S, GH07-98D 68
GH07-99 69
GH08-107 70
GH08-109 71
GH08-111 72
GH08-112 73
GH08-113 74
GH08-115 75
GH08-116 76
GH08-117 77
GH08-118 78
GH08-119 79
GH08-120 80

Table of Contents (cont'd.)

GH08-121 81
GH08-123 82
GH08-124 83
GH08-125 84
GH08-126 85
GH08-127 86
GH08-128 87
GH08-129 88
GH08-131 89
GH08-132 90
GH08-133 91
GH08-135 92
GH08-136 93
GH08-137 94
GH08-138 95
GH08-139 96
GH08-140 97
GH08-141 98
GH08-142 99
GH08-143 100
GH08-144 101
GH08-145 102
GH08-146 103
GH08-147 104
GH08-148 105
GH08-149 106
GH08-150 107
GH08-151 108
GH08-152 109
GH08-153 110
GH08-154 111
GH08-155 112
GH08-156 113
GH08-157 114
GH08-158 115
GH08-159 116
GH08-160 117
GH08-161 118
GH08-162 119
GH08-163 120
GH08-164 121

Pebble Project Environmental Baseline Document 2004 through 2008
Appendix 8.1G Time Series of Piezometric Elevations (uniform scale)

Table of Contents (cont'd.)

GH08-165 122
GH08-166 123
GH08-167 124
GH08-168 125
GH08-169 (Vibrating Wire) 126
GH08-170 (Vibrating Wire) 127
GH08-171 128
GH08-172 129
GH08-173 130
GH08-174 131
GH08-175 132
GH08-176 133
GH08-177 134
GH08-178 135
GH08-179 136
GH08-180 137
GH08-181S, GH08-181D 138
GH08-182 139
GH08-183 140
GH08-184 141
GH08-185 142
GH08-186 143
GH08-187 144
GH08-188 145
GH08-189S, GH08-189D 146
GH08-190 147
GH08-191 148
GH08-192 149
GH08-193 150
GH08-195 151
GH08-196 152
GH08-198 153
GH08-199S, GH08-199D 154
GH08-200 155
GH08-203 156
GH08-204 157
GH08-205S, GH08-205D 158
GH08-206S, GH08-206D 159
GH08-207S, GH08-207D 160
GH08-208 161
GH08-209 162

Pebble Project Environmental Baseline Document 2004 through 2008
Appendix 8.1G Time Series of Piezometric Elevations (uniform scale)

Table of Contents (cont'd.)

GH08-210S, GH08-210D 163
I-125 164
I-172 165
I-201 166
KP-P1/SRK-2 167
KP-P3S/SRK-5S, KP-P3M/SRK-5M, KP-P3D/SRK-5D 168
KP-P4 169
M-110 170
M-12 171
M-21 172
M-62 173
MW-05-11SS 174
MW-05-12S, MW-05-12D 175
MW-05-13S, MW-05-13S (Transducer), MW-05-13D, MW-05-13D (Transducer) 176
MW-05-14S, MW-05-14D 177
MW-05-2SR, MW-05-02M 178
MW-1S, MW-1M, MW-1D 179
MW-10 180
MW-11S, MW-11M, MW-11D 181
MW-2S, MW-2D 182
MW-3D 183
MW-4S 184
MW-5S, MW-5S (Transducer), MW-5M, MW-5M (Transducer), MW-5D, MW-5D (Transducer) 185
MW-6D 186
MW-7S, MW-7D 187
MW-8S, MW-8M, MW-8D 188
MW-9D 189
P-05-07S, P-05-07S (Transducer), P-05-07D, P-05-07D (Transducer) ..190
P-05-08 191
P-05-09S, P-05-09D 192
P-05-10S, P-05-10D 193
P-05-11S, P-05-11M, P-05-11D 194
P-05-12 195
P-05-13 196
P-05-14S, P-05-14D 197
P-05-15S, P-05-15D 198
P-05-16SS, P-05-16S, P-05-16M, P-05-16D 199
P-05-17S, P-05-17D 200
P-05-18 201
P-05-19S, P-05-19M 202

Pebble Project Environmental Baseline Document 2004 through 2008
Appendix 8.1G Time Series of Piezometric Elevations (uniform scale)

Table of Contents (cont'd.)

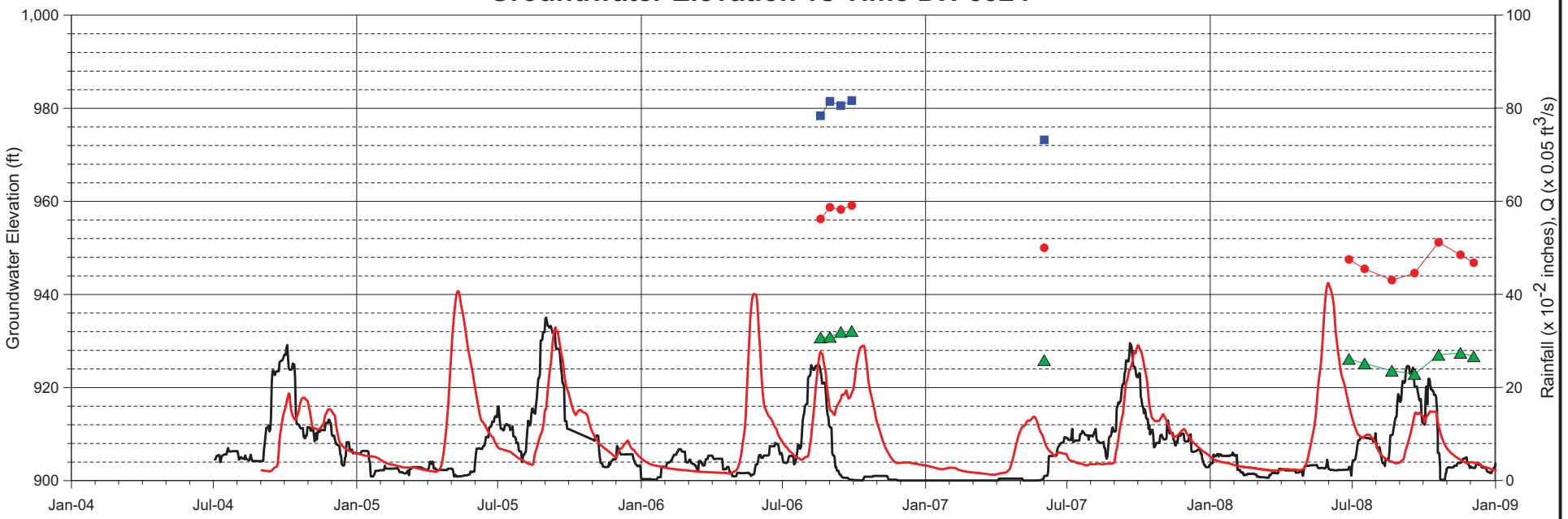
P-05-20S, P-05-20D....203
P-05-21S, P-05-21M, P-05-21D....204
P-05-22D....205
P-05-23....206
P-05-24S, P-05-24D....207
P-05-25....208
P-05-26S, P-05-26M, P-05-26D....209
P-05-27S, P-05-27S (Transducer), P-05-27M, P-05-27M (Transducer), P-05-27D, P-05-27D (Transducer)....210
P-05-28S, P-05-28D....211
P-05-29S, P-05-29M, P-05-29D2, P-05-29D....212
P-05-30S, P-05-30D....213
P-05-31S, P-05-31D....214
P-05-32D....215
P-05-33D....216
P-05-35D....217
P-05-36S, P-05-36M, P-05-36D....218
P-06-37S, P-06-37M, P-06-37D....219
P-06-38M, P-06-38D....220
P-06-39S, P-06-39D....221
P-06-40S, P-06-40M, P-06-40D....222
P-06-41S, P-06-41M, P-06-41D....223
P-07-42S, P-07-42D....224
P-07-43S, P-07-43M, P-07-43D....225
P-07-45D....226
P-07-46D....227
P-07-47D....228
P-07-48S, P-07-48D....229
P-07-49S, P-07-49D....230
P-07-50SS, P-07-50S, P-07-50D....231
P-07-51S, P-07-51D....232
P-07-52S, P-07-52D....233
P-07-53S, P-07-53D....234
P-08-55S, P-08-55D....235
P-08-56S, P-08-56M, P-08-56D....236
P-08-57D....237
P-08-58M, P-08-58D....238
P-08-59S, P-08-59D....239
P-08-60S, P-08-60D....240
P-08-61S, P-08-61D....241
P-08-62S, P-08-62M, P-08-62D....242

Pebble Project Environmental Baseline Document 2004 through 2008
Appendix 8.1G Time Series of Piezometric Elevations (uniform scale)

Table of Contents (cont'd.)

P-08-63S, P-08-63M, P-08-63D 243
P-08-64S, P-08-64D.....244
P-08-65S, P-08-65M, P-08-65D 245
P-08-66S, P-08-66D.....246
P-08-67S, P-08-67D.....247
P-08-68D.....248
P-08-69S, P-08-69D.....249
P-08-70S, P-08-70D.....250
P-08-71S, P-08-71D.....251
P-08-72S, P-08-72D.....252
P-08-73S, P-08-73D.....253
P-08-74S, P-08-74D.....254
P-08-75S, P-08-75M, P-08-75D 255
P-08-76S, P-08-76D.....256
P-08-77S, P-08-77D.....257
P-08-78S, P-08-78D.....258
P-08-79S, P-08-79M, P-08-79D 259
P-08-80S, P-08-80M, P-08-80D 260
P-08-81S, P-08-81D.....261
P-08-82S, P-08-82M, P-08-82D 262
P-08-83S, P-08-83M, P-08-83D 263
P-08-84S, P-08-84D.....264
P-08-85S, P-08-85D.....265
P-08-86S, P-08-86D.....266
P-08-87S, P-08-87D.....267
P-08-88S, P-08-88D.....268
P-08-89S, P-08-89M, P-08-89D 269
P-2M, P-2D.....270
P-3.....271
P-4 Mid, P-4AS, P-4AD 272
P-6S, P-6M, P-6D 273
PQ-4.....274
PQ-8.....275
PQ-9.....276
SRK-2 (AKA 4251).....277
SRK-2A.....278
SRK-3 (AKA 4250).....279

Groundwater Elevation vs Time DH-5324



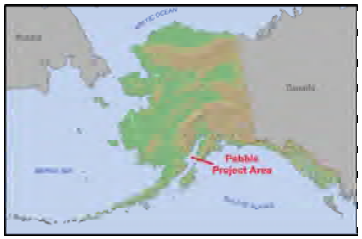
LEGEND:

Groundwater Elevation Plot Legend

- DH-5324C (Vibrating Wire)
- DH-5324B (Vibrating Wire)
- DH-5324A (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

Transducer Elevation (ft asl):
DH-5324C : 645.9
DH-5324B : 413.9
DH-5324A : 150.9

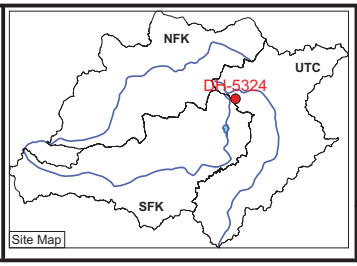


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 957.9 ft asl

The y range for this graph is 100 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\DH-5324.grf

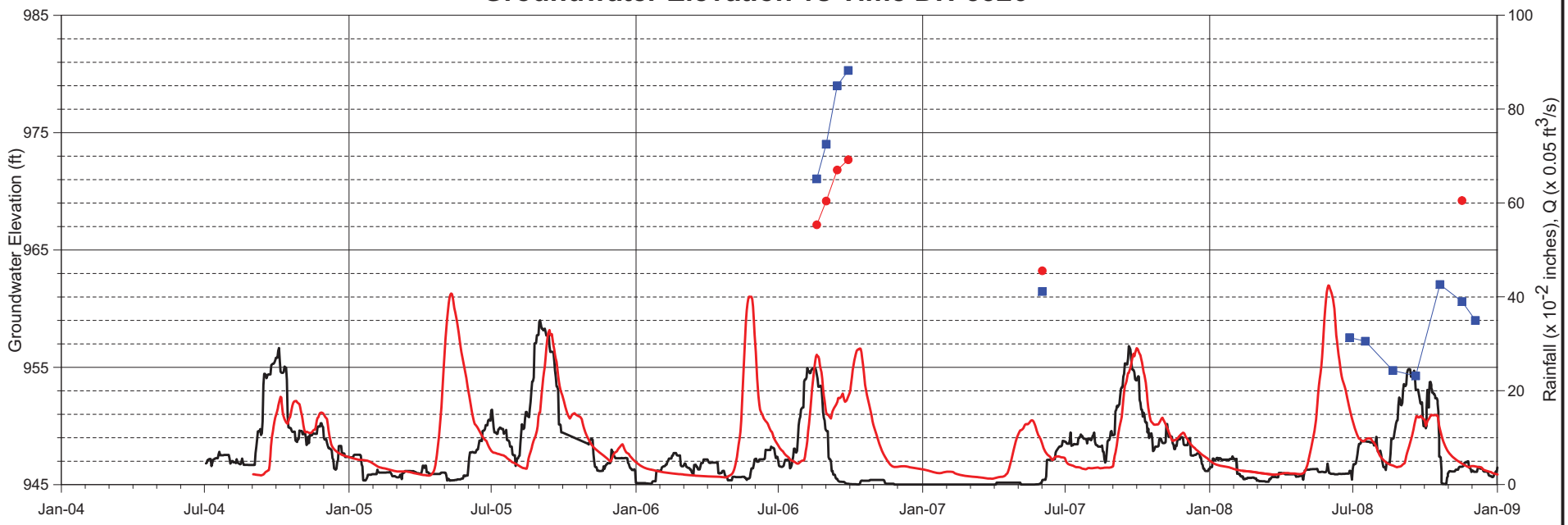


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time DH-5326



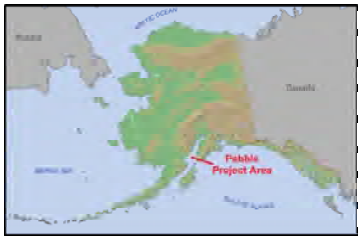
LEGEND:

Groundwater Elevation Plot Legend

- DH-5326B (Vibrating Wire)
- DH-5326A (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

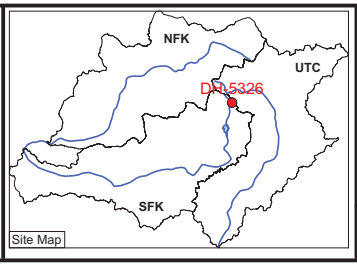
Transducer Elevation (ft asl):
DH-5326B : 863.1
DH-5326A : 351.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1044.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\DH-5326.grf

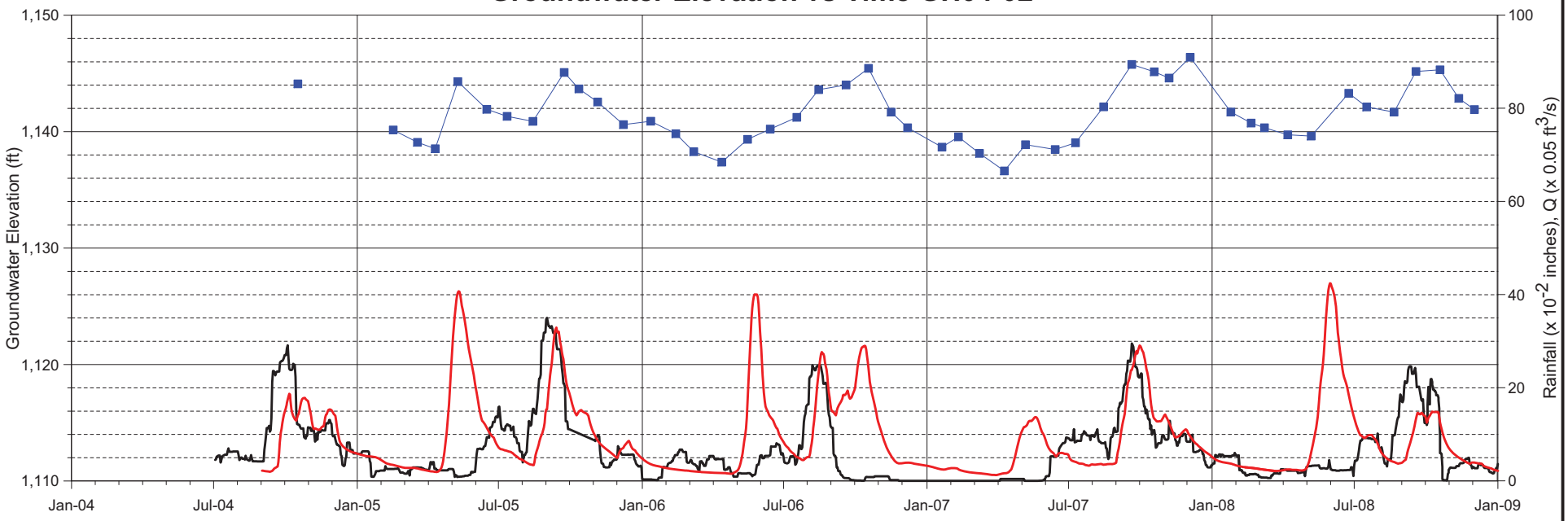


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-02



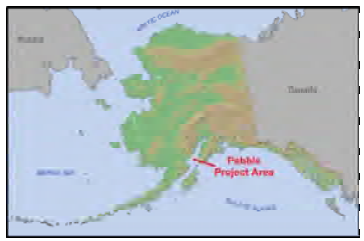
LEGEND:

Groundwater Elevation Plot Legend

- GH04-02
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

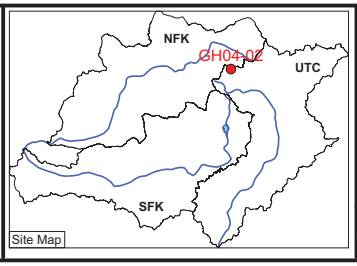
Screens (ft asl):
GH04-02 : 1123.2 - 1133.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1148.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-02.grf

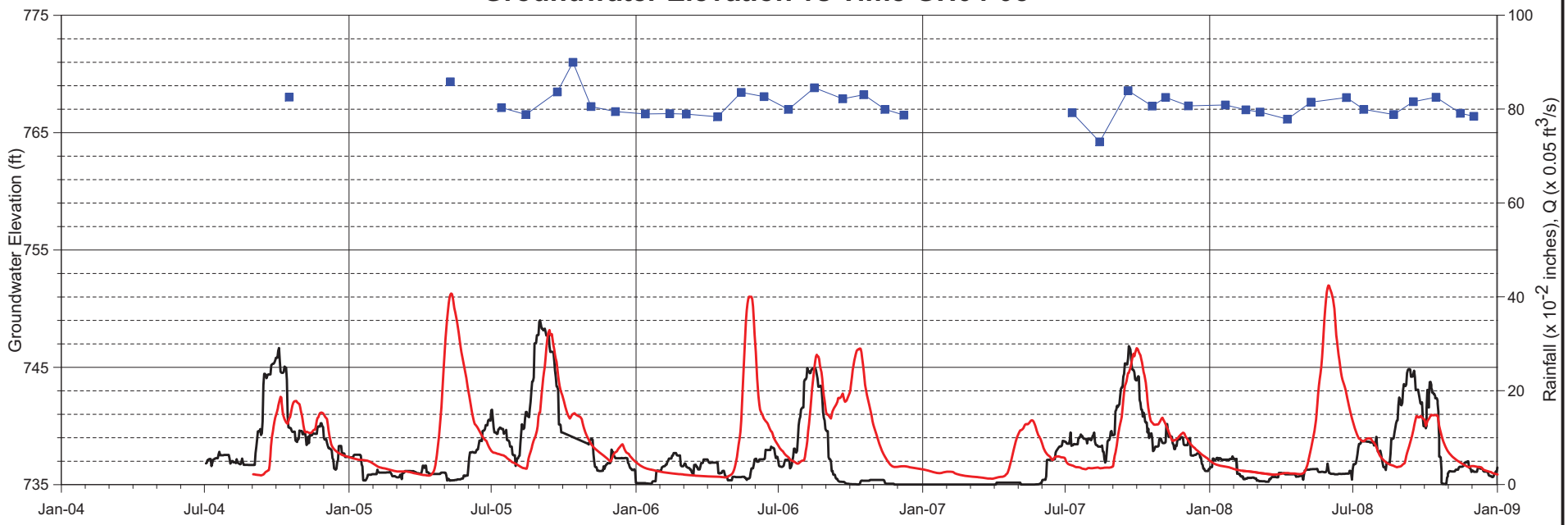


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-05



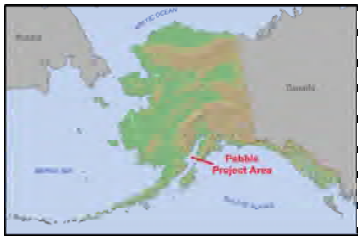
LEGEND:

Groundwater Elevation Plot Legend

- GH04-05
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

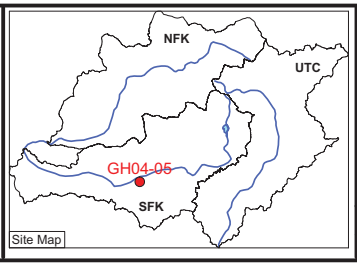
Screens (ft asl):
GH04-05 : 732.9 - 742.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 770.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-05.grf

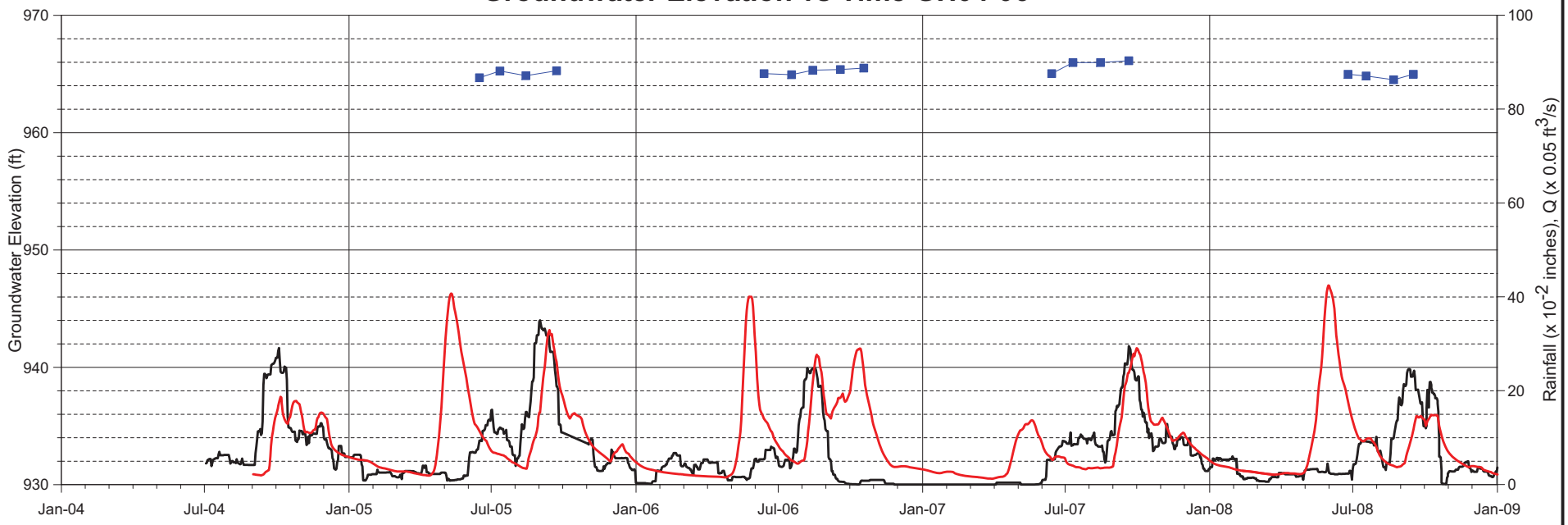


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-06



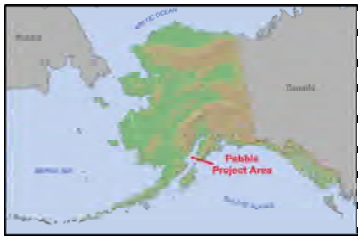
LEGEND:

Groundwater Elevation Plot Legend

- GH04-06
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

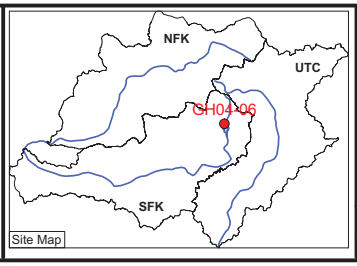
Screens (ft asl):
GH04-06 : 929.4 - 939.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 965.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-06.grf

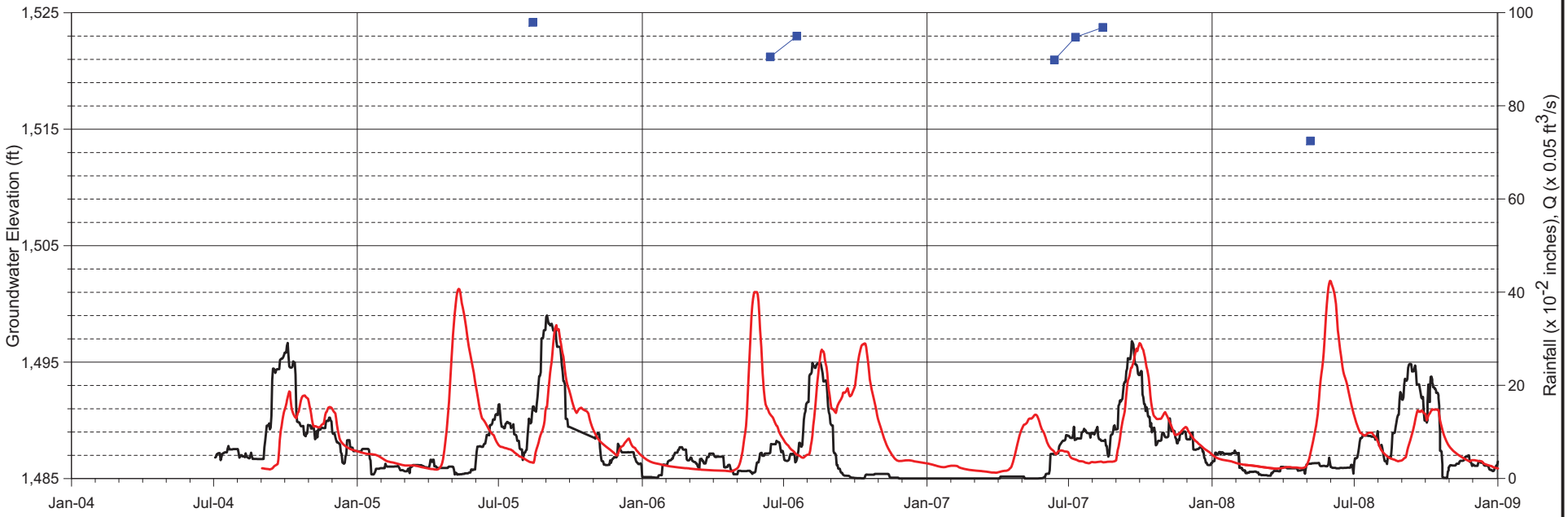


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-08



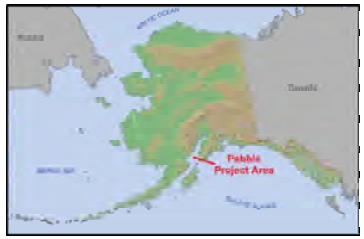
LEGEND:

Groundwater Elevation Plot Legend

- GH04-08
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-08 : 1489.1 - 1499.1

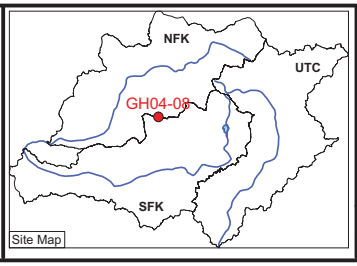


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1525.1 ft asl

GH04-08 was flowing most of the time, water levels were recorded when they fell below top of riser.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-08.grf

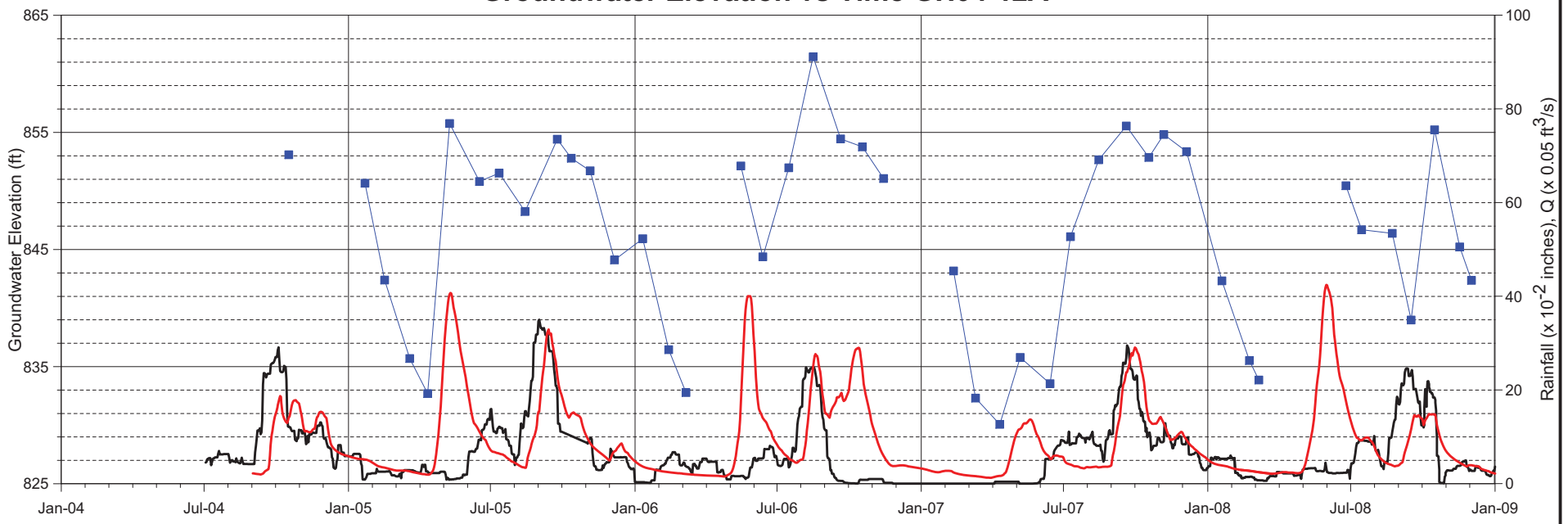


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-12A



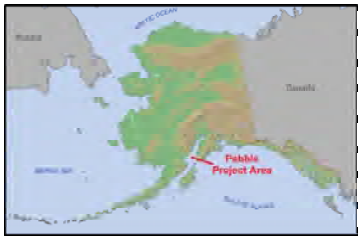
LEGEND:

Groundwater Elevation Plot Legend

- GH04-12A
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

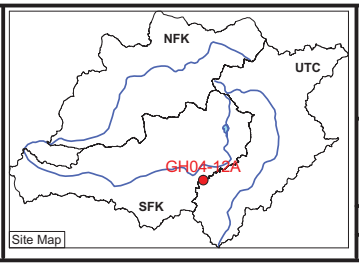
Screens (ft asl):
GH04-12A : 818.9 - 828.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 881.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-12A.grf

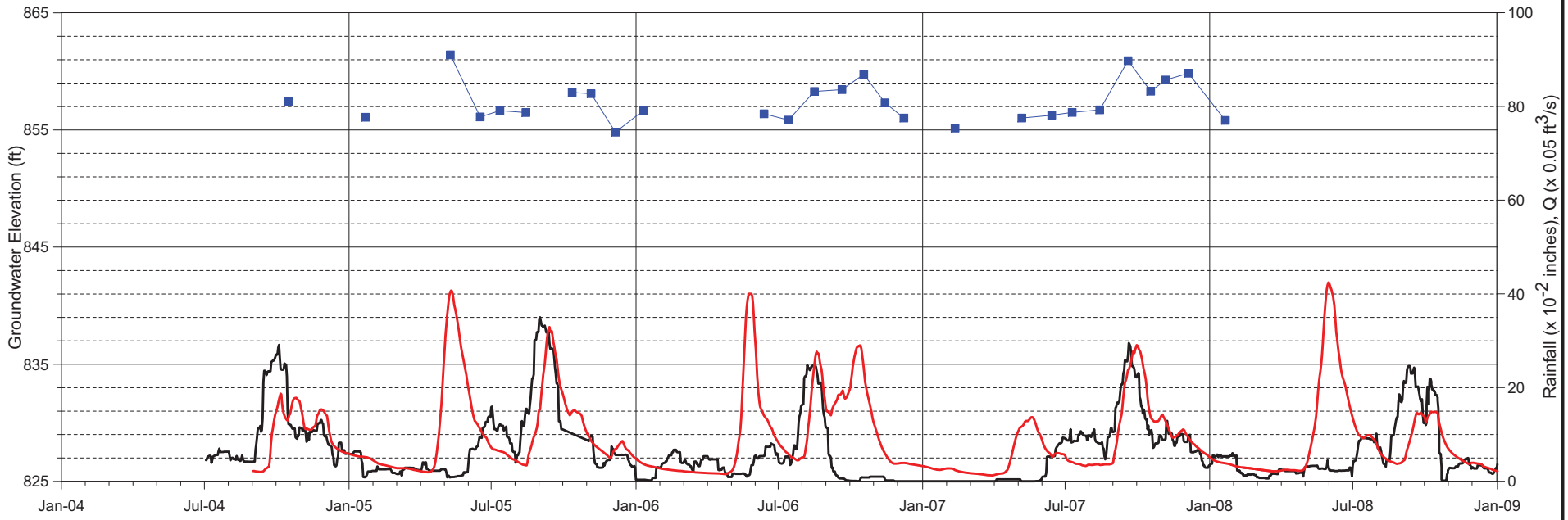


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-14



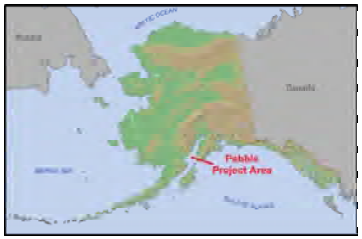
LEGEND:

Groundwater Elevation Plot Legend

- GH04-14
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

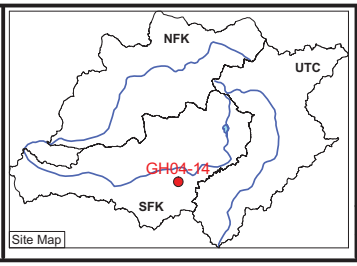
Screens (ft asl):
GH04-14 : 854.0 - 864.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 927 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-14.grf

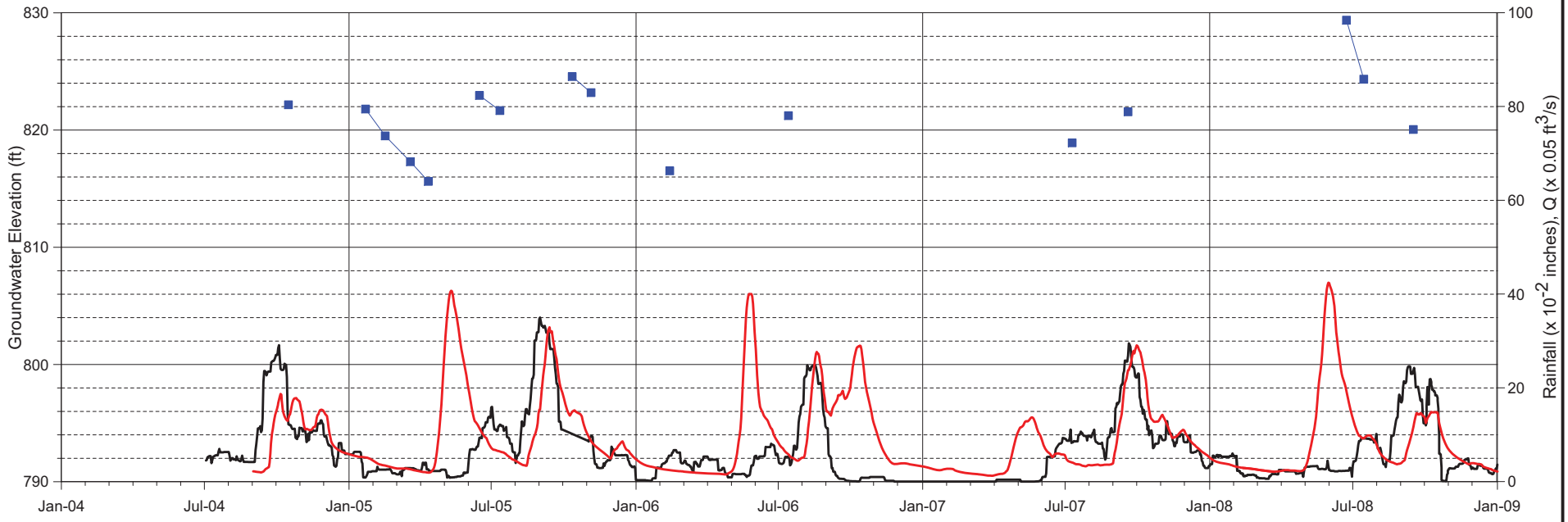


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-16



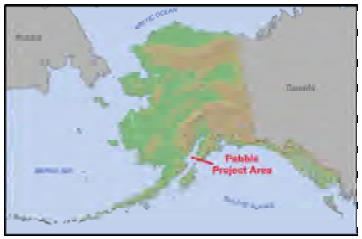
LEGEND:

Groundwater Elevation Plot Legend

- GH04-16
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-16 : 790.5 - 800.5

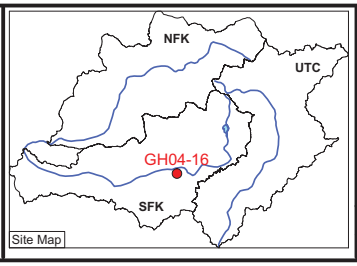


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 889.6 ft asl

PVC was visibly separated at a depth of about 2 ft, water level readings were not always possible.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-16.grf

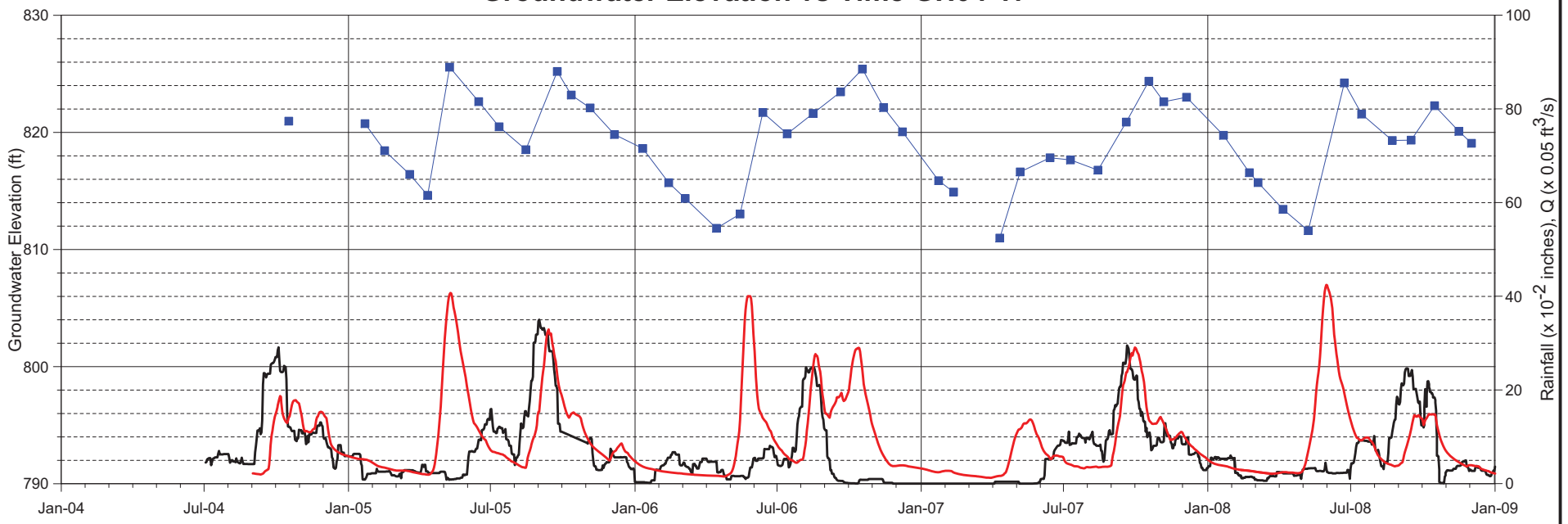


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-17



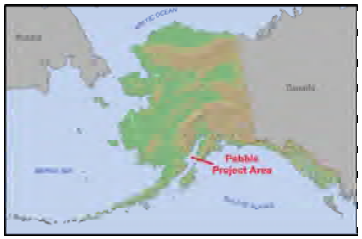
LEGEND:

Groundwater Elevation Plot Legend

- GH04-17
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

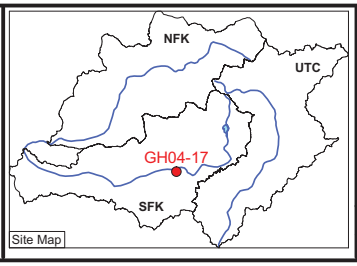
Screens (ft asl):
GH04-17 : 804.2 - 814.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 841.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-17.grf

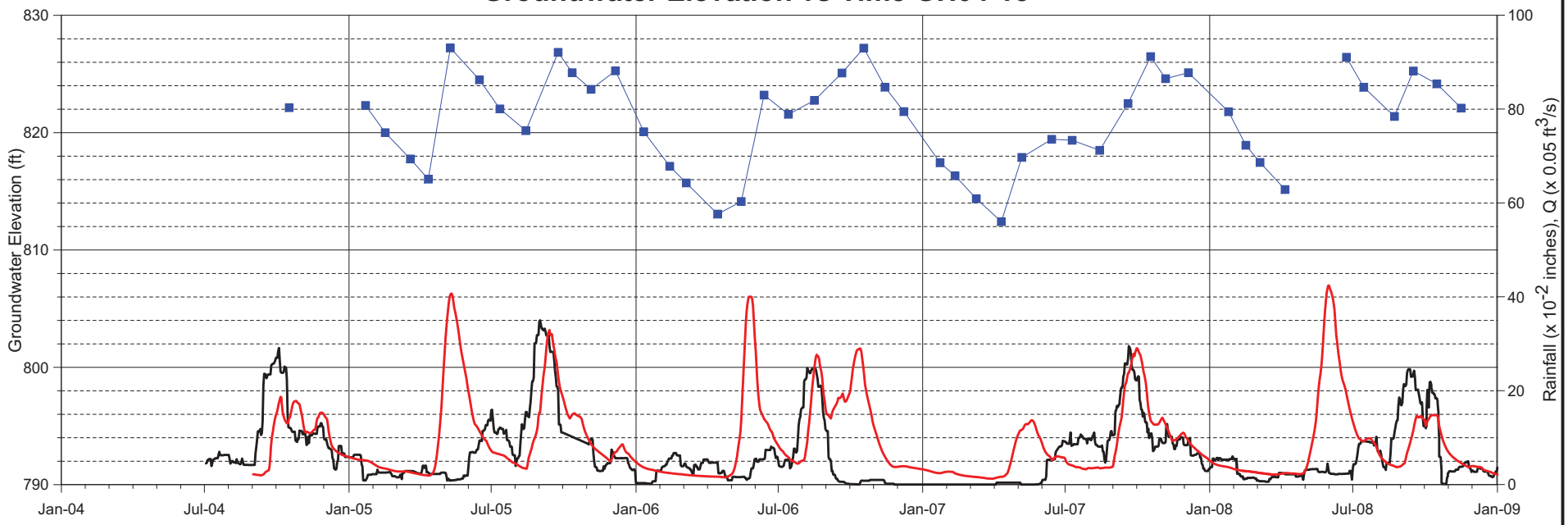


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-18



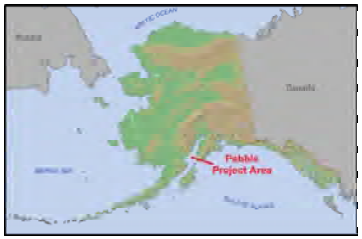
LEGEND:

Groundwater Elevation Plot Legend

- GH04-18
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

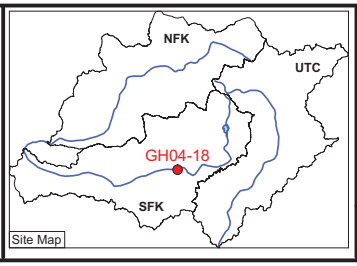
Screens (ft asl):
GH04-18 : 777.5 - 787.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 832 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-18.grf

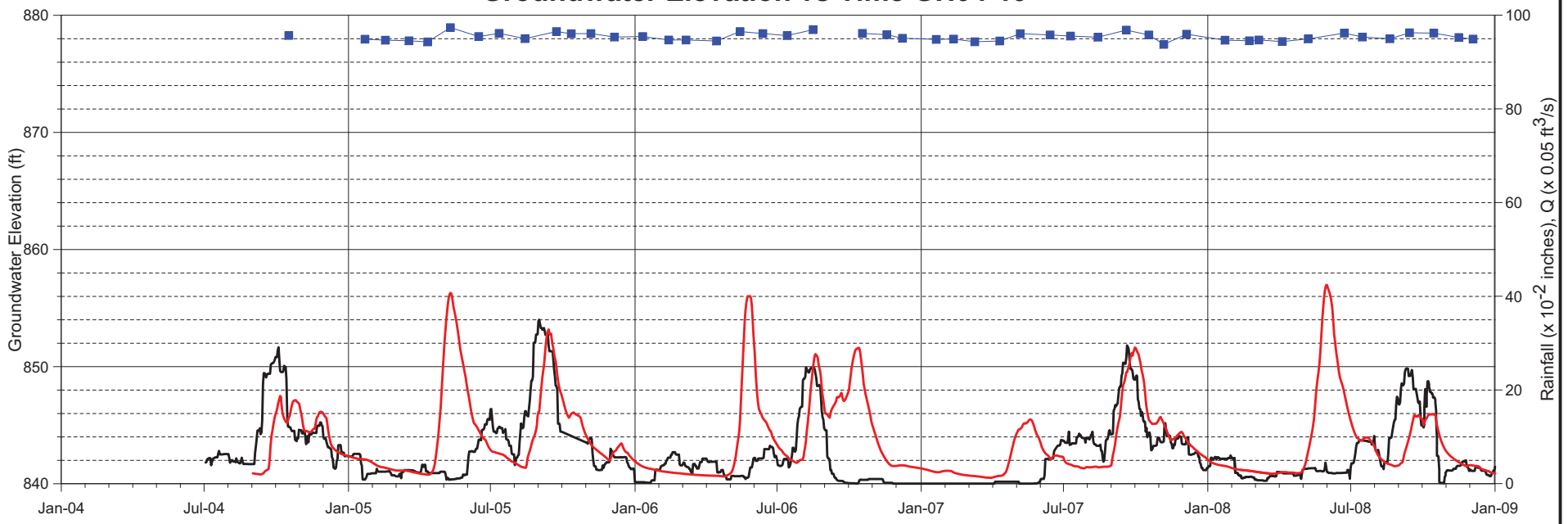


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-19



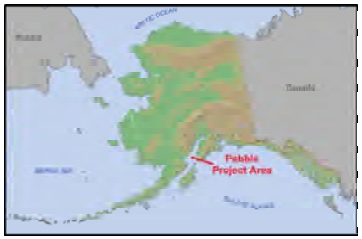
LEGEND:

Groundwater Elevation Plot Legend

- GH04-19
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

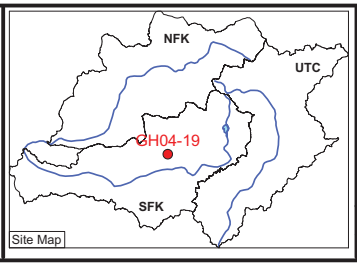
Screens (ft asl):
GH04-19 : 865.0 - 875.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 880 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-19.grf

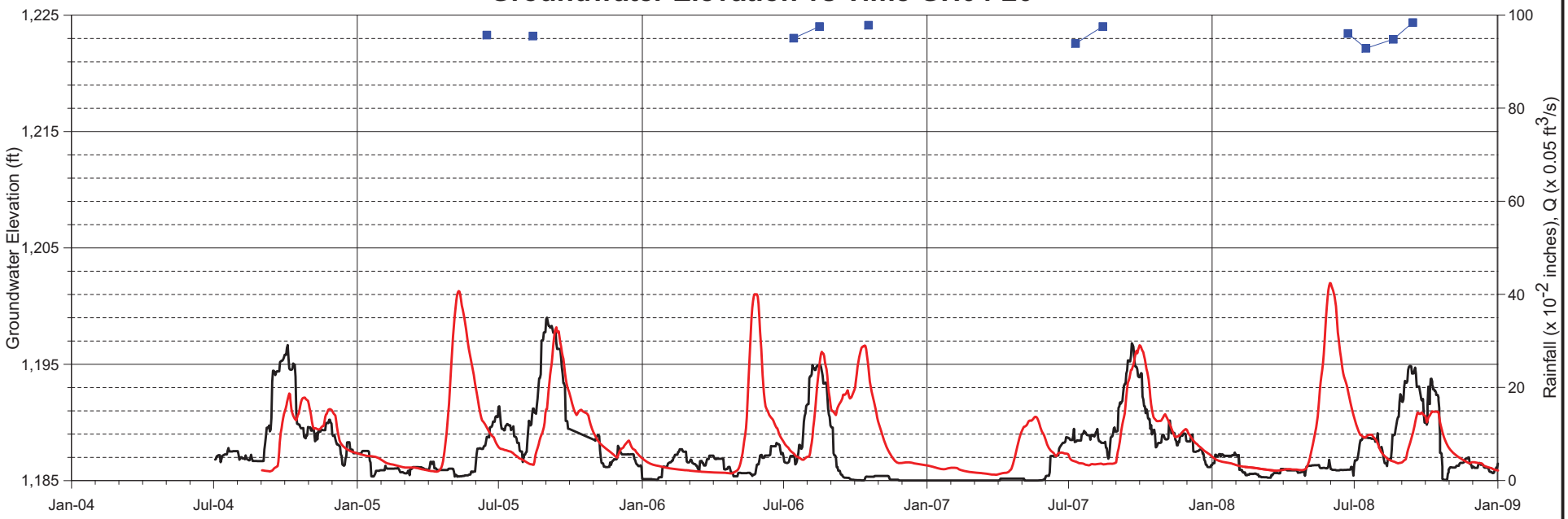


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-20



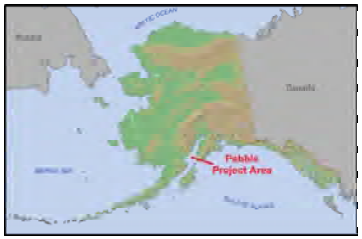
LEGEND:

Groundwater Elevation Plot Legend

- GH04-20
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-20 : 1209.5 - 1219.5

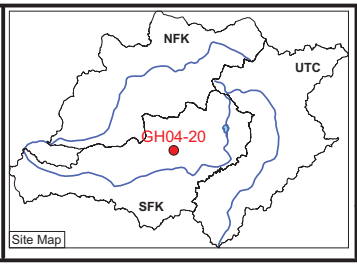


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1223.5 ft asl

GH04-20 was flowing most of the time, water levels recorded when they fall below top of riser.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-20.grf

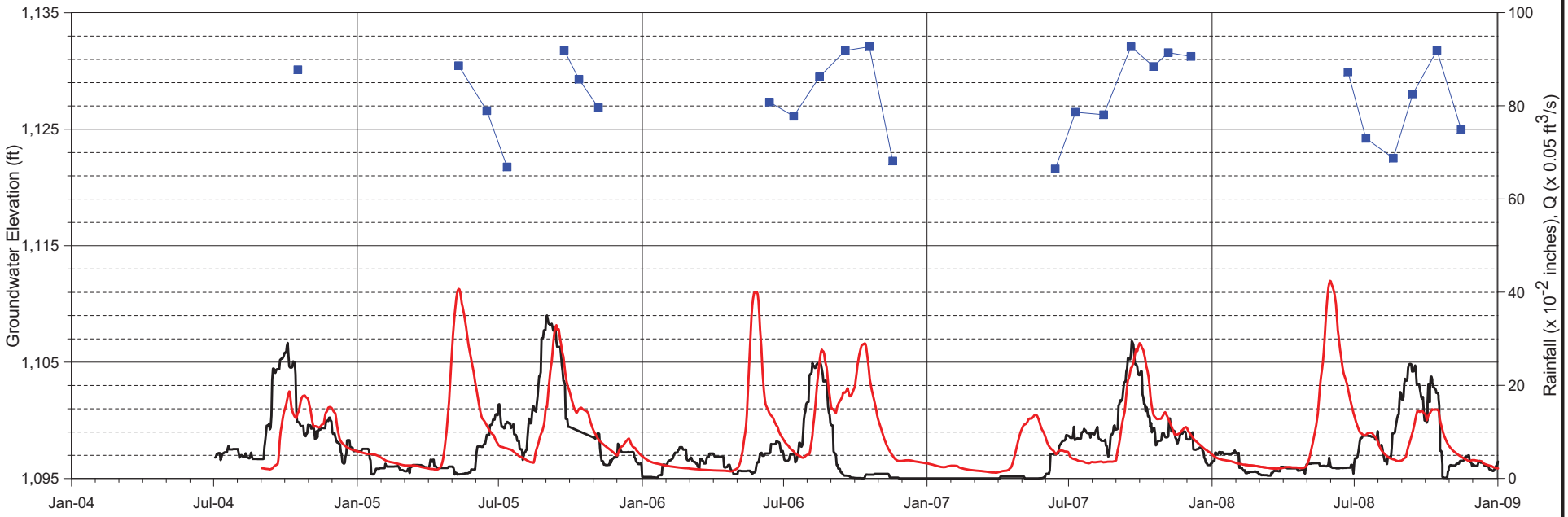


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-22



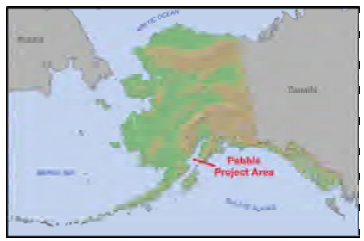
LEGEND:

Groundwater Elevation Plot Legend

- GH04-22
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-22 : 1116.7 - 1127.7

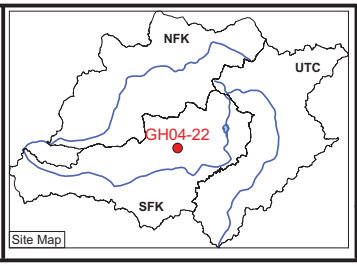


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1132.7 ft asl

GH04-22 dries seasonally during the winter, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-22.grf

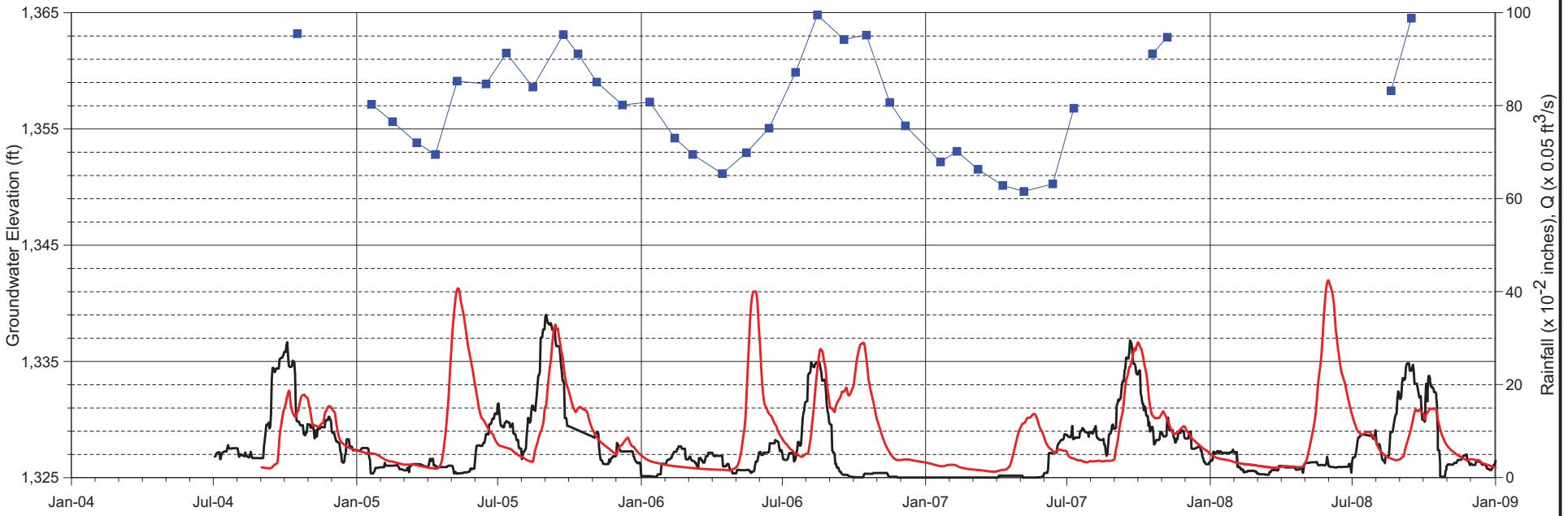


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-23



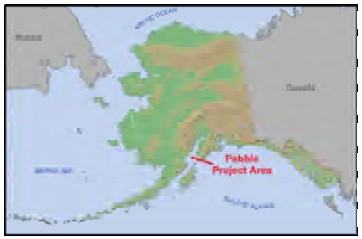
LEGEND:

Groundwater Elevation Plot Legend

- GH04-23
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-23 : 1347.8 - 1357.8

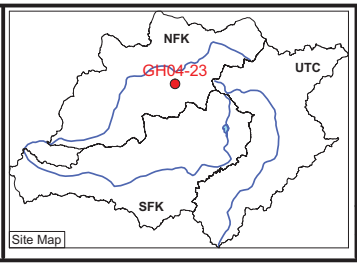


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1364.8 ft asl

Well had infilling with sediment, which was sometimes above the groundwater level since July, 2007. Therefore, few water levels recorded since July, 2007.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-23.grf

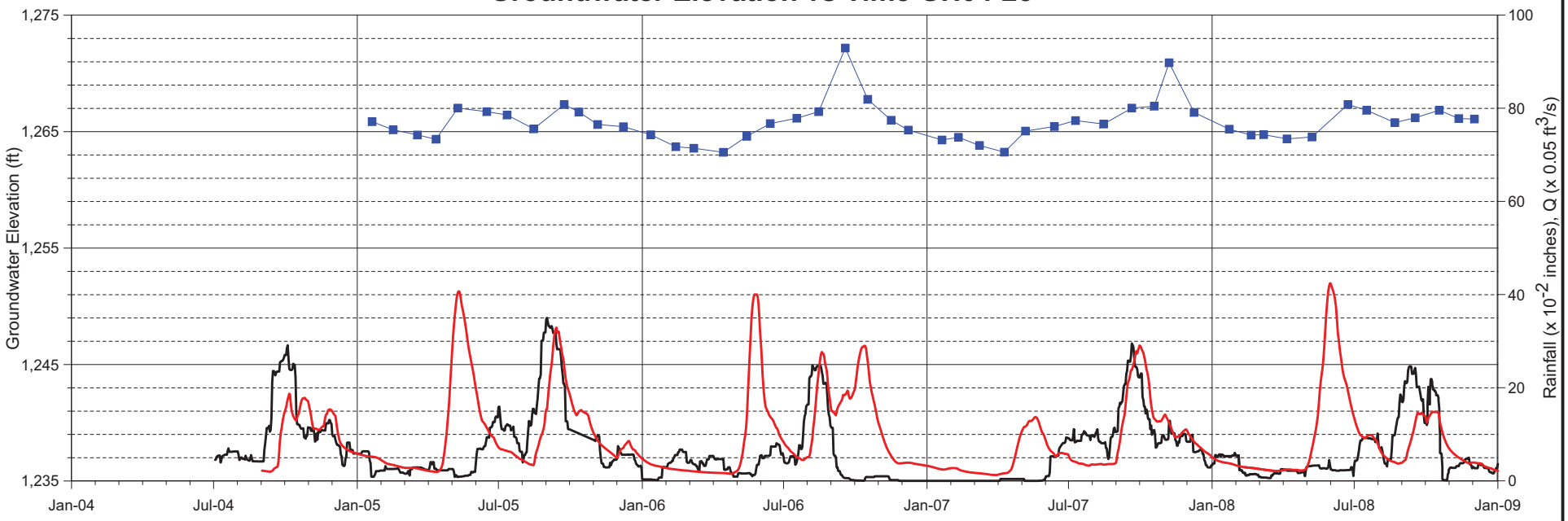


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-25



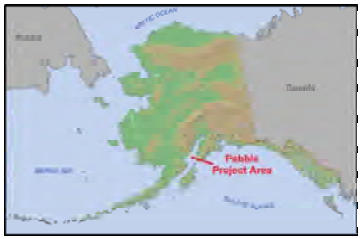
LEGEND:

Groundwater Elevation Plot Legend

- GH04-25
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

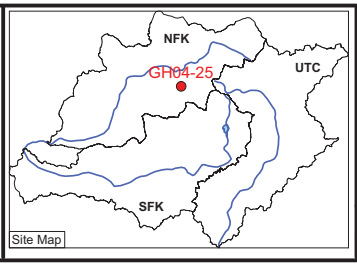
Screens (ft asl):
GH04-25 : 1238.4 - 1248.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1313.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-25.grf

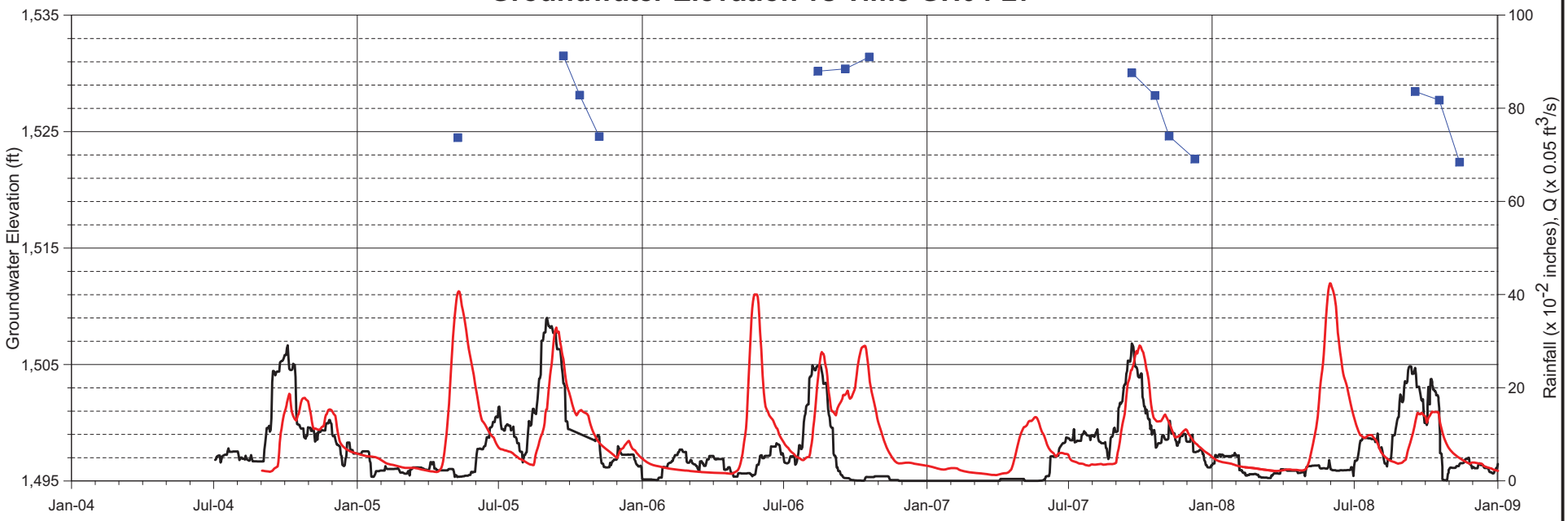


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-27



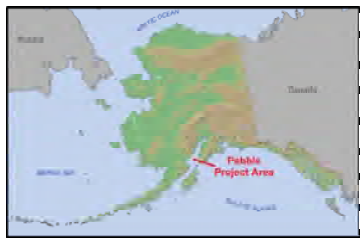
LEGEND:

Groundwater Elevation Plot Legend

- GH04-27
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-27 : 1518.6 - 1528.6

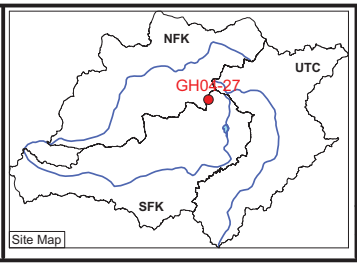


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1550.6 ft asl

GH04-27 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-27.grf

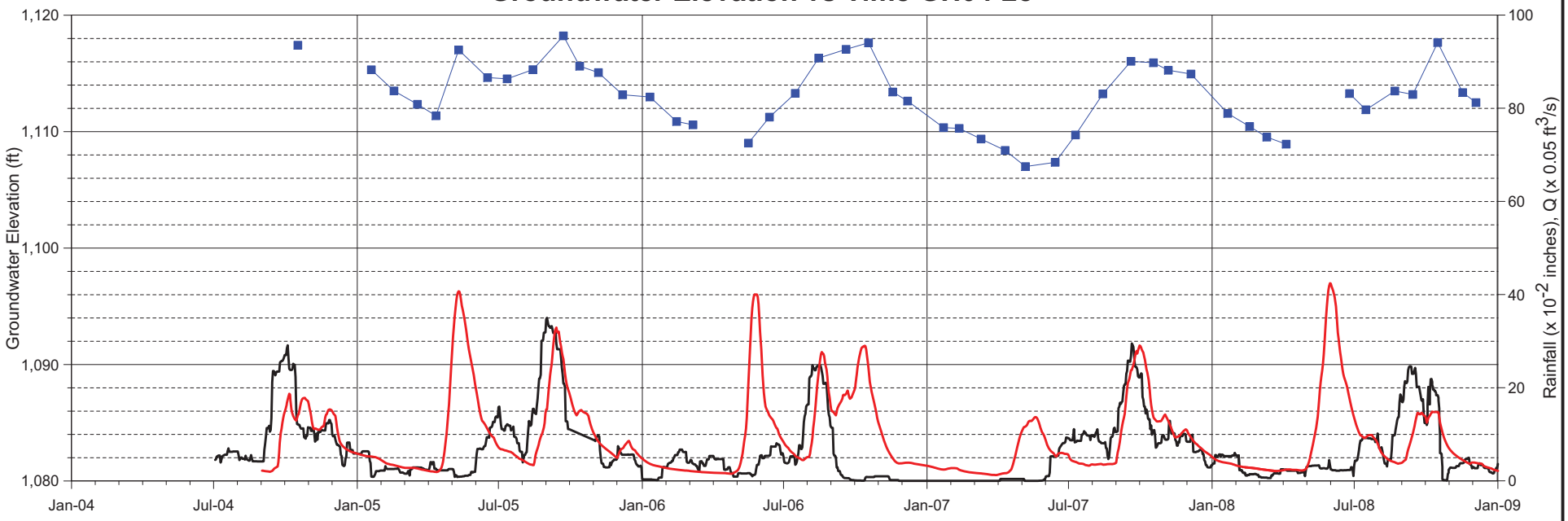


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-28



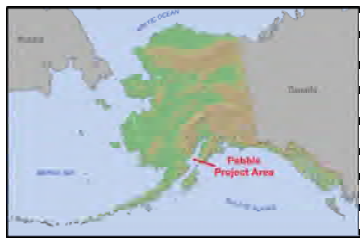
LEGEND:

Groundwater Elevation Plot Legend

- GH04-28
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

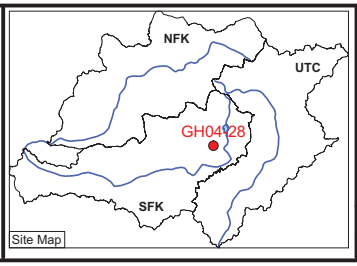
Screens (ft asl):
GH04-28 : 1098.1 - 1108.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1155.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-28.grf

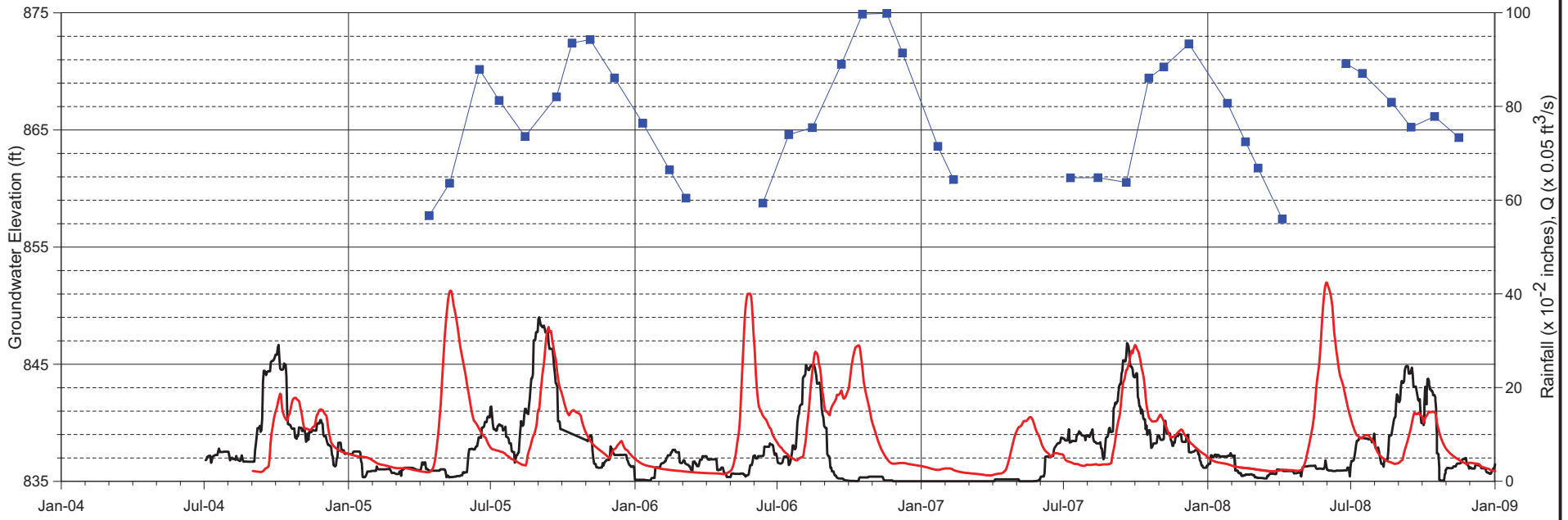


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-30



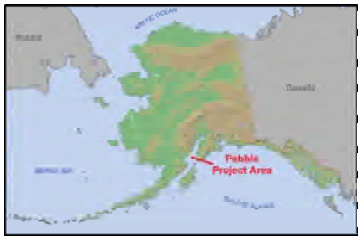
LEGEND:

Groundwater Elevation Plot Legend

- GH04-30
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-30 : 859.8 - 869.8

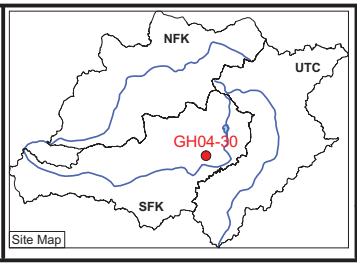


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 936.8 ft asl

GH04-30 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-30.grf

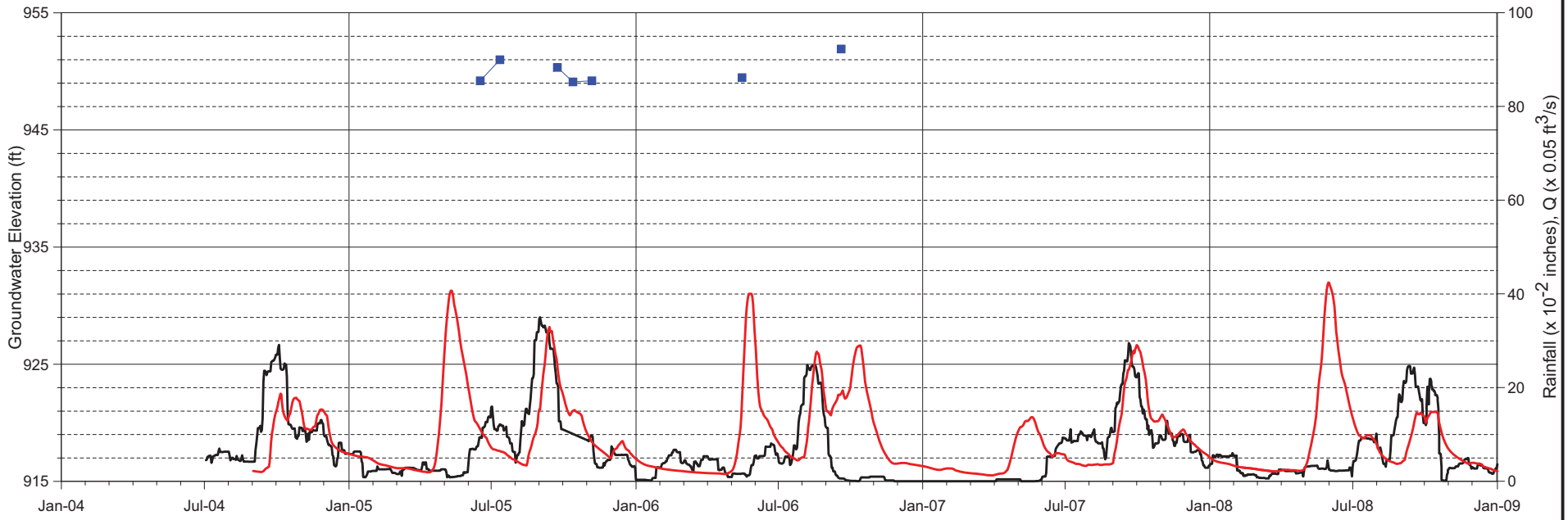


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-31



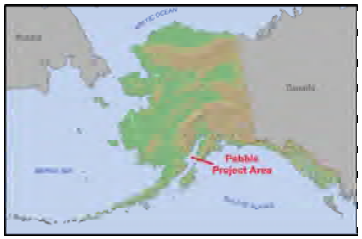
LEGEND:

Groundwater Elevation Plot Legend

- GH04-31
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-31 : 947.6 - 957.6

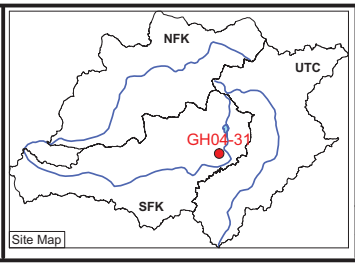


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1009.6 ft asl

Recorded water levels measured water pooled in bottom of the piezometer; actual groundwater level was below bottom of screen.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-31.grf

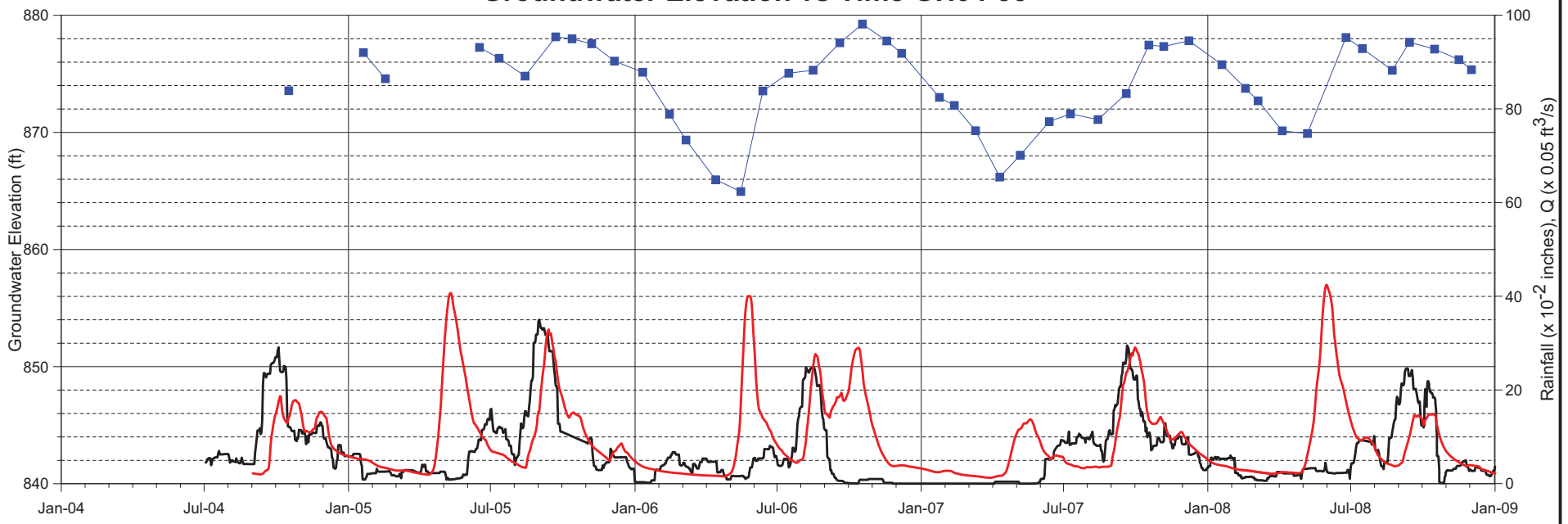


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-33



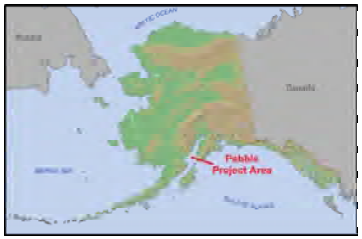
LEGEND:

Groundwater Elevation Plot Legend

- GH04-33
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

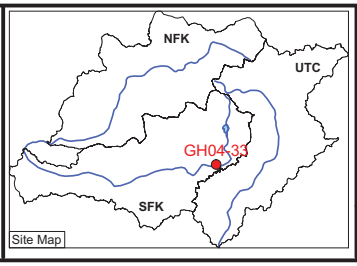
Screens (ft asl):
GH04-33 : 846.4 - 856.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 903.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-33.grf

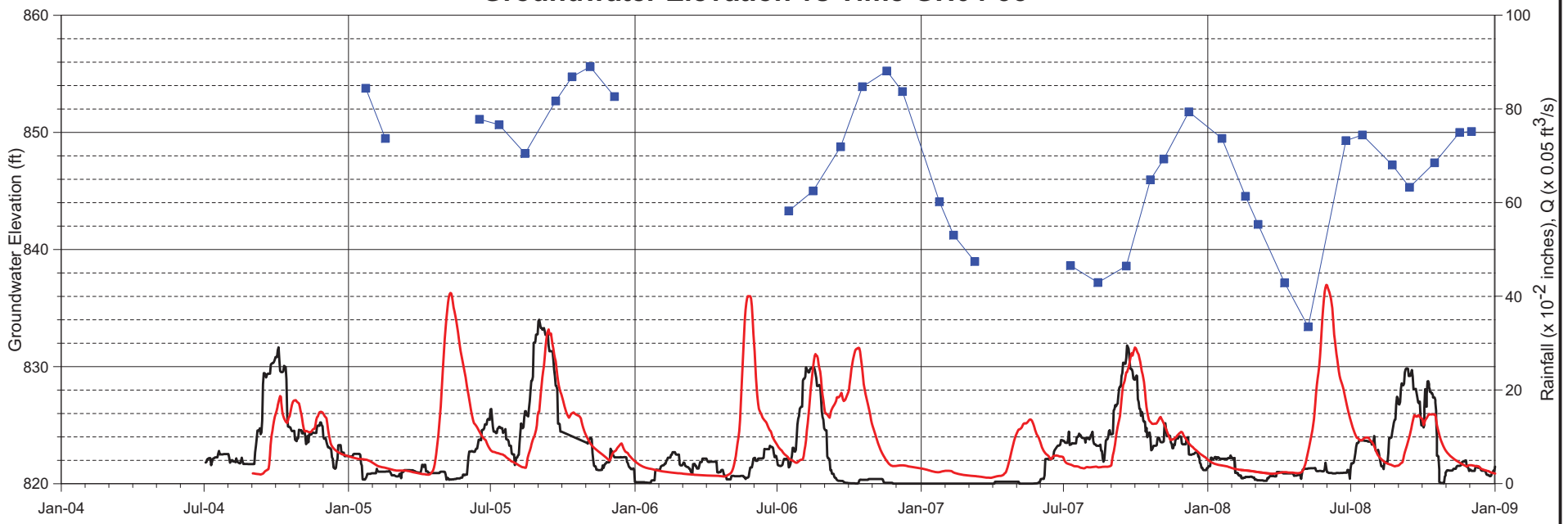


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-35



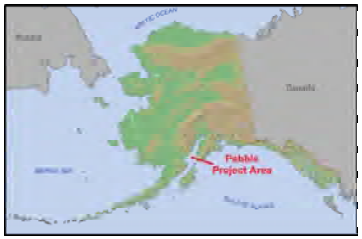
LEGEND:

Groundwater Elevation Plot Legend

- GH04-35
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

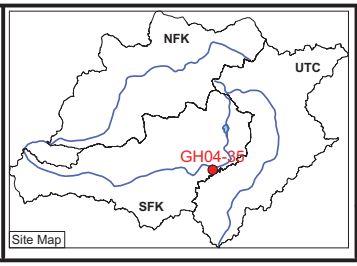
Screens (ft asl):
GH04-35 : 822.7 - 832.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 888.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-35.grf

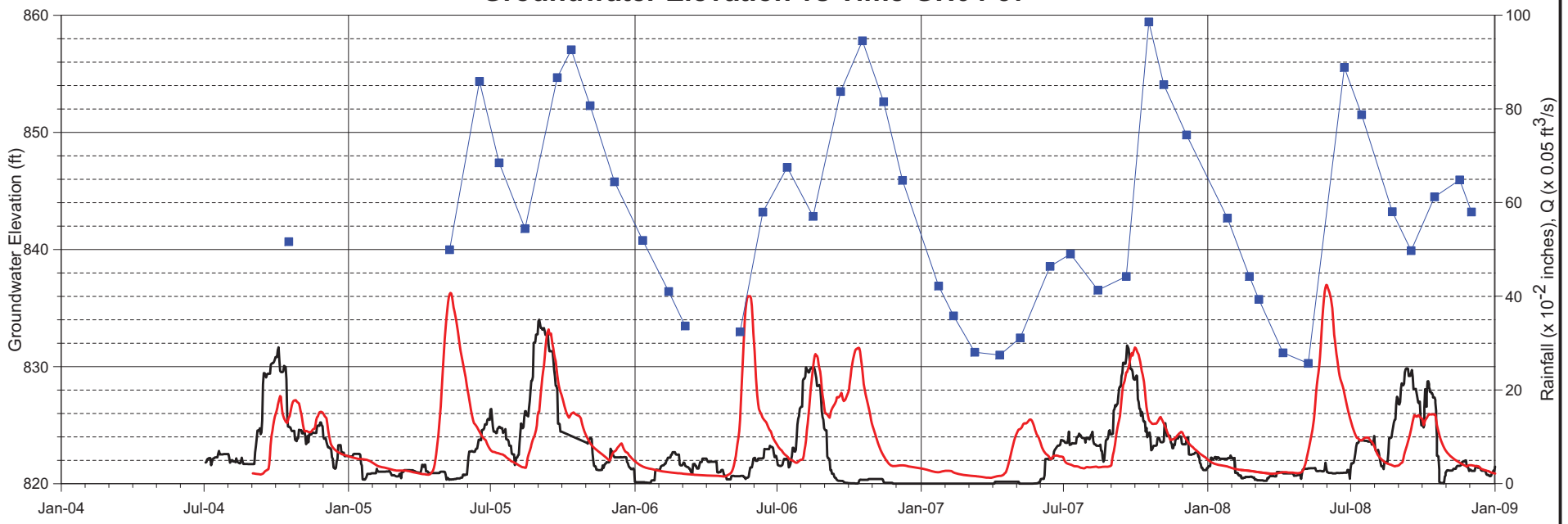


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-37



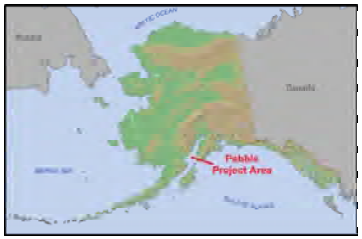
LEGEND:

Groundwater Elevation Plot Legend

- GH04-37
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

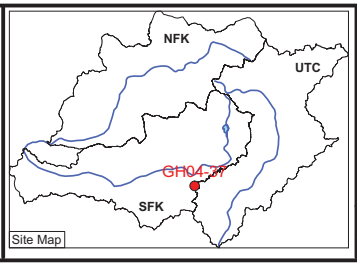
Screens (ft asl):
GH04-37 : 826.6 - 836.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 975.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-37.grf

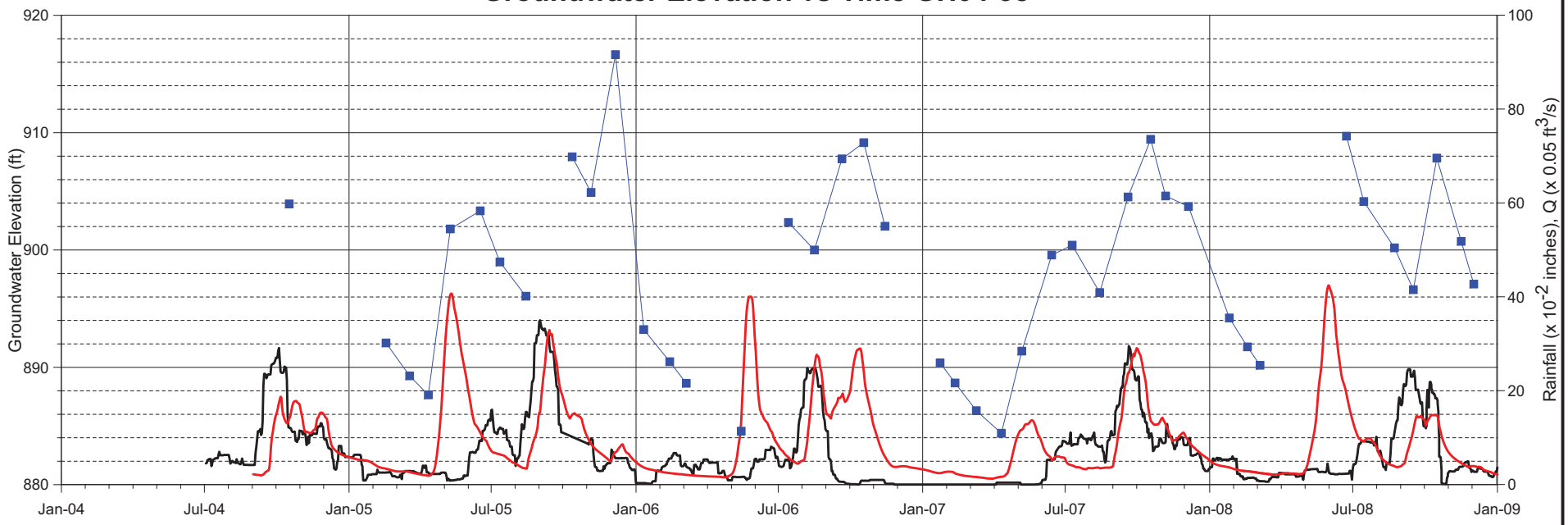


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-38



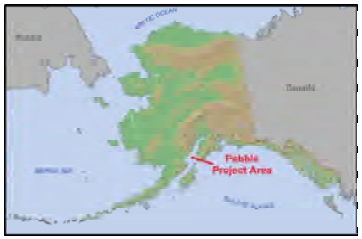
LEGEND:

Groundwater Elevation Plot Legend

- GH04-38
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

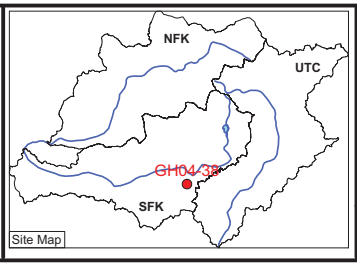
Screens (ft asl):
GH04-38 : 882.2 - 892.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 942.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-38.grf

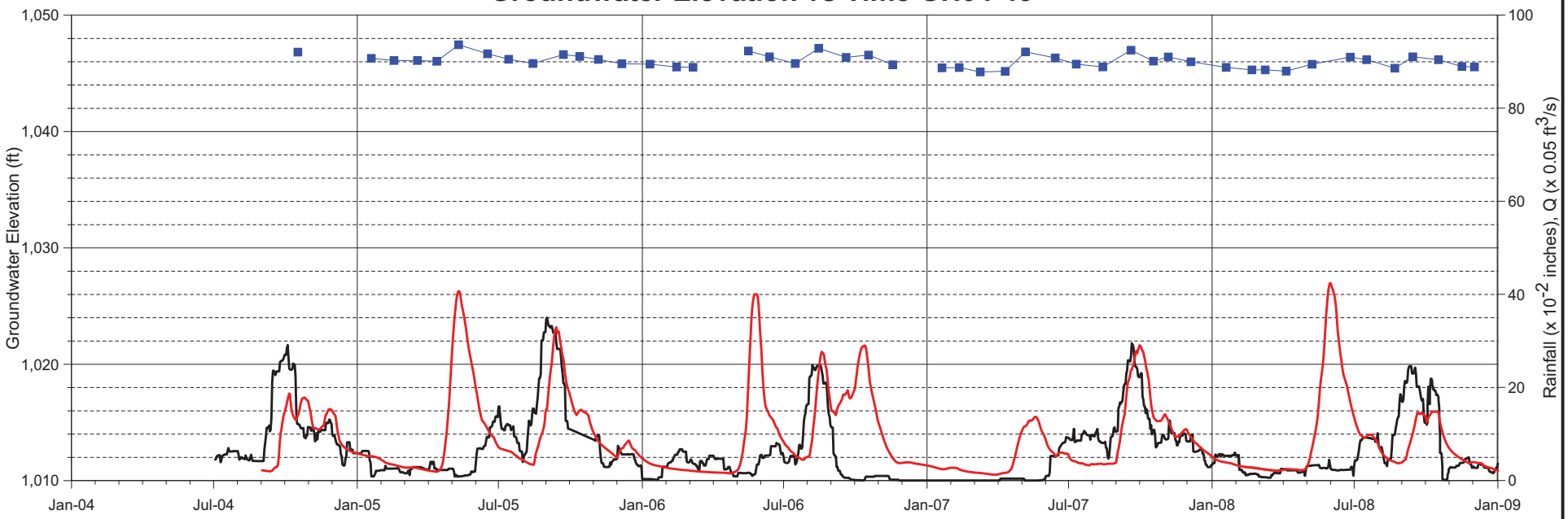


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-43



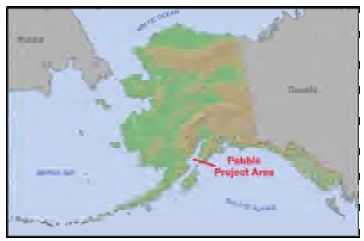
LEGEND:

Groundwater Elevation Plot Legend

- GH04-43
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

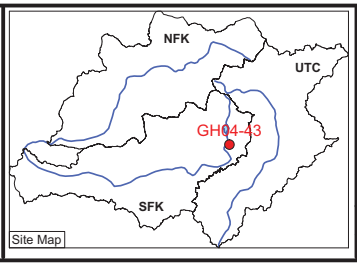
Screens (ft asl):
GH04-43 : 1020.7 - 1030.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1120.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-43.grf

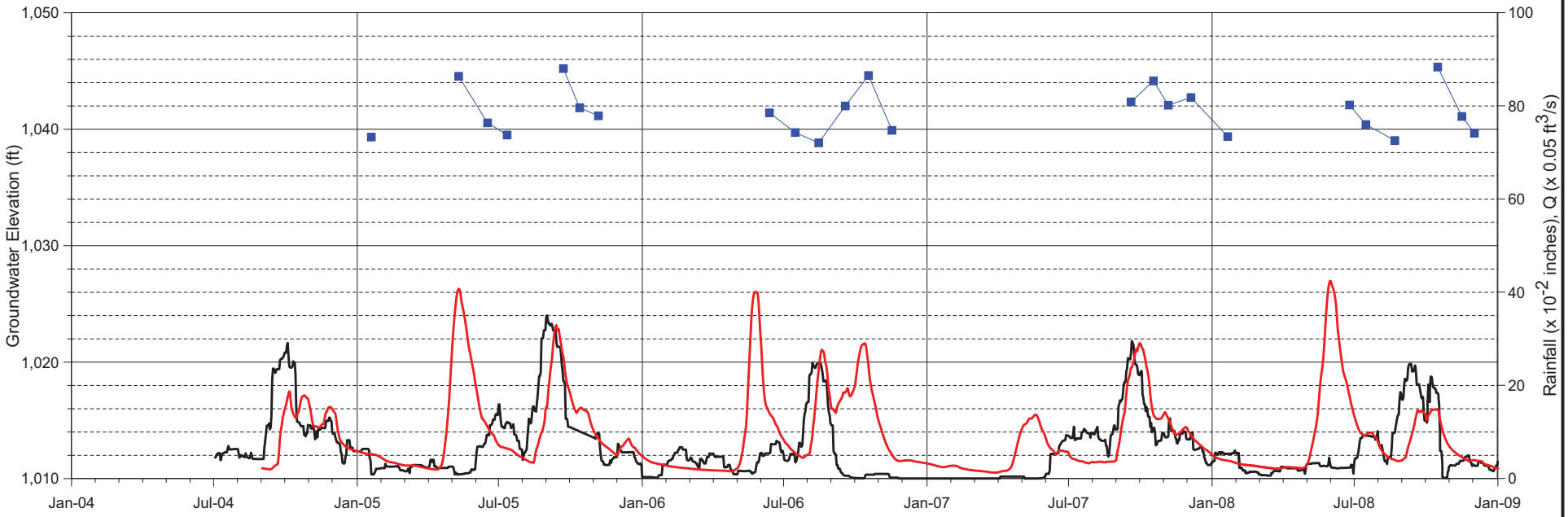


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-45A



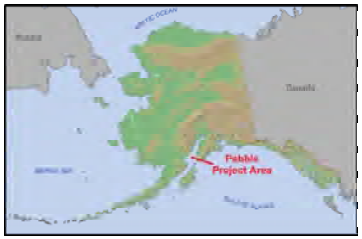
LEGEND:

Groundwater Elevation Plot Legend

- GH04-45A
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-45A : 1036.3 - 1047.3

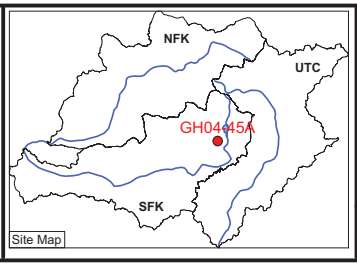


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1120.3 ft asl

GH04-45A dries seasonally during the winter, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-45A.grf

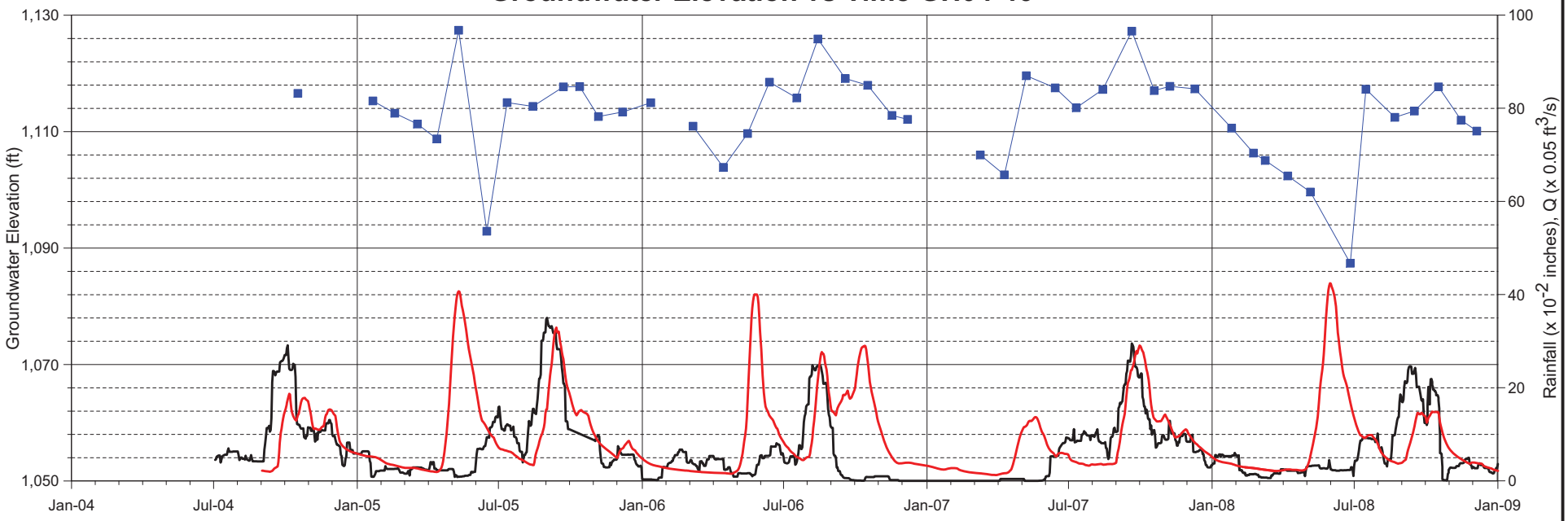


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-46



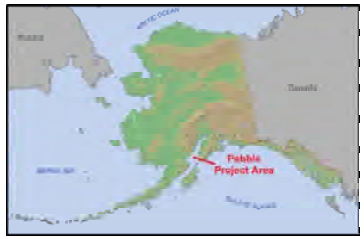
LEGEND:

Groundwater Elevation Plot Legend

- GH04-46
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-46 : 1057.0 - 1068.0

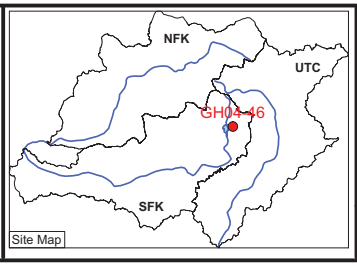


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1141 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-46.grf

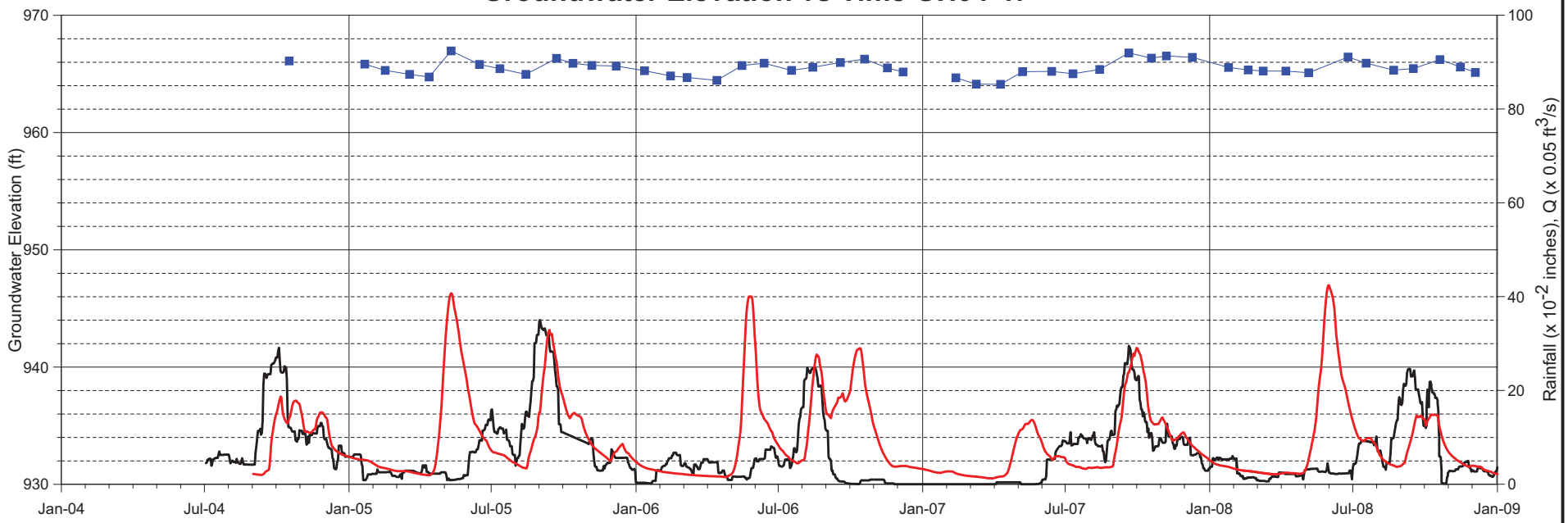


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-47



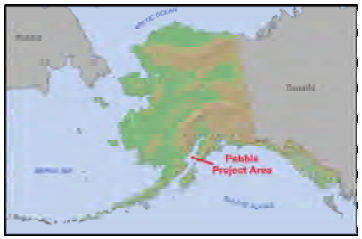
LEGEND:

Groundwater Elevation Plot Legend

- GH04-47
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

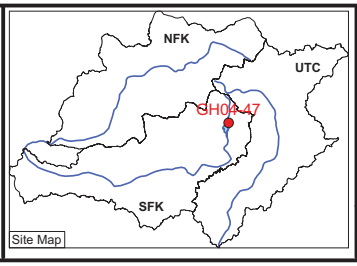
Screens (ft asl):
GH04-47 : 929.7 - 939.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 970.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-47.grf

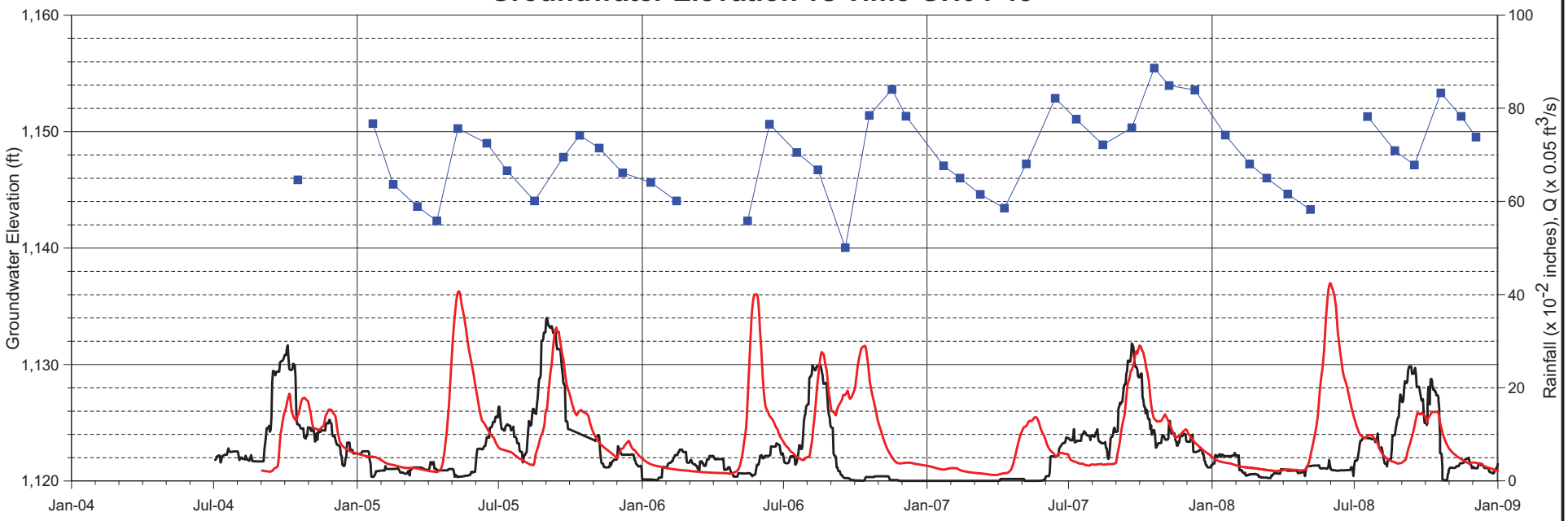


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-48



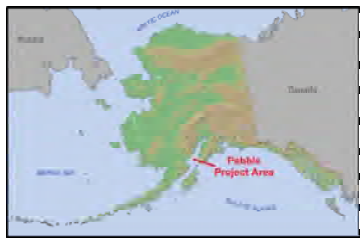
LEGEND:

Groundwater Elevation Plot Legend

- GH04-48
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

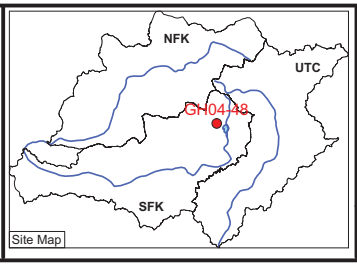
Screens (ft asl):
GH04-48 : 1131.8 - 1141.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1181.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-48.grf

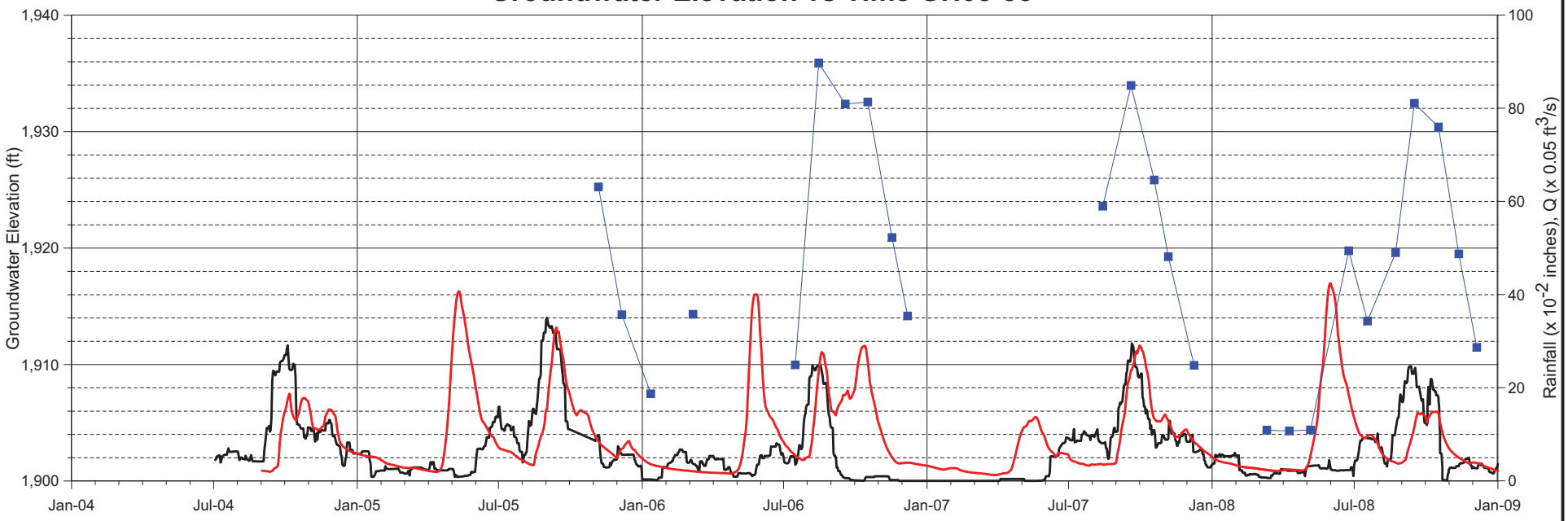


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-53



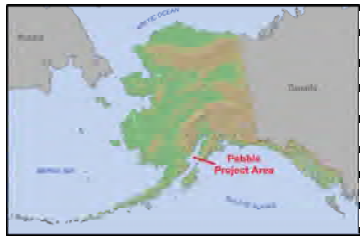
LEGEND:

Groundwater Elevation Plot Legend

- GH05-53
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH05-53 : 1911.5 - 1921.5

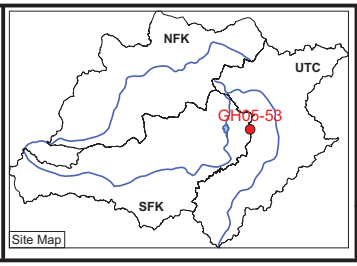


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1941.5 ft asl

GH05-53 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-53.grf

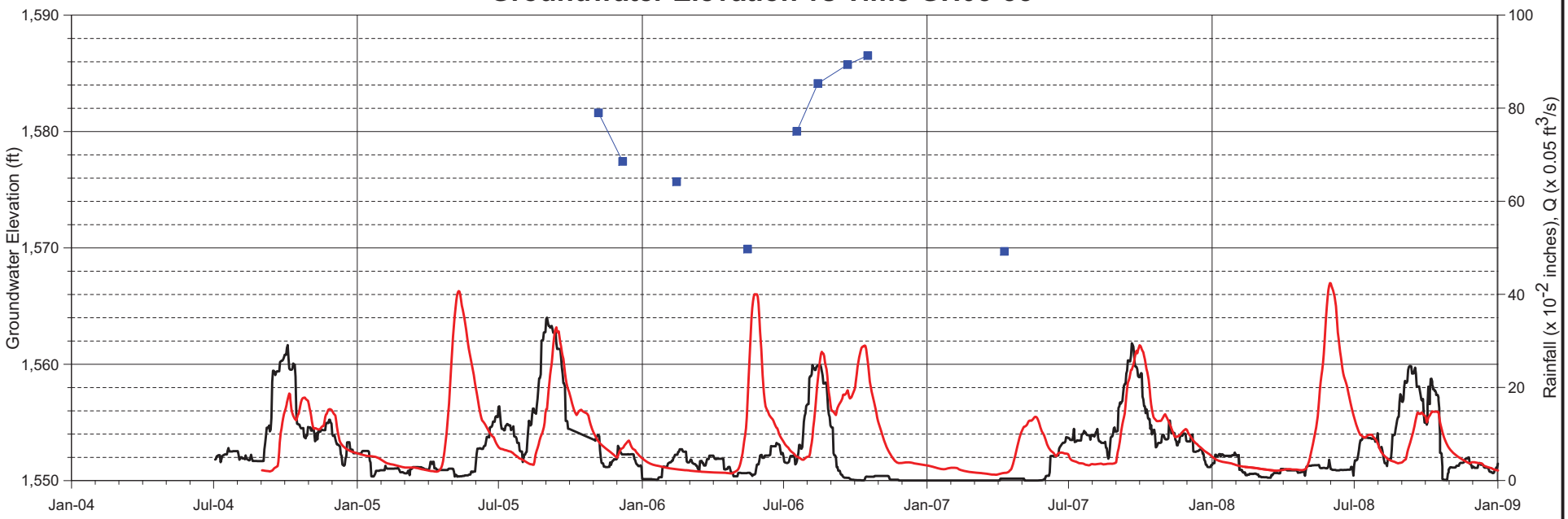


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-55



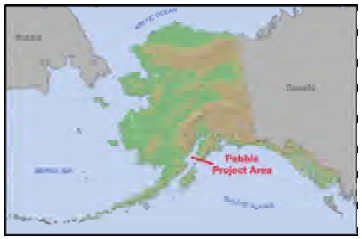
LEGEND:

Groundwater Elevation Plot Legend

- GH05-55
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH05-55 : 1575.6 - 1585.1

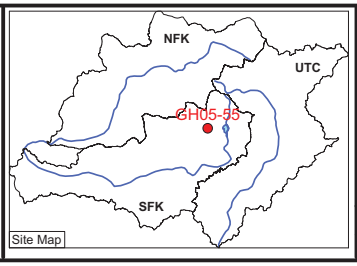


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1588.6 ft asl

GH05-55 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-55.grf

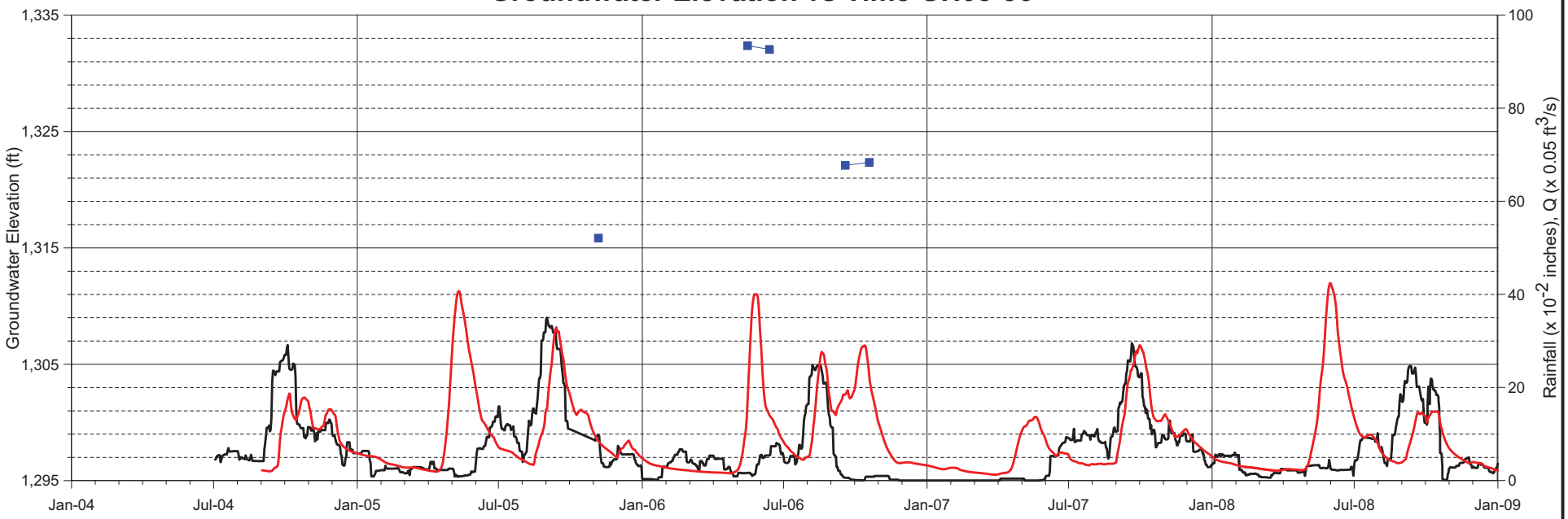


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-56



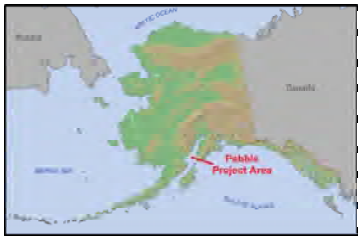
LEGEND:

Groundwater Elevation Plot Legend

- GH05-56
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH05-56 : 1311.6 - 1321.6

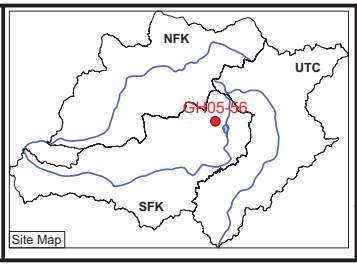


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1356.1 ft asl

GH05-56 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-56.grf

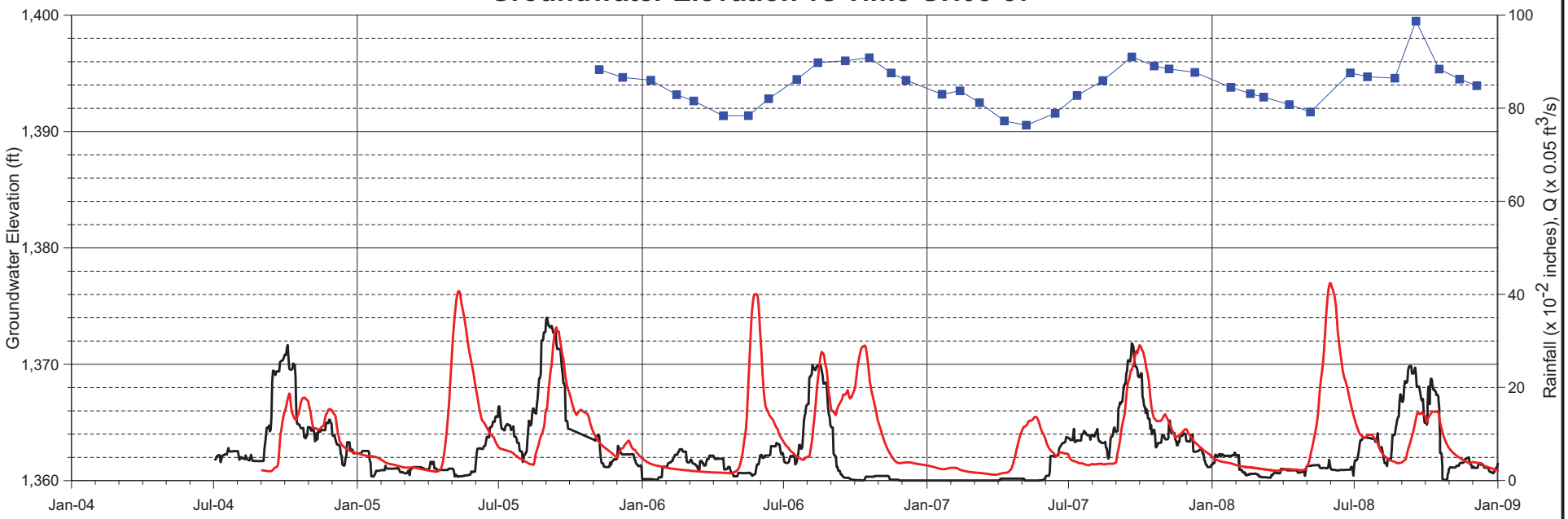


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-57



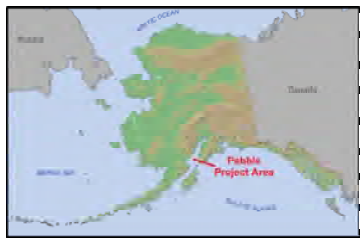
LEGEND:

Groundwater Elevation Plot Legend

- GH05-57
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

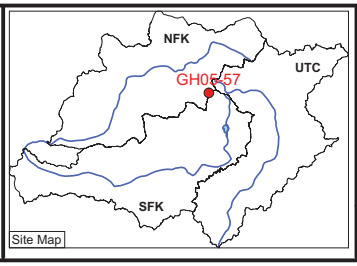
Screens (ft asl):
GH05-57 : 1368.9 - 1379.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1405.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-57.grf

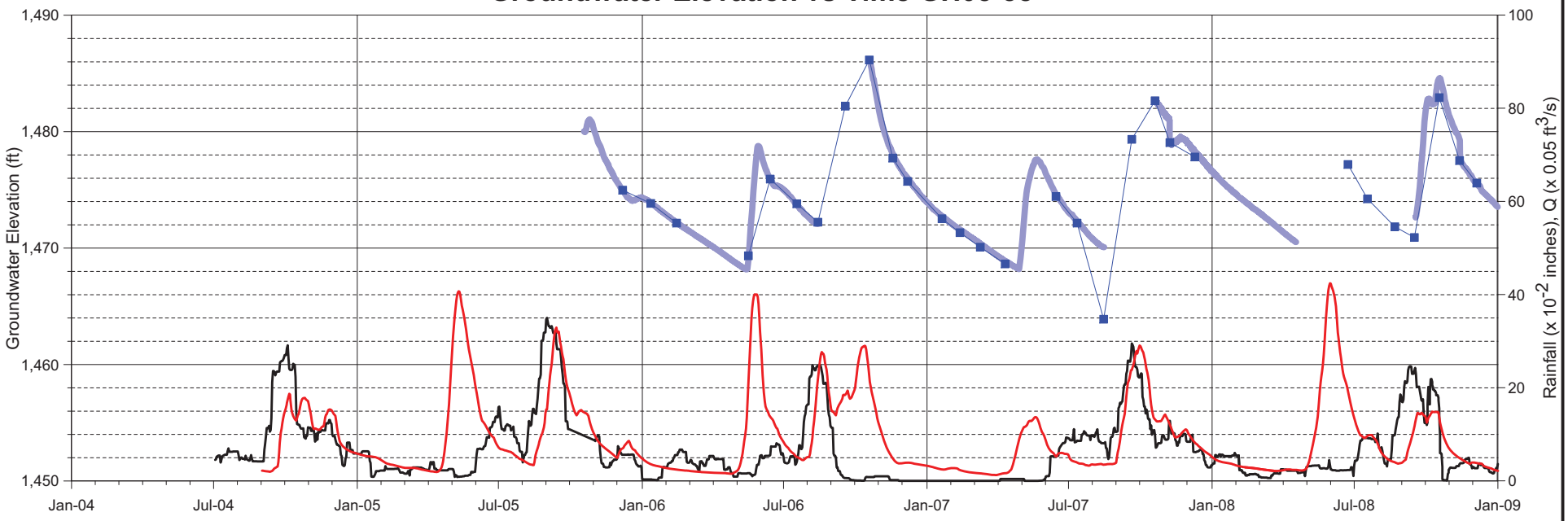


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-58



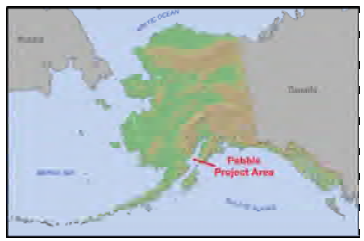
LEGEND:

Groundwater Elevation Plot Legend

- GH05-58
- GH05-58(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

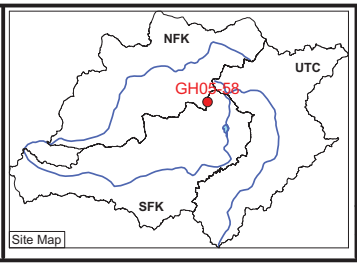
Screens (ft asl):
GH05-58 : 1465.1 - 1475.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1503 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-58.grf

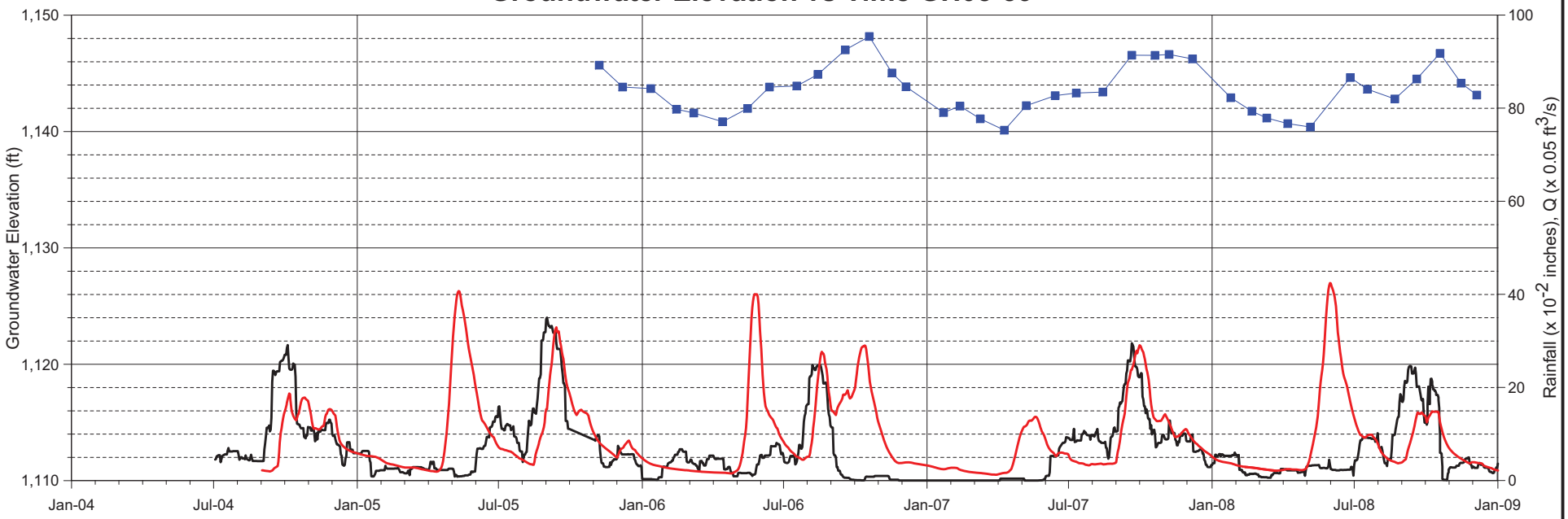


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-59



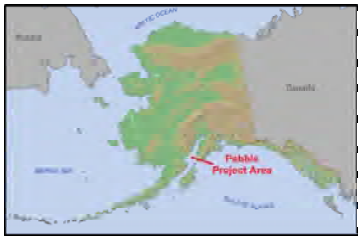
LEGEND:

Groundwater Elevation Plot Legend

- GH05-59
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

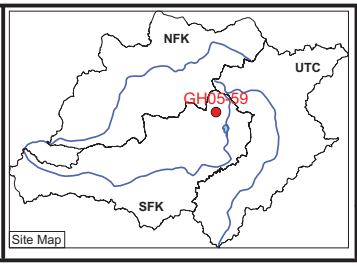
Screens (ft asl):
GH05-59 : 1103.9 - 1113.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1181.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-59.grf

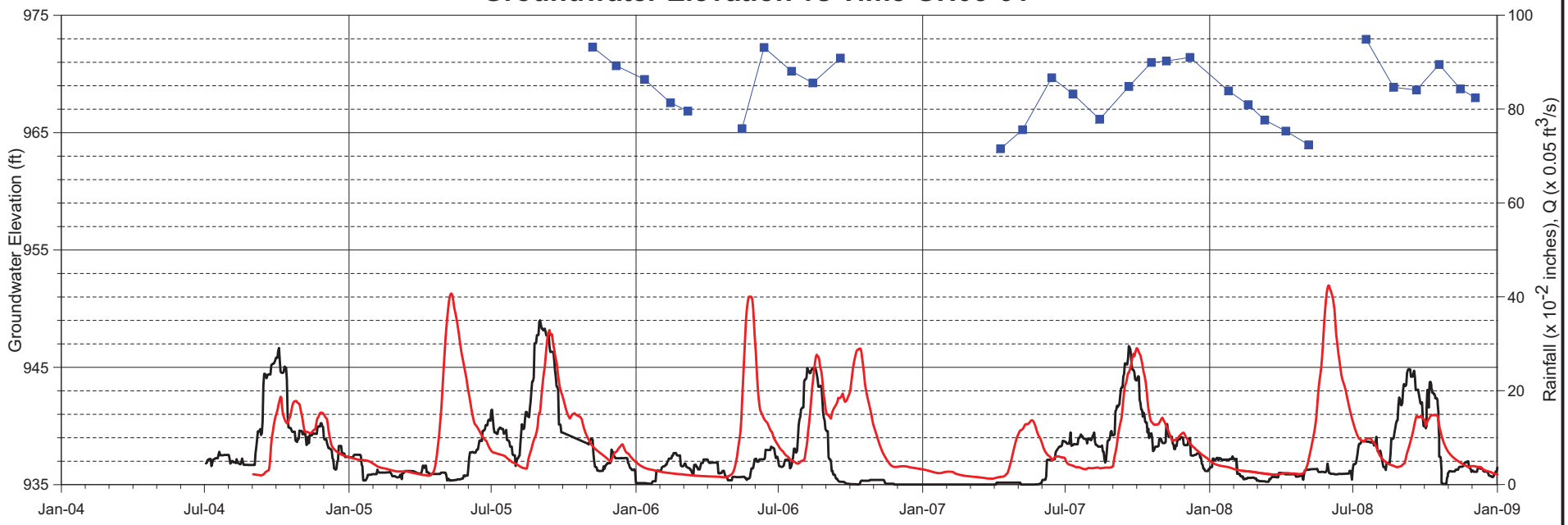


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-61



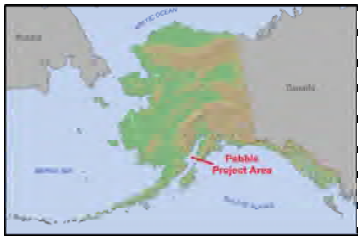
LEGEND:

Groundwater Elevation Plot Legend

- GH05-61
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

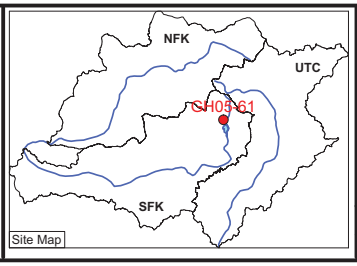
Screens (ft asl):
GH05-61 : 804.8 - 813.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 973.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-61.grf

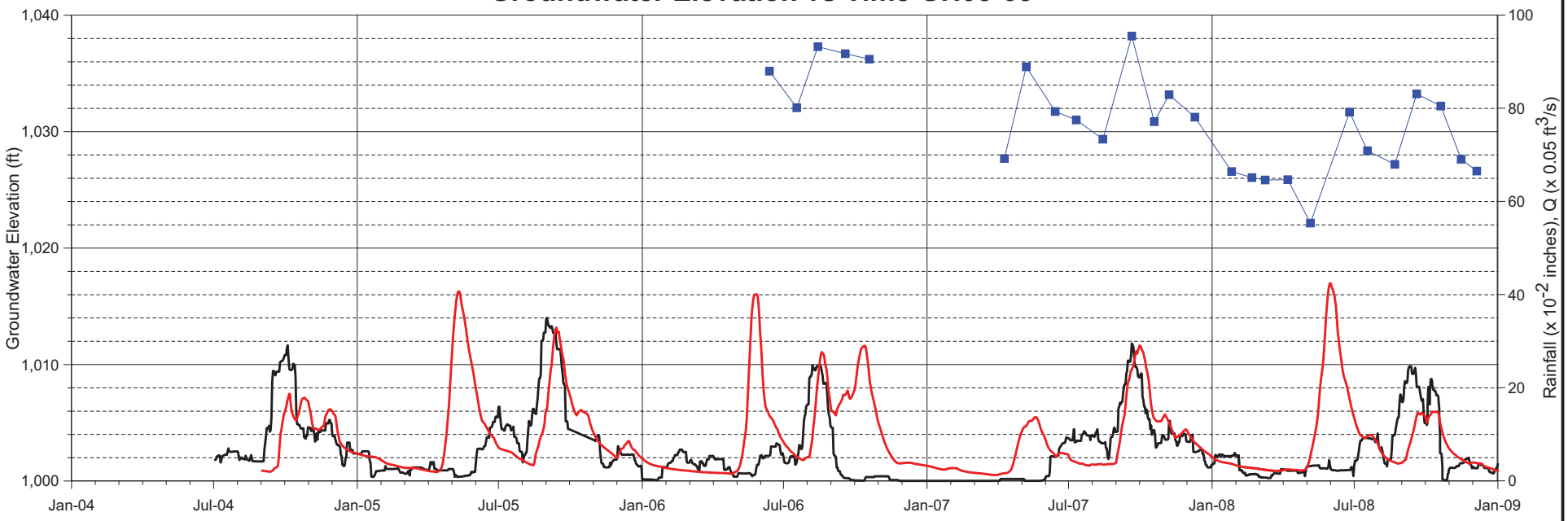


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-63



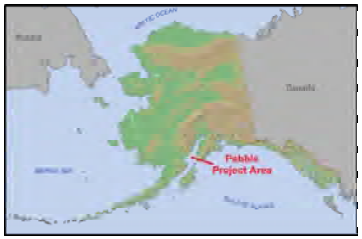
LEGEND:

Groundwater Elevation Plot Legend

- GH05-63
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

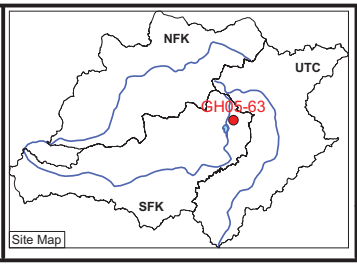
Screens (ft asl):
GH05-63 : 979.3 - 989.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1038.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-63.grf

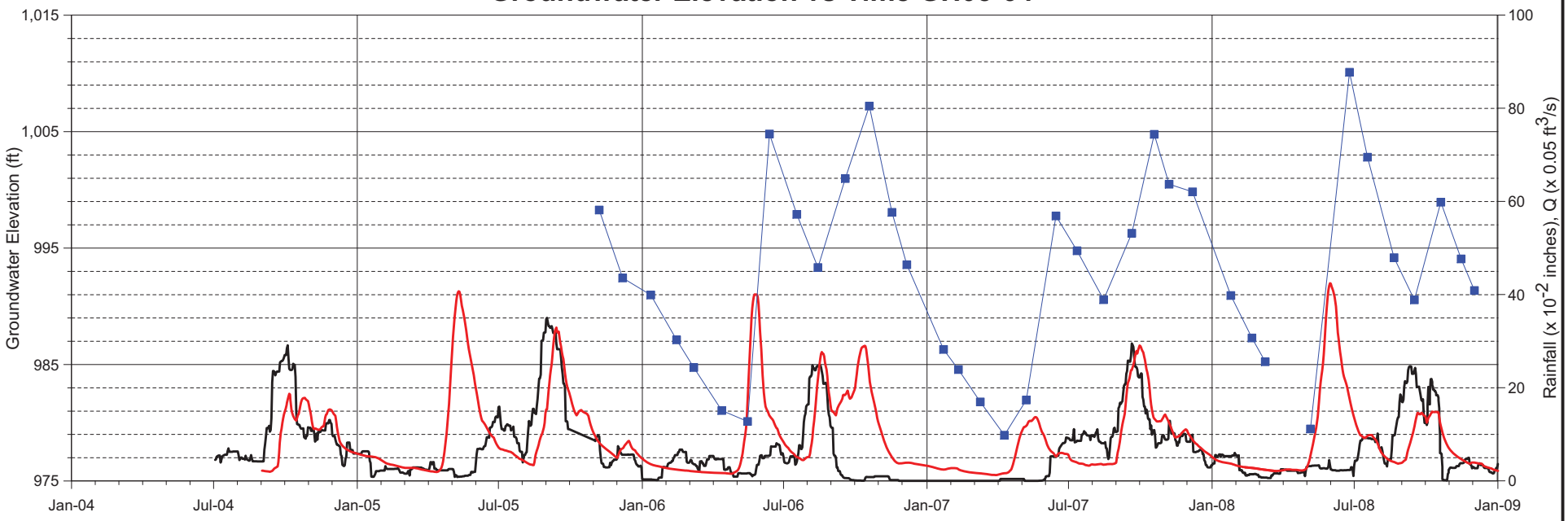


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-64



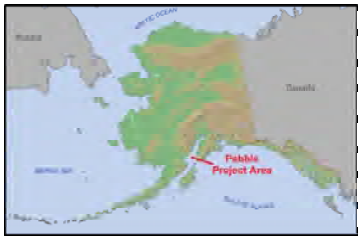
LEGEND:

Groundwater Elevation Plot Legend

- GH05-64
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

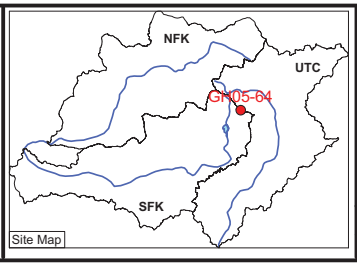
Screens (ft asl):
GH05-64 : 956.9 - 967.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1016.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-64.grf

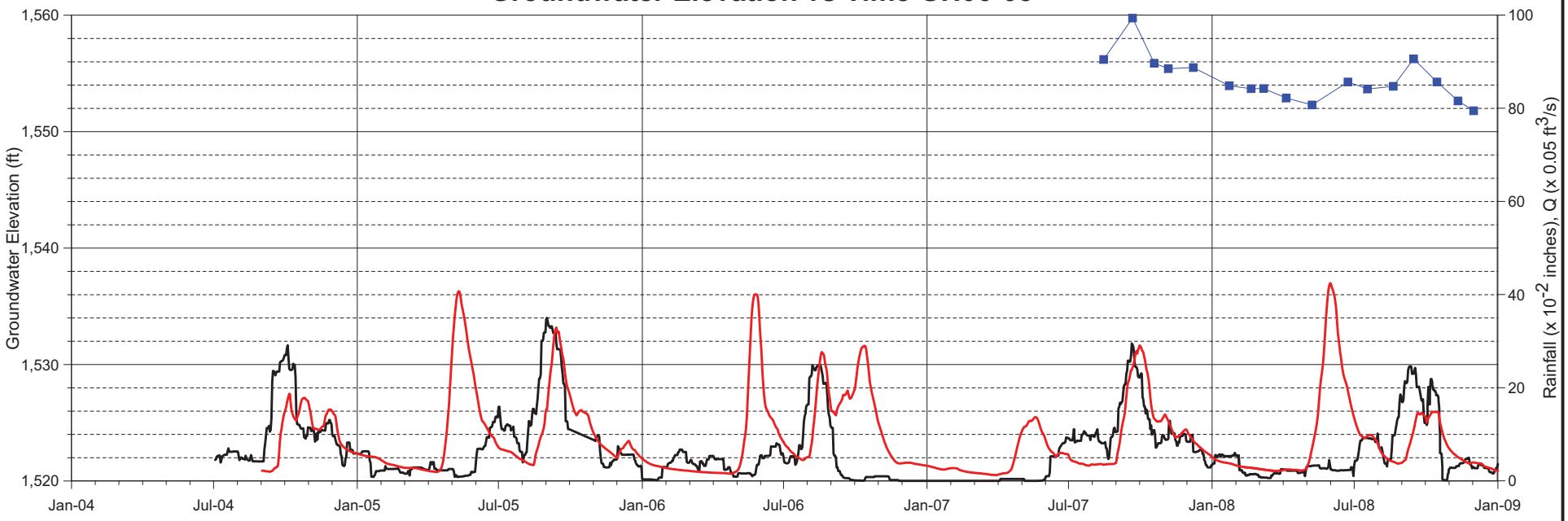


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-65



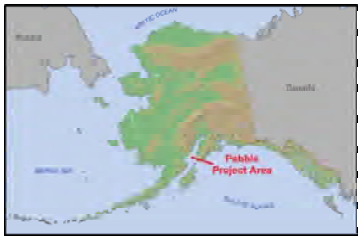
LEGEND:

Groundwater Elevation Plot Legend

- GH06-65
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

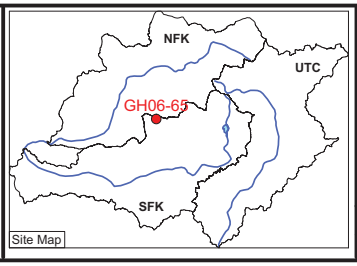
Screens (ft asl):
GH06-65 : 1550.3 - 1560.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1643.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-65.grf

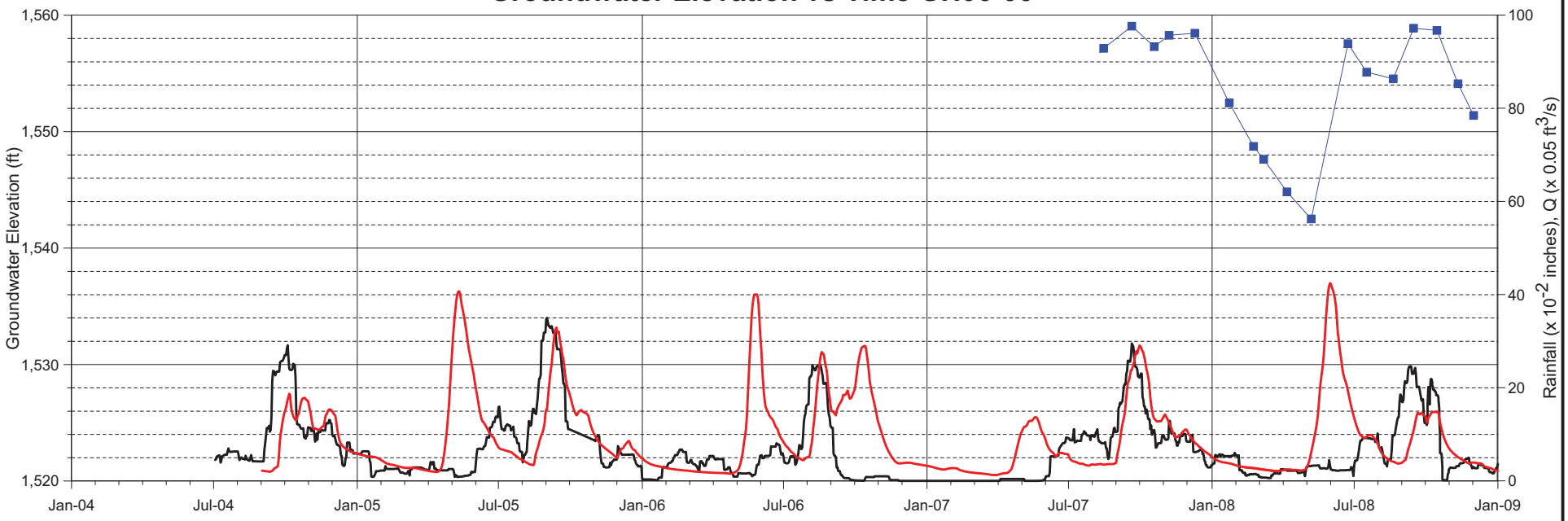


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-66



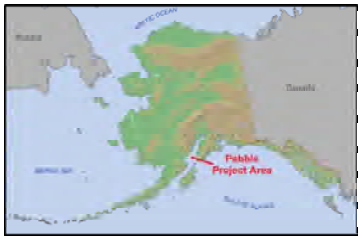
LEGEND:

Groundwater Elevation Plot Legend

- GH06-66
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

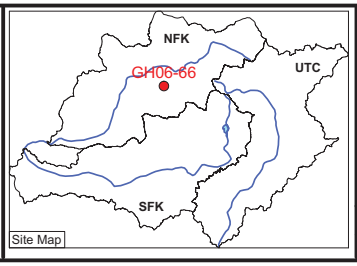
Screens (ft asl):
GH06-66 : 1513.6 - 1523.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1559.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-66.grf

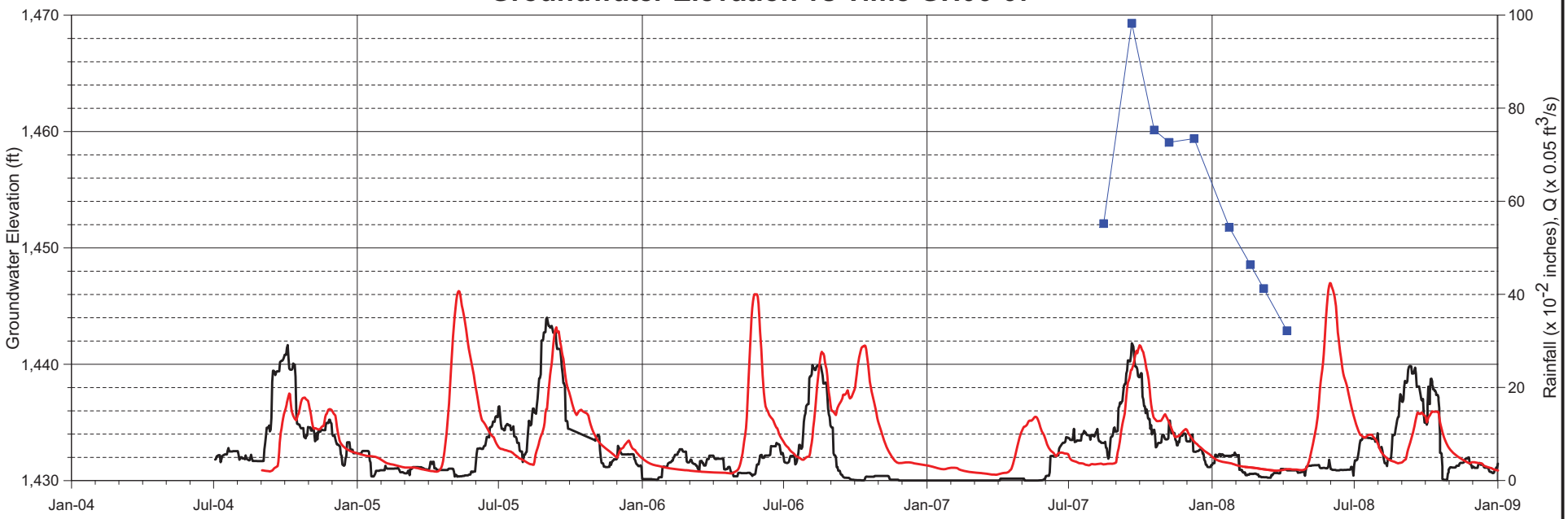


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-67



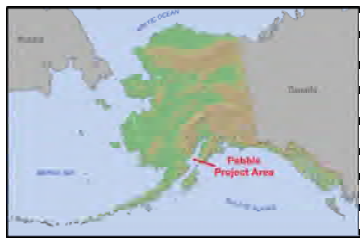
LEGEND:

Groundwater Elevation Plot Legend

- GH06-67
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH06-67 : 1433.7 - 1443.7

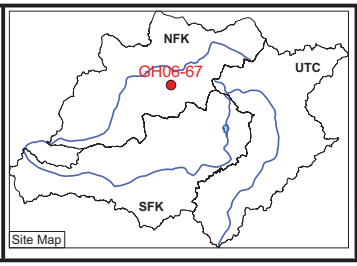


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1476.7 ft asl

The top section of riser broke in 2008, water levels no longer possible to record.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-67.grf

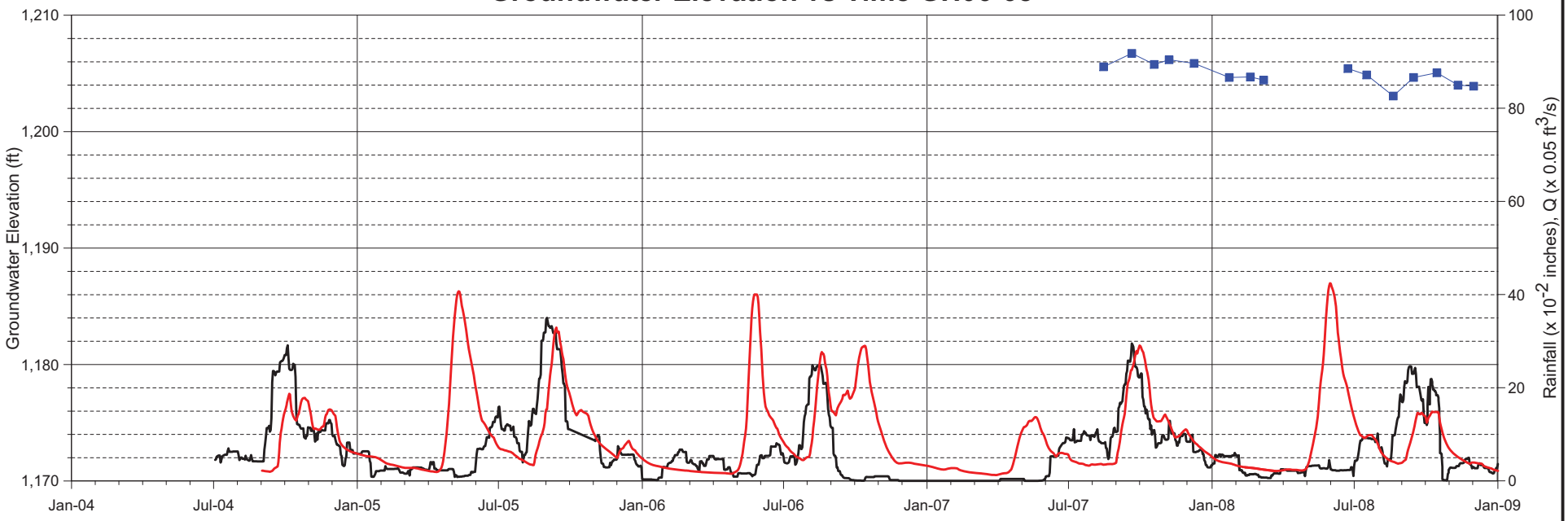


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-68



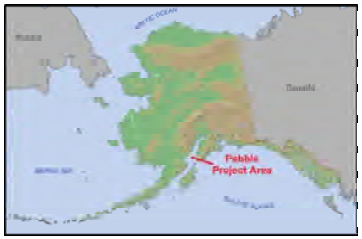
LEGEND:

Groundwater Elevation Plot Legend

- GH06-68
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

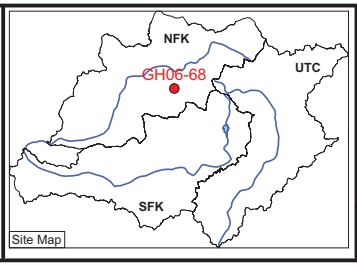
Screens (ft asl):
GH06-68 : 1092.7 - 1112.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1208.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-68.grf

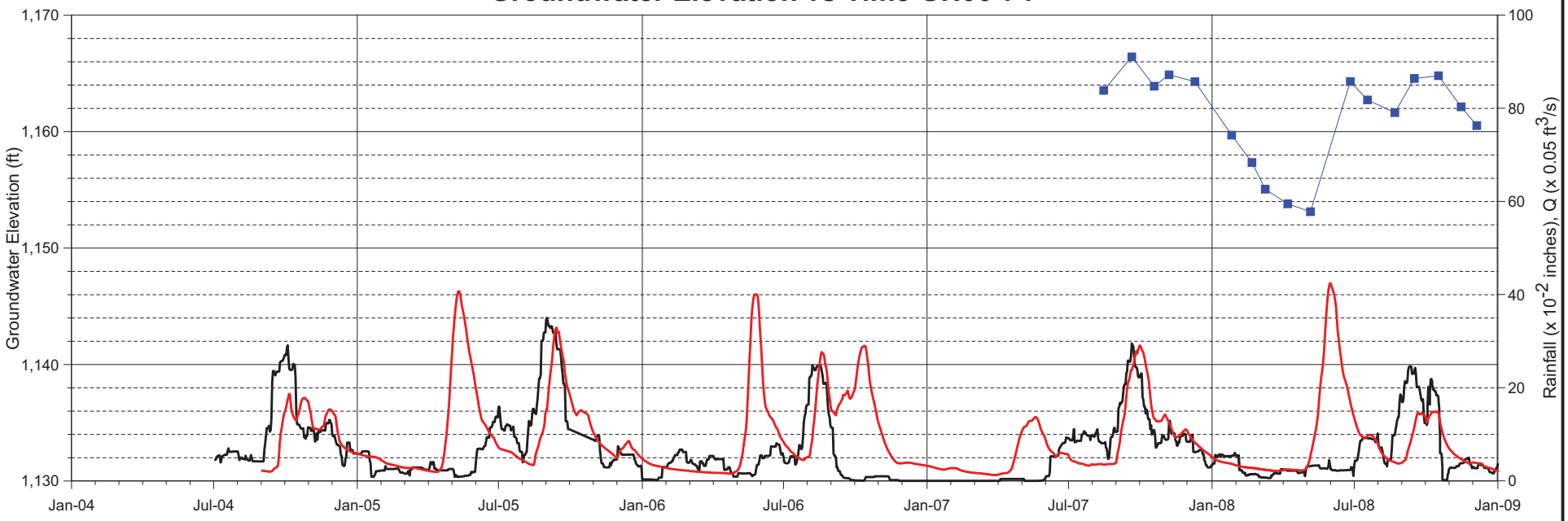


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-74



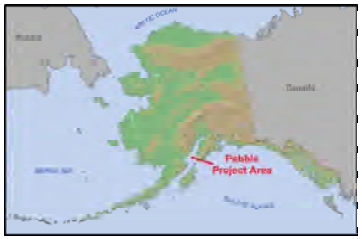
LEGEND:

Groundwater Elevation Plot Legend

- GH06-74
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

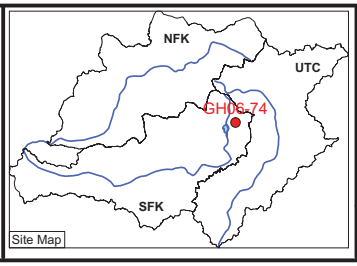
Screens (ft asl):
GH06-74 : 1147.9 - 1157.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1191.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-74.grf

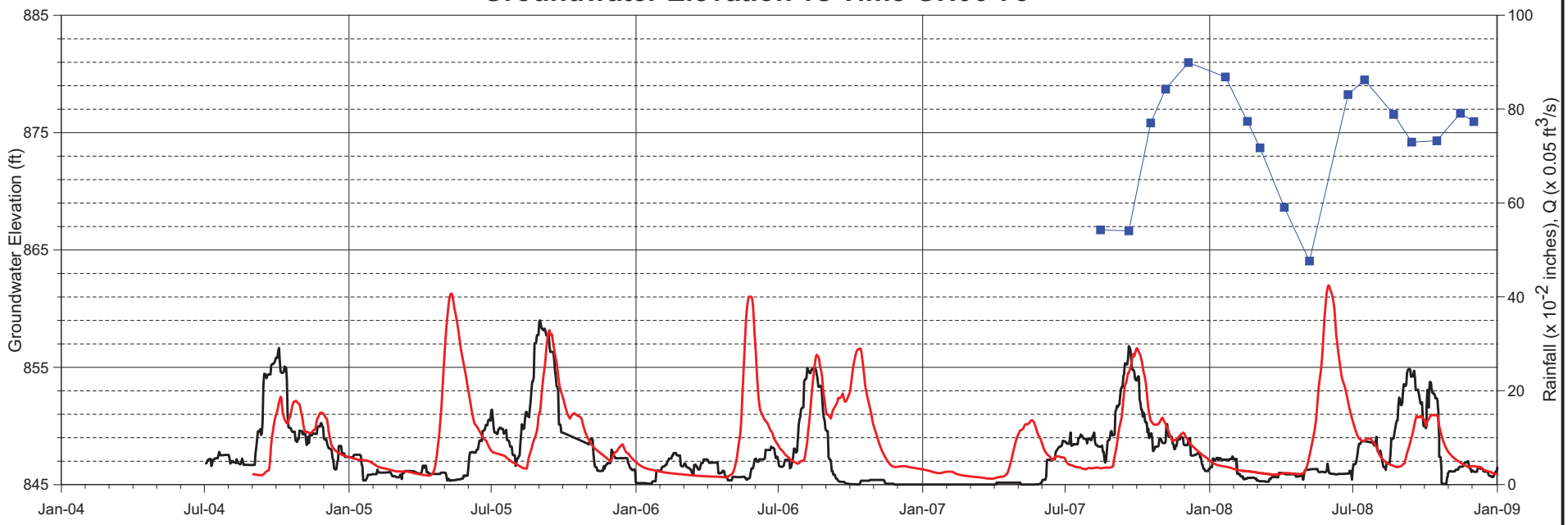


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-75



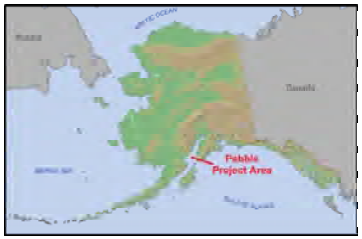
LEGEND:

Groundwater Elevation Plot Legend

- GH06-75
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

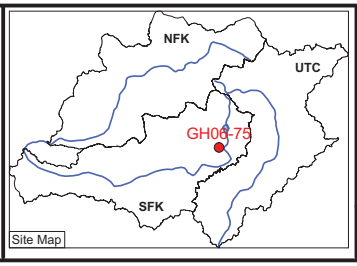
Screens (ft asl):
GH06-75 : 848.4 - 868.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1018.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-75.grf

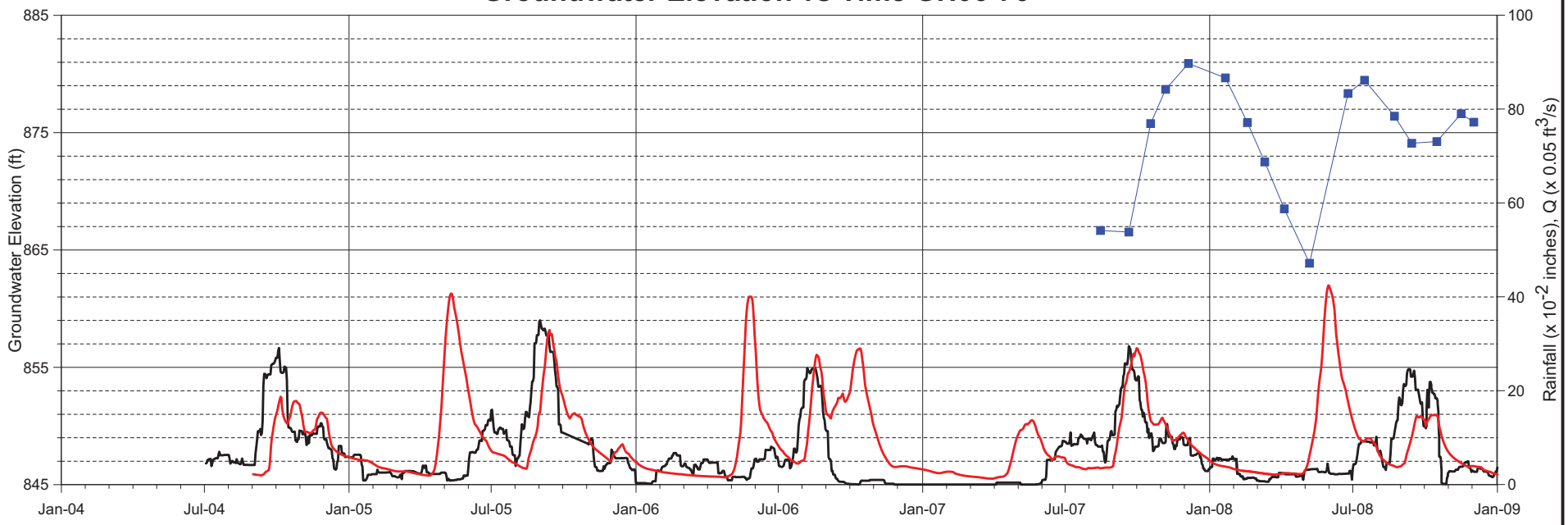


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-76



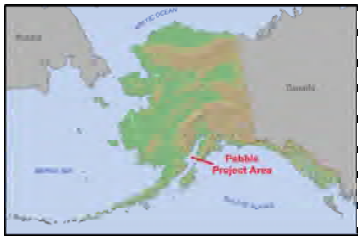
LEGEND:

Groundwater Elevation Plot Legend

- GH06-76
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

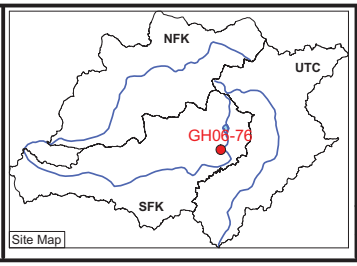
Screens (ft asl):
GH06-76 : 859.7 - 869.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 981.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-76.grf

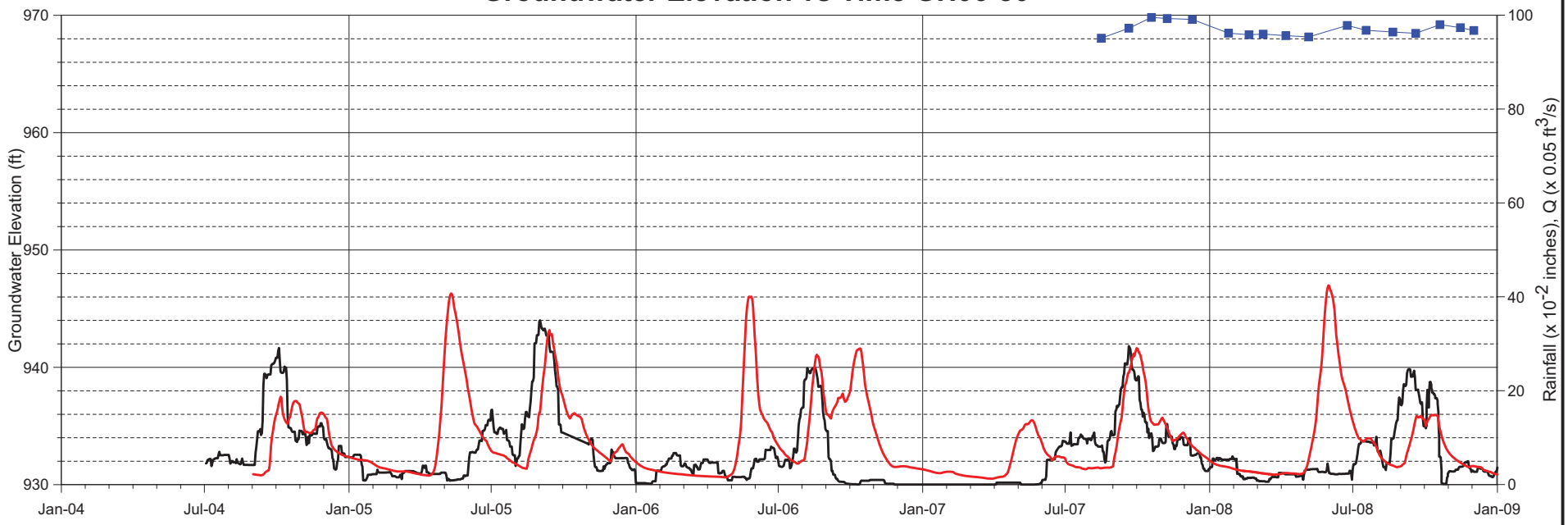


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-80



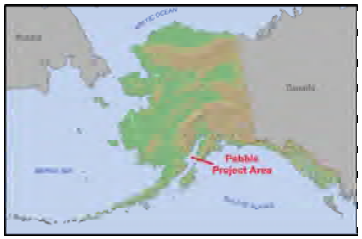
LEGEND:

Groundwater Elevation Plot Legend

- GH06-80
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

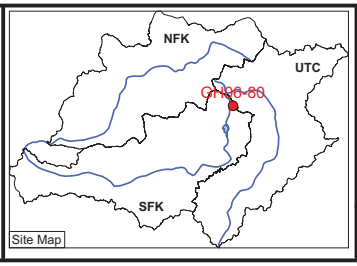
Screens (ft asl):
GH06-80 : 963.1 - 973.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1011.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-80.grf

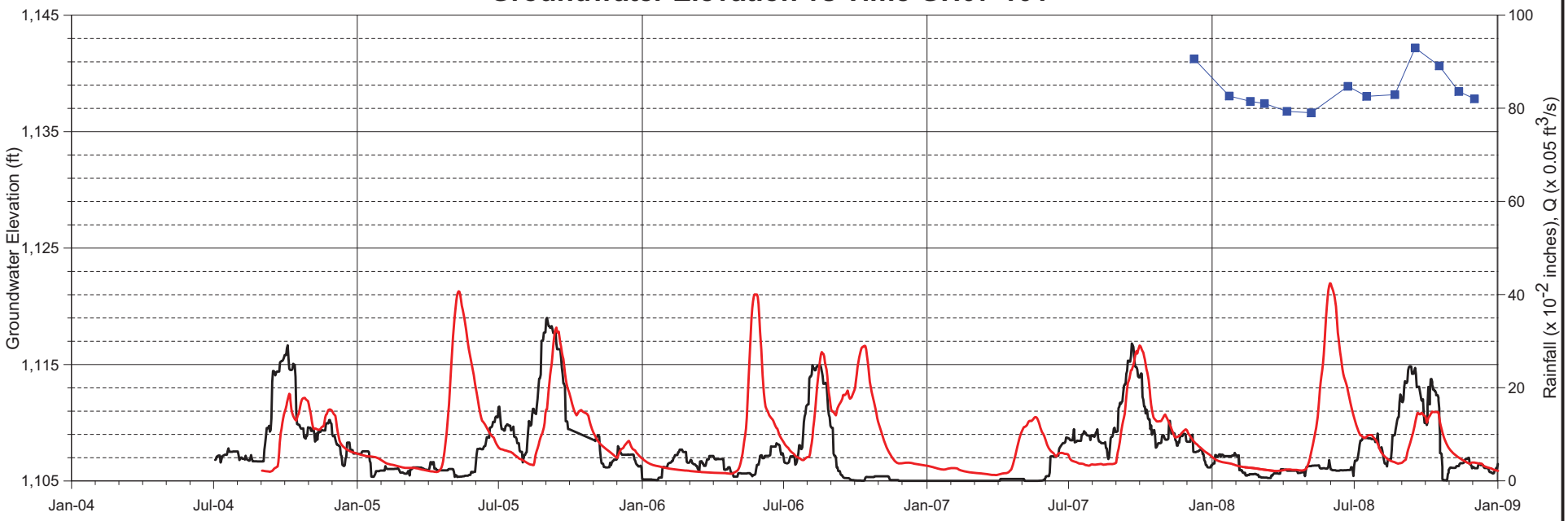


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-101



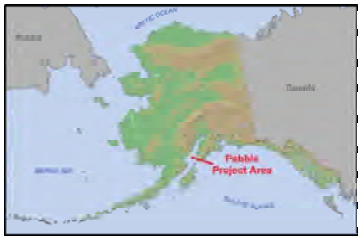
LEGEND:

Groundwater Elevation Plot Legend

- GH07-101
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

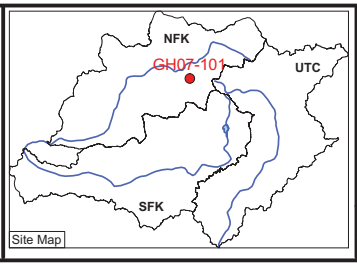
Screens (ft asl):
GH07-101 : 1136.4 - 1146.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1161.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-101.grf

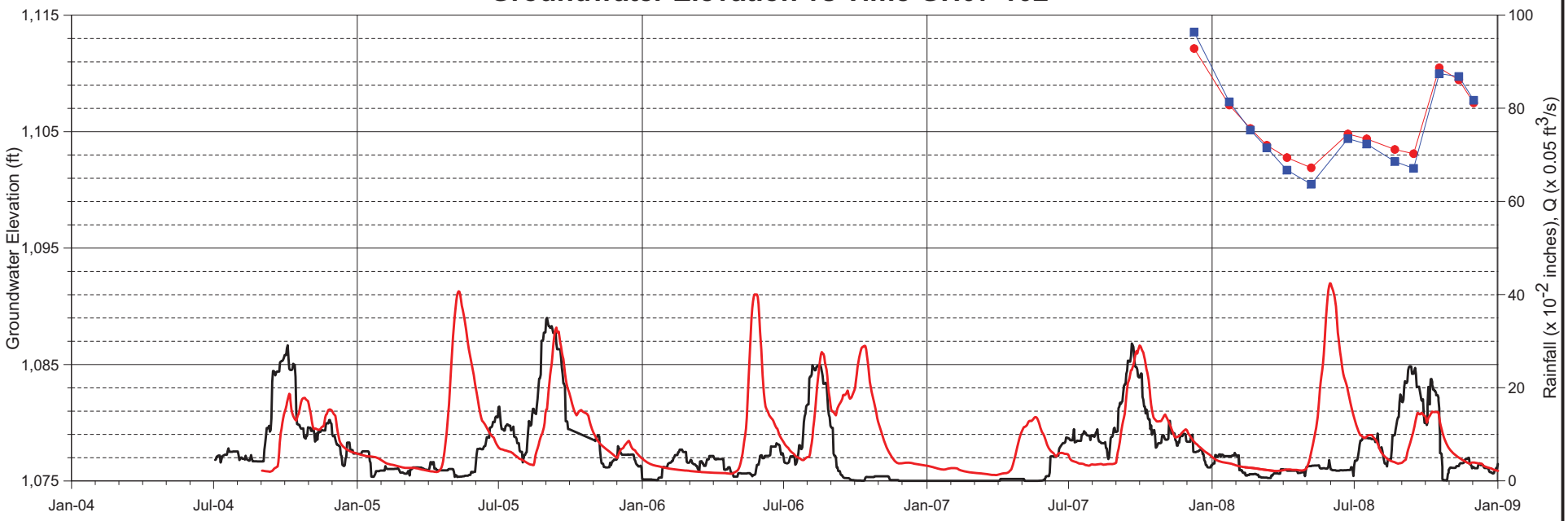


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-102



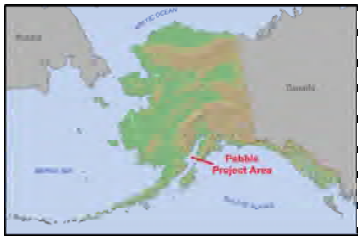
LEGEND:

Groundwater Elevation Plot Legend

- GH07-102S
- GH07-102D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

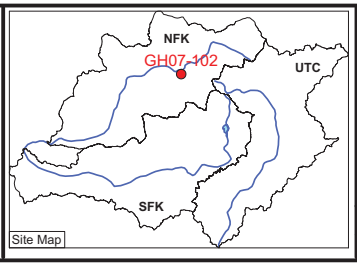
Screens (ft asl):
GH07-102S : 1099.8 - 1109.8
GH07-102D : 1039.8 - 1049.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1139.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-102.grf

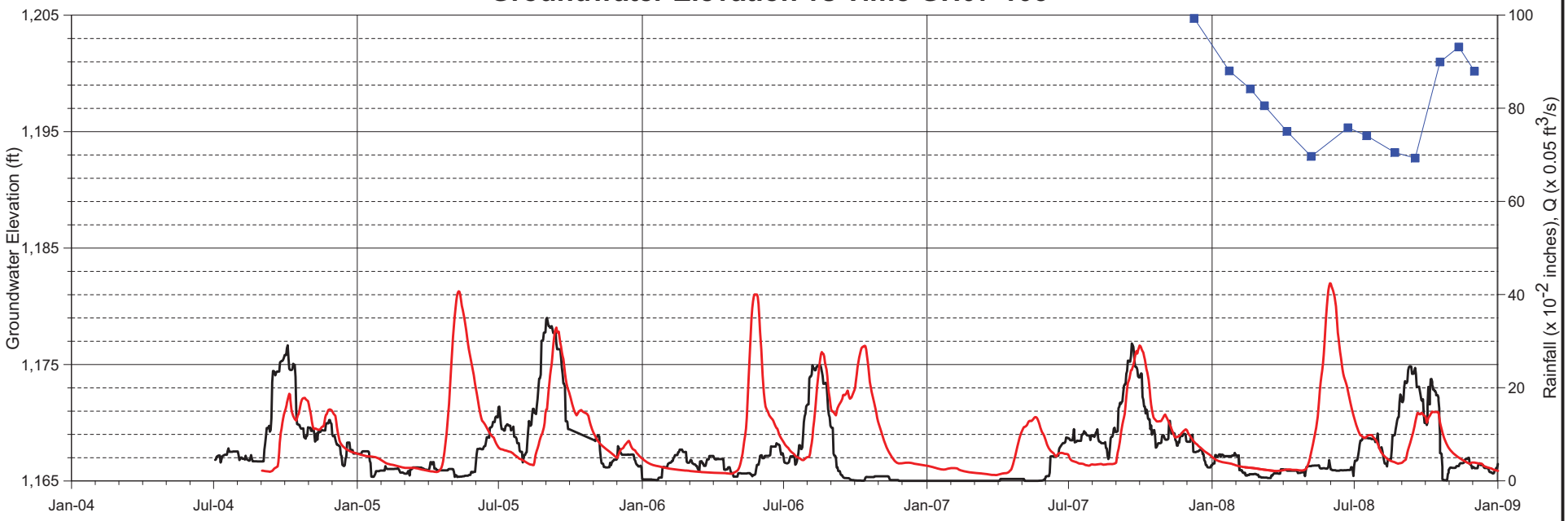


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-103



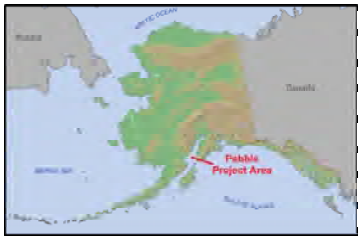
LEGEND:

Groundwater Elevation Plot Legend

- GH07-103D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH07-103S : 1208.3 - 1218.3
GH07-103D : 1149.3 - 1159.3

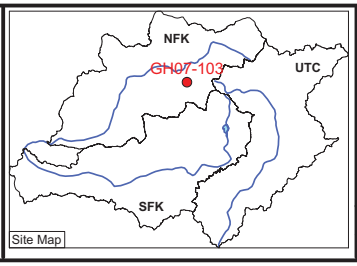


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1234.3 ft asl

GH07-103S was dry for most measurement periods, therefore few water levels were recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-103.grf

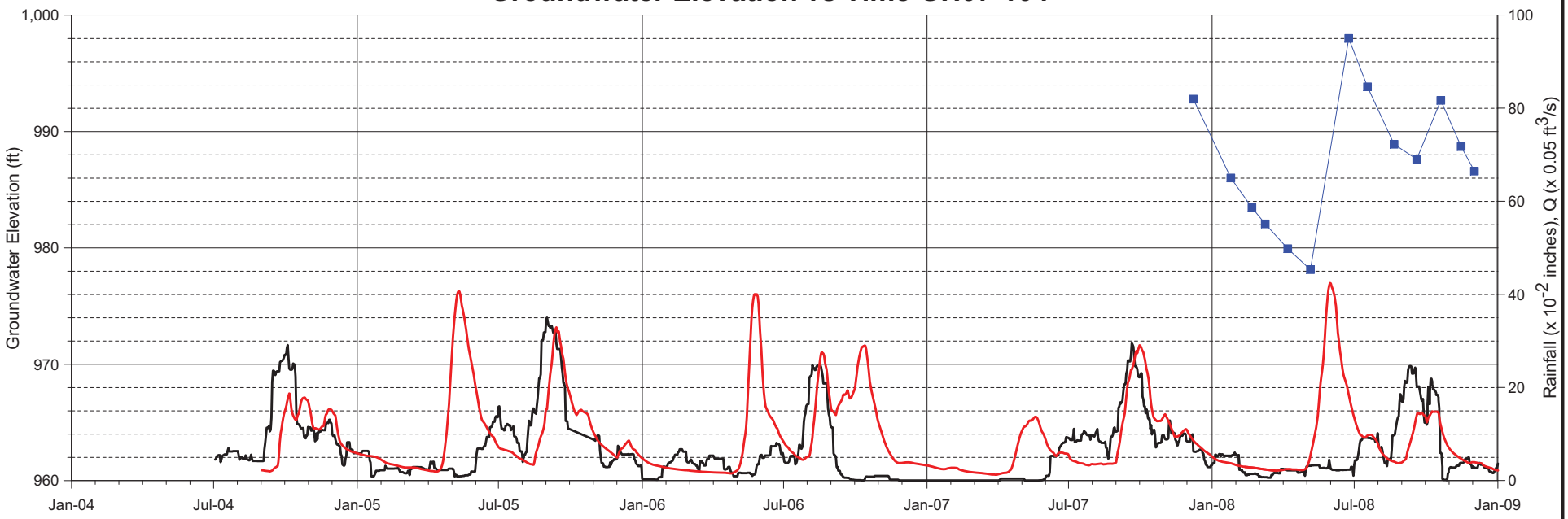


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-104



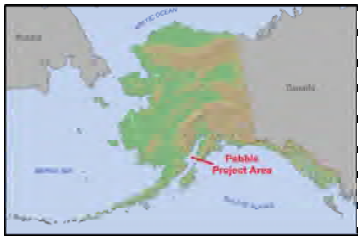
LEGEND:

Groundwater Elevation Plot Legend

- GH07-104
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

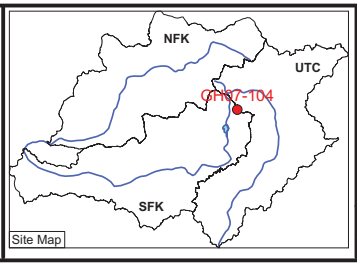
Screens (ft asl):
GH07-104 : 811.4 - 821.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 996.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-104.grf

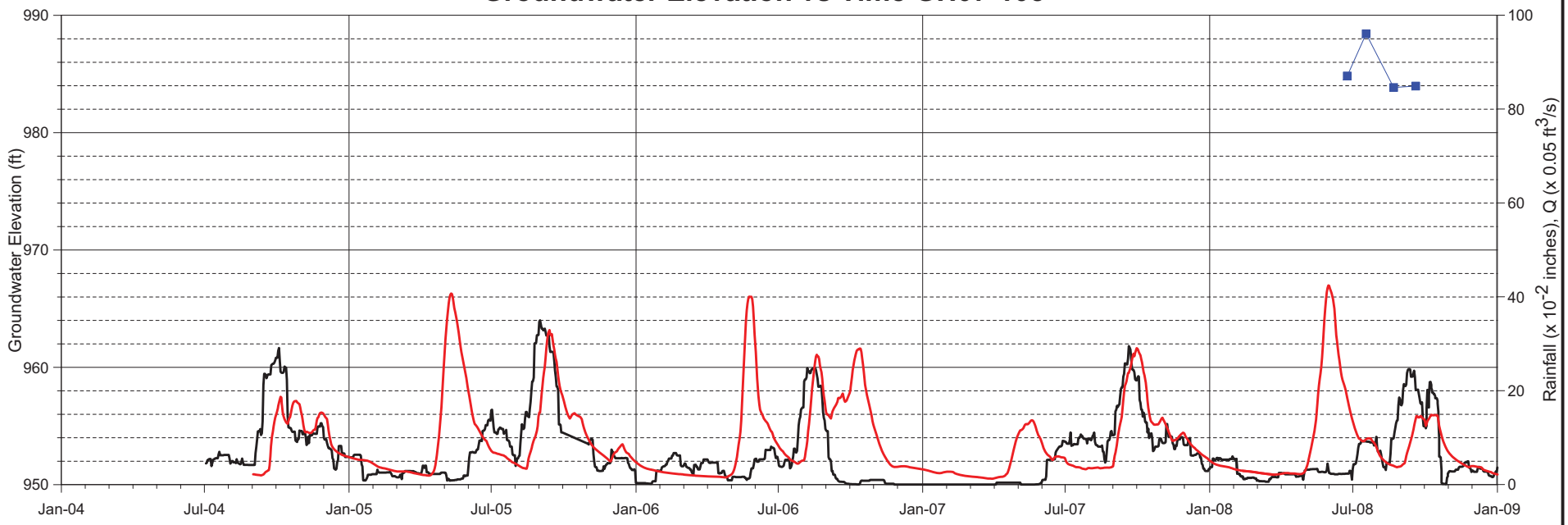


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-105



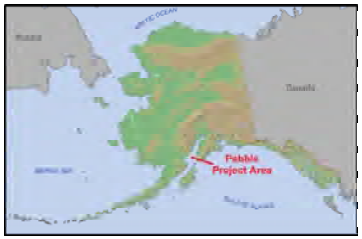
LEGEND:

Groundwater Elevation Plot Legend

- GH07-105
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

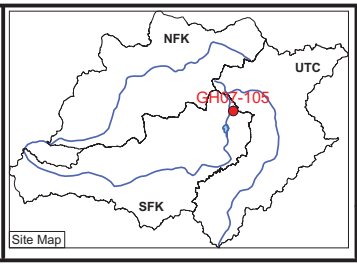
Screens (ft asl):
GH07-105 : 825.8 - 835.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 988.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-105.grf

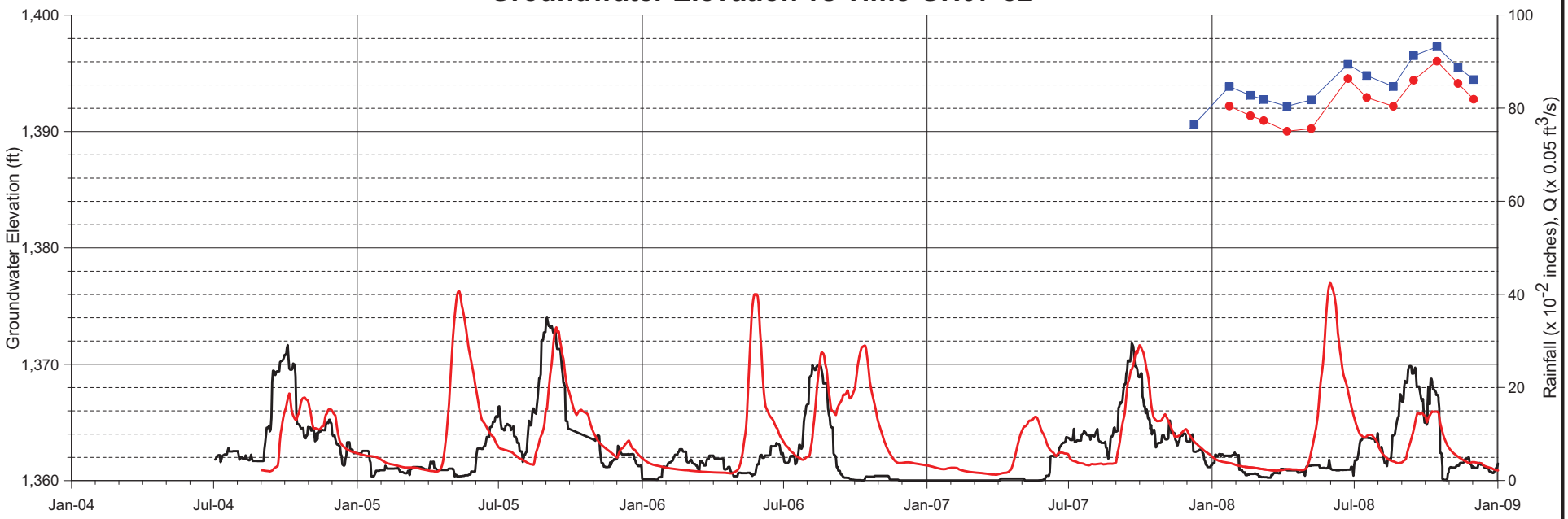


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-82



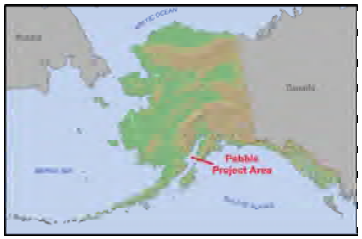
LEGEND:

Groundwater Elevation Plot Legend

- GH07-82S
- GH07-82D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

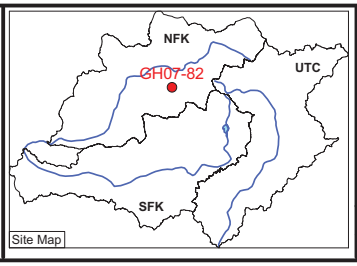
Screens (ft asl):
GH07-82S : 1355.9 - 1365.9
GH07-82D : 1273.8 - 1283.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1400.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-82.grf

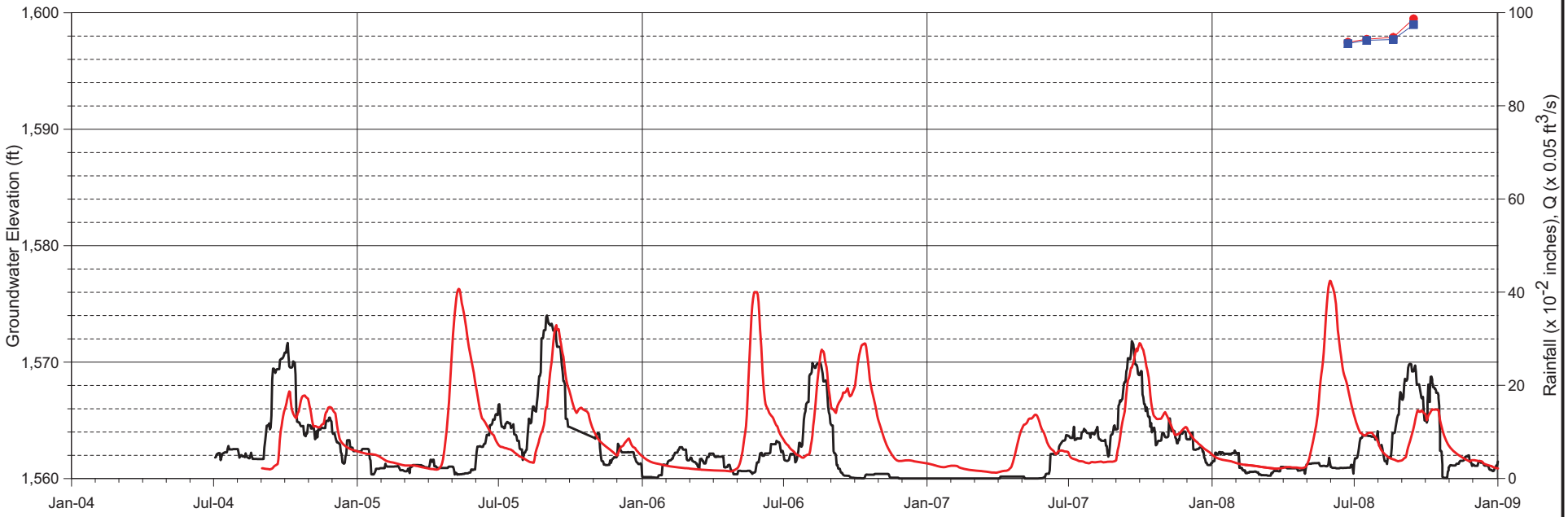


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-83



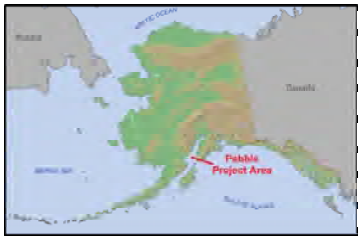
LEGEND:

Groundwater Elevation Plot Legend

- GH07-83S
- GH07-83D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

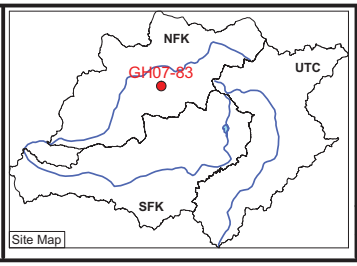
Screens (ft asl):
GH07-83S : 1579.2 - 1589.2
GH07-83D : 1568.2 - 1578.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1598.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-83.grf

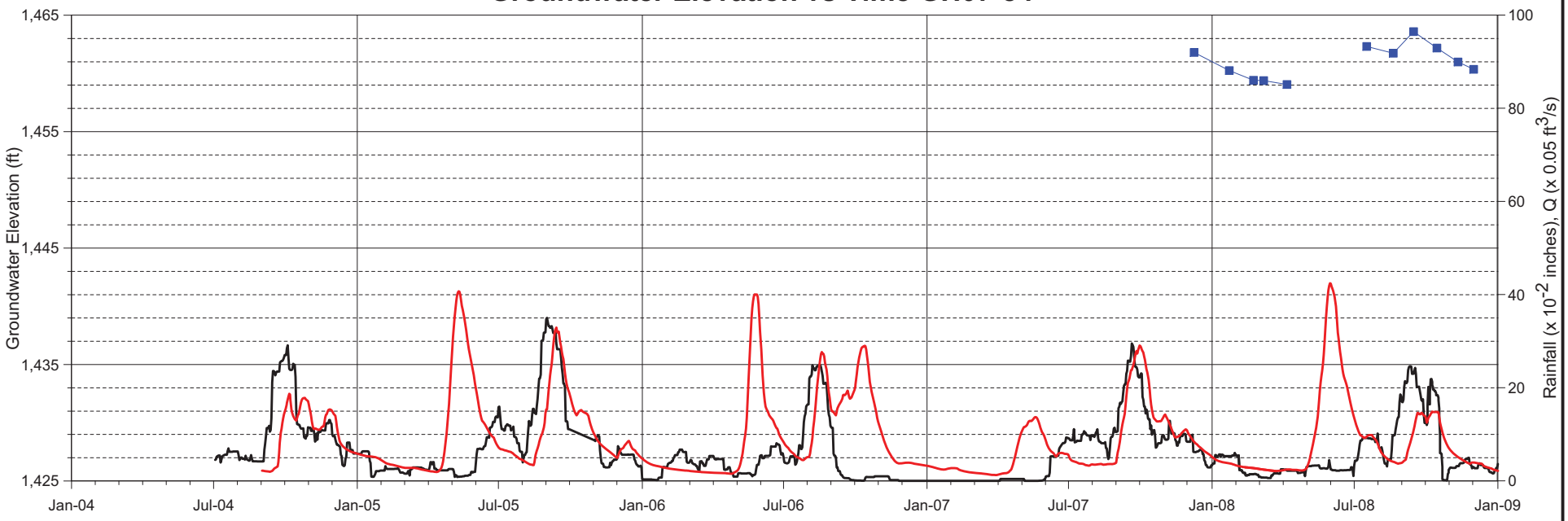


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-84



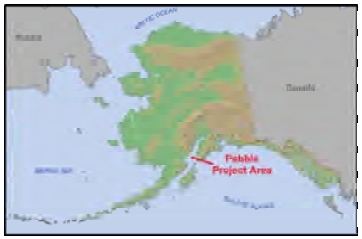
LEGEND:

Groundwater Elevation Plot Legend

- GH07-84
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

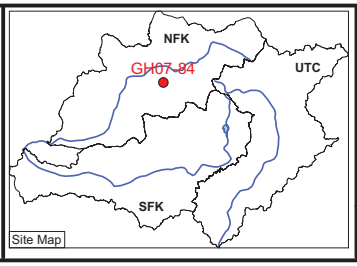
Screens (ft asl):
GH07-84 : 1444.5 - 1454.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1474.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-84.grf

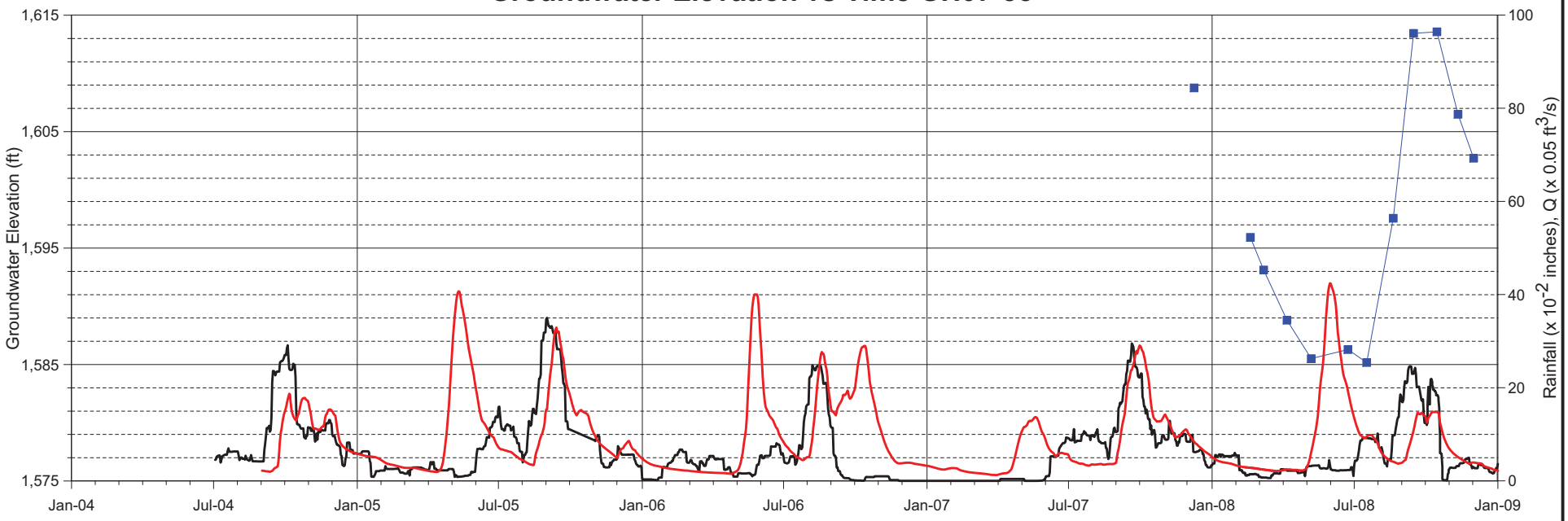


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-85



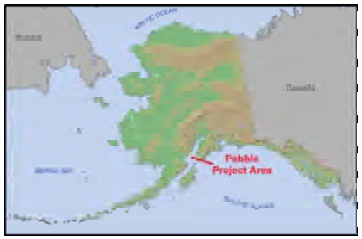
LEGEND:

Groundwater Elevation Plot Legend

- GH07-85
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

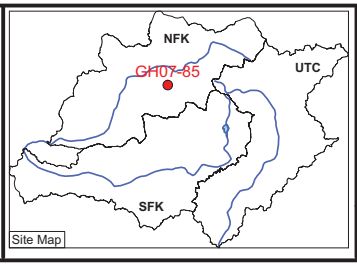
Screens (ft asl):
GH07-85 : 1568.0 - 1578.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1622 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-85.grf

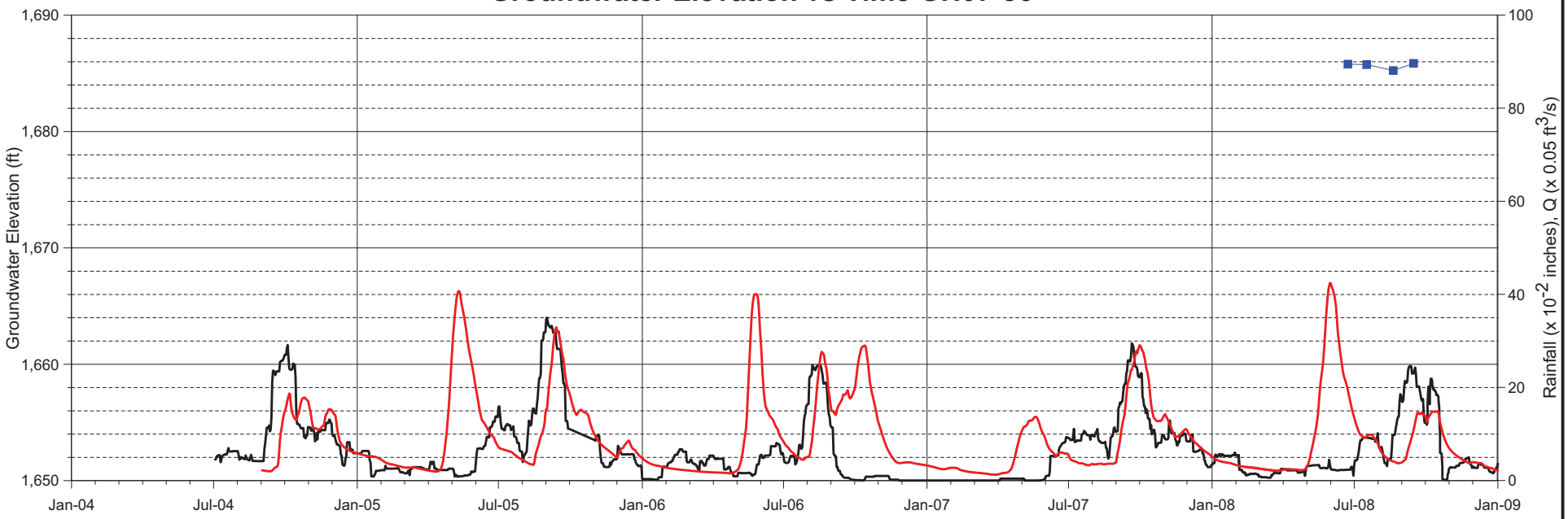


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-86



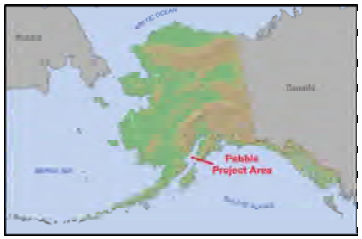
LEGEND:

Groundwater Elevation Plot Legend

- GH07-86
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH07-86 : 1664.0 - 1674.0

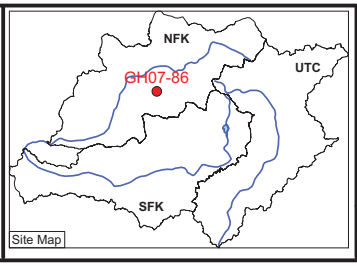


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1684 ft asl

Water was often frozen in riser, therefore few water levels were recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-86.grf

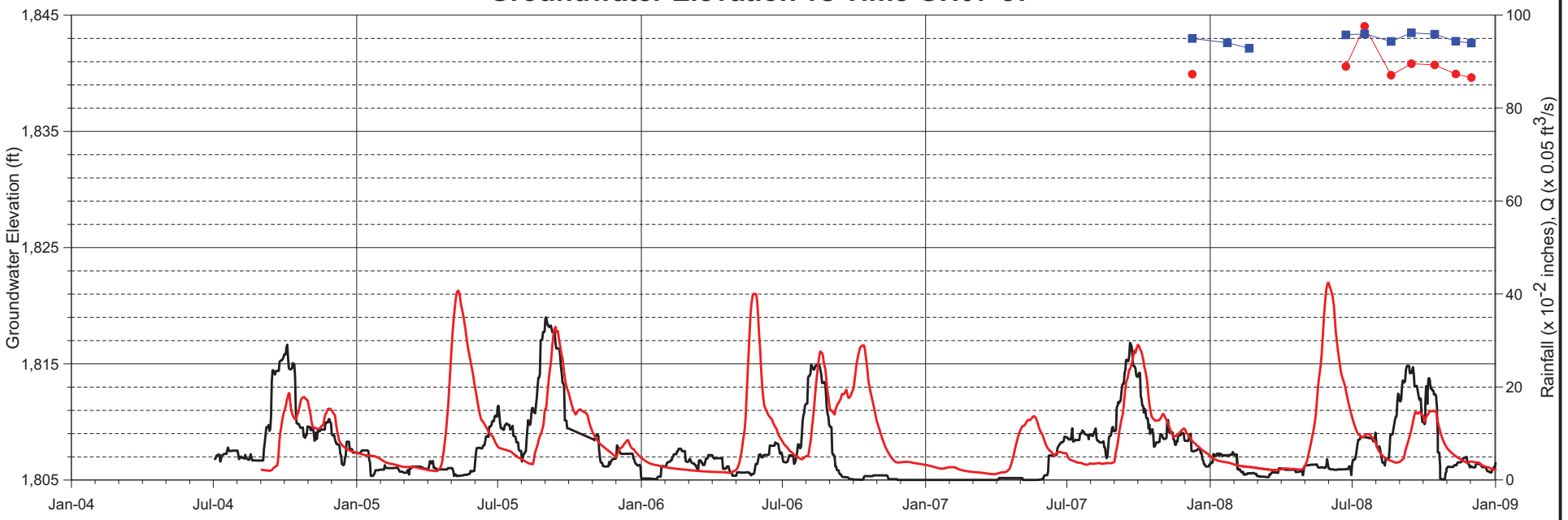


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-87



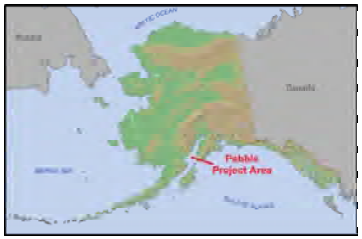
LEGEND:

Groundwater Elevation Plot Legend

- GH07-87S
- GH07-87D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

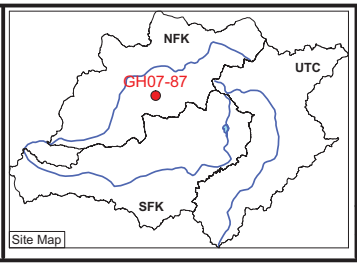
Screens (ft asl):
GH07-87S : 1757.5 - 1767.5
GH07-87D : 1650.5 - 1660.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1849.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-87.grf

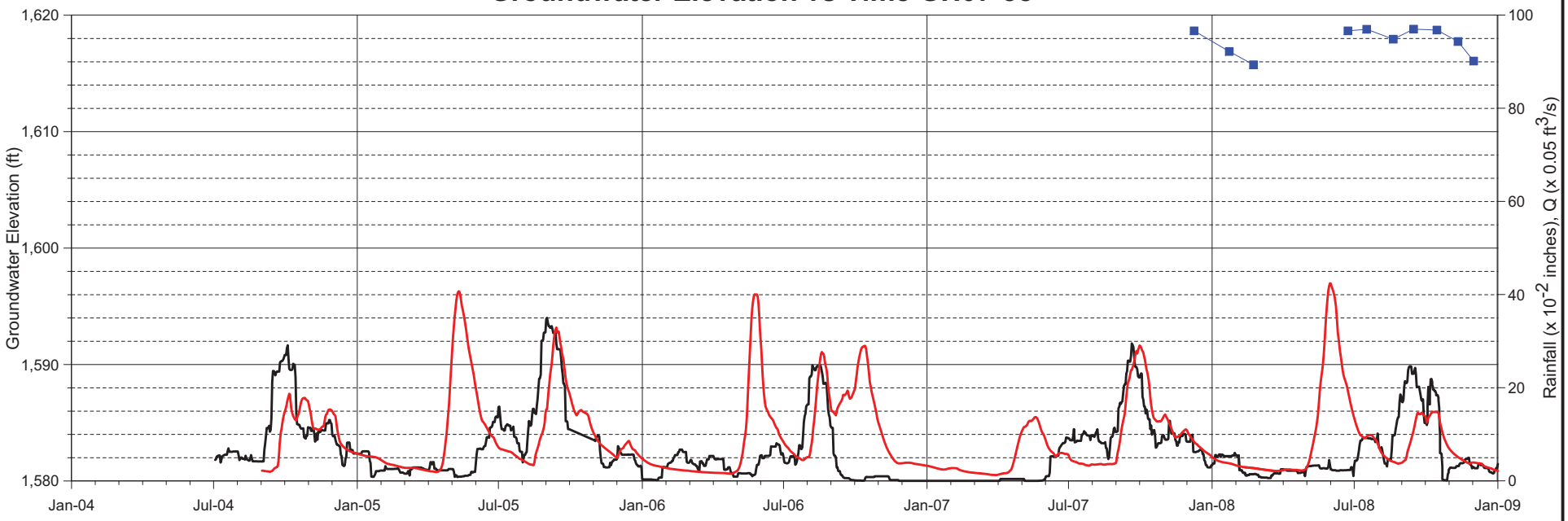


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-88



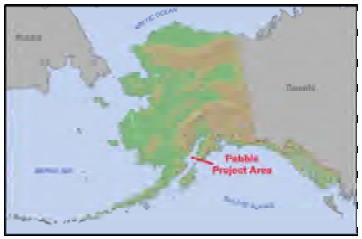
LEGEND:

Groundwater Elevation Plot Legend

- GH07-88
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

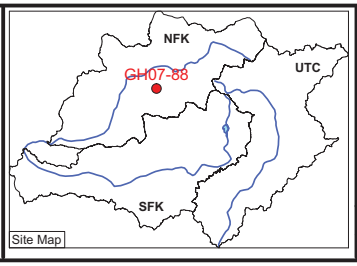
Screens (ft asl):
GH07-88 : 1605.6 - 1616.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1620.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-88.grf

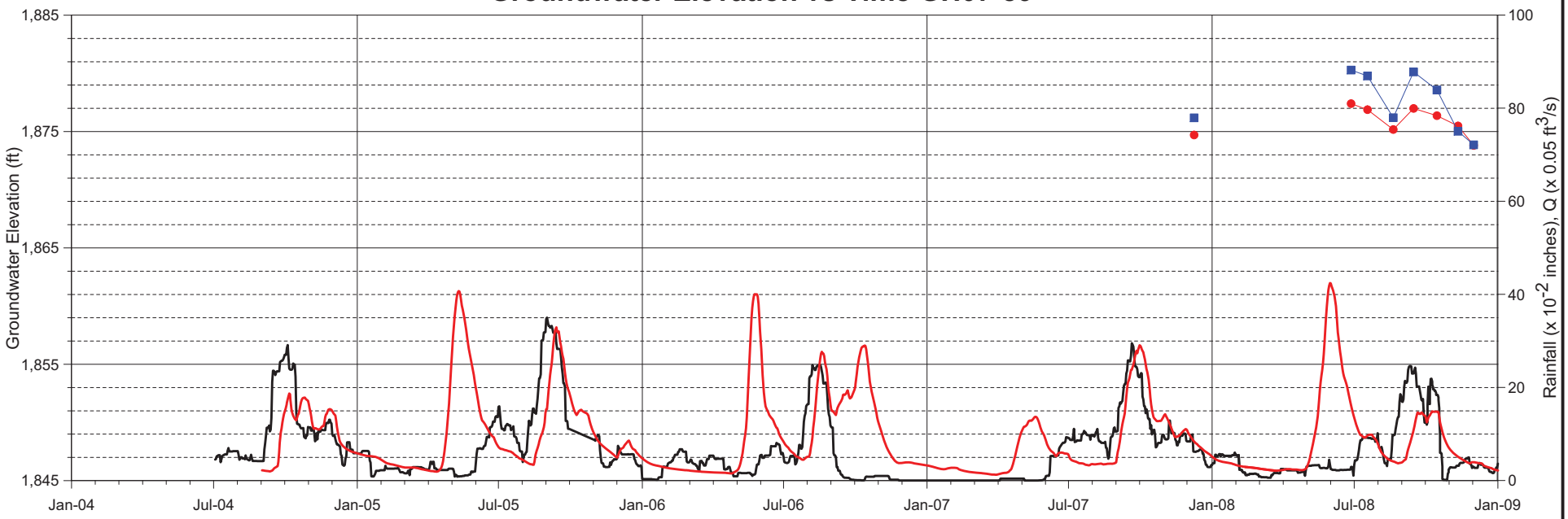


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-89



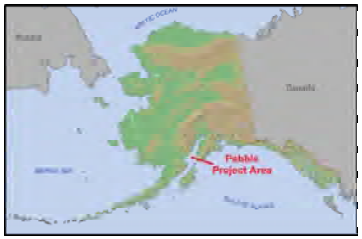
LEGEND:

Groundwater Elevation Plot Legend

- GH07-89S
- GH07-89D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

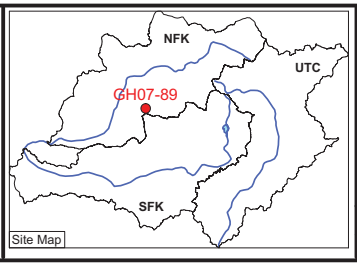
Screens (ft asl):
GH07-89S : 1834.8 - 1844.8
GH07-89D : 1804.8 - 1814.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1884.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-89.grf

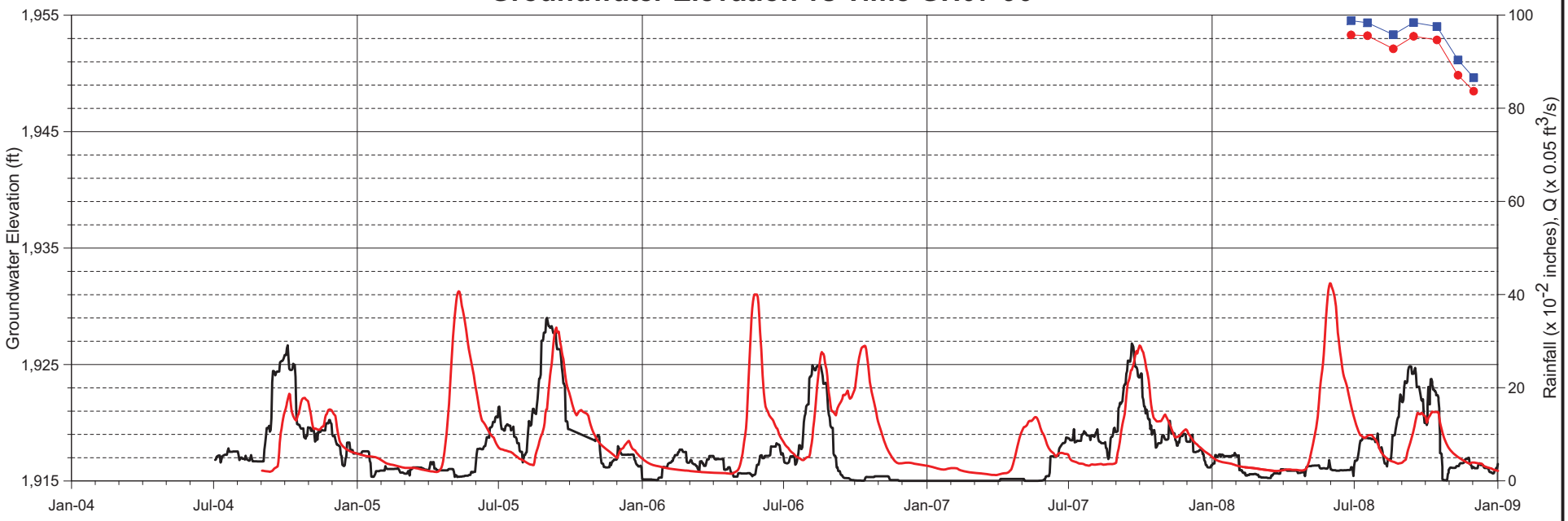


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-90



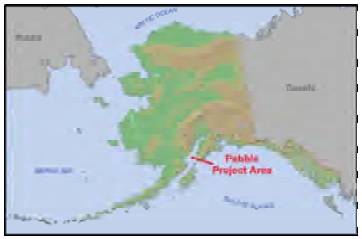
LEGEND:

Groundwater Elevation Plot Legend

- GH07-90S
- GH07-90D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

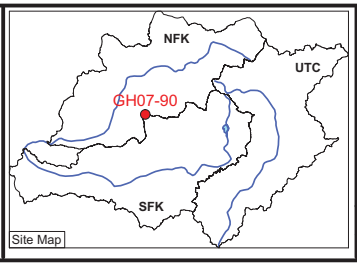
Screens (ft asl):
GH07-90S : 1926.6 - 1936.6
GH07-90D : 1866.6 - 1876.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1956.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-90.grf

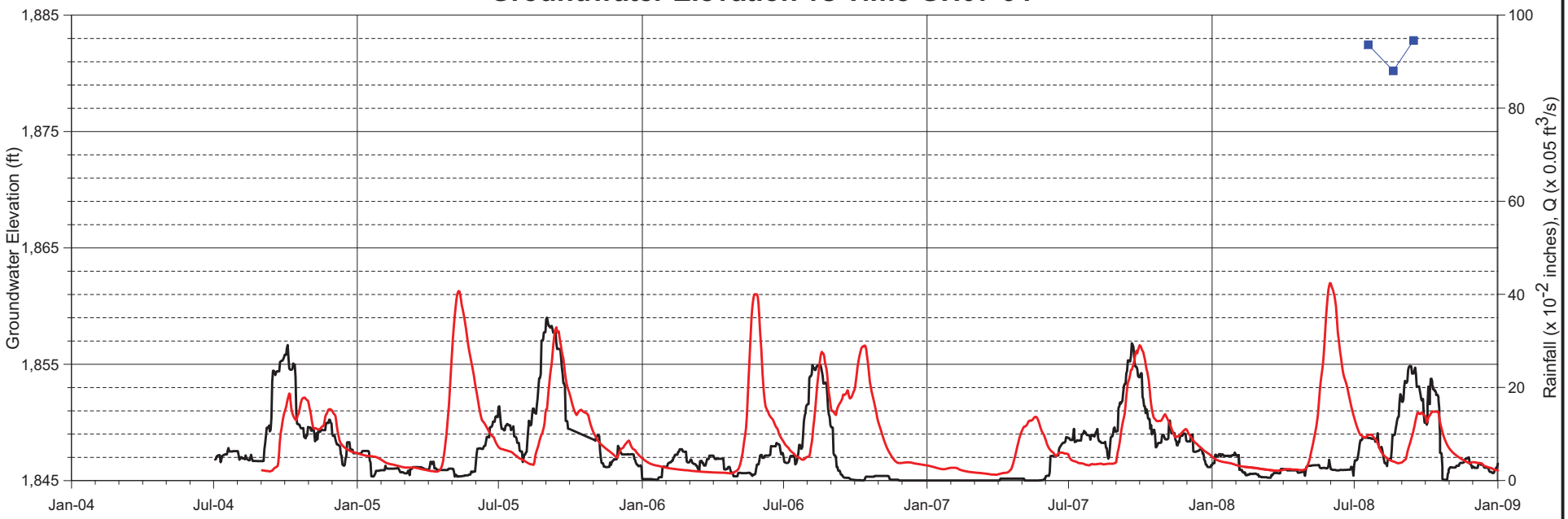


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-91



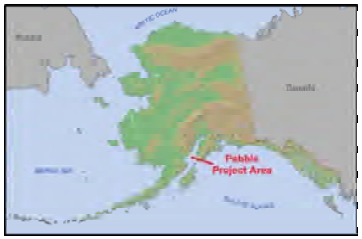
LEGEND:

Groundwater Elevation Plot Legend

- GH07-91
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

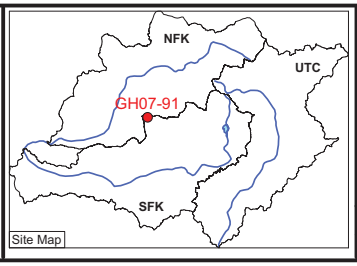
Screens (ft asl):
GH07-91 : 1852.8 - 1862.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1882.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-91.grf

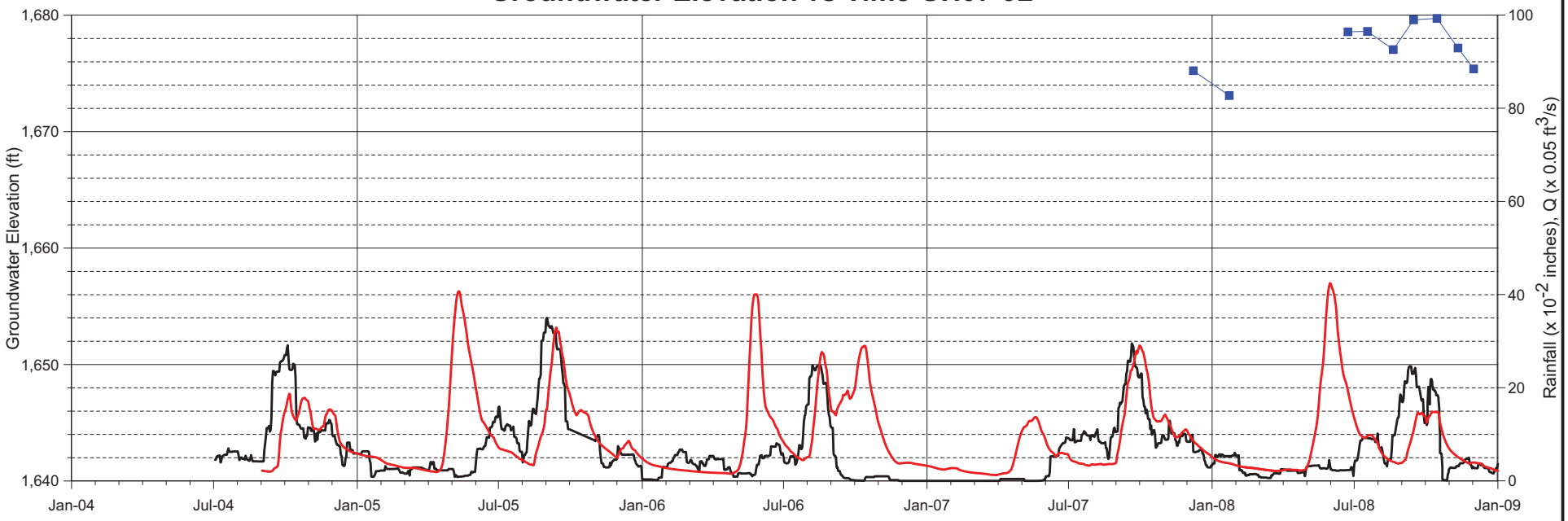


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-92



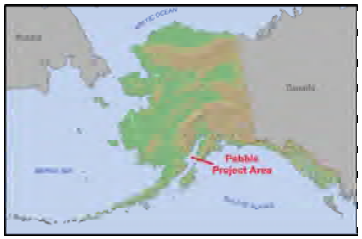
LEGEND:

Groundwater Elevation Plot Legend

- GH07-92D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

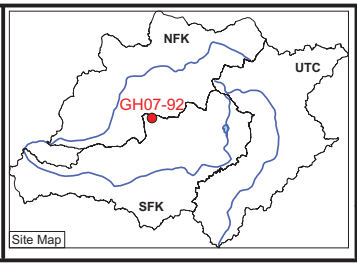
Screens (ft asl):
GH07-92S : 1663.2 - 1673.2
GH07-92D : 1618.2 - 1628.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1693.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-92.grf

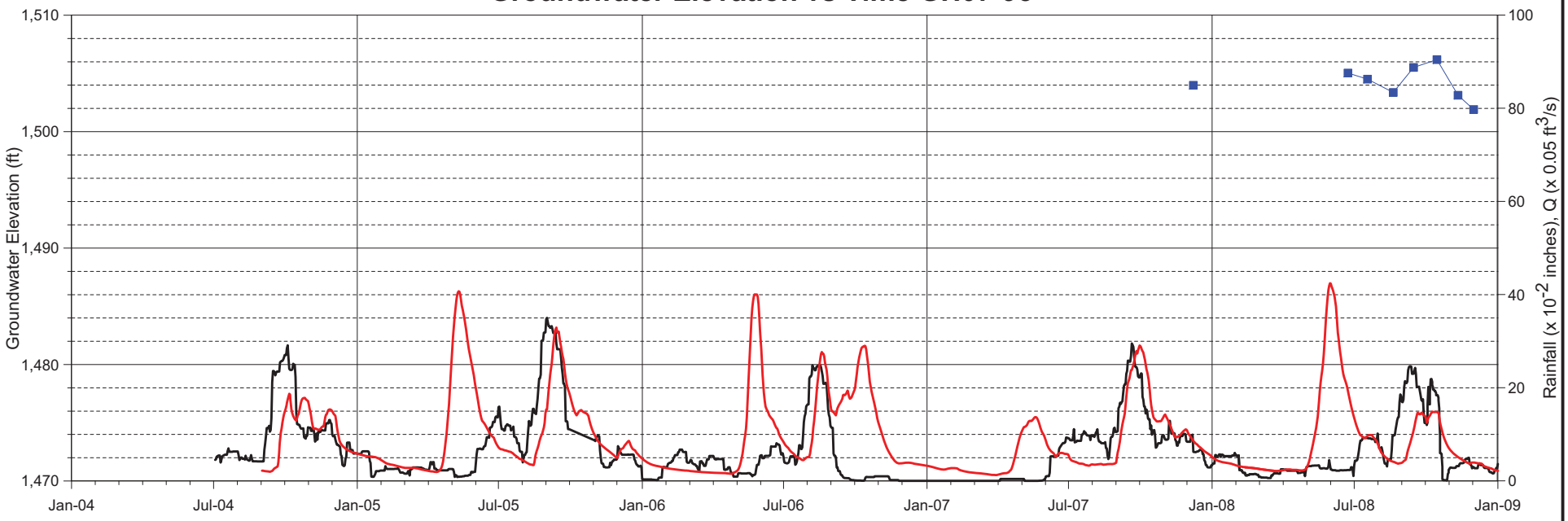


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-93



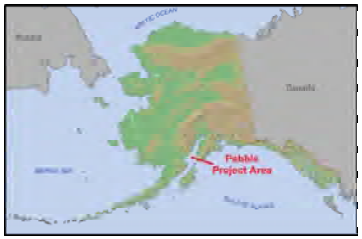
LEGEND:

Groundwater Elevation Plot Legend

- GH07-93
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

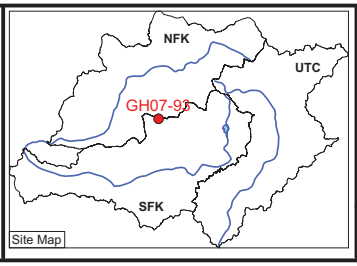
Screens (ft asl):
GH07-93 : 1467.3 - 1477.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1510.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-93.grf

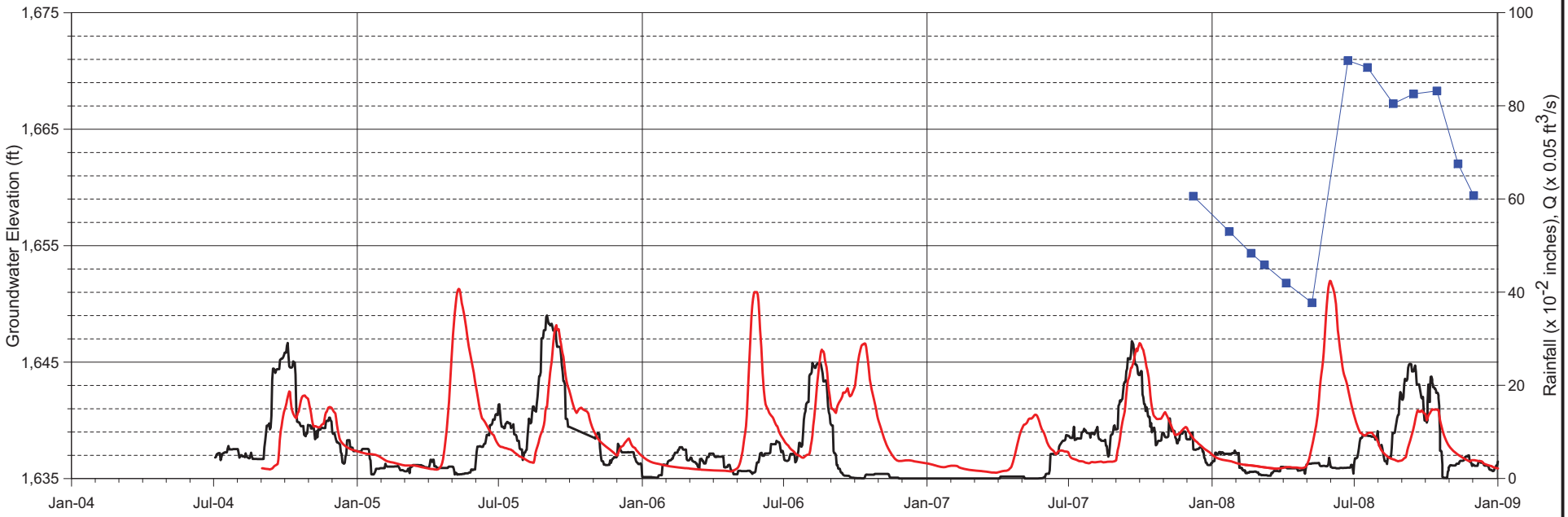


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-94



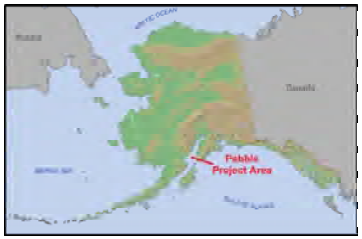
LEGEND:

Groundwater Elevation Plot Legend

- GH07-94
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

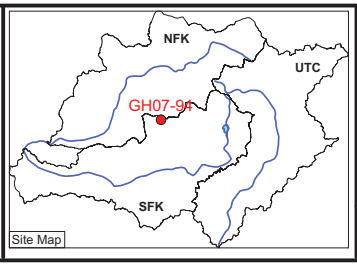
Screens (ft asl):
GH07-94 : 1644.2 - 1654.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1669.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-94.grf

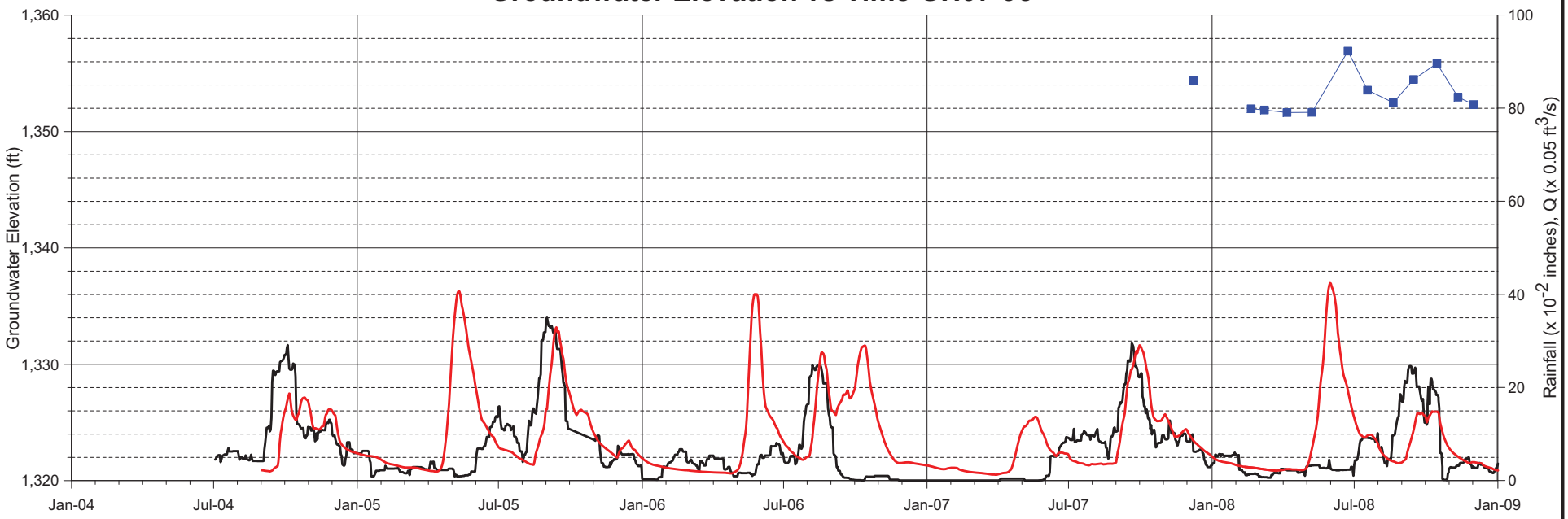


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-95



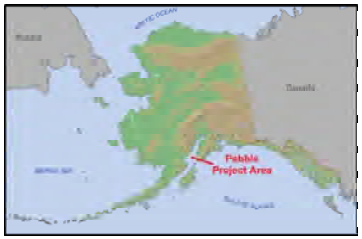
LEGEND:

Groundwater Elevation Plot Legend

- GH07-95
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

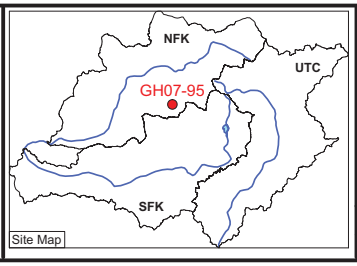
Screens (ft asl):
GH07-95 : 1333.7 - 1343.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1361.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-95.grf

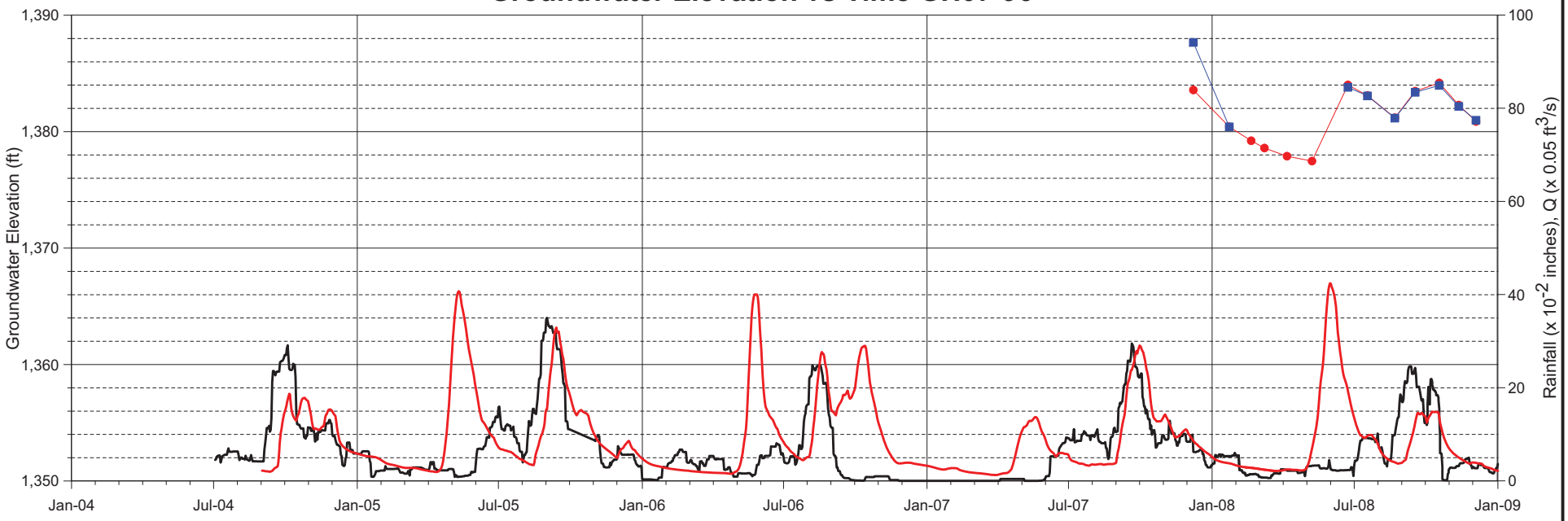


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-96



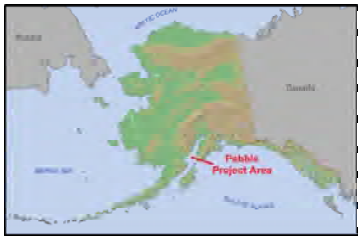
LEGEND:

Groundwater Elevation Plot Legend

- GH07-96S
- GH07-96D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

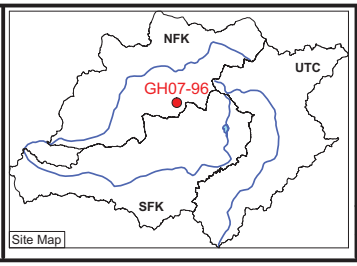
Screens (ft asl):
GH07-96S : 1347.8 - 1357.8
GH07-96D : 1307.8 - 1317.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1387.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-96.grf

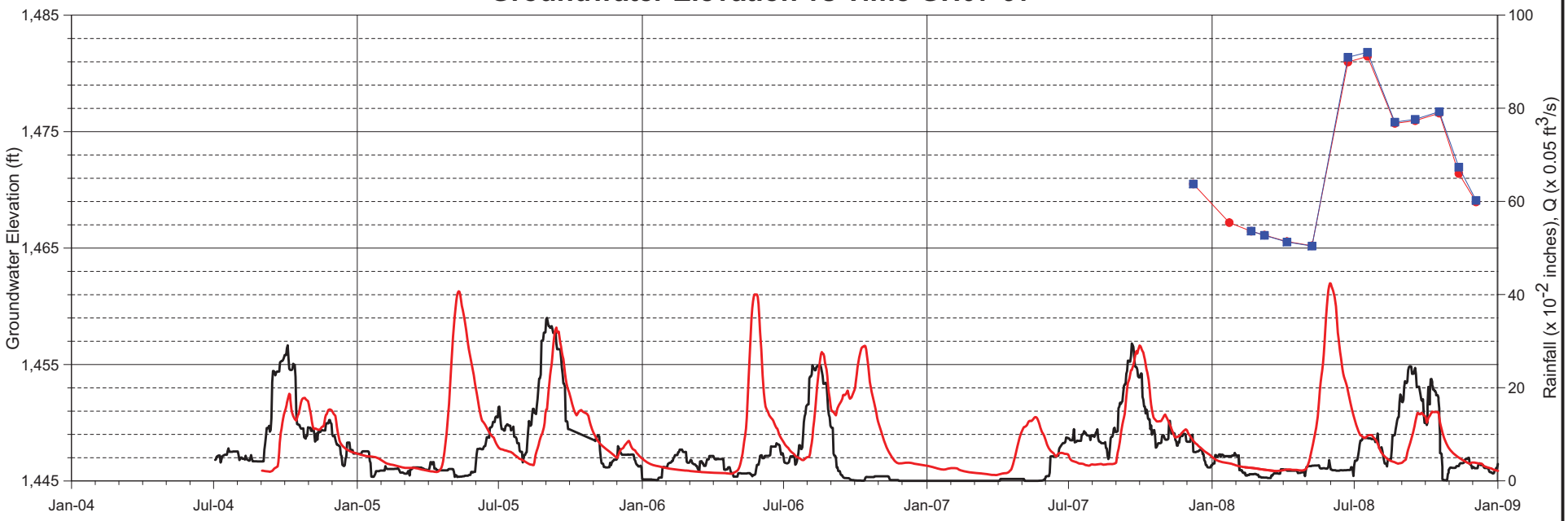


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-97



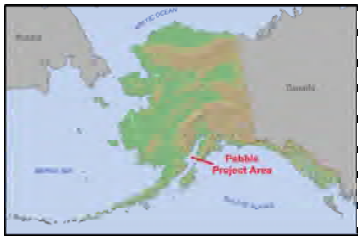
LEGEND:

Groundwater Elevation Plot Legend

- GH07-97S
- GH07-97D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

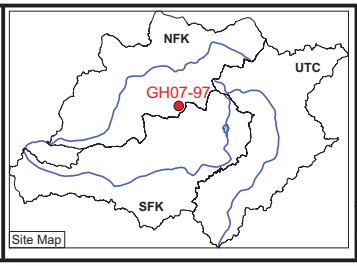
Screens (ft asl):
GH07-97S : 1451.1 - 1461.1
GH07-97D : 1411.1 - 1421.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1491.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-97.grf

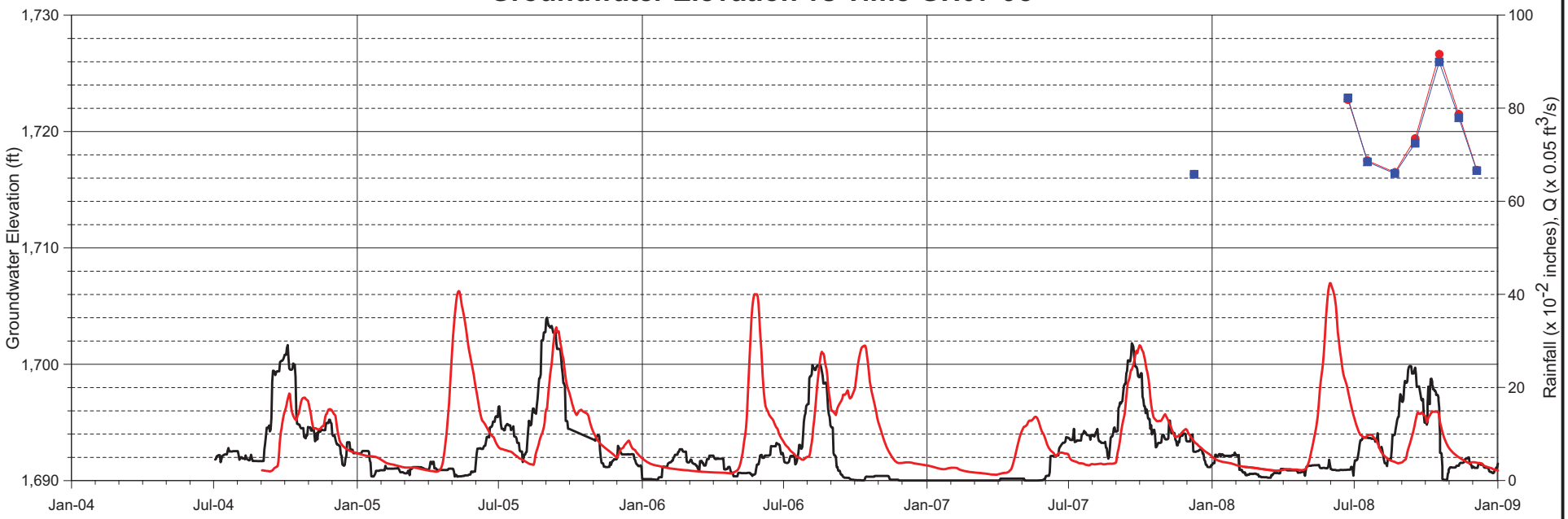


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-98



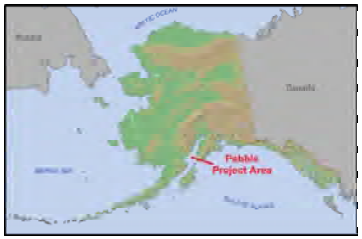
LEGEND:

Groundwater Elevation Plot Legend

- GH07-98S
- GH07-98D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

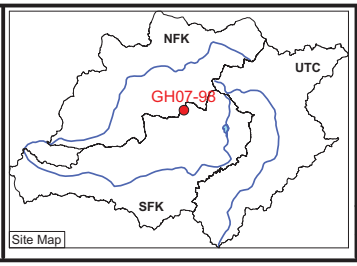
Screens (ft asl):
GH07-98S : 1689.8 - 1699.8
GH07-98D : 1650.3 - 1660.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1739.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-98.grf

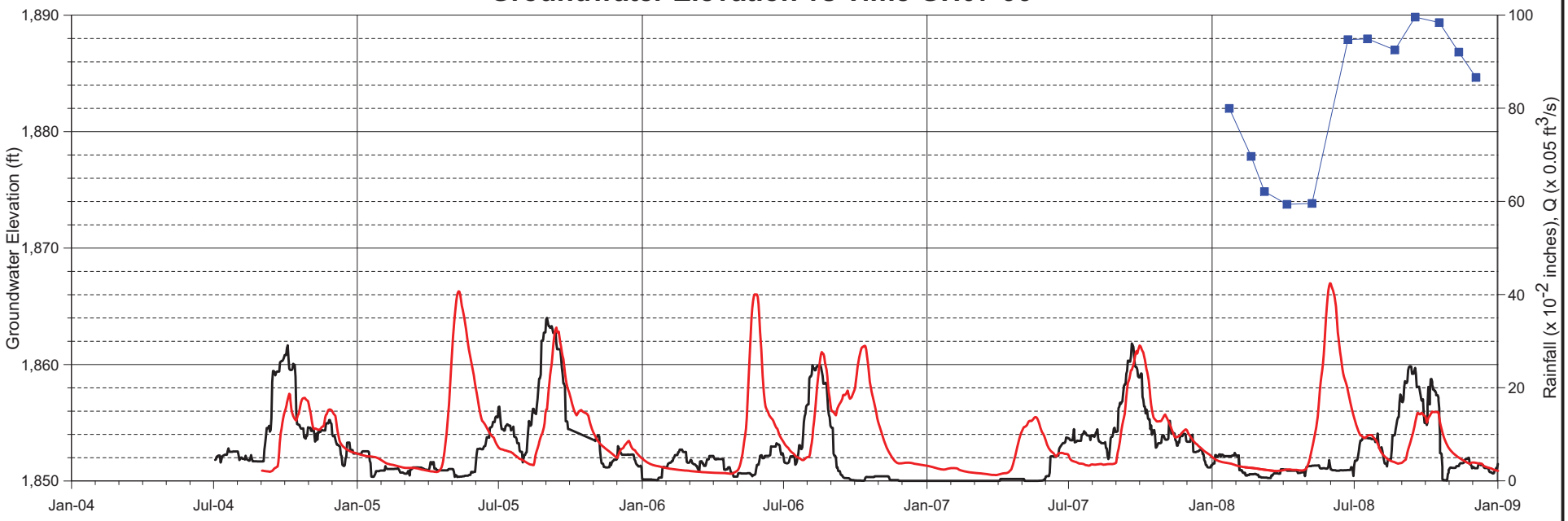


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-99



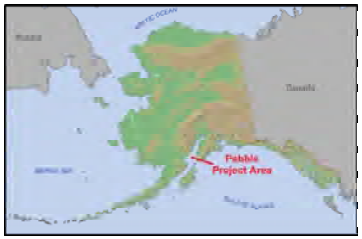
LEGEND:

Groundwater Elevation Plot Legend

- GH07-99
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

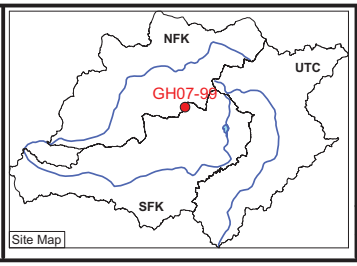
Screens (ft asl):
GH07-99 : 1873.7 - 1883.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1893.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-99.grf

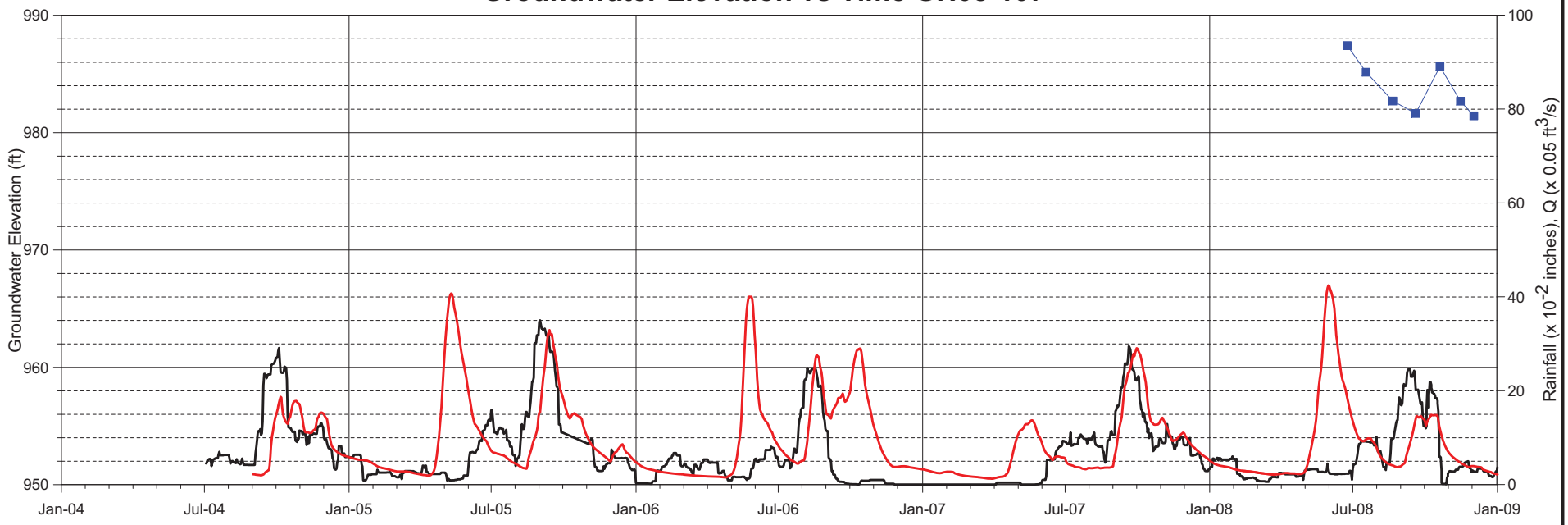


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-107



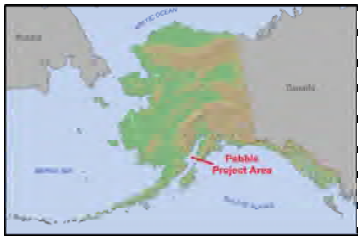
LEGEND:

Groundwater Elevation Plot Legend

- GH08-107
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

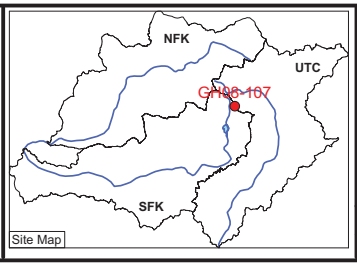
Screens (ft asl):
GH08-107 : 890.5 - 900.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1025.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-107.grf

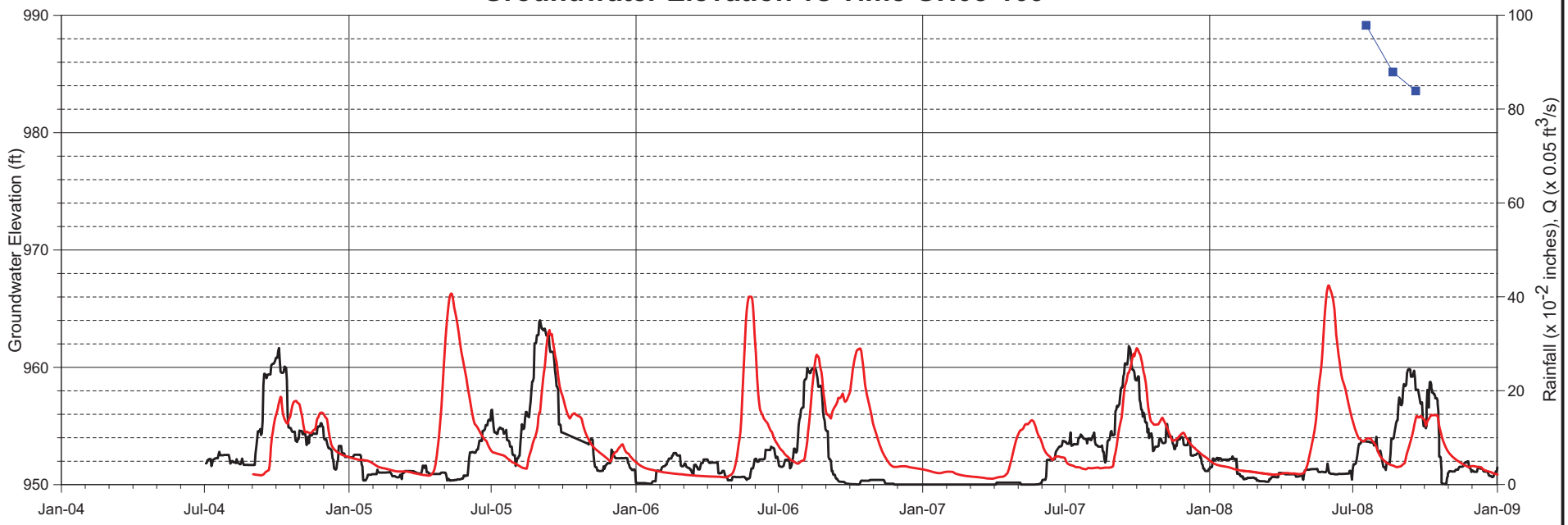


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-109



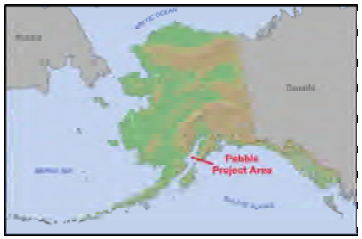
LEGEND:

Groundwater Elevation Plot Legend

- GH08-109
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

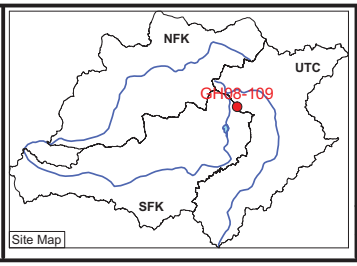
Screens (ft asl):
GH08-109 : 882.1 - 892.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 989.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-109.grf

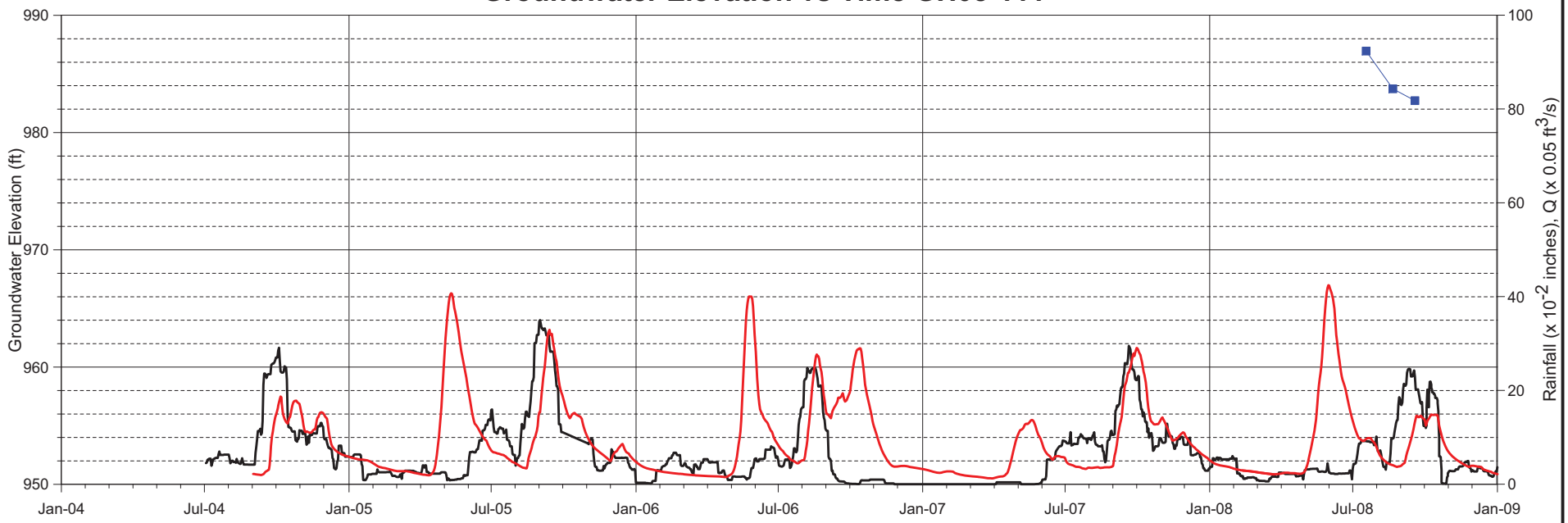


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-111



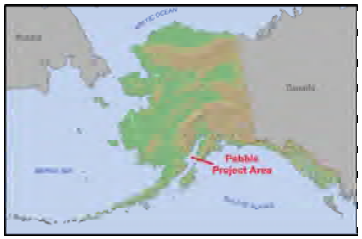
LEGEND:

Groundwater Elevation Plot Legend

- GH08-111
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

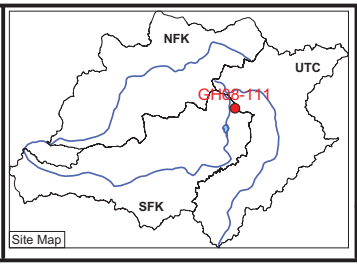
Screens (ft asl):
GH08-111 : 883.7 - 893.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 985.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-111.grf

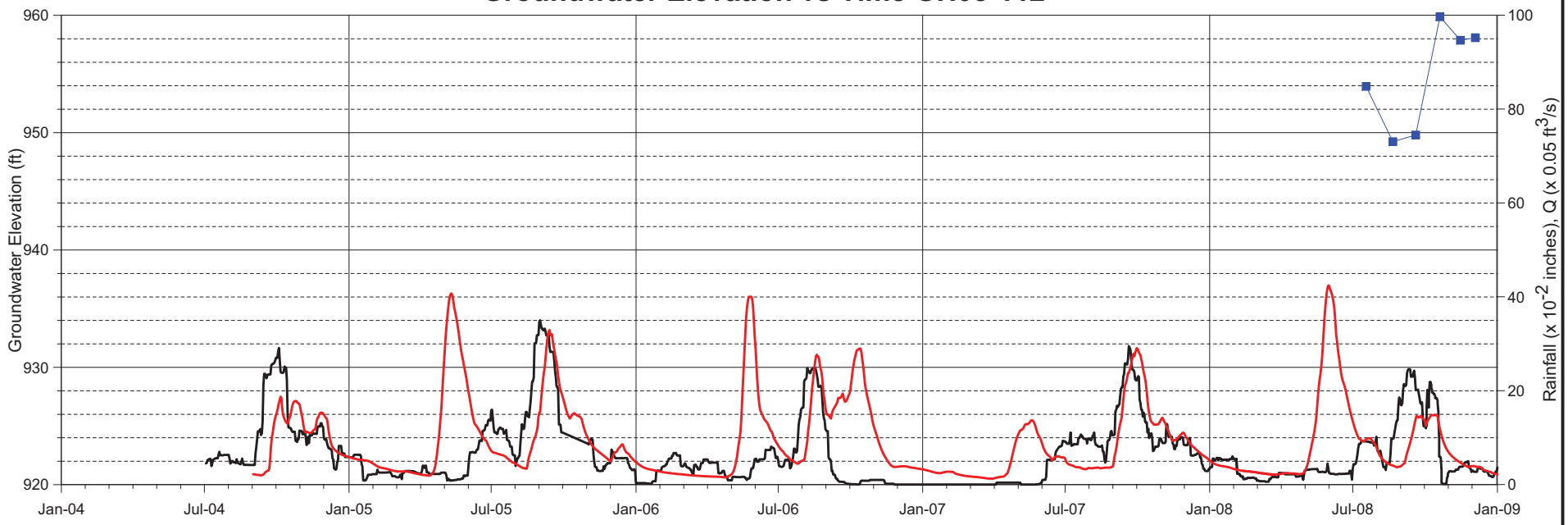


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-112



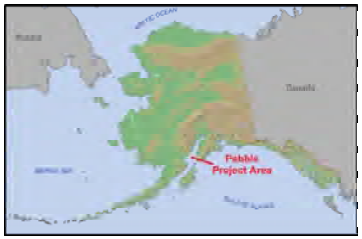
LEGEND:

Groundwater Elevation Plot Legend

- GH08-112
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

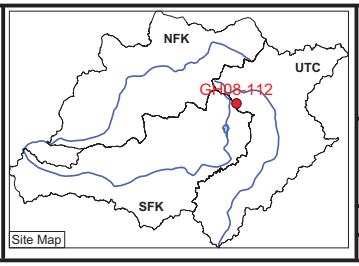
Screens (ft asl):
GH08-112 : 745.5 - 765.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1003.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-112.grf

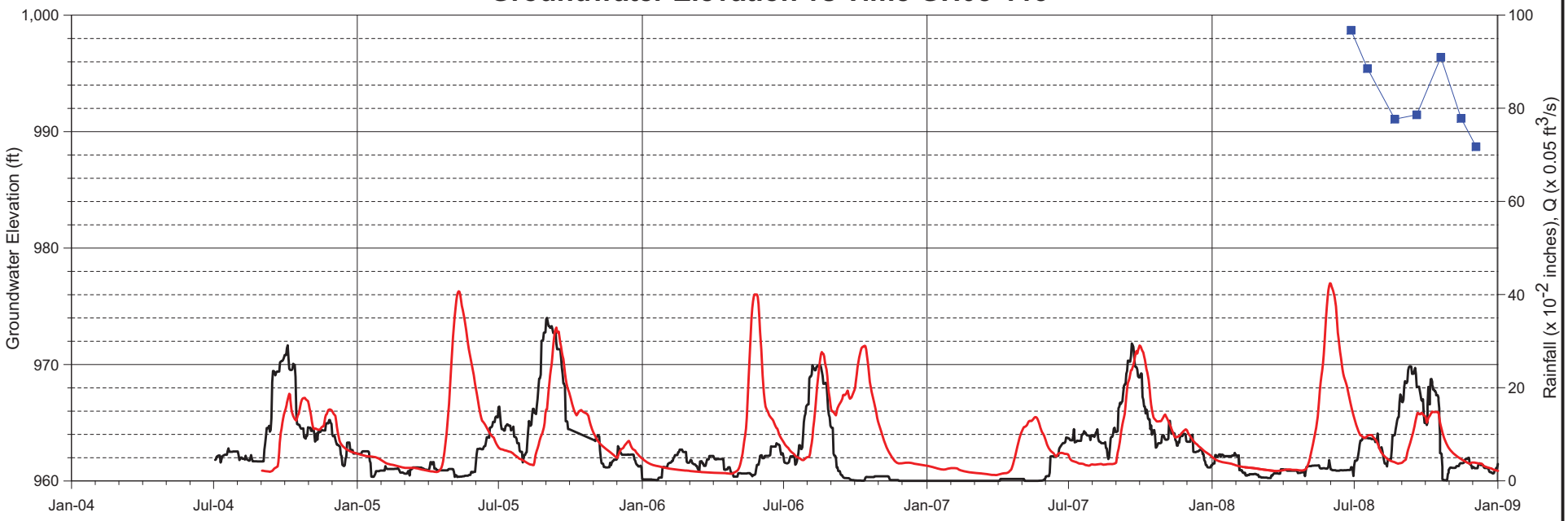


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-113



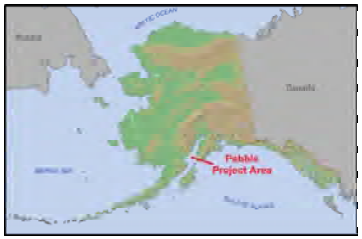
LEGEND:

Groundwater Elevation Plot Legend

- GH08-113
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

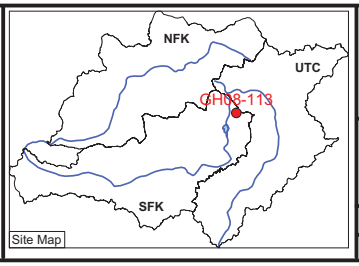
Screens (ft asl):
GH08-113 : 918.7 - 938.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 997.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-113.grf

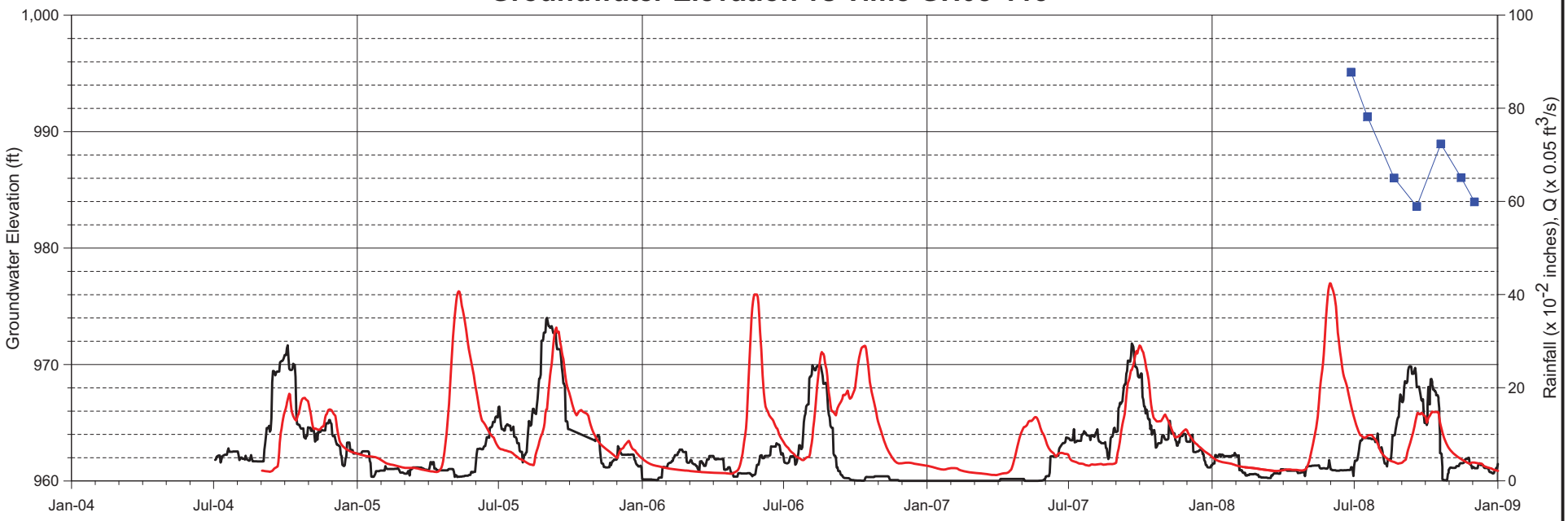


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-115



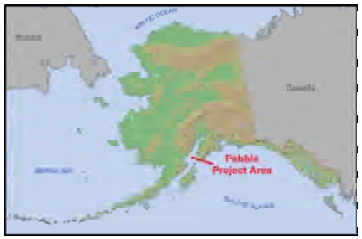
LEGEND:

Groundwater Elevation Plot Legend

- GH08-115
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

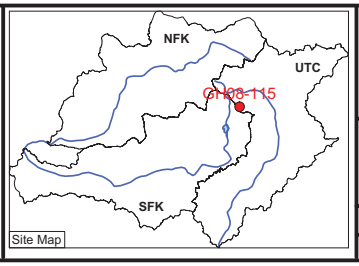
Screens (ft asl):
GH08-115 : 838.2 - 848.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1012.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-115.grf

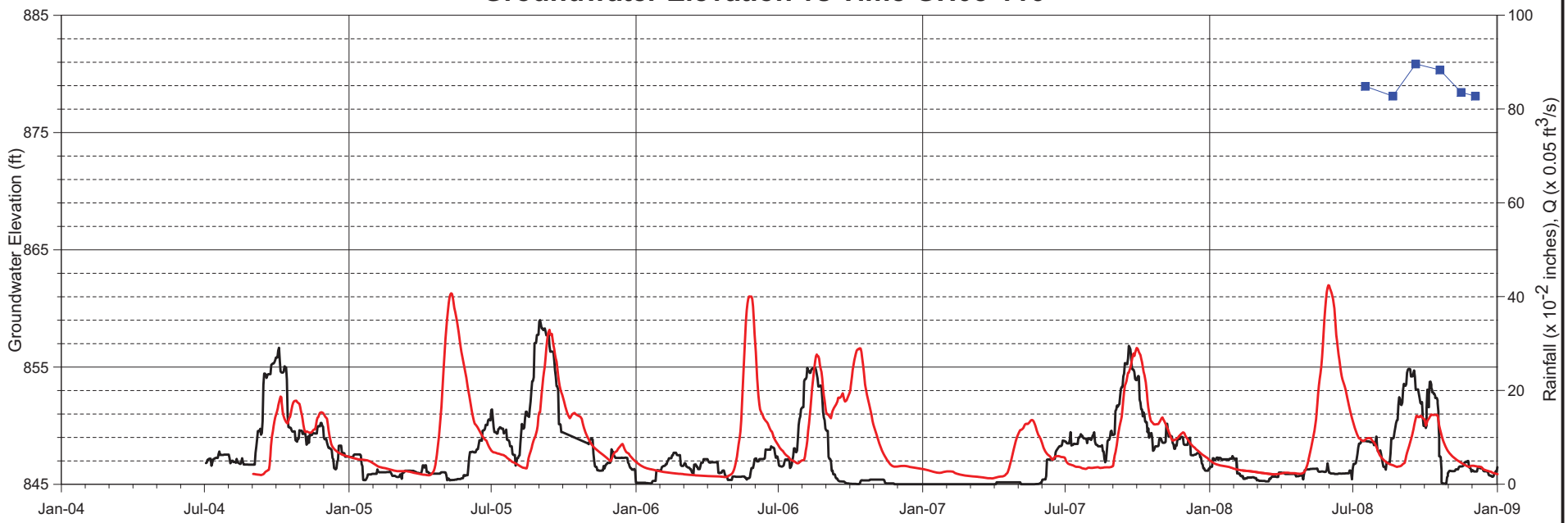


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-116



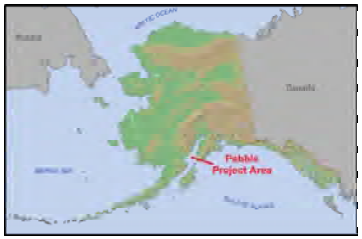
LEGEND:

Groundwater Elevation Plot Legend

- GH08-116
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

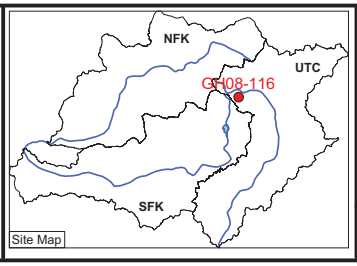
Screens (ft asl):
GH08-116 : 864.2 - 874.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 886.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-116.grf

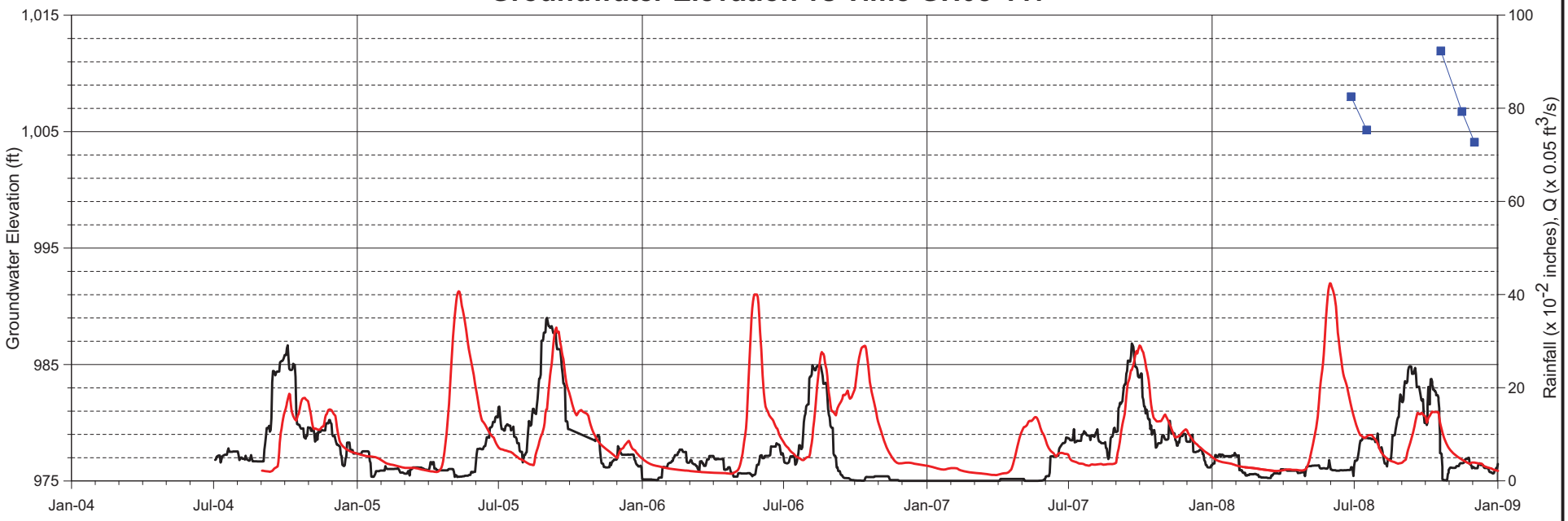


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-117



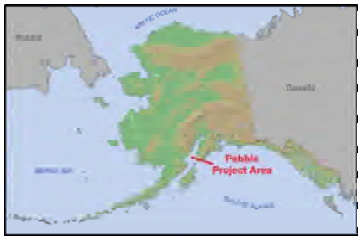
LEGEND:

Groundwater Elevation Plot Legend

- GH08-117
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

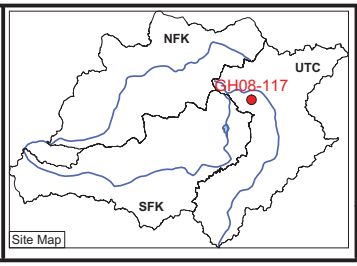
Screens (ft asl):
GH08-117 : 995.7 - 1004.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1039.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-117.grf

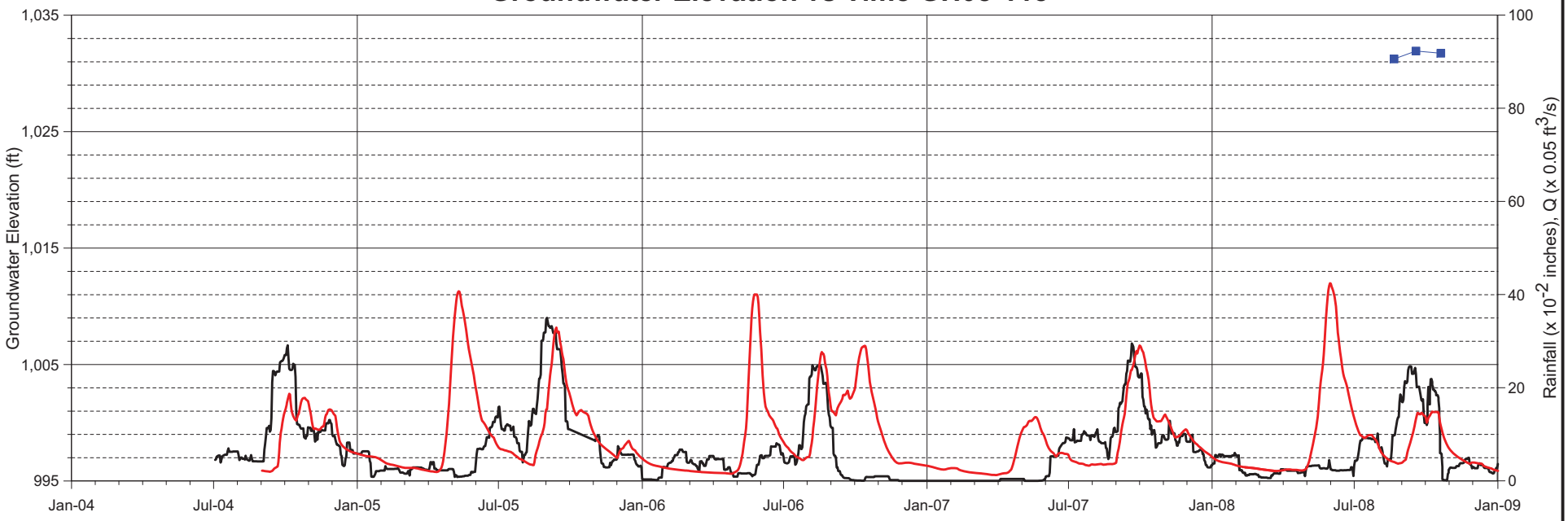


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-118



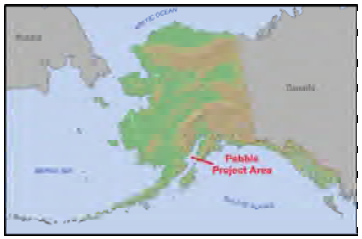
LEGEND:

Groundwater Elevation Plot Legend

- GH08-118
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

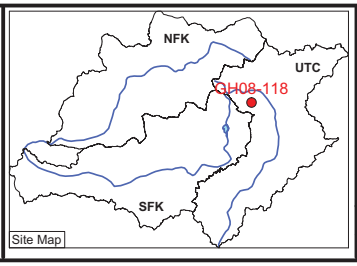
Screens (ft asl):
GH08-118 : 1002.4 - 1012.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1032.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-118.grf

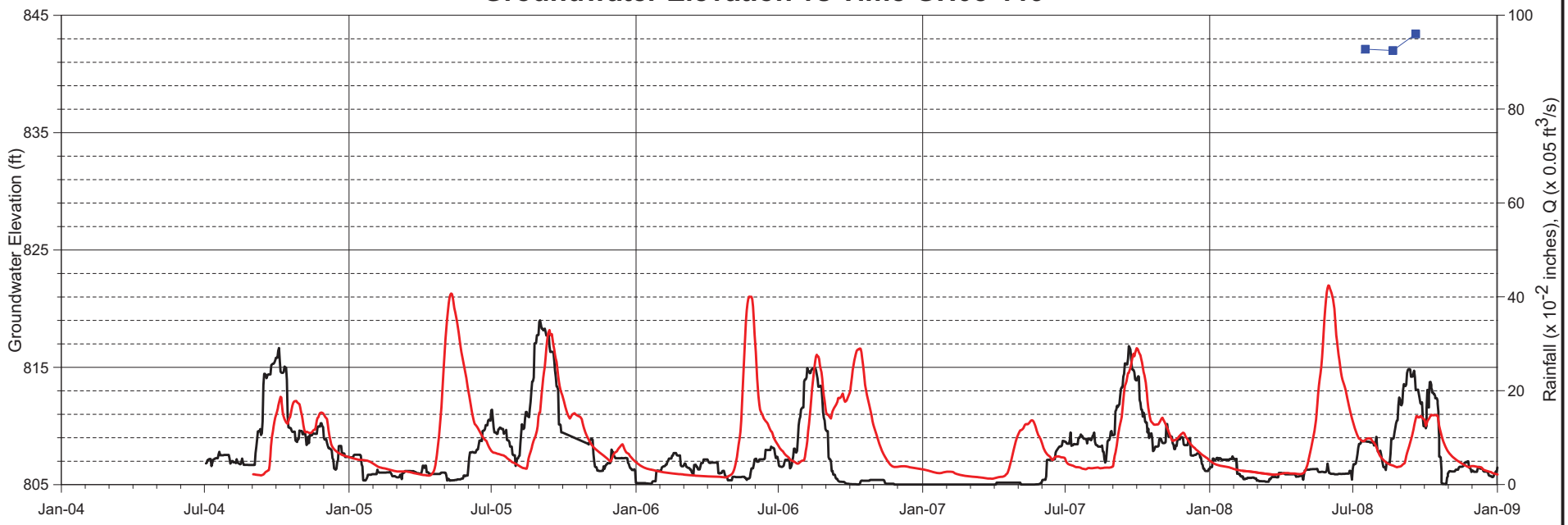


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-119



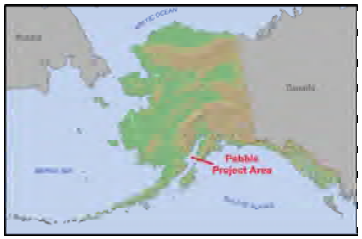
LEGEND:

Groundwater Elevation Plot Legend

- GH08-119
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

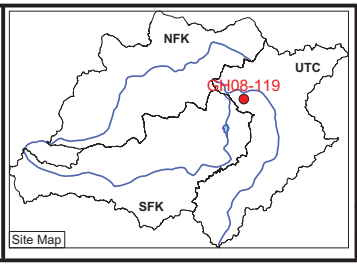
Screens (ft asl):
GH08-119 : 817.2 - 828.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 842.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-119.grf

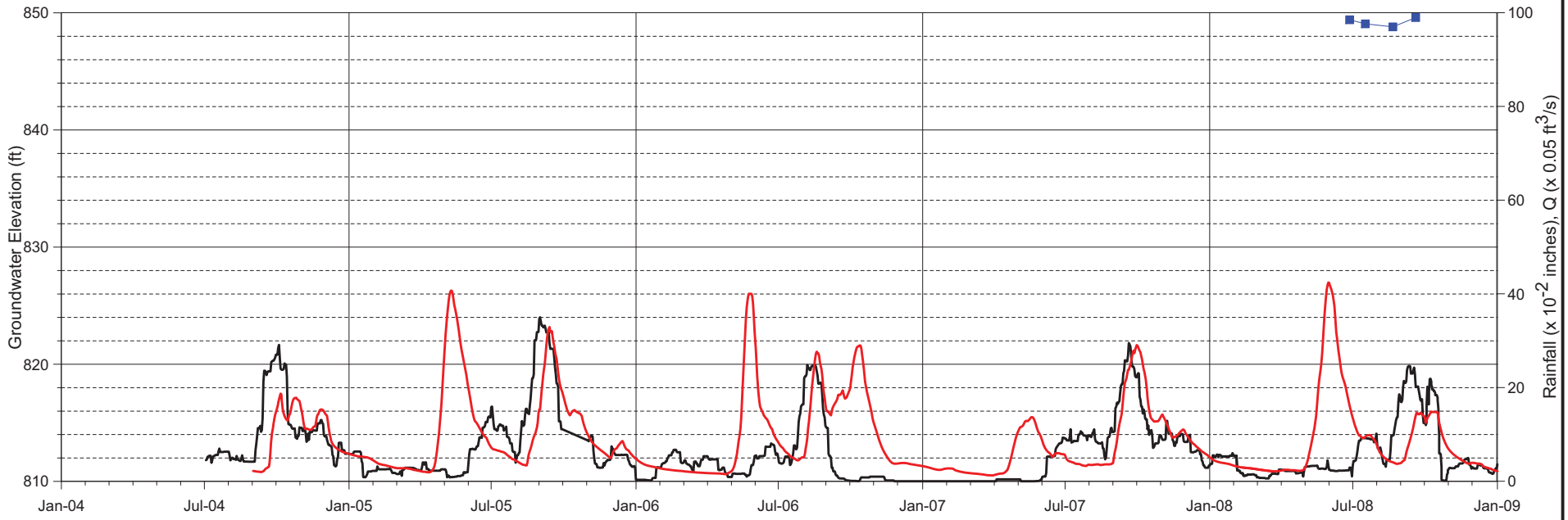


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-120



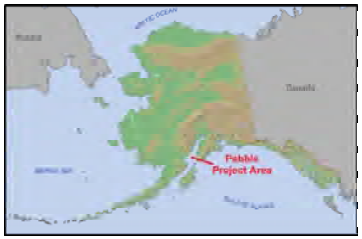
LEGEND:

Groundwater Elevation Plot Legend

- GH08-120
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

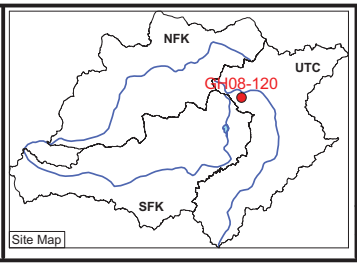
Screens (ft asl):
GH08-120 : 815.7 - 825.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 847.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-120.grf

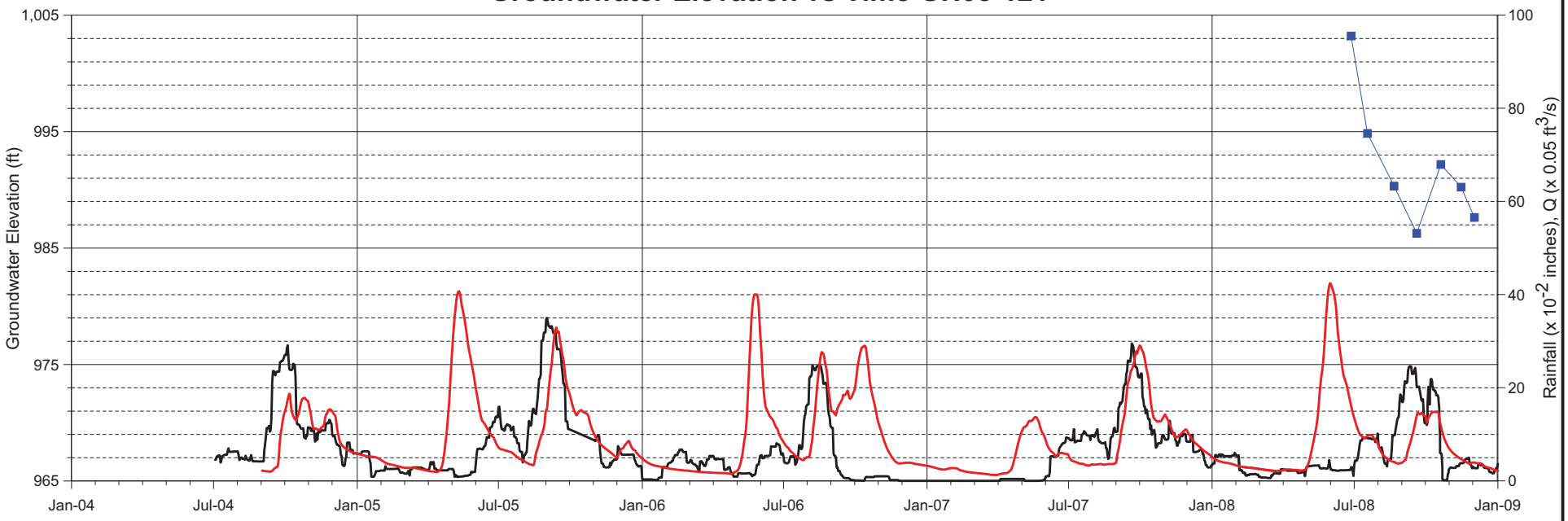


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-121



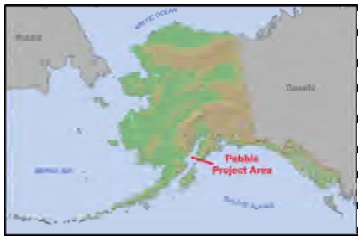
LEGEND:

Groundwater Elevation Plot Legend

- GH08-121
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

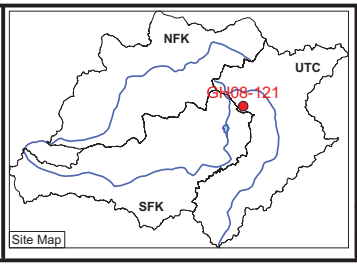
Screens (ft asl):
GH08-121 : 923.0 - 933.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1038 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-121.grf

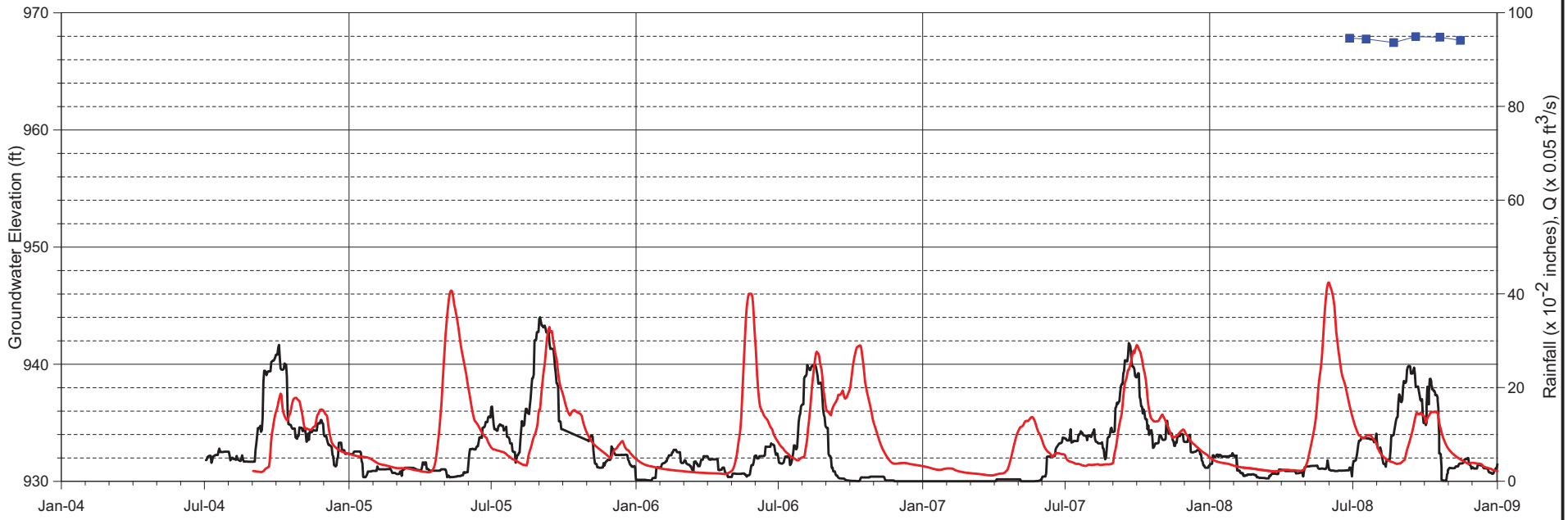


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-123



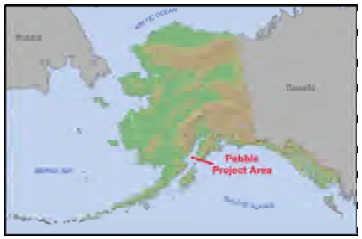
LEGEND:

Groundwater Elevation Plot Legend

- GH08-123
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

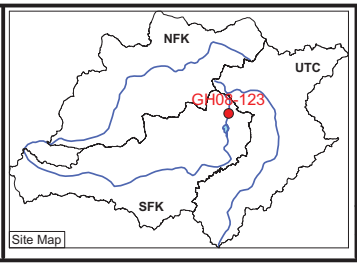
Screens (ft asl):
GH08-123 : 941.1 - 951.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 969.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-123.grf

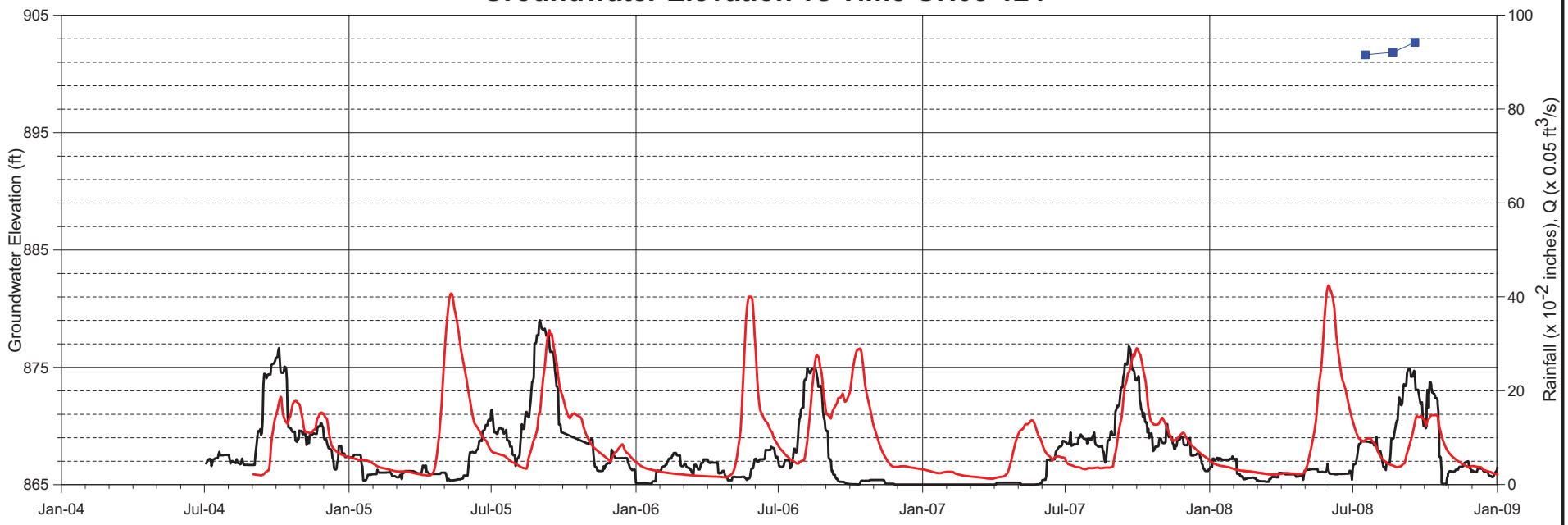


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-124



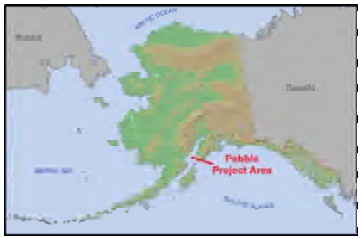
LEGEND:

Groundwater Elevation Plot Legend

- GH08-124
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

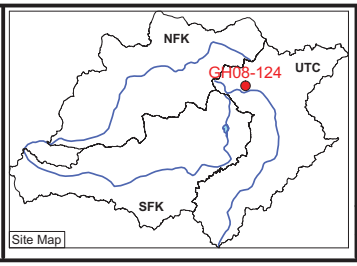
Screens (ft asl):
GH08-124 : 758.0 - 768.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 902.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-124.grf

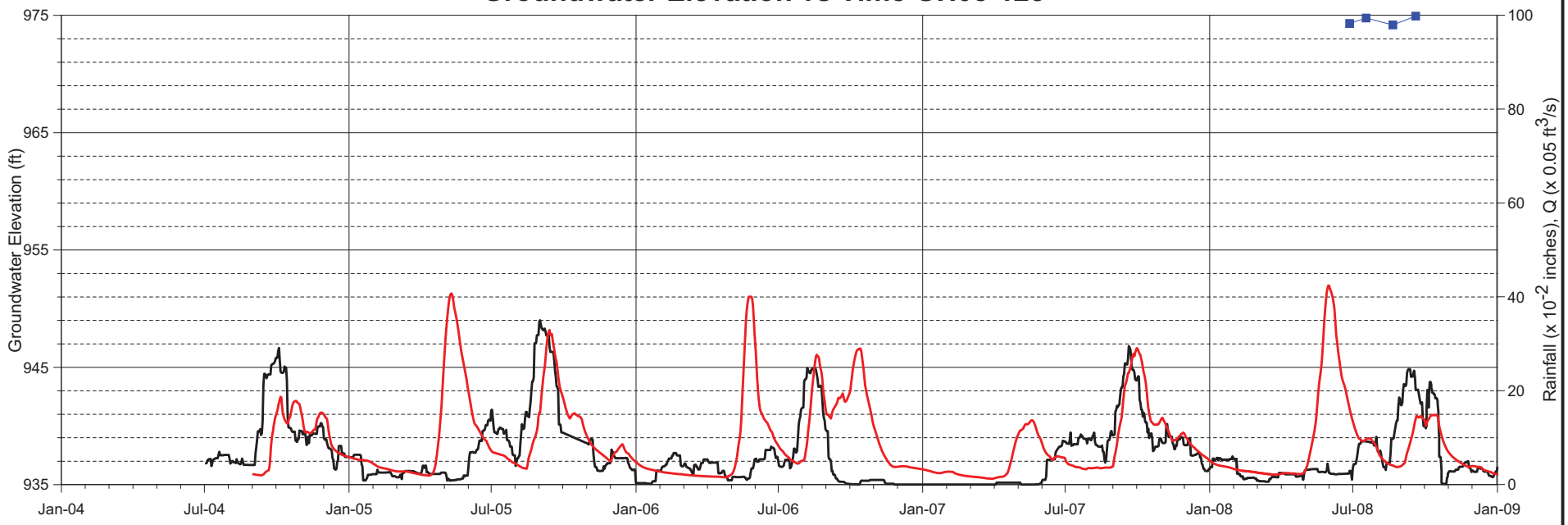


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-125



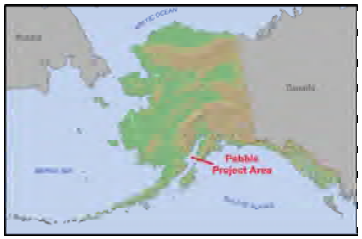
LEGEND:

Groundwater Elevation Plot Legend

- GH08-125
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

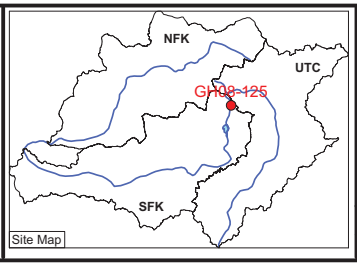
Screens (ft asl):
GH08-125 : 871.8 - 881.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 976.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-125.grf

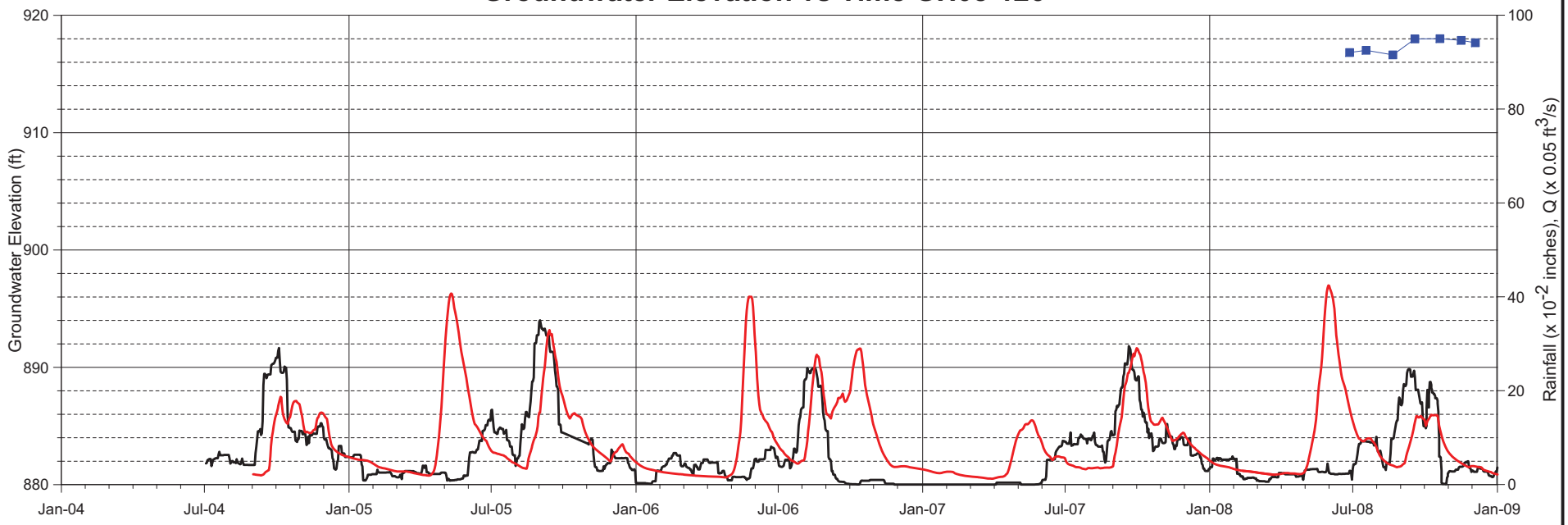


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-126



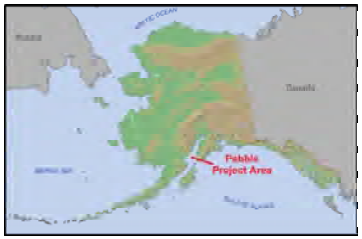
LEGEND:

Groundwater Elevation Plot Legend

- GH08-126
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

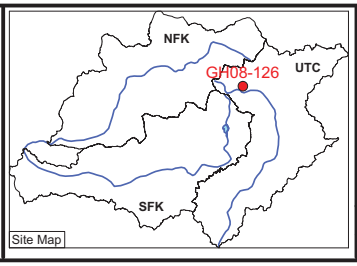
Screens (ft asl):
GH08-126 : 885.8 - 895.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 920.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-126.grf

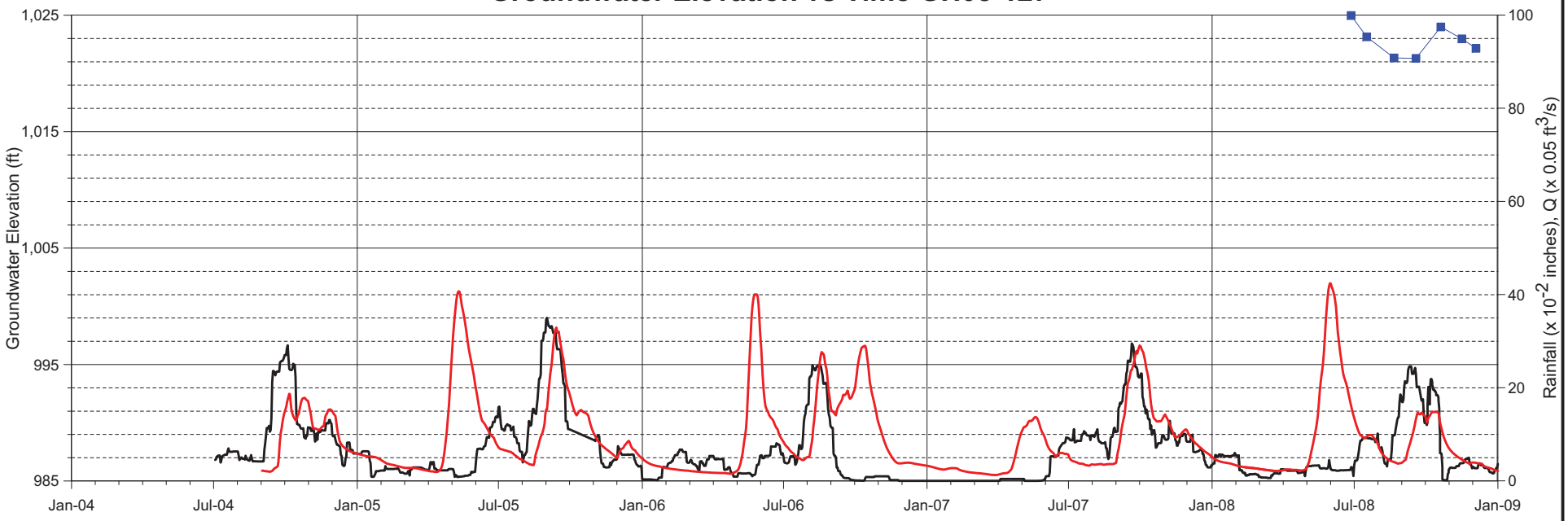


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-127



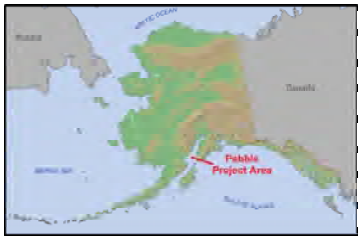
LEGEND:

Groundwater Elevation Plot Legend

- GH08-127
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

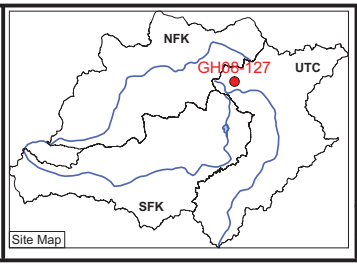
Screens (ft asl):
GH08-127 : 944.3 - 954.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1064.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-127.grf

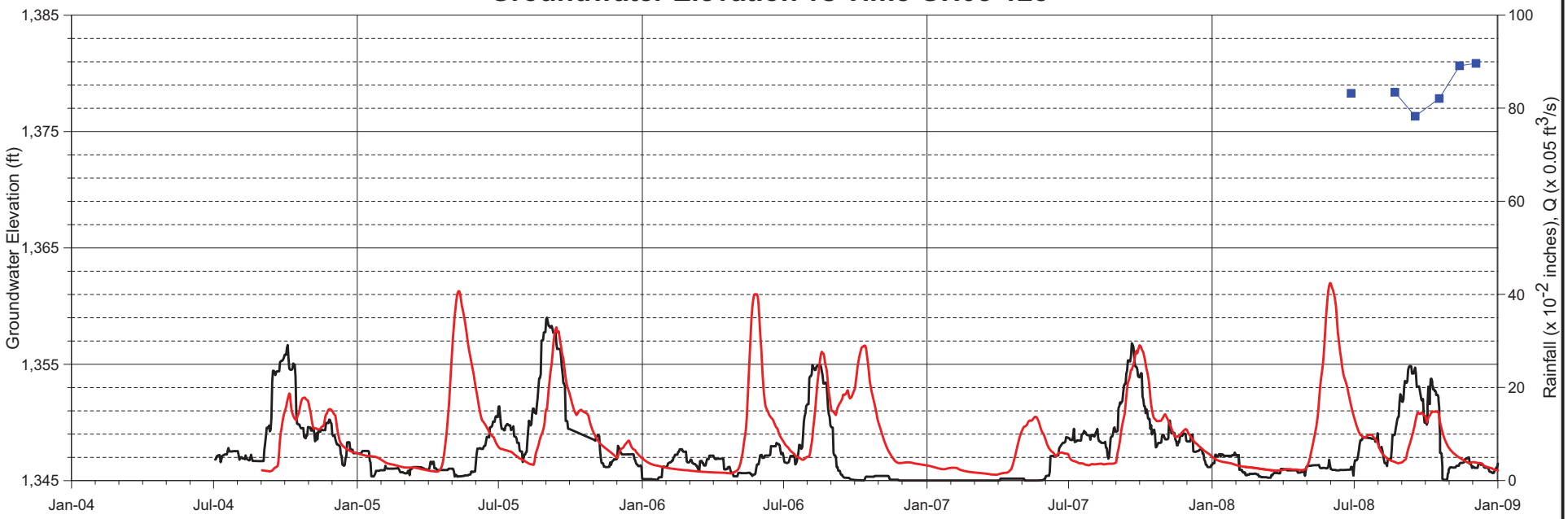


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-128



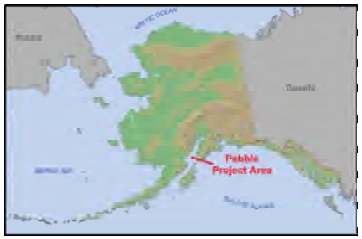
LEGEND:

Groundwater Elevation Plot Legend

- GH08-128
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

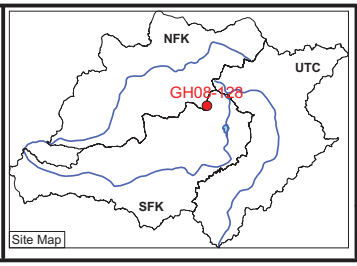
Screens (ft asl):
GH08-128 : 1353.9 - 1363.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1458.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-128.grf

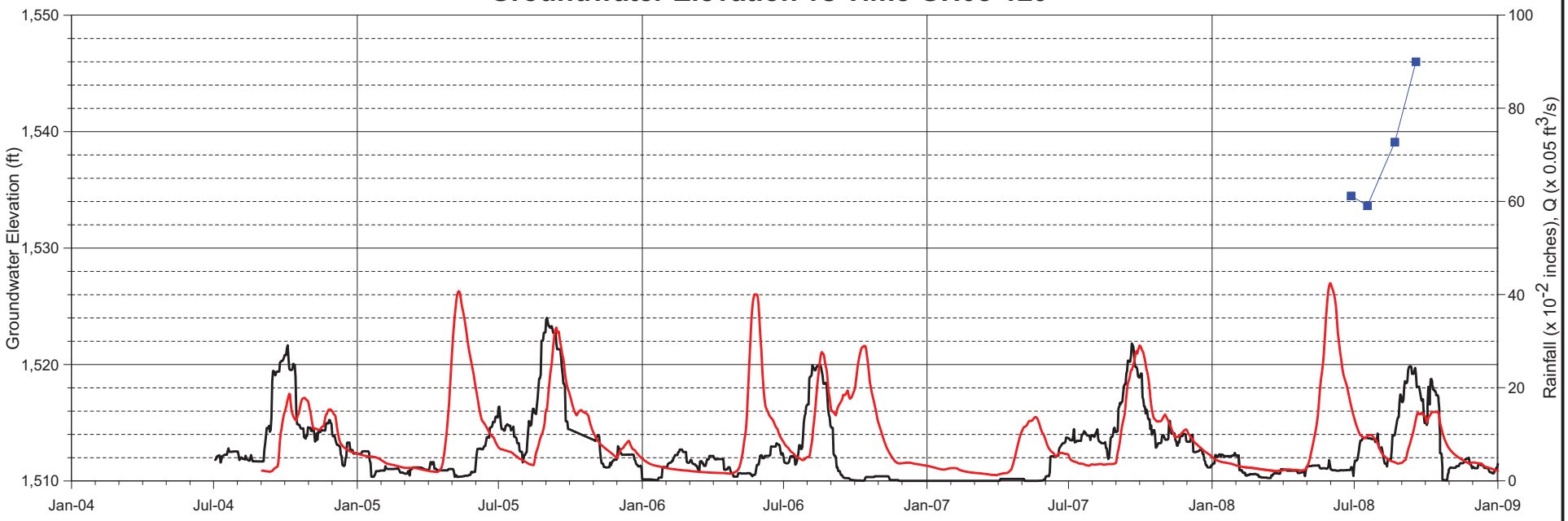


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-129



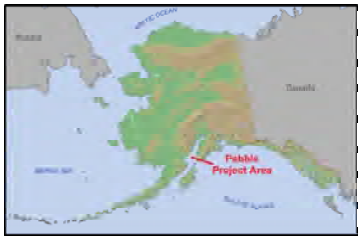
LEGEND:

Groundwater Elevation Plot Legend

- GH08-129
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

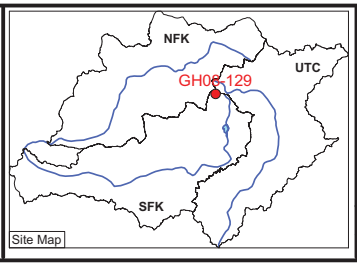
Screens (ft asl):
GH08-129 : 1500.0 - 1510.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1545 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-129.grf

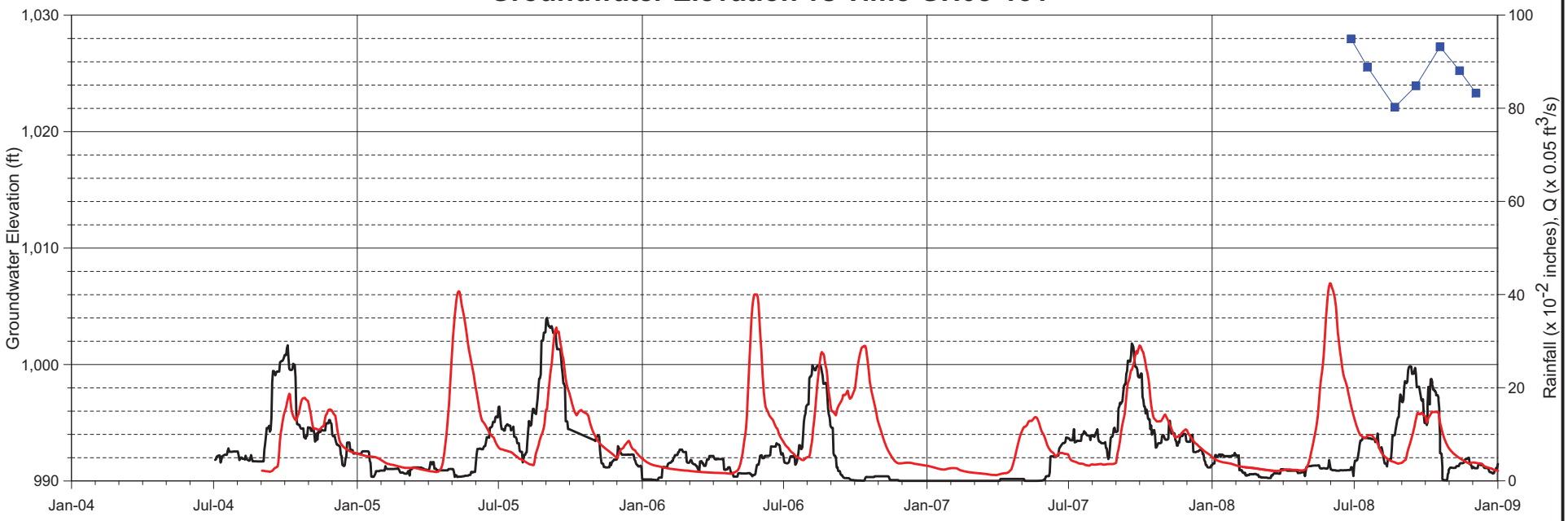


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-131



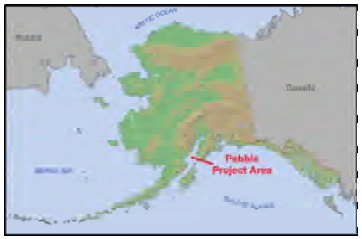
LEGEND:

Groundwater Elevation Plot Legend

- GH08-131
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

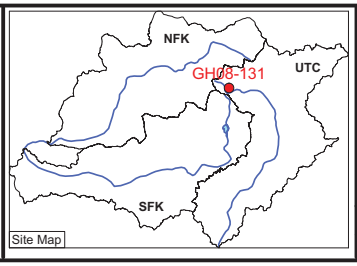
Screens (ft asl):
GH08-131 : 986.3 - 996.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1056.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-131.grf

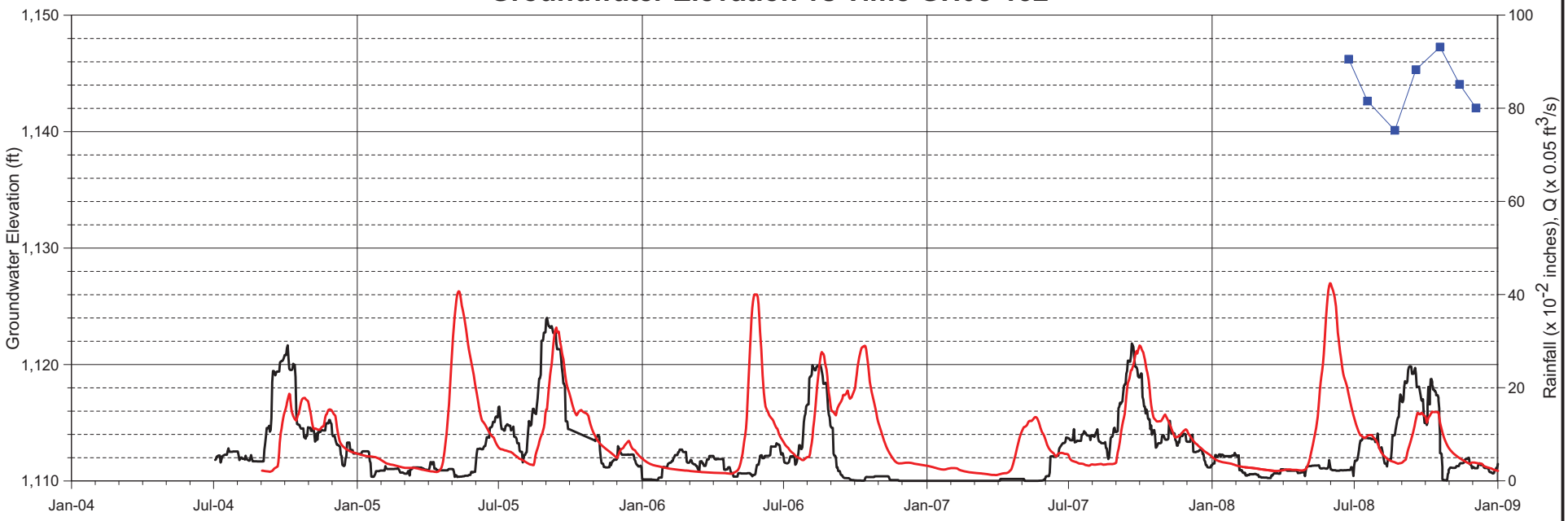


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-132



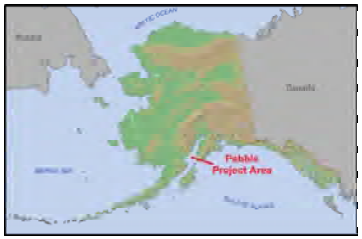
LEGEND:

Groundwater Elevation Plot Legend

- GH08-132
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

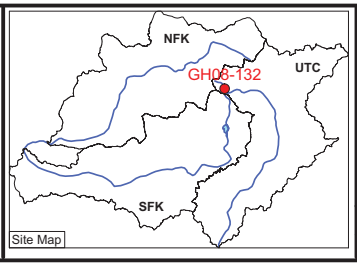
Screens (ft asl):
GH08-132 : 1115.6 - 1126.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1156.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-132.grf

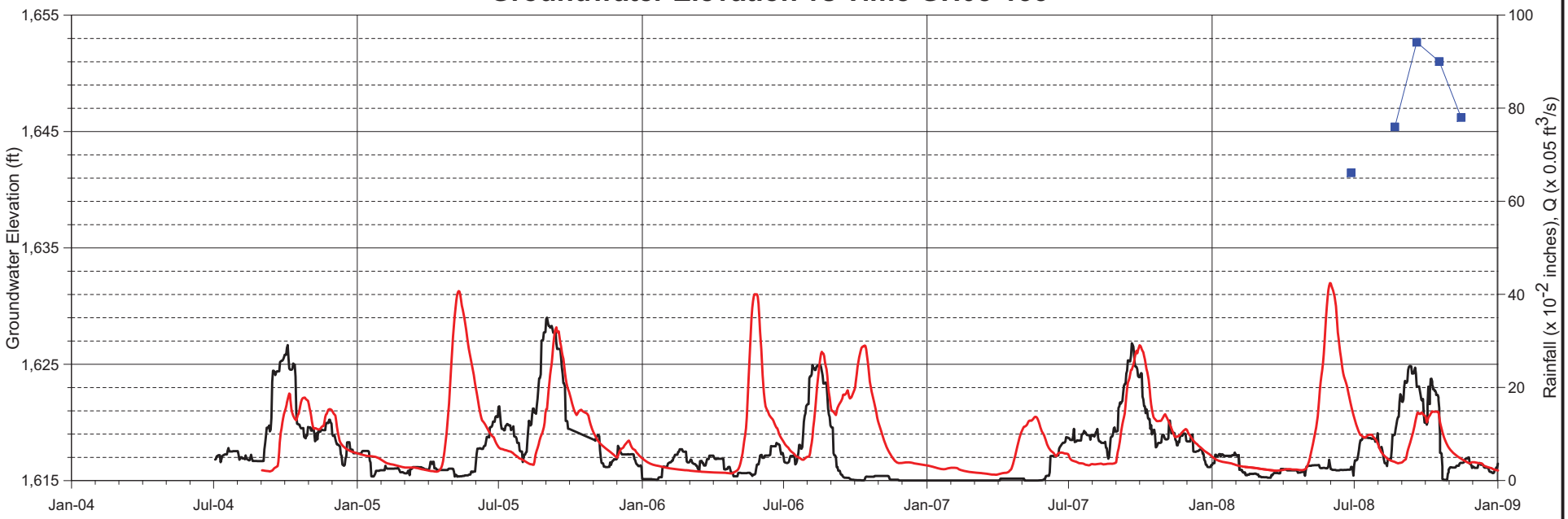


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-133



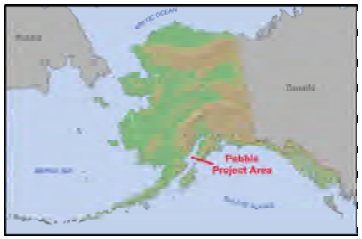
LEGEND:

Groundwater Elevation Plot Legend

- GH08-133
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

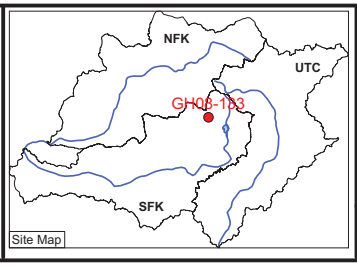
Screens (ft asl):
GH08-133 : 1638.9 - 1648.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1663.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-133.grf

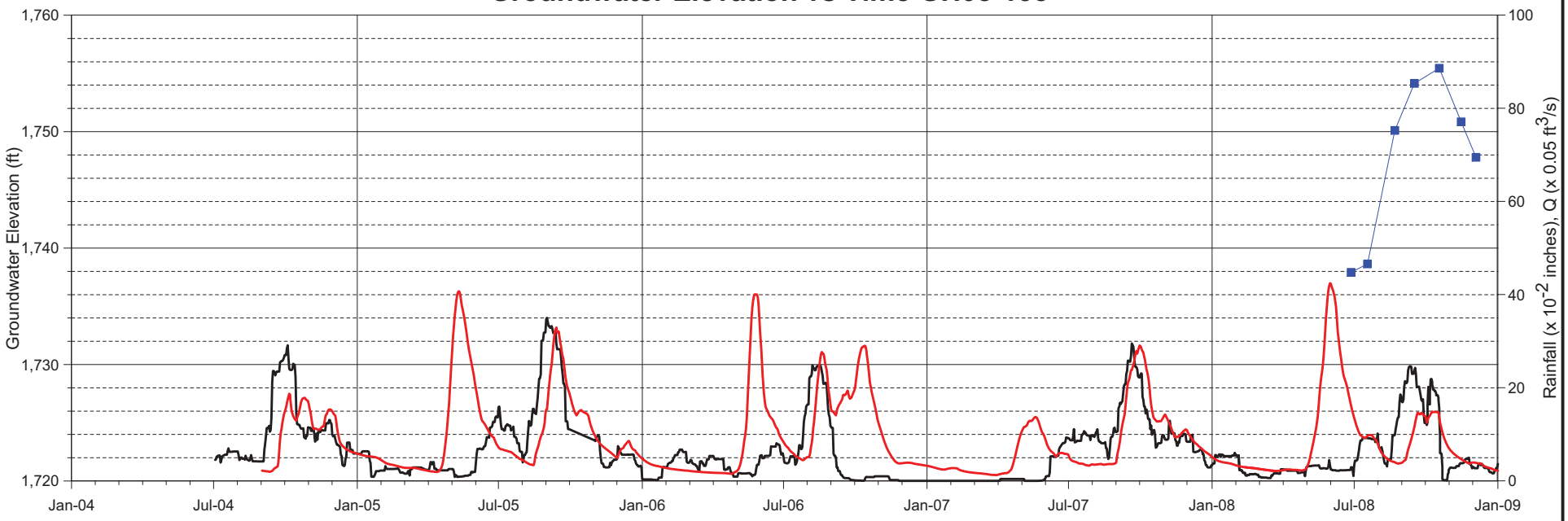


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-135



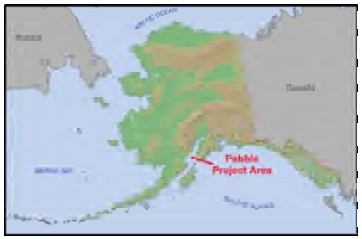
LEGEND:

Groundwater Elevation Plot Legend

- GH08-135
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

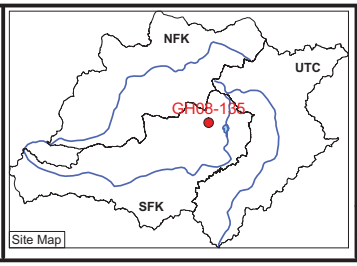
Screens (ft asl):
GH08-135 : 1661.8 - 1671.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1761.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-135.grf

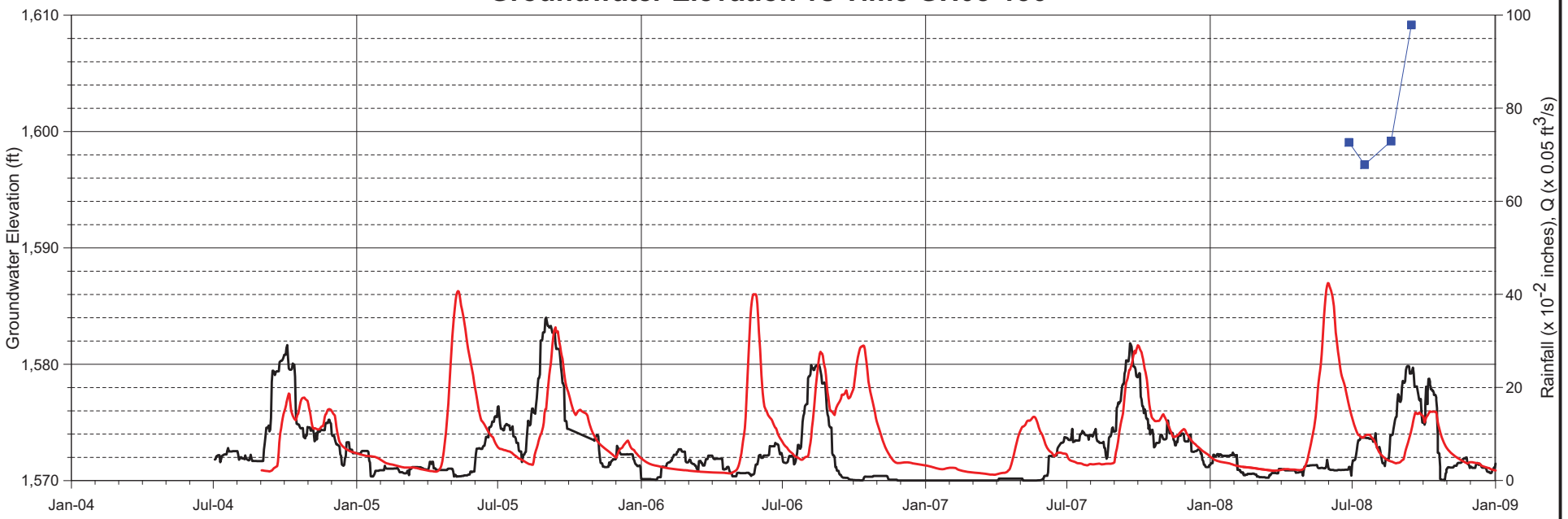


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-136



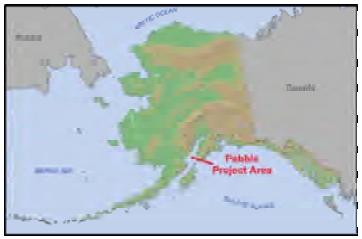
LEGEND:

Groundwater Elevation Plot Legend

- GH08-136
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

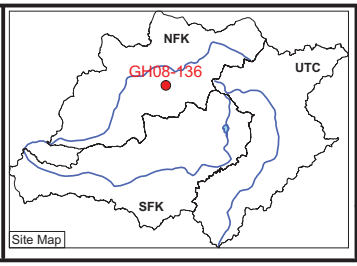
Screens (ft asl):
GH08-136 : 1500.2 - 1510.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1610.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-136.grf

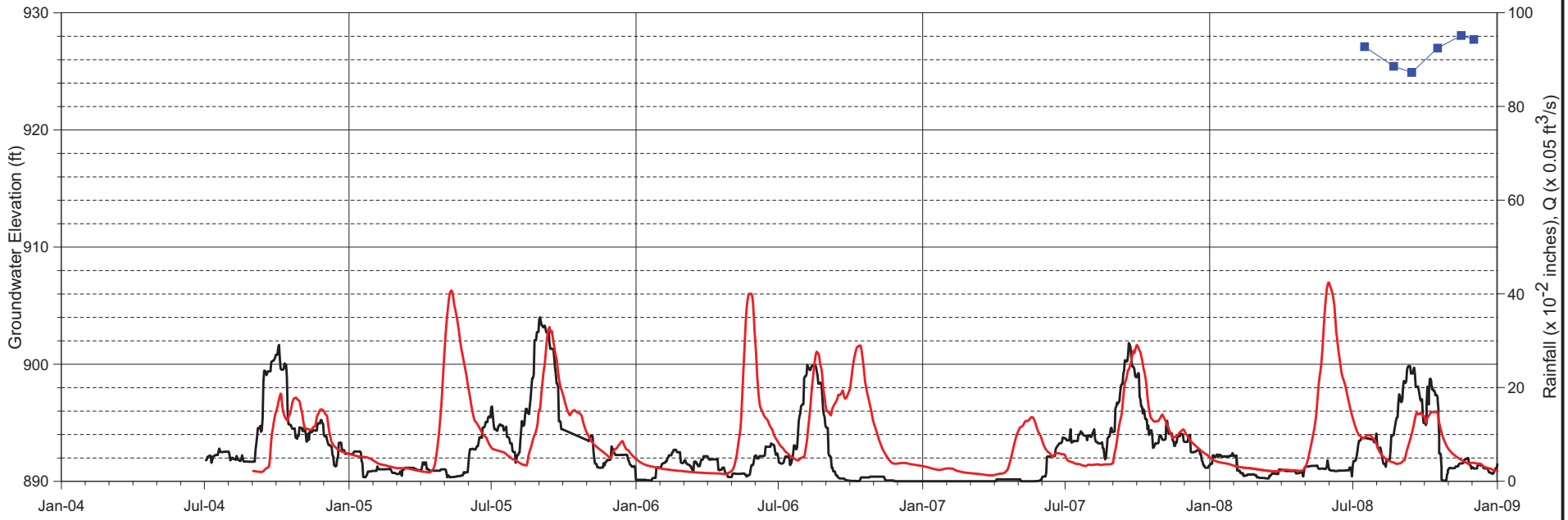


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-137



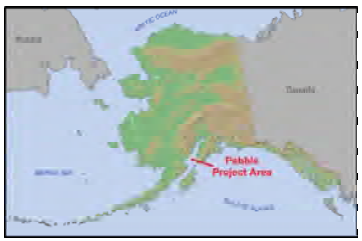
LEGEND:

Groundwater Elevation Plot Legend

- GH08-137
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

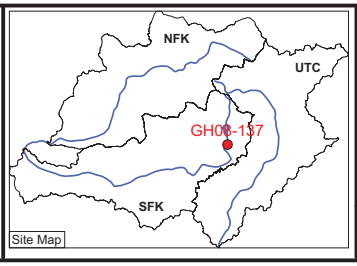
Screens (ft asl):
GH08-137 : 900.1 - 910.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1038.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-137.grf

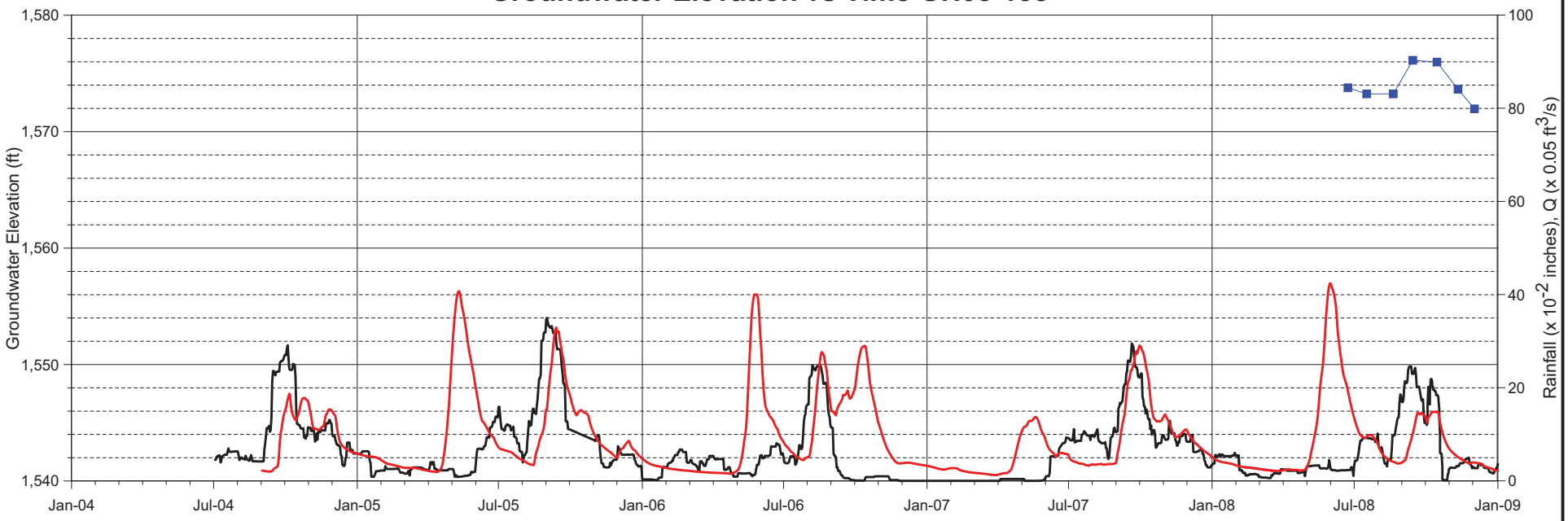


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-138



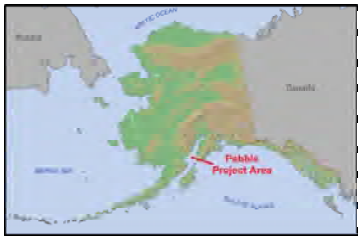
LEGEND:

Groundwater Elevation Plot Legend

- GH08-138
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

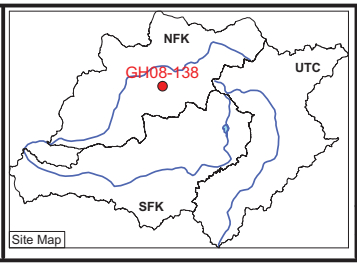
Screens (ft asl):
GH08-138 : 1417.2 - 1437.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1577.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-138.grf

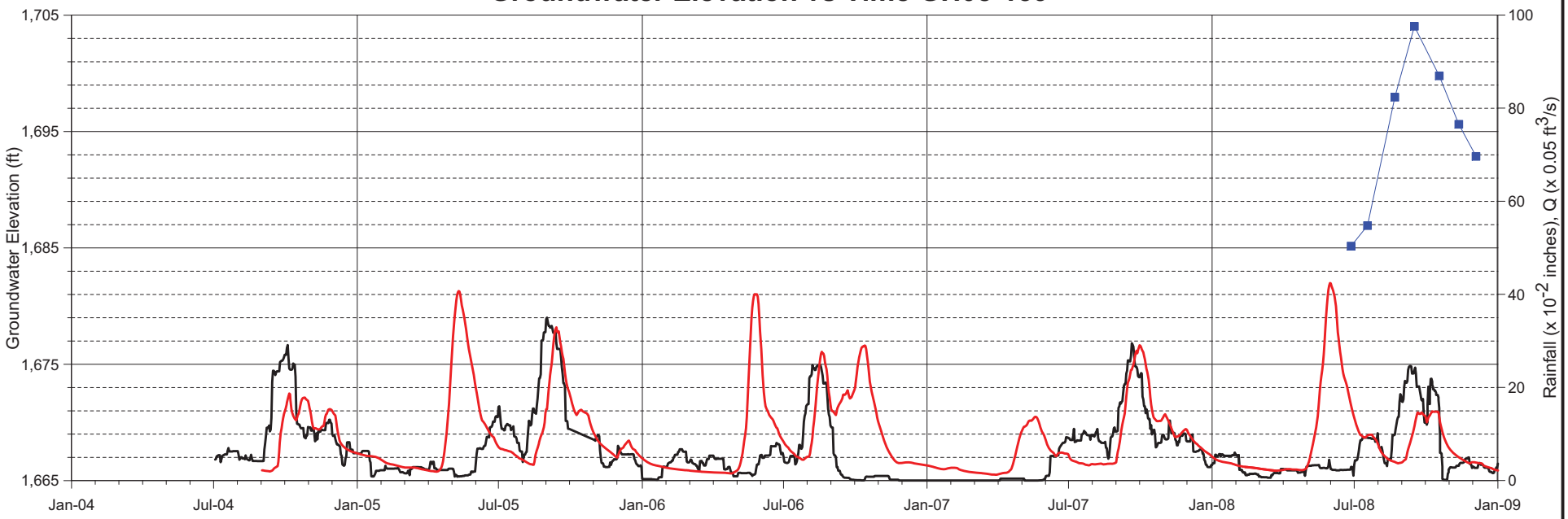


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-139



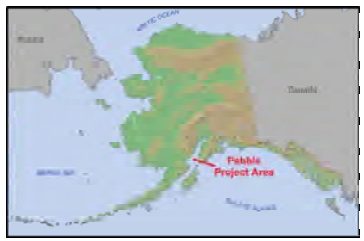
LEGEND:

Groundwater Elevation Plot Legend

- GH08-139
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

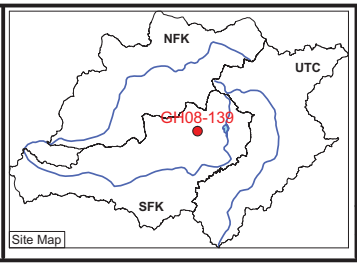
Screens (ft asl):
GH08-139 : 1595.8 - 1605.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1710.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-139.grf

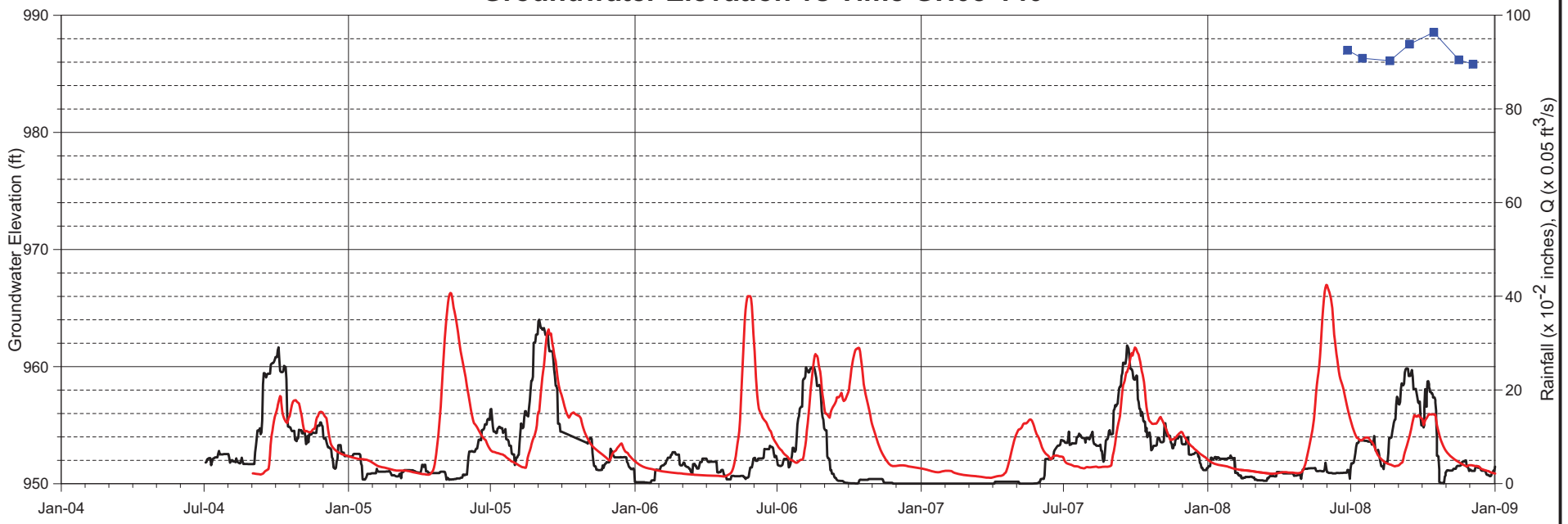


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-140



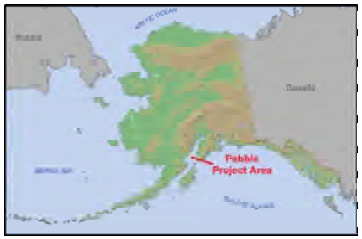
LEGEND:

Groundwater Elevation Plot Legend

- GH08-140
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

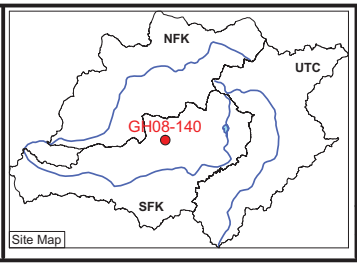
Screens (ft asl):
GH08-140 : 900.7 - 910.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1025.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-140.grf

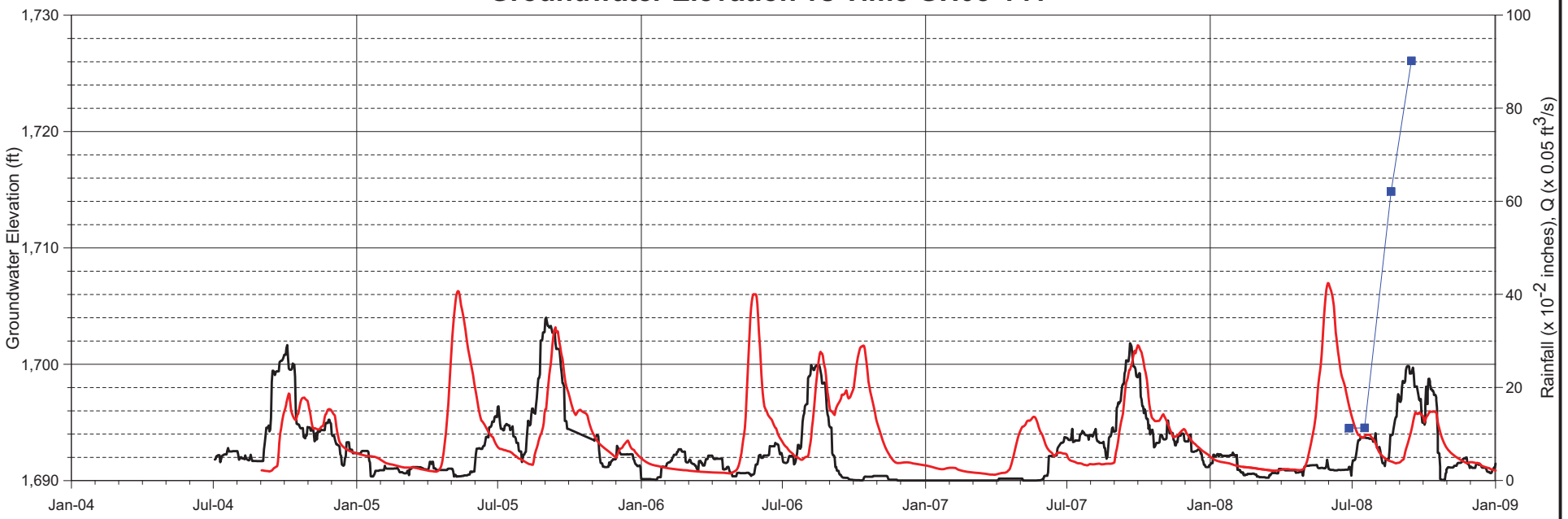


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-141



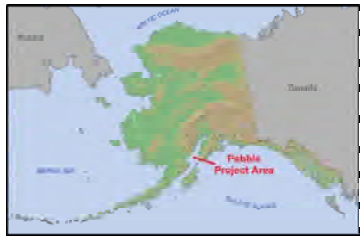
LEGEND:

Groundwater Elevation Plot Legend

- GH08-141
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

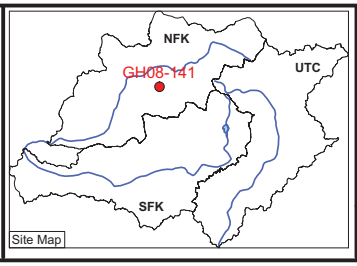
Screens (ft asl):
GH08-141 : 1675.0 - 1685.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1725 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-141.grf

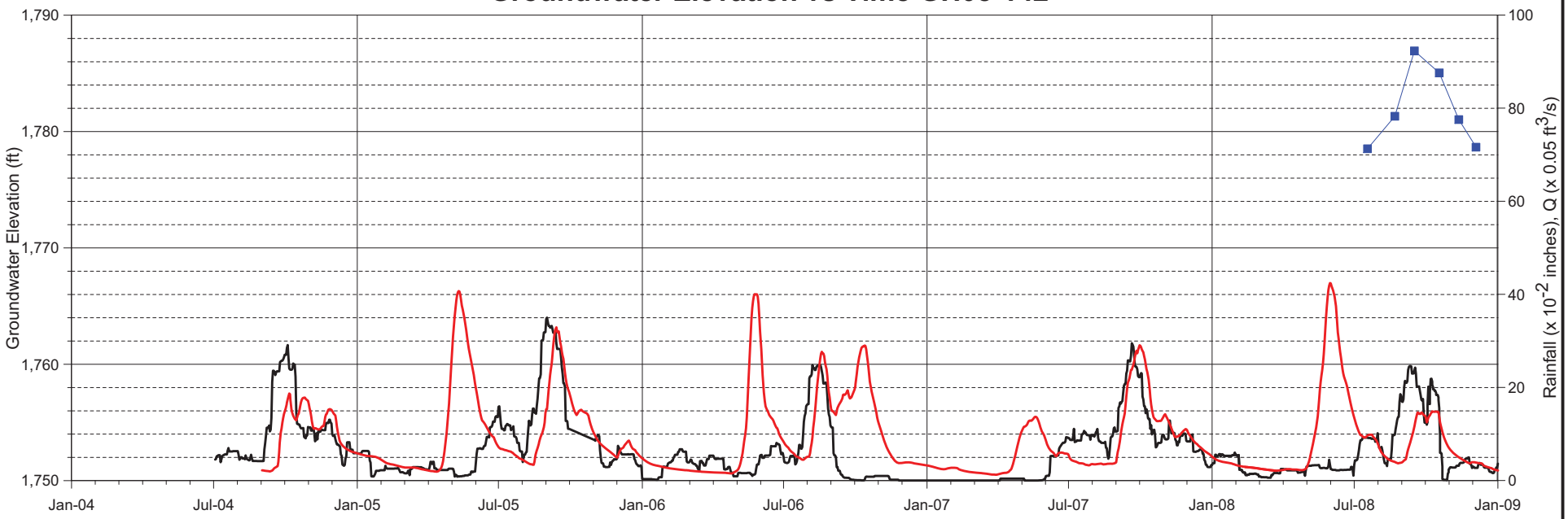


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-142



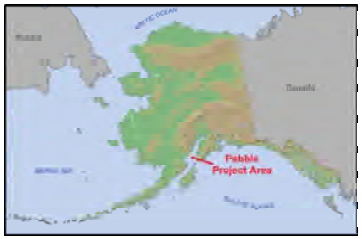
LEGEND:

Groundwater Elevation Plot Legend

- GH08-142
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

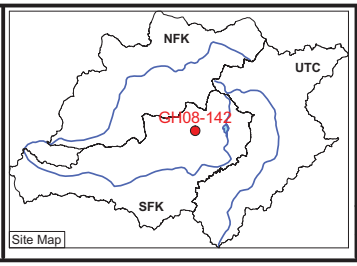
Screens (ft asl):
GH08-142 : 1652.4 - 1662.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1802.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-142.grf

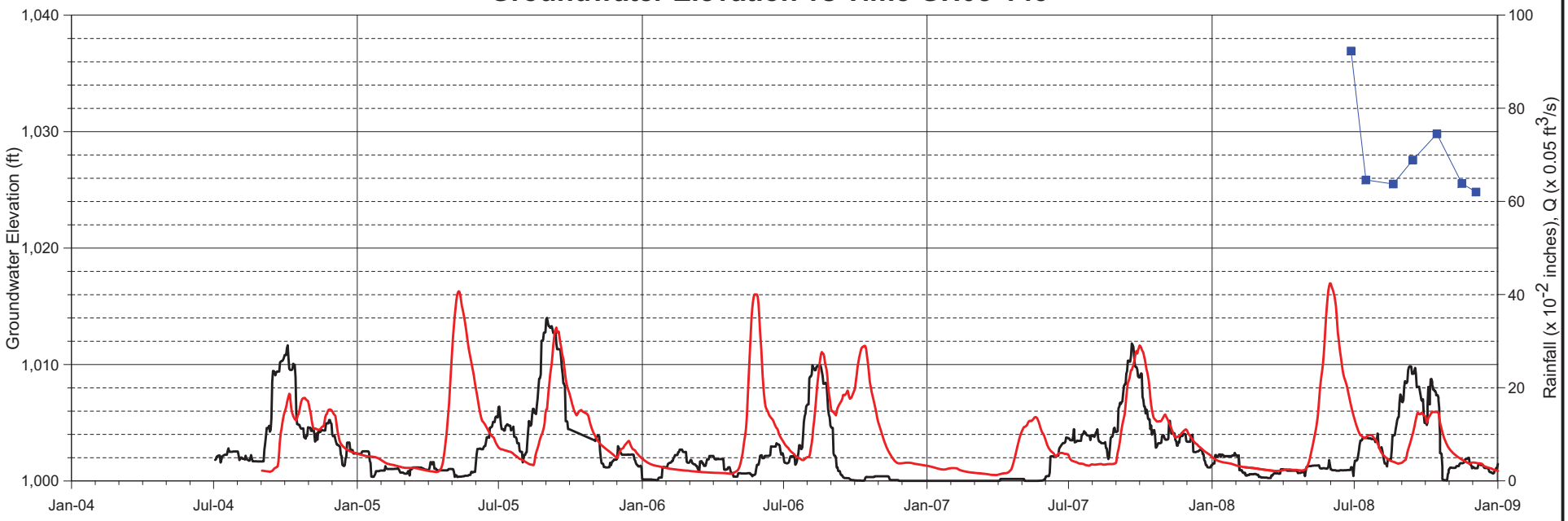


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-143



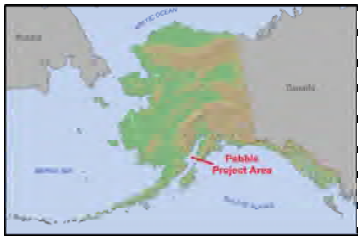
LEGEND:

Groundwater Elevation Plot Legend

- GH08-143
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

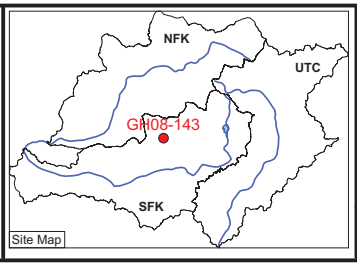
Screens (ft asl):
GH08-143 : 885.7 - 895.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1060.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-143.grf

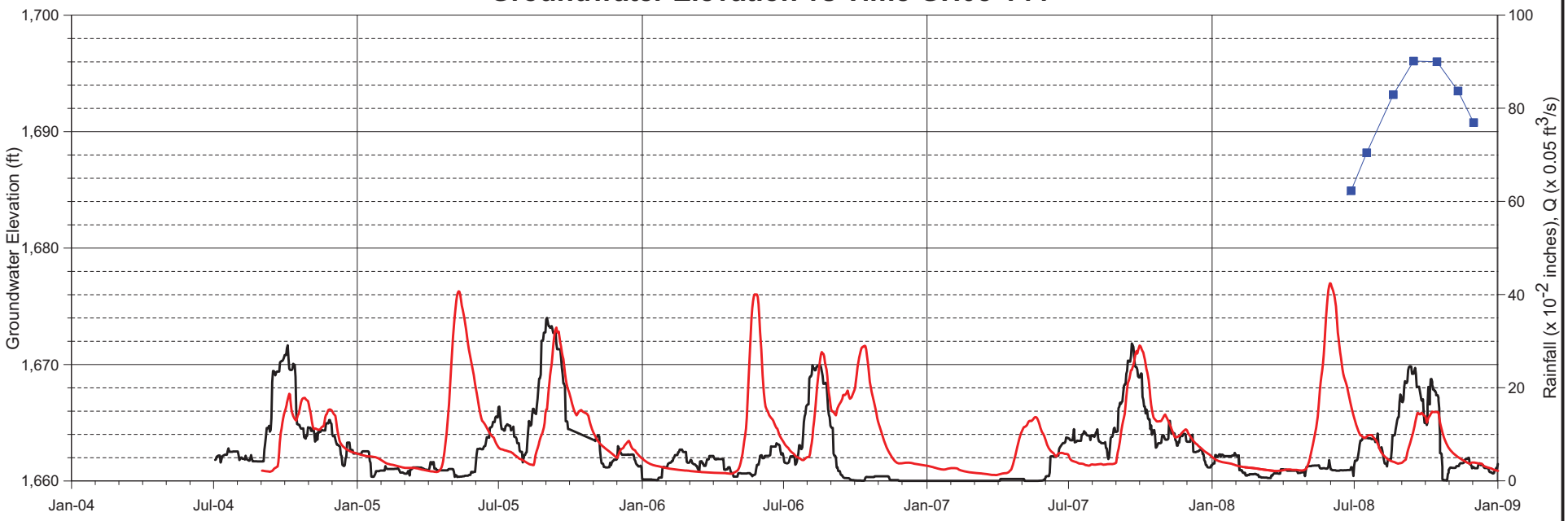


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-144



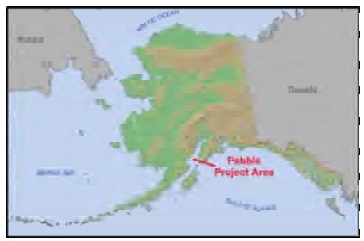
LEGEND:

Groundwater Elevation Plot Legend

- GH08-144
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

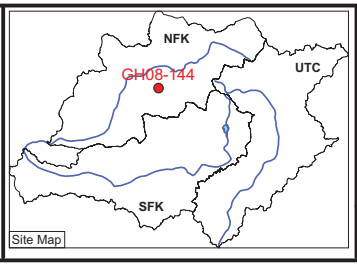
Screens (ft asl):
GH08-144 : 1666.9 - 1676.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1696.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-144.grf

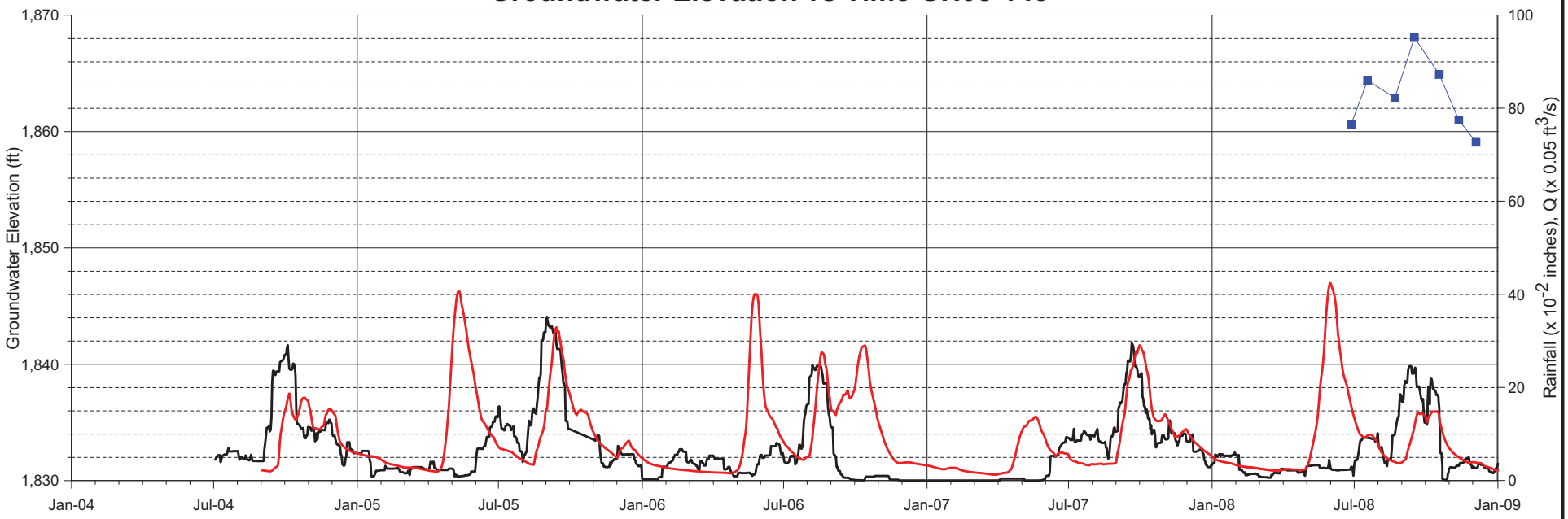


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-145



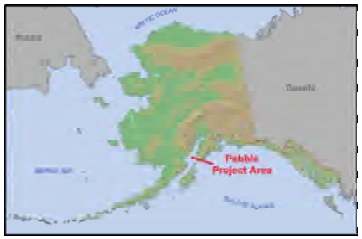
LEGEND:

Groundwater Elevation Plot Legend

- GH08-145
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

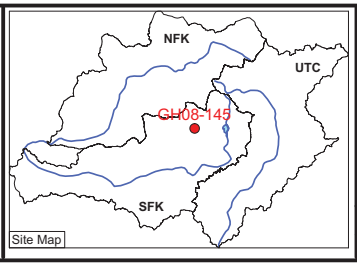
Screens (ft asl):
GH08-145 : 1826.1 - 1836.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1876.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-145.grf

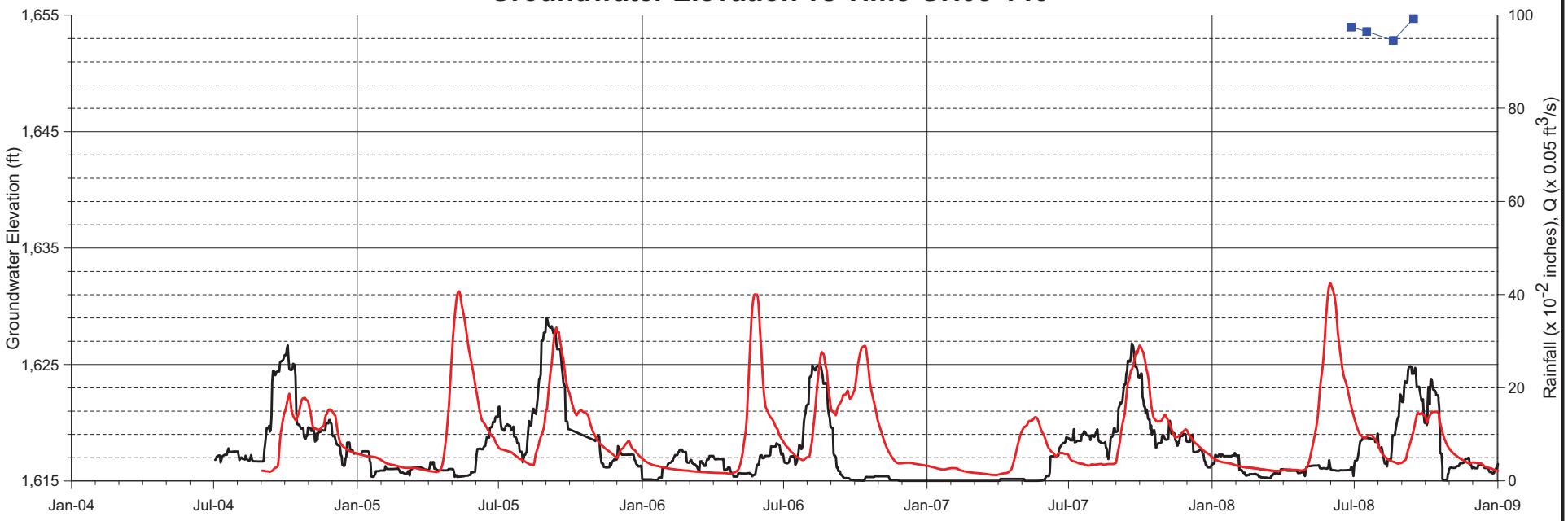


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-146



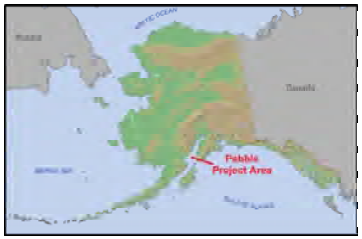
LEGEND:

Groundwater Elevation Plot Legend

- GH08-146
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

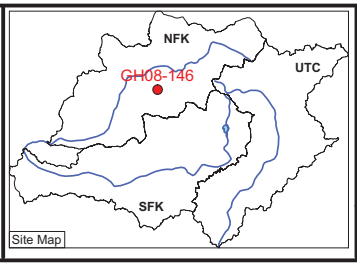
Screens (ft asl):
GH08-146 : 1605.2 - 1615.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1655.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-146.grf

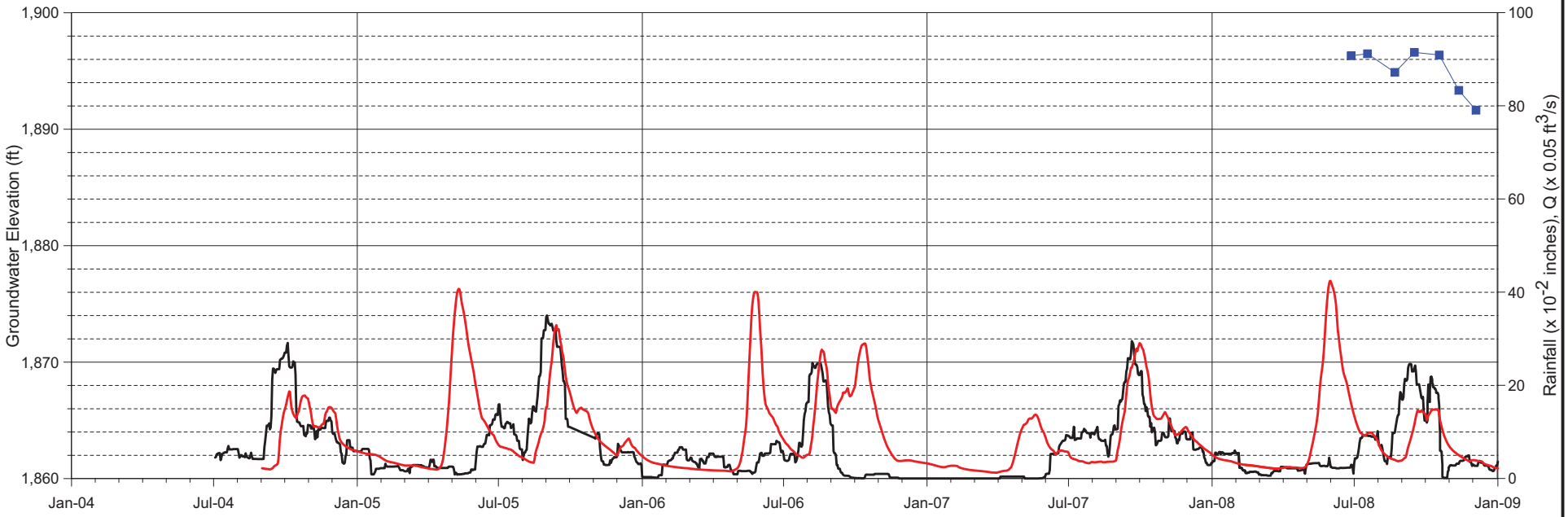


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-147



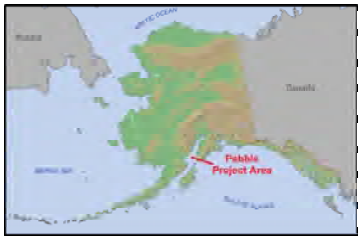
LEGEND:

Groundwater Elevation Plot Legend

- GH08-147
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

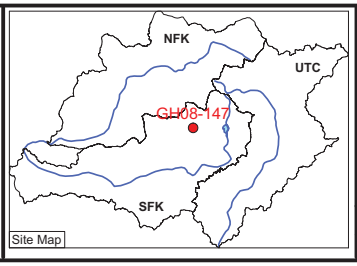
Screens (ft asl):
GH08-147 : 1805.3 - 1815.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1899.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-147.grf

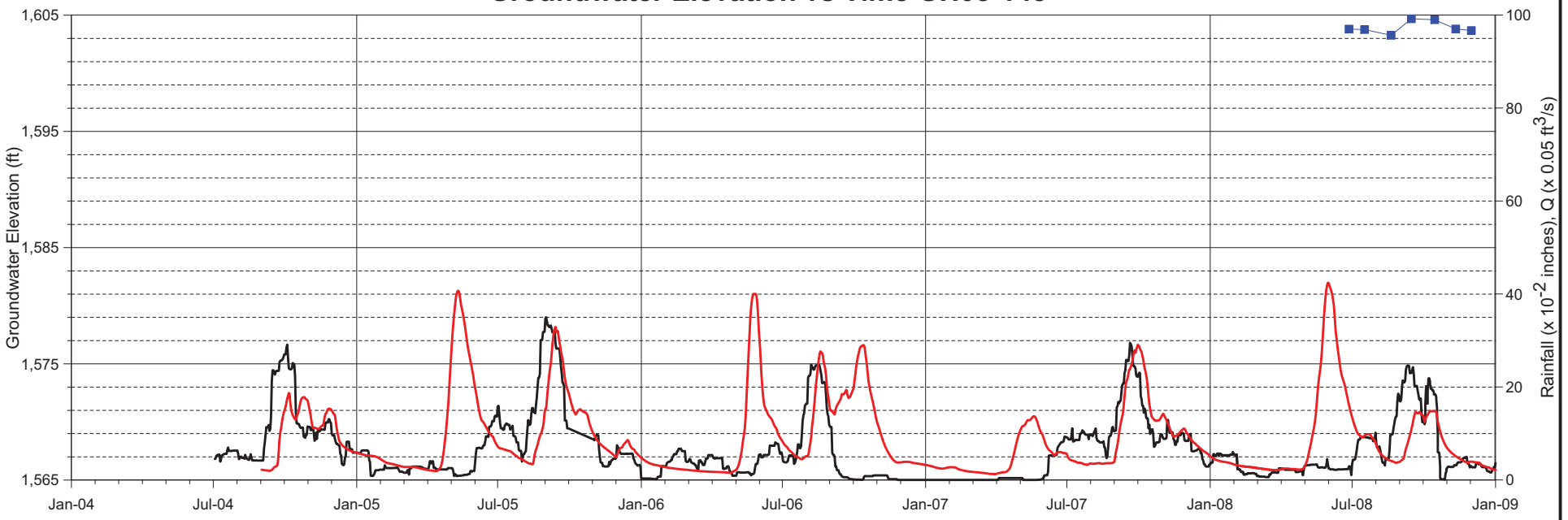


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-148



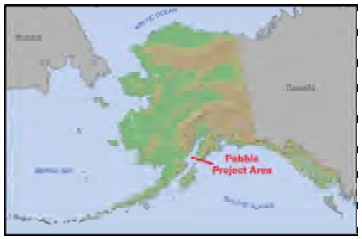
LEGEND:

Groundwater Elevation Plot Legend

- GH08-148
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

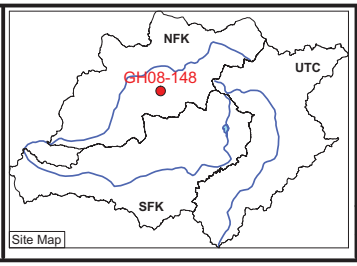
Screens (ft asl):
GH08-148 : 1387.1 - 1407.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1612.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-148.grf

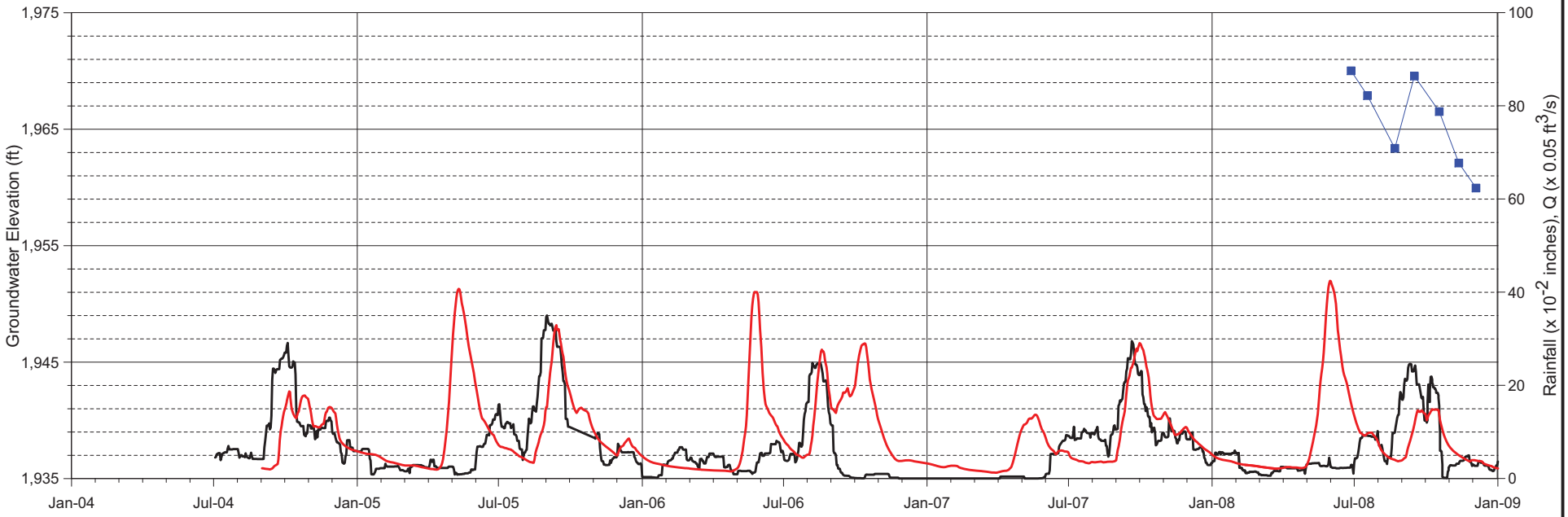


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-149



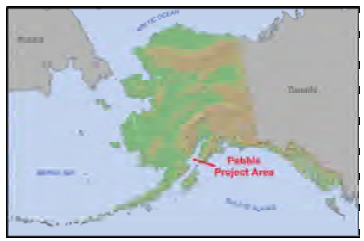
LEGEND:

Groundwater Elevation Plot Legend

- GH08-149
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

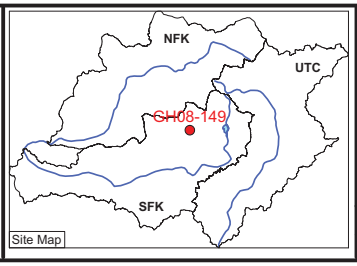
Screens (ft asl):
GH08-149 : 1899.8 - 1909.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1969.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-149.grf

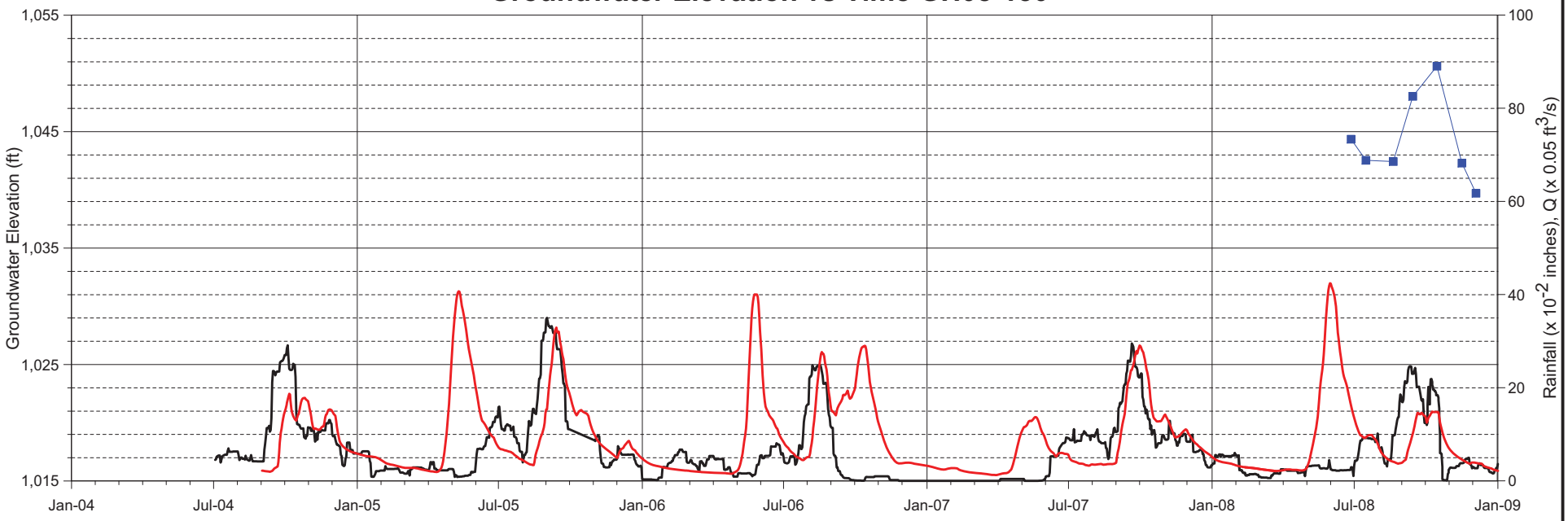


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-150



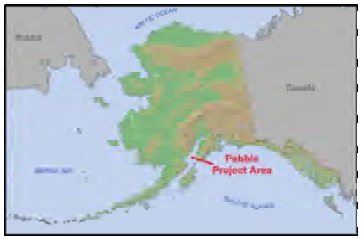
LEGEND:

Groundwater Elevation Plot Legend

- GH08-150
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

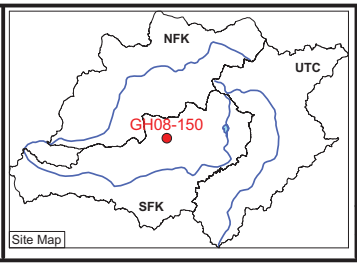
Screens (ft asl):
GH08-150 : 1027.7 - 1037.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1077.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-150.grf

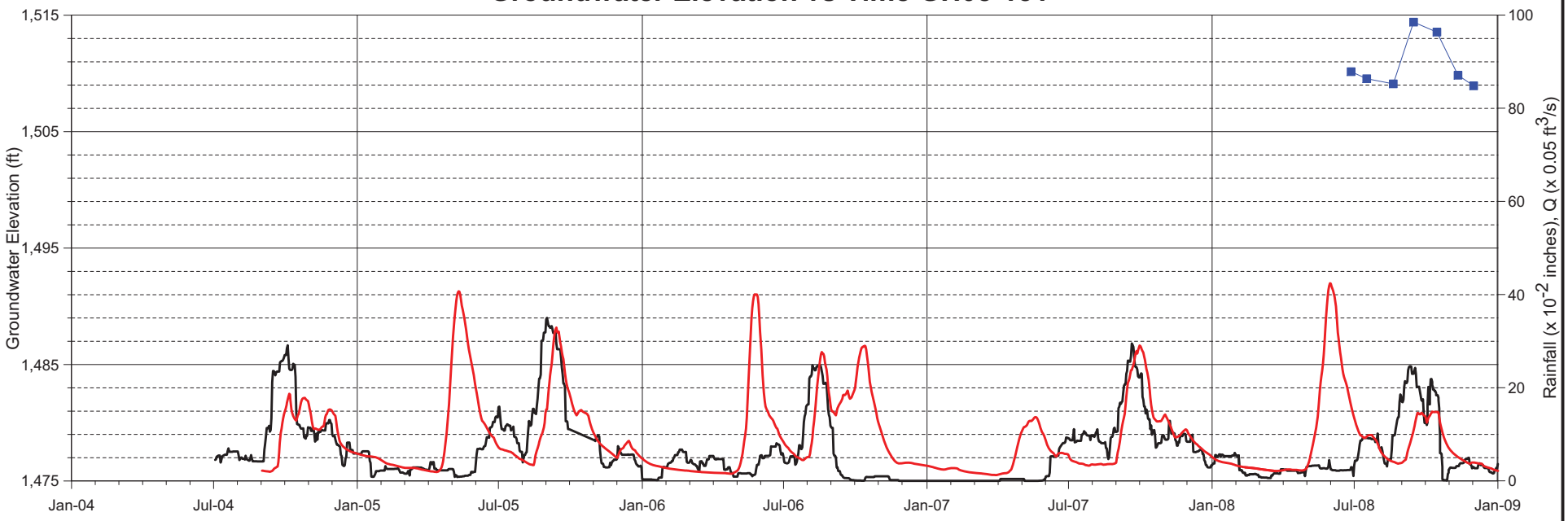


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-151



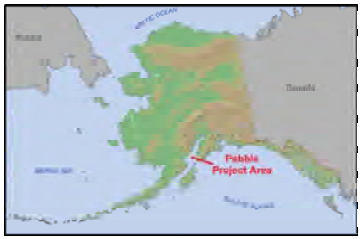
LEGEND:

Groundwater Elevation Plot Legend

- GH08-151
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

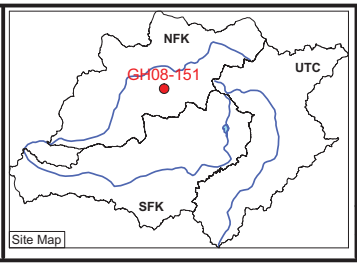
Screens (ft asl):
GH08-151 : 1429.5 - 1439.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1519.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-151.grf

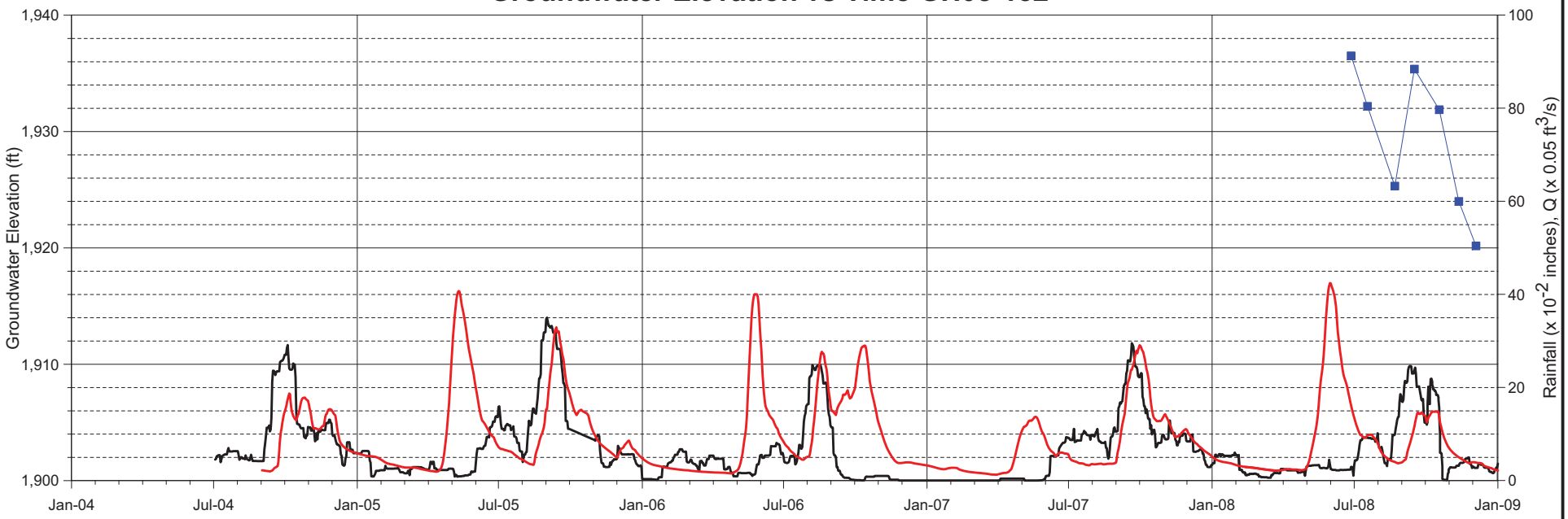


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-152



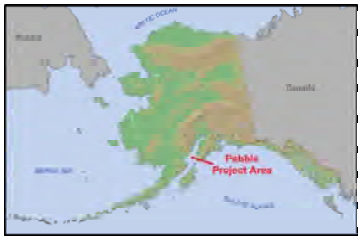
LEGEND:

Groundwater Elevation Plot Legend

- GH08-152
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

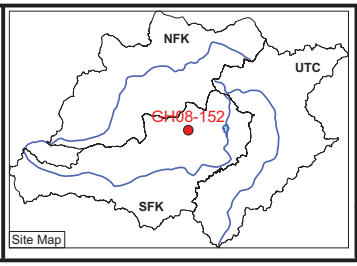
Screens (ft asl):
GH08-152 : 1852.8 - 1862.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1947.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-152.grf

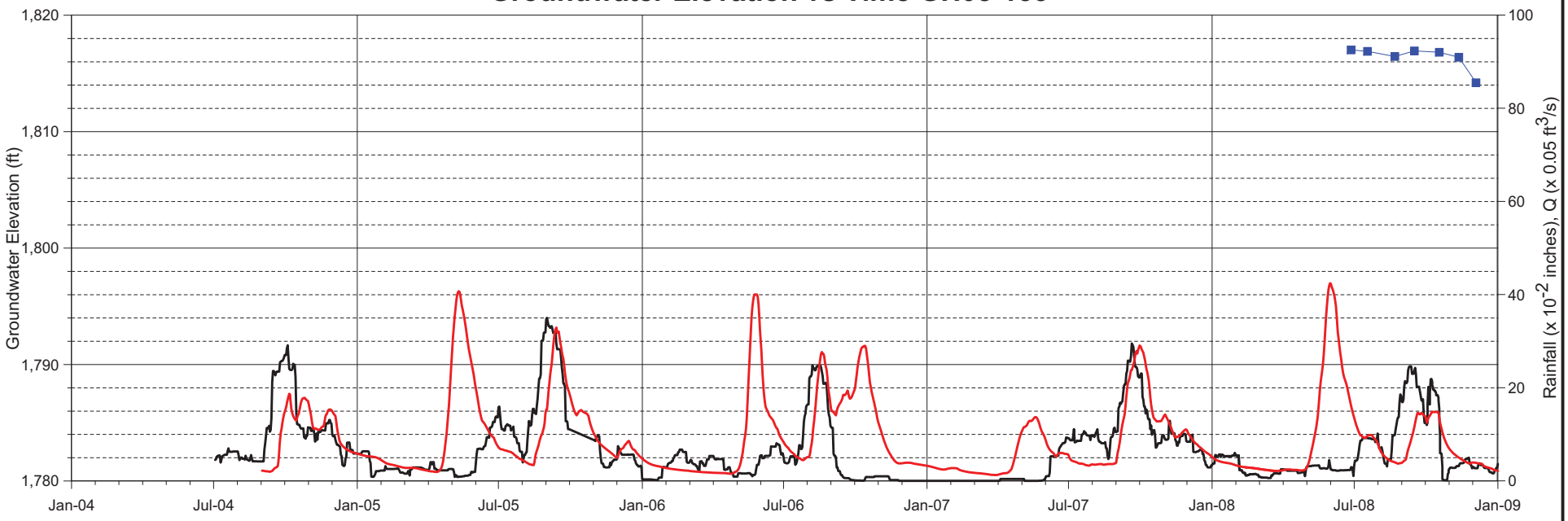


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-153



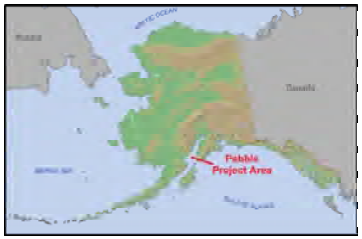
LEGEND:

Groundwater Elevation Plot Legend

- GH08-153
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

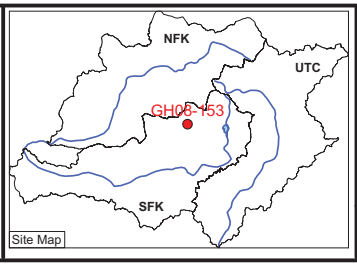
Screens (ft asl):
GH08-153 : 1788.8 - 1798.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1818.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-153.grf

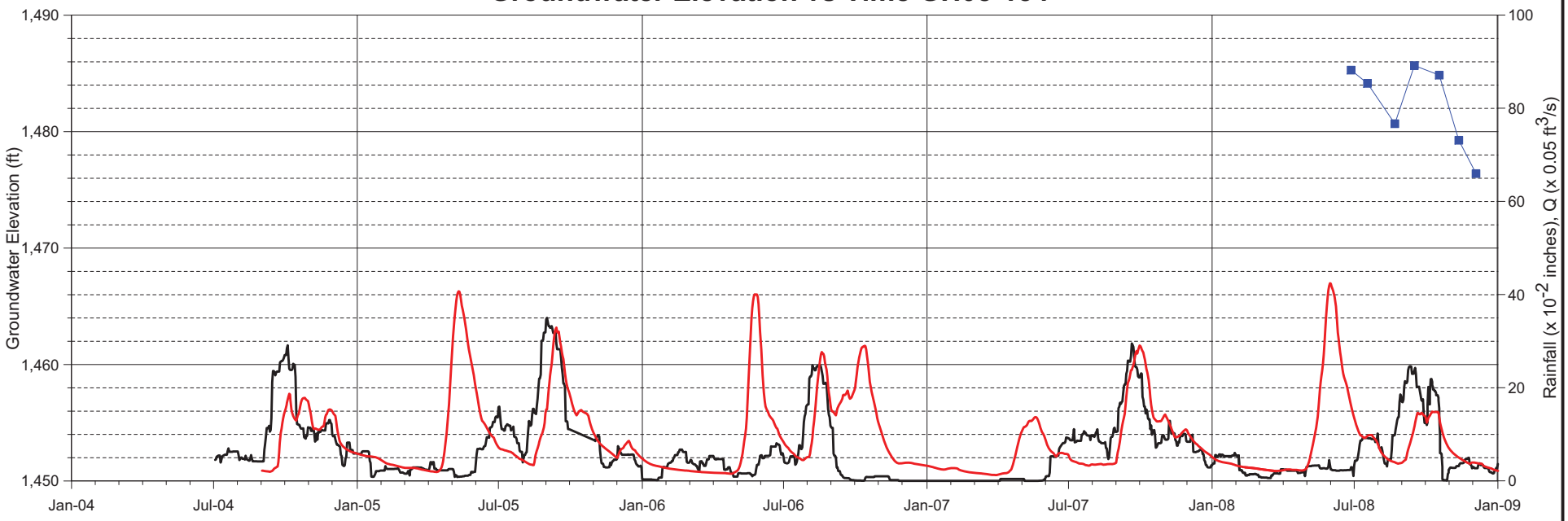


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-154



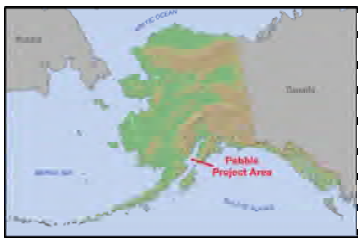
LEGEND:

Groundwater Elevation Plot Legend

- GH08-154
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

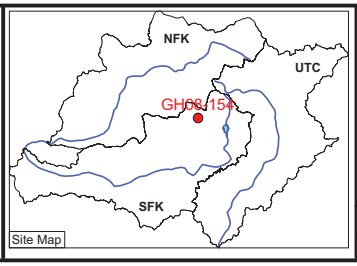
Screens (ft asl):
GH08-154 : 1438.0 - 1448.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1488 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-154.grf

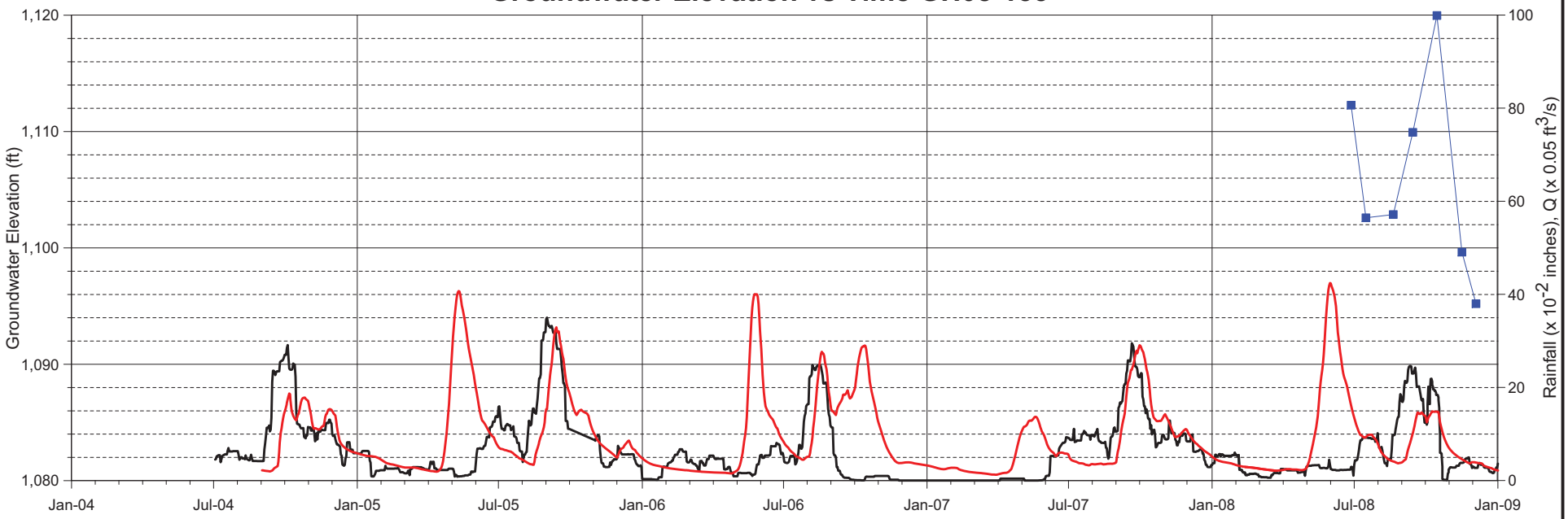


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-155



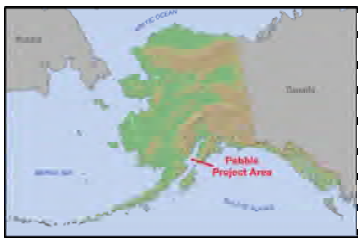
LEGEND:

Groundwater Elevation Plot Legend

- GH08-155
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

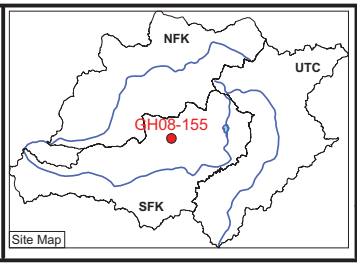
Screens (ft asl):
GH08-155 : 1087.6 - 1107.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1307.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-155.grf

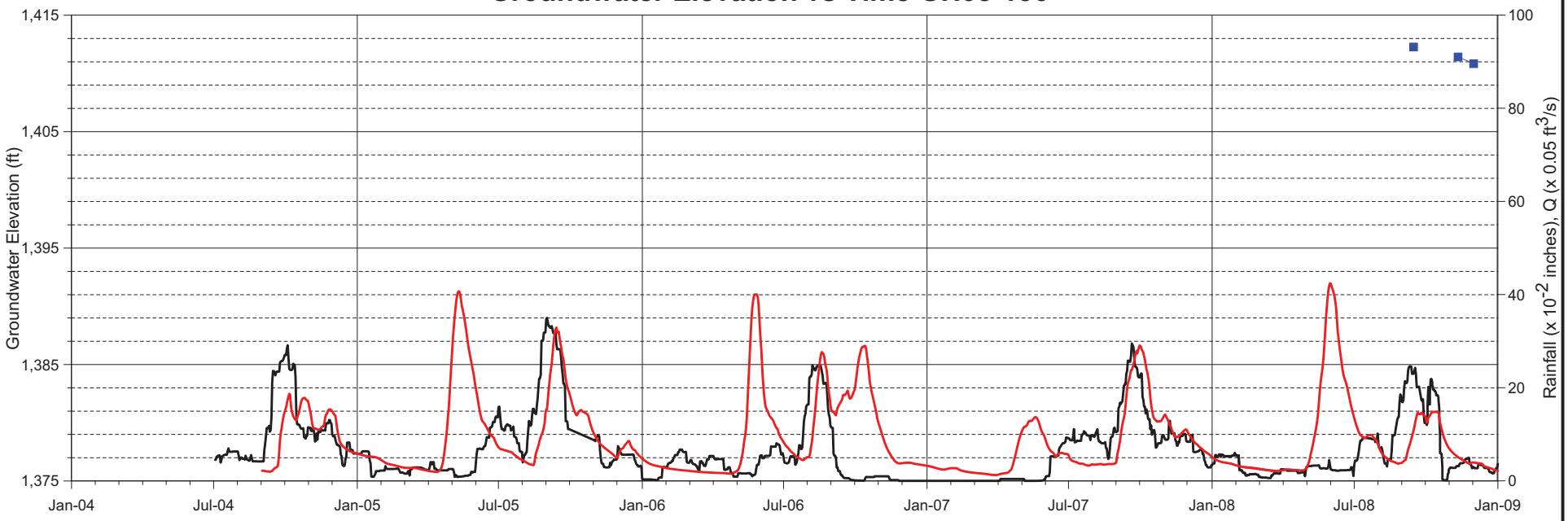


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-156



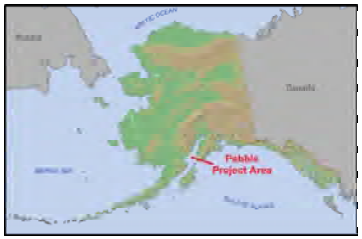
LEGEND:

Groundwater Elevation Plot Legend

- GH08-156
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

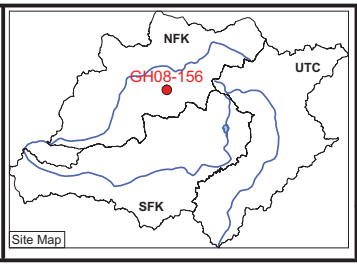
Screens (ft asl):
GH08-156 : 1288.5 - 1298.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1418.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-156.grf

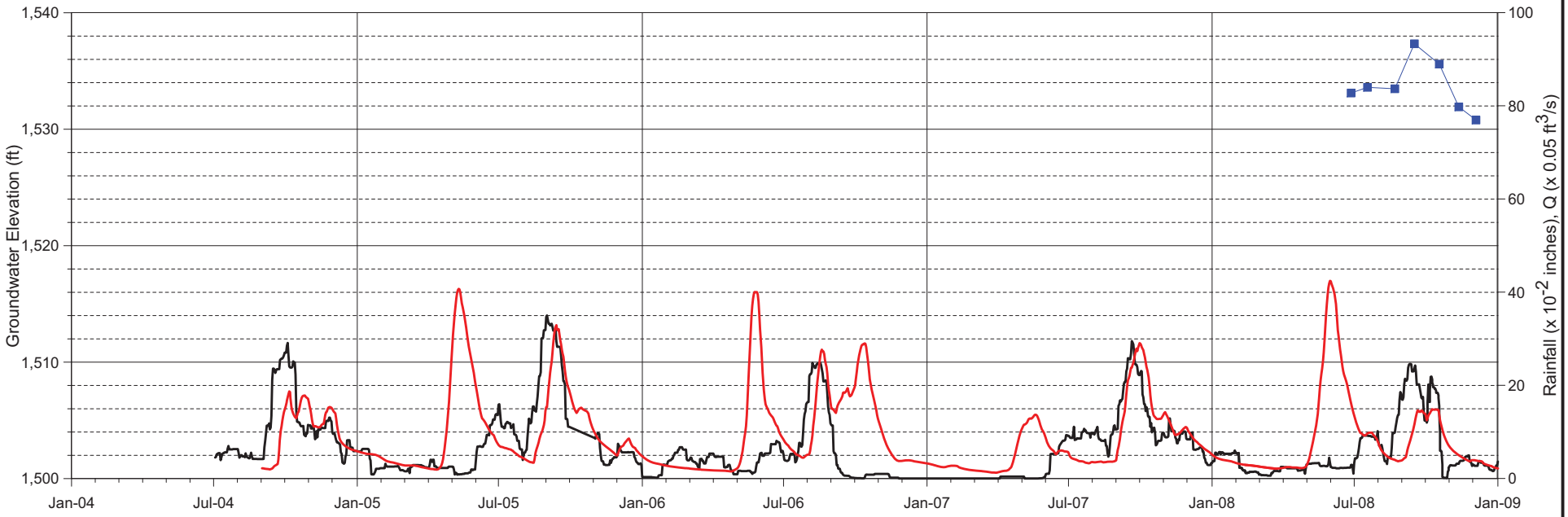


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-157



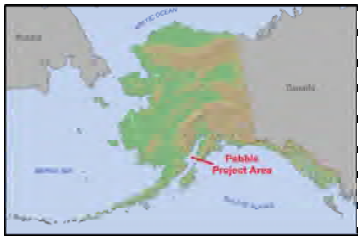
LEGEND:

Groundwater Elevation Plot Legend

- GH08-157
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

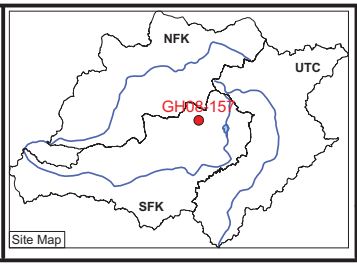
Screens (ft asl):
GH08-157 : 1322.8 - 1332.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1544.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-157.grf

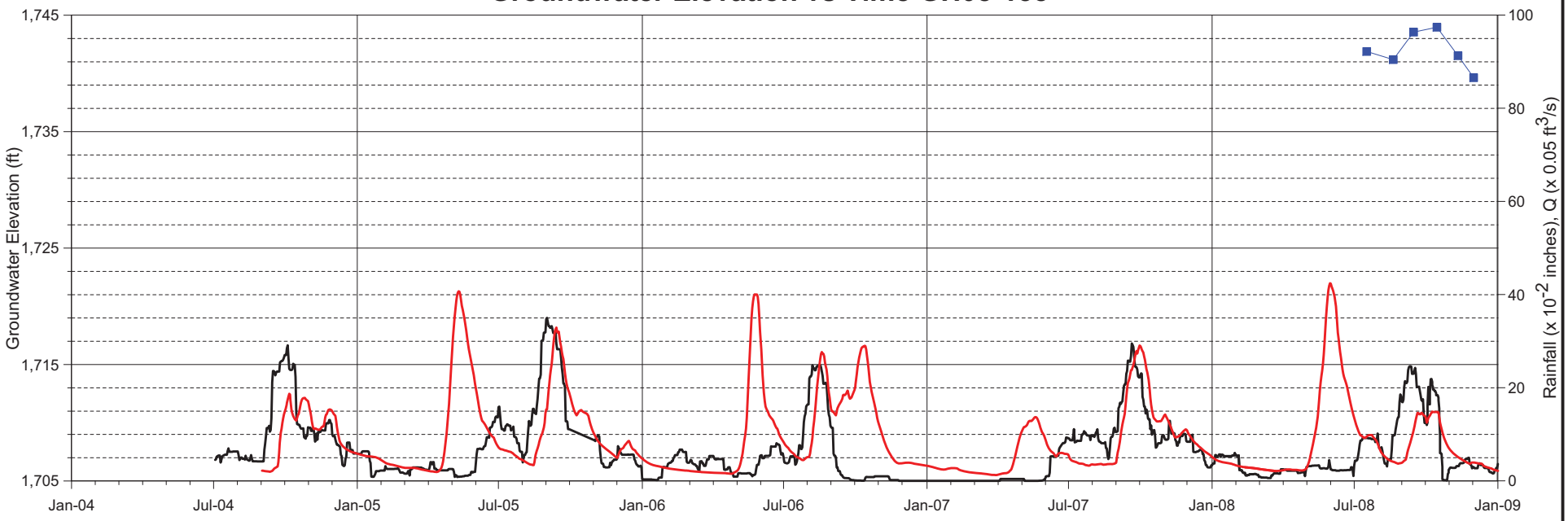


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-158



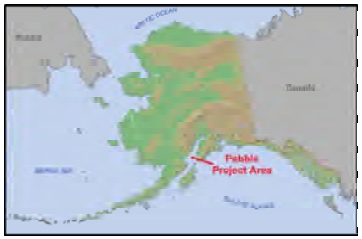
LEGEND:

Groundwater Elevation Plot Legend

- GH08-158
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

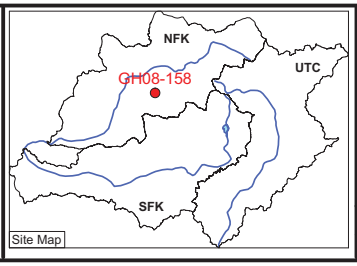
Screens (ft asl):
GH08-158 : 1461.3 - 1471.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1751.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-158.grf

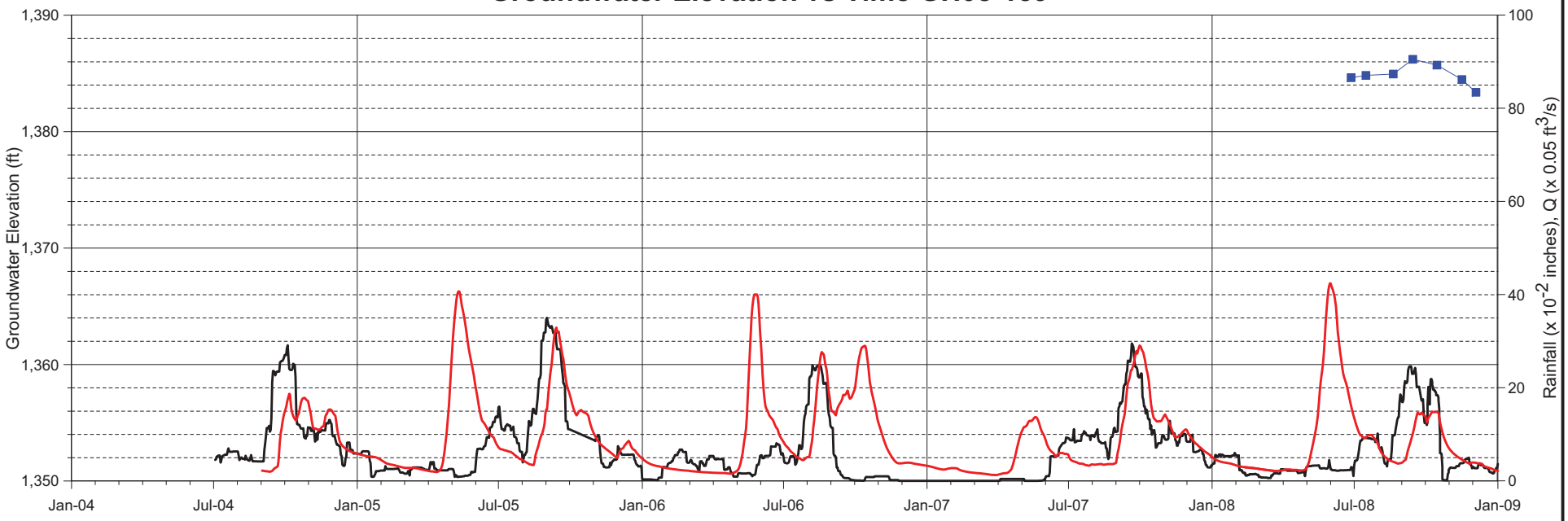


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-159



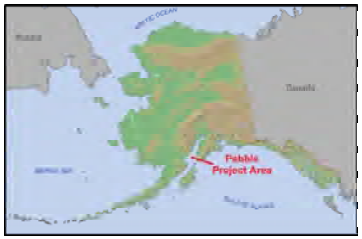
LEGEND:

Groundwater Elevation Plot Legend

- GH08-159
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

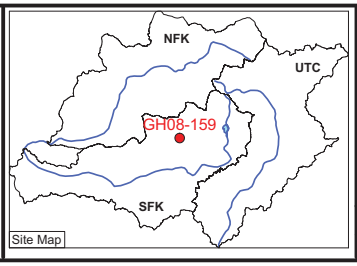
Screens (ft asl):
GH08-159 : 1366.9 - 1376.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1396.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-159.grf

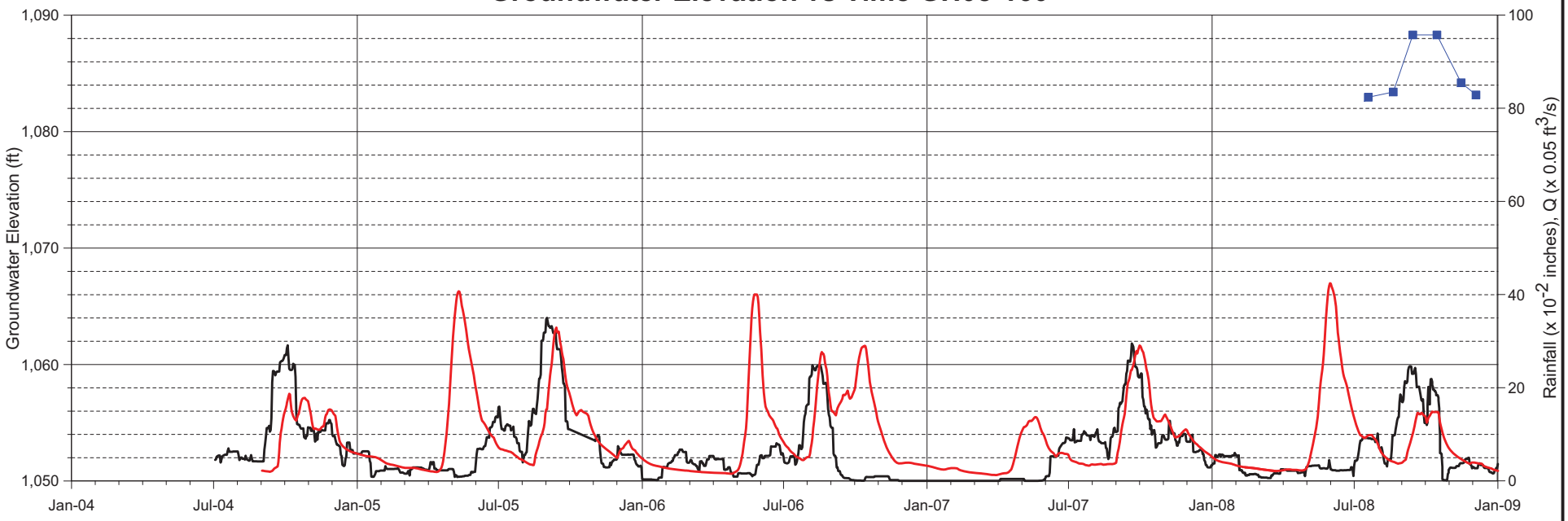


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-160



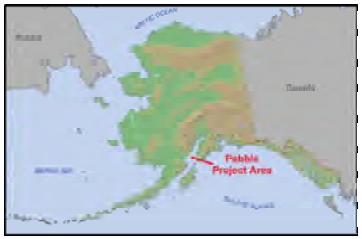
LEGEND:

Groundwater Elevation Plot Legend

- GH08-160
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

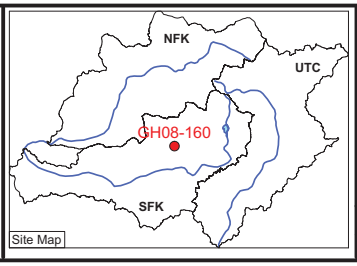
Screens (ft asl):
GH08-160 : 1064.5 - 1074.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1094.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-160.grf

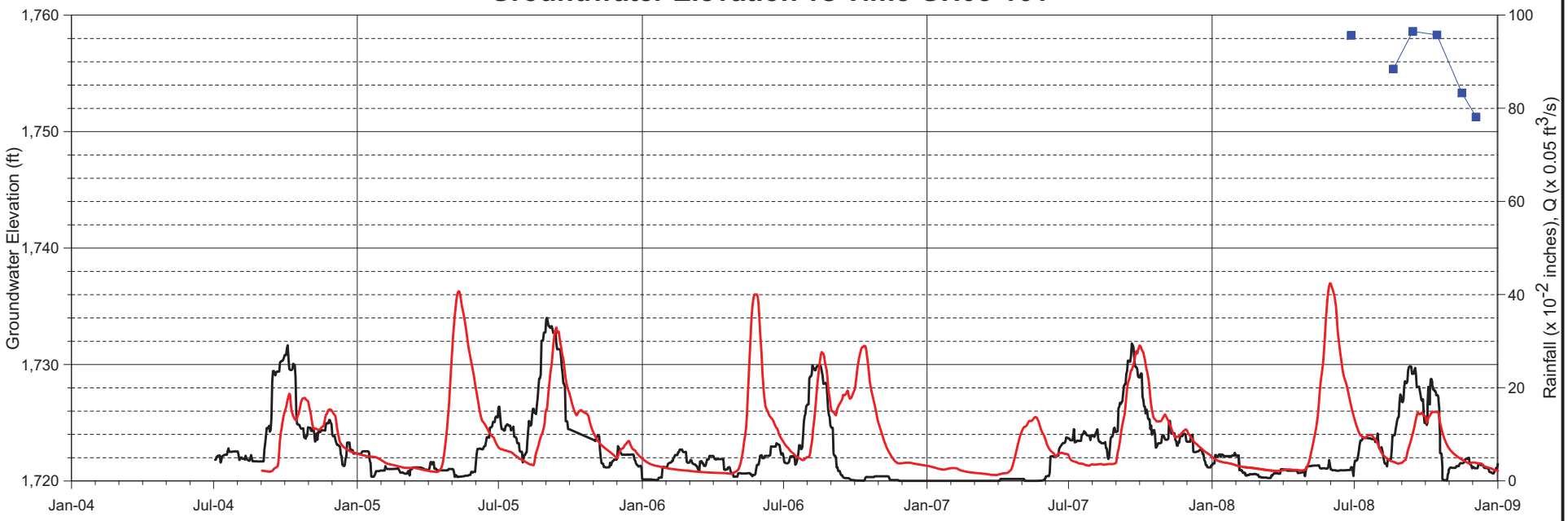


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-161



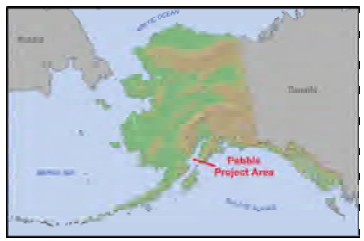
LEGEND:

Groundwater Elevation Plot Legend

- GH08-161
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

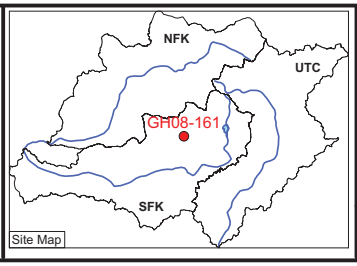
Screens (ft asl):
GH08-161 : 1730.4 - 1740.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1760.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-161.grf

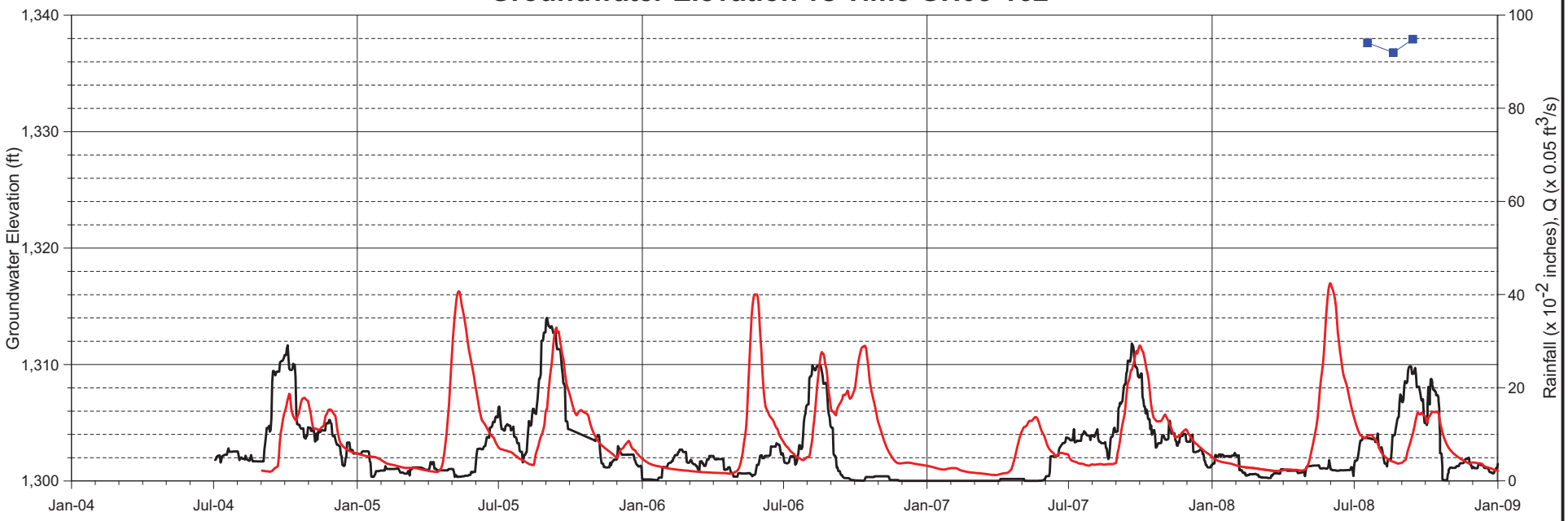


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-162



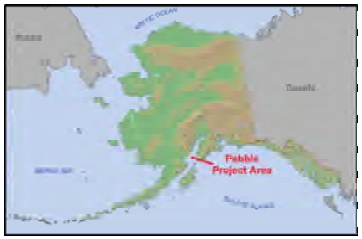
LEGEND:

Groundwater Elevation Plot Legend

- GH08-162
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

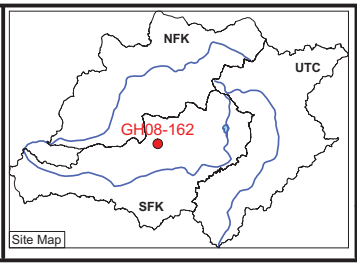
Screens (ft asl):
GH08-162 : 1301.5 - 1311.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1336.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-162.grf

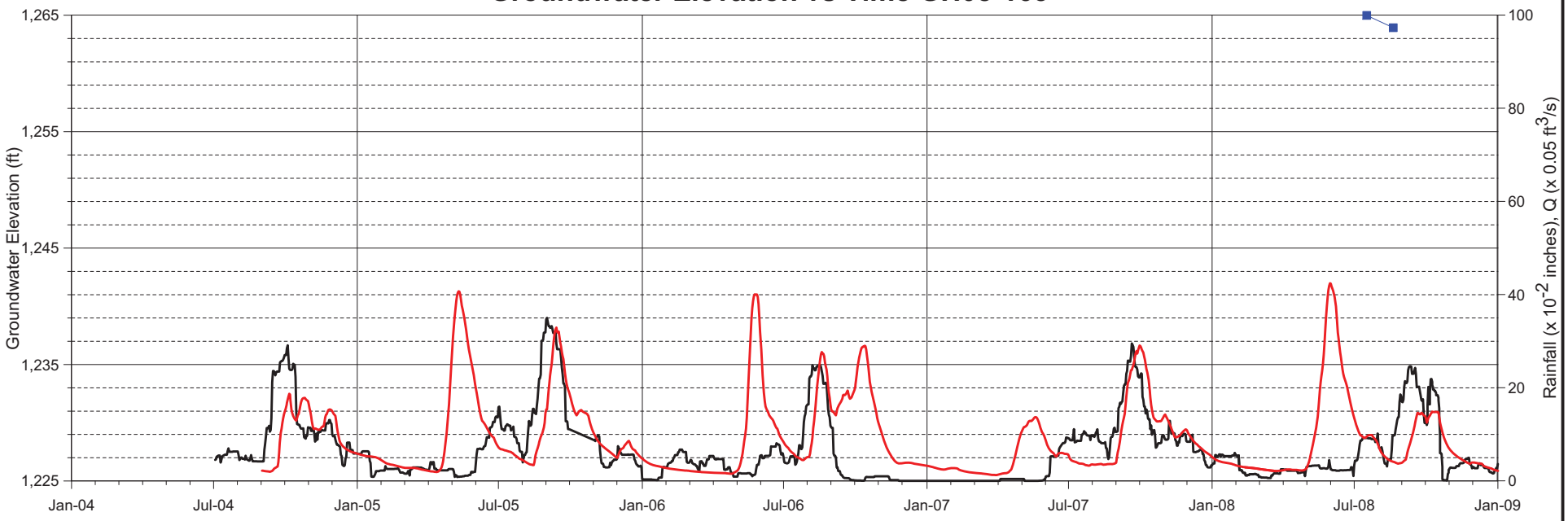


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-163



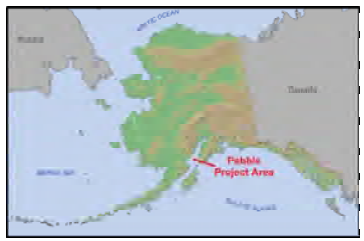
LEGEND:

Groundwater Elevation Plot Legend

- GH08-163
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

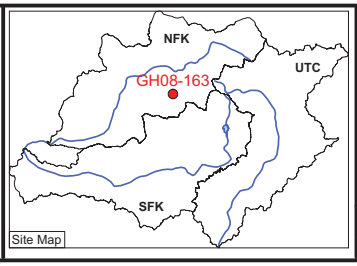
Screens (ft asl):
GH08-163 : 1124.5 - 1139.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1264.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-163.grf

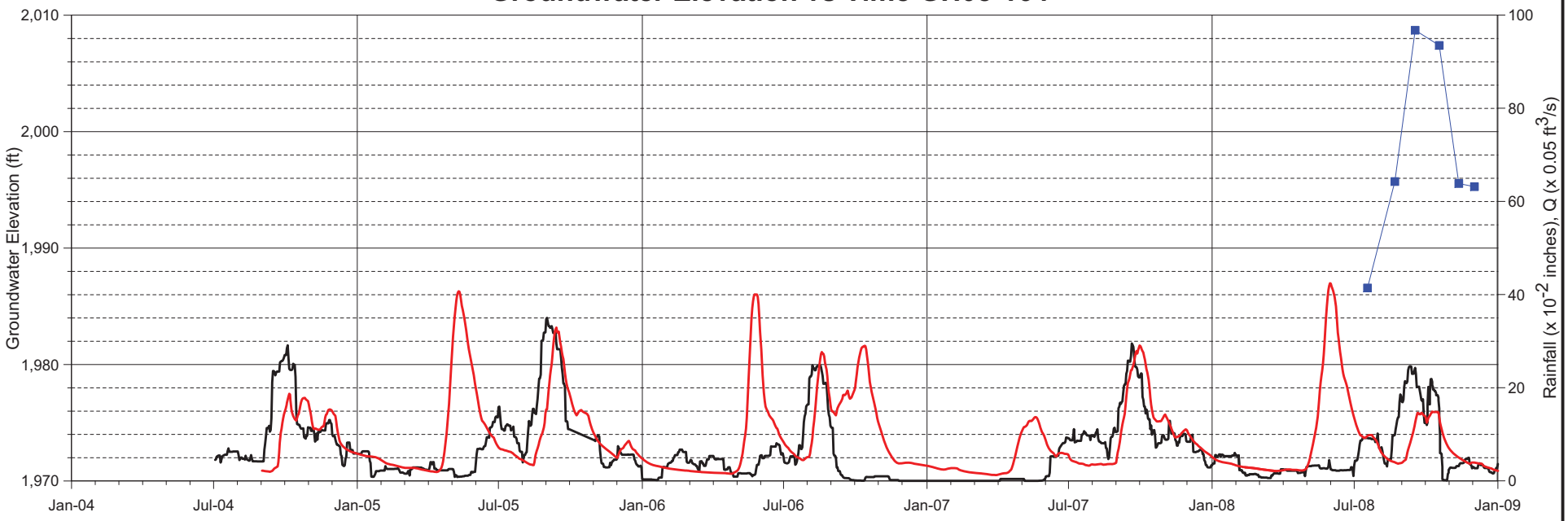


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-164



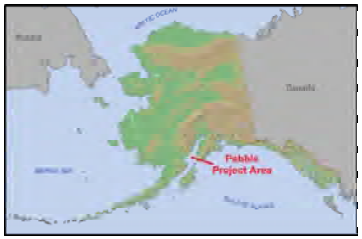
LEGEND:

Groundwater Elevation Plot Legend

- GH08-164
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

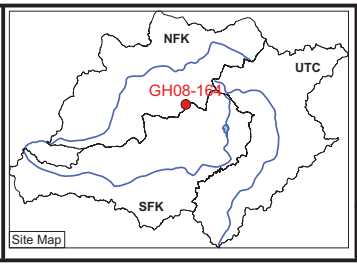
Screens (ft asl):
GH08-164 : 1962.9 - 1972.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 2022.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-164.grf

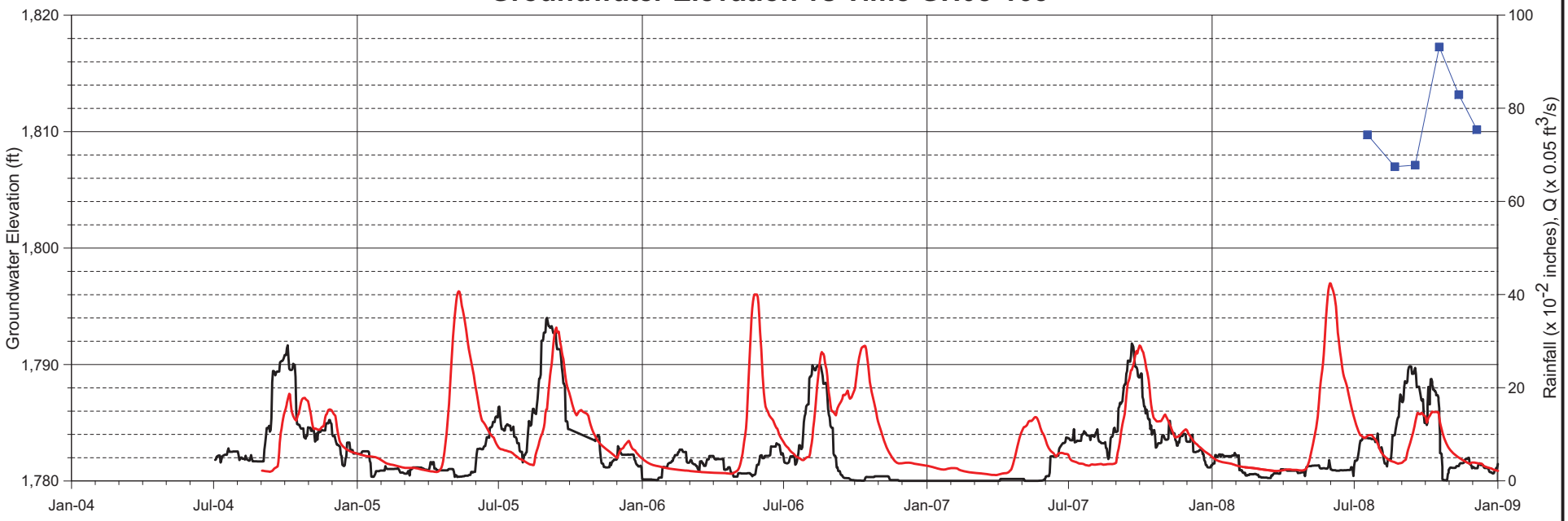


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-165



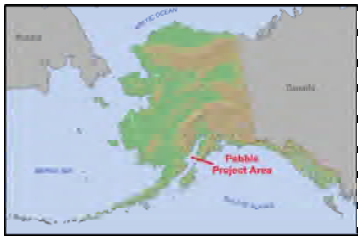
LEGEND:

Groundwater Elevation Plot Legend

- GH08-165
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

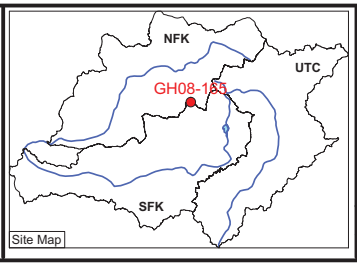
Screens (ft asl):
GH08-165 : 1756.2 - 1766.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1826.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-165.grf

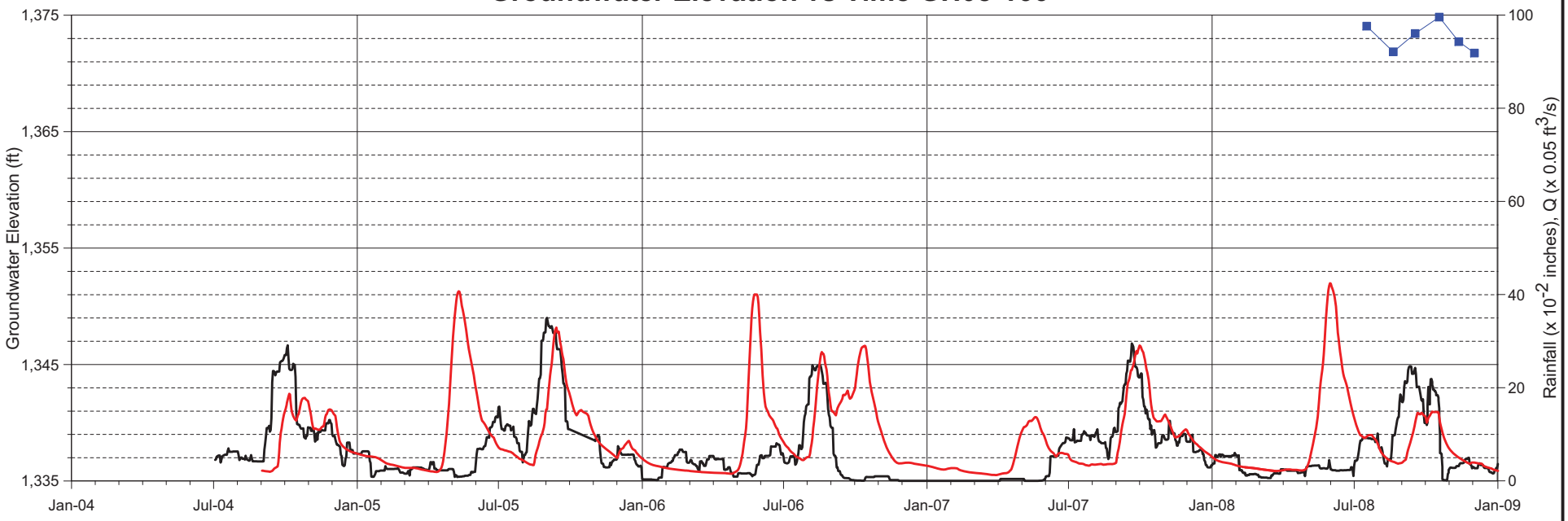


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-166



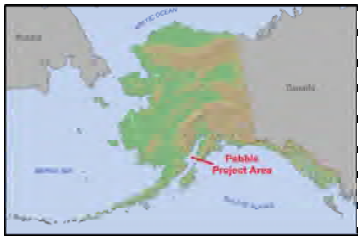
LEGEND:

Groundwater Elevation Plot Legend

- GH08-166
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

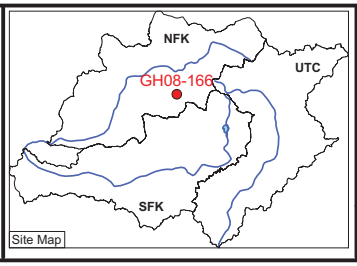
Screens (ft asl):
GH08-166 : 1258.9 - 1278.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1398.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-166.grf

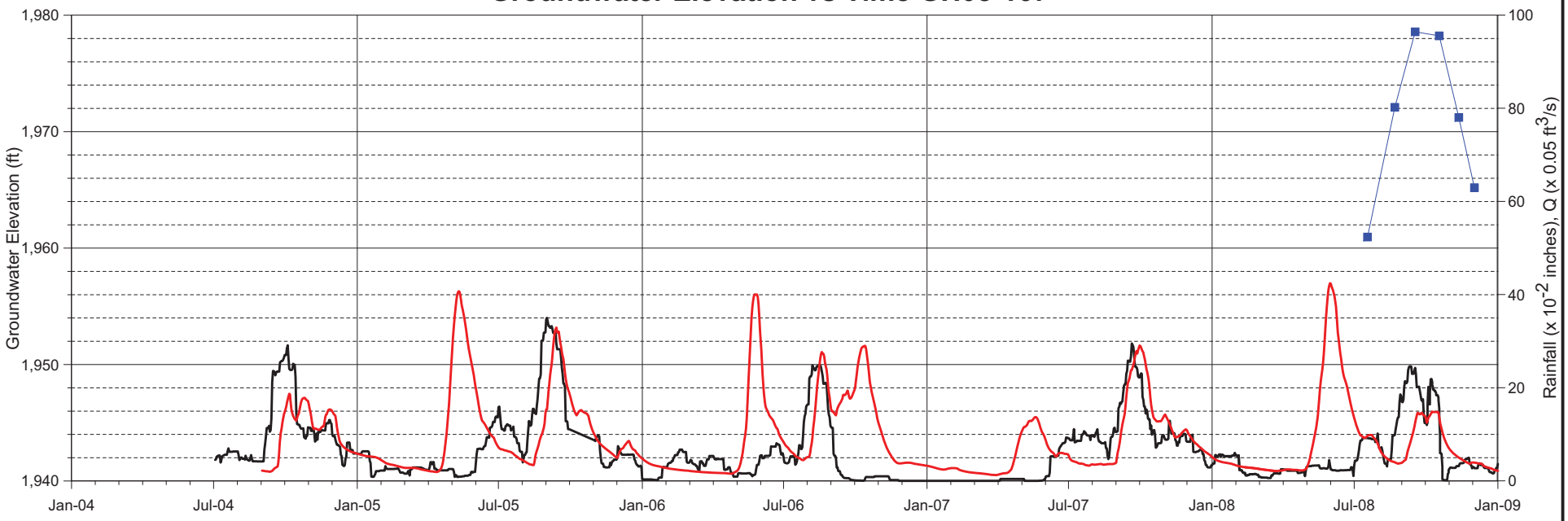


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-167



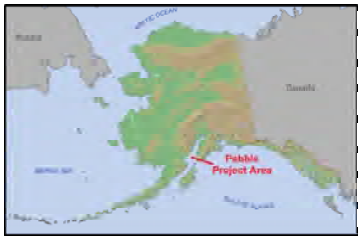
LEGEND:

Groundwater Elevation Plot Legend

- GH08-167
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

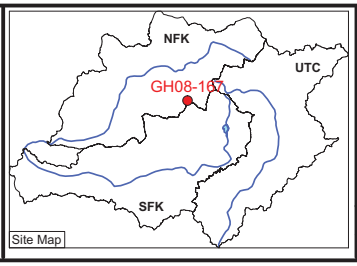
Screens (ft asl):
GH08-167 : 1893.4 - 1903.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1983.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-167.grf

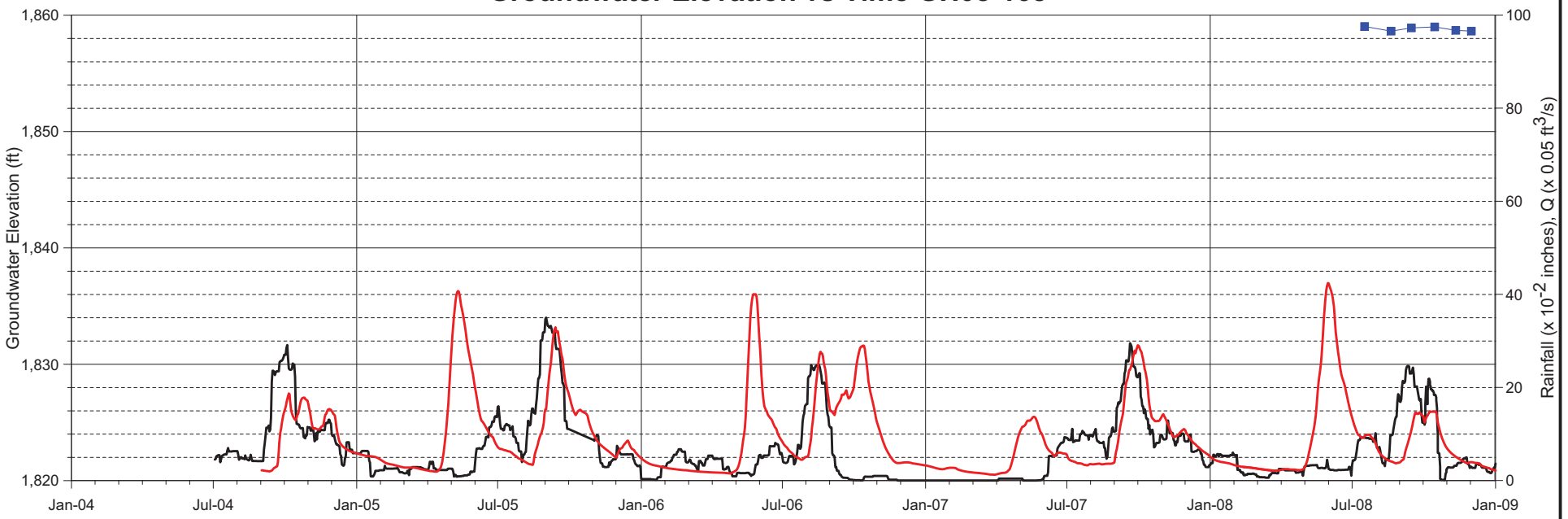


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-168



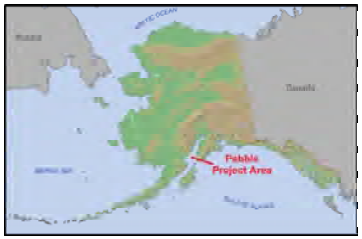
LEGEND:

Groundwater Elevation Plot Legend

- GH08-168
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

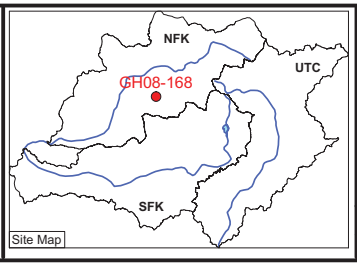
Screens (ft asl):
GH08-168 : 1599.4 - 1619.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1864.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-168.grf

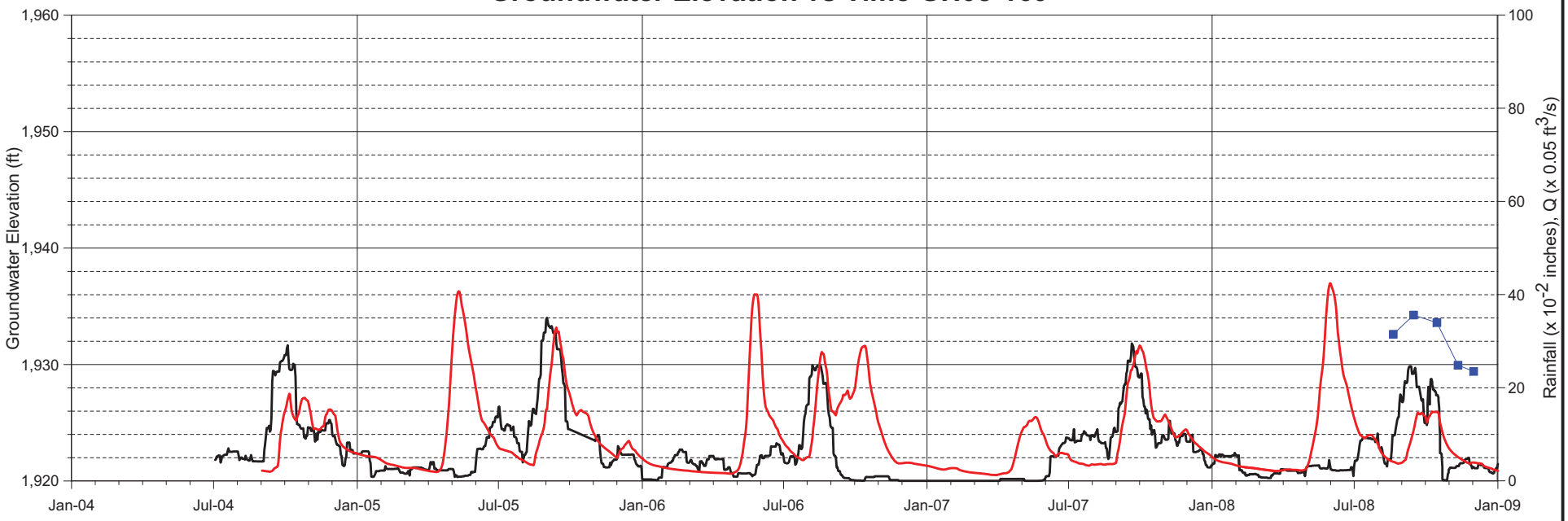


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-169



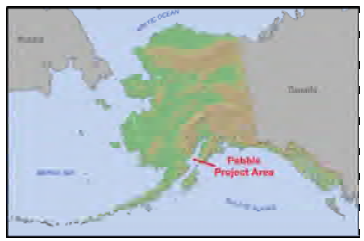
LEGEND:

Groundwater Elevation Plot Legend

- GH08-169 (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

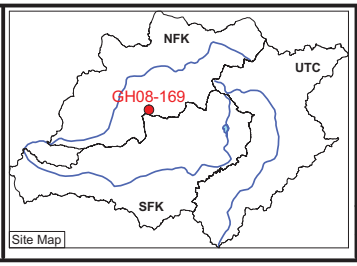
Transducer Elevation (ft asl):
GH08-169 : 1645.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1936.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-169.grf

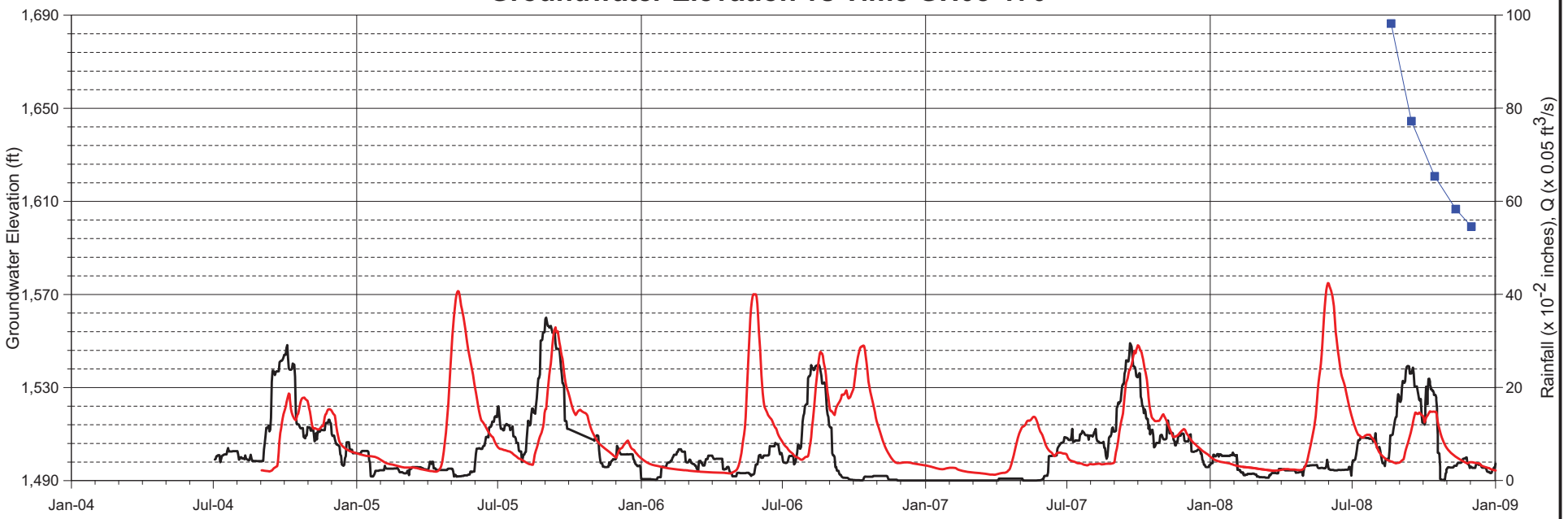


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-170



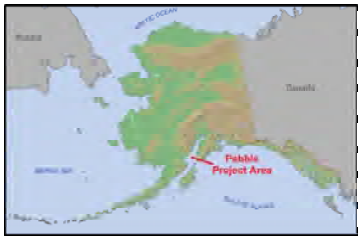
LEGEND:

Groundwater Elevation Plot Legend

- GH08-170 (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

Transducer Elevation (ft asl):
GH08-170 : 1487.2

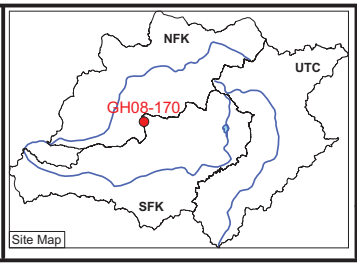


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1975.2 ft asl

The y range for this graph is 200 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-170.grf

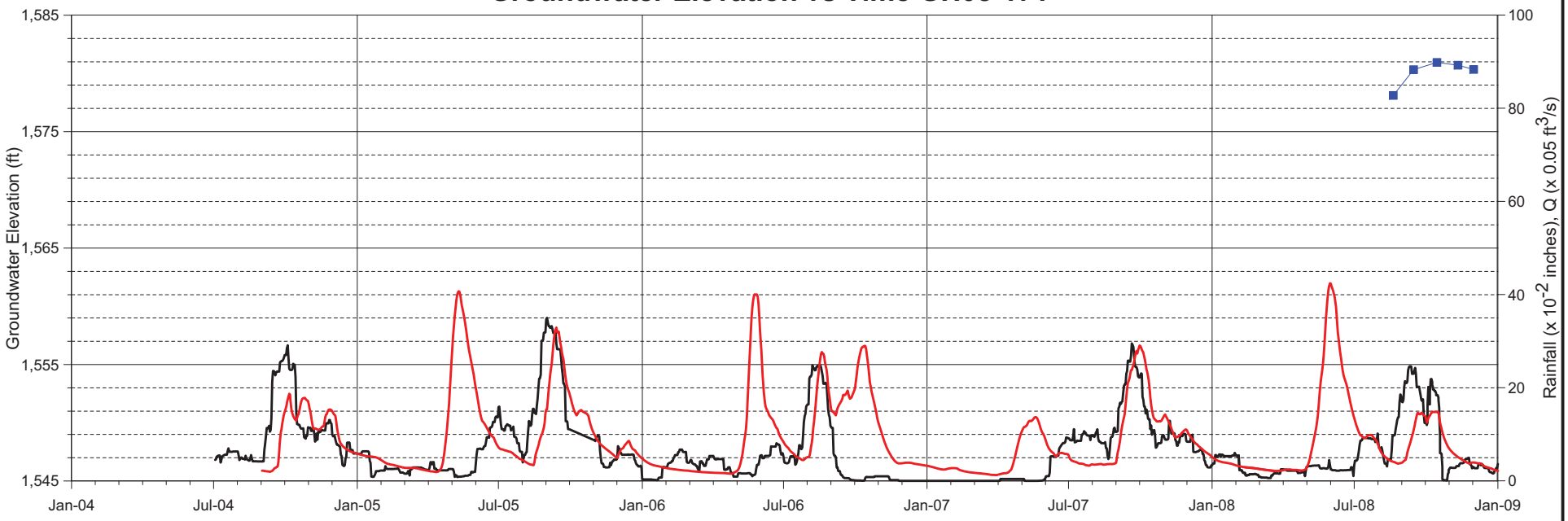


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-171



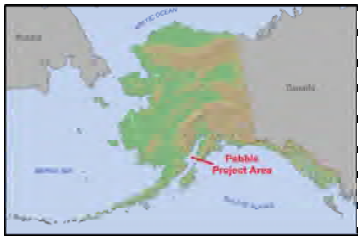
LEGEND:

Groundwater Elevation Plot Legend

- GH08-171
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

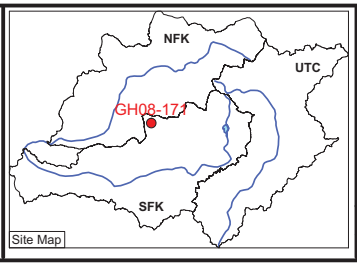
Screens (ft asl):
GH08-171 : 1540.6 - 1550.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1585.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-171.grf

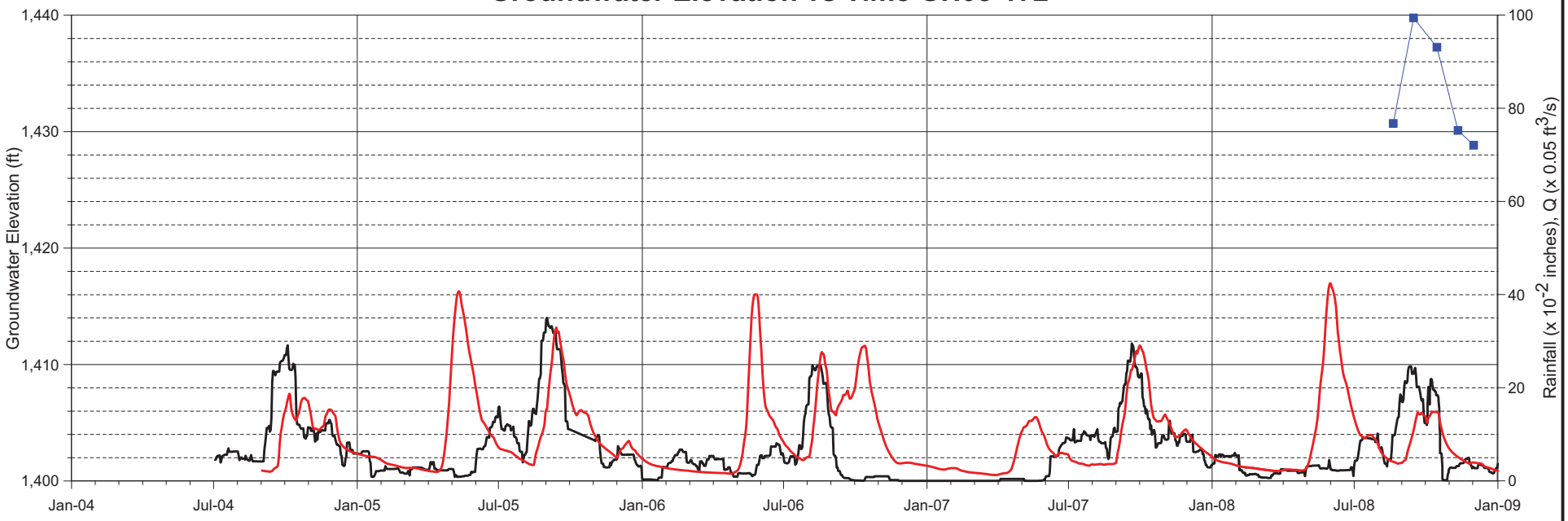


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-172



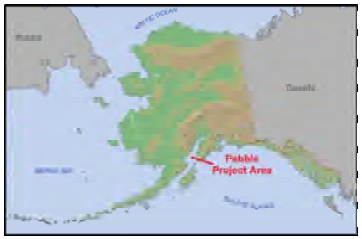
LEGEND:

Groundwater Elevation Plot Legend

- GH08-172
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

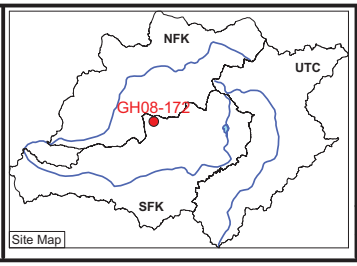
Screens (ft asl):
GH08-172 : 1389.0 - 1399.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1454 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-172.grf

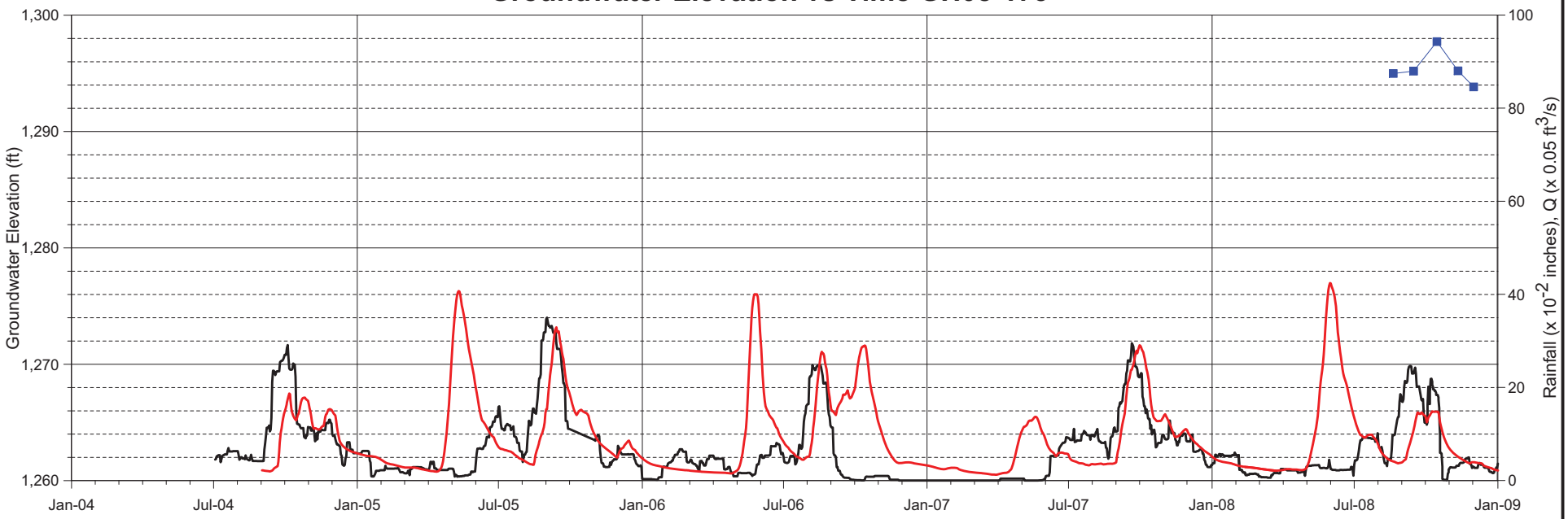


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-173



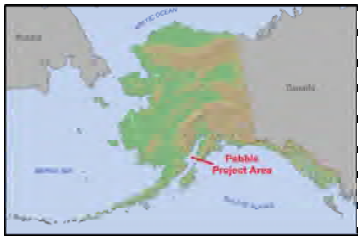
LEGEND:

Groundwater Elevation Plot Legend

- GH08-173
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

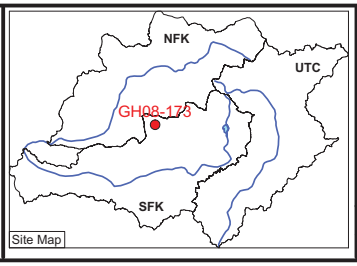
Screens (ft asl):
GH08-173 : 1198.4 - 1208.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1338.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-173.grf

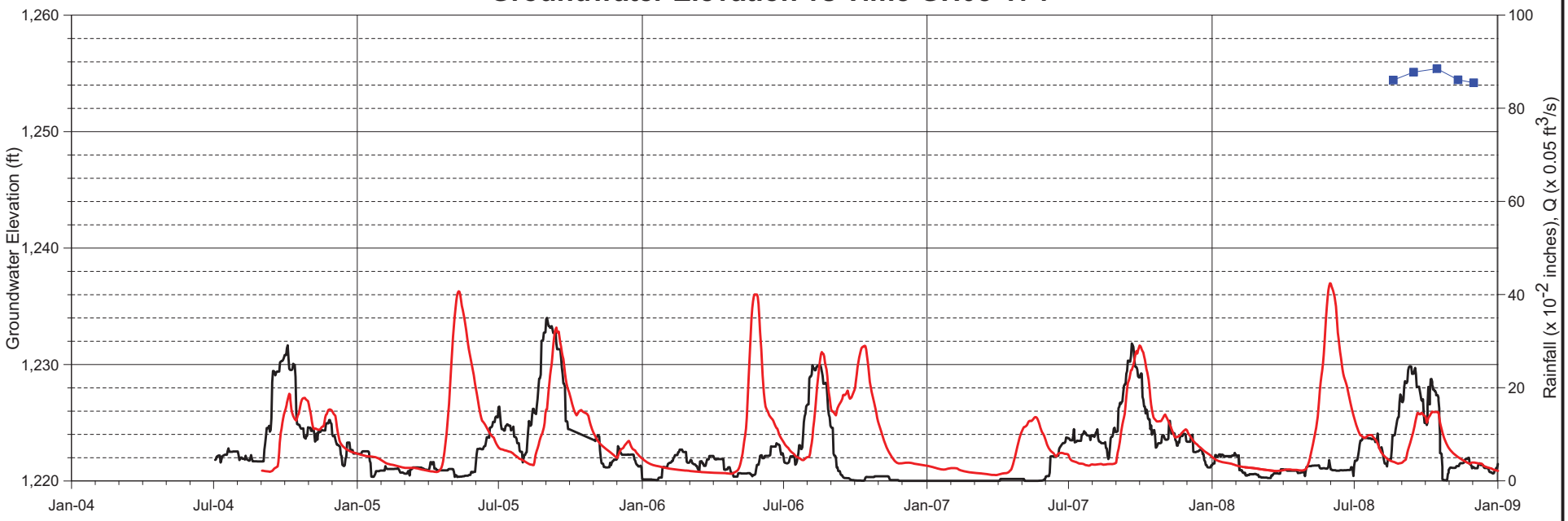


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-174



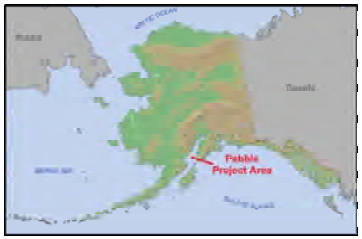
LEGEND:

Groundwater Elevation Plot Legend

- GH08-174
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

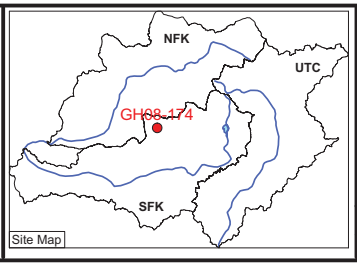
Screens (ft asl):
GH08-174 : 1100.2 - 1110.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1260.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-174.grf

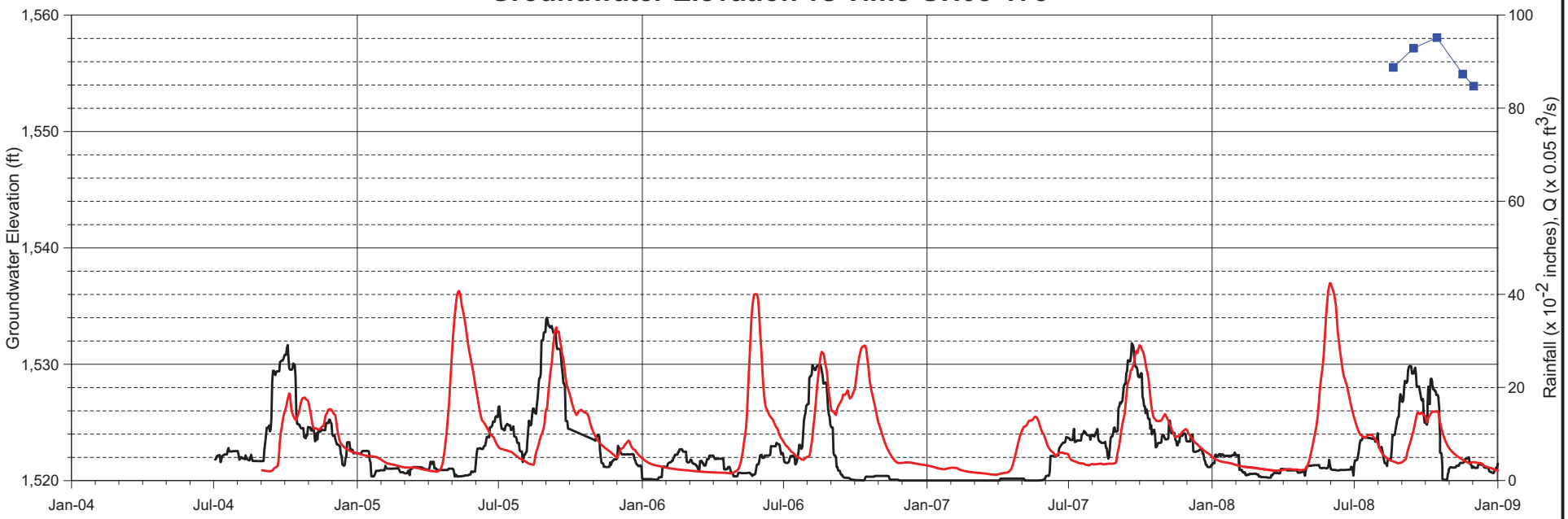


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-175



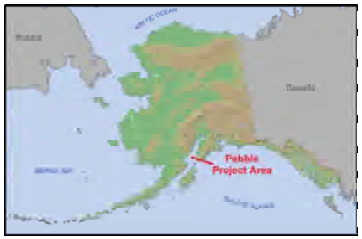
LEGEND:

Groundwater Elevation Plot Legend

- GH08-175
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

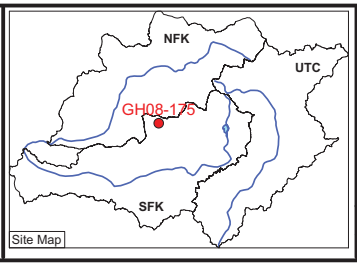
Screens (ft asl):
GH08-175 : 1427.8 - 1437.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1562.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-175.grf

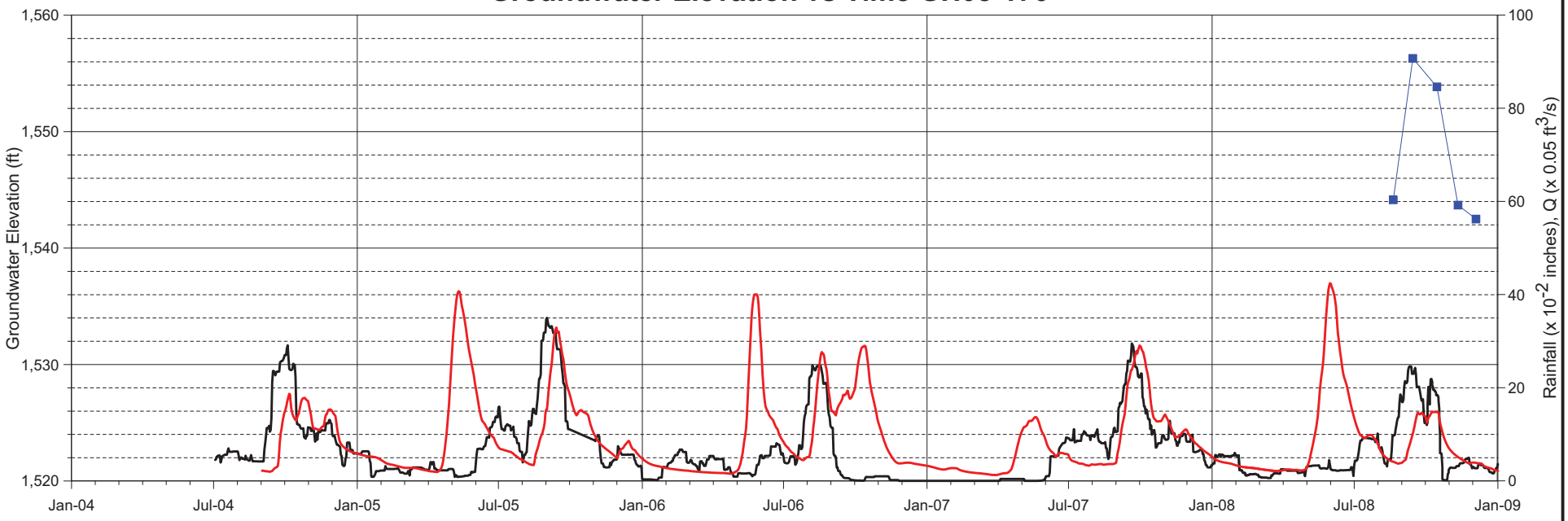


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-176



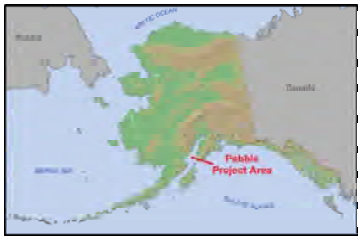
LEGEND:

Groundwater Elevation Plot Legend

- GH08-176
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

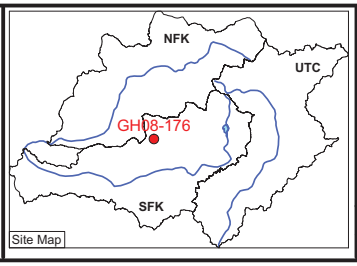
Screens (ft asl):
GH08-176 : 1501.8 - 1511.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1571.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-176.grf

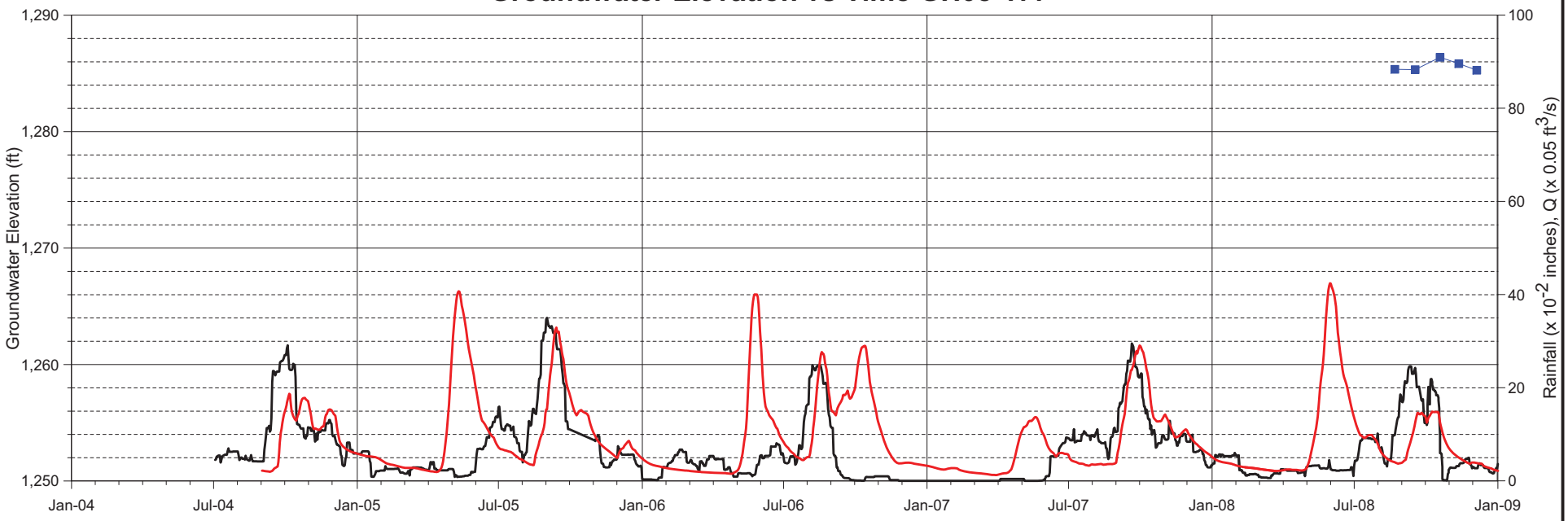


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-177



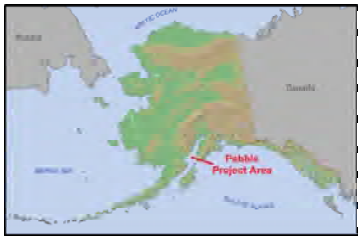
LEGEND:

Groundwater Elevation Plot Legend

- GH08-177
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

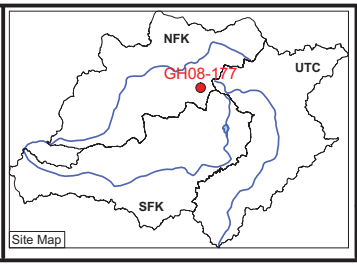
Screens (ft asl):
GH08-177 : 1127.9 - 1137.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1332.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-177.grf

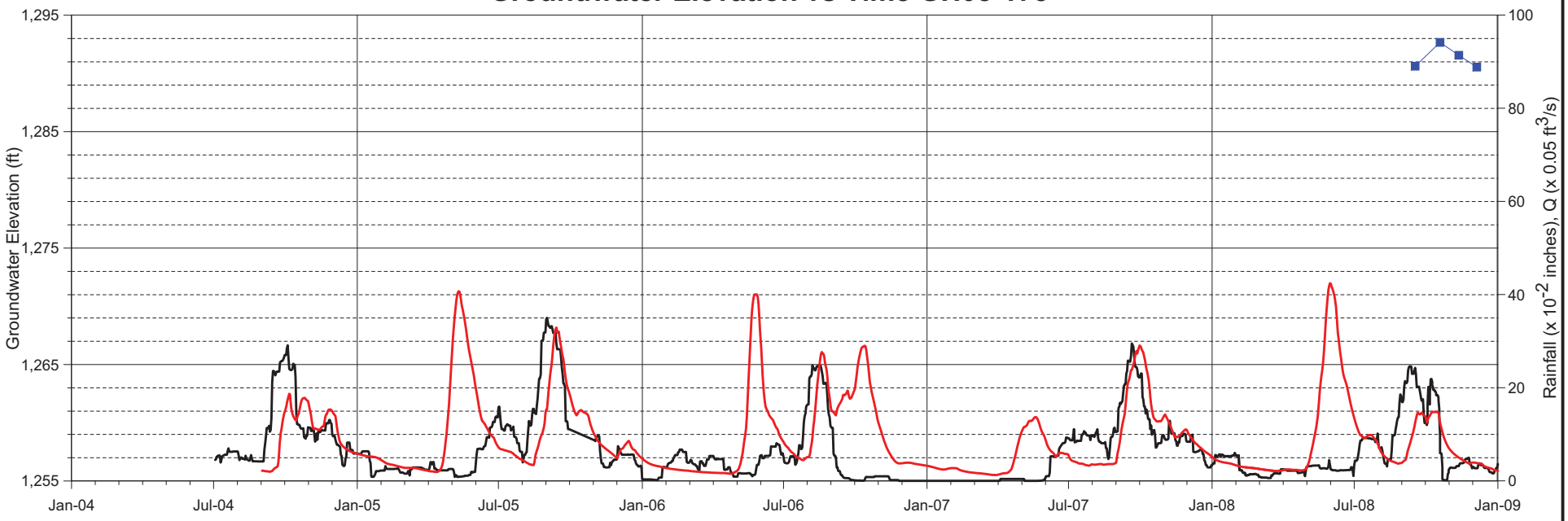


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-178



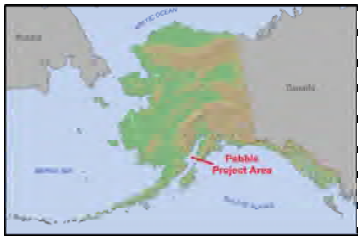
LEGEND:

Groundwater Elevation Plot Legend

- GH08-178
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

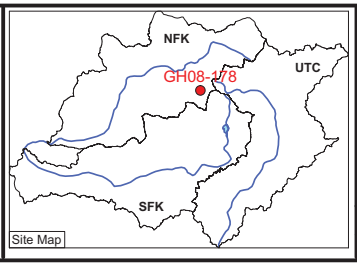
Screens (ft asl):
GH08-178 : 1227.4 - 1237.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1342.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-178.grf

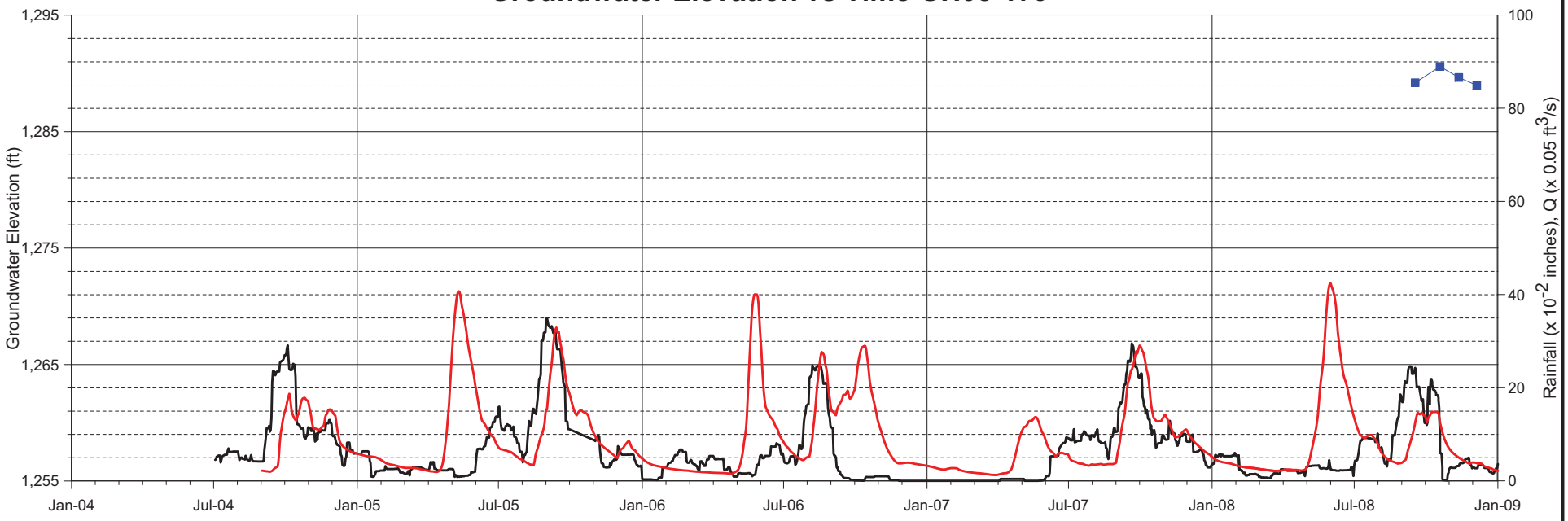


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-179



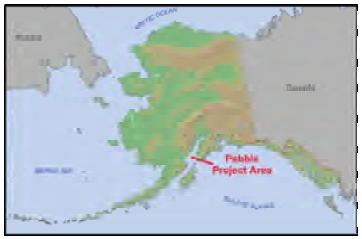
LEGEND:

Groundwater Elevation Plot Legend

- GH08-179
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

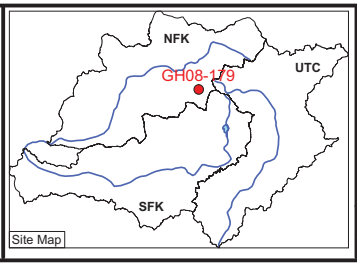
Screens (ft asl):
GH08-179 : 1190.6 - 1200.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1305.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-179.grf

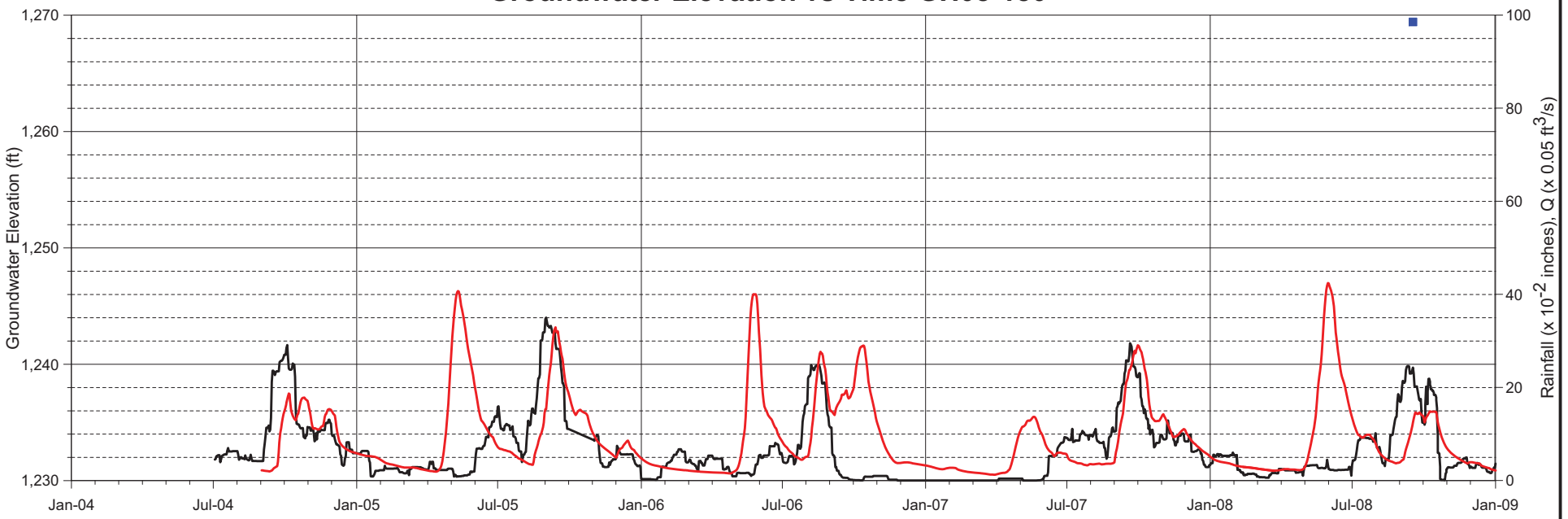


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-180



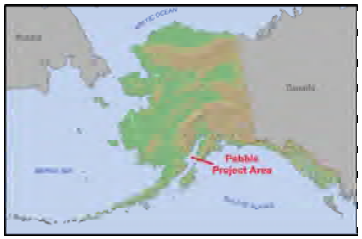
LEGEND:

Groundwater Elevation Plot Legend

- GH08-180
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

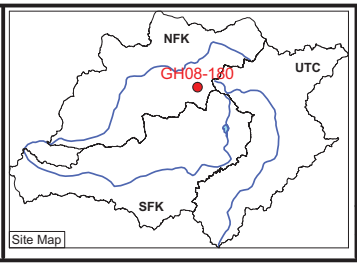
Screens (ft asl):
GH08-180 : 1202.2 - 1222.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1269.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-180.grf

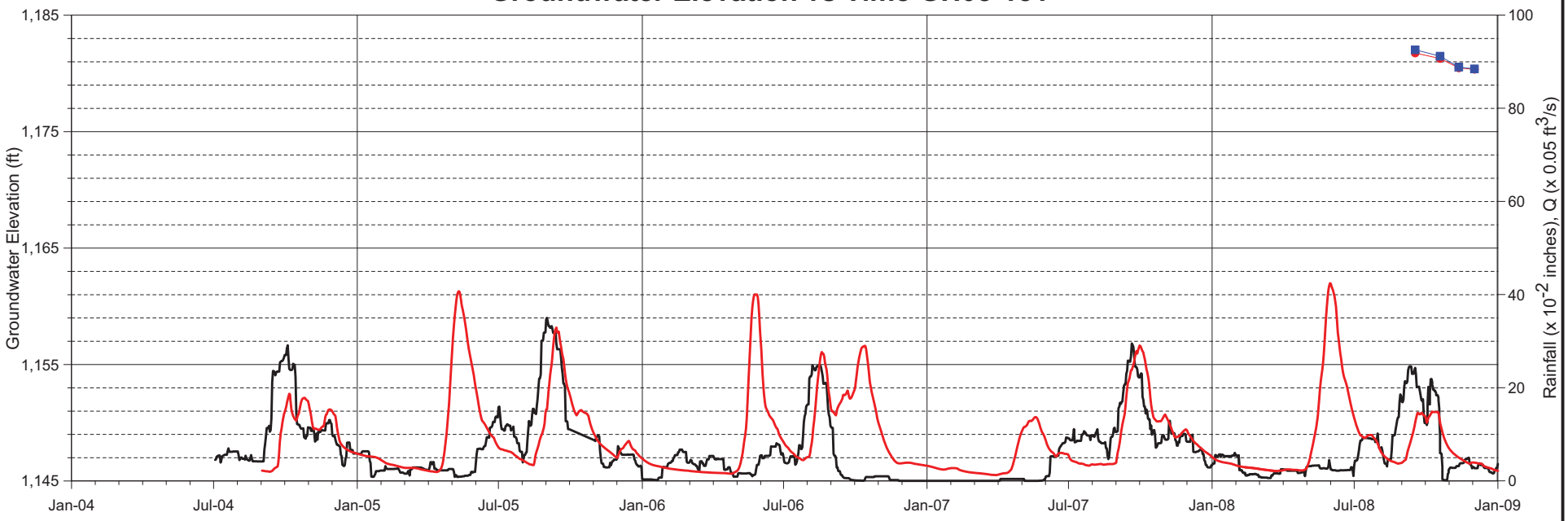


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-181



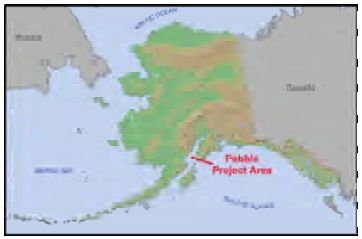
LEGEND:

Groundwater Elevation Plot Legend

- GH08-181S
- GH08-181D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

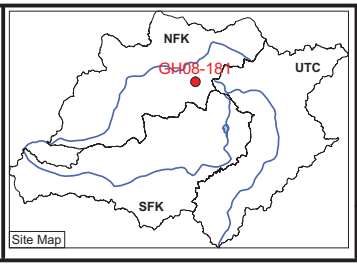
Screens (ft asl):
GH08-181S : 1171.9 - 1181.9
GH08-181D : 1136.9 - 1146.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1196.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-181.grf

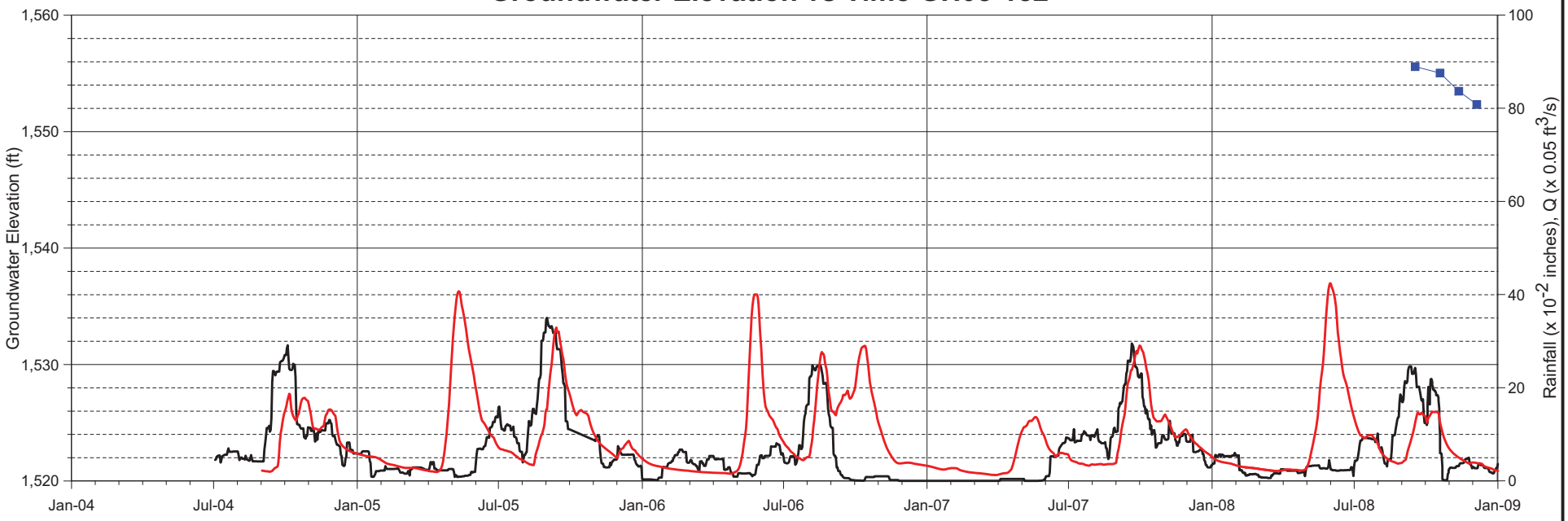


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-182



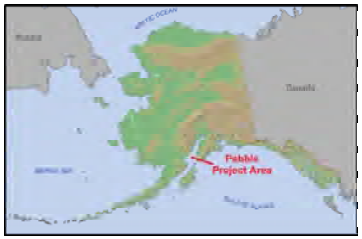
LEGEND:

Groundwater Elevation Plot Legend

- GH08-182
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

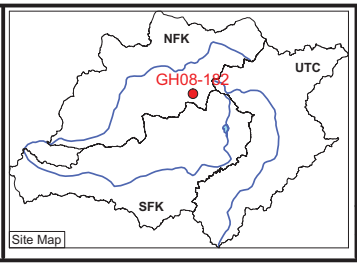
Screens (ft asl):
GH08-182 : 1525.9 - 1535.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1560.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-182.grf

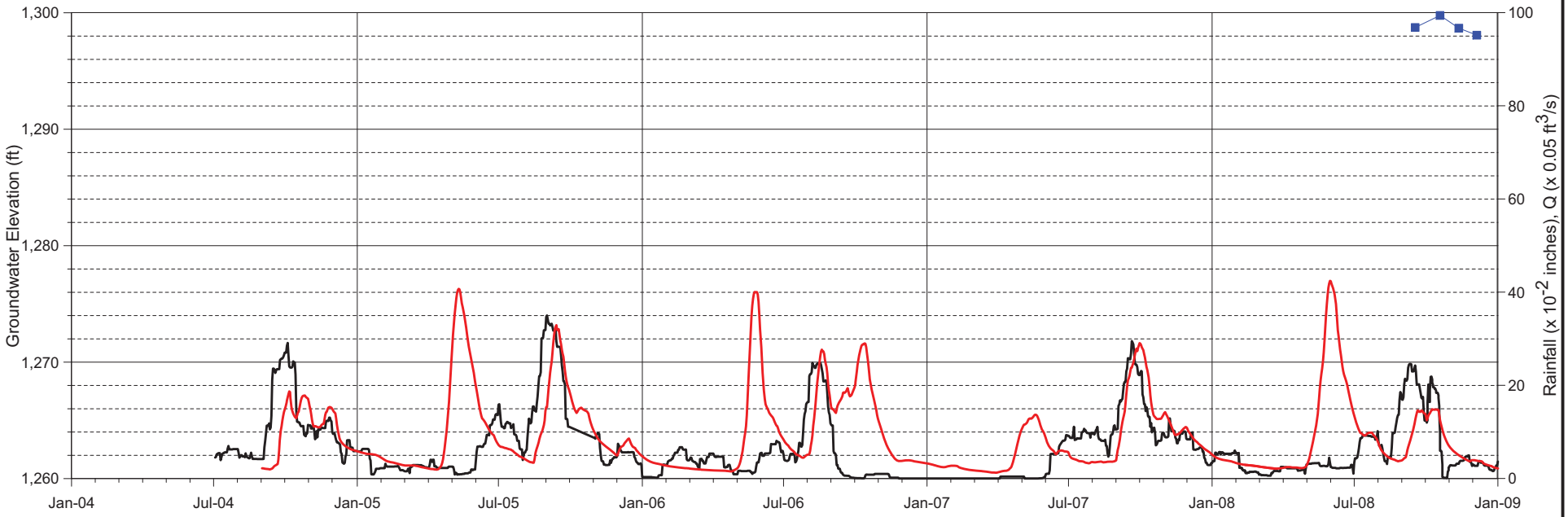


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-183



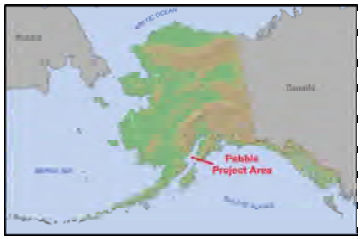
LEGEND:

Groundwater Elevation Plot Legend

- GH08-183
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

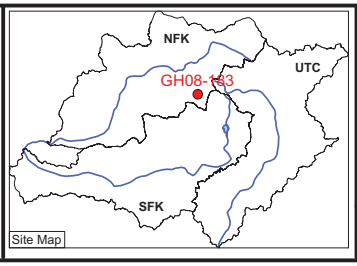
Screens (ft asl):
GH08-183 : 1125.7 - 1135.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1305.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-183.grf

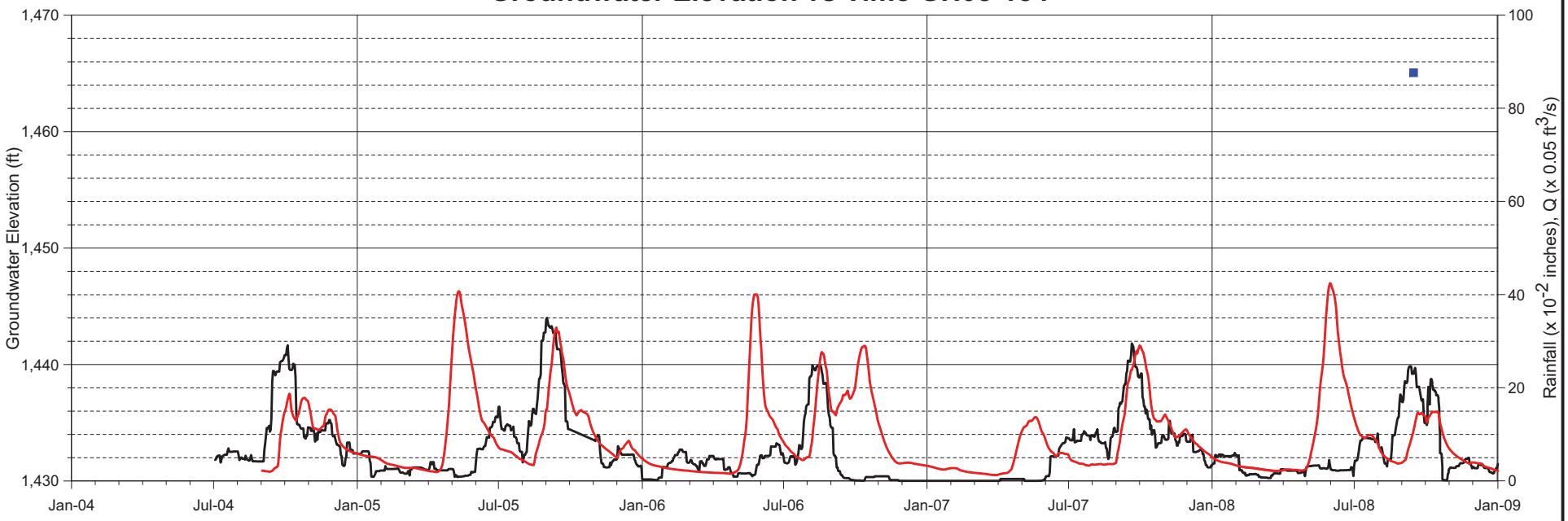


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-184



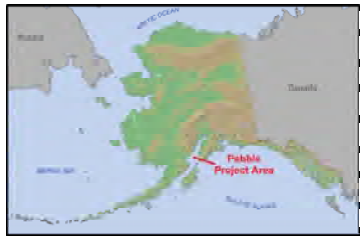
LEGEND:

Groundwater Elevation Plot Legend

- GH08-184
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH08-184 : 1424.0 - 1434.0

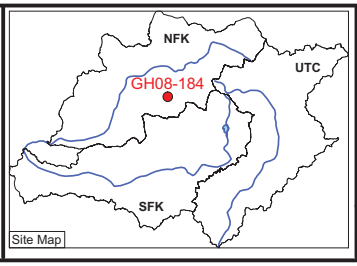


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1464 ft asl

Water was frozen in riser for most measurement periods.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-184.grf

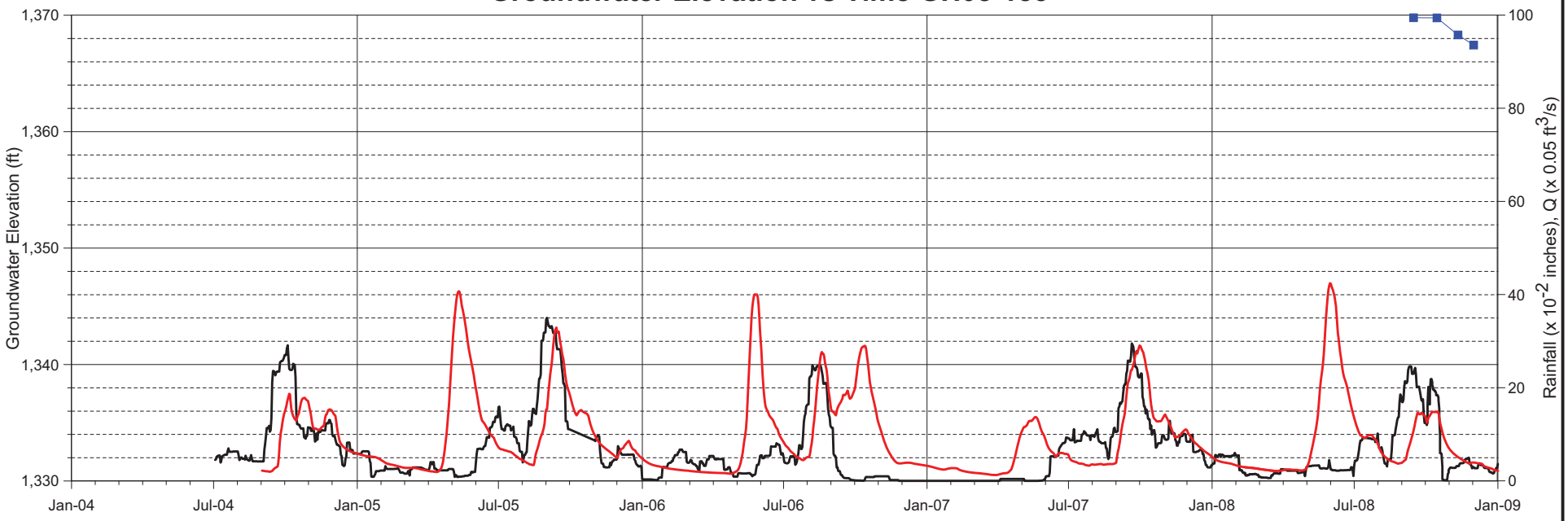


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-185



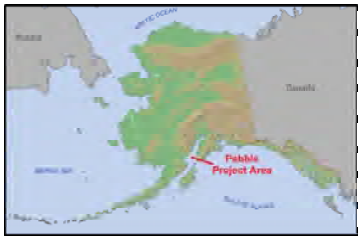
LEGEND:

Groundwater Elevation Plot Legend

- GH08-185
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

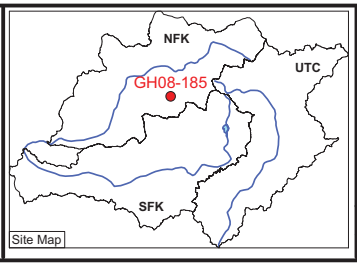
Screens (ft asl):
GH08-185 : 1319.7 - 1329.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1369.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-185.grf

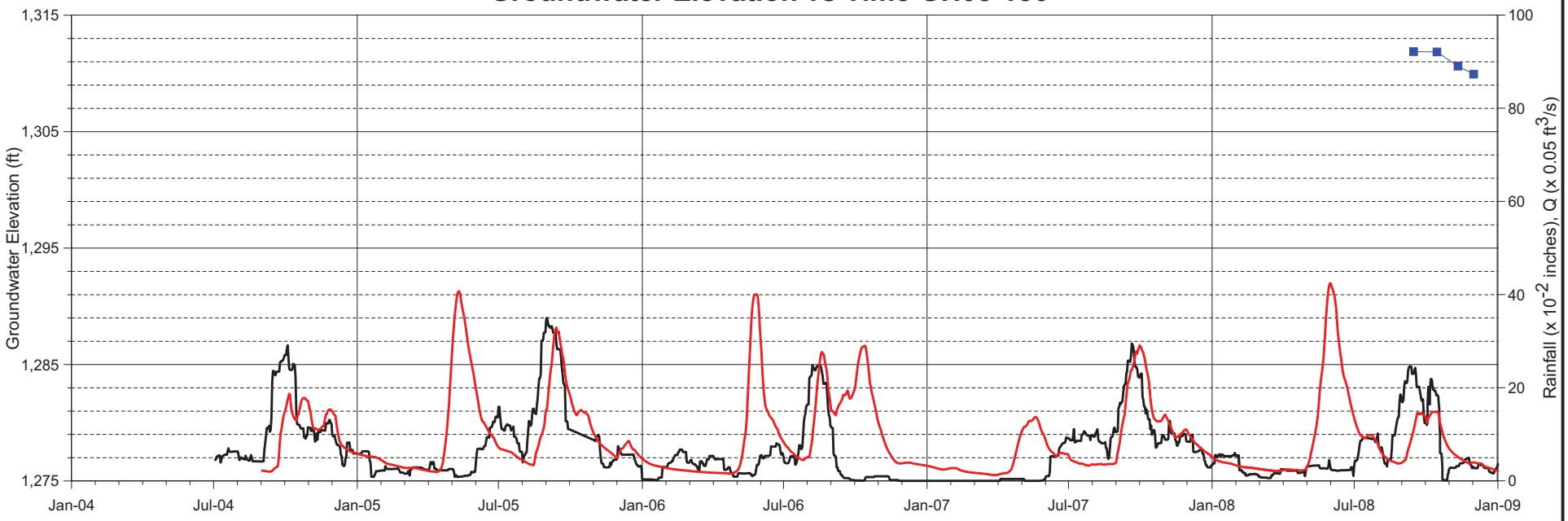


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-186



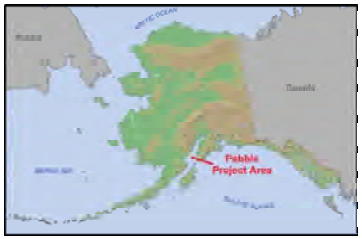
LEGEND:

Groundwater Elevation Plot Legend

- GH08-186
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

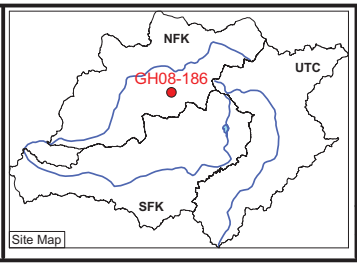
Screens (ft asl):
GH08-186 : 1292.6 - 1302.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1312.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-186.grf

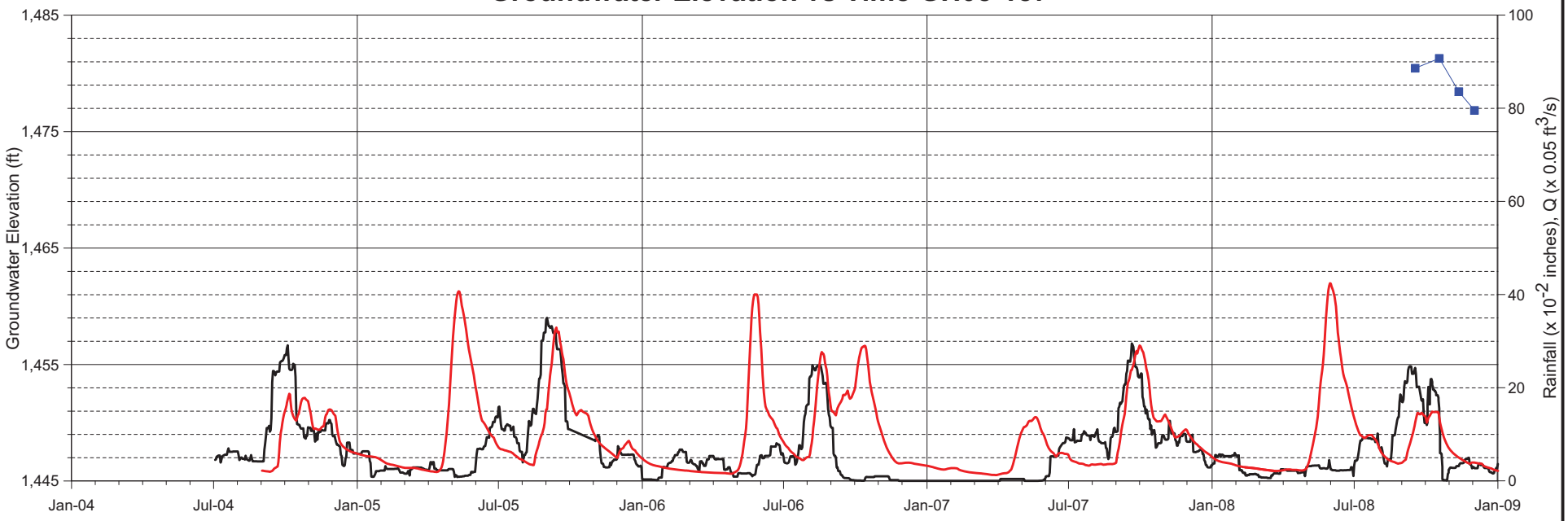


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-187



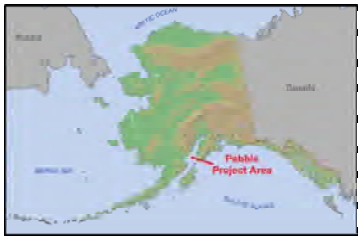
LEGEND:

Groundwater Elevation Plot Legend

- GH08-187
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

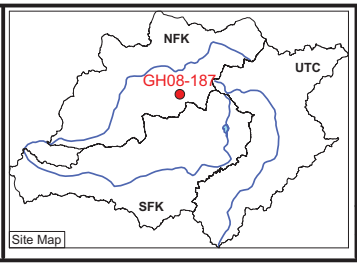
Screens (ft asl):
GH08-187 : 1433.9 - 1443.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1493.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-187.grf

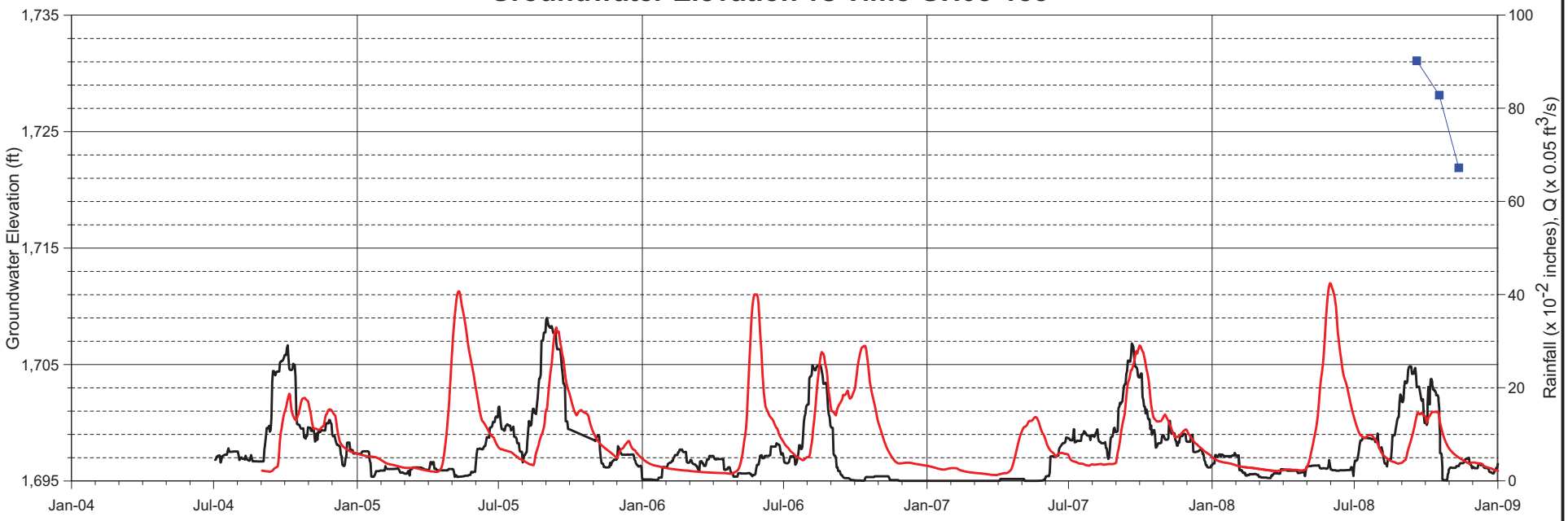


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-188



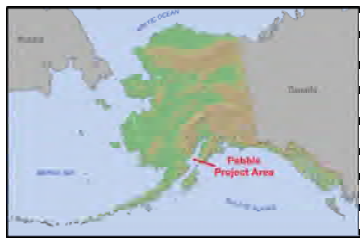
LEGEND:

Groundwater Elevation Plot Legend

- GH08-188
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

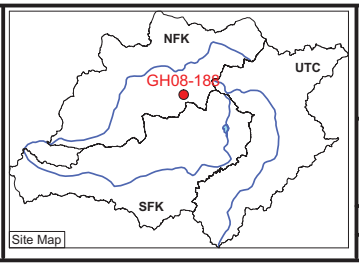
Screens (ft asl):
GH08-188 : 1715.8 - 1725.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1760.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-188.grf

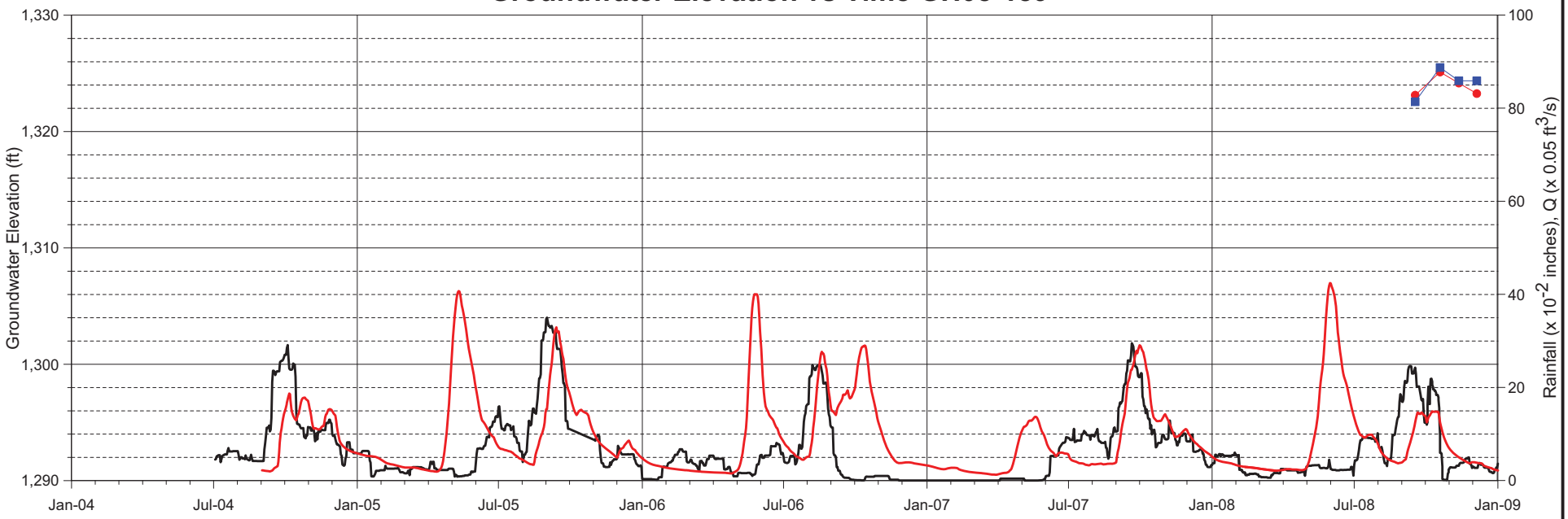


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-189



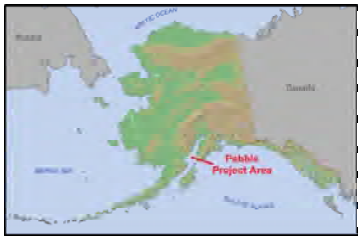
LEGEND:

Groundwater Elevation Plot Legend

- GH08-189S
- GH08-189D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

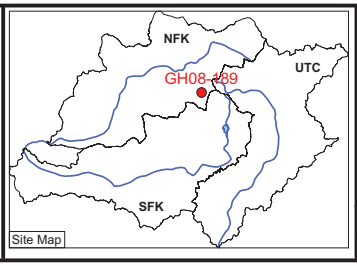
Screens (ft asl):
GH08-189S : 1186.2 - 1191.2
GH08-189D : 1151.2 - 1161.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1371.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-189.grf

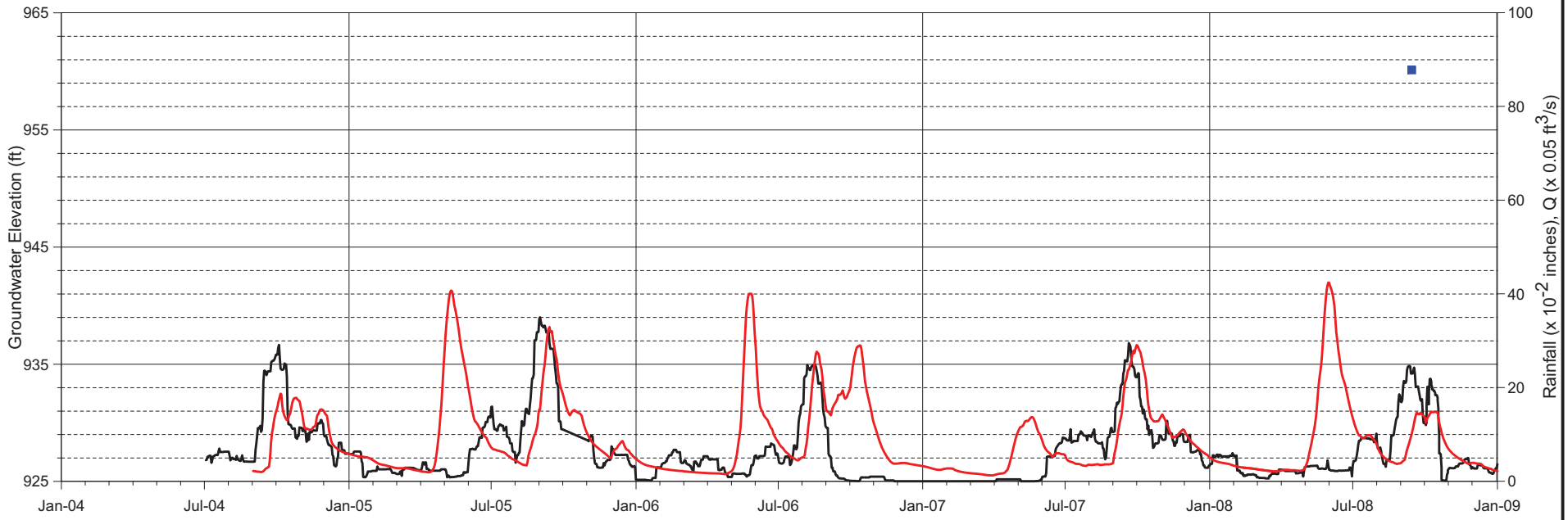


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-190



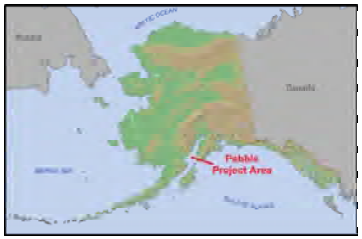
LEGEND:

Groundwater Elevation Plot Legend

- GH08-190
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH08-190 : 894.3 - 904.3

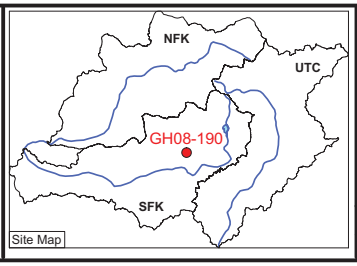


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 959.3 ft asl

Water was frozen in riser for most measurement periods.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-190.grf

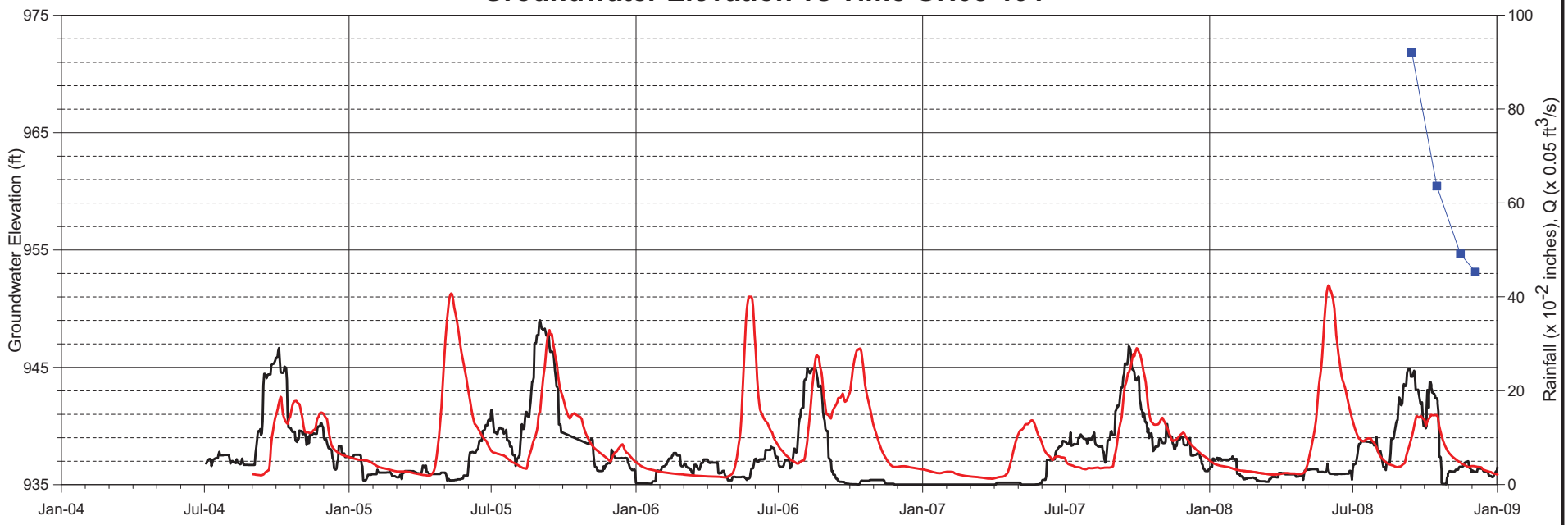


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-191



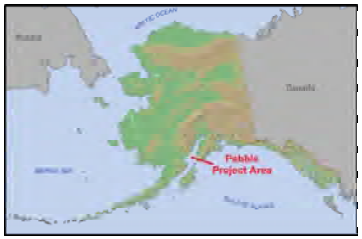
LEGEND:

Groundwater Elevation Plot Legend

- GH08-191
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

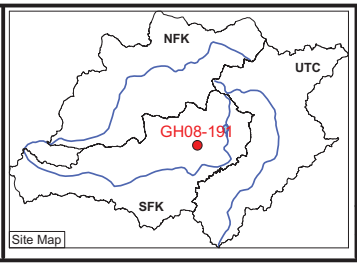
Screens (ft asl):
GH08-191 : 919.3 - 929.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1004.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-191.grf

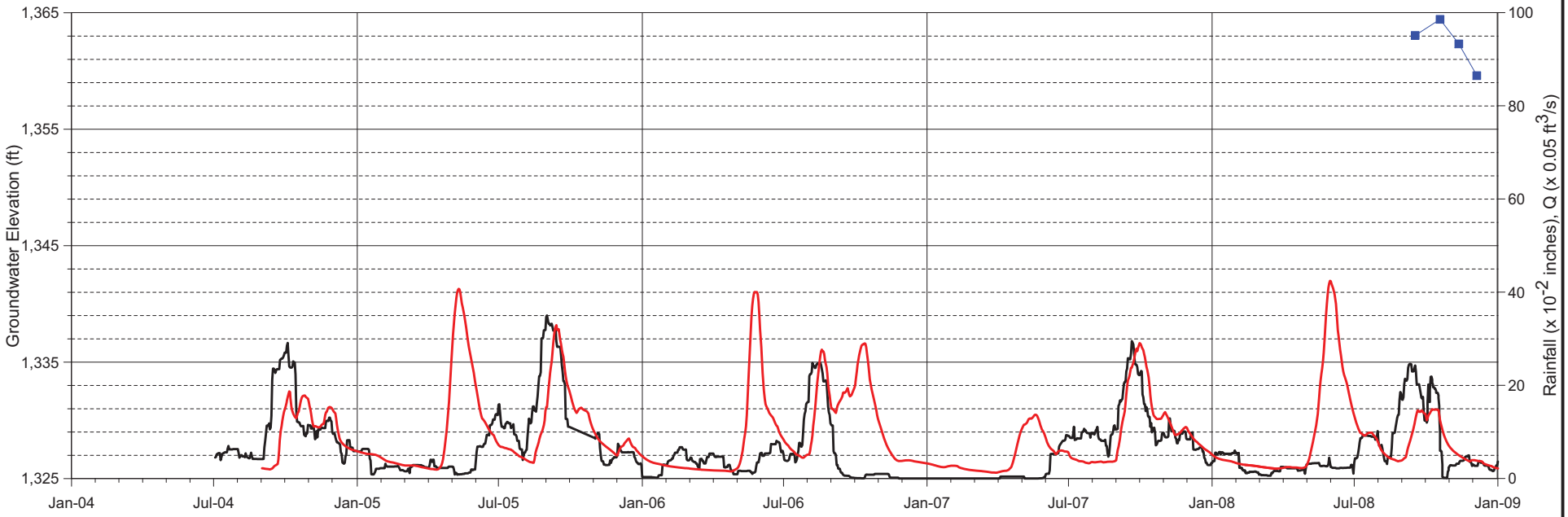


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-192



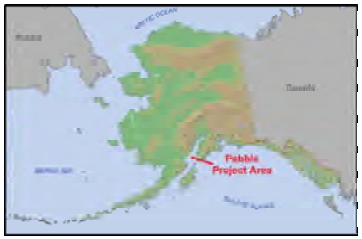
LEGEND:

Groundwater Elevation Plot Legend

- GH08-192
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

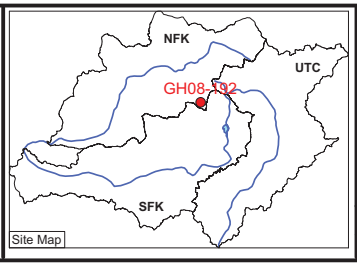
Screens (ft asl):
GH08-192 : 1206.4 - 1216.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1371.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-192.grf

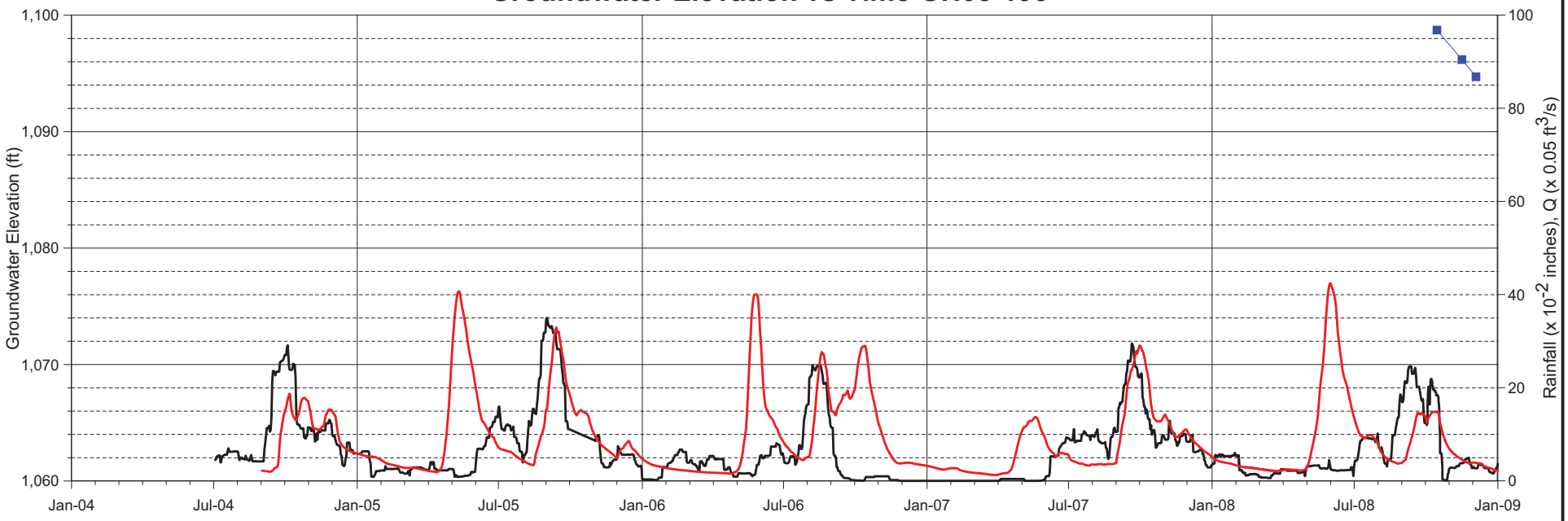


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-193



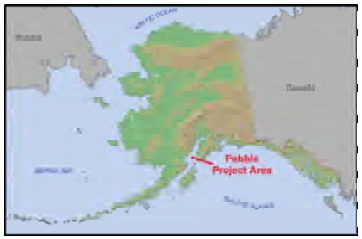
LEGEND:

Groundwater Elevation Plot Legend

- GH08-193
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

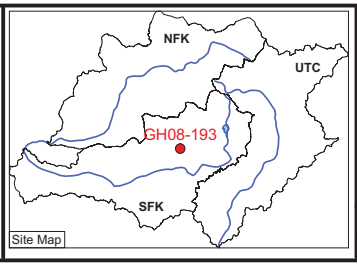
Screens (ft asl):
GH08-193 : 1062.5 - 1072.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1102.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-193.grf

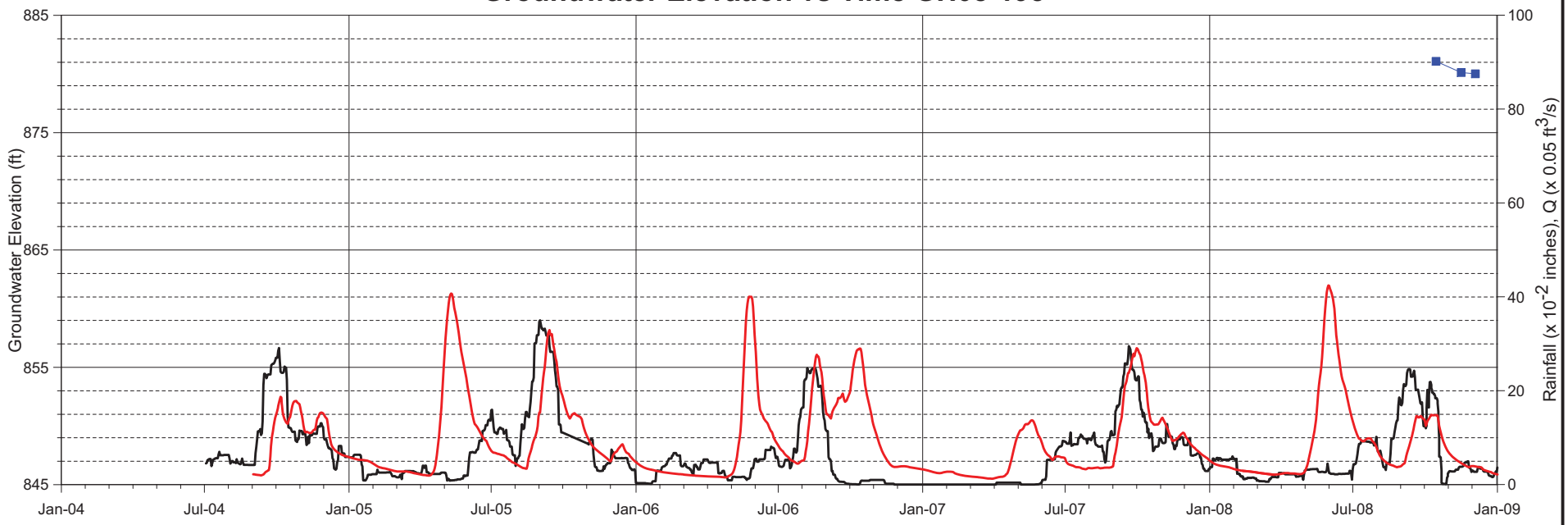


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-195



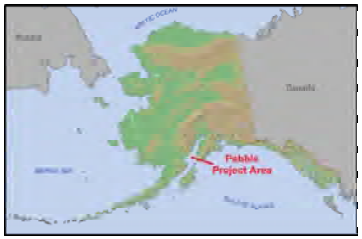
LEGEND:

Groundwater Elevation Plot Legend

- GH08-195
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

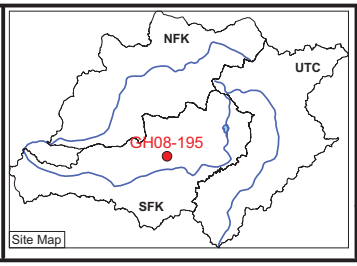
Screens (ft asl):
GH08-195 : 848.3 - 858.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 883.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-195.grf

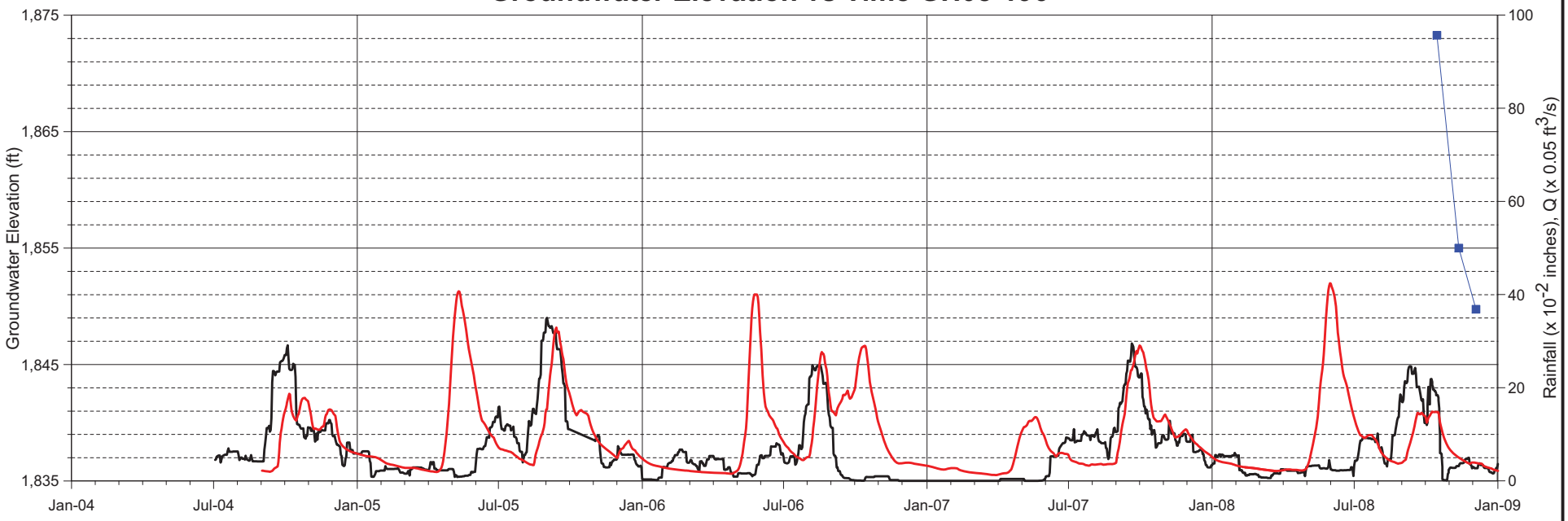


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-196



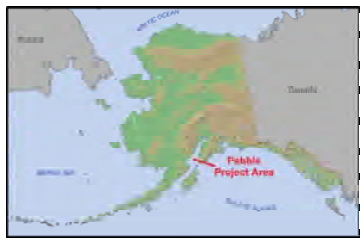
LEGEND:

Groundwater Elevation Plot Legend

- GH08-196
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

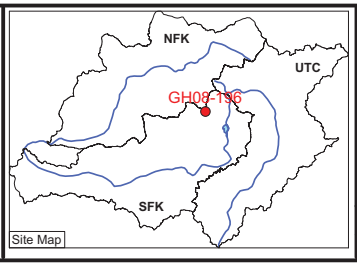
Screens (ft asl):
GH08-196 : 1841.6 - 1851.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1903.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-196.grf

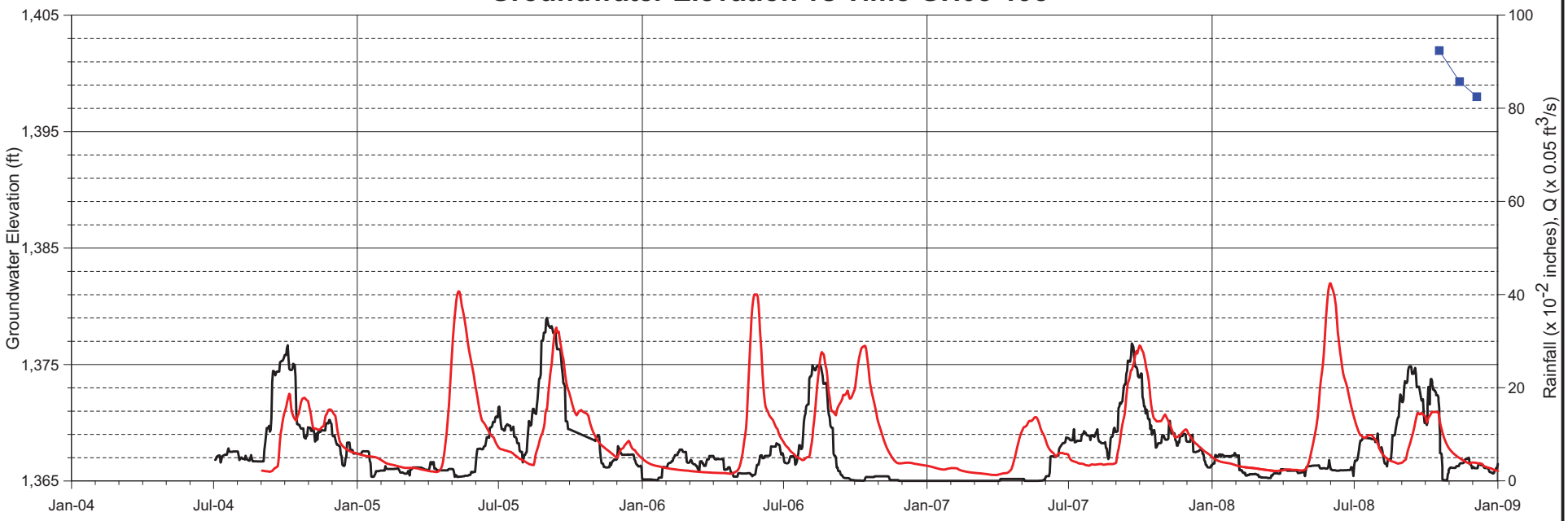


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-198



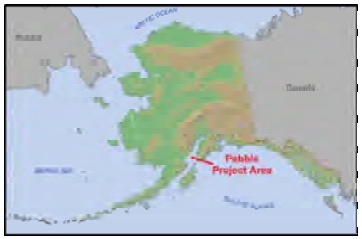
LEGEND:

Groundwater Elevation Plot Legend

- GH08-198
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

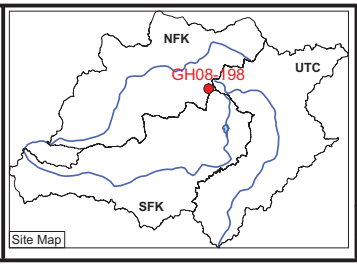
Screens (ft asl):
GH08-198 : 1367.9 - 1377.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1412.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-198.grf

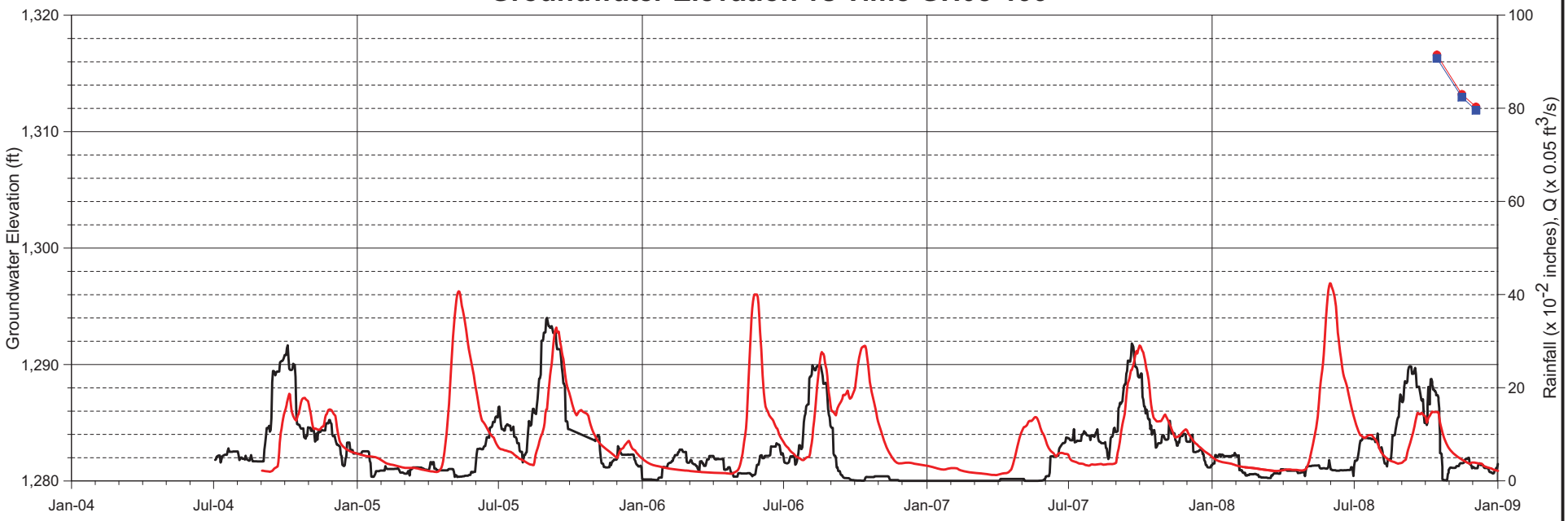


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-199



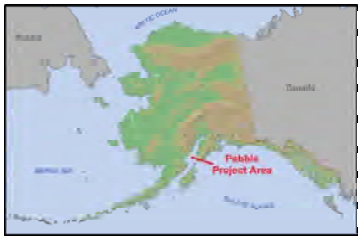
LEGEND:

Groundwater Elevation Plot Legend

- GH08-199S
- GH08-199D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

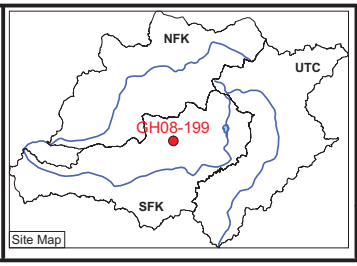
Screens (ft asl):
GH08-199S : 1242.2 - 1257.2
GH08-199D : 1197.2 - 1217.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1327.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-199.grf

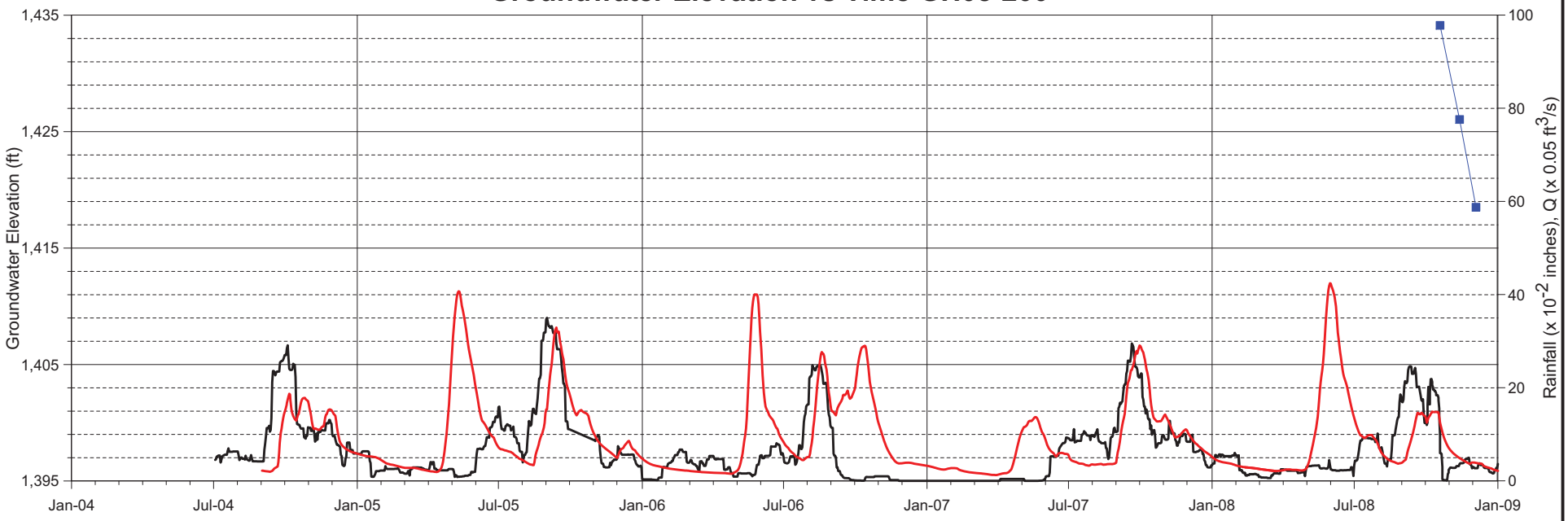


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-200



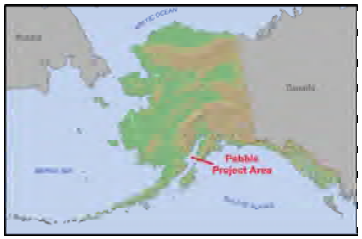
LEGEND:

Groundwater Elevation Plot Legend

- GH08-200
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

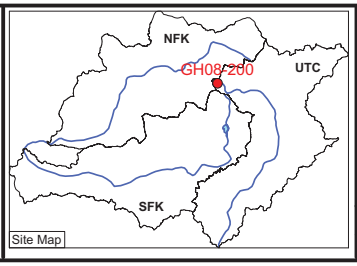
Screens (ft asl):
GH08-200 : 1368.9 - 1378.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1438.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-200.grf

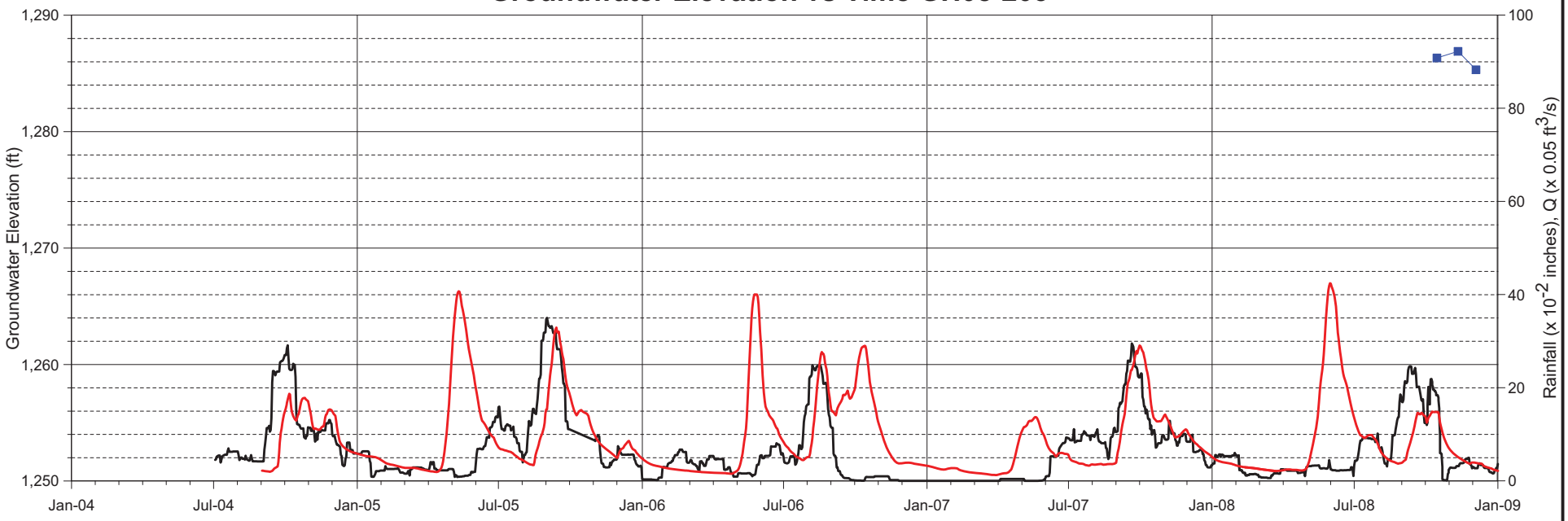


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-203



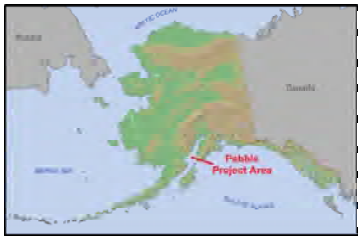
LEGEND:

Groundwater Elevation Plot Legend

- GH08-203
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

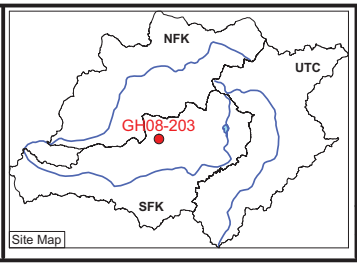
Screens (ft asl):
GH08-203 : 1255.8 - 1265.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1298.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-203.grf

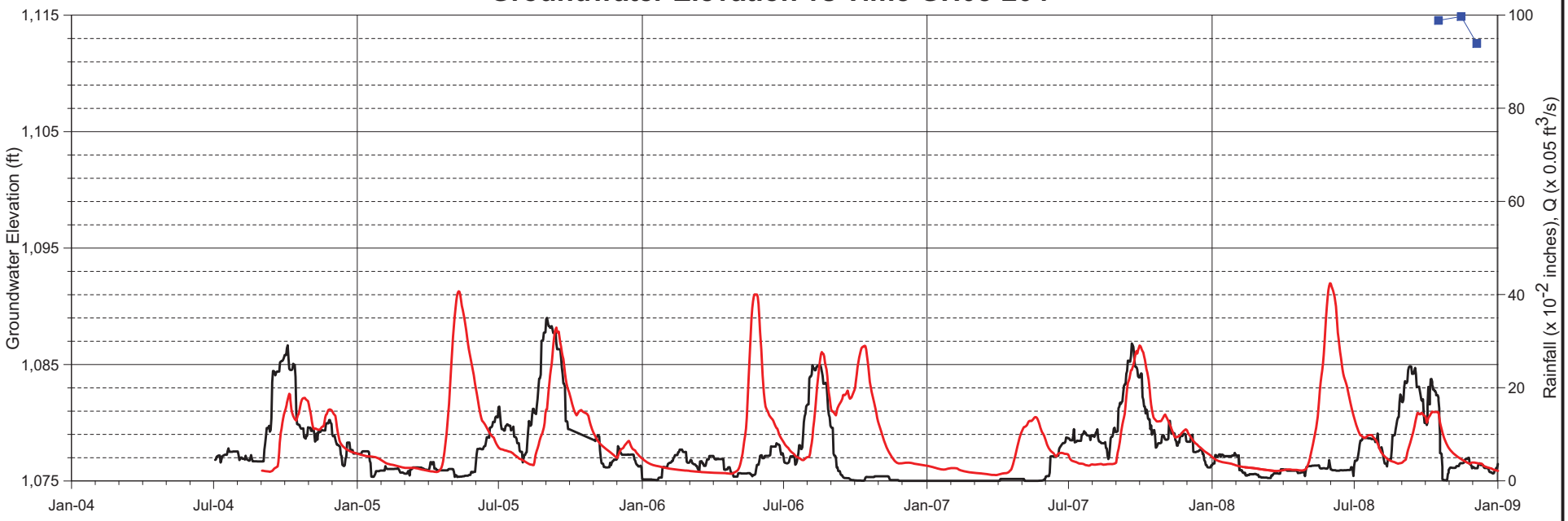


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-204



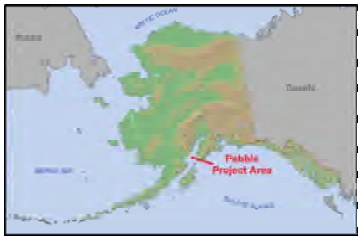
LEGEND:

Groundwater Elevation Plot Legend

- GH08-204
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

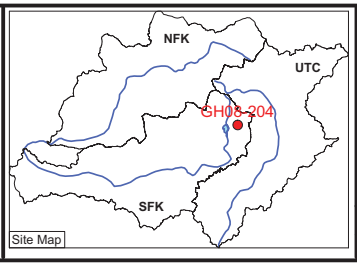
Screens (ft asl):
GH08-204 : 1072.2 - 1082.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-204.grf

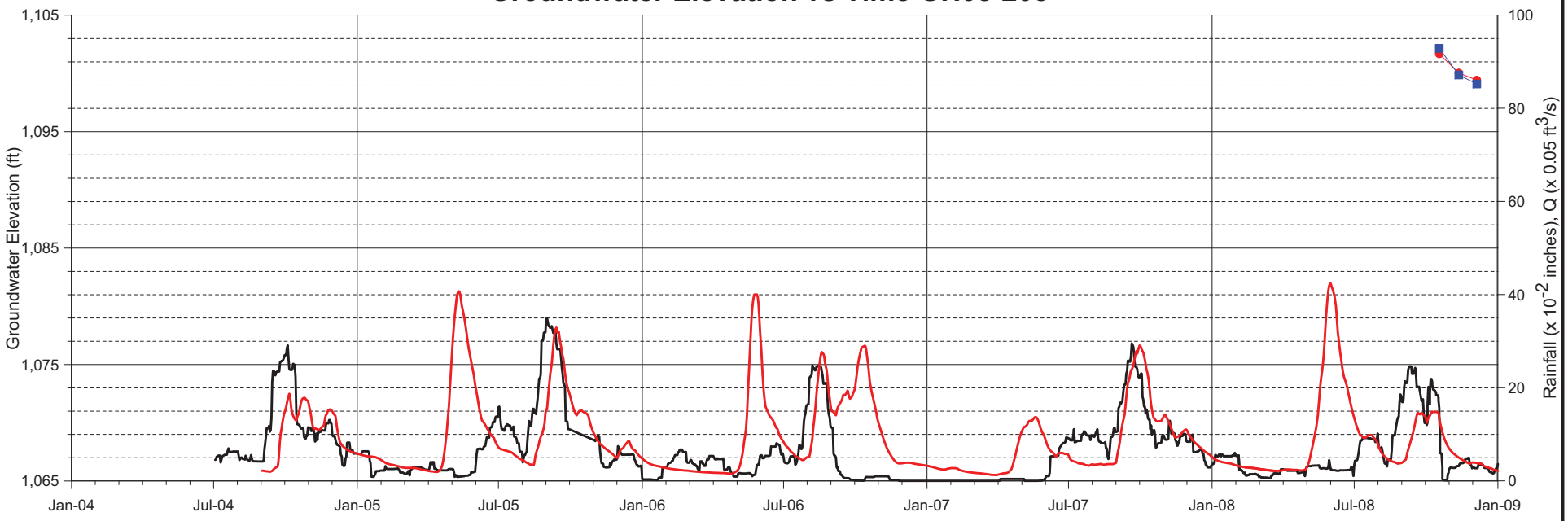


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-205



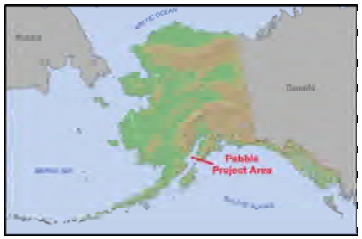
LEGEND:

Groundwater Elevation Plot Legend

- GH08-205S
- GH08-205D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

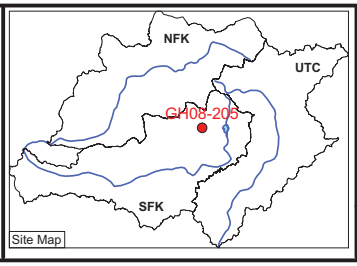
Screens (ft asl):
GH08-205S : 1058.1 - 1078.1
GH08-205D : 1011.6 - 1031.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1108.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-205.grf

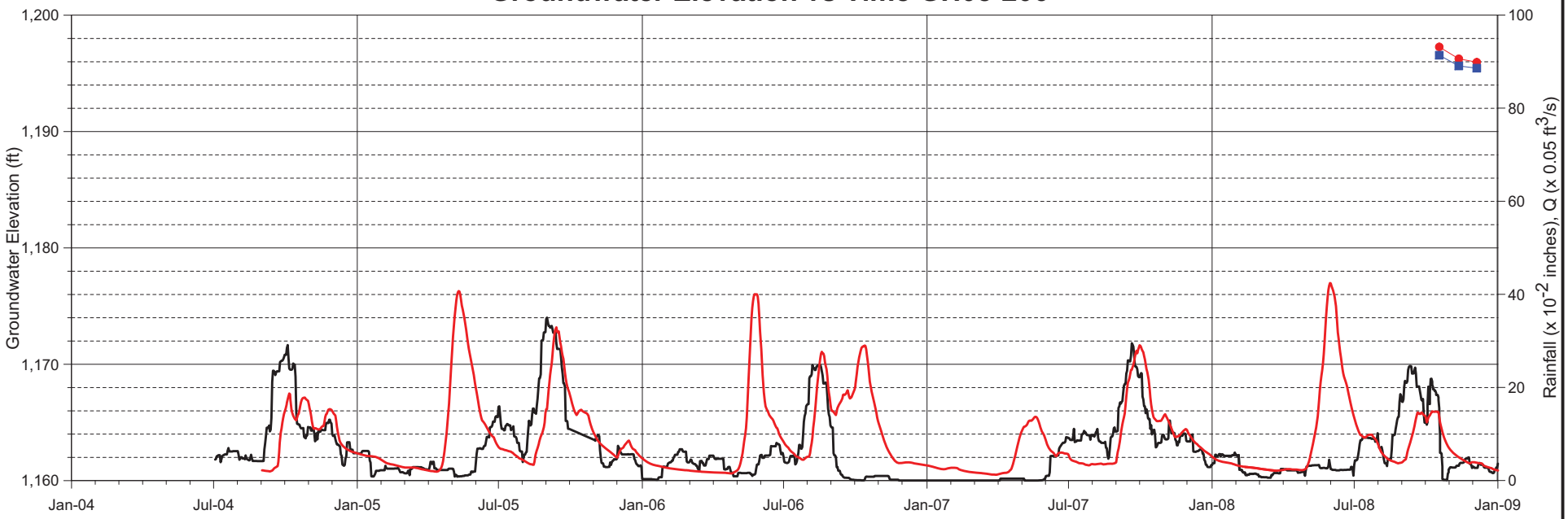


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-206



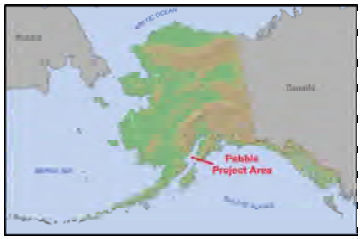
LEGEND:

Groundwater Elevation Plot Legend

- GH08-206S
- GH08-206D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

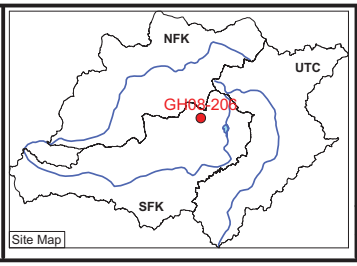
Screens (ft asl):
GH08-206S : 1089.6 - 1099.6
GH08-206D : 1034.6 - 1044.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1199.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-206.grf

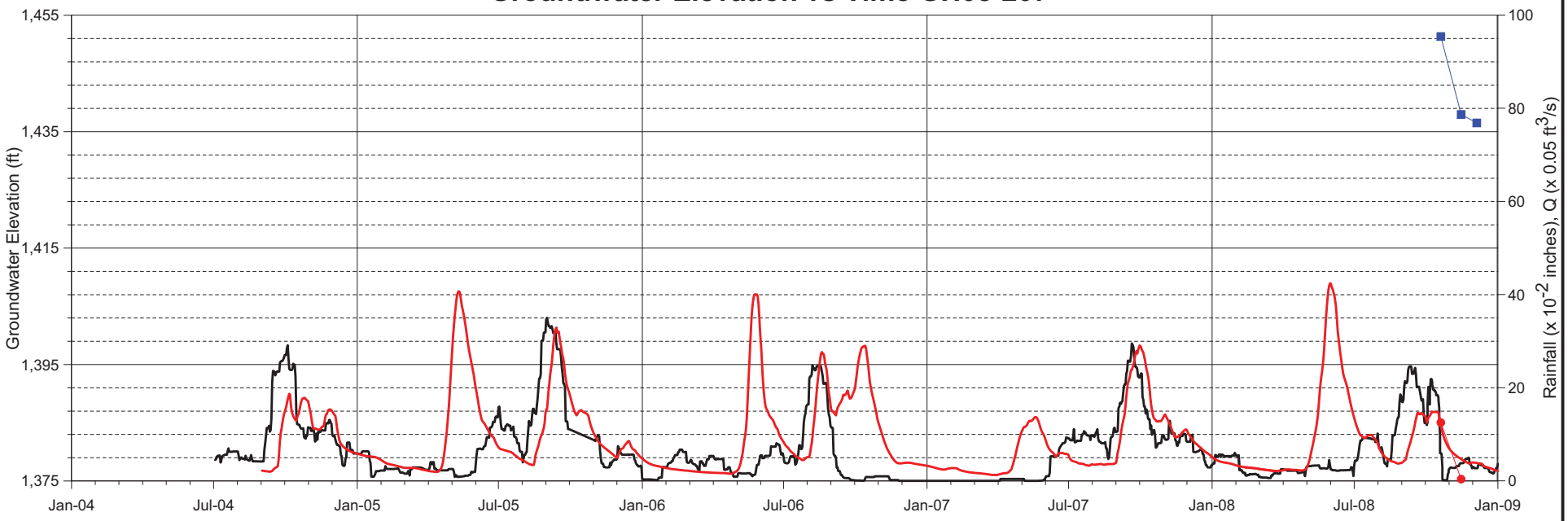


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-207



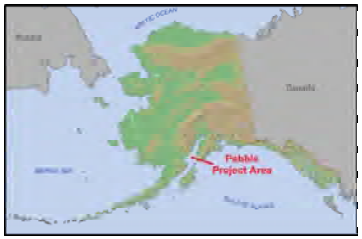
LEGEND:

Groundwater Elevation Plot Legend

- GH08-207S
- GH08-207D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH08-207S : 1433.8 - 1443.8
GH08-207D : 1374.8 - 1384.8

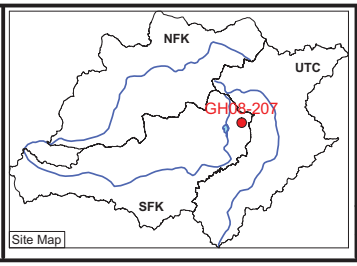


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1478.8 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-207.grf

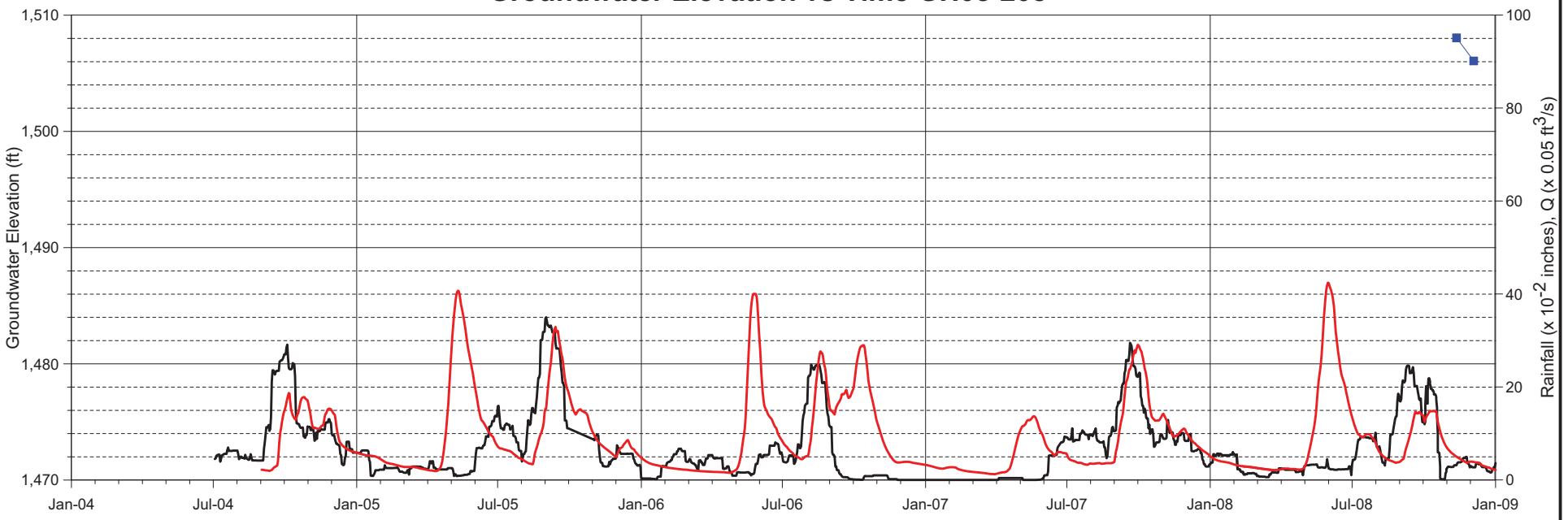


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-208



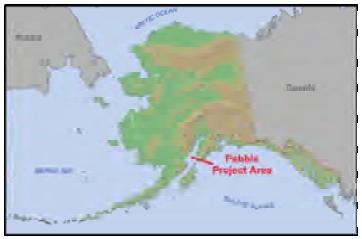
LEGEND:

Groundwater Elevation Plot Legend

- GH08-208
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

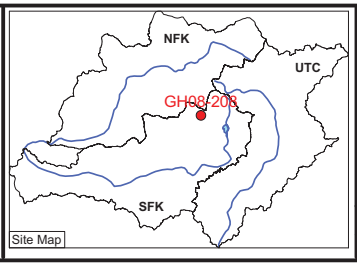
Screens (ft asl):
GH08-208 : 1451.2 - 1461.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1515.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-208.grf

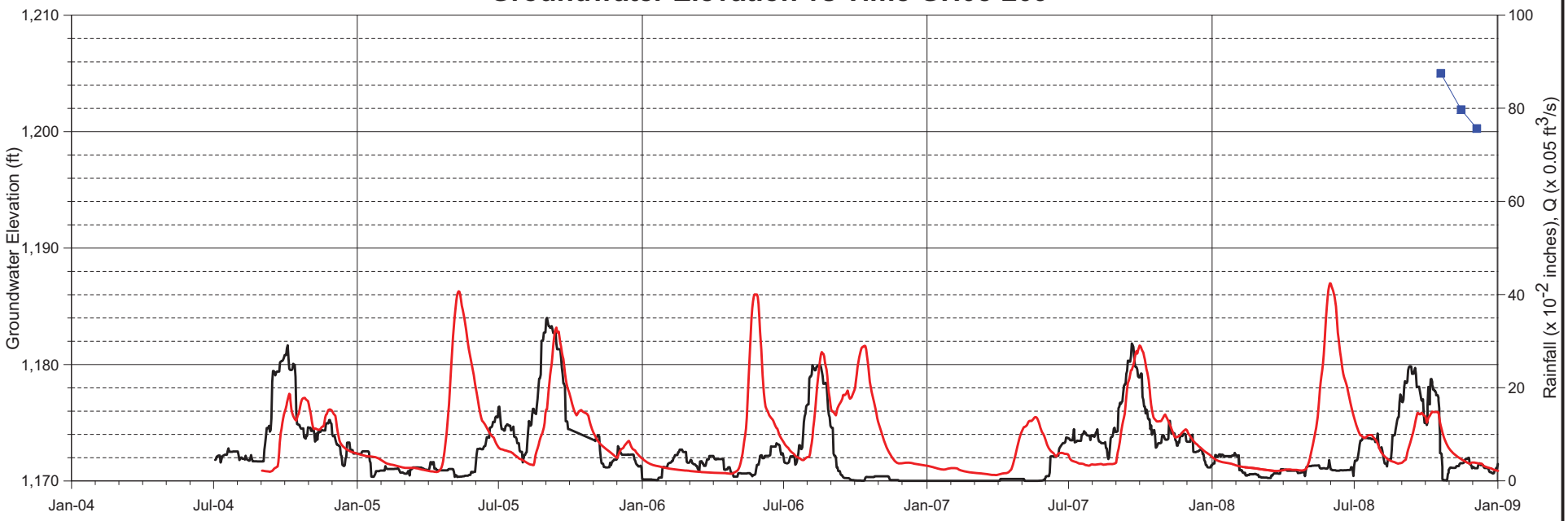


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-209



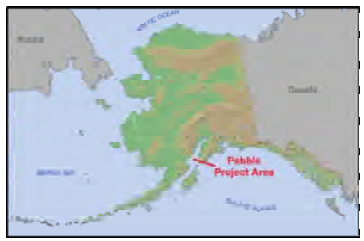
LEGEND:

Groundwater Elevation Plot Legend

- GH08-209
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

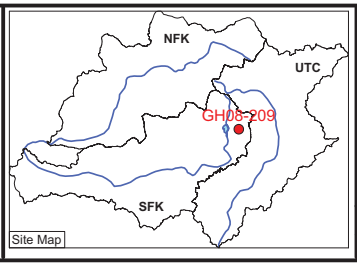
Screens (ft asl):
GH08-209 : 1147.9 - 1157.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1221.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-209.grf

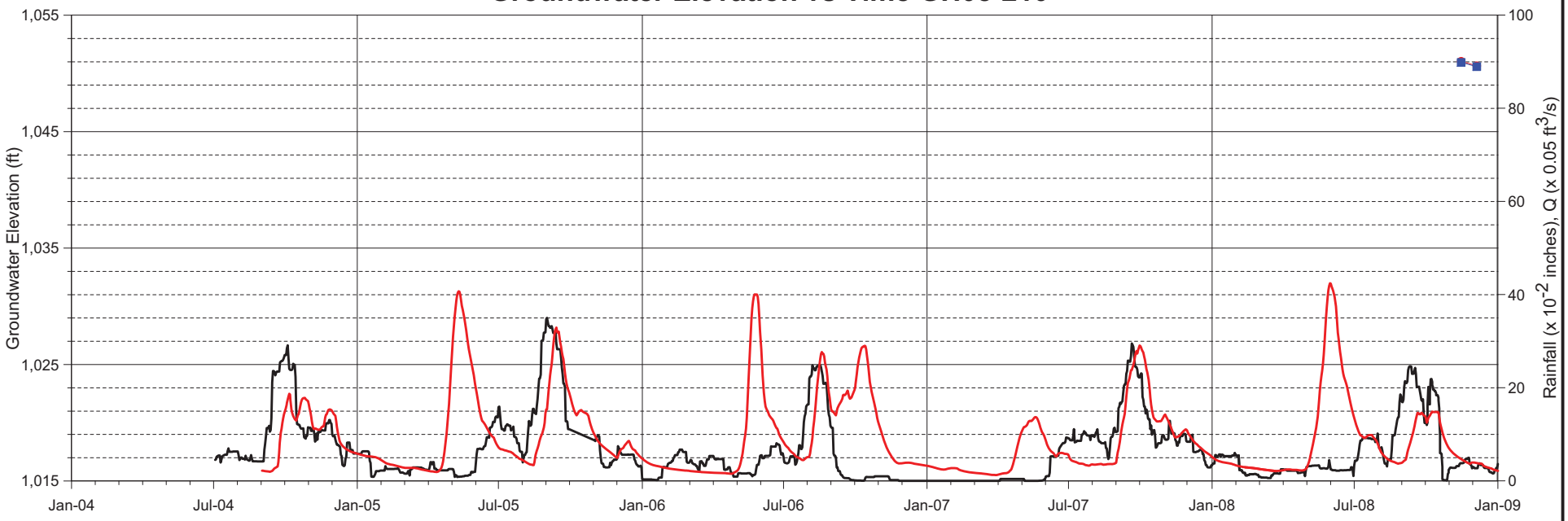


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-210



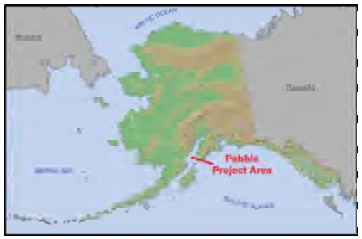
LEGEND:

Groundwater Elevation Plot Legend

- GH08-210S
- GH08-210D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

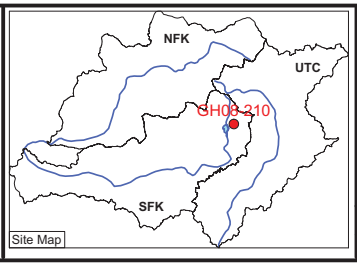
Screens (ft asl):
GH08-210S : 1007.5 - 1017.5
GH08-210D : 962.5 - 972.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1092.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-210.grf

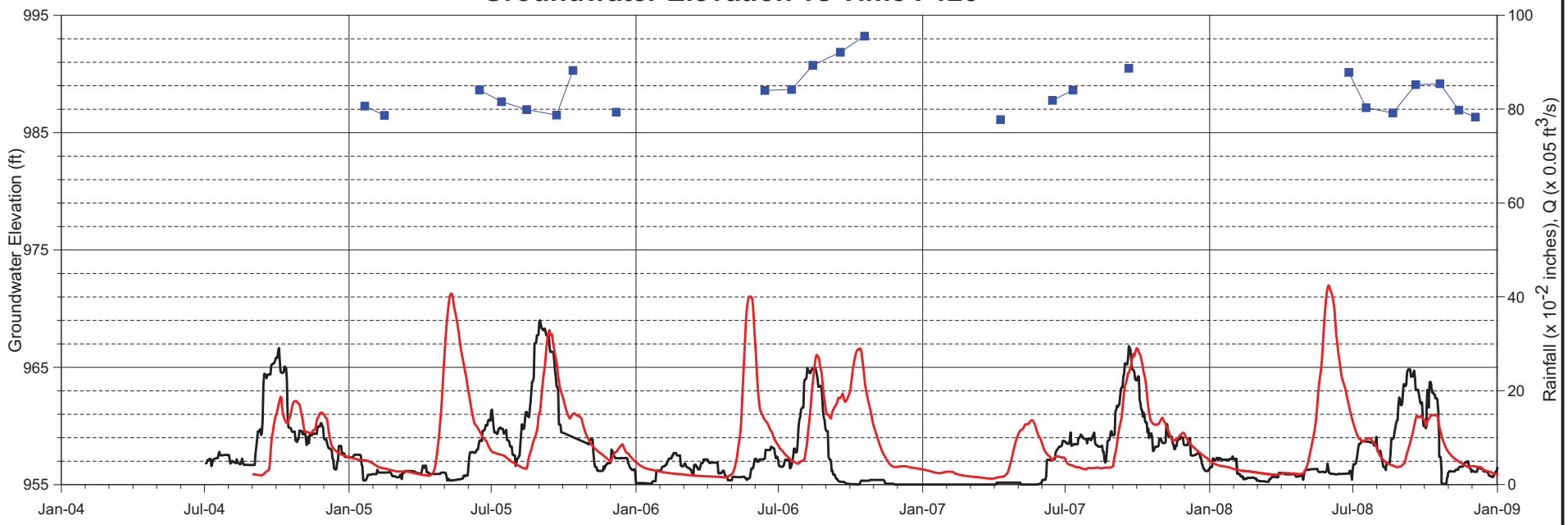


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time I-125



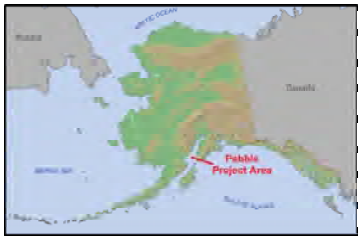
LEGEND:

Groundwater Elevation Plot Legend

- I-125
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

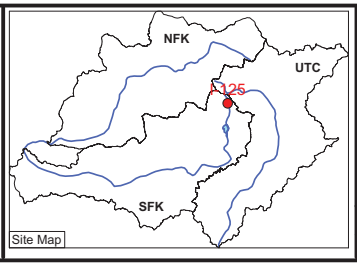
Screens (ft asl):
I-125 : 926.5 - 936.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1005.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\I-125.grf

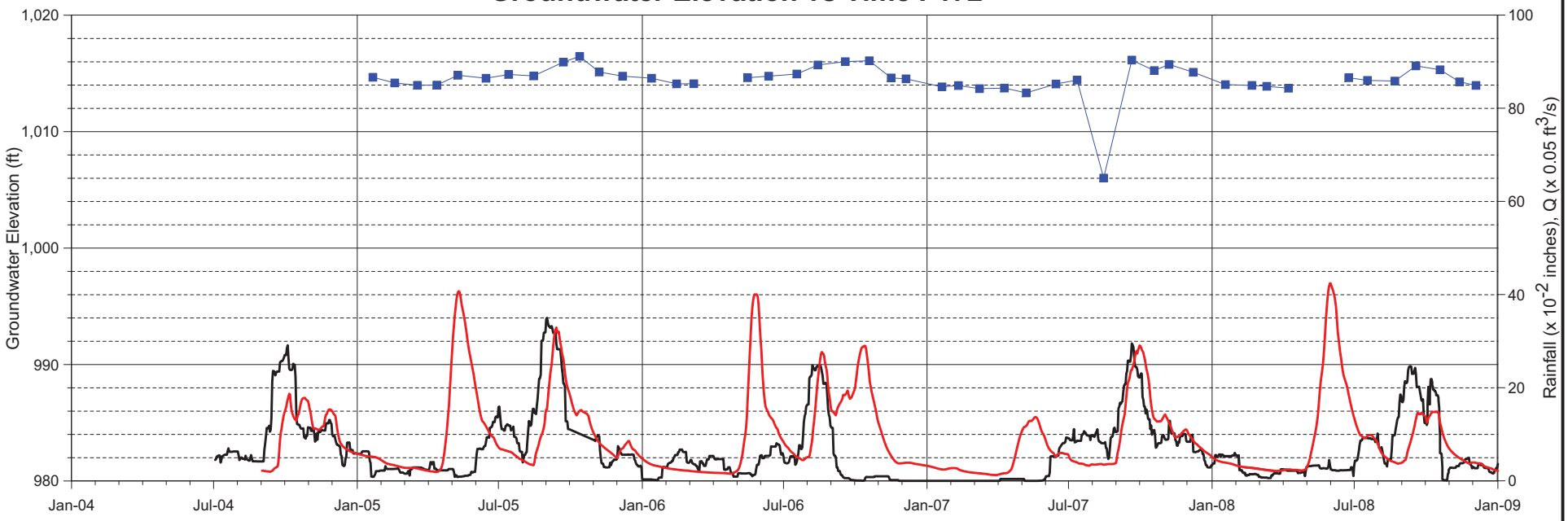


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time I-172



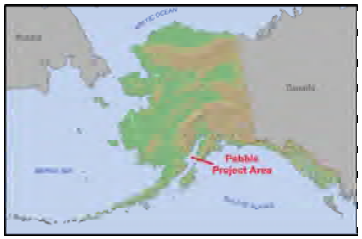
LEGEND:

Groundwater Elevation Plot Legend

- I-172
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

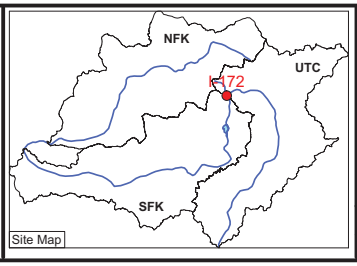
Screens (ft asl):
I-172 : 896.3 - 906.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1023.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\I-172.grf

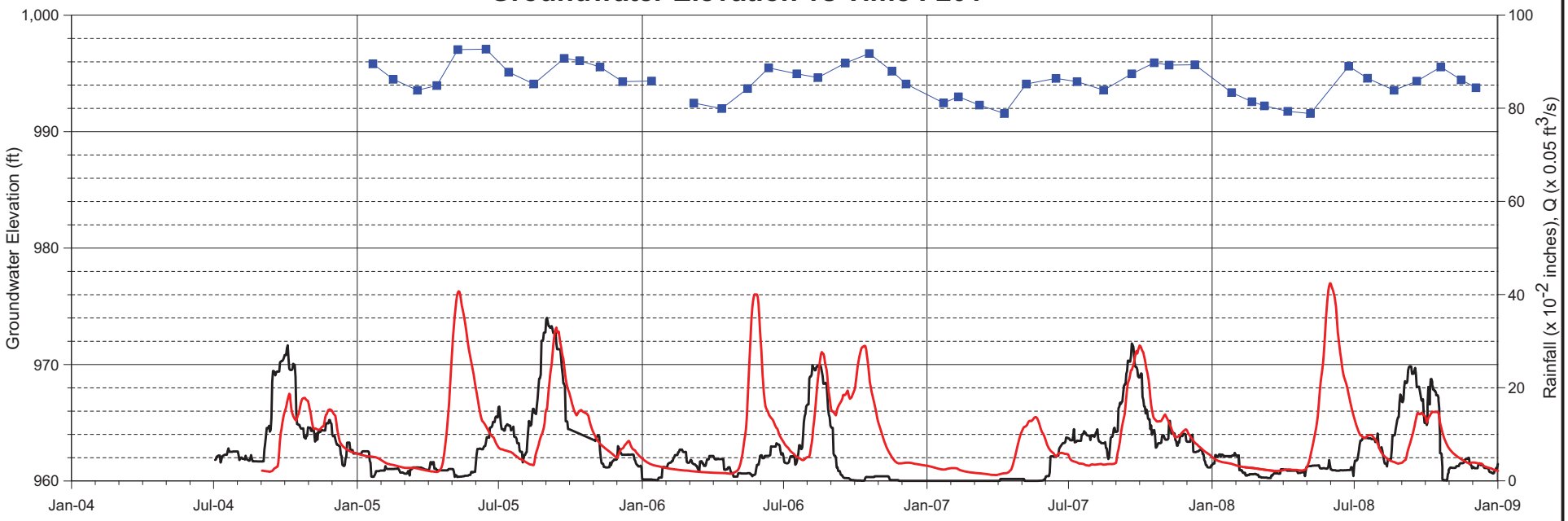


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time I-201



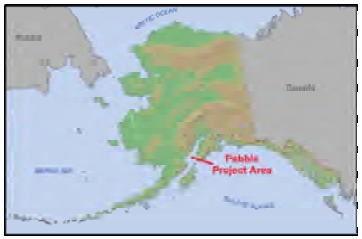
LEGEND:

Groundwater Elevation Plot Legend

- I-201
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

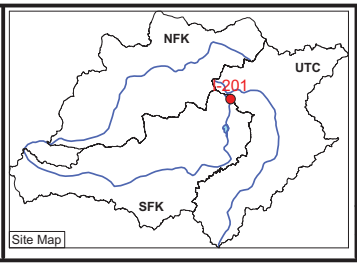
Screens (ft asl):
I-201 : 902.1 - 912.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1055.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\I-201.grf

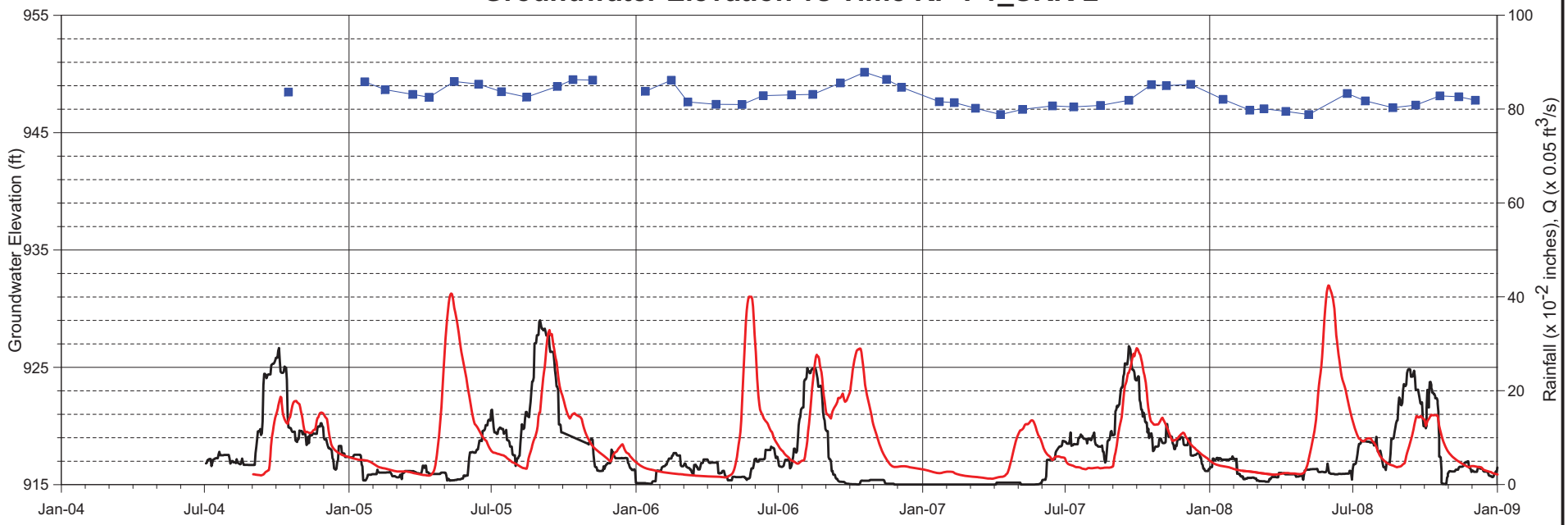


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time KP-P1_SRK-2



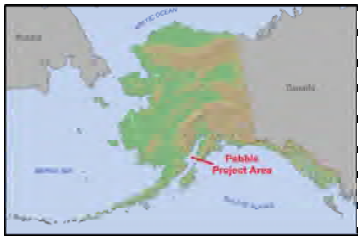
LEGEND:

Groundwater Elevation Plot Legend

- KP-P1/SRK-2
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

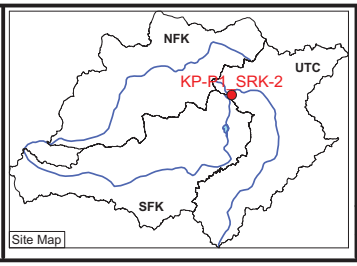
Screens (ft asl):
KP-P1/SRK-2 : 863.8 - 873.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 997.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\KP-P1_SRK-2.grf

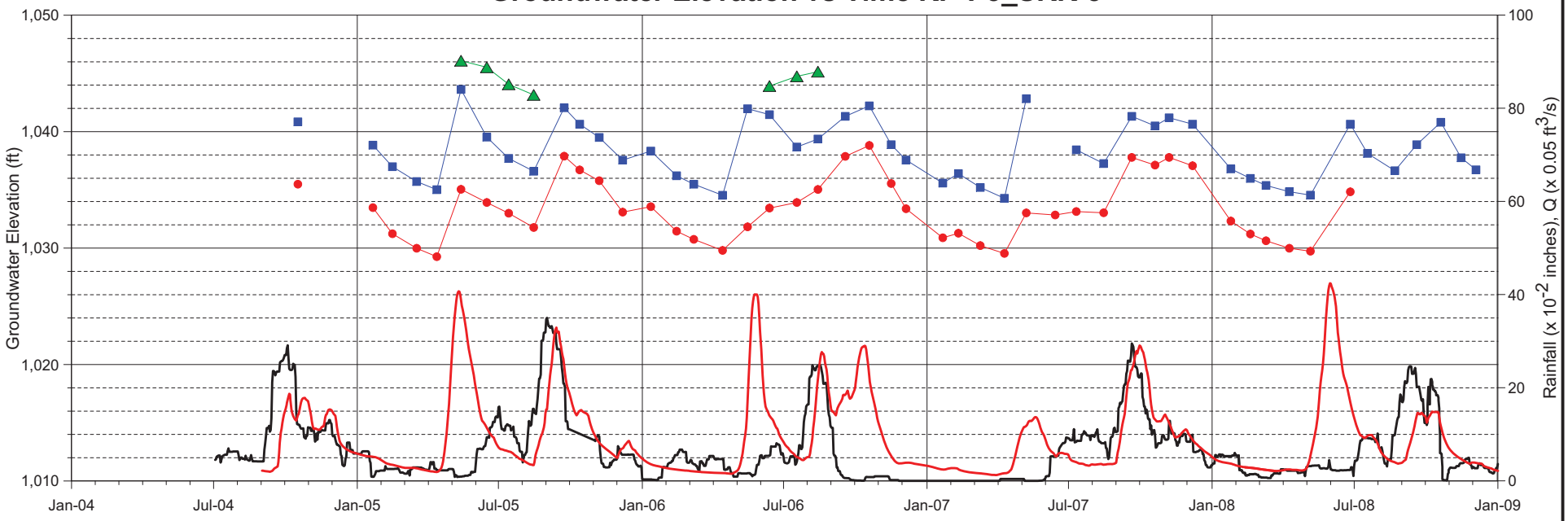


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time KP-P3_SRK-5



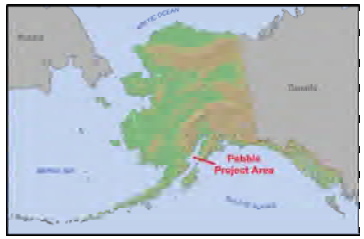
LEGEND:

Groundwater Elevation Plot Legend

- KP-P3S/SRK-5S
- KP-P3M/SRK-5M
- KP-P3D/SRK-5D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
KP-P3S/SRK-5S : 1024.6 - 1034.6
KP-P3M/SRK-5M : 992.1 - 1002.1
KP-P3D/SRK-5D : 965.1 - 975.1

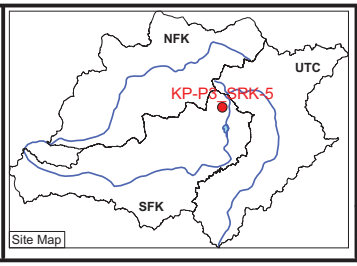


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1042.6 ft asl

KP-P3D is a flowing well. Water levels were recorded occasionally when an extension was placed on the well.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\KP-P3_SRK-5.grf

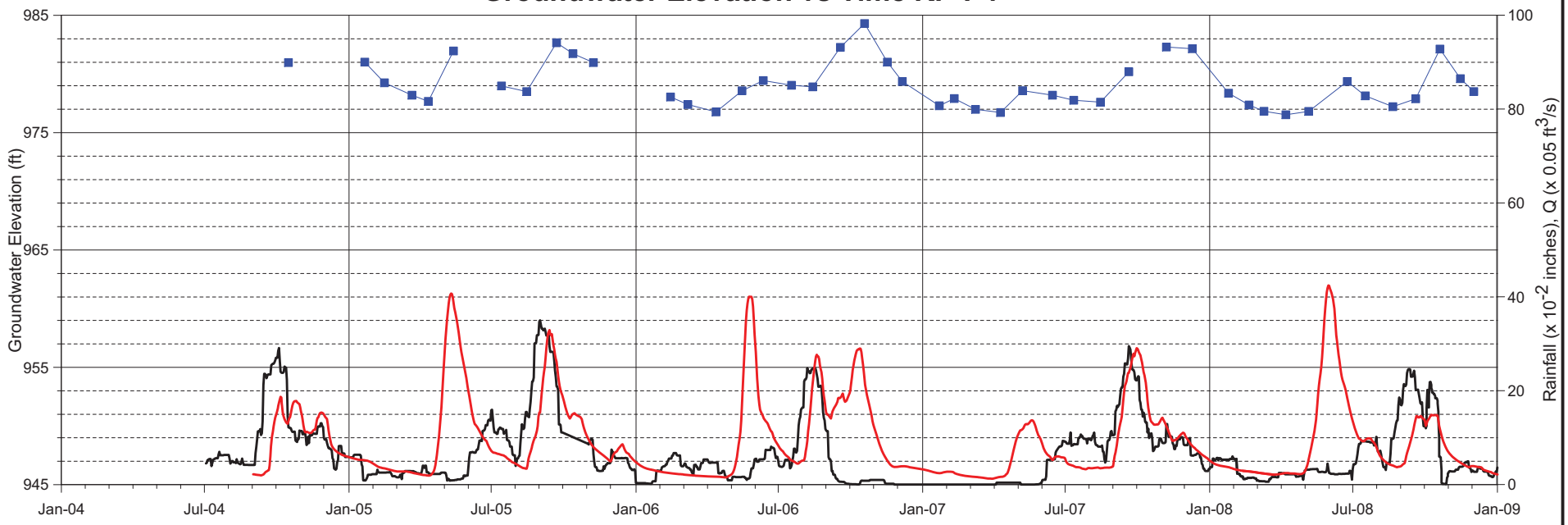


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time KP-P4



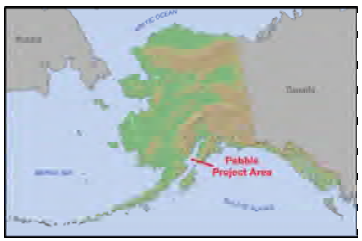
LEGEND:

Groundwater Elevation Plot Legend

- KP-P4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

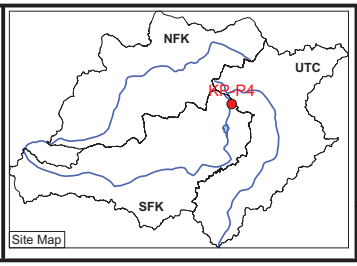
Screens (ft asl):



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 999.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\KP-P4.grf

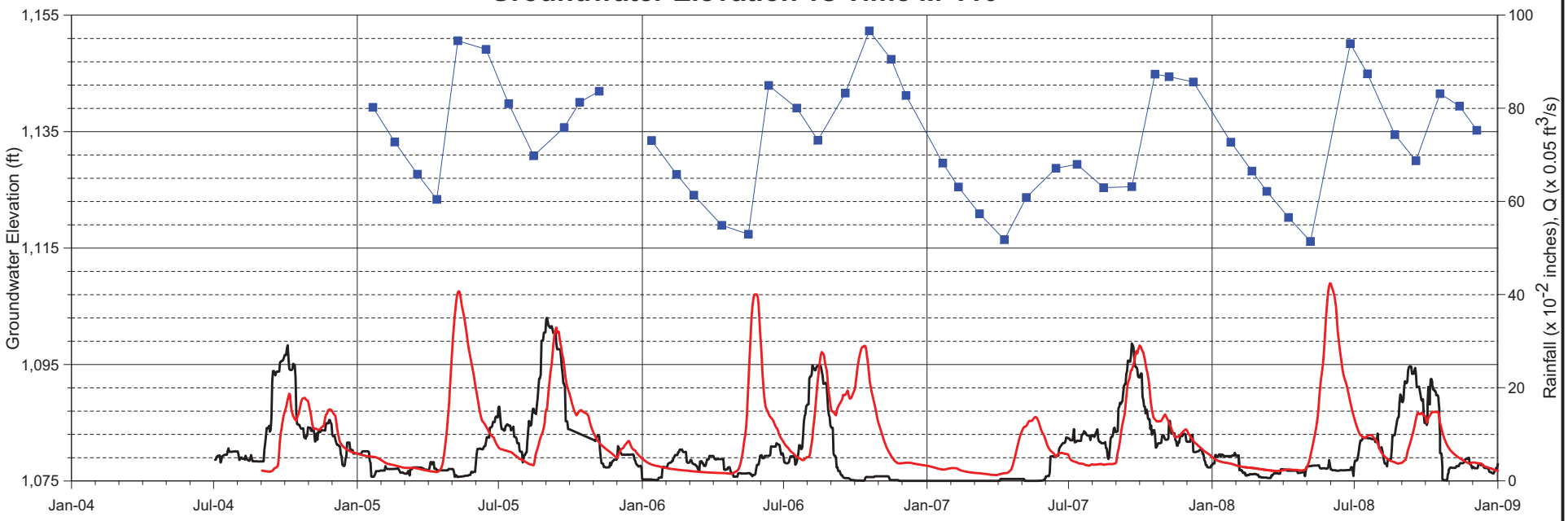


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-110



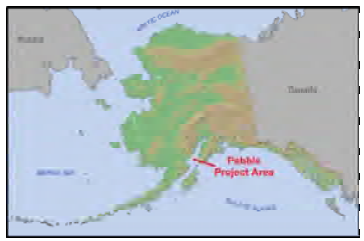
LEGEND:

Groundwater Elevation Plot Legend

- M-110
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
M-110 : 1082.1 - 1092.2

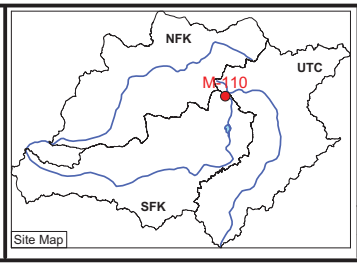


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1179.1 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-110.grf

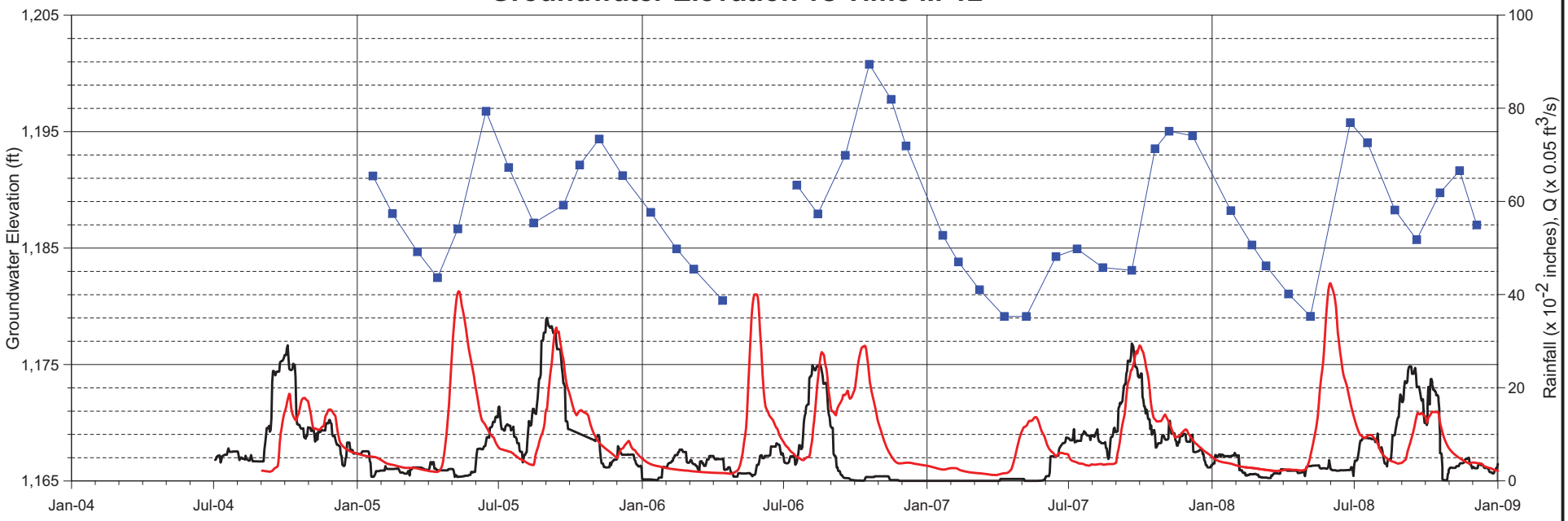


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-12



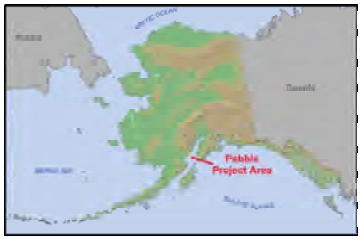
LEGEND:

Groundwater Elevation Plot Legend

- M-12
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

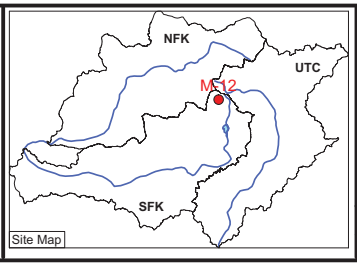
Screens (ft asl):
M-12 : 1155.2 - 1165.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1201.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-12.grf

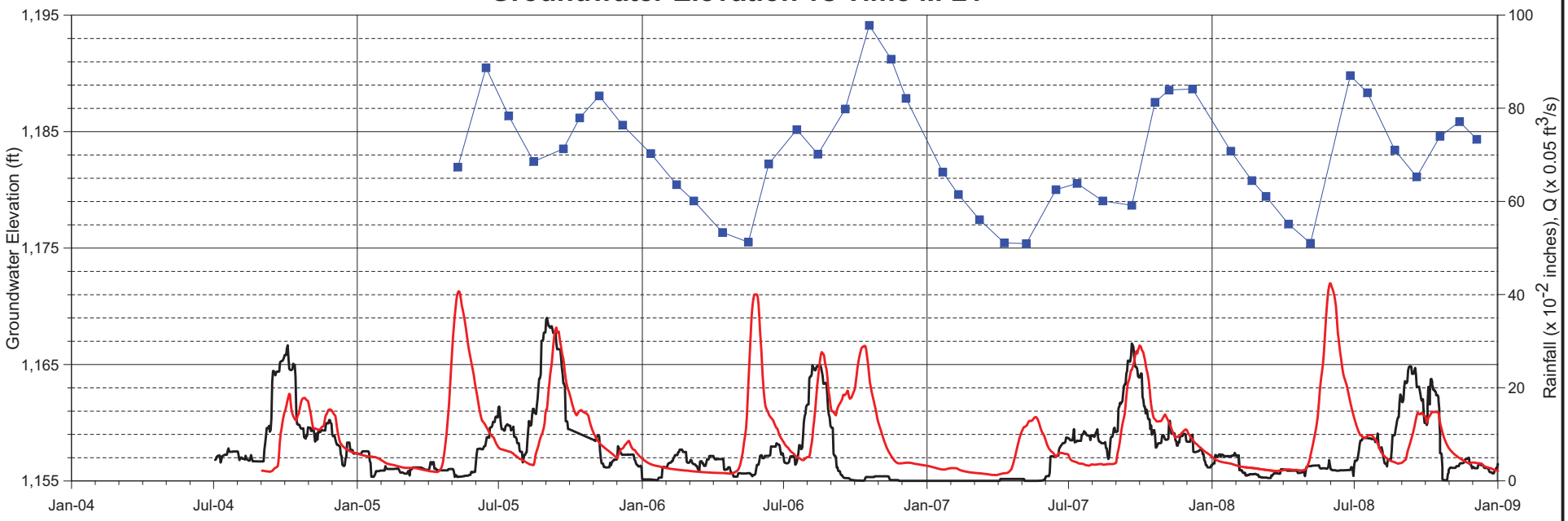


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-21



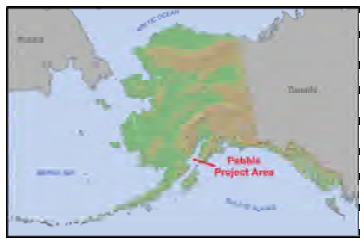
LEGEND:

Groundwater Elevation Plot Legend

- M-21
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

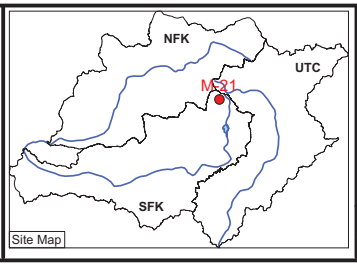
Screens (ft asl):
M-21 : 1126.4 - 1136.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1215.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-21.grf

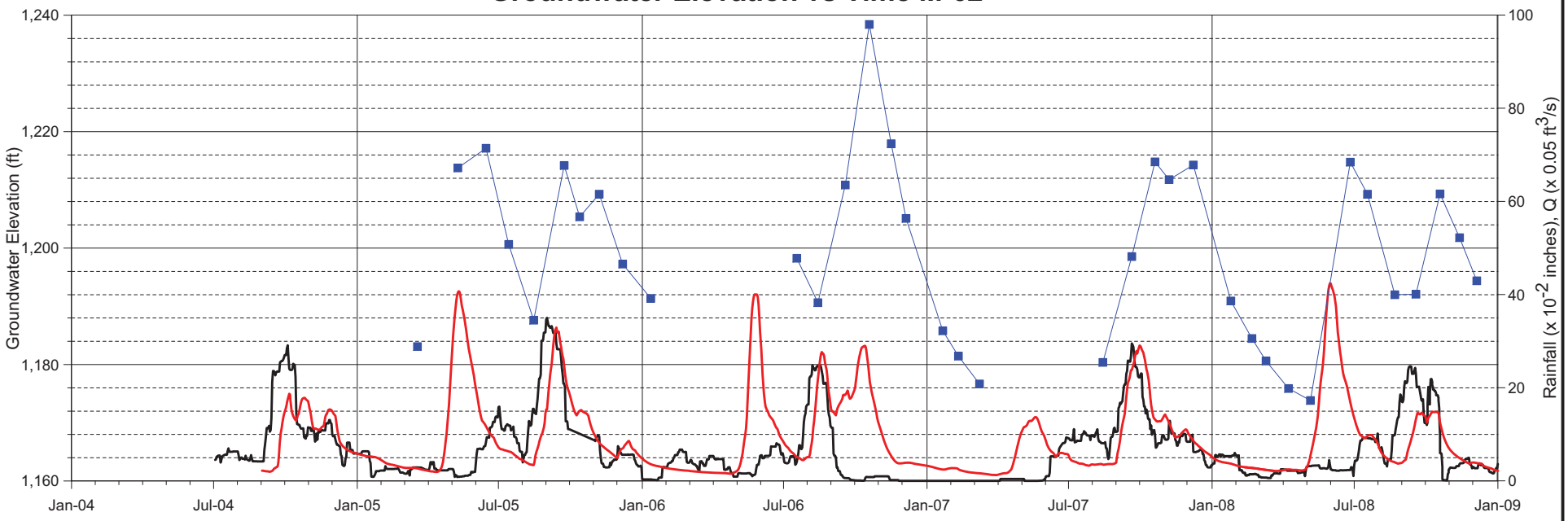


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-62



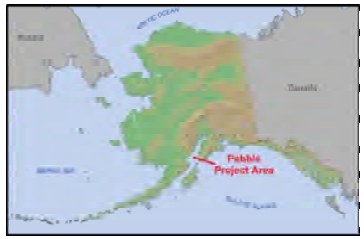
LEGEND:

Groundwater Elevation Plot Legend

- M-62
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
M-62 : 1157.4 - 1177.2

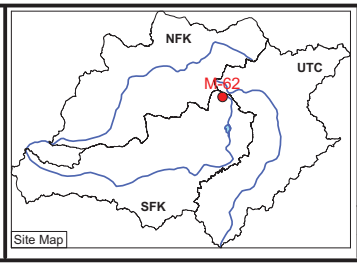


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1320.4 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-62.grf

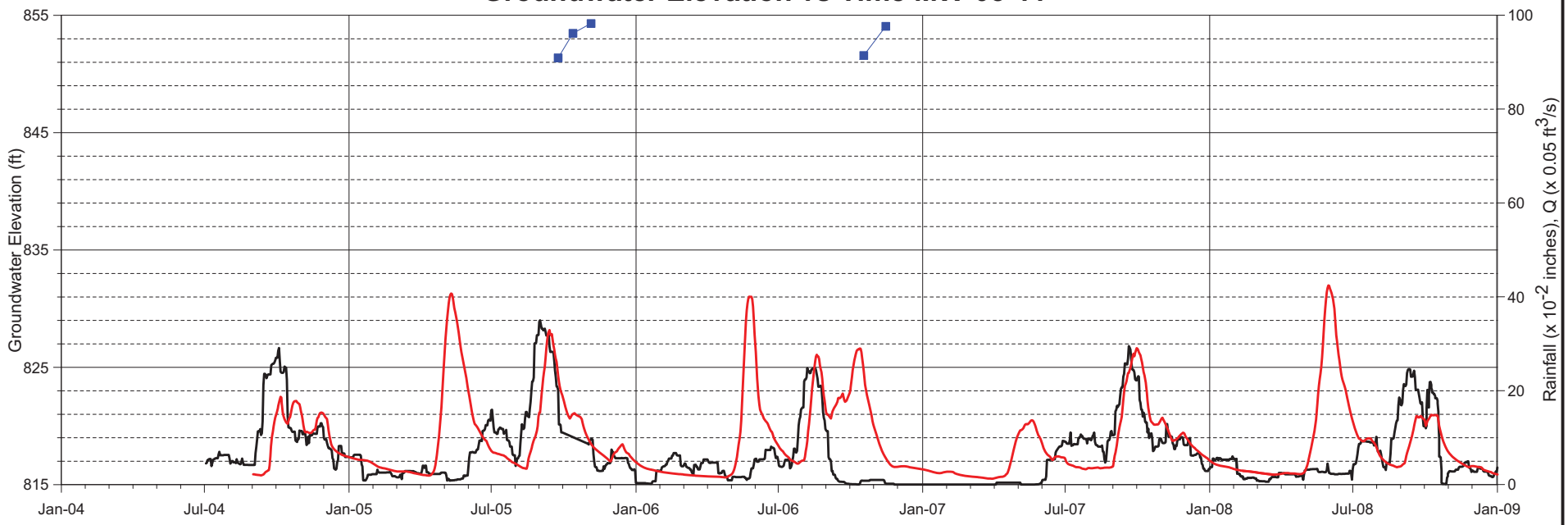


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-11



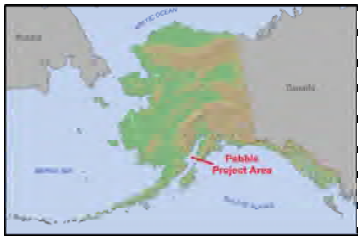
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-11SS
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-05-11SS : 849.0 - 859.0

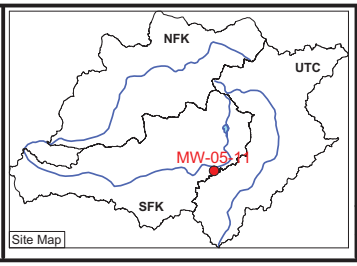


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 880.3 ft asl

MW-05-11 was dry for most of the period of record.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-11.grf

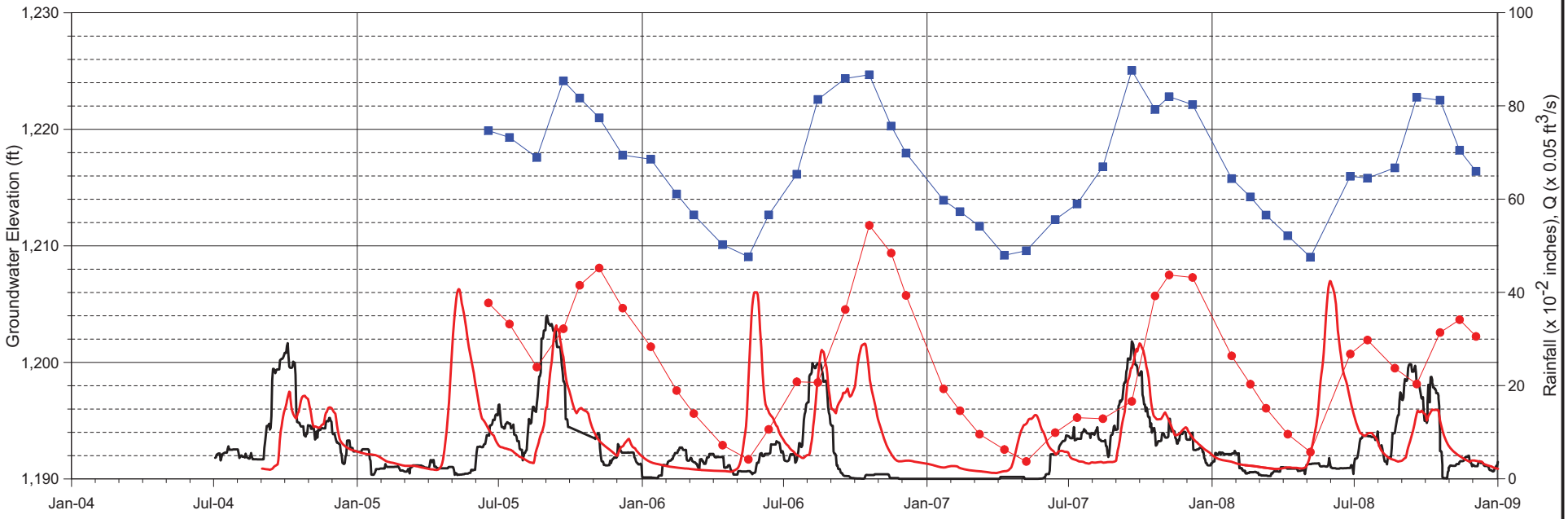


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time MW-05-12



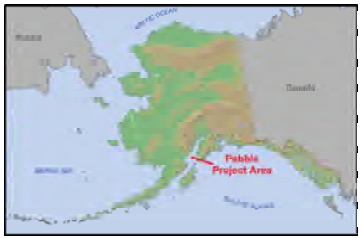
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-12S
- MW-05-12D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

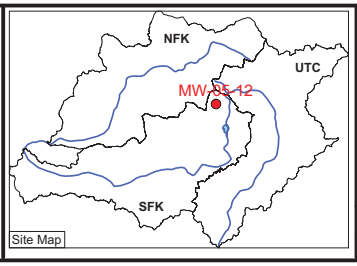
Screens (ft asl):
MW-05-12S : 1184.9 - 1189.9
MW-05-12D : 1104.6 - 1124.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1225.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-12.grf

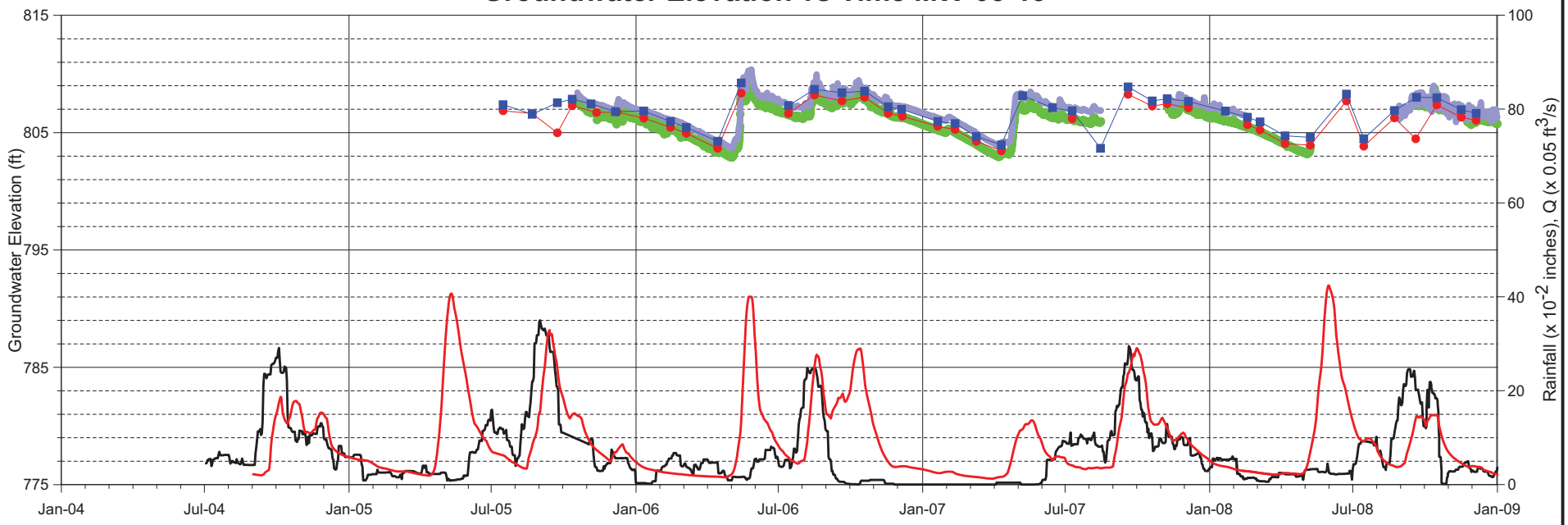


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-13



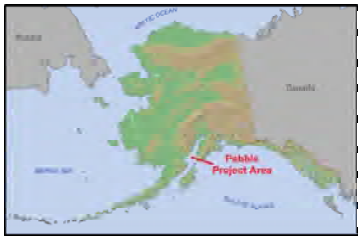
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-13S
- MW-05-13D
- MW-05-13S(Transducer)
- MW-05-13D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

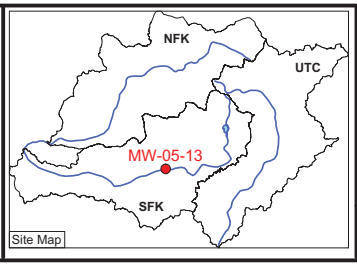
Screens (ft asl):
MW-05-13S : 780.5 - 795.5
MW-05-13D : 701.3 - 716.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 811.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-13.grf

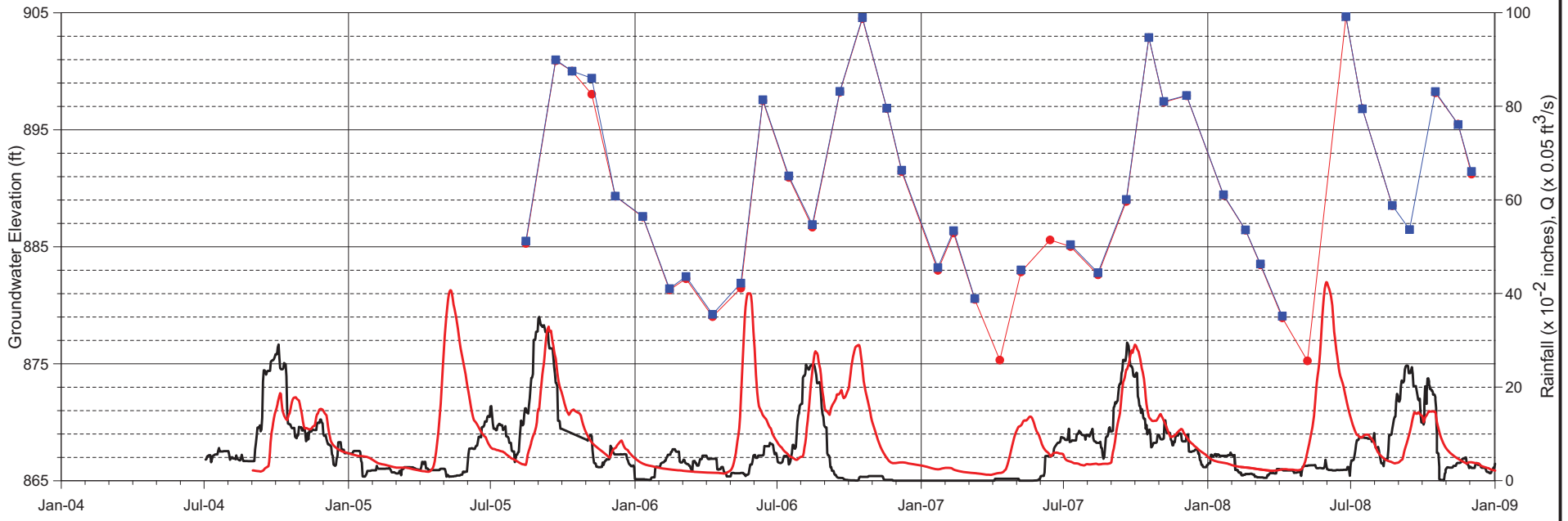


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-14



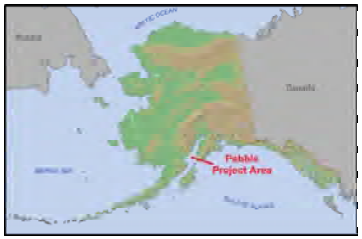
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-14S
- MW-05-14D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

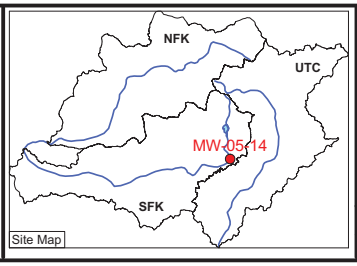
Screens (ft asl):
MW-05-14S : 876.8 - 881.8
MW-05-14D : 821.7 - 831.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 922.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-14.grf

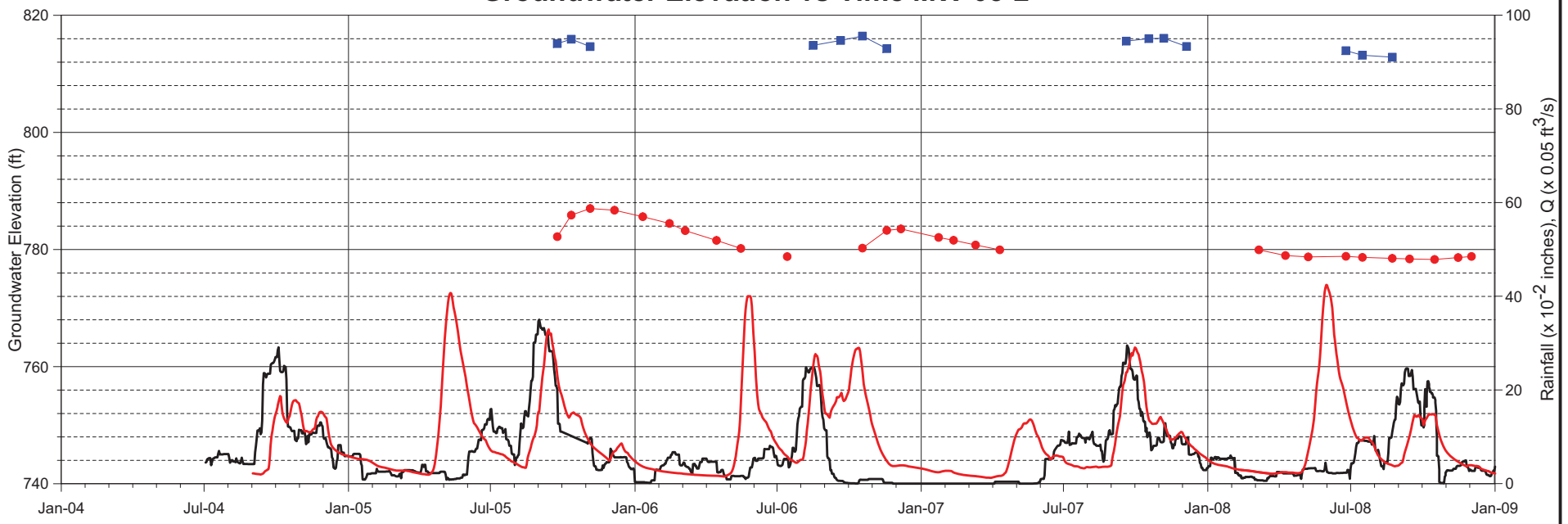


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-2



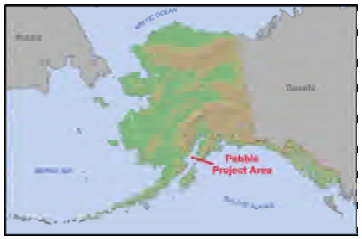
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-2SR
- MW-05-02M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-05-2SR : 812.2 - 817.2
MW-05-2SR : 812.2 - 817.2
MW-05-02M : 768.8 - 778.8
MW-05-02M : 768.8 - 778.8

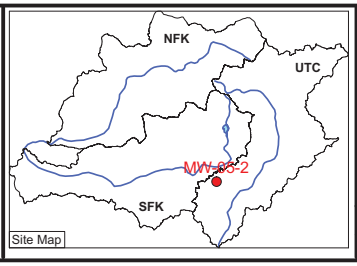


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 830.7 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-2.grf

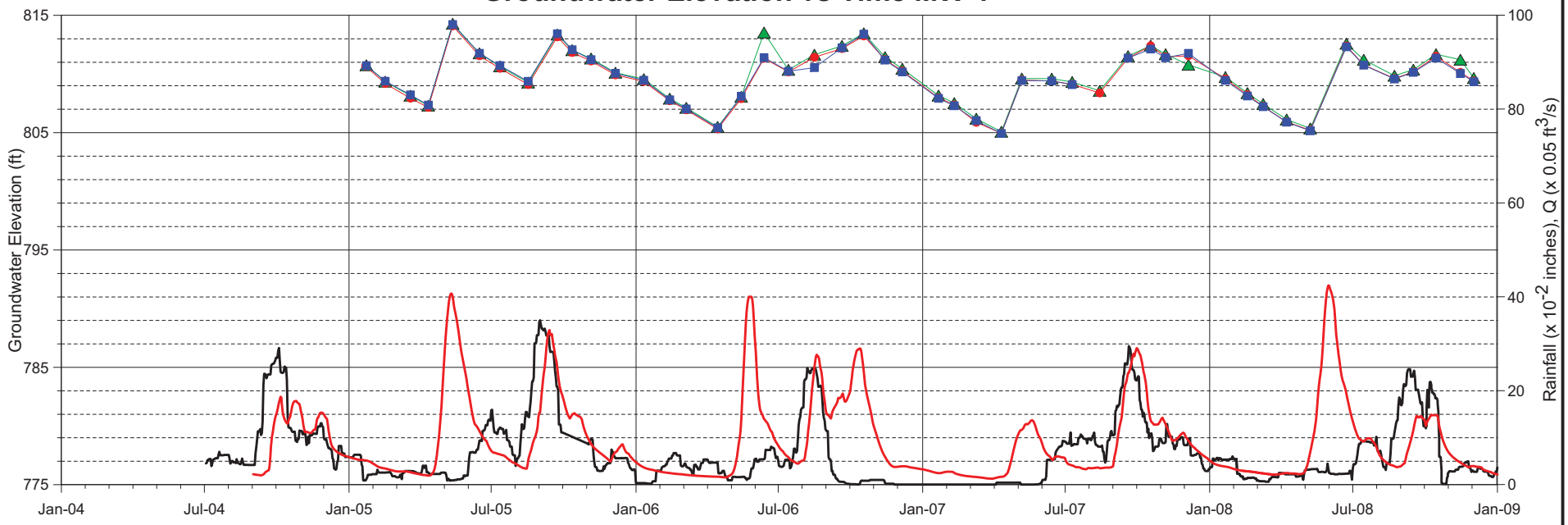


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-1



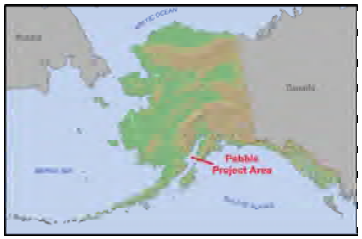
LEGEND:

Groundwater Elevation Plot Legend

- MW-1S
- MW-1M
- MW-1D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

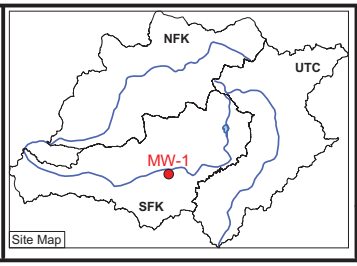
Screens (ft asl):
MW-1S : 791.2 - 801.2
MW-1M : 745.3 - 755.3
MW-1D : 682.1 - 692.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 816.2 ft asl

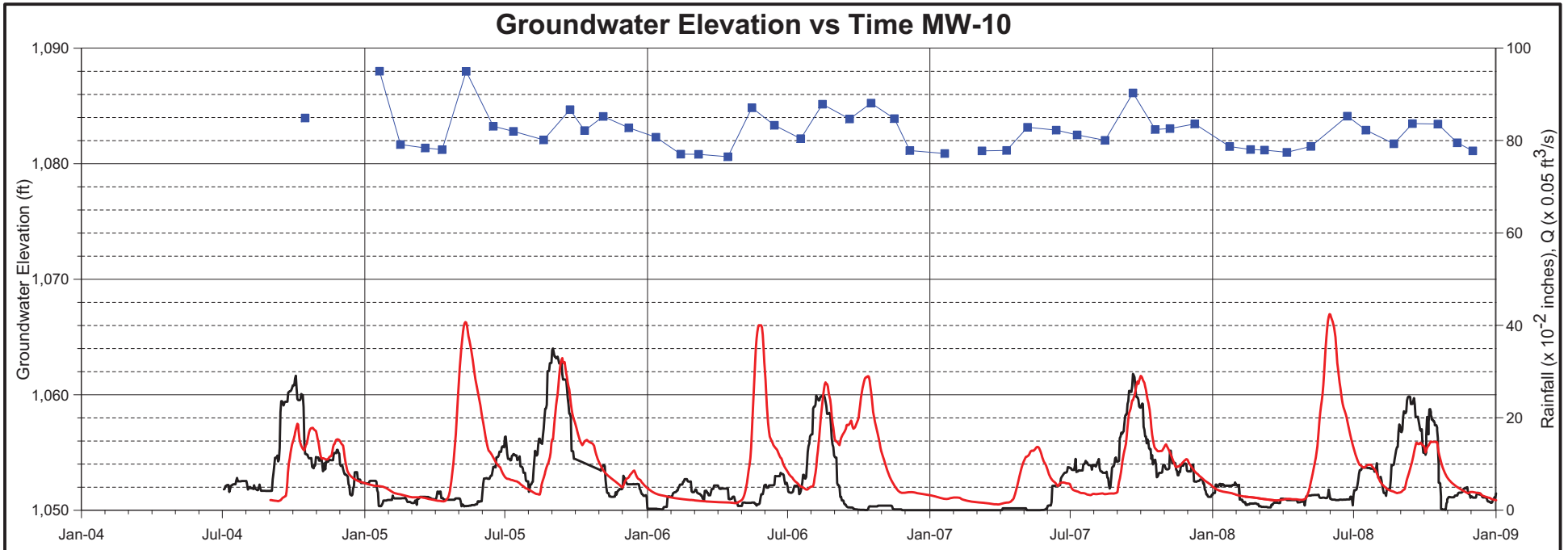
File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-1.grf



THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011



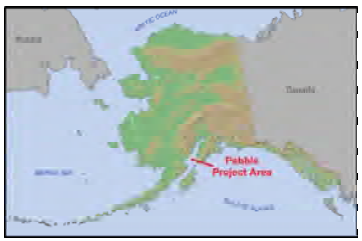
LEGEND:

Groundwater Elevation Plot Legend

- MW-10
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

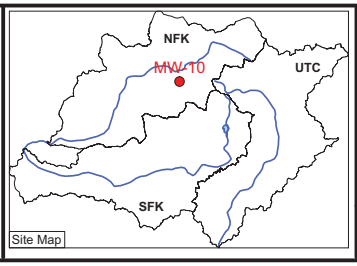
Screens (ft asl):
MW-10 : 1067.8 - 1077.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1107.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-10.grf

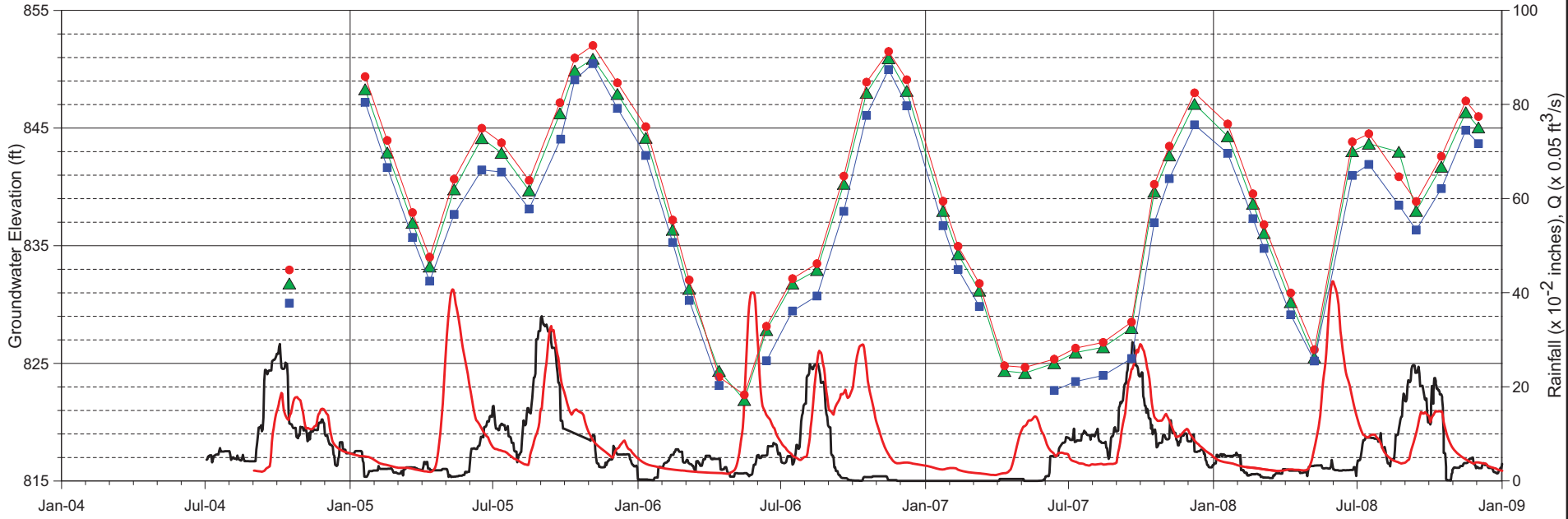


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-11



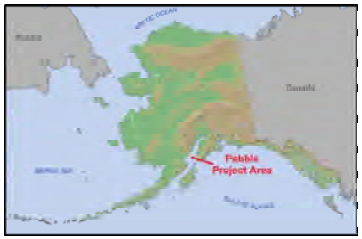
LEGEND:

Groundwater Elevation Plot Legend

- MW-11S
- MW-11M
- MW-11D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

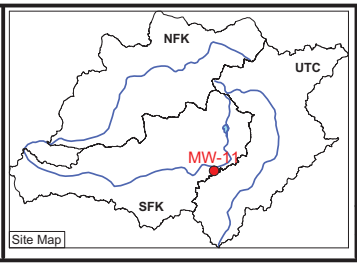
Screens (ft asl):
MW-11S : 810.4 - 830.4
MW-11M : 769.3 - 779.3
MW-11D : 745.2 - 755.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 881.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-11.grf

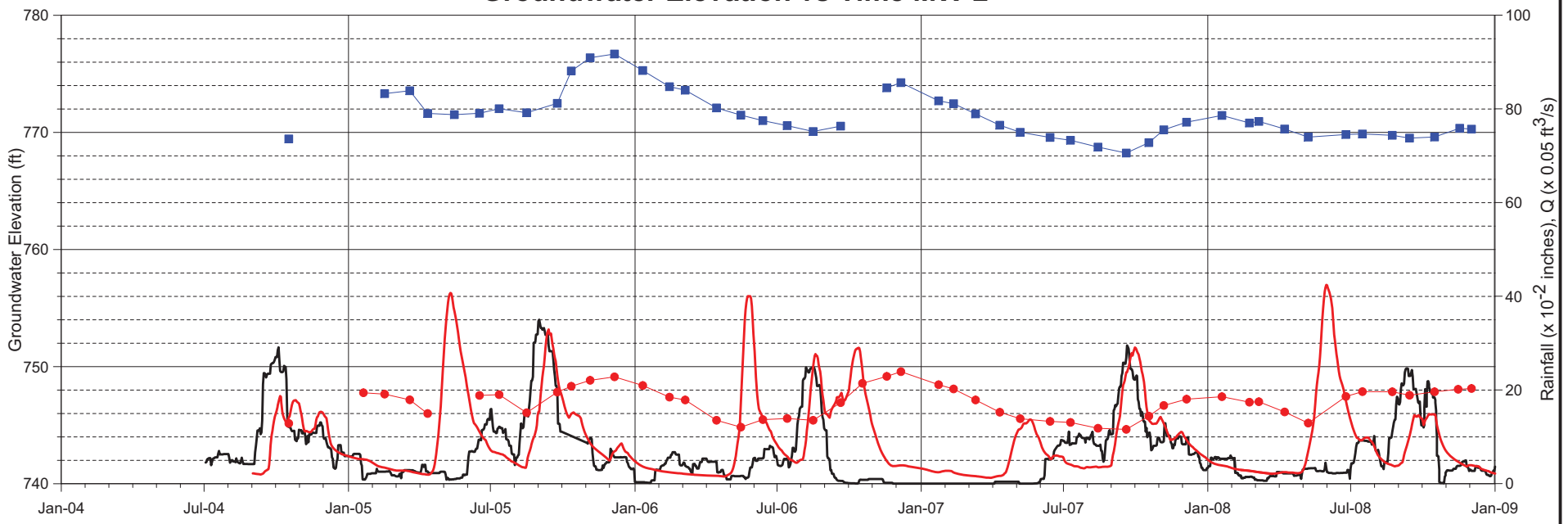


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-2



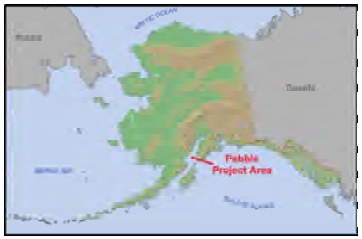
LEGEND:

Groundwater Elevation Plot Legend

- MW-2S
- MW-2D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-2S : 755.0 - 765.0
MW-2D : 695.4 - 710.4

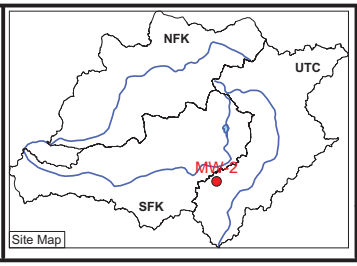


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 830 ft asl

MW05-02M and MW-05-2SR were dry seasonally during the winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-2.grf

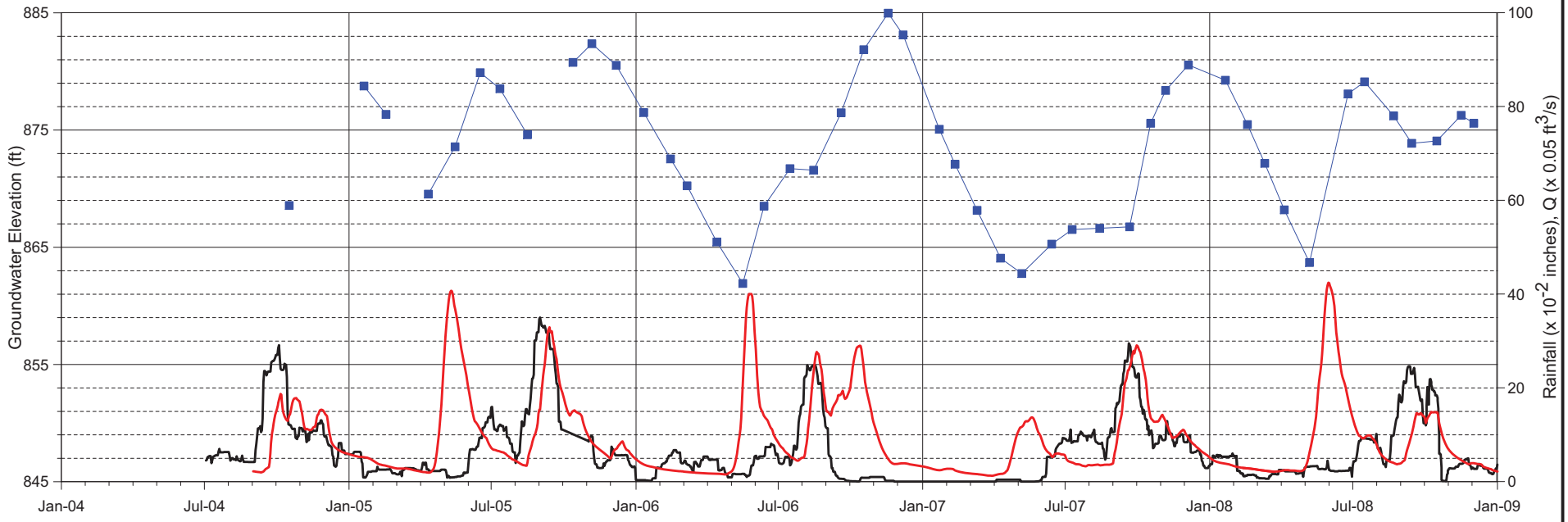


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-3D



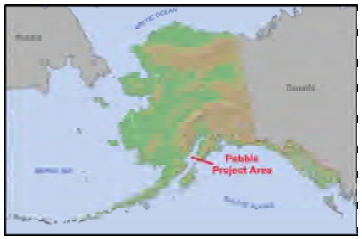
LEGEND:

Groundwater Elevation Plot Legend

- MW-3D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

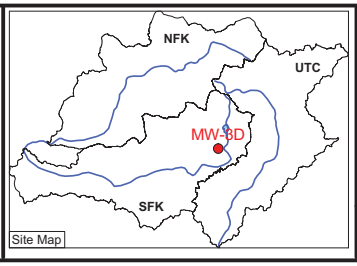
Screens (ft asl):
MW-3D : 830.1 - 845.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1024.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-3D.grf

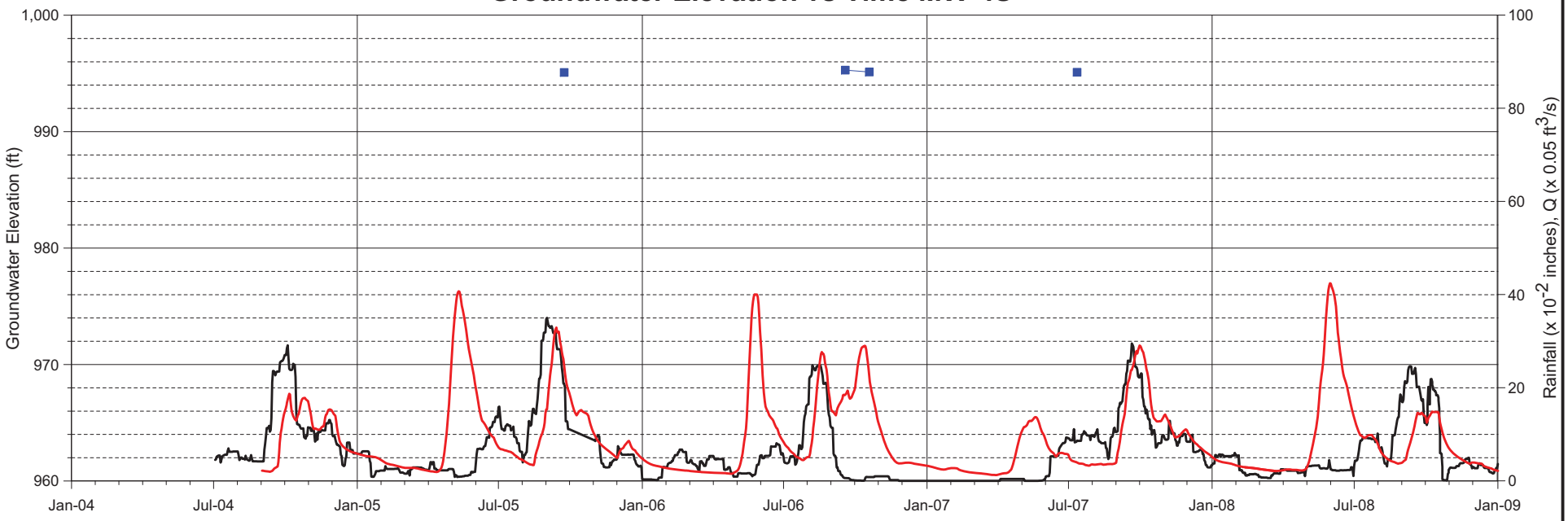


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-4S



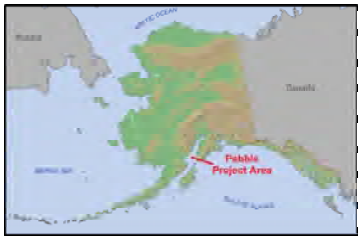
LEGEND:

Groundwater Elevation Plot Legend

- MW-4S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-4S : 983.9 - 993.9

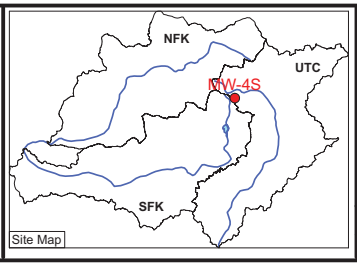


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1008.9 ft asl

MW-4S was dry, recorded water levels do not represent true groundwater elevations.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-4S.grf

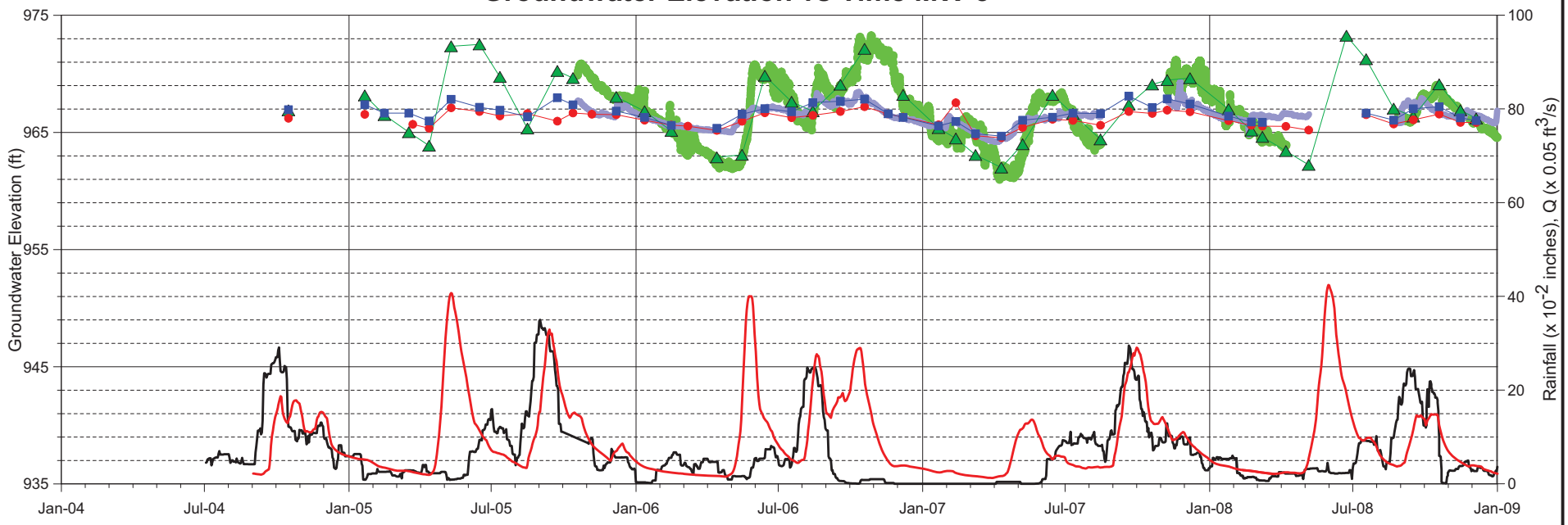


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time MW-5



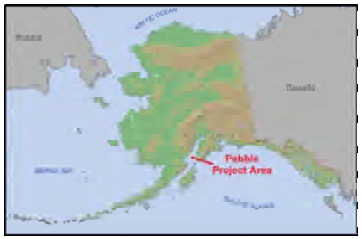
LEGEND:

Groundwater Elevation Plot Legend

- MW-5S
- MW-5M
- MW-5D
- MW-5S(Transducer)
- MW-5D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

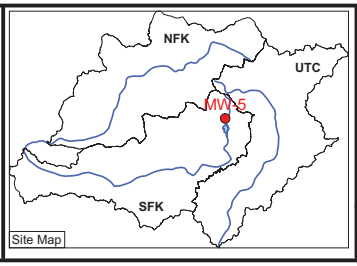
Screens (ft asl):
MW-5S : 936.6 - 946.6
MW-5M : 912.9 - 922.9
MW-5D : 873.0 - 888.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 977.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-5.grf

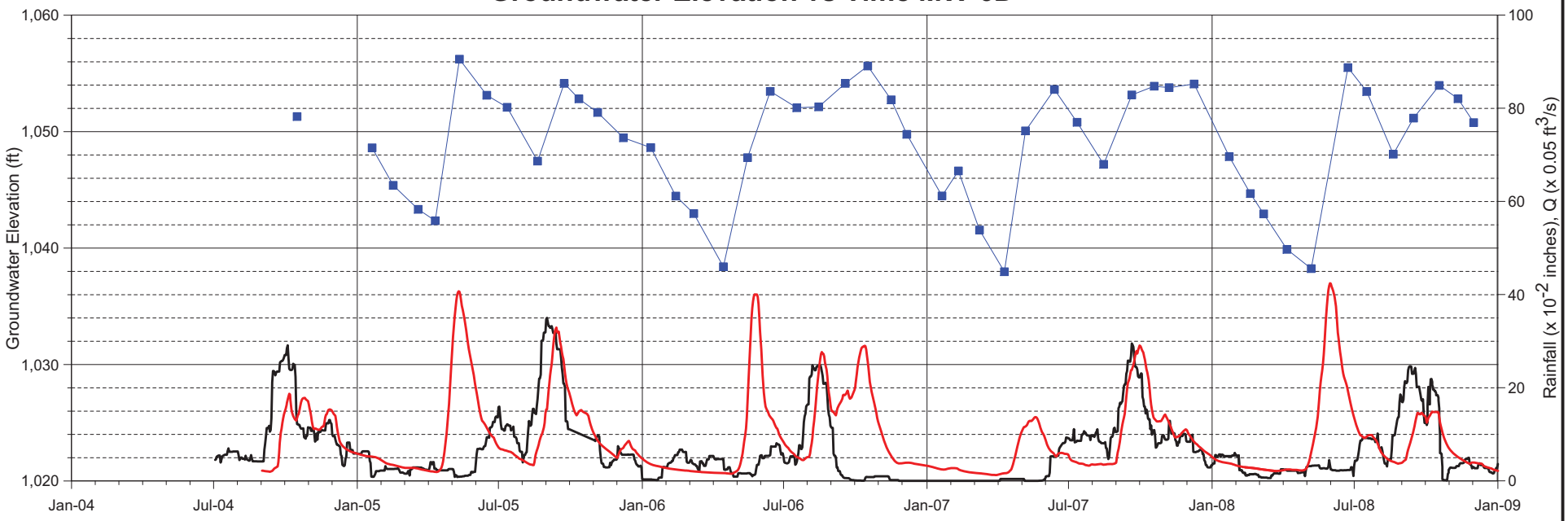


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-6D



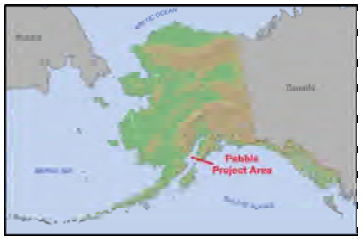
LEGEND:

Groundwater Elevation Plot Legend

- MW-6D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

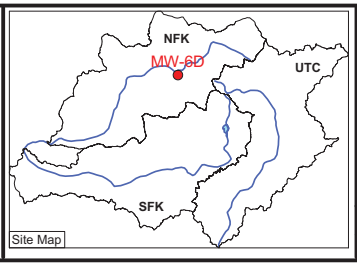
Screens (ft asl):
MW-6D : 1027.0 - 1037.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1118 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-6D.grf

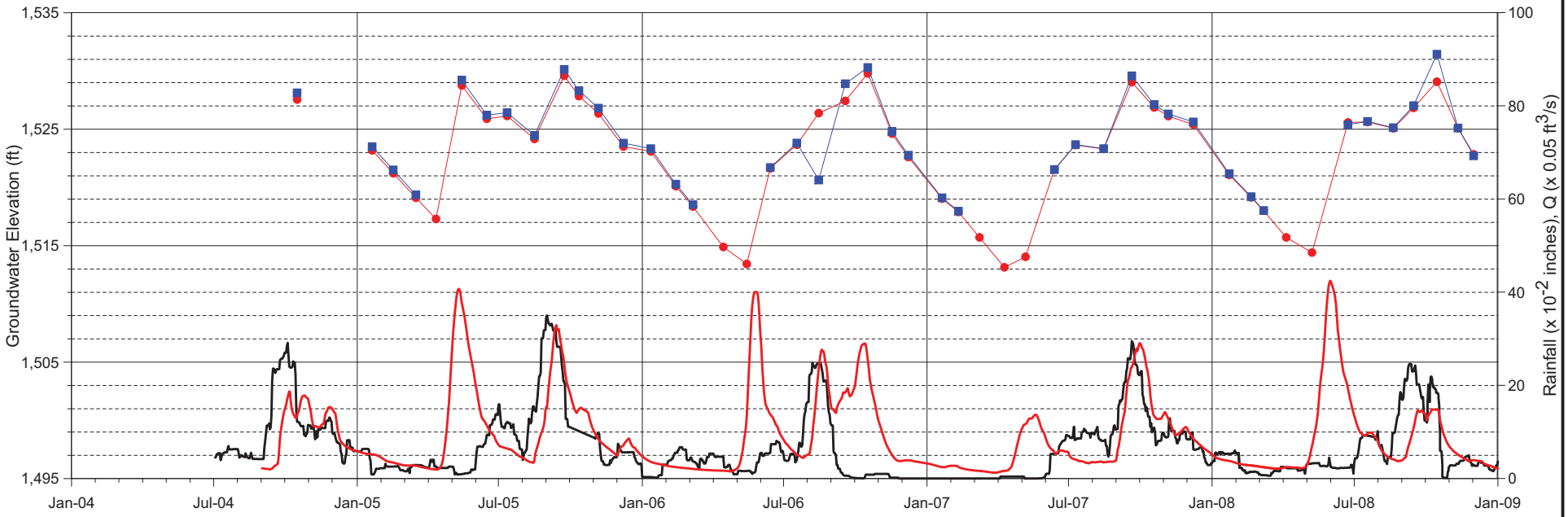


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-7



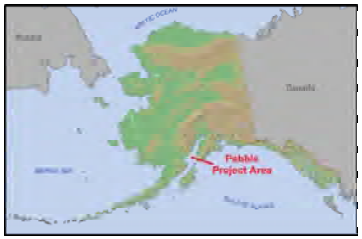
LEGEND:

Groundwater Elevation Plot Legend

- MW-7S
- MW-7D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

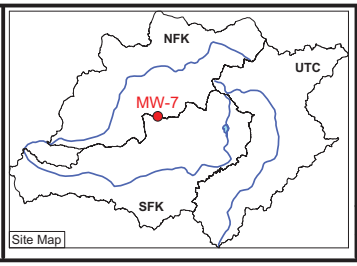
Screens (ft asl):
MW-7S : 1514.5 - 1524.5
MW-7D : 1471.8 - 1481.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1544.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-7.grf

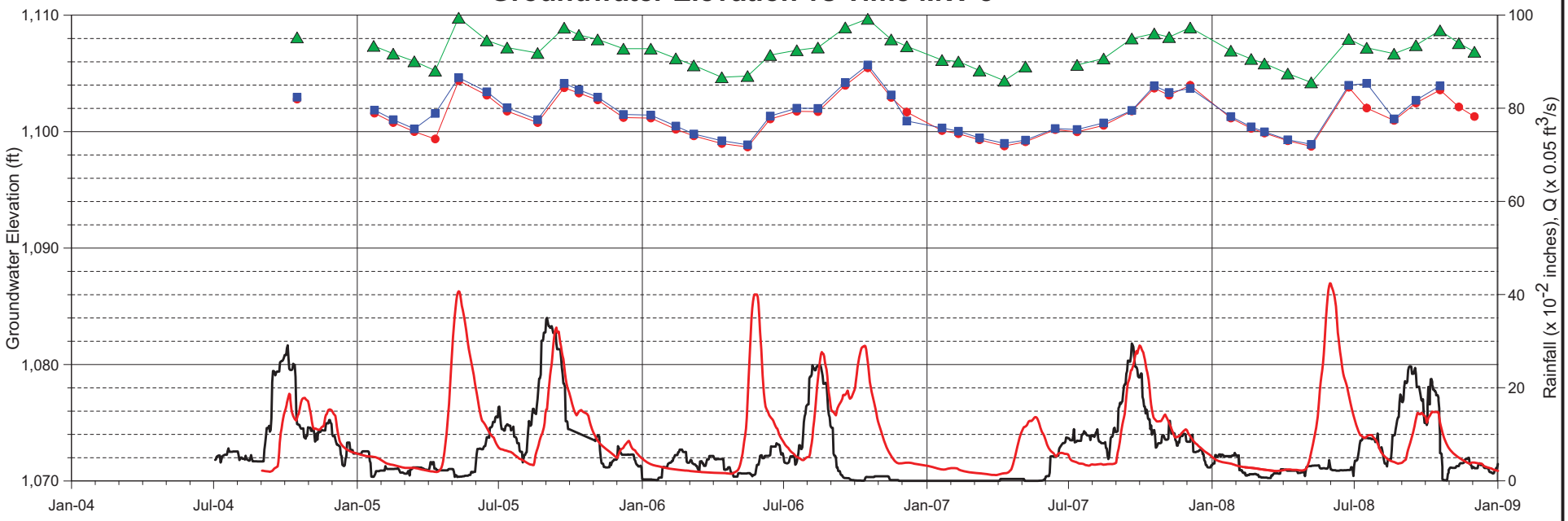


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-8



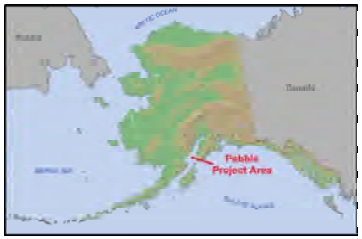
LEGEND:

Groundwater Elevation Plot Legend

- MW-8S
- MW-8M
- MW-8D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

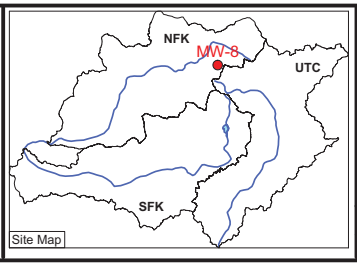
Screens (ft asl):
MW-8S : 1096.4 - 1106.4
MW-8M : 1067.6 - 1082.6
MW-8D : 1017.6 - 1027.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1114.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-8.grf

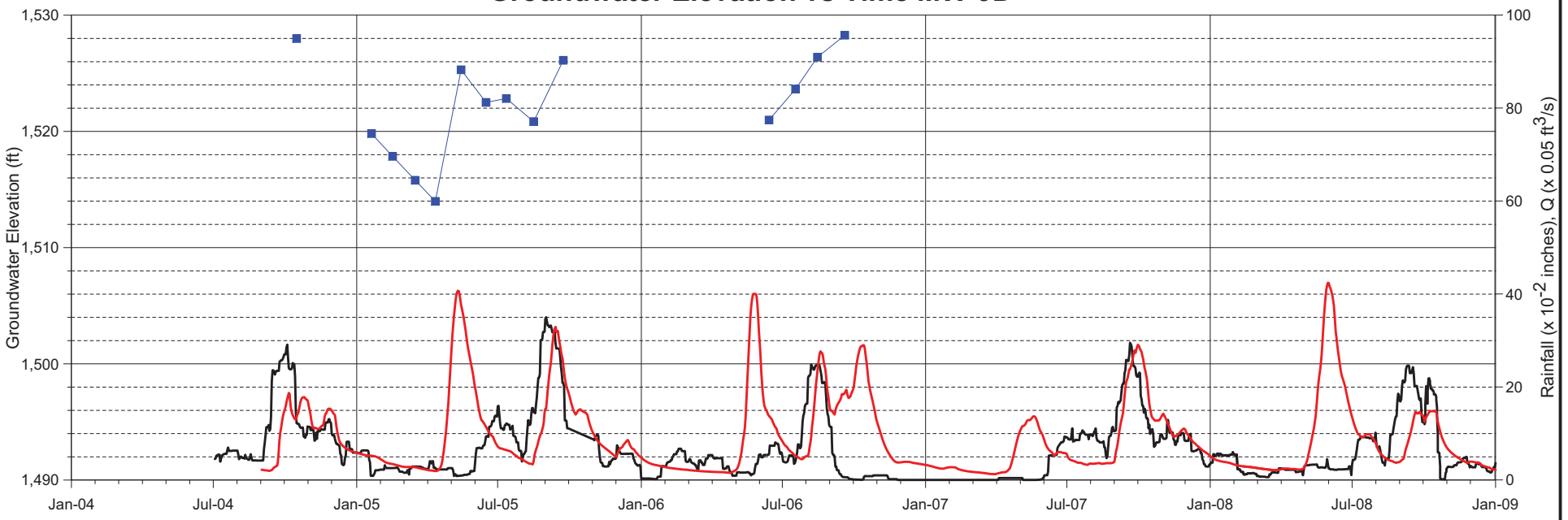


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-9D



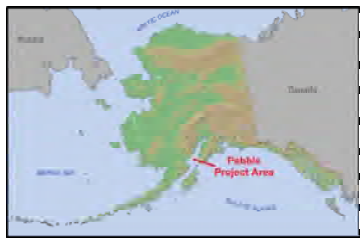
LEGEND:

Groundwater Elevation Plot Legend

- MW-9D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-9D : 1453.3 - 1467.3

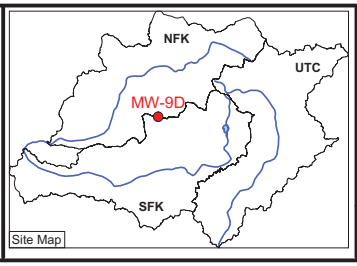


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1525.3 ft asl

MW-9D is a flowing well. Water levels were recorded occasionally when an extension was in place and the water was not frozen.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-9D.grf

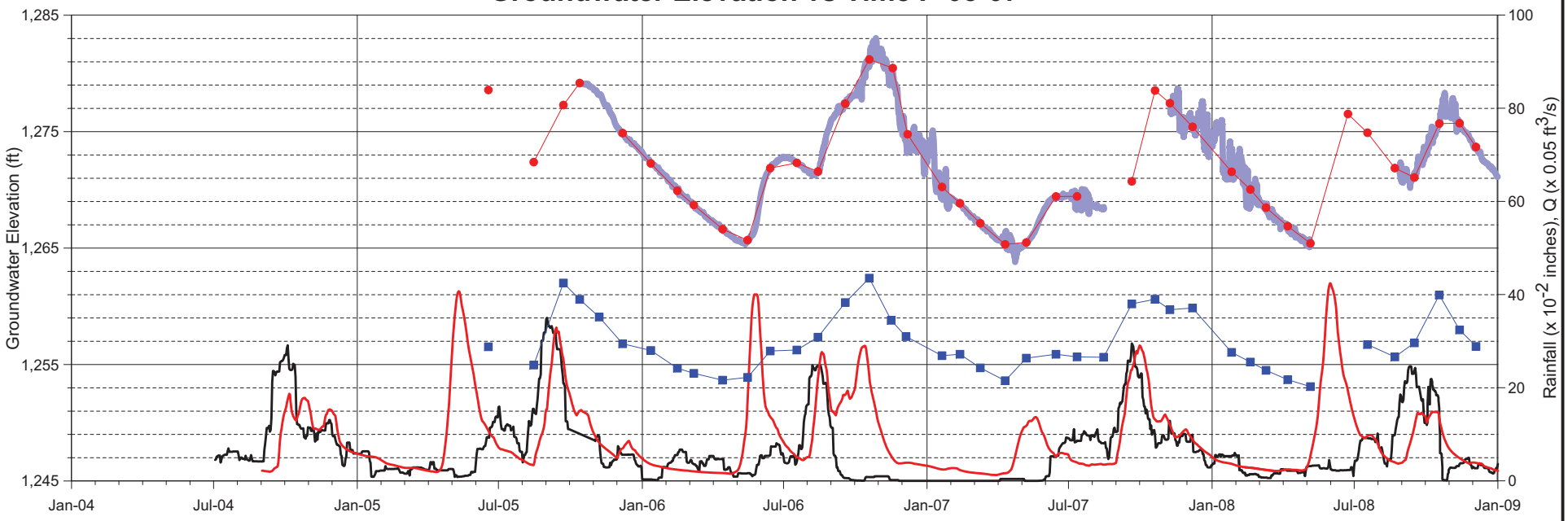


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-07



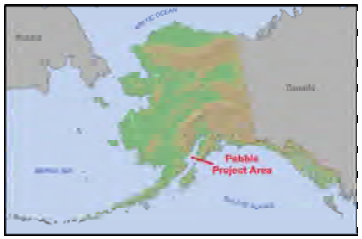
LEGEND:

Groundwater Elevation Plot Legend

- P-05-07S
- P-05-07D
- P-05-07D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

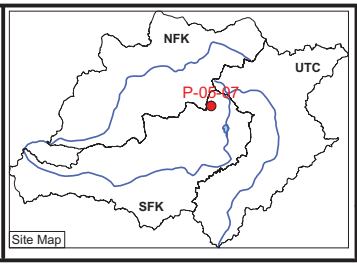
Screens (ft asl):
P-05-07S : 1214.8 - 1224.8
P-05-07D : 1094.6 - 1104.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1290.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-07.grf

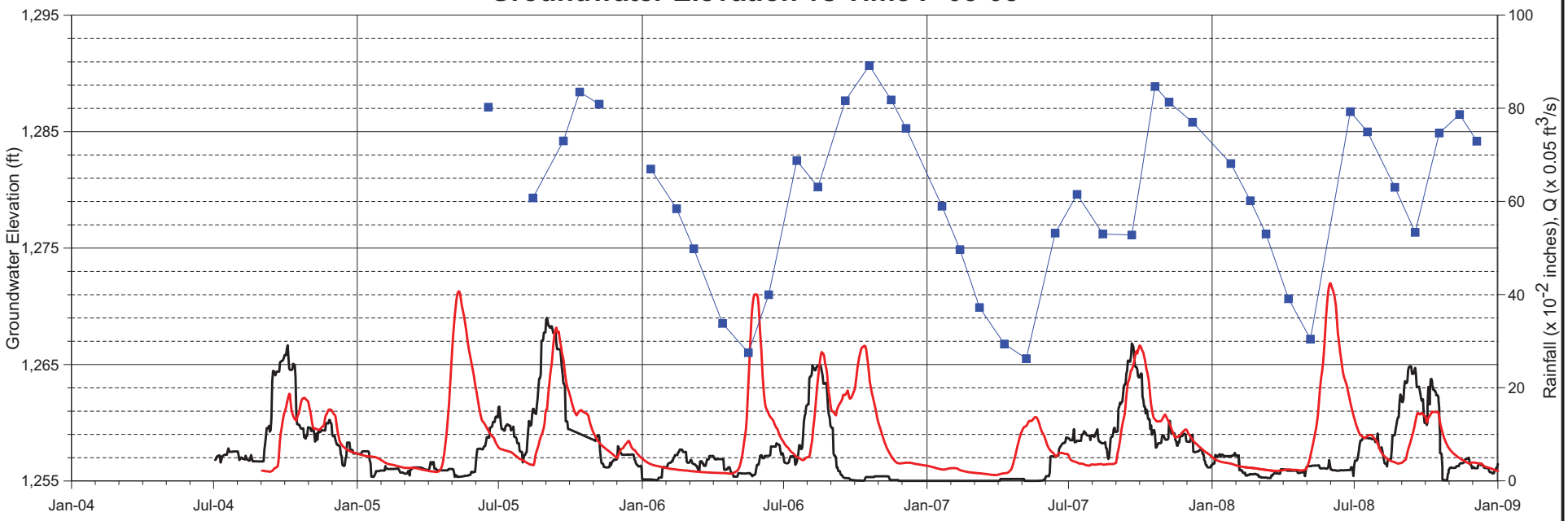


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-08



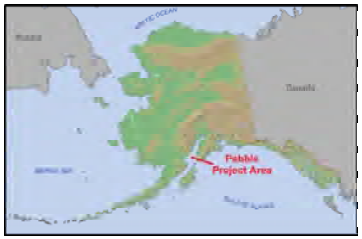
LEGEND:

Groundwater Elevation Plot Legend

- P-05-08
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

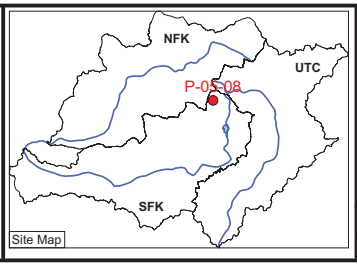
Screens (ft asl):
P-05-08 : 1248.1 - 1258.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1320 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-08.grf

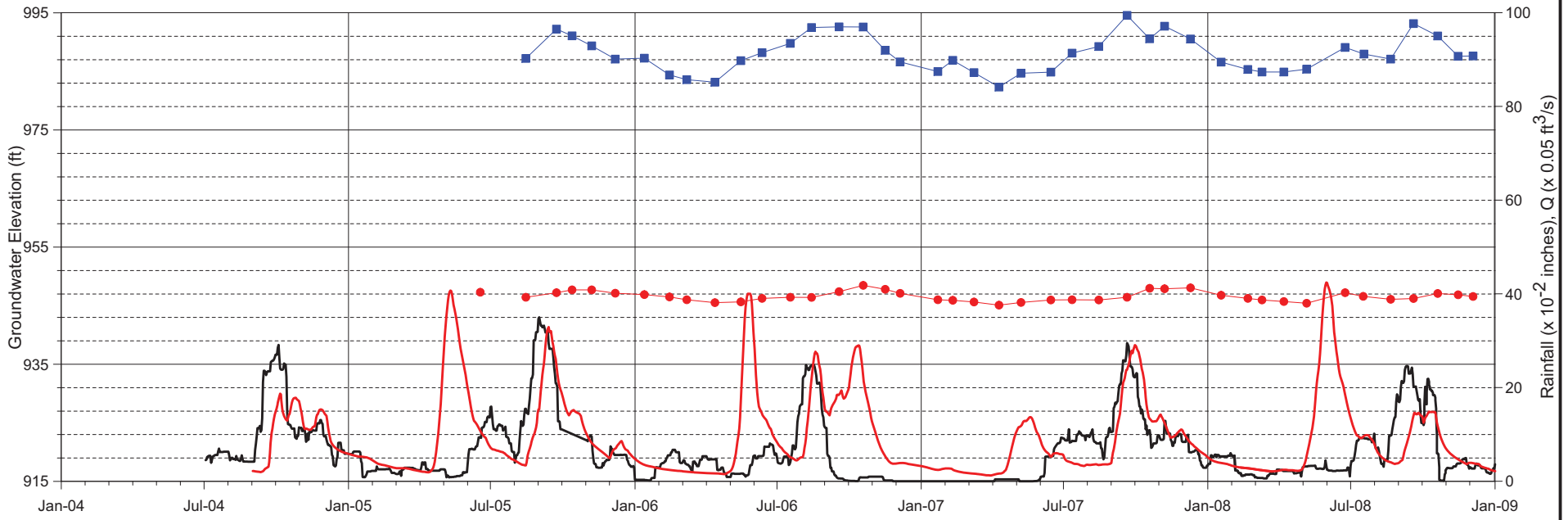


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-09



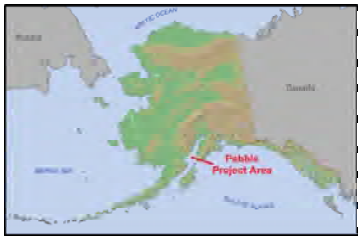
LEGEND:

Groundwater Elevation Plot Legend

- P-05-09S
- P-05-09D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-09S : 977.4 - 980.4
P-05-09D : 901.1 - 916.1

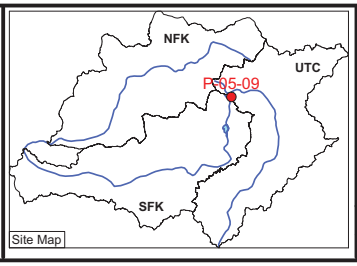


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 997.4 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-09.grf

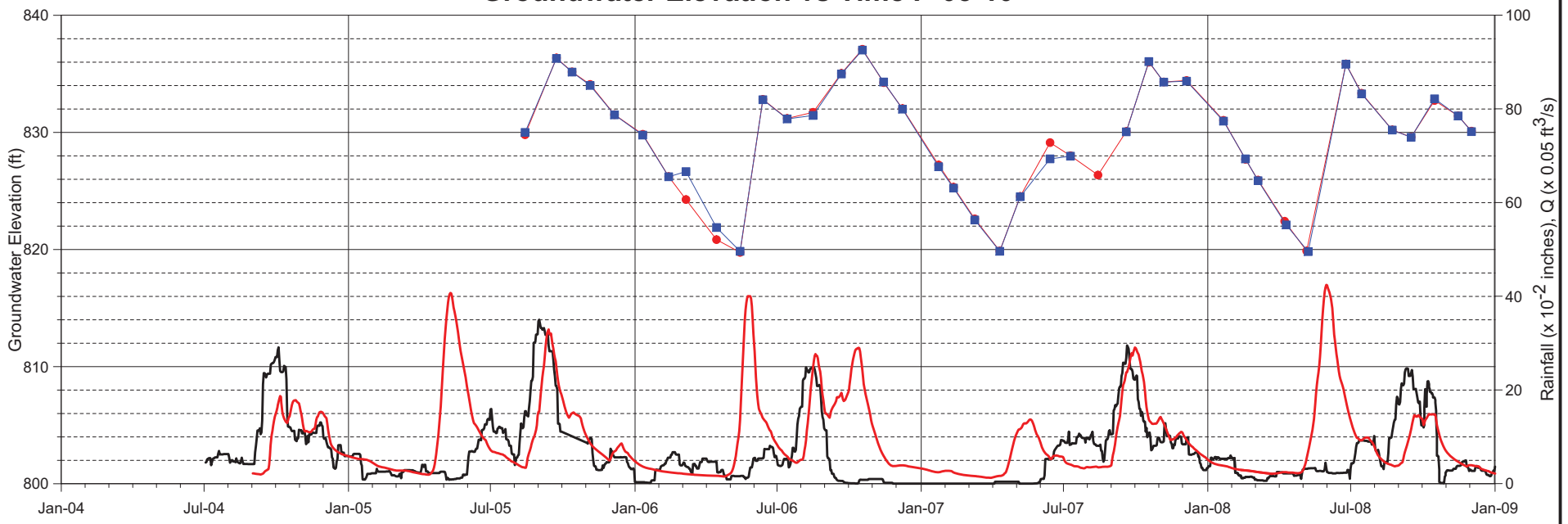


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-10



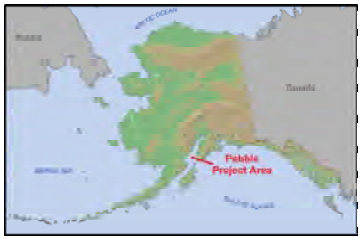
LEGEND:

Groundwater Elevation Plot Legend

- P-05-10S
- P-05-10D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

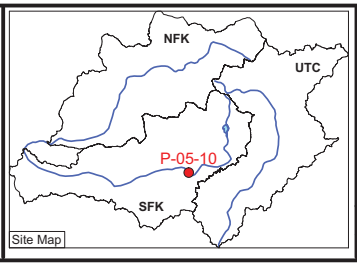
Screens (ft asl):
P-05-10S : 811.2 - 821.2
P-05-10D : 705.4 - 715.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 841.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-10.grf

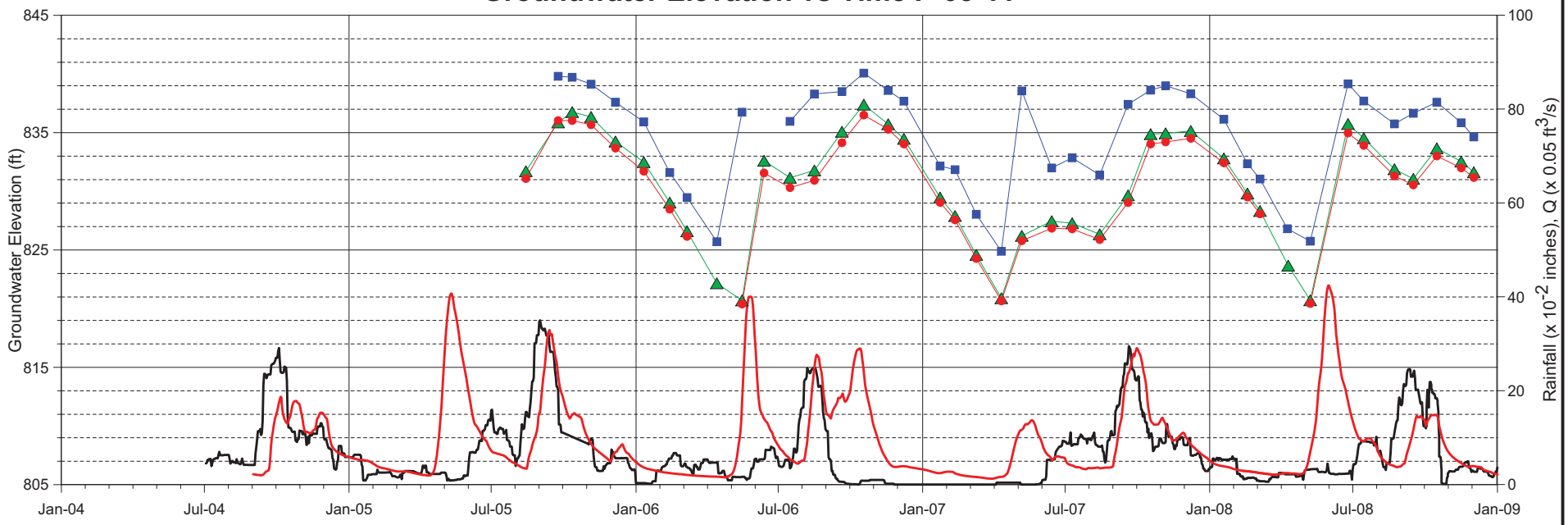


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-11



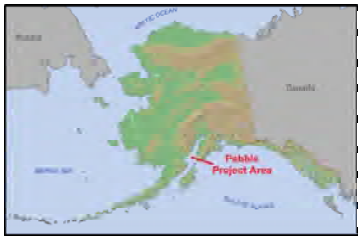
LEGEND:

Groundwater Elevation Plot Legend

- P-05-11S
- P-05-11M
- P-05-11D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

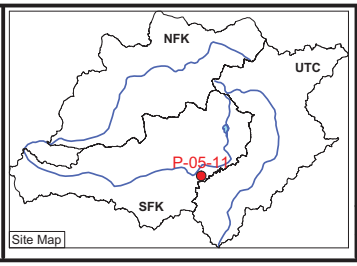
Screens (ft asl):
P-05-11S : 823.4 - 828.4
P-05-11M : 769.3 - 779.3
P-05-11D : 680.4 - 695.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 844.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-11.grf

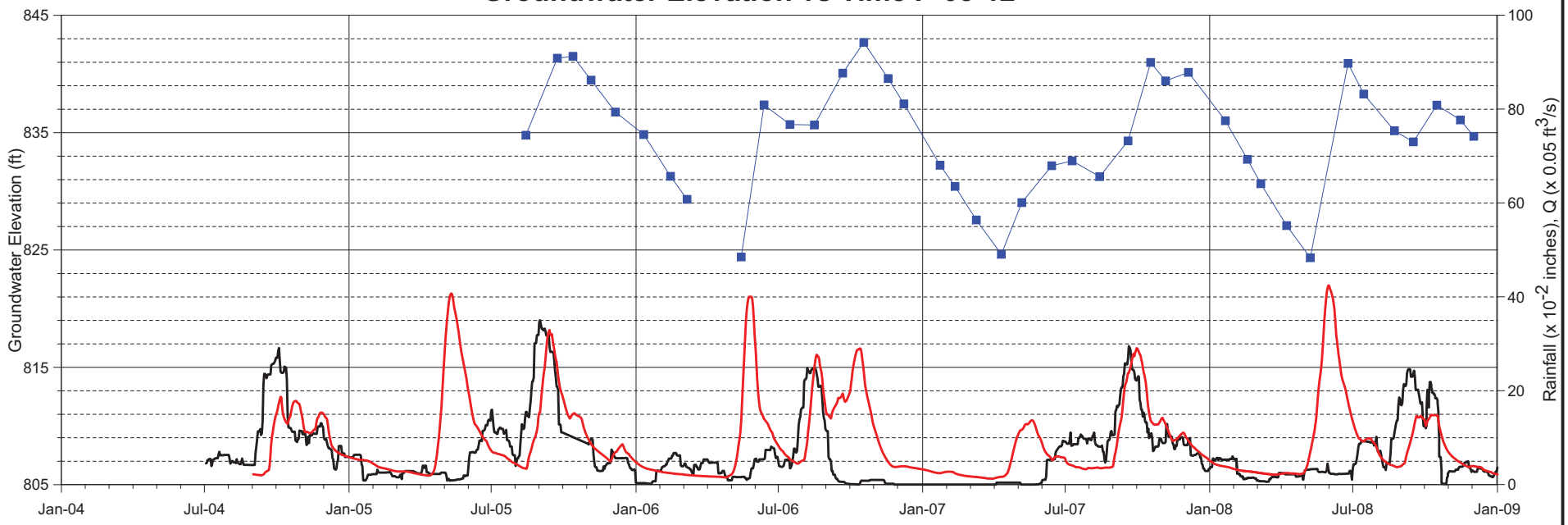


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-12



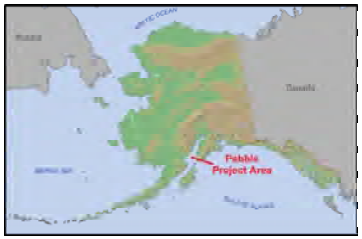
LEGEND:

Groundwater Elevation Plot Legend

- P-05-12
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

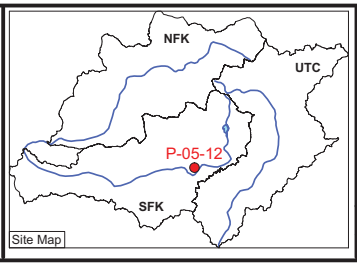
Screens (ft asl):
P-05-12 : 787.9 - 807.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 868.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-12.grf

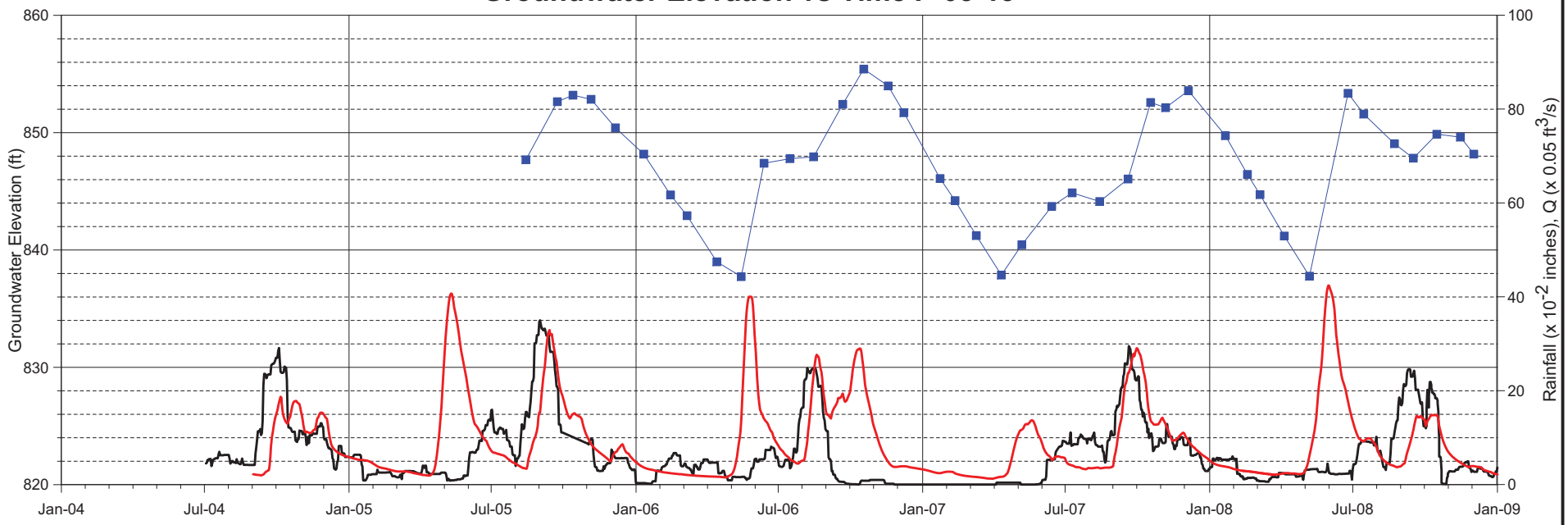


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-13



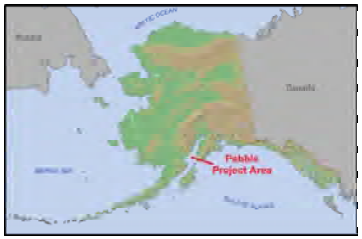
LEGEND:

Groundwater Elevation Plot Legend

- P-05-13
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

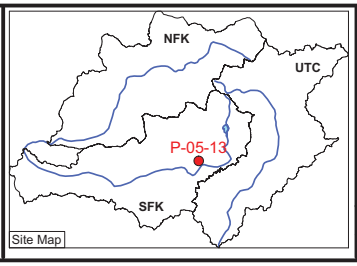
Screens (ft asl):
P-05-13 : 763.8 - 773.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 877.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-13.grf

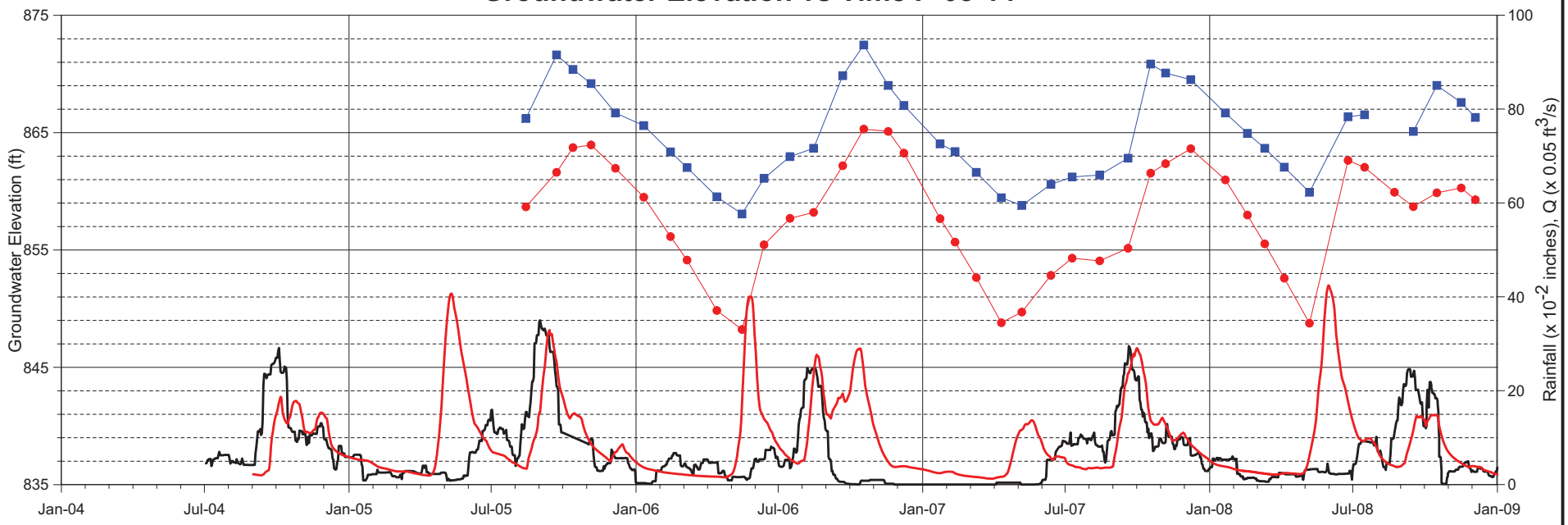


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-14



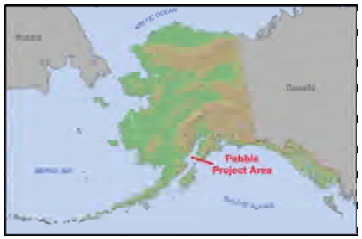
LEGEND:

Groundwater Elevation Plot Legend

- P-05-14S
- P-05-14D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

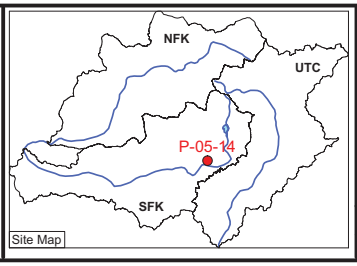
Screens (ft asl):
P-05-14S : 848.3 - 863.3
P-05-14D : 770.6 - 780.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 884.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-14.grf

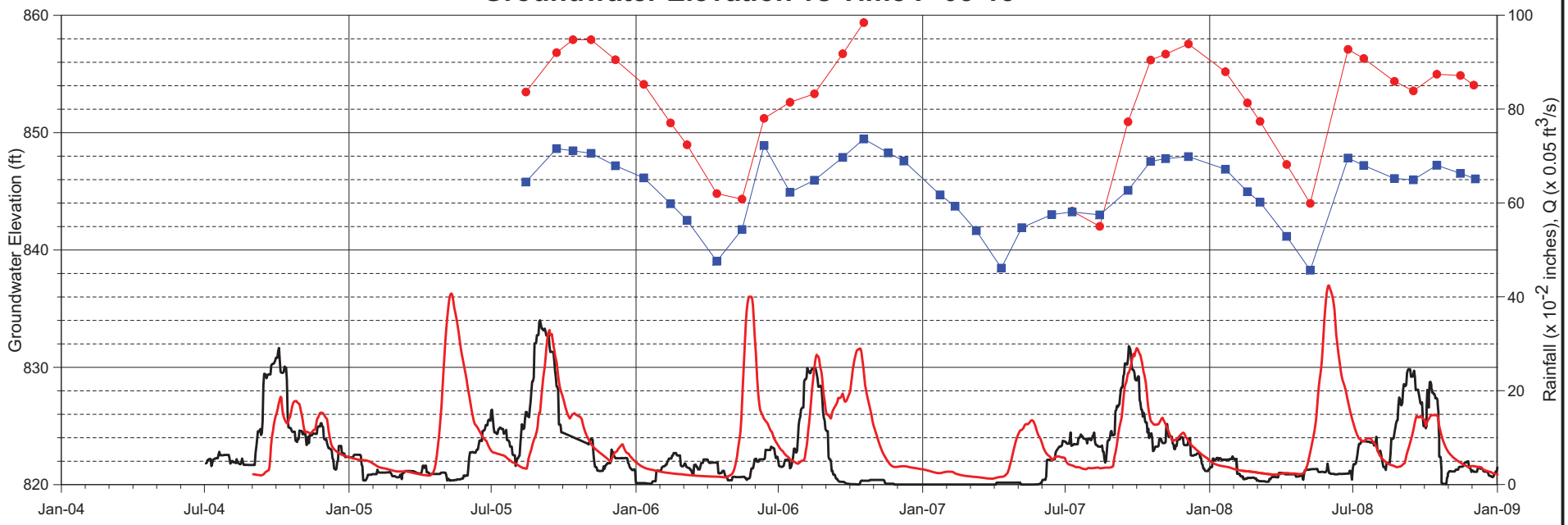


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-15



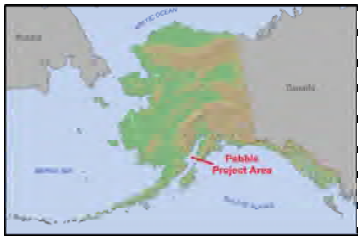
LEGEND:

Groundwater Elevation Plot Legend

- P-05-15S
- P-05-15D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

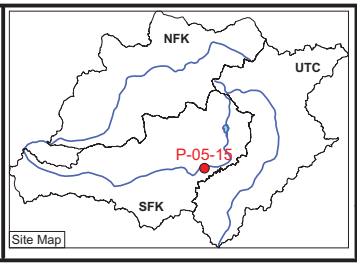
Screens (ft asl):
P-05-15S : 784.7 - 794.7
P-05-15D : 738.7 - 748.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 862 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-15.grf

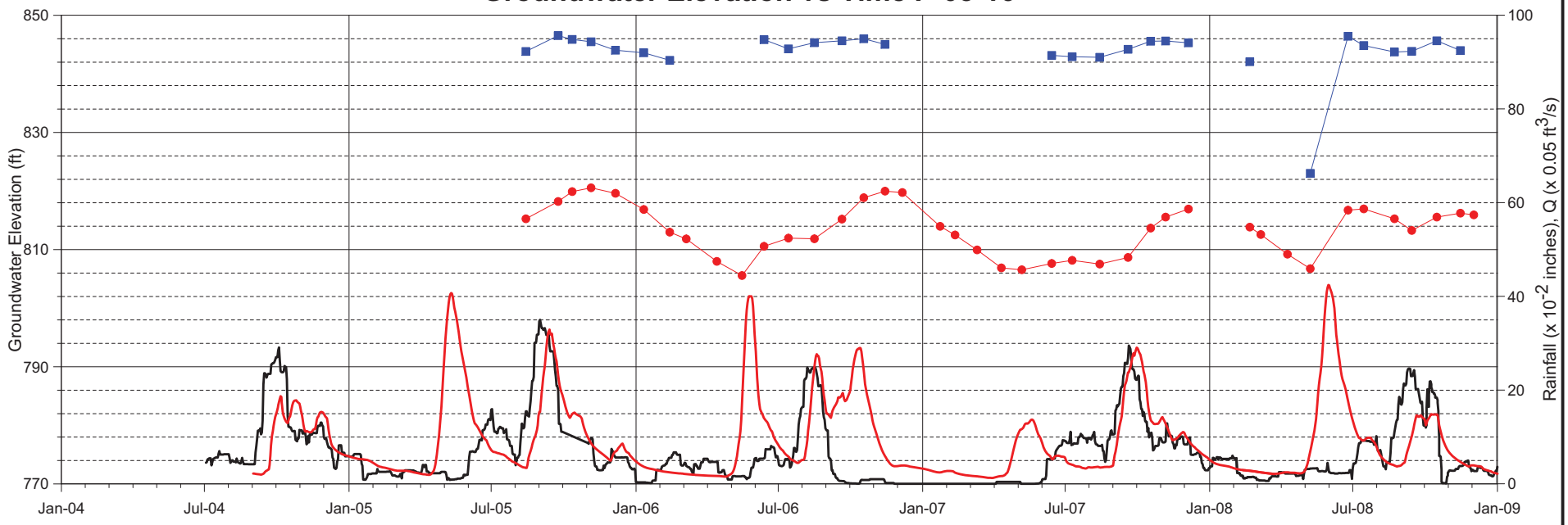


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-16



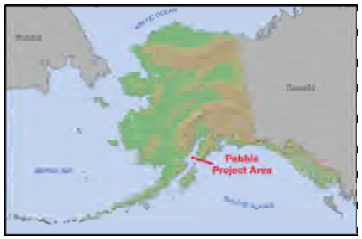
LEGEND:

Groundwater Elevation Plot Legend

- P-05-16SS
- P-05-16M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-16SS : 840.4 - 845.4
P-05-16S : 803.1 - 808.1
P-05-16M : 773.6 - 778.6
P-05-16D : 722.7 - 732.7



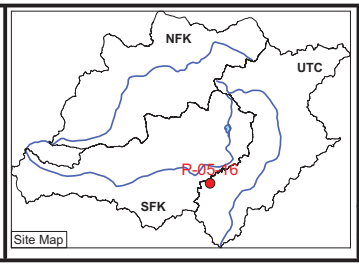
Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 856.4 ft asl

P05-16SS dries seasonally during the winter and spring, water levels were not recorded during this period.

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs.

File: J:\Jobs\7126\004\Wrk\Hydrographs\Grapher\P-05-16.grf

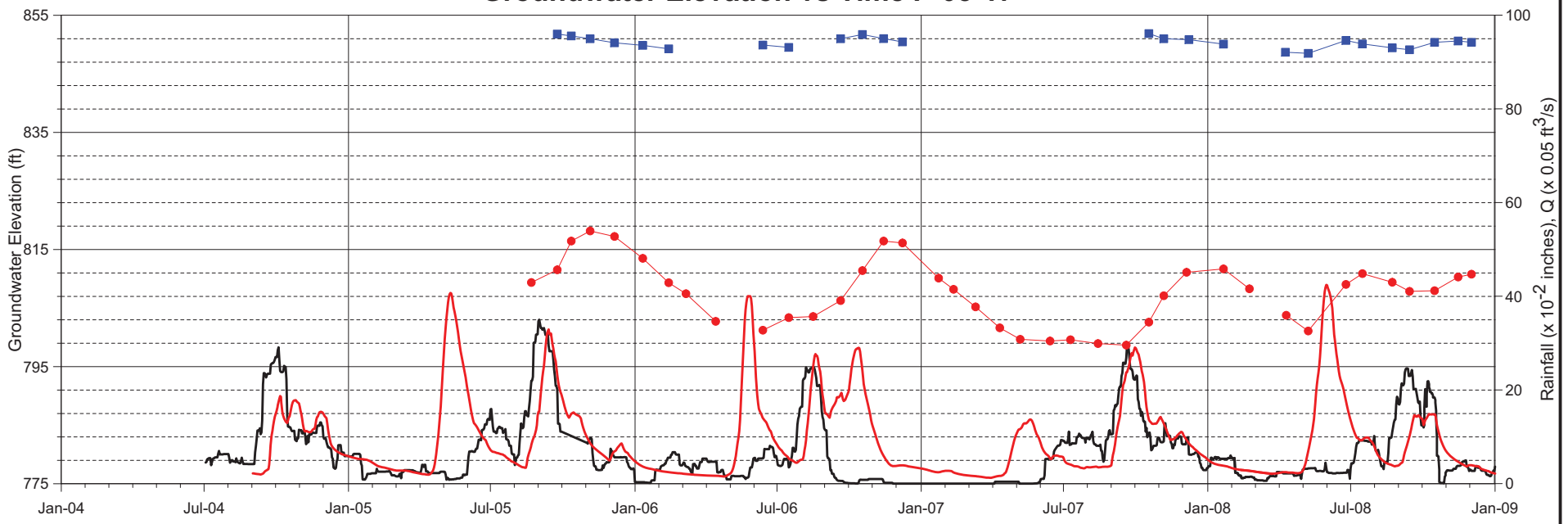


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-17



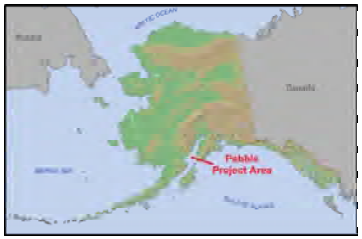
LEGEND:

Groundwater Elevation Plot Legend

- P-05-17S
- P-05-17D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-17S : 848.3 - 853.3
P-05-17D : 772.6 - 777.6



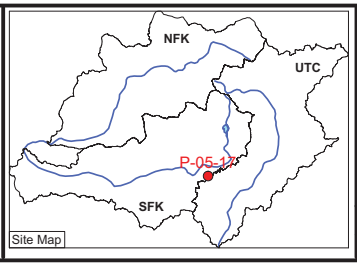
Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 907.1 ft asl

P05-17S dries seasonally during the winter and spring, water levels were not recorded during this period.

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: J:\Jobs\7126 2010\Data\Hydrographs\Grapher\P-05-17.grf

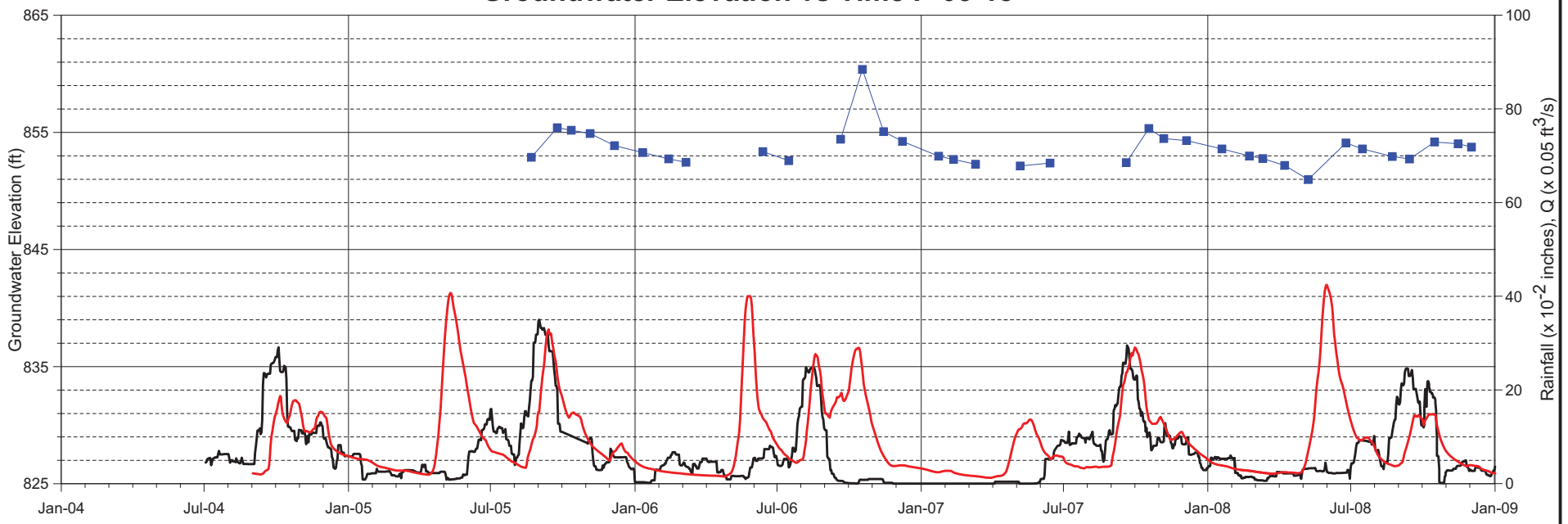


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-18



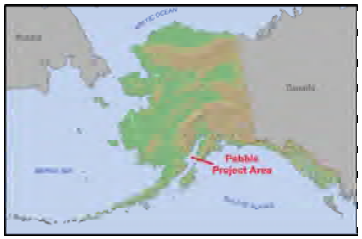
LEGEND:

Groundwater Elevation Plot Legend

- P-05-18
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

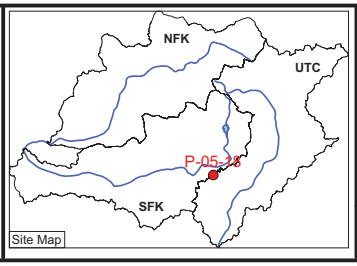
Screens (ft asl):
P-05-18 : 850.4 - 860.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 912.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-18.grf

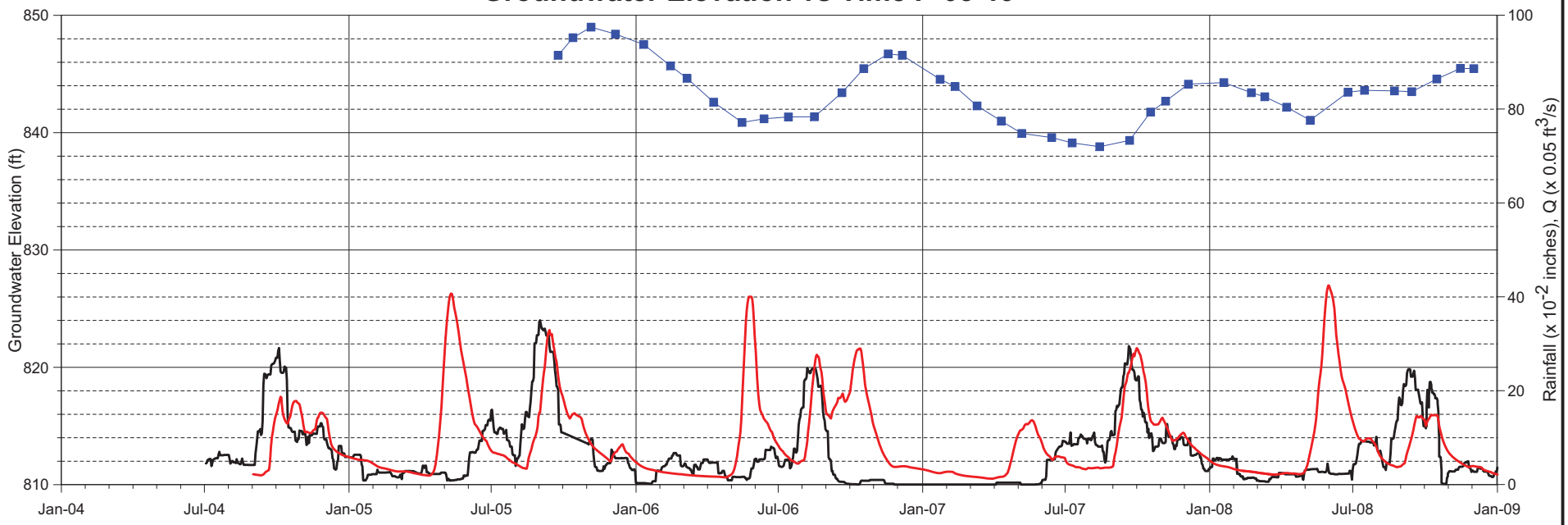


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-19



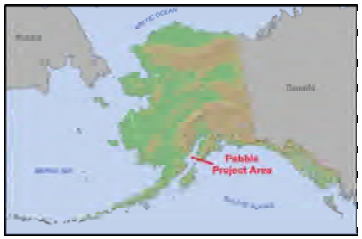
LEGEND:

Groundwater Elevation Plot Legend

- P-05-19M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-19S : 843.5 - 853.5
P-05-19M : 800.1 - 810.1

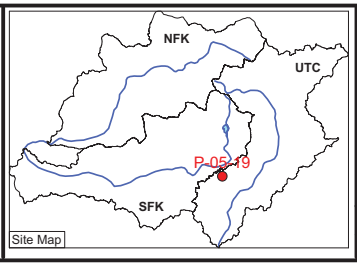


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 881.1 ft asl

P05-19S dries seasonally during the winter and spring, and during all of 2008; water levels were not recorded during these periods.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-19.grf

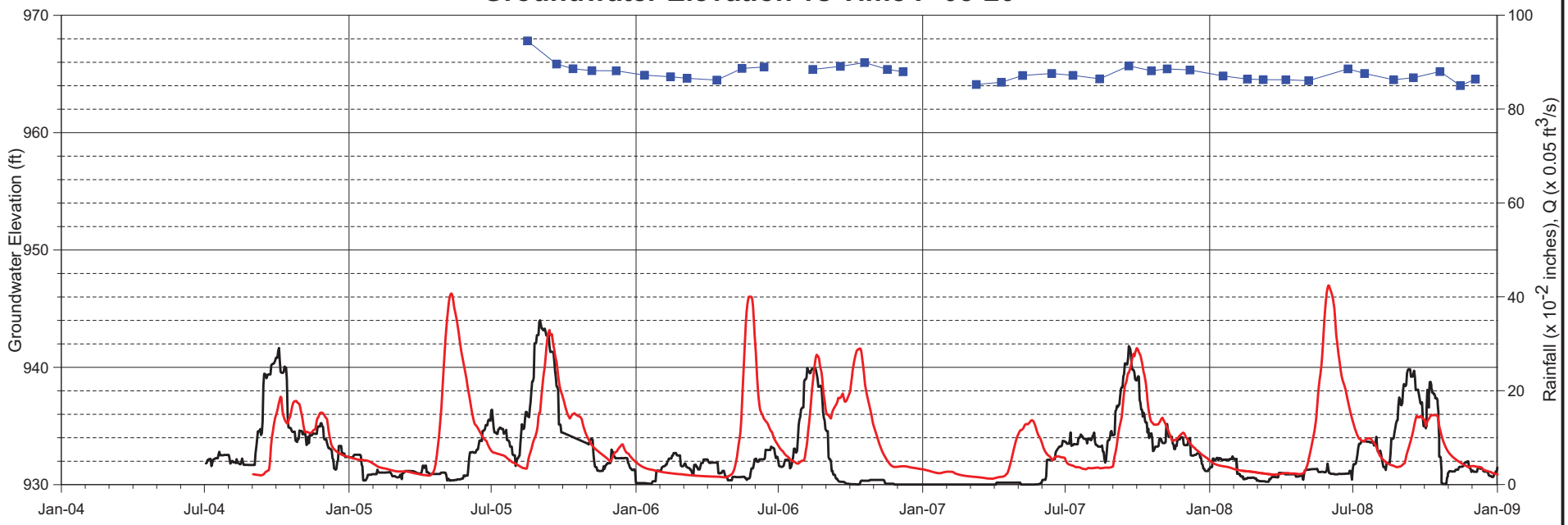


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-20



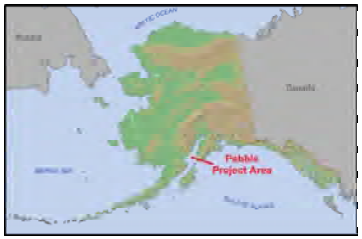
LEGEND:

Groundwater Elevation Plot Legend

- P-05-20S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-20S : 941.3 - 946.3
P-05-20D : 908.9 - 918.9

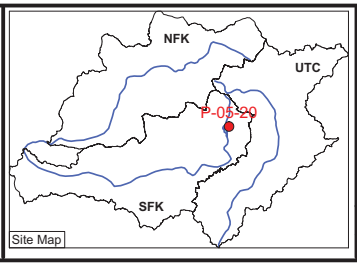


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 970.2 ft asl

P05-20D was flowing, therefore water levels were not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-20.grf

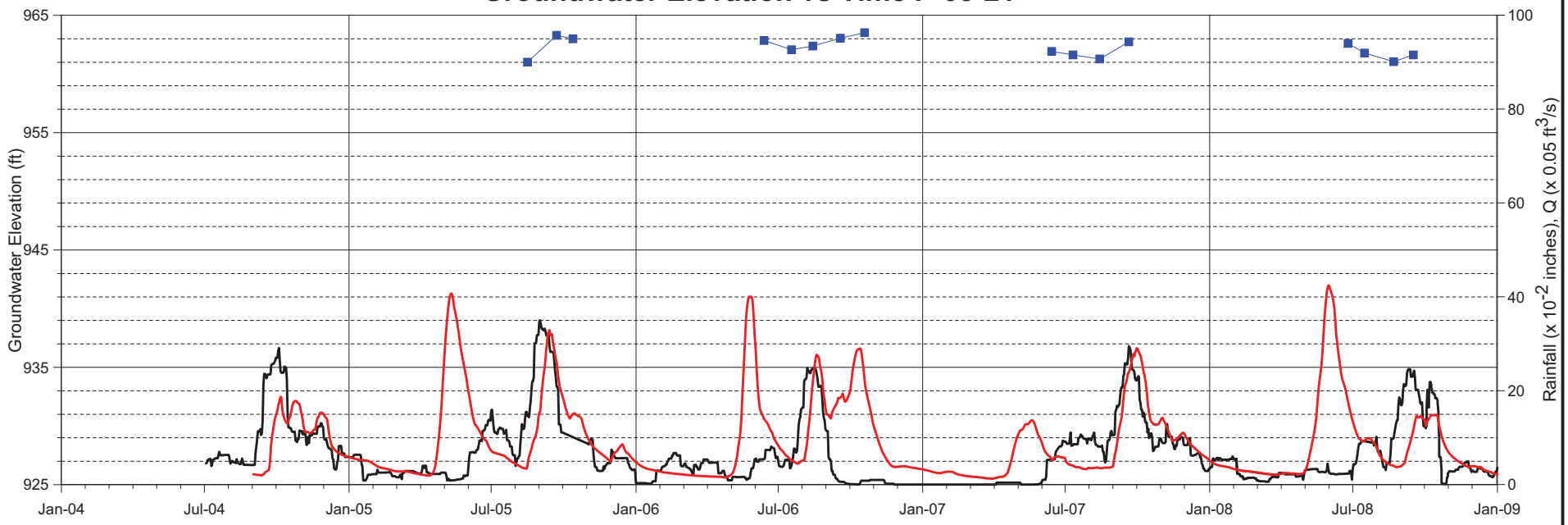


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-21



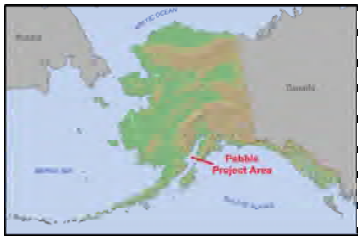
LEGEND:

Groundwater Elevation Plot Legend

- P-05-21S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-21S : 946.3 - 951.3
P-05-21M : 872.5 - 882.5
P-05-21D : 789.3 - 809.3

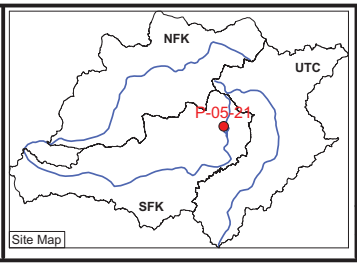


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 962.2 ft asl

P05-21D and P05-21M were flowing, therefore water levels not recorded

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-21.grf

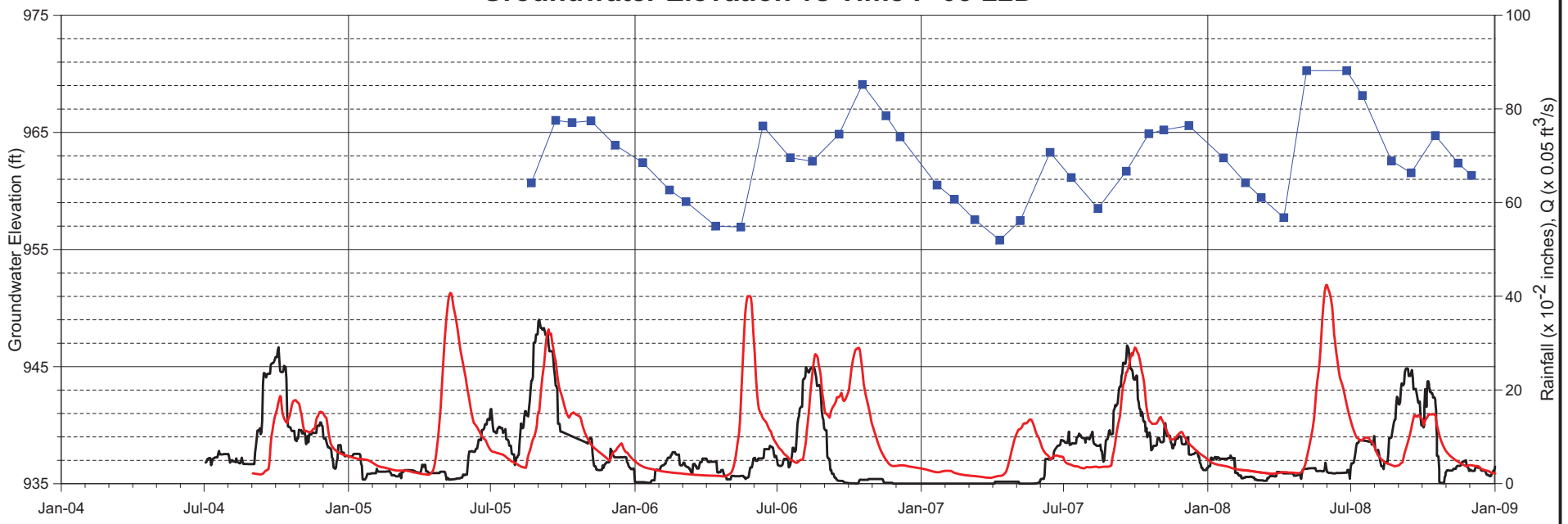


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-22D



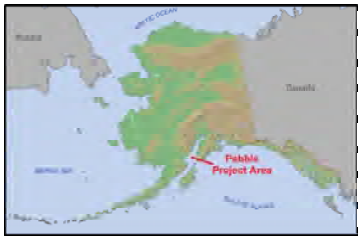
LEGEND:

Groundwater Elevation Plot Legend

- P-05-22D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

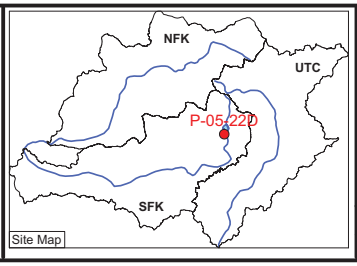
Screens (ft asl):
P-05-22D : 766.4 - 776.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 991.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-22D.grf

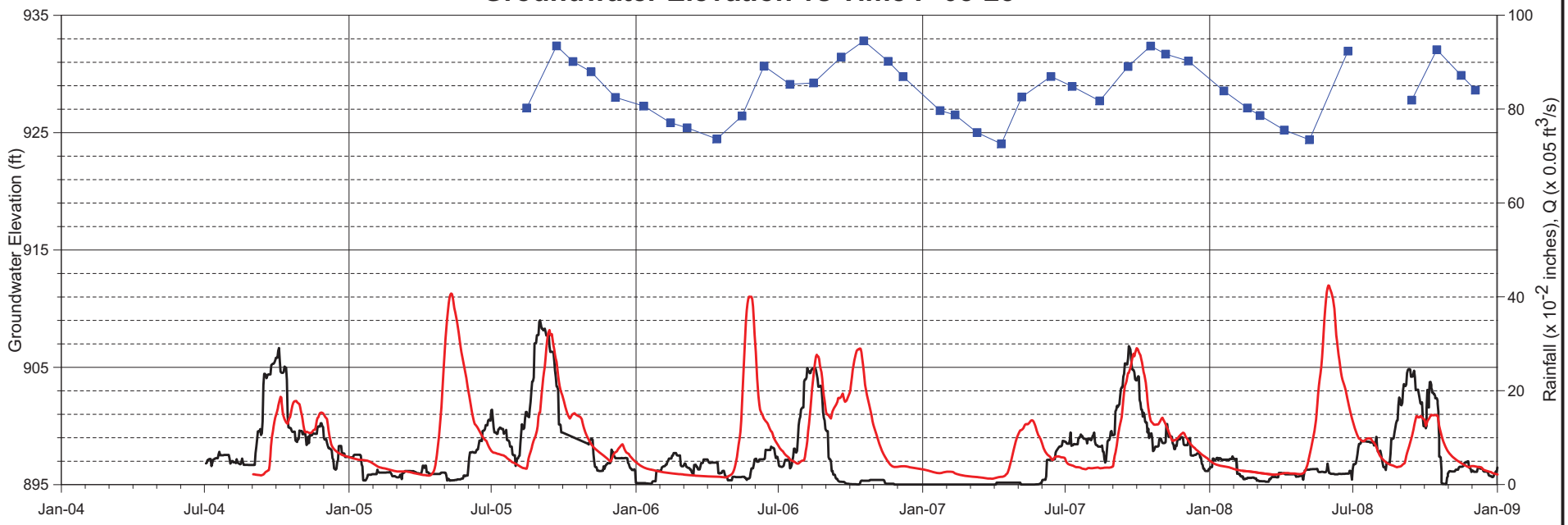


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-23



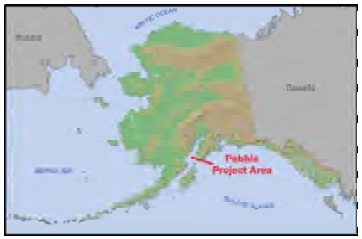
LEGEND:

Groundwater Elevation Plot Legend

- P-05-23
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

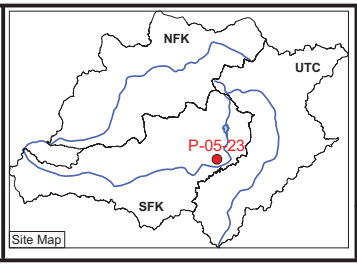
Screens (ft asl):
P-05-23 : 892.2 - 902.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 950.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-23.grf

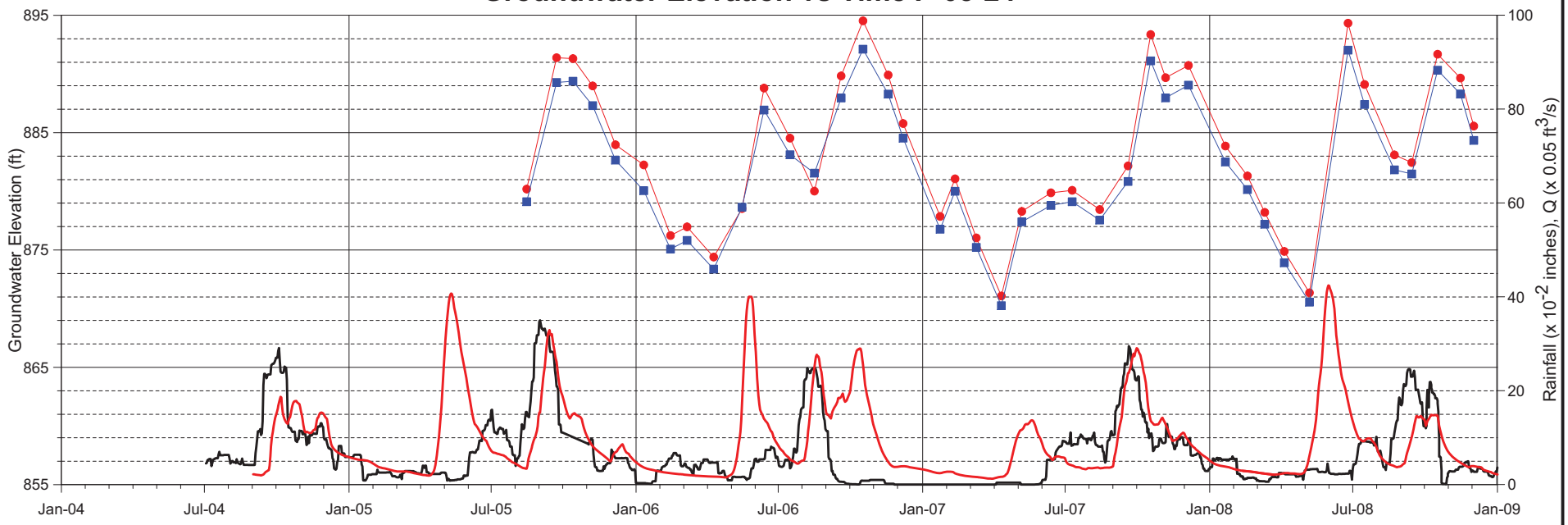


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-24



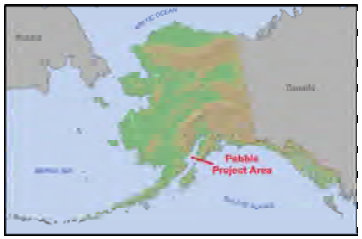
LEGEND:

Groundwater Elevation Plot Legend

- P-05-24S
- P-05-24D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

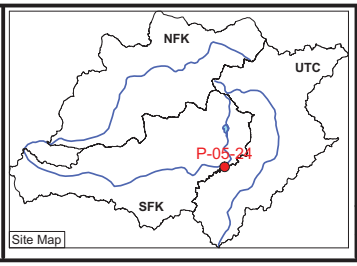
Screens (ft asl):
P-05-24S : 863.9 - 868.9
P-05-24D : 760.9 - 770.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 901.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-24.grf

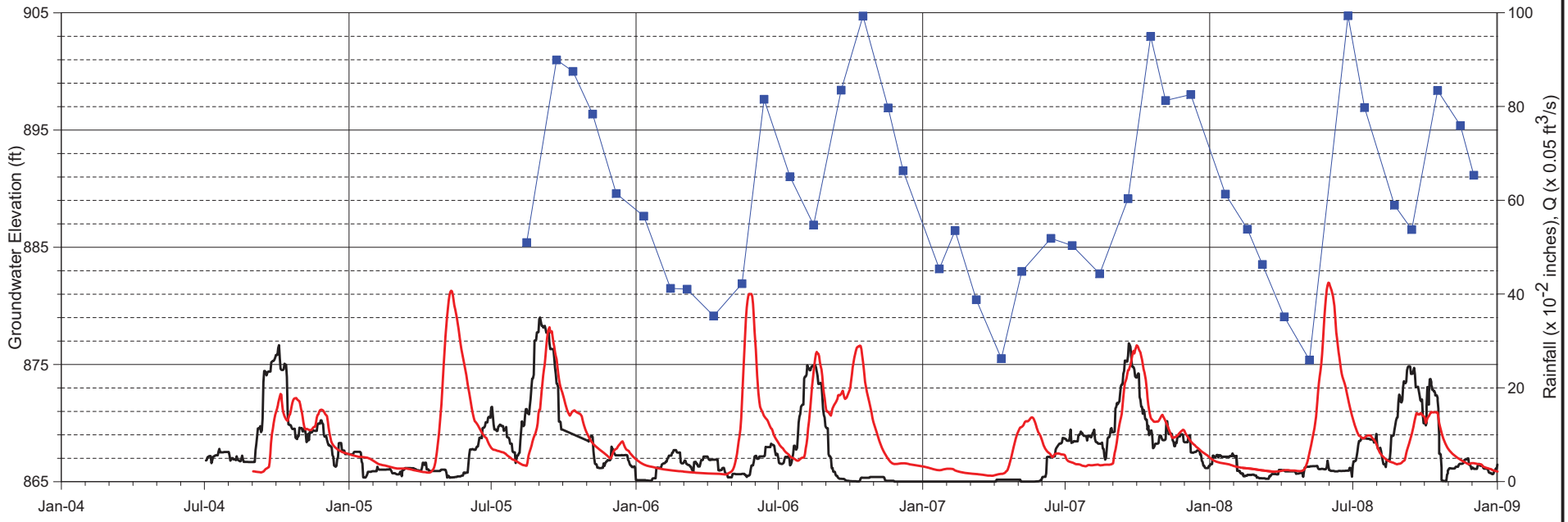


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-25



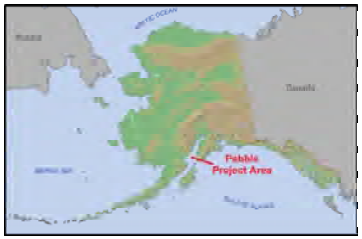
LEGEND:

Groundwater Elevation Plot Legend

- P-05-25
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

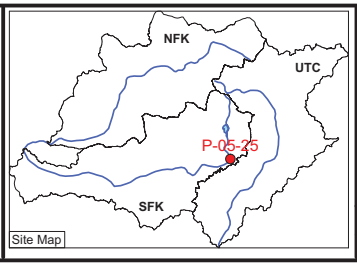
Screens (ft asl):
P-05-25 : 861.4 - 871.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 922.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-25.grf

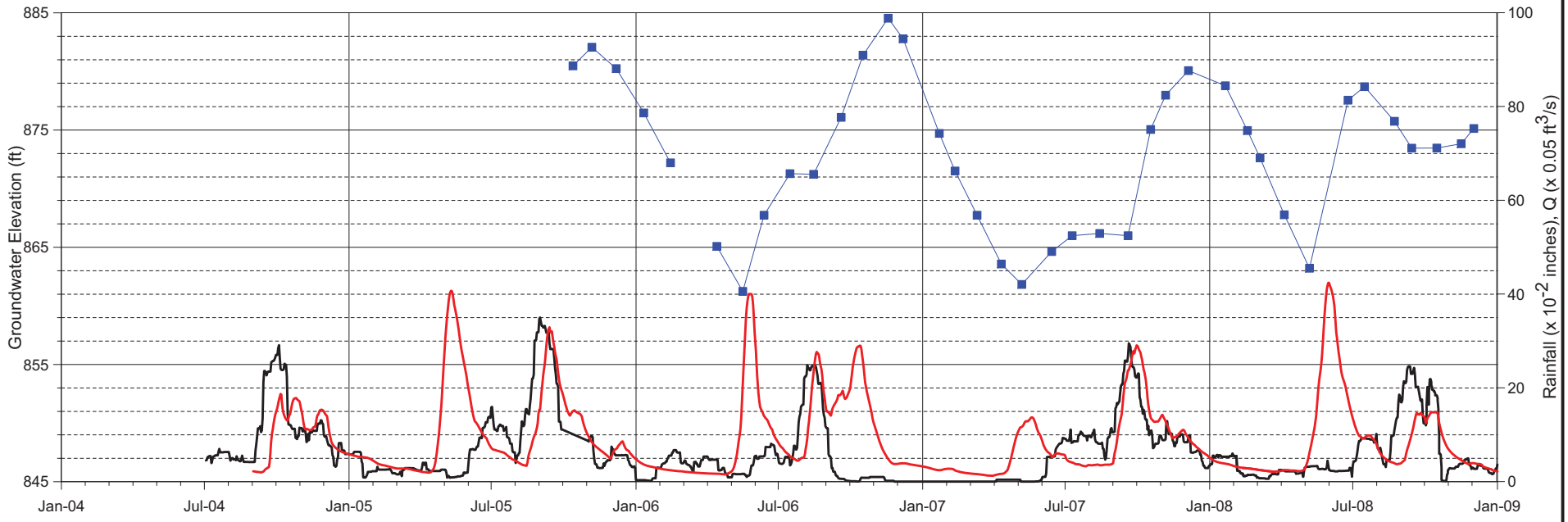


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-26



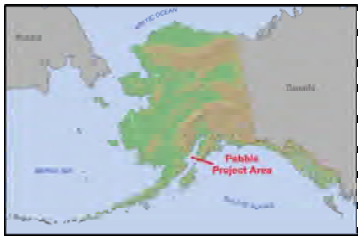
LEGEND:

Groundwater Elevation Plot Legend

- P-05-26D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-26S : 979.7 - 989.7
P-05-26M : 910.6 - 920.6
P-05-26D : 834.5 - 849.2

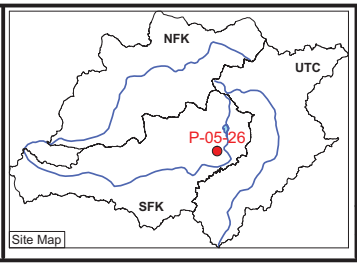


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1010.1 ft asl

Water levels recorded for P05-26M represent water pooled in bottom of piezometer; actual groundwater level below bottom of screen.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-26.grf

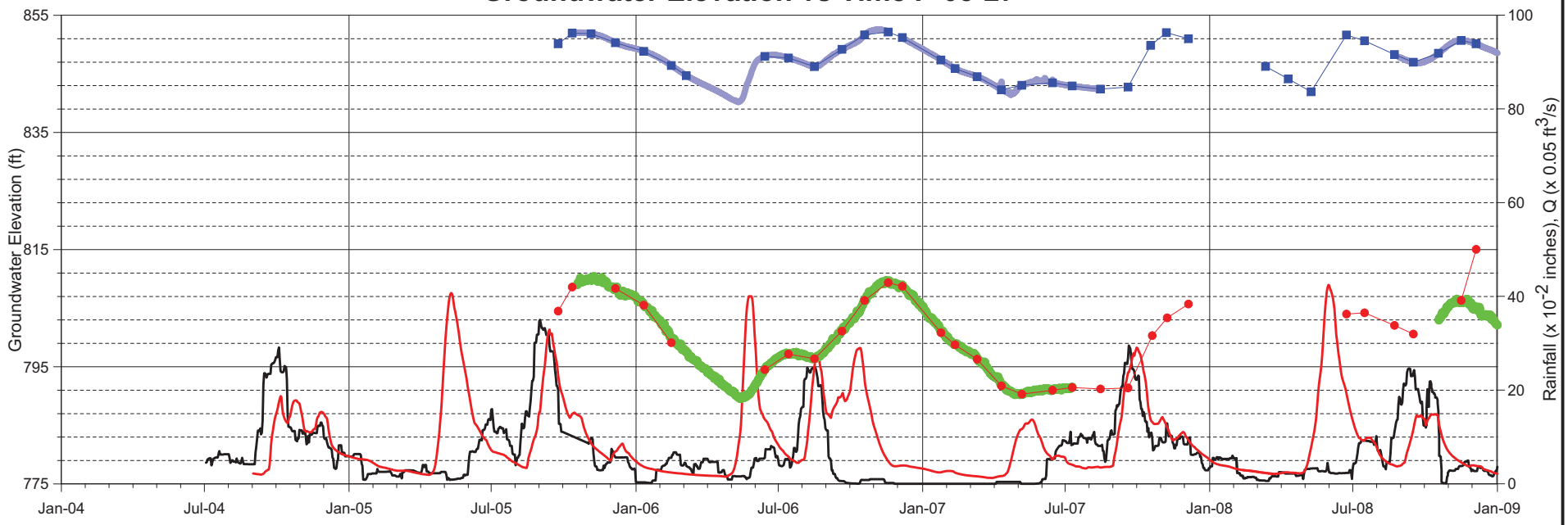


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-27



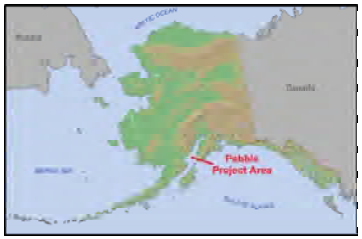
LEGEND:

Groundwater Elevation Plot Legend

- P-05-27S
- P-05-27D
- P-05-27S(Transducer)
- P-05-27D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-27S : 835.9 - 840.9
P-05-27M : 801.6 - 811.6
P-05-27D : 727.2 - 737.2

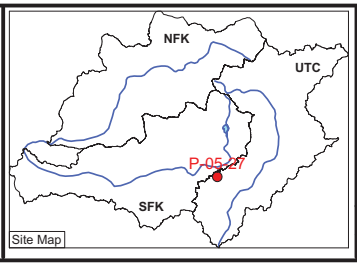


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 871.2 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-27.grf

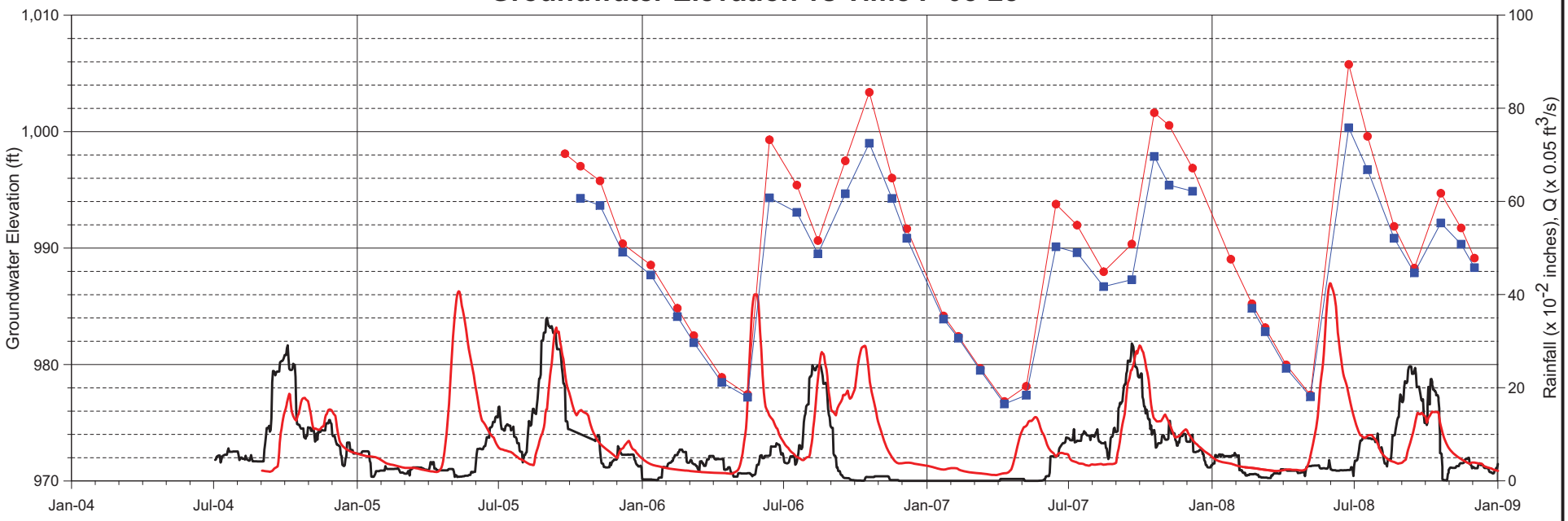


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-28



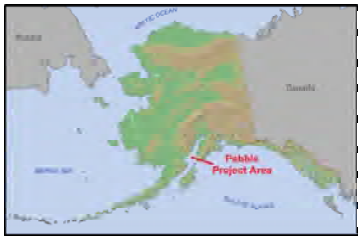
LEGEND:

Groundwater Elevation Plot Legend

- P-05-28S
- P-05-28D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

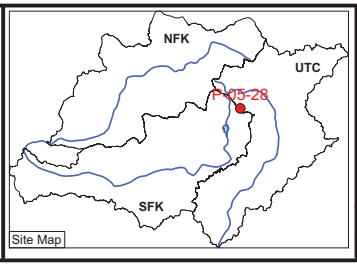
Screens (ft asl):
P-05-28S : 955.1 - 965.1
P-05-28D : 869.8 - 889.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1030.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-28.grf

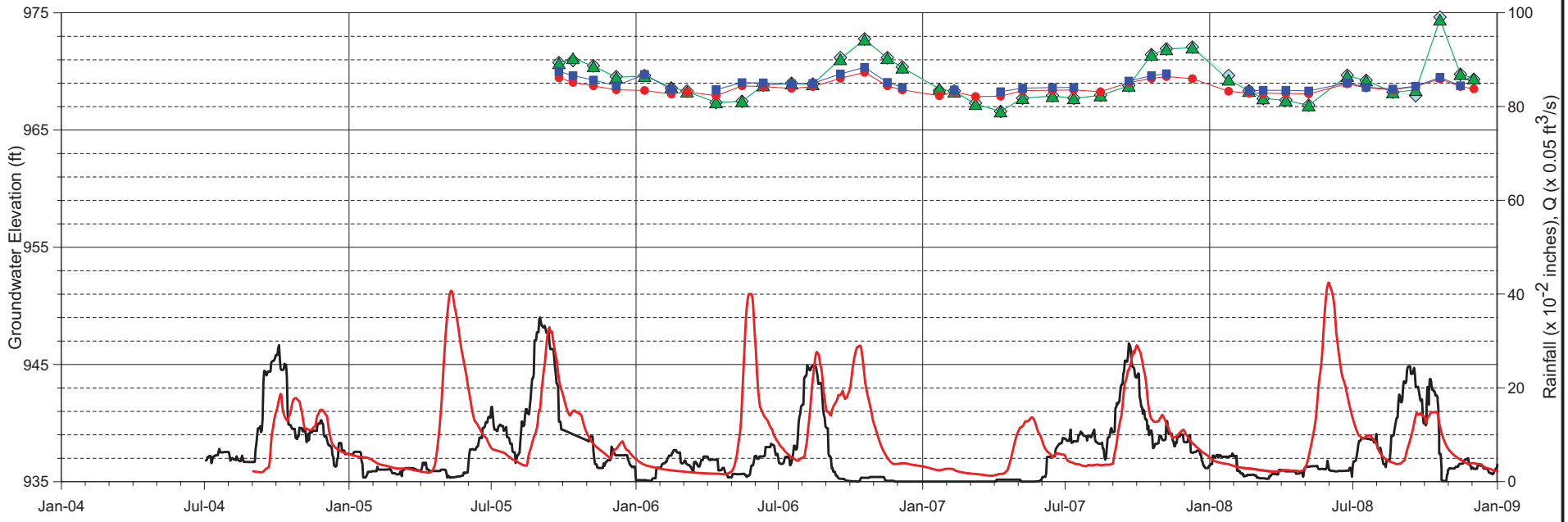


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-29



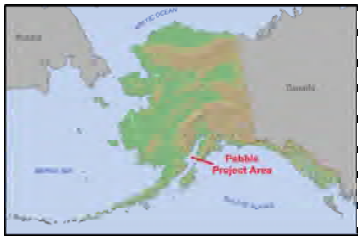
LEGEND:

Groundwater Elevation Plot Legend

- P-05-29S
- P-05-29M
- P-05-29D2
- P-05-29D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

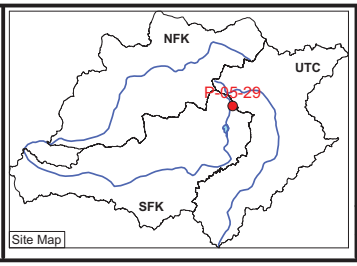
Screens (ft asl):
P-05-29S : 968.3 - 973.3
P-05-29M : 940.0 - 950.0
P-05-29D2 : 873.0 - 883.0
P-05-29D : 867.2 - 877.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 995.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-29.grf

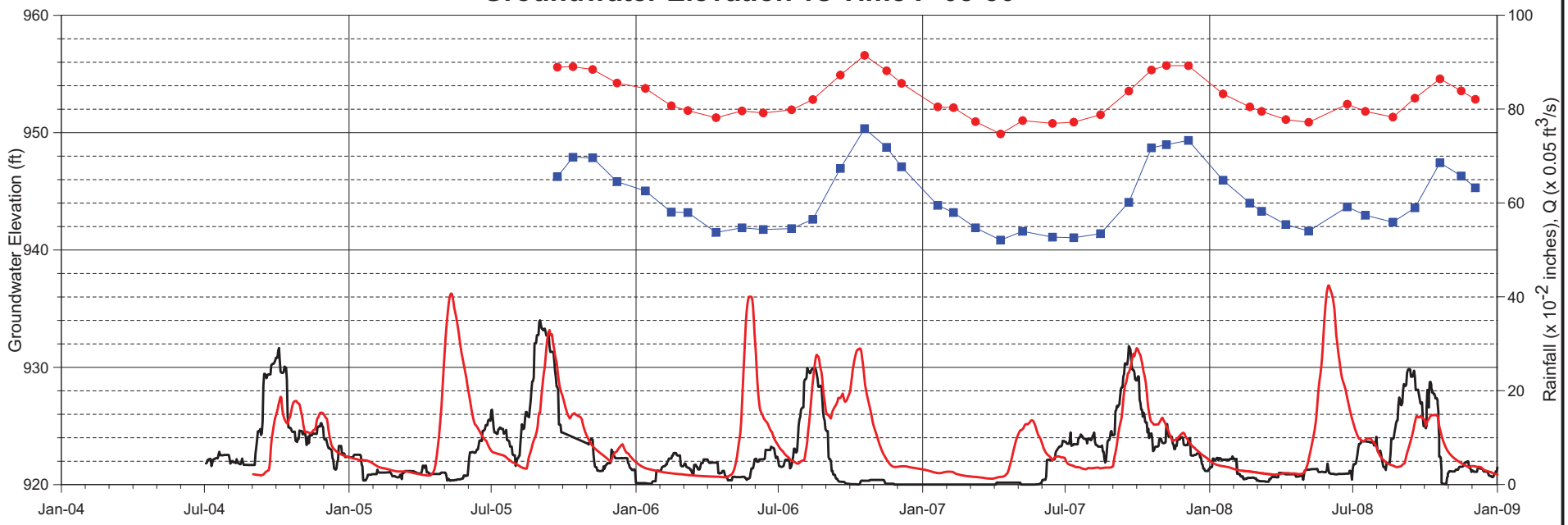


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-30



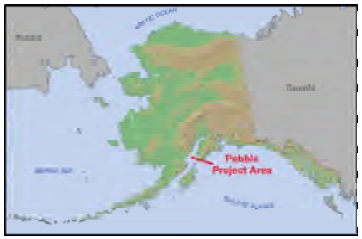
LEGEND:

Groundwater Elevation Plot Legend

- P-05-30S
- P-05-30D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

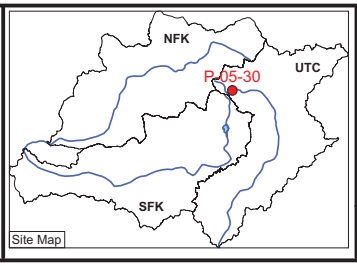
Screens (ft asl):
P-05-30S : 898.3 - 903.3
P-05-30D : 865.5 - 875.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 971.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-30.grf

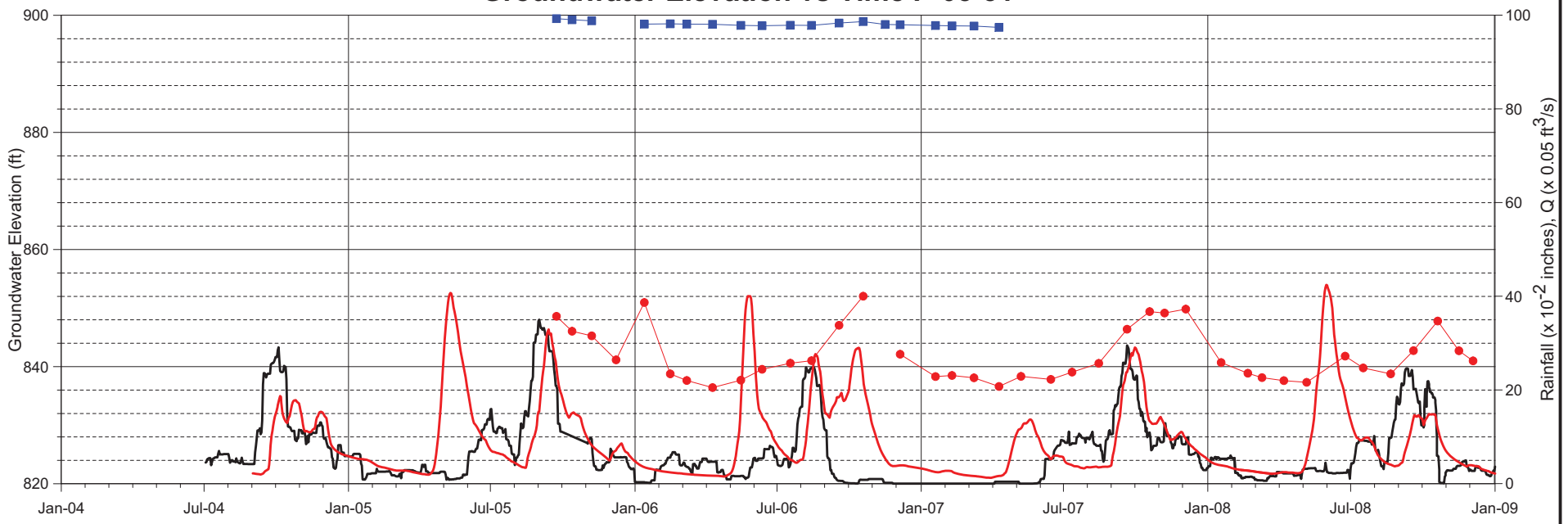


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-31



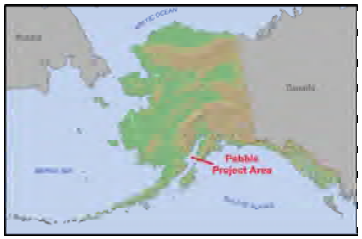
LEGEND:

Groundwater Elevation Plot Legend

- P-05-31S
- P-05-31D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-31S : 894.5 - 899.5
P-05-31D : 772.7 - 782.7



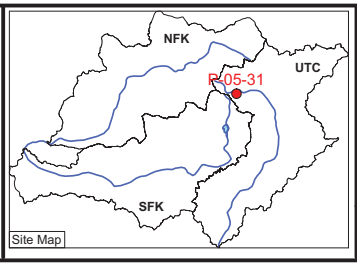
Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 919.3 ft asl

P05-31S gradually infilled with sediment to same level as water. No water levels could be recorded after April, 2007.

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: J:\Projects\7126-40-01\Drilling\Hydrographer\P-05-31.grf

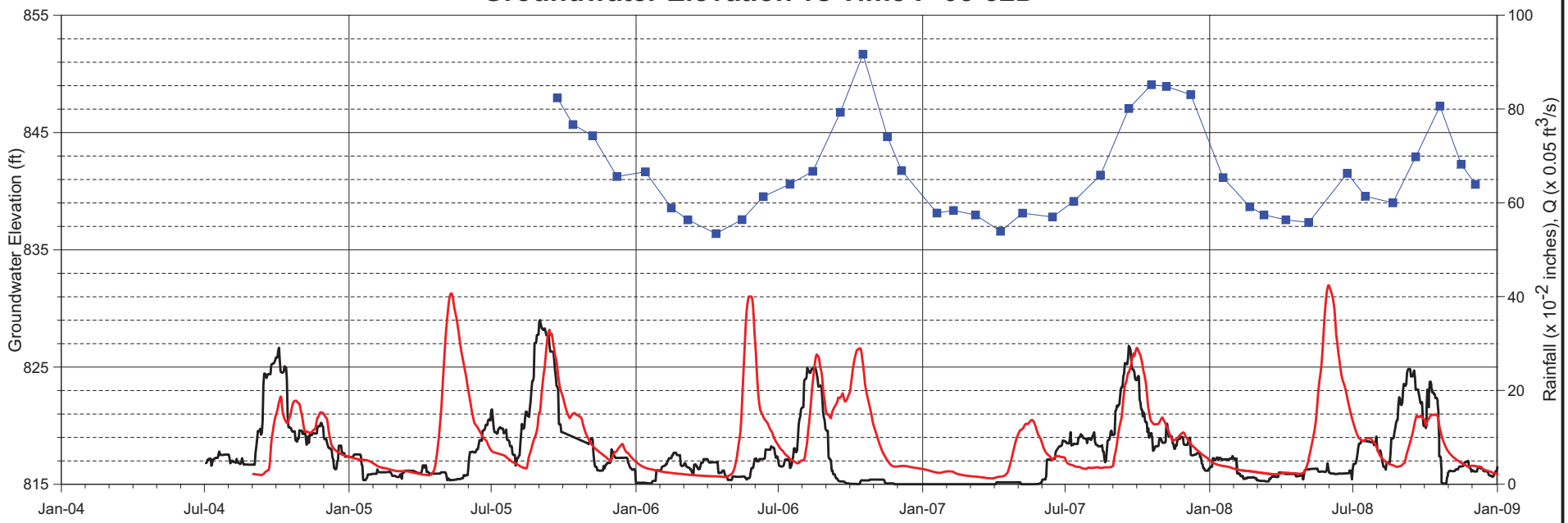


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-32D



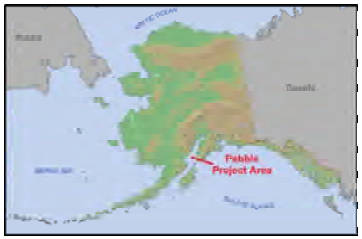
LEGEND:

Groundwater Elevation Plot Legend

- P-05-32D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

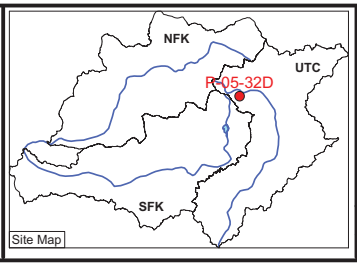
Screens (ft asl):
P-05-32D : 787.5 - 807.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 887.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-32D.grf

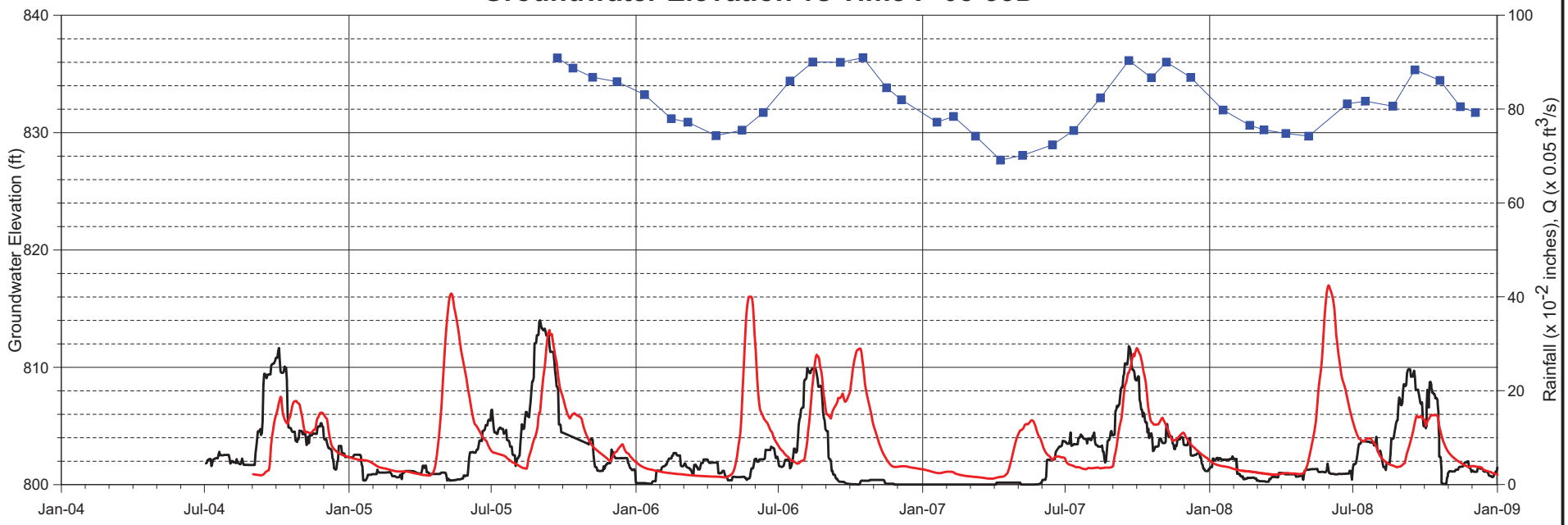


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-33D



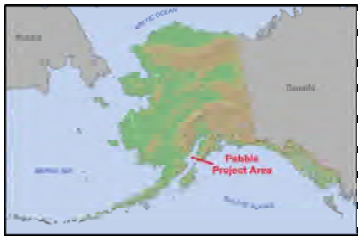
LEGEND:

Groundwater Elevation Plot Legend

- P-05-33D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

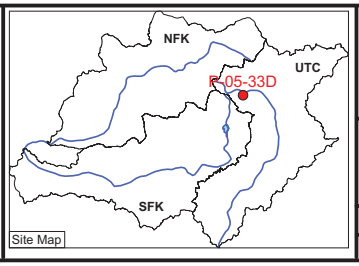
Screens (ft asl):
P-05-33D : 793.1 - 803.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 837.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-33D.grf

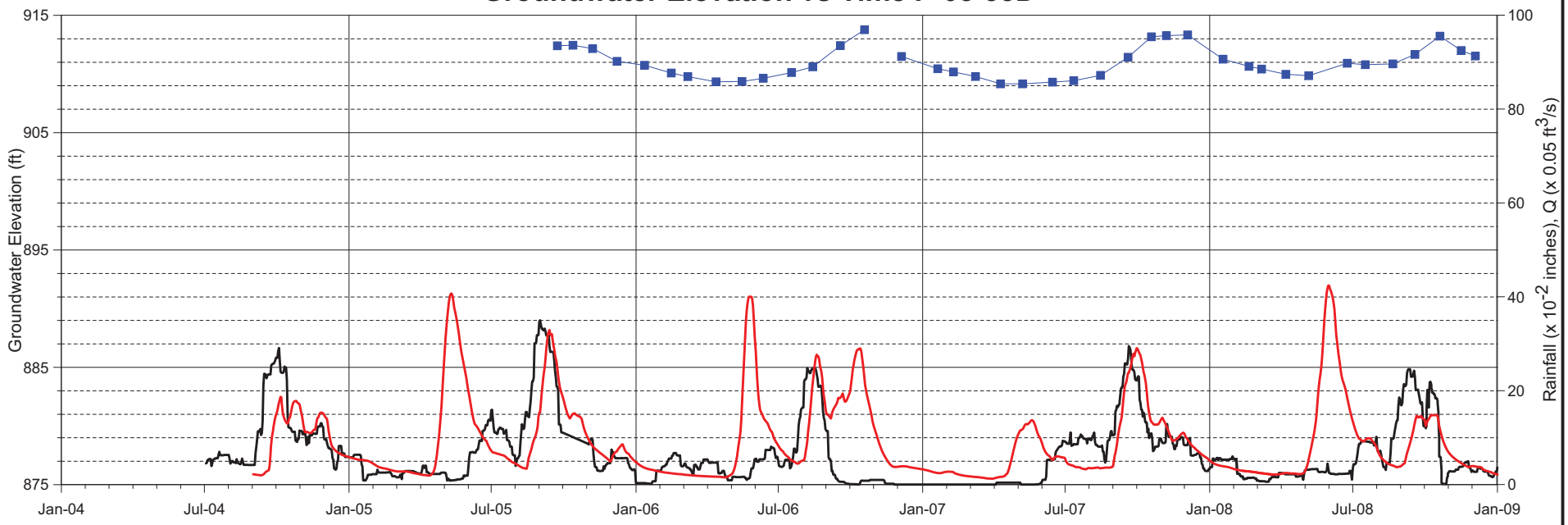


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-35D



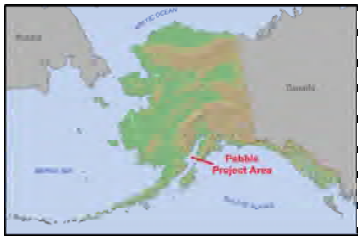
LEGEND:

Groundwater Elevation Plot Legend

- P-05-35D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

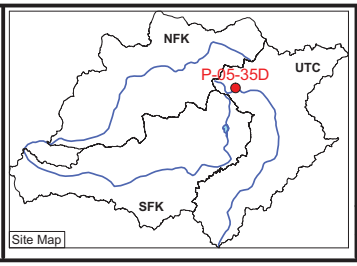
Screens (ft asl):
P-05-35D : 876.5 - 881.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 933.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-35D.grf

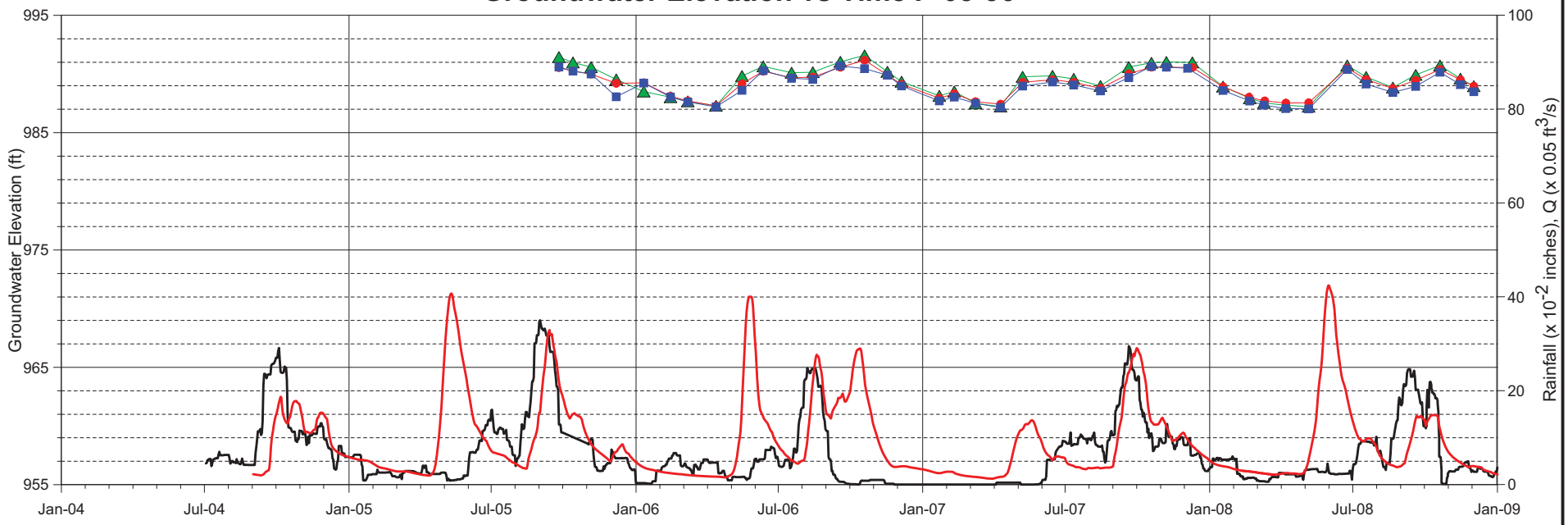


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-36



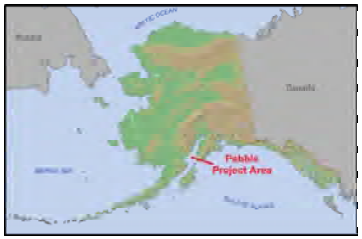
LEGEND:

Groundwater Elevation Plot Legend

- P-05-36S
- P-05-36M
- P-05-36D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

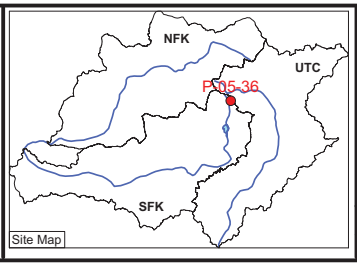
Screens (ft asl):
P-05-36S : 975.5 - 985.5
P-05-36M : 919.2 - 929.2
P-05-36D : 861.4 - 871.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1008.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-36.grf

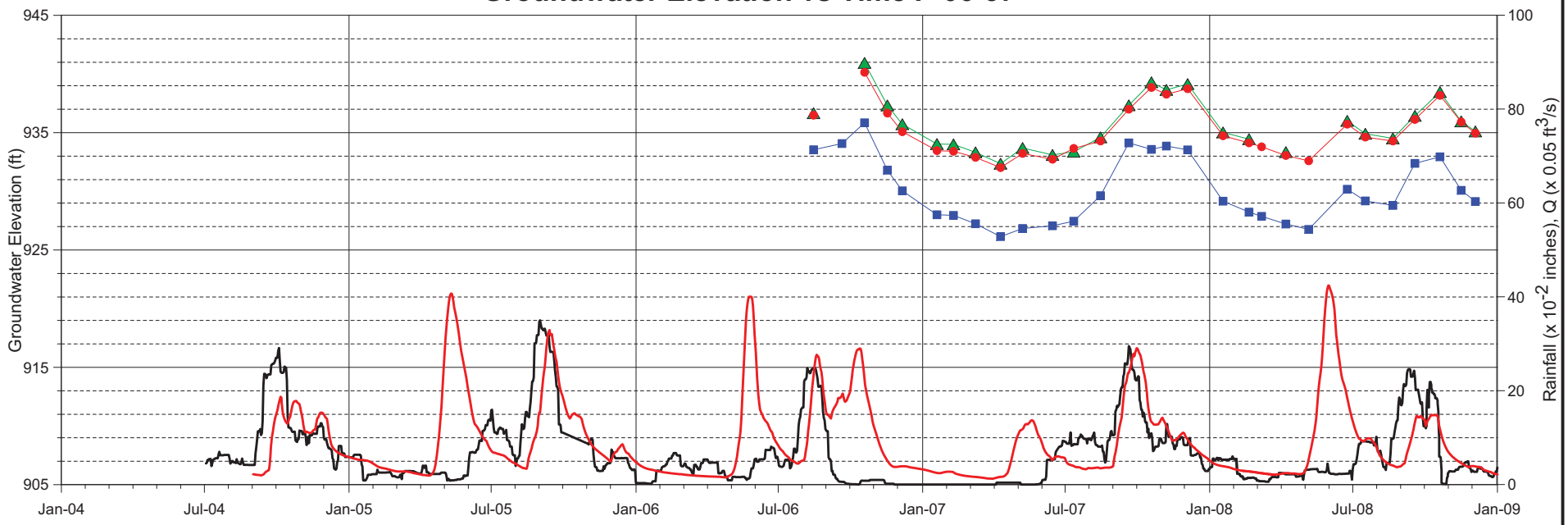


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-37



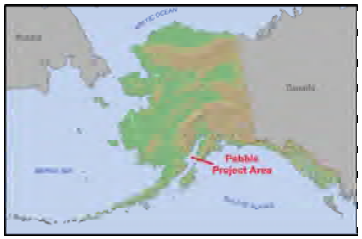
LEGEND:

Groundwater Elevation Plot Legend

- P-06-37S
- P-06-37M
- P-06-37D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

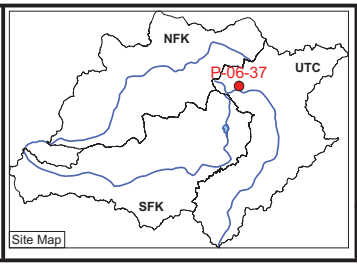
Screens (ft asl):
P-06-37S : 919.1 - 924.1
P-06-37M : 854.0 - 869.5
P-06-37D : 745.3 - 765.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 944.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-37.grf

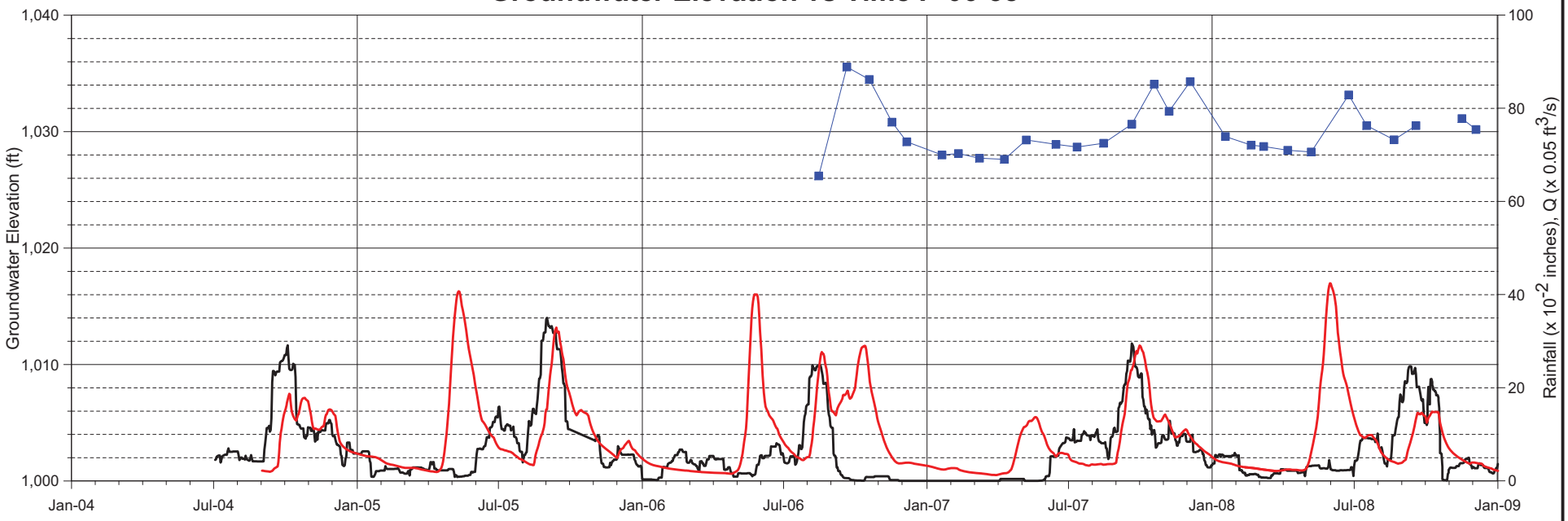


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-38



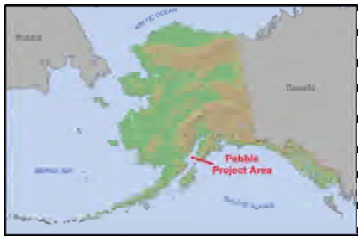
LEGEND:

Groundwater Elevation Plot Legend

- P-06-38M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-06-38M : 995.8 - 1005.8
P-06-38D : 893.2 - 908.2

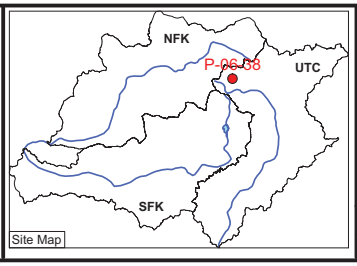


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1063.3 ft asl

P-06-38D was flowing,
therefore water levels not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-38.grf

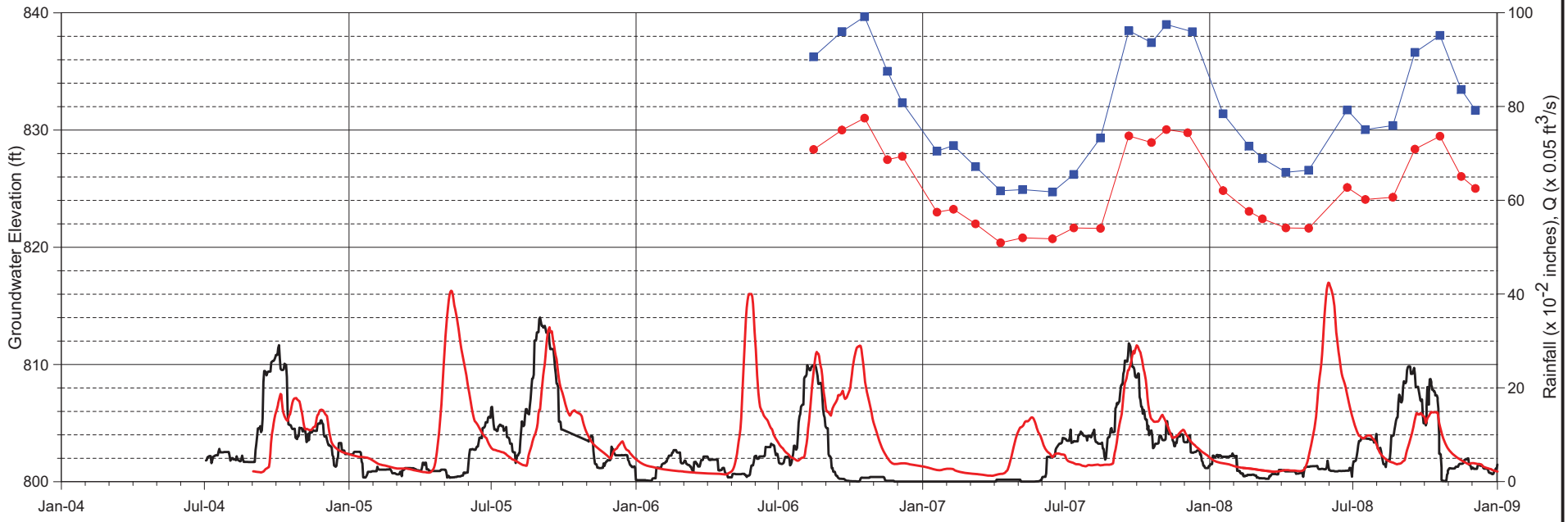


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-39



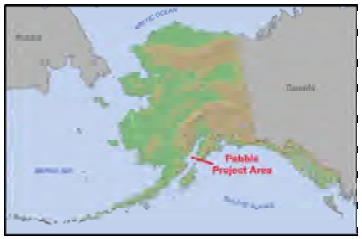
LEGEND:

Groundwater Elevation Plot Legend

- P-06-39S
- P-06-39D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

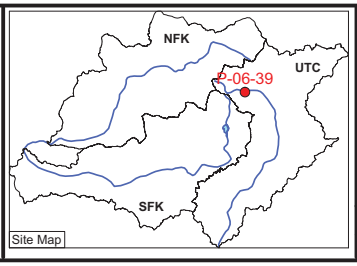
Screens (ft asl):
P-06-39S : 807.7 - 812.7
P-06-39D : 730.5 - 750.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 842.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-39.grf

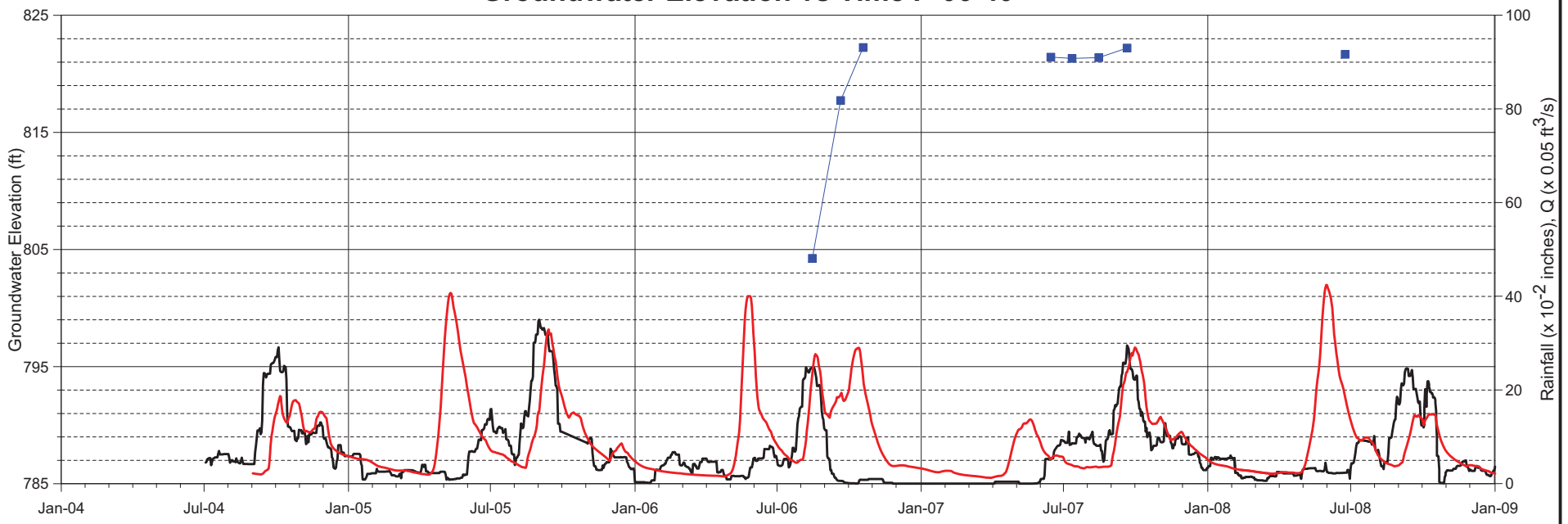


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-40



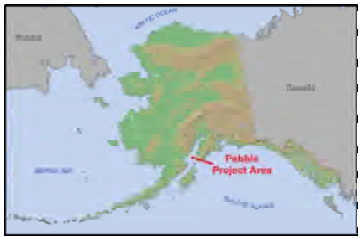
LEGEND:

Groundwater Elevation Plot Legend

- P-06-40S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-06-40S : 800.7 - 805.7
P-06-40M : 757.0 - 767.0
P-06-40D : 675.0 - 685.0

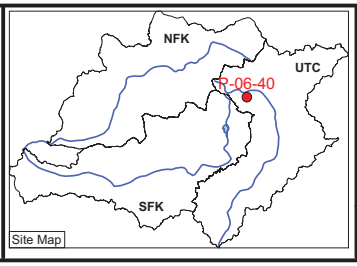


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 819.9 ft asl

P06-40D and P06-40M were flowing, therefore water levels not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-40.grf

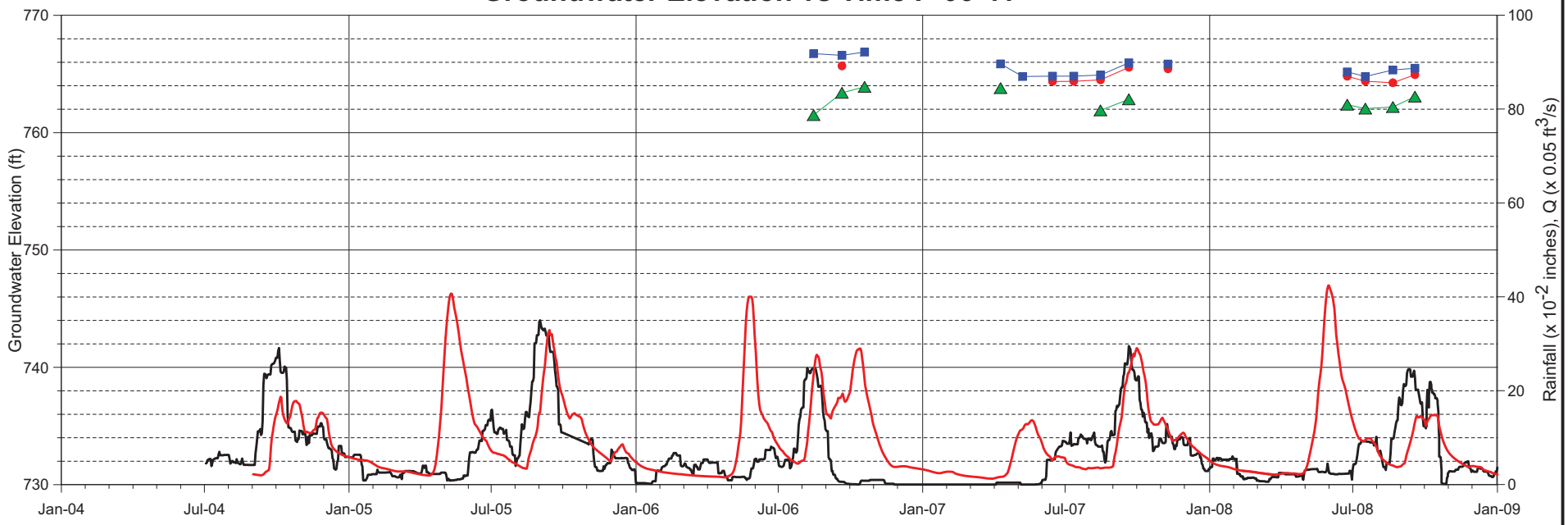


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-41



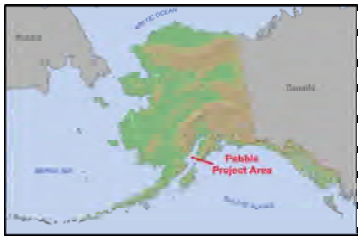
LEGEND:

Groundwater Elevation Plot Legend

- P-06-41S
- P-06-41M
- P-06-41D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

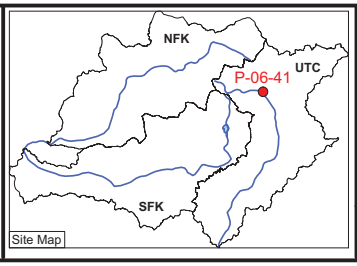
Screens (ft asl):
P-06-41S : 722.7 - 727.7
P-06-41M : 700.9 - 710.9
P-06-41D : 563.1 - 573.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 764.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-41.grf

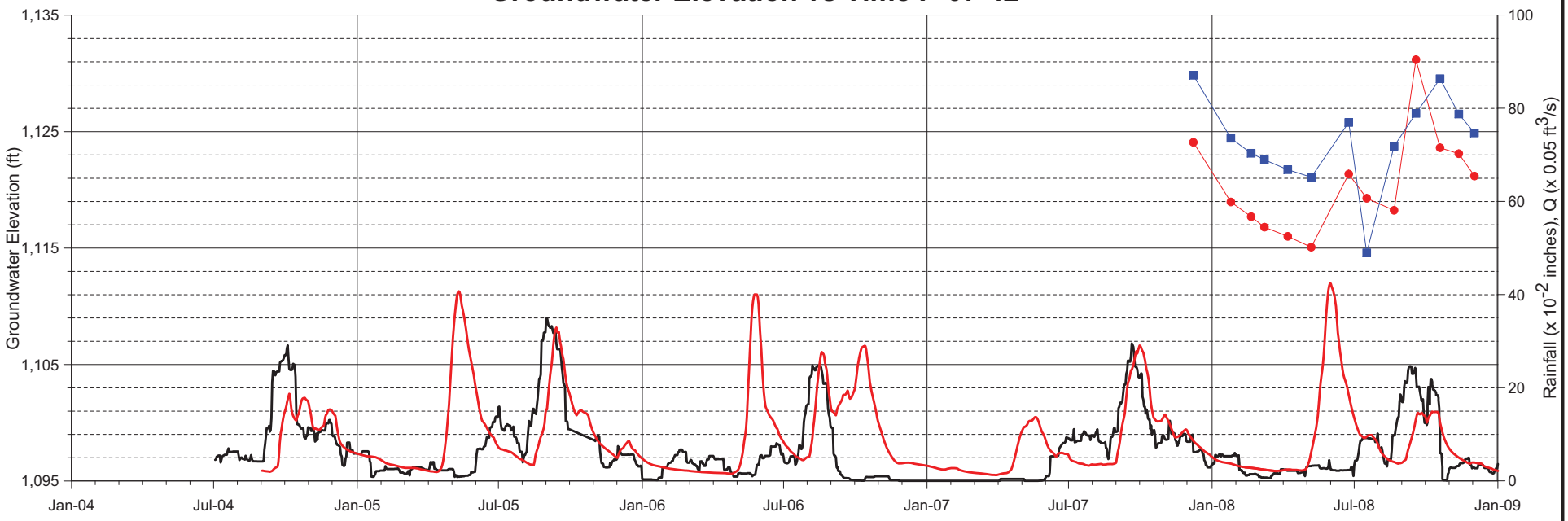


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-42



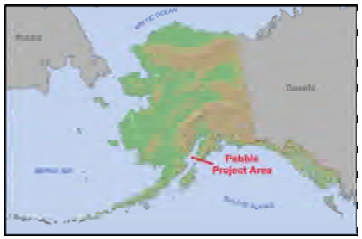
LEGEND:

Groundwater Elevation Plot Legend

- P-07-42S
- P-07-42D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

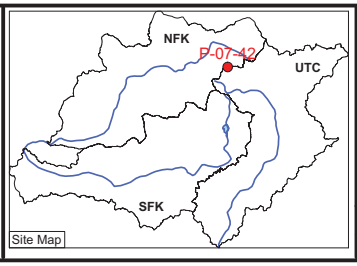
Screens (ft asl):
P-07-42S : 1107.5 - 1116.5
P-07-42D : 1035.3 - 1045.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1156.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-42.grf

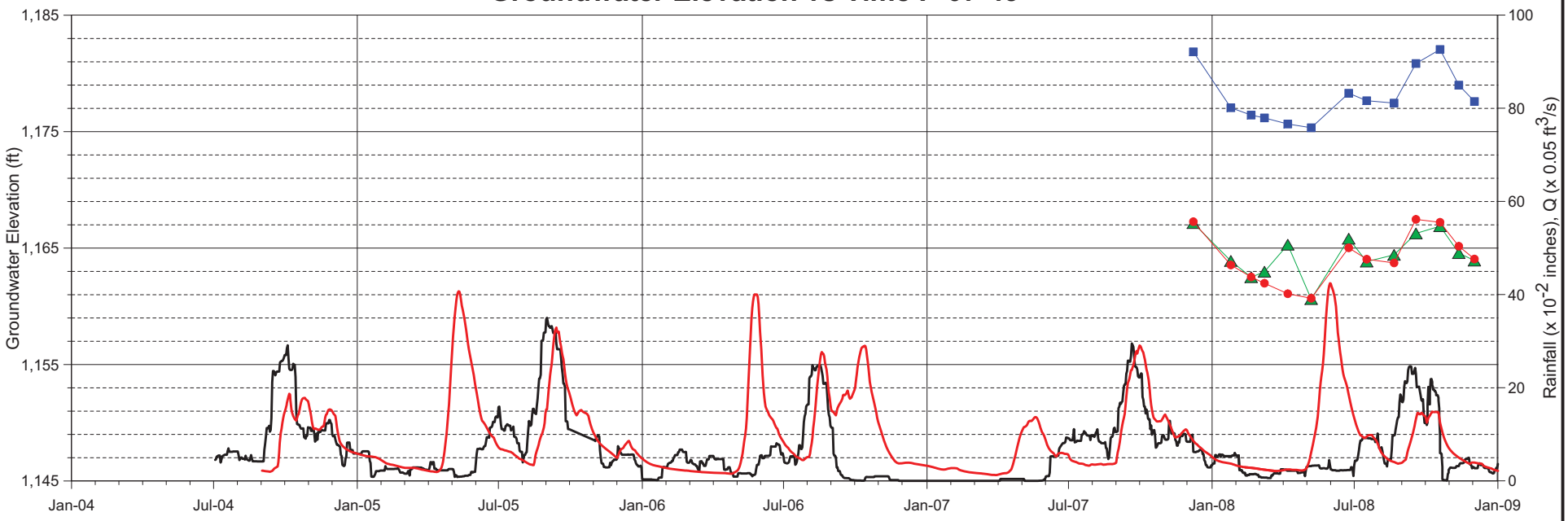


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-43



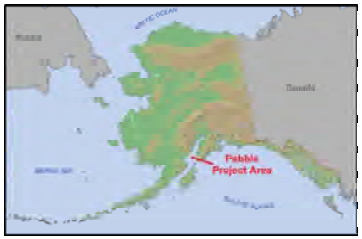
LEGEND:

Groundwater Elevation Plot Legend

- P-07-43S
- P-07-43M
- P-07-43D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

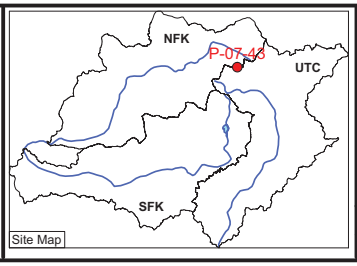
Screens (ft asl):
P-07-43S : 1161.4 - 1170.4
P-07-43M : 1122.0 - 1132.0
P-07-43D : 1058.2 - 1063.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1191.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-43.grf

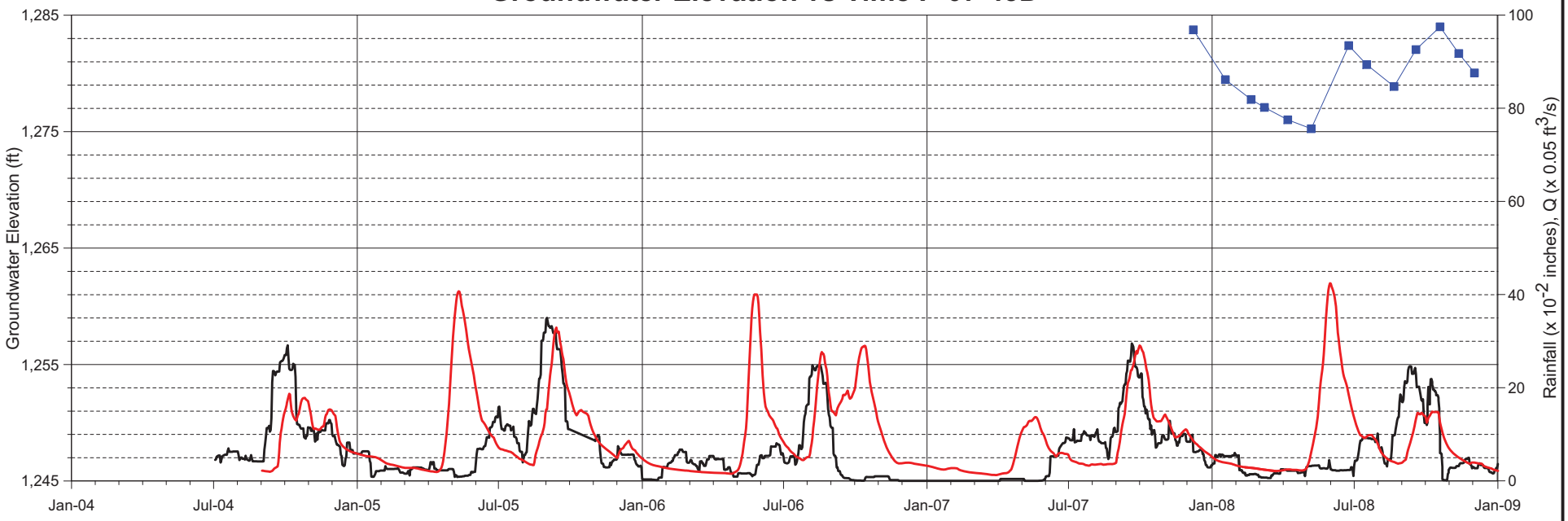


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-45D



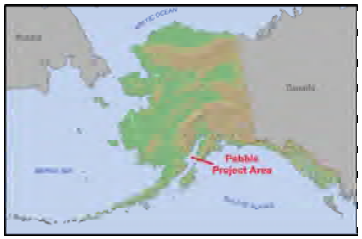
LEGEND:

Groundwater Elevation Plot Legend

- P-07-45D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

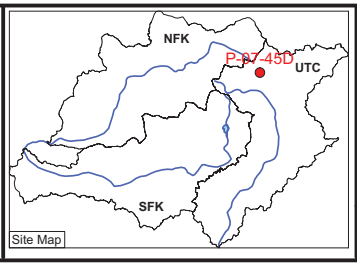
Screens (ft asl):
P-07-45D : 1253.0 - 1268.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1313 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-45D.grf

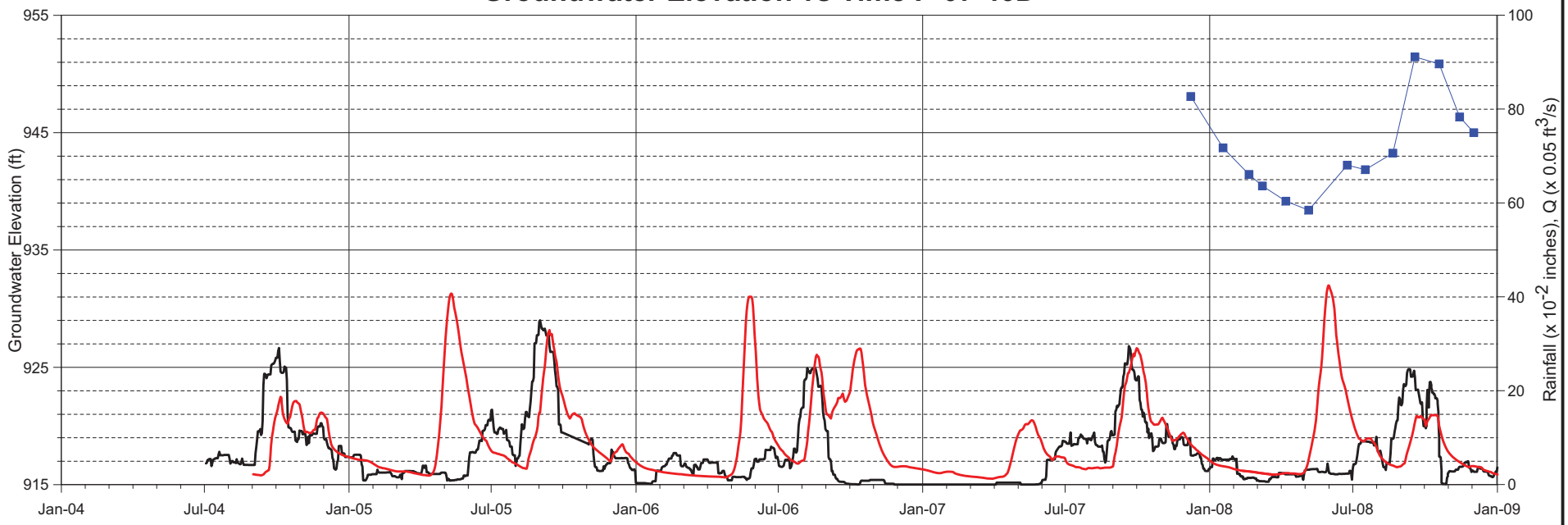


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-46D



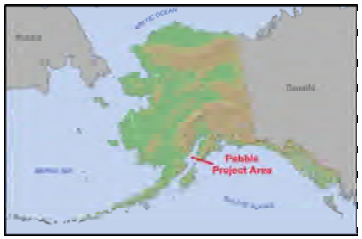
LEGEND:

Groundwater Elevation Plot Legend

- P-07-46D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

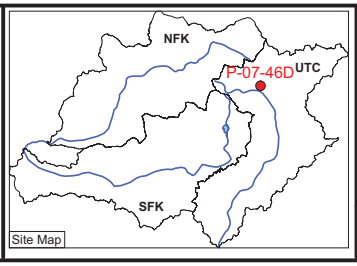
Screens (ft asl):
P-07-46D : 920.0 - 925.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 962.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-46D.grf

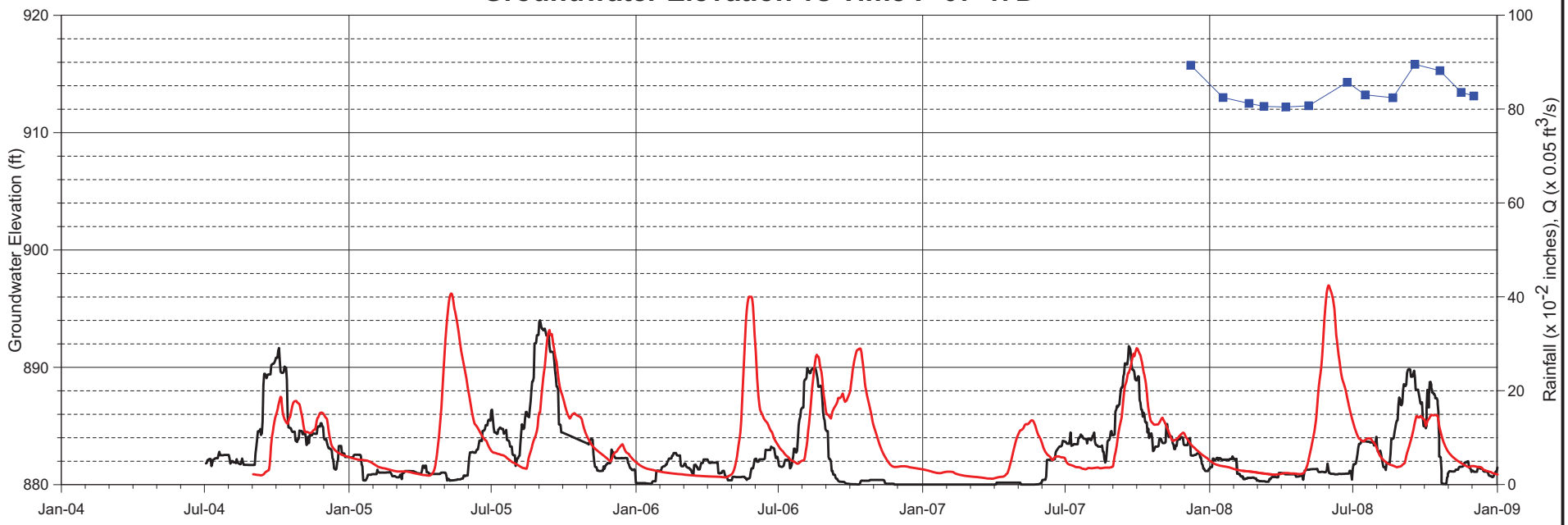


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-47D



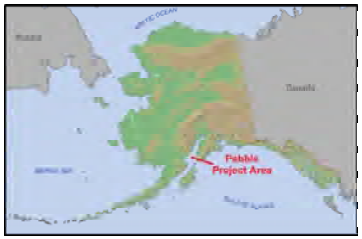
LEGEND:

Groundwater Elevation Plot Legend

- P-07-47D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

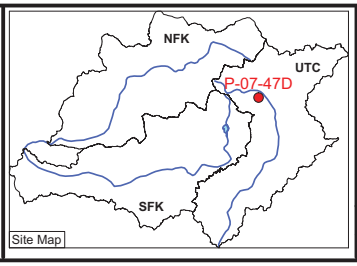
Screens (ft asl):
P-07-47D : 837.4 - 842.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 917 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-47D.grf

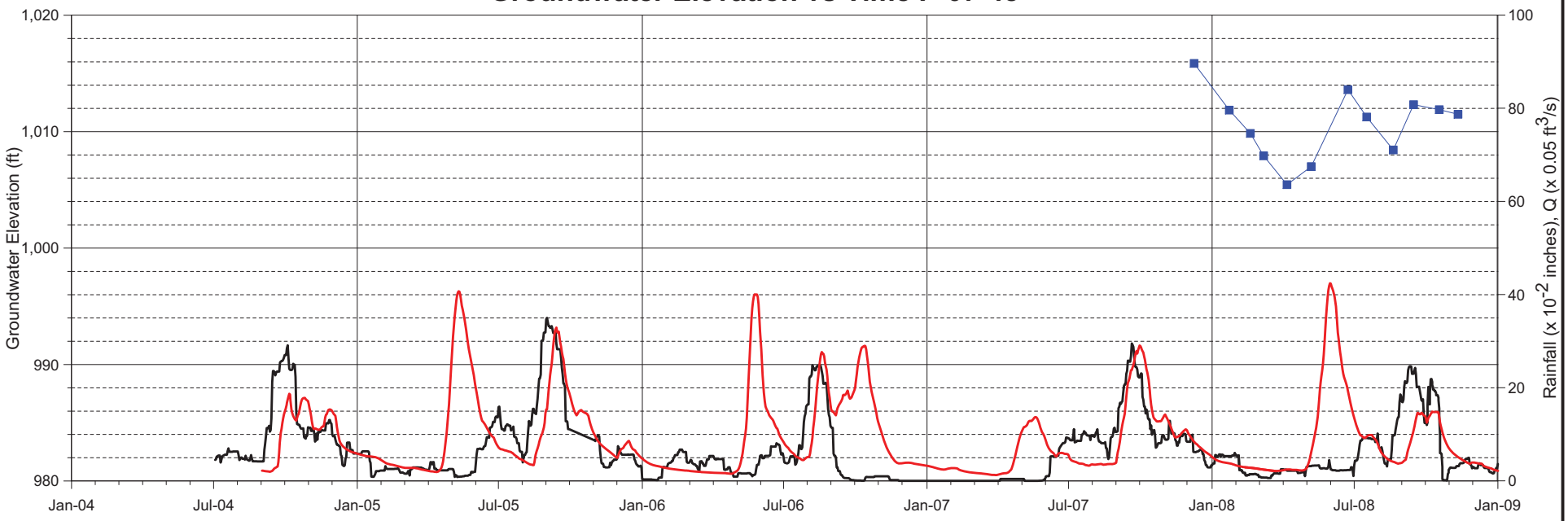


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-48



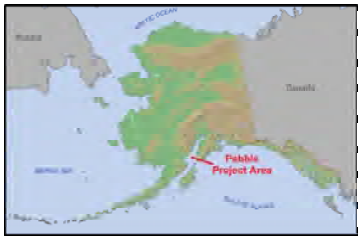
LEGEND:

Groundwater Elevation Plot Legend

- P-07-48D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

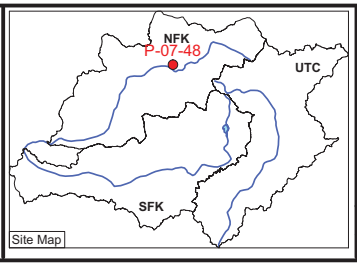
Screens (ft asl):
P-07-48S : 1021.4 - 1026.4
P-07-48D : 988.6 - 998.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1045.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-48.grf

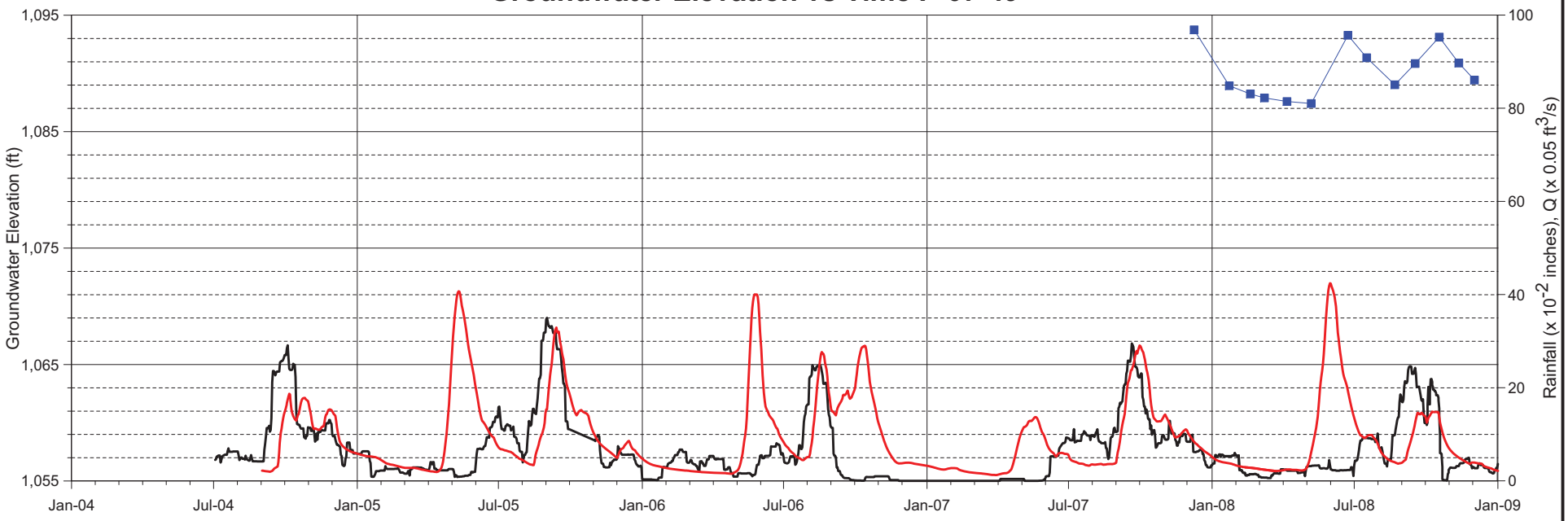


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-49



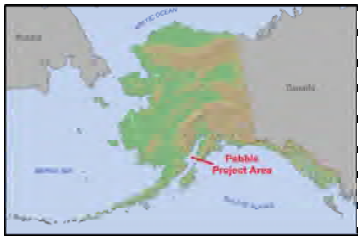
LEGEND:

Groundwater Elevation Plot Legend

- P-07-49D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

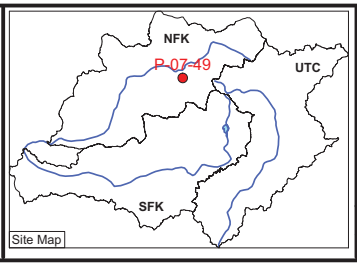
Screens (ft asl):
P-07-49S : 1091.9 - 1096.9
P-07-49D : 1017.4 - 1022.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1114.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-49.grf

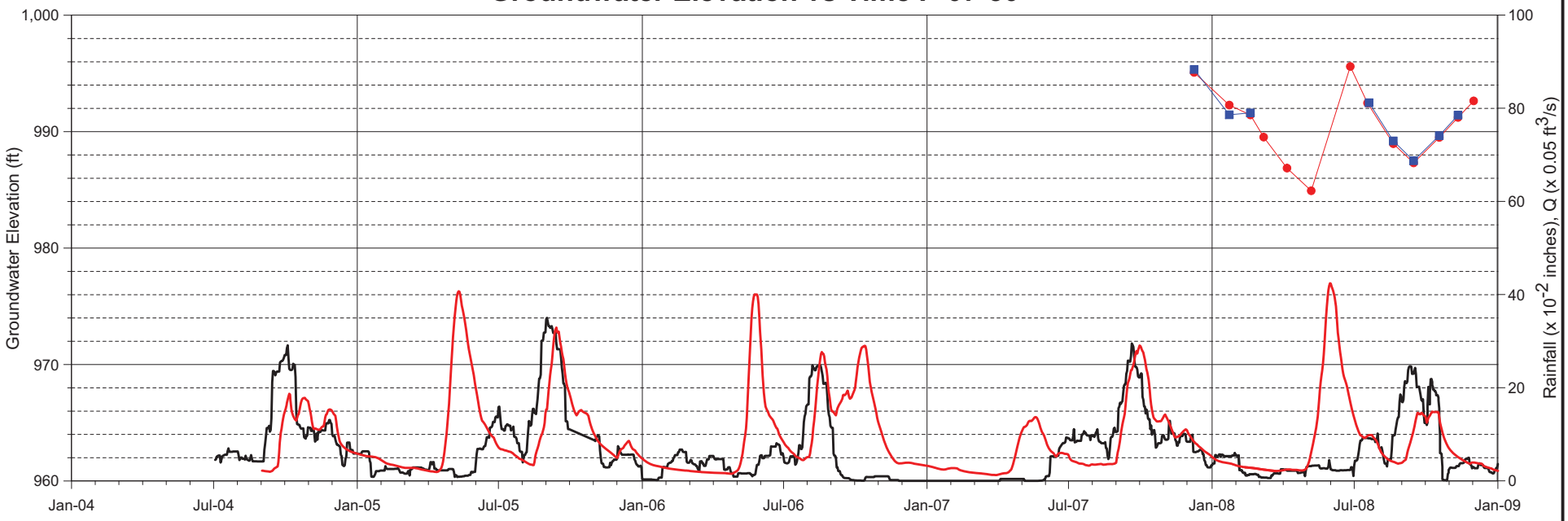


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-50



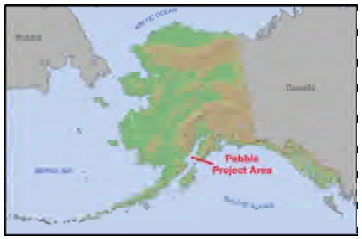
LEGEND:

Groundwater Elevation Plot Legend

- P-07-50S
- P-07-50D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

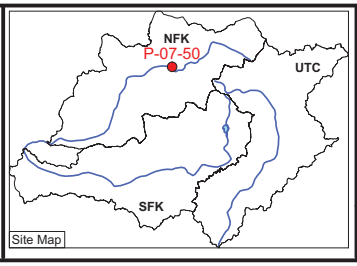
Screens (ft asl):
P-07-50SS : 1023.4 - 1033.4
P-07-50S : 983.3 - 993.3
P-07-50D : 891.5 - 901.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1053.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-50.grf

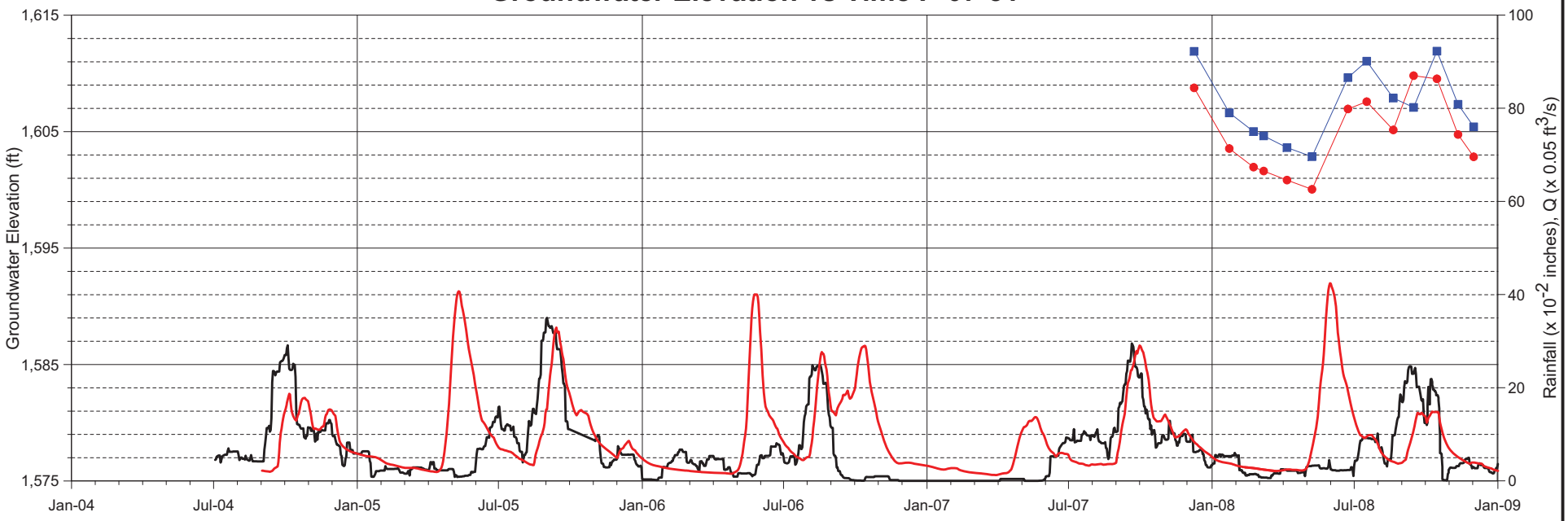


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-51



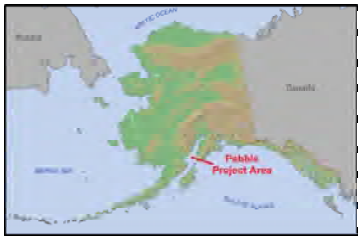
LEGEND:

Groundwater Elevation Plot Legend

- P-07-51S
- P-07-51D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

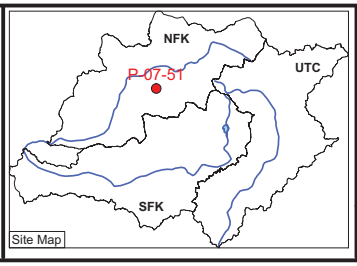
Screens (ft asl):
P-07-51S : 1594.3 - 1604.3
P-07-51D : 1568.0 - 1578.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1614.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-51.grf

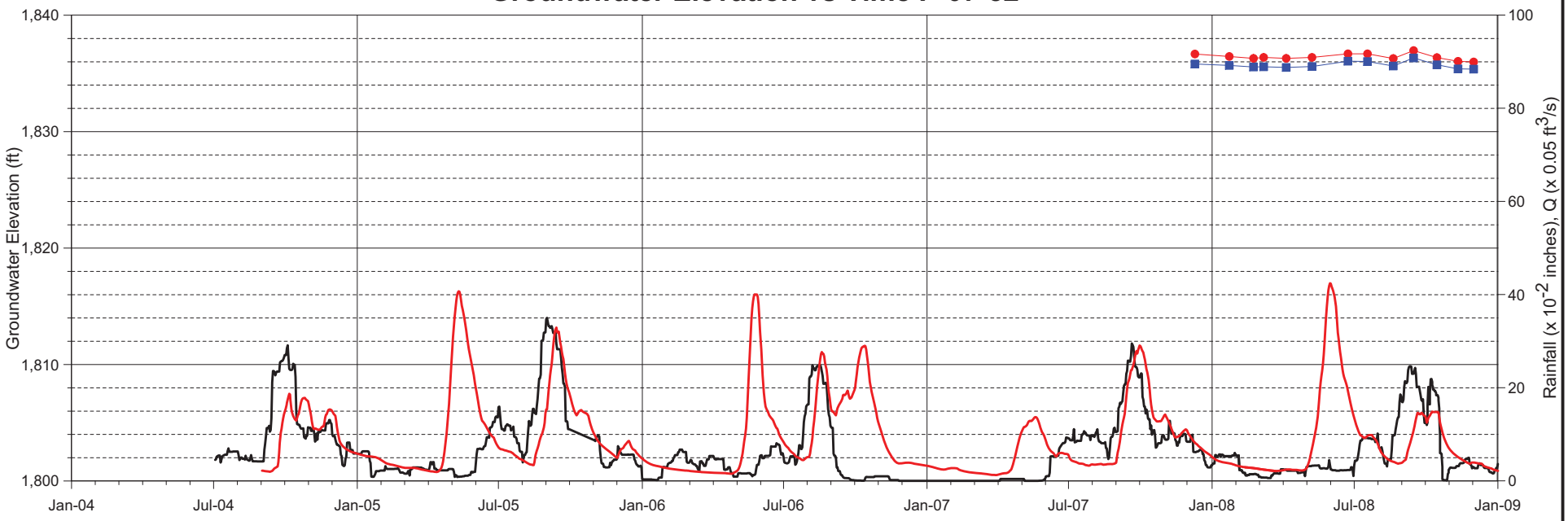


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-52



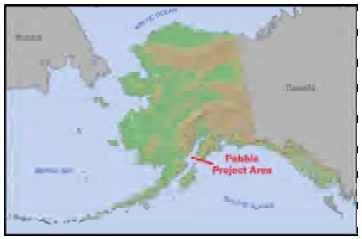
LEGEND:

Groundwater Elevation Plot Legend

- P-07-52S
- P-07-52D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

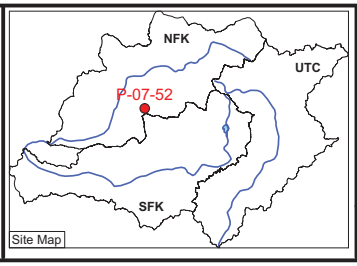
Screens (ft asl):
P-07-52S : 1824.7 - 1834.7
P-07-52D : 1793.4 - 1803.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1852.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-52.grf

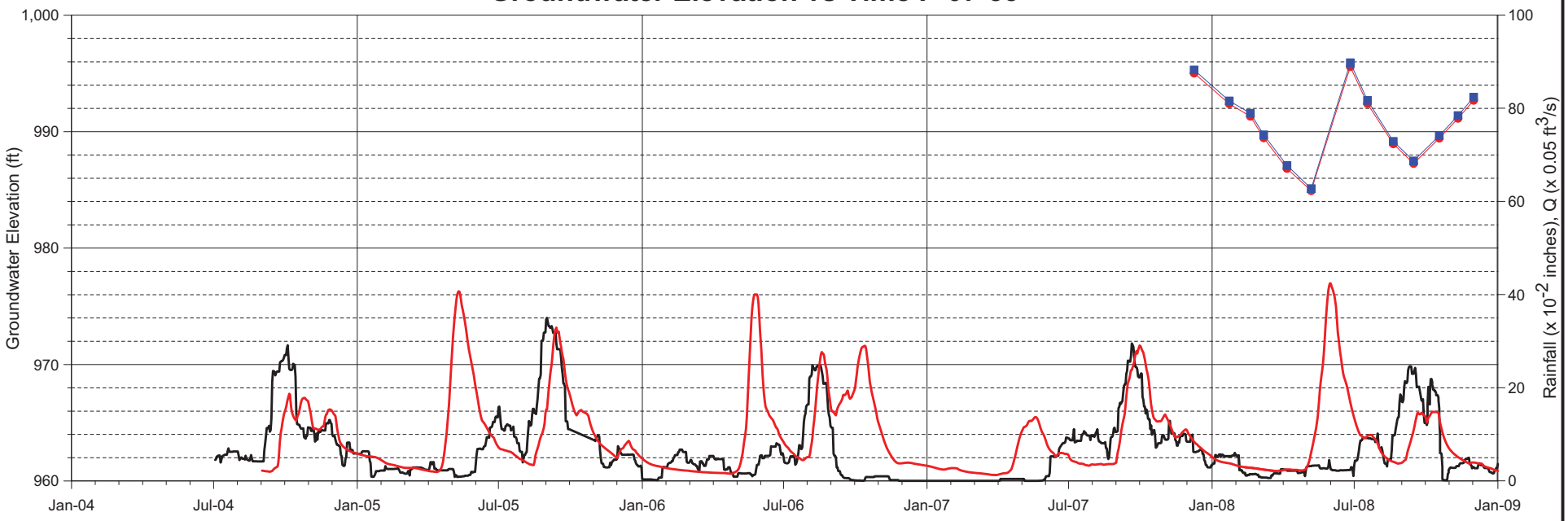


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-53



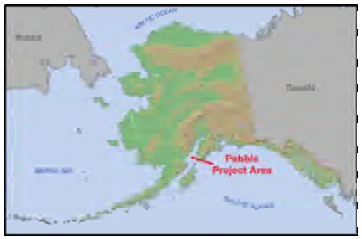
LEGEND:

Groundwater Elevation Plot Legend

- P-07-53S
- P-07-53D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

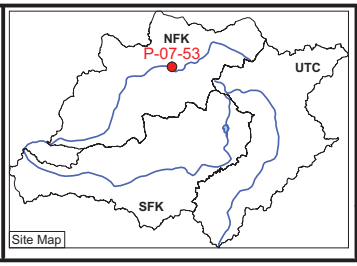
Screens (ft asl):
P-07-53S : 981.0 - 991.0
P-07-53D : 890.6 - 900.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1053.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-53.grf

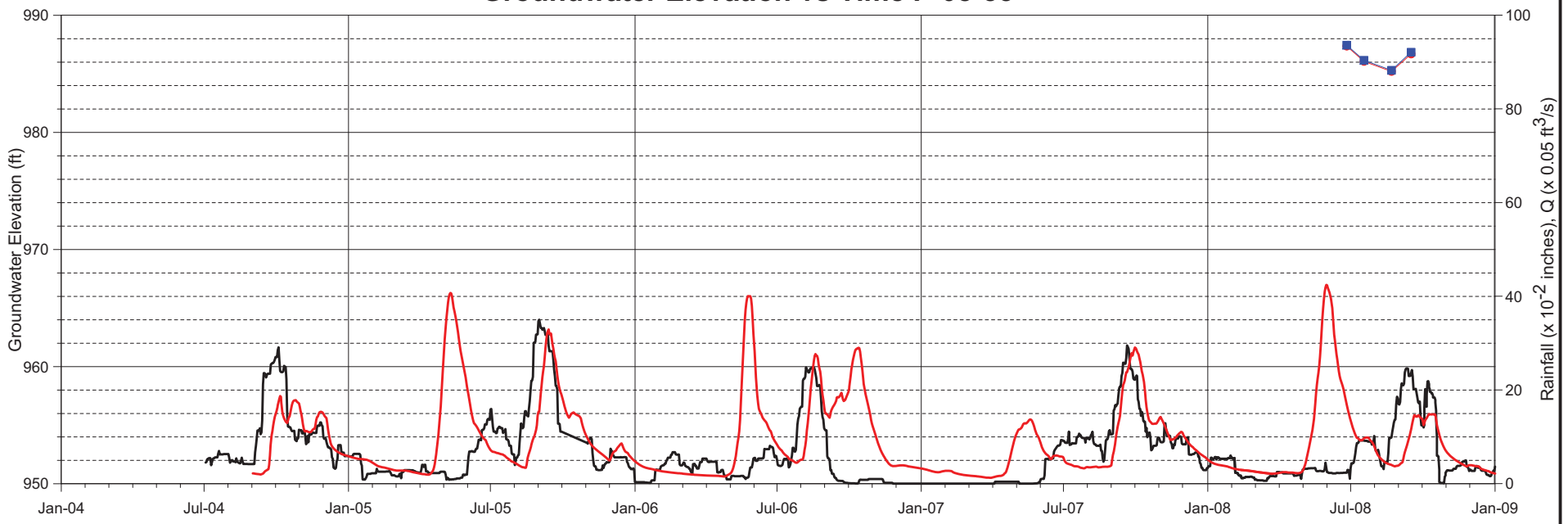


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-55



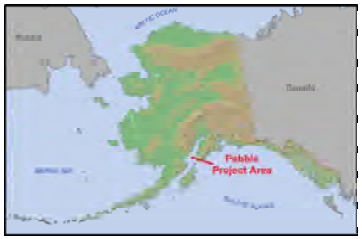
LEGEND:

Groundwater Elevation Plot Legend

- P-08-55S
- P-08-55D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

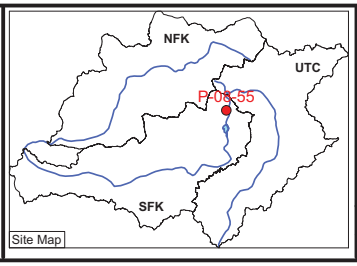
Screens (ft asl):
P-08-55S : 920.7 - 940.4
P-08-55D : 870.6 - 880.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 985.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-55.grf

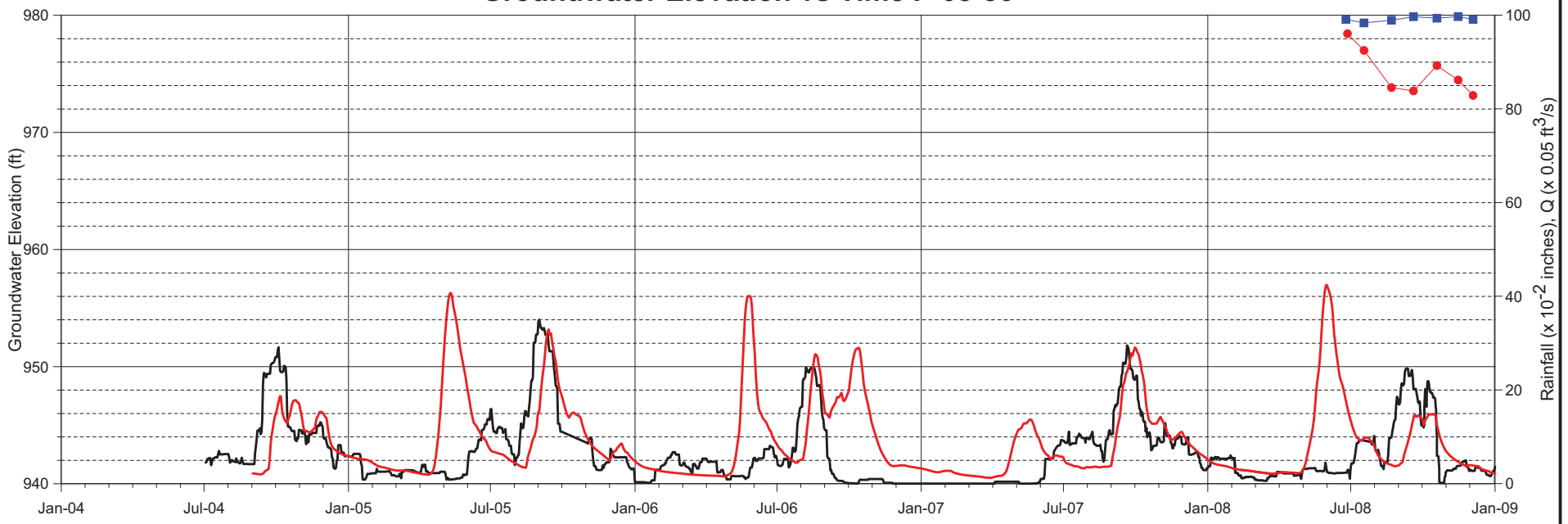


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-56



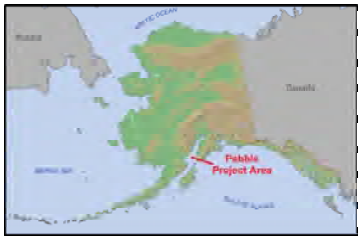
LEGEND:

Groundwater Elevation Plot Legend

- P-08-56S
- P-08-56M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

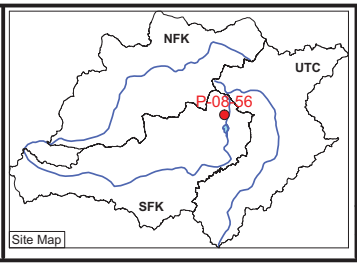
Screens (ft asl):
P-08-56S : 963.3 - 968.3
P-08-56M : 885.7 - 895.7
P-08-56D : 843.4 - 853.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 983.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-56.grf

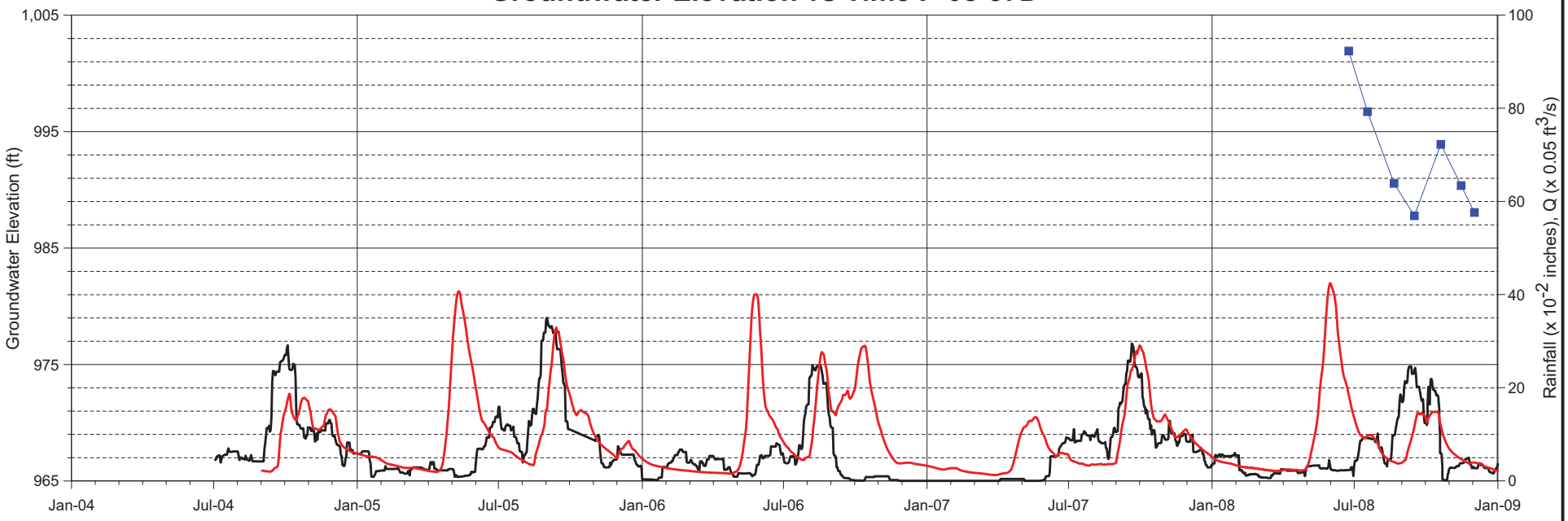


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-57D



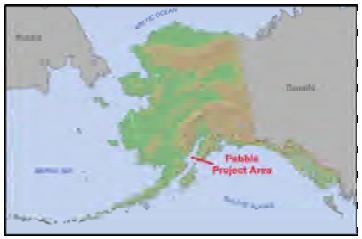
LEGEND:

Groundwater Elevation Plot Legend

- P-08-57D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

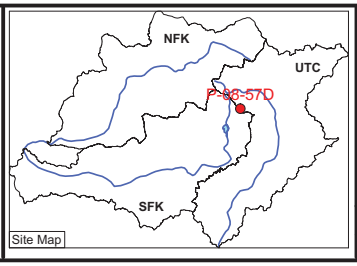
Screens (ft asl):
P-08-57D : 787.5 - 797.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1029.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-57D.grf

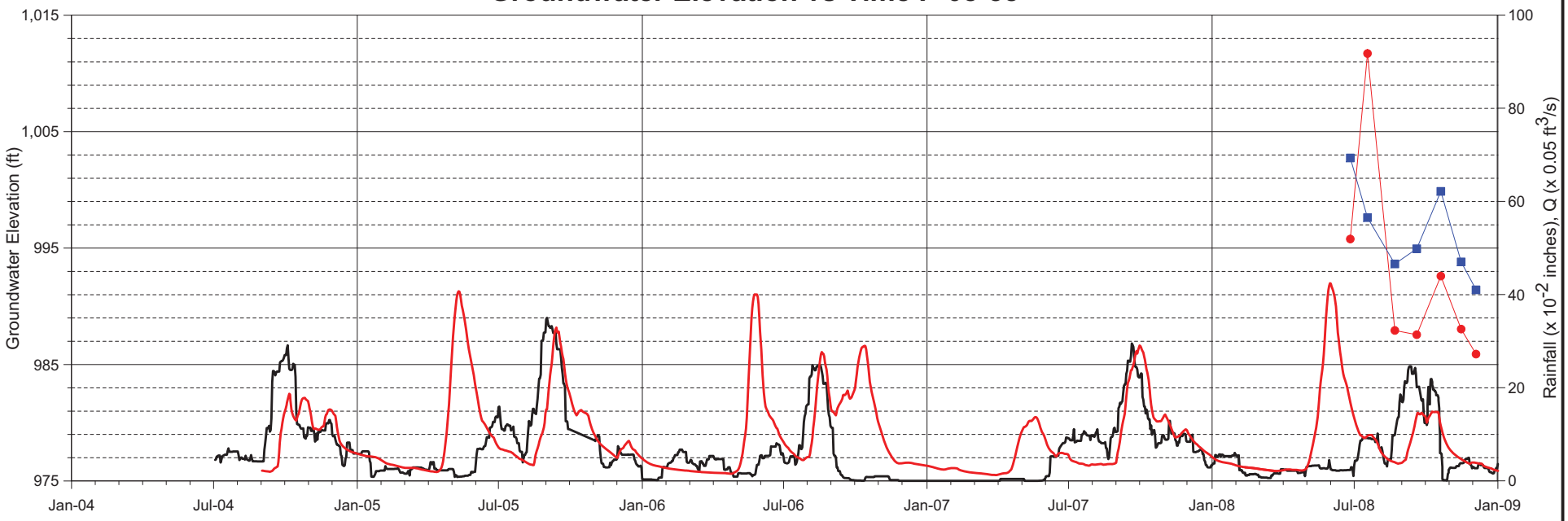


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-58



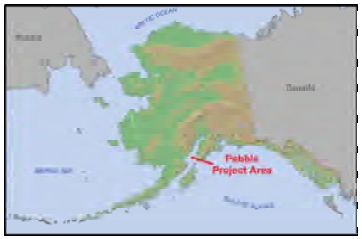
LEGEND:

Groundwater Elevation Plot Legend

- P-08-58M
- P-08-58D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

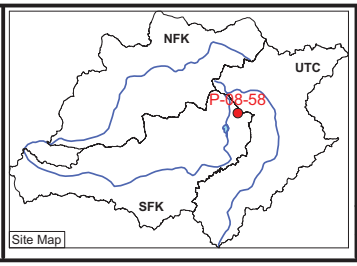
Screens (ft asl):
P-08-58M : 964.2 - 974.0
P-08-58D : 906.4 - 916.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1009.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-58.grf

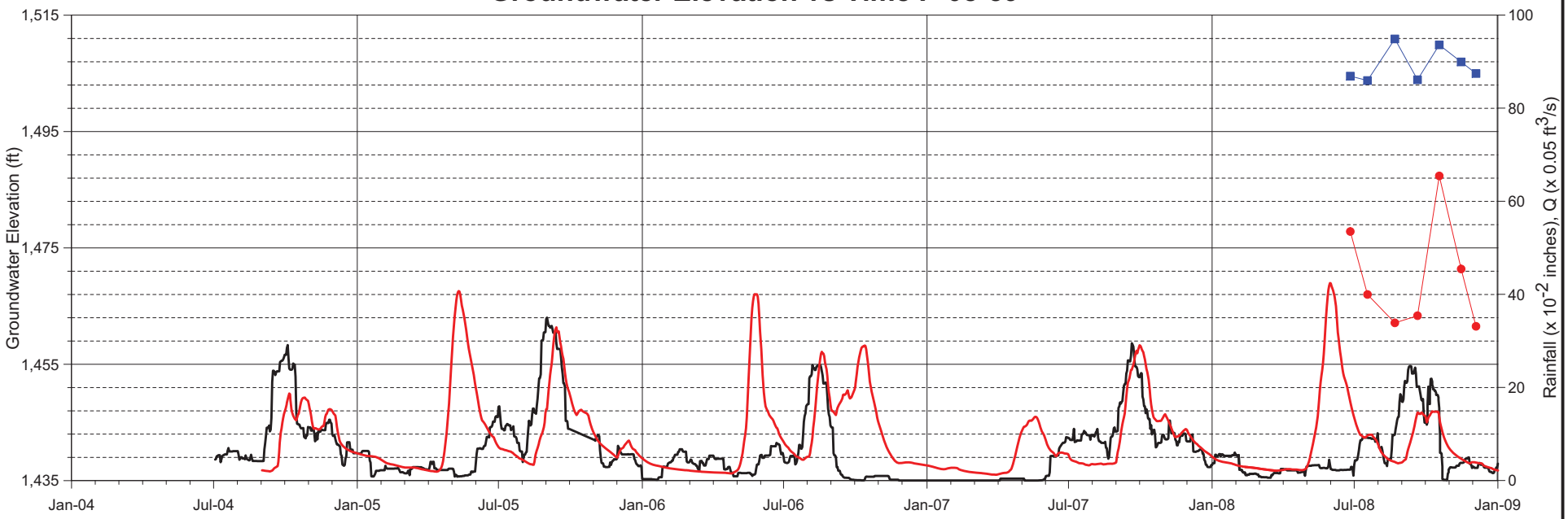


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-59



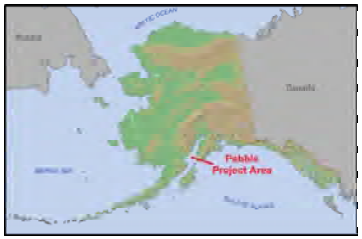
LEGEND:

Groundwater Elevation Plot Legend

- P-08-59S
- P-08-59D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-08-59S : 1484.4 - 1488.4
P-08-59D : 1429.4 - 1449.1

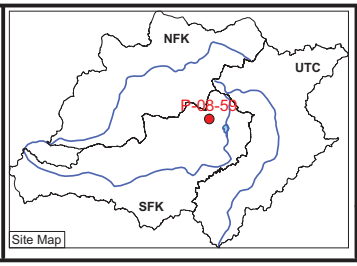


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1529.9 ft asl

The y range for this graph is 80 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-59.grf

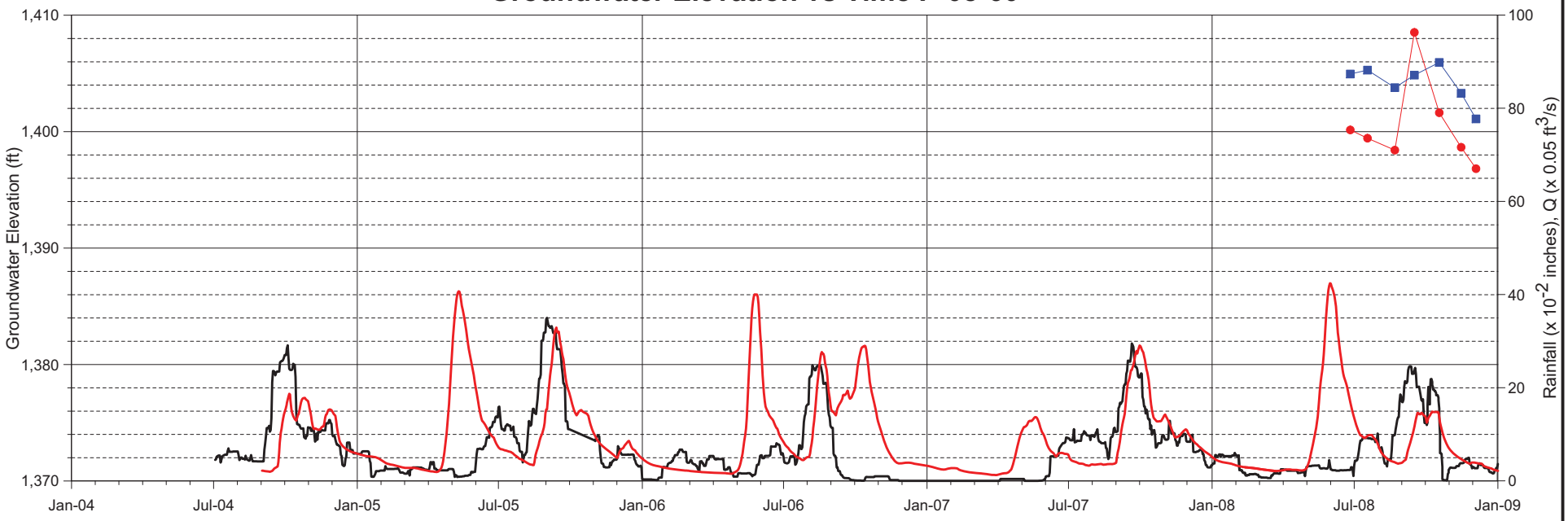


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-60



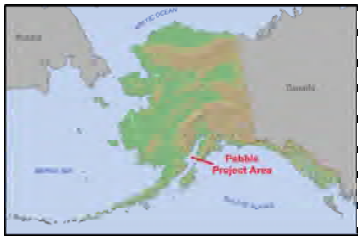
LEGEND:

Groundwater Elevation Plot Legend

- P-08-60S
- P-08-60D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

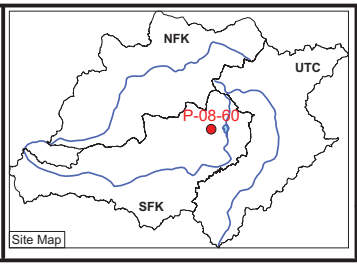
Screens (ft asl):
P-08-60S : 1379.7 - 1385.7
P-08-60D : 1331.1 - 1350.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1409.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-60.grf

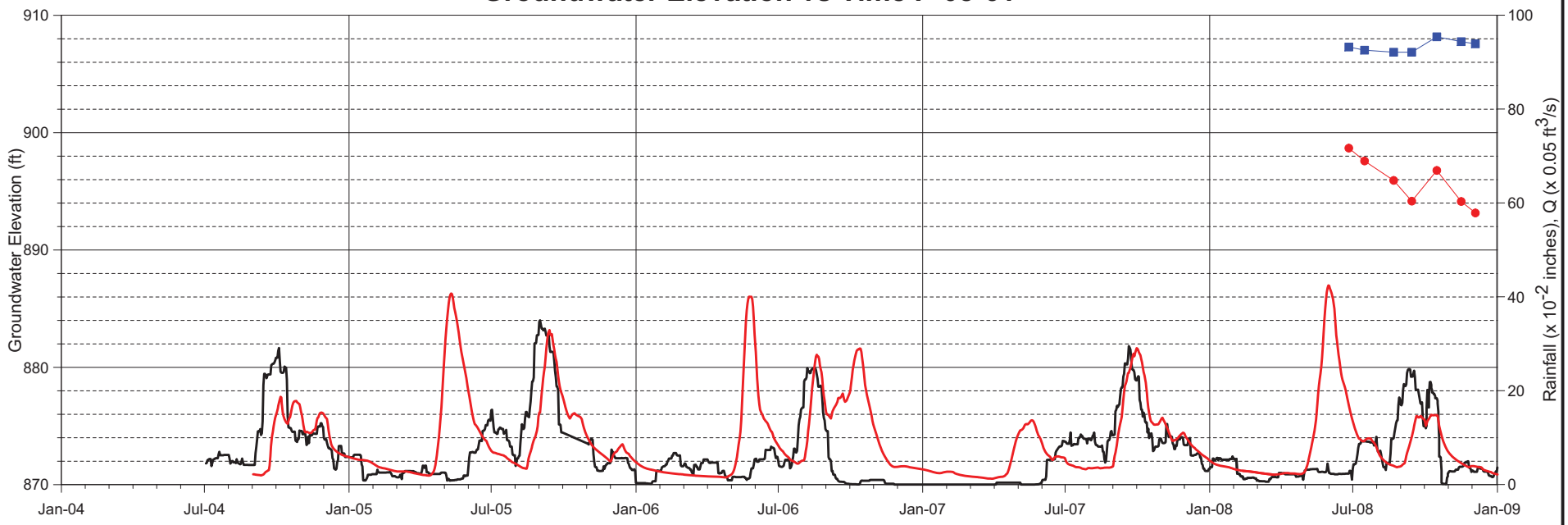


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-61



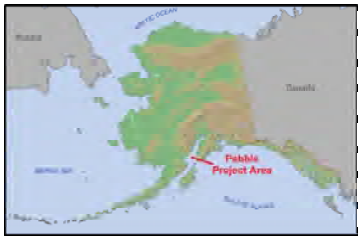
LEGEND:

Groundwater Elevation Plot Legend

- P-08-61S
- P-08-61D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

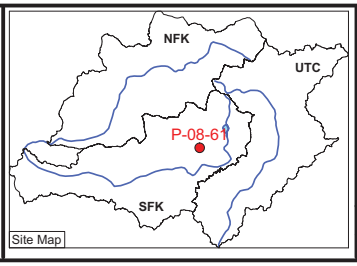
Screens (ft asl):
P-08-61S : 903.2 - 923.2
P-08-61D : 883.8 - 893.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 974.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-61.grf

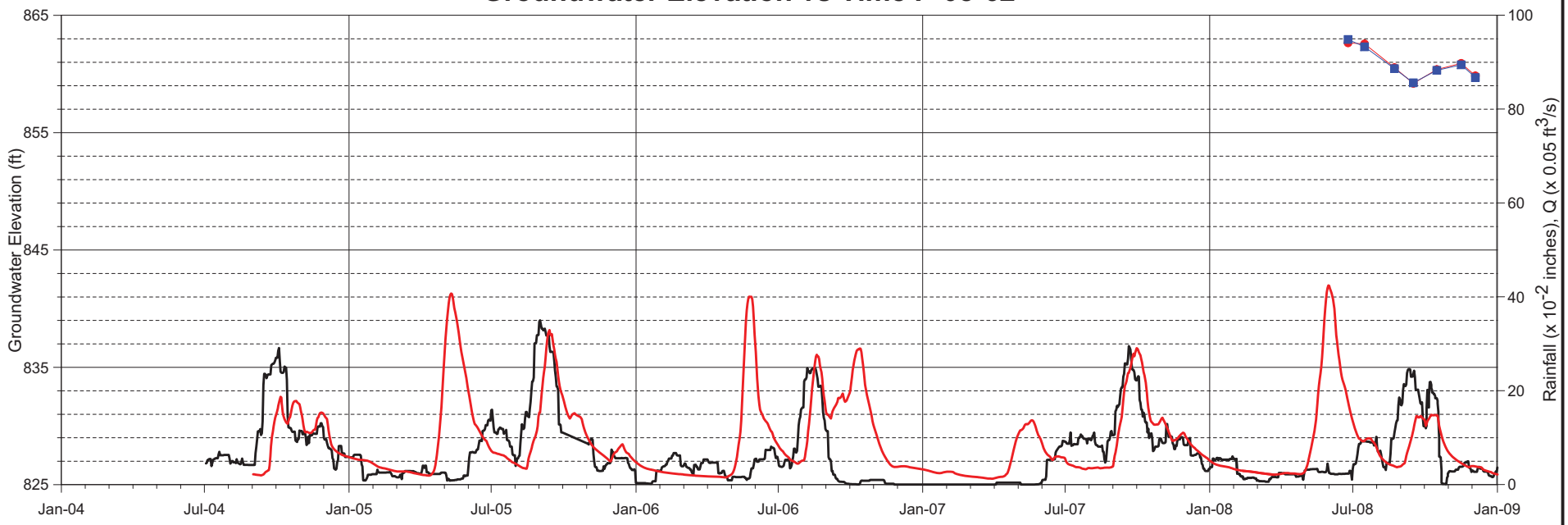


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-62



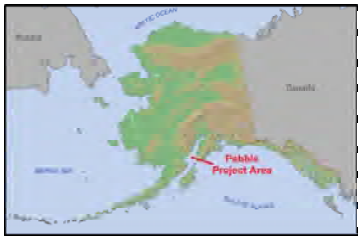
LEGEND:

Groundwater Elevation Plot Legend

- P-08-62M
- P-08-62D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

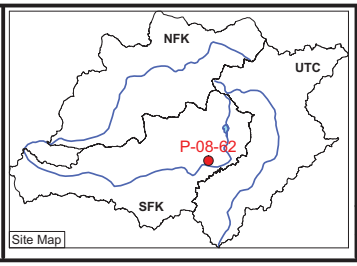
Screens (ft asl):
P-08-62S : 872.4 - 882.2
P-08-62M : 814.7 - 824.5
P-08-62D : 585.3 - 594.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 891.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-62.grf

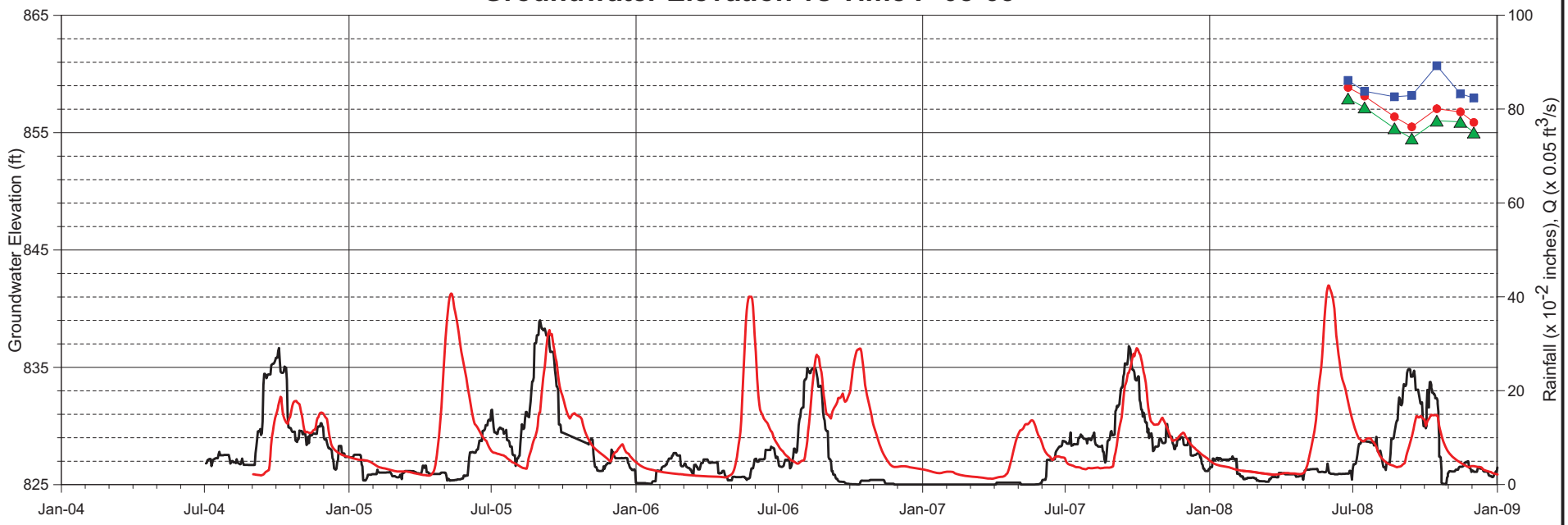


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-63



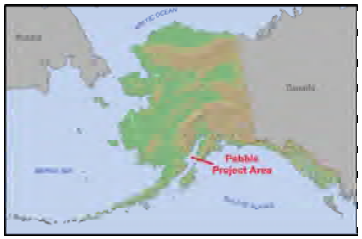
LEGEND:

Groundwater Elevation Plot Legend

- P-08-63S
- P-08-63M
- P-08-63D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

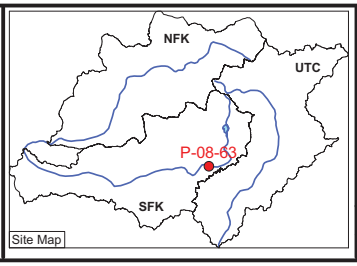
Screens (ft asl):
P-08-63S : 834.9 - 844.8
P-08-63M : 797.9 - 807.7
P-08-63D : 754.5 - 774.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 879.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-63.grf

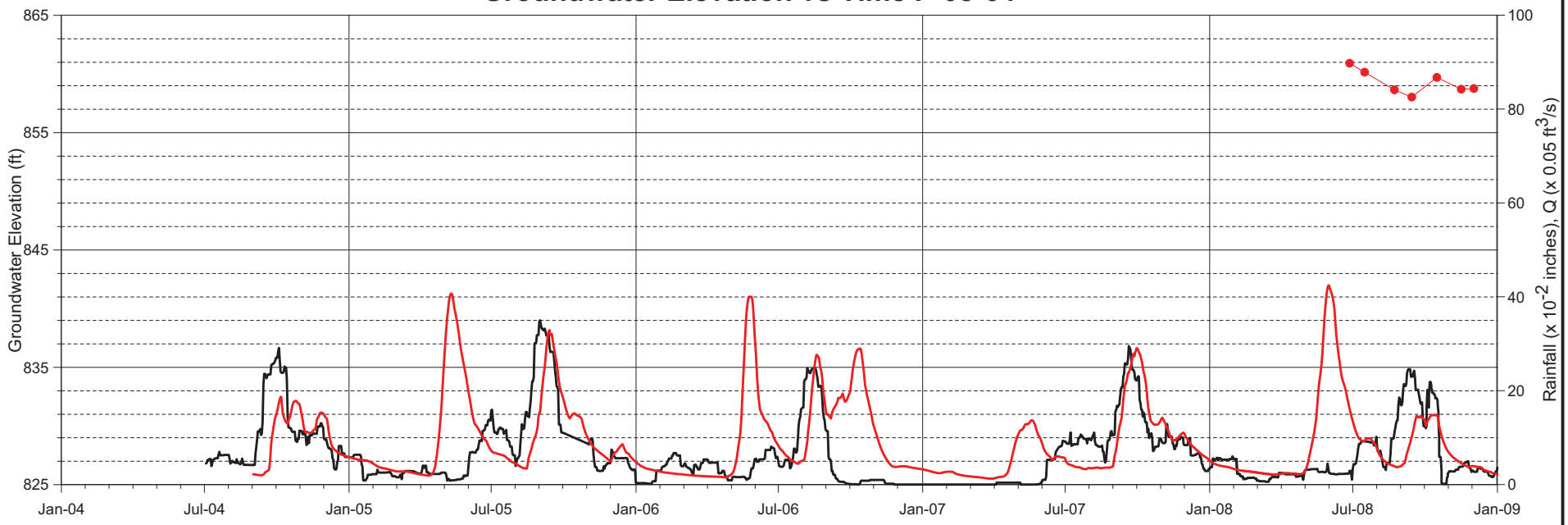


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-64



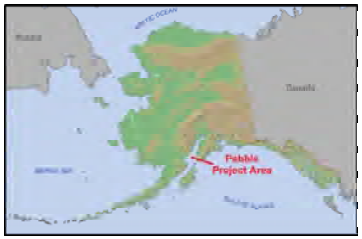
LEGEND:

Groundwater Elevation Plot Legend

- P-08-64S
- P-08-64D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

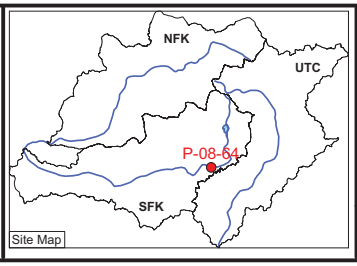
Screens (ft asl):
P-08-64S : 861.0 - 870.8
P-08-64D : 830.3 - 840.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 889 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-64.grf

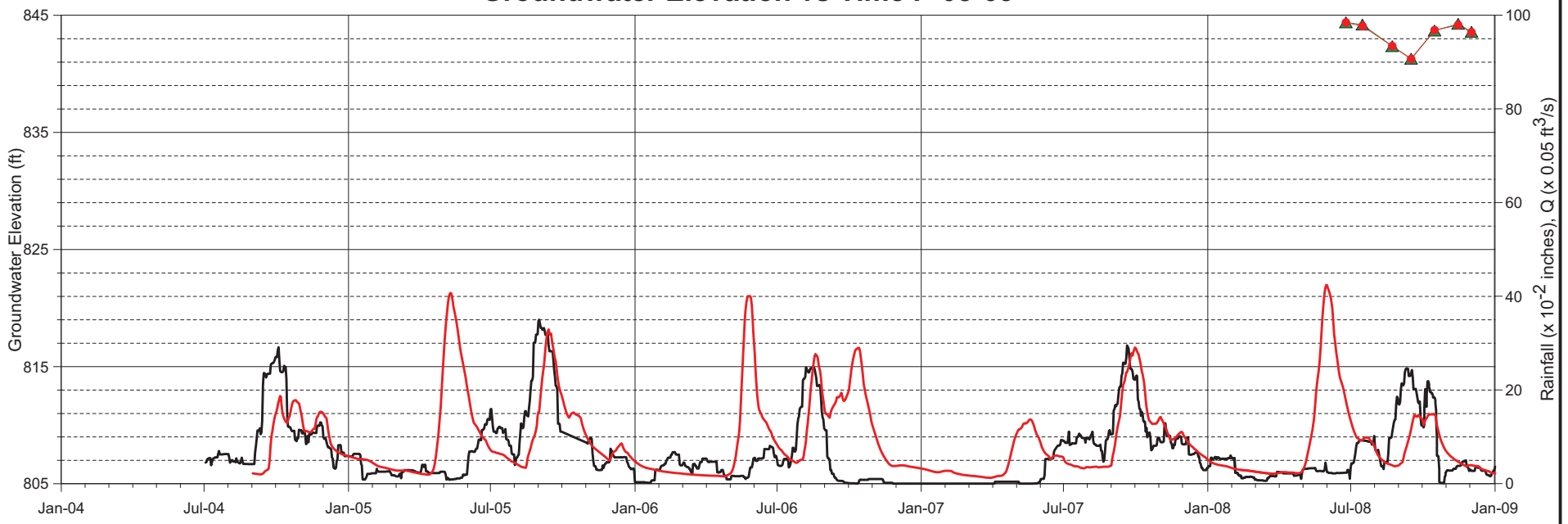


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-65



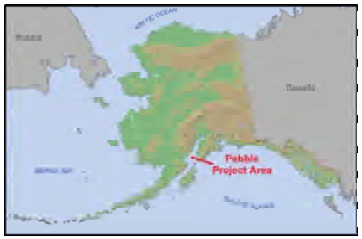
LEGEND:

Groundwater Elevation Plot Legend

- P-08-65S
- P-08-65M
- P-08-65D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

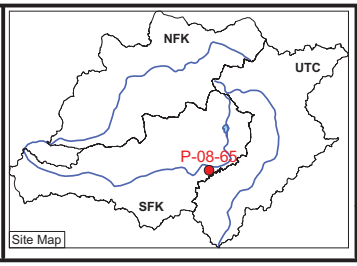
Screens (ft asl):
P-08-65S : 856.4 - 866.2
P-08-65M : 747.2 - 757.2
P-08-65D : 710.3 - 720.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 893.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-65.grf

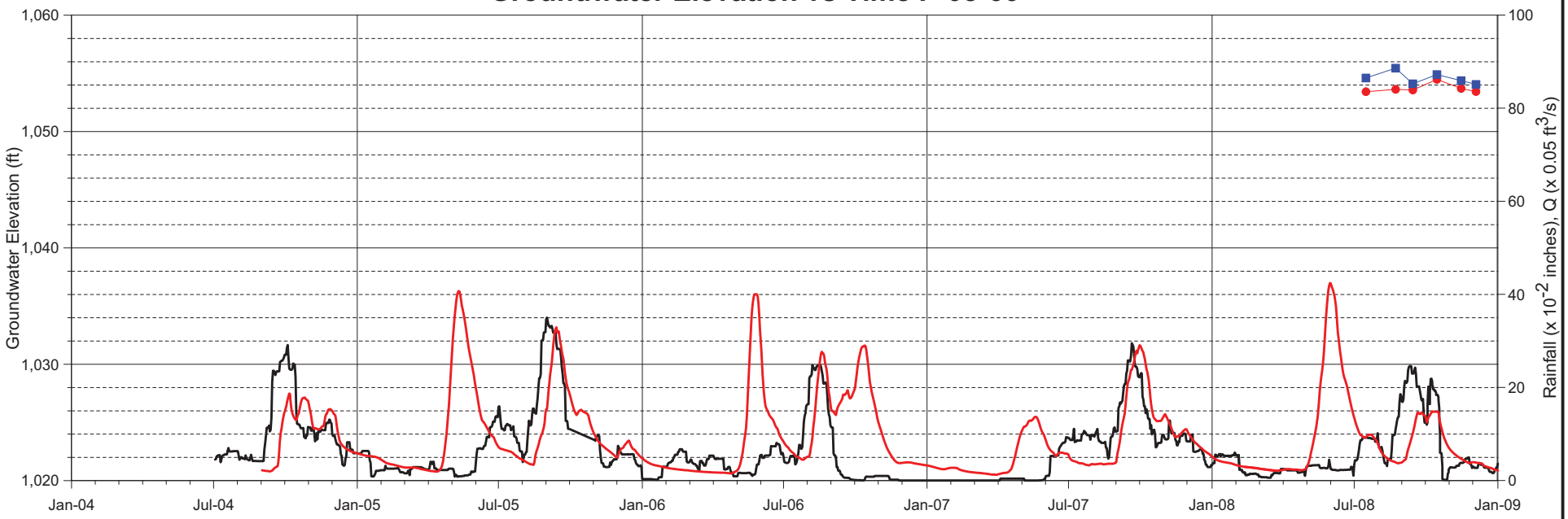


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-66



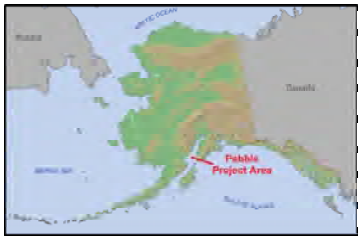
LEGEND:

Groundwater Elevation Plot Legend

- P-08-66S
- P-08-66D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

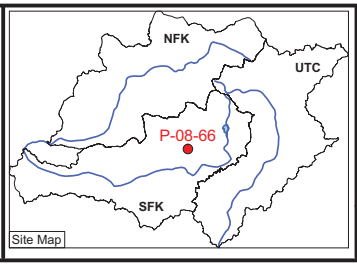
Screens (ft asl):
P-08-66S : 1051.1 - 1056.1
P-08-66D : 1022.4 - 1032.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1079.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-66.grf

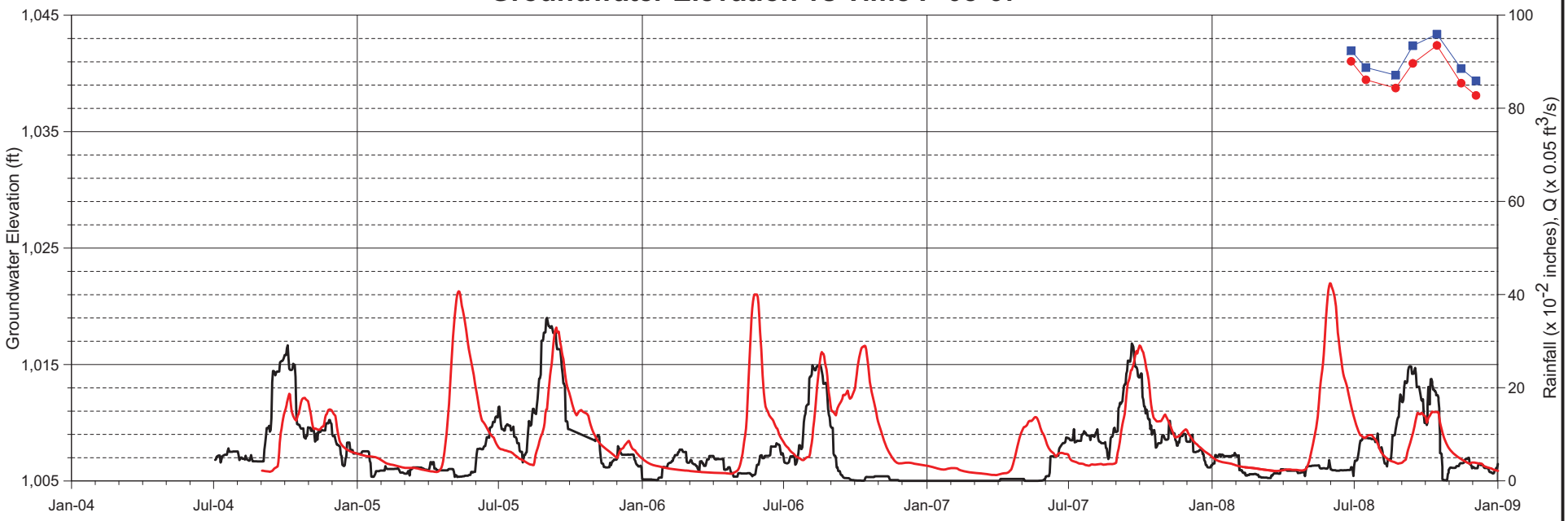


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-67



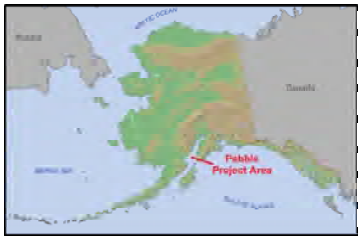
LEGEND:

Groundwater Elevation Plot Legend

- P-08-67S
- P-08-67D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

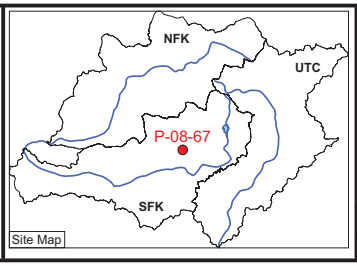
Screens (ft asl):
P-08-67S : 1026.6 - 1036.6
P-08-67D : 997.6 - 1007.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1054 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-67.grf

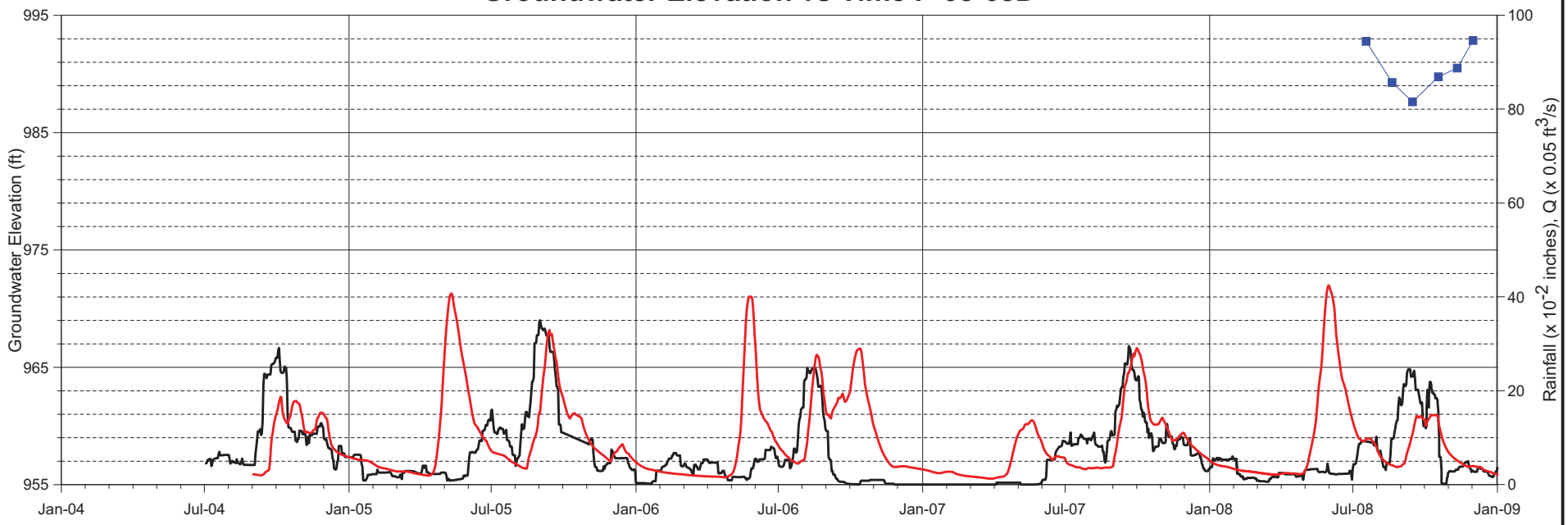


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-68D



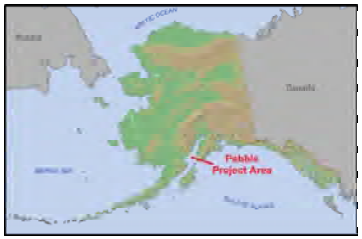
LEGEND:

Groundwater Elevation Plot Legend

- P-08-68D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

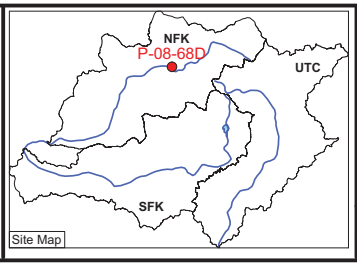
Screens (ft asl):
P-08-68D : 969.5 - 979.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1053.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-68D.grf

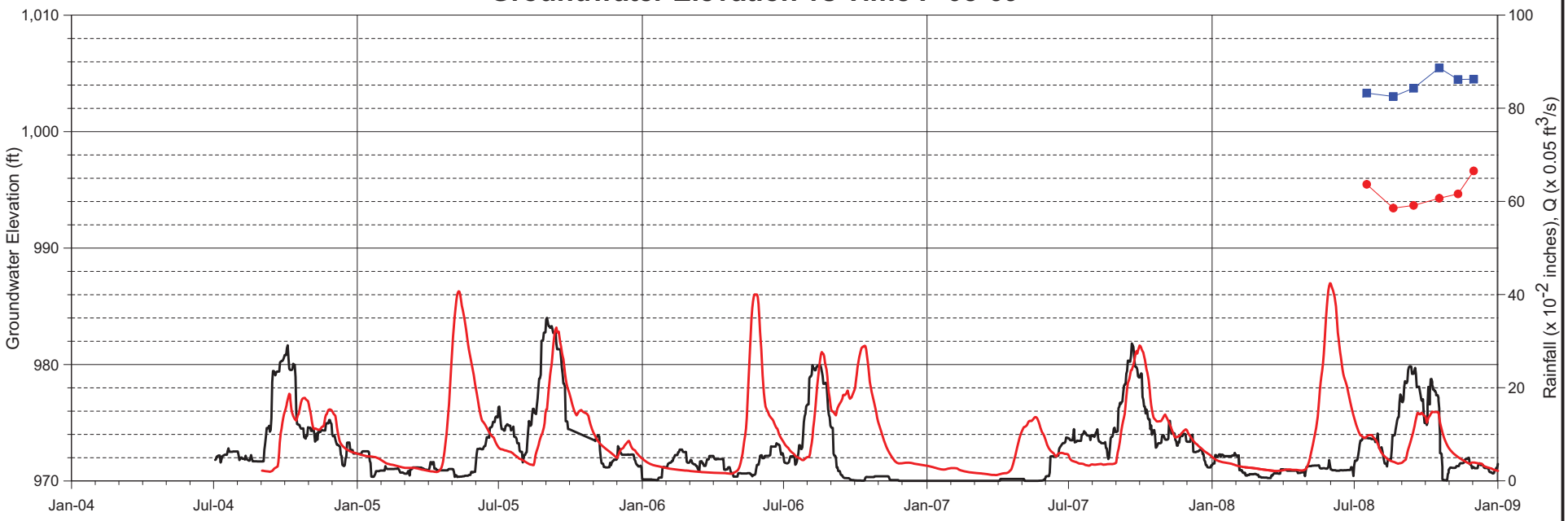


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-69



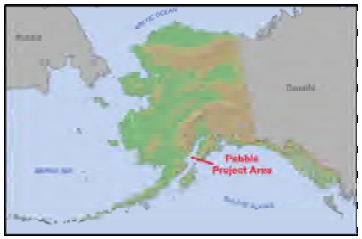
LEGEND:

Groundwater Elevation Plot Legend

- P-08-69S
- P-08-69D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

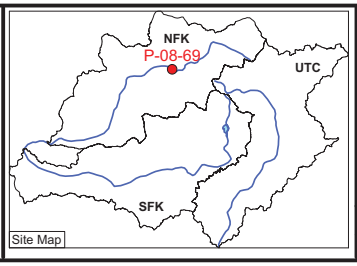
Screens (ft asl):
P-08-69S : 1001.7 - 1005.7
P-08-69D : 965.3 - 975.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1021.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-69.grf

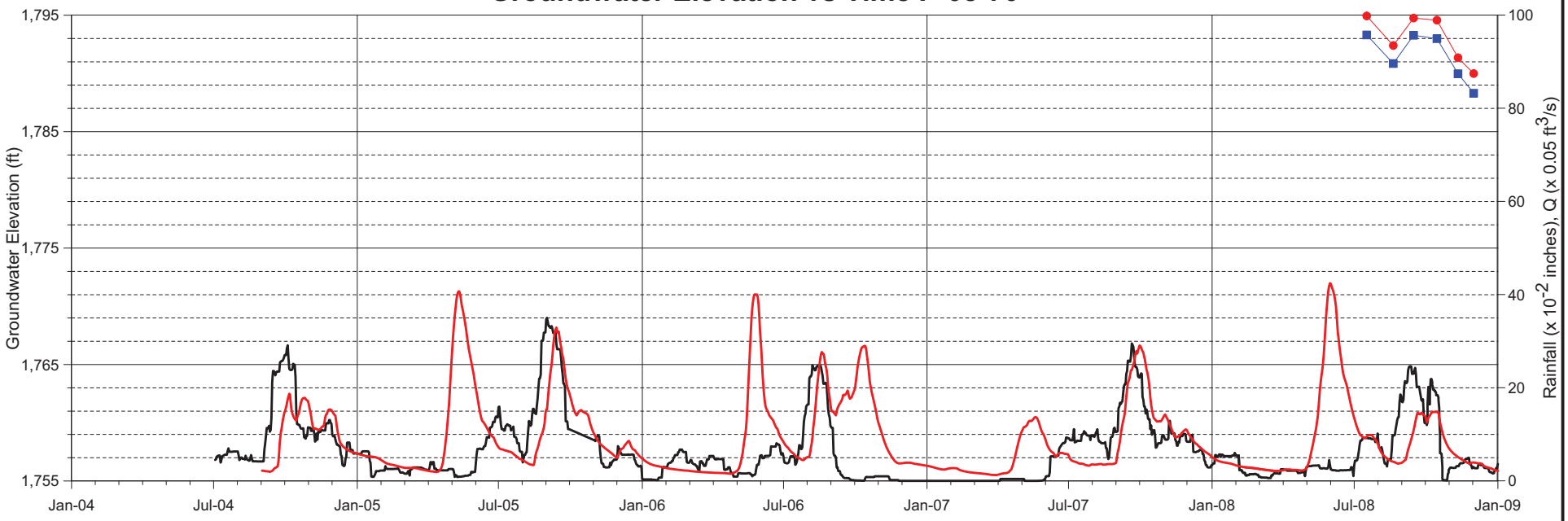


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-70



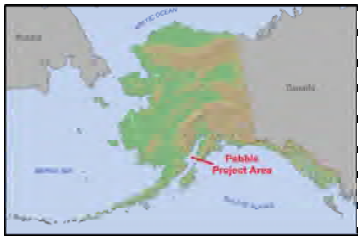
LEGEND:

Groundwater Elevation Plot Legend

- P-08-70S
- P-08-70D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

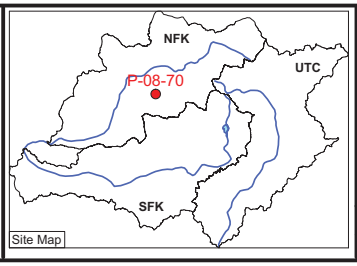
Screens (ft asl):
P-08-70S : 1774.6 - 1779.6
P-08-70D : 1741.9 - 1761.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1794.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-70.grf

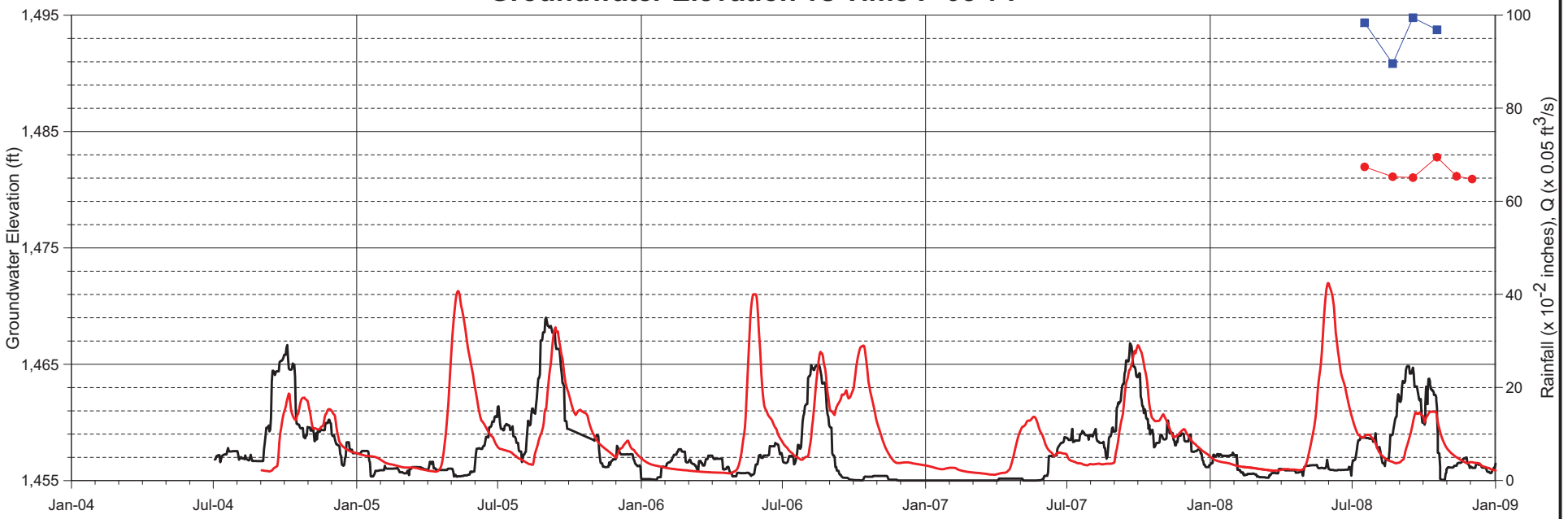


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-71



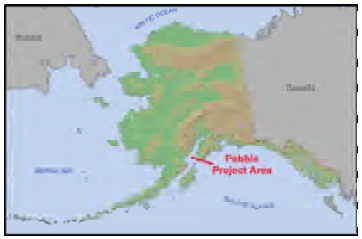
LEGEND:

Groundwater Elevation Plot Legend

- P-08-71S
- P-08-71D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

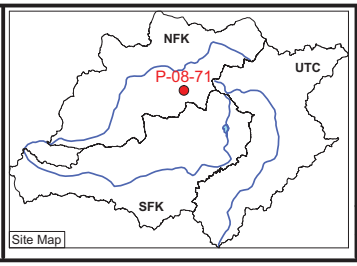
Screens (ft asl):
P-08-71S : 1490.6 - 1493.6
P-08-71D : 1466.1 - 1476.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1500.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-71.grf

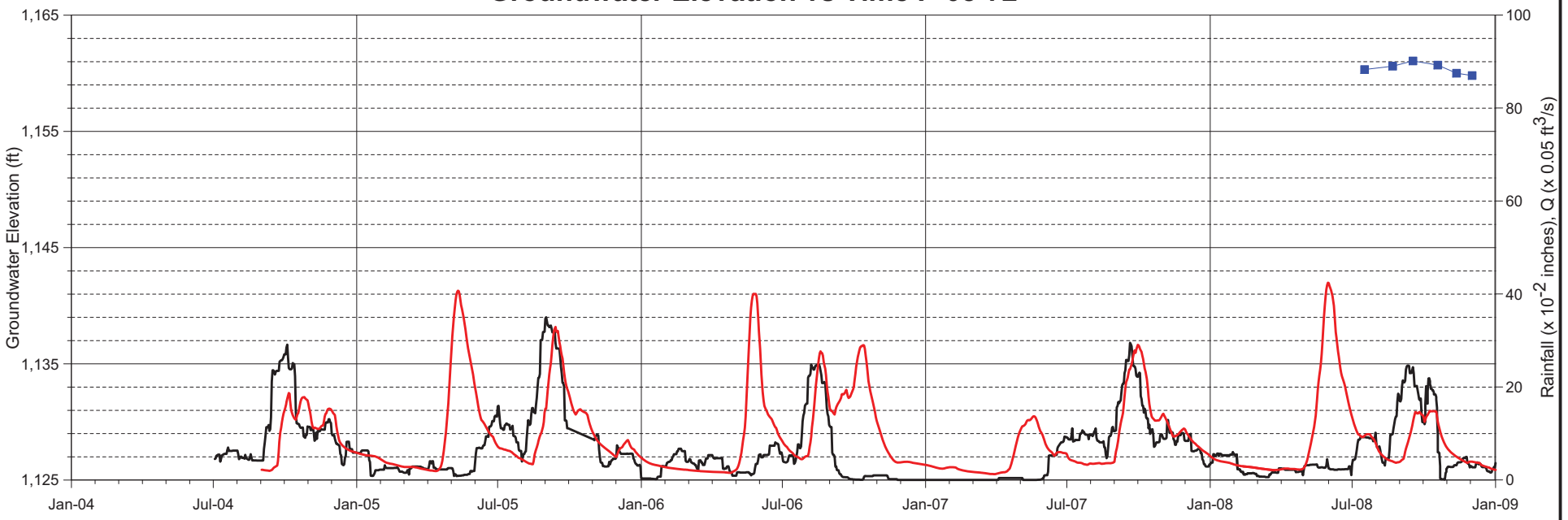


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-72



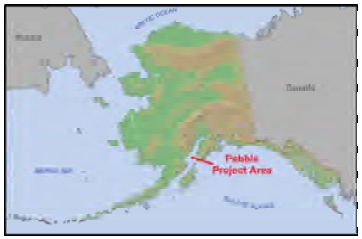
LEGEND:

Groundwater Elevation Plot Legend

- P-08-72D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

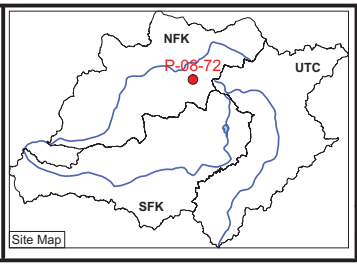
Screens (ft asl):
P-08-72S : 1172.6 - 1176.7
P-08-72D : 1139.6 - 1149.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1187.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-72.grf

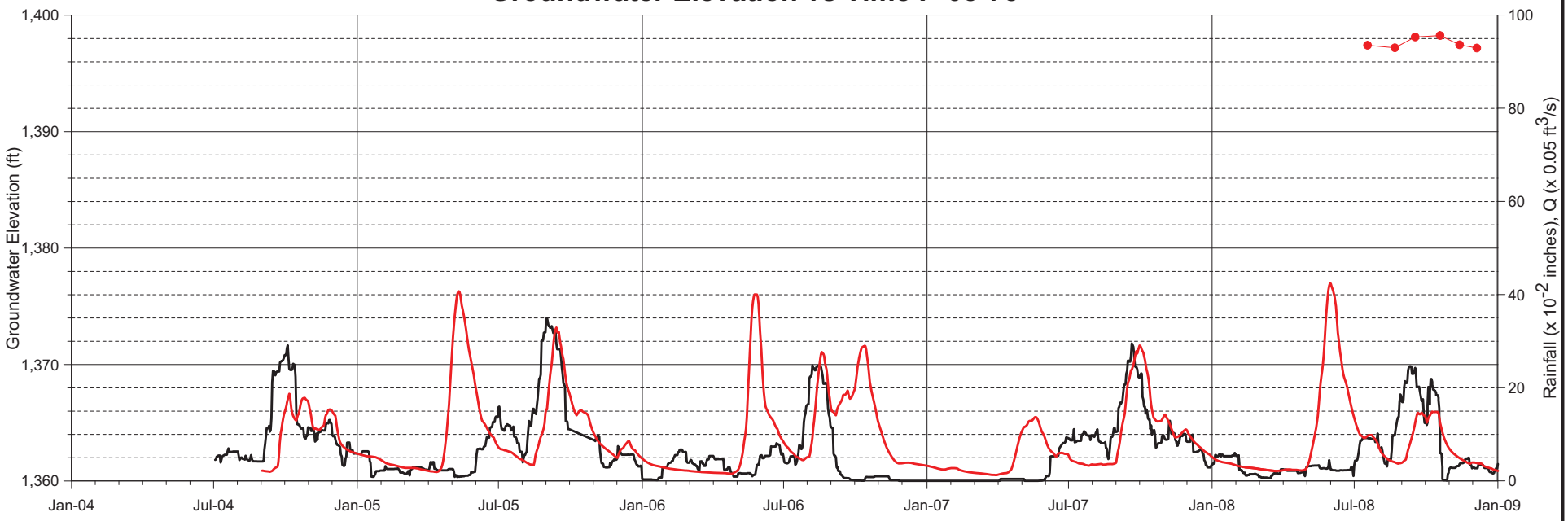


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-73



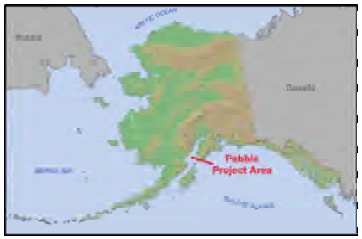
LEGEND:

Groundwater Elevation Plot Legend

- P-08-73S
- P-08-73D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

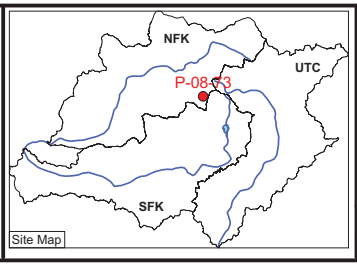
Screens (ft asl):
P-08-73S : 1357.5 - 1367.4
P-08-73D : 1293.1 - 1302.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1397 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-73.grf

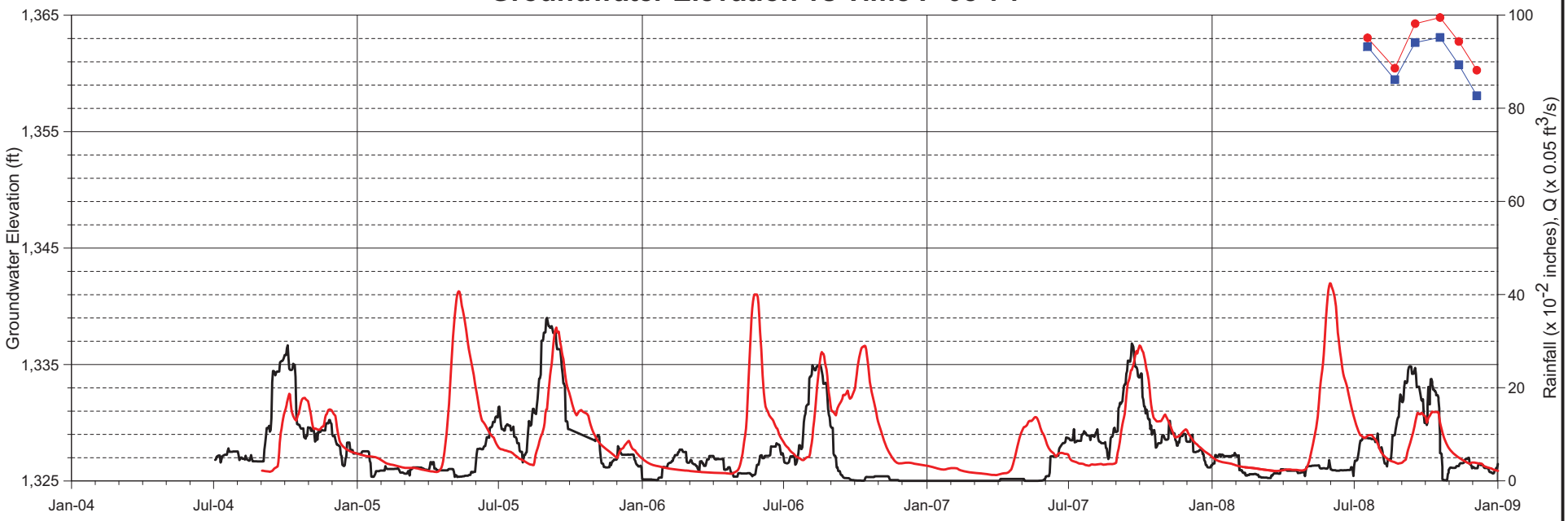


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-74



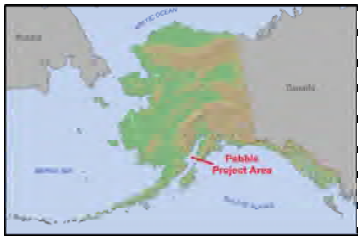
LEGEND:

Groundwater Elevation Plot Legend

- P-08-74S
- P-08-74D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

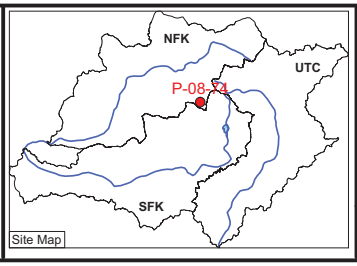
Screens (ft asl):
P-08-74S : 1317.8 - 1328.2
P-08-74D : 1283.4 - 1293.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1369.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-74.grf

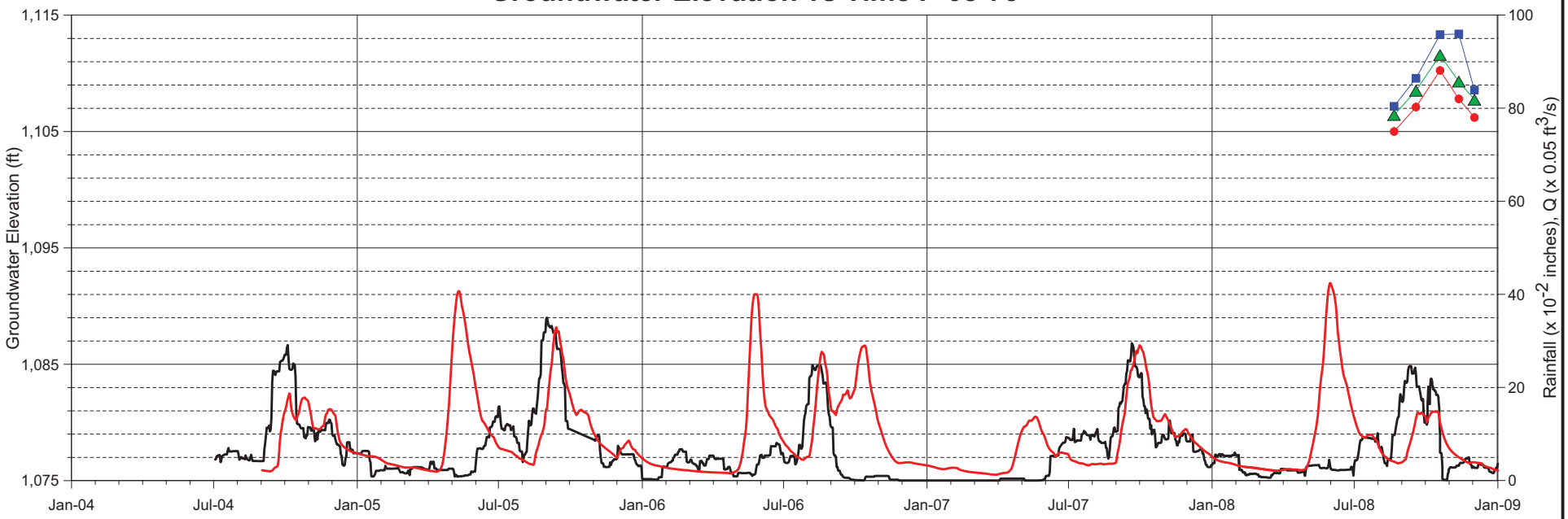


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-75



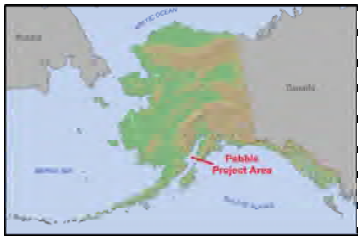
LEGEND:

Groundwater Elevation Plot Legend

- P-08-75S
- P-08-75M
- P-08-75D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

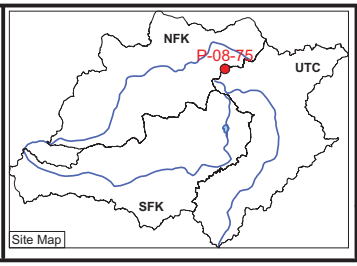
Screens (ft asl):
P-08-75S : 1081.0 - 1091.0
P-08-75M : 992.1 - 1011.7
P-08-75D : 948.9 - 958.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1122.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-75.grf

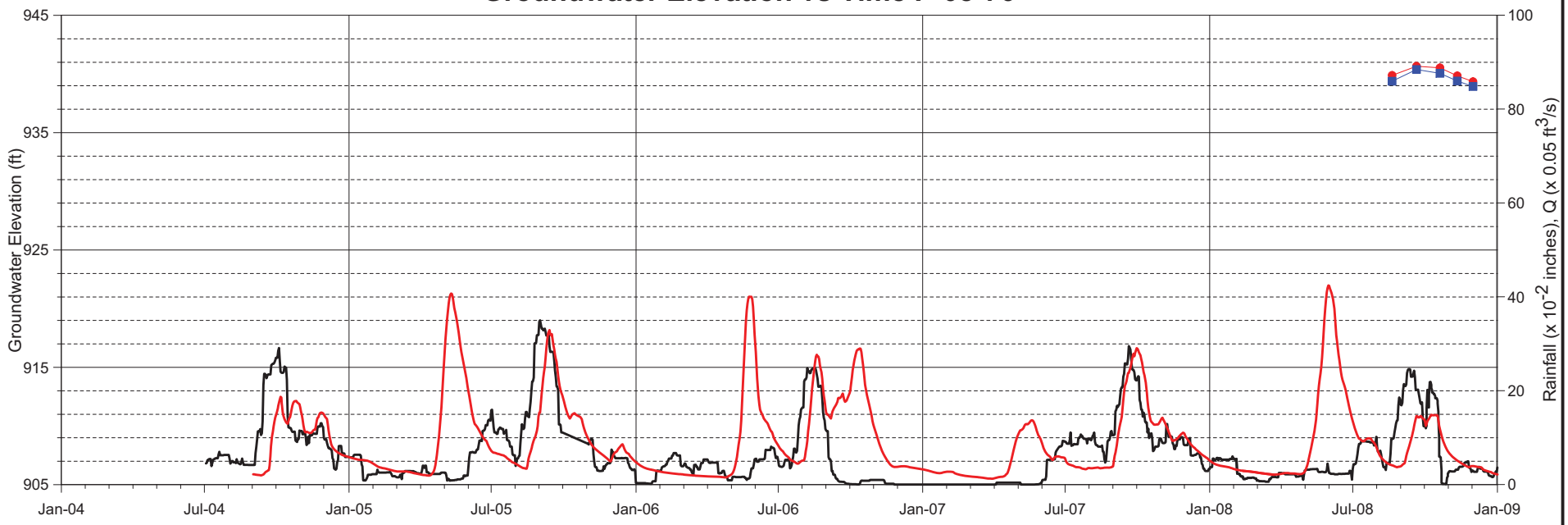


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-76



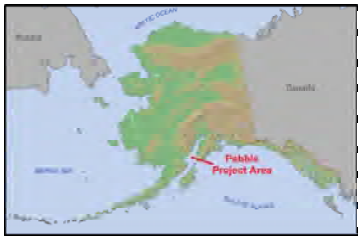
LEGEND:

Groundwater Elevation Plot Legend

- P-08-76S
- P-08-76D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

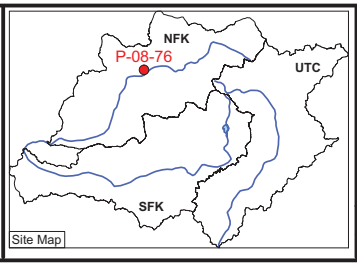
Screens (ft asl):
P-08-76S : 914.8 - 924.8
P-08-76D : 811.6 - 821.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 949.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-76.grf

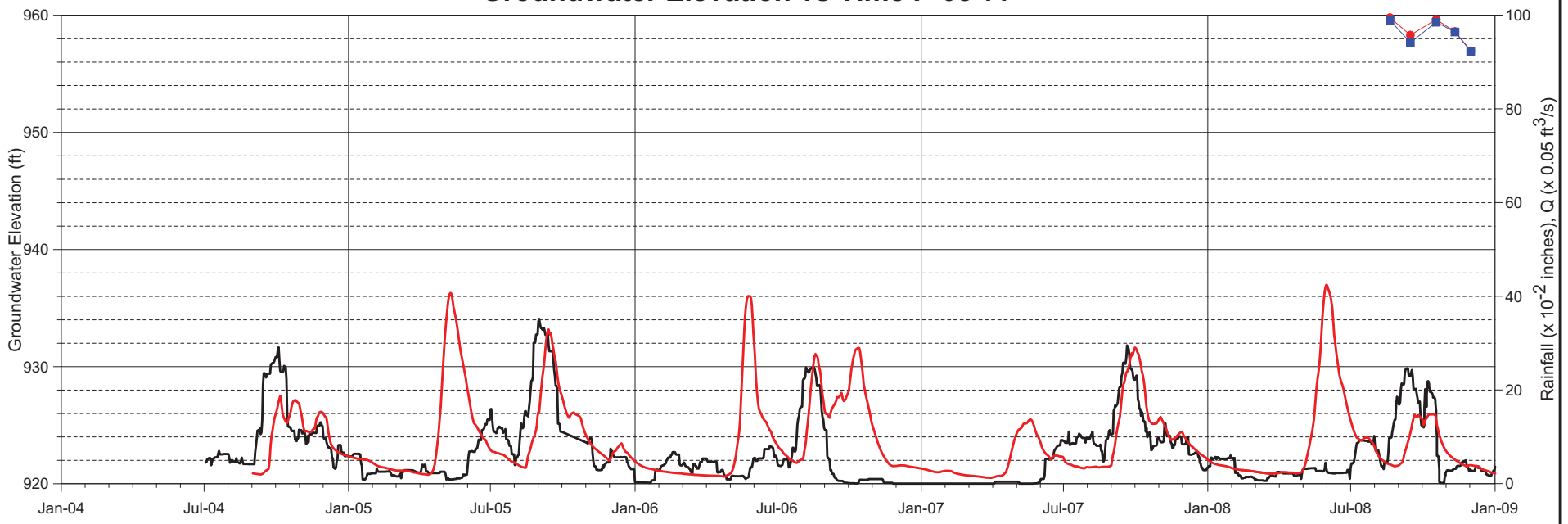


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-77



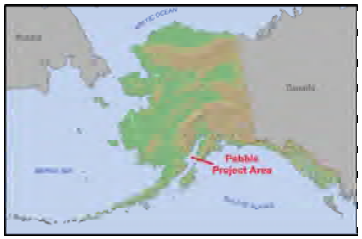
LEGEND:

Groundwater Elevation Plot Legend

- P-08-77S
- P-08-77D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

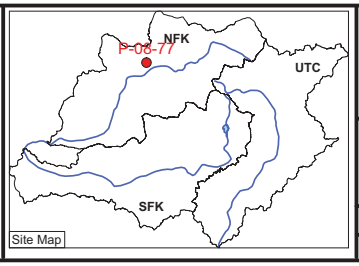
Screens (ft asl):
P-08-77S : 947.7 - 957.5
P-08-77D : 880.9 - 890.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 970.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-77.grf

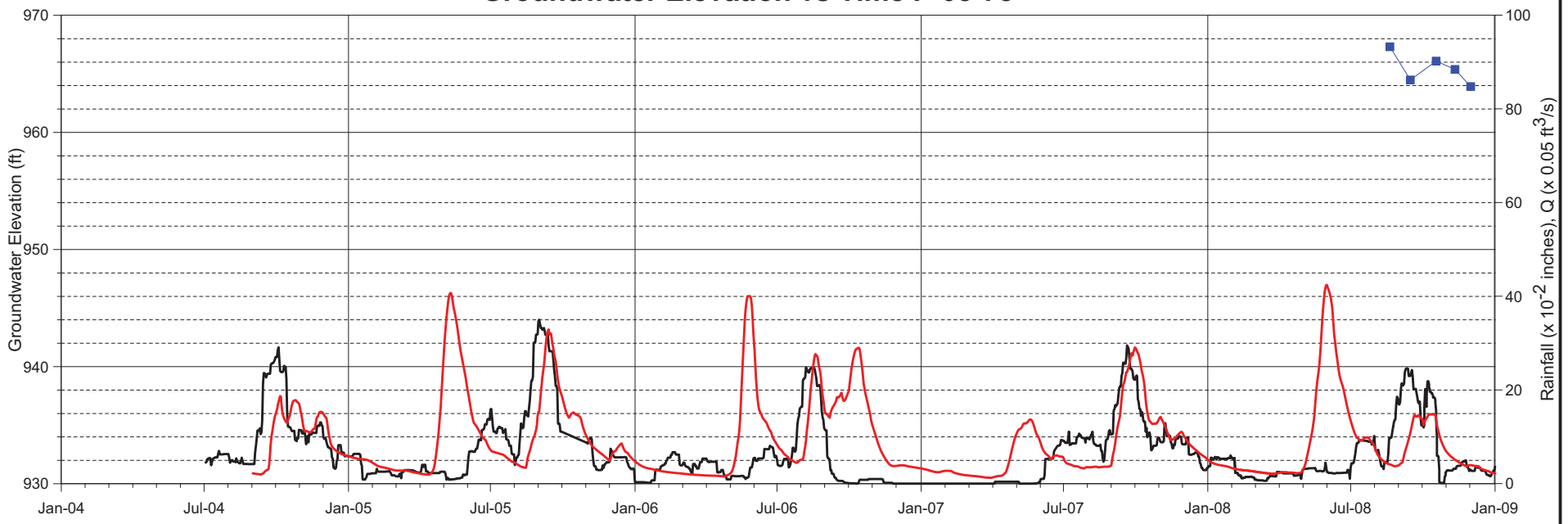


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-78



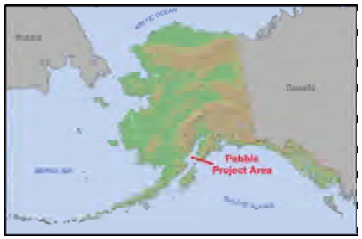
LEGEND:

Groundwater Elevation Plot Legend

- P-08-78D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

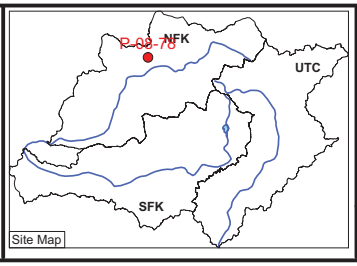
Screens (ft asl):
P-08-78S : 975.2 - 985.2
P-08-78D : 915.7 - 925.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1008.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-78.grf

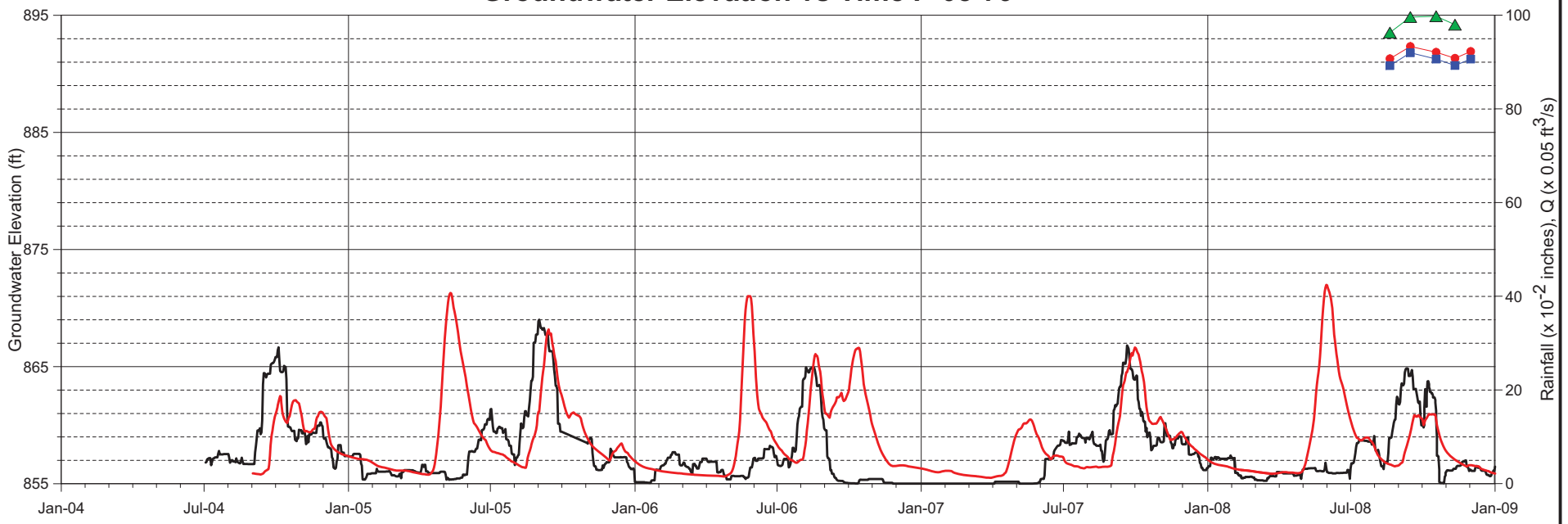


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-79



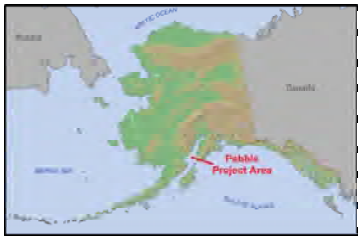
LEGEND:

Groundwater Elevation Plot Legend

- P-08-79S
- P-08-79M
- P-08-79D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

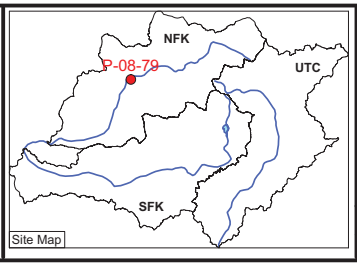
Screens (ft asl):
P-08-79S : 880.0 - 885.0
P-08-79M : 826.3 - 836.1
P-08-79D : 746.0 - 756.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 896 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-79.grf

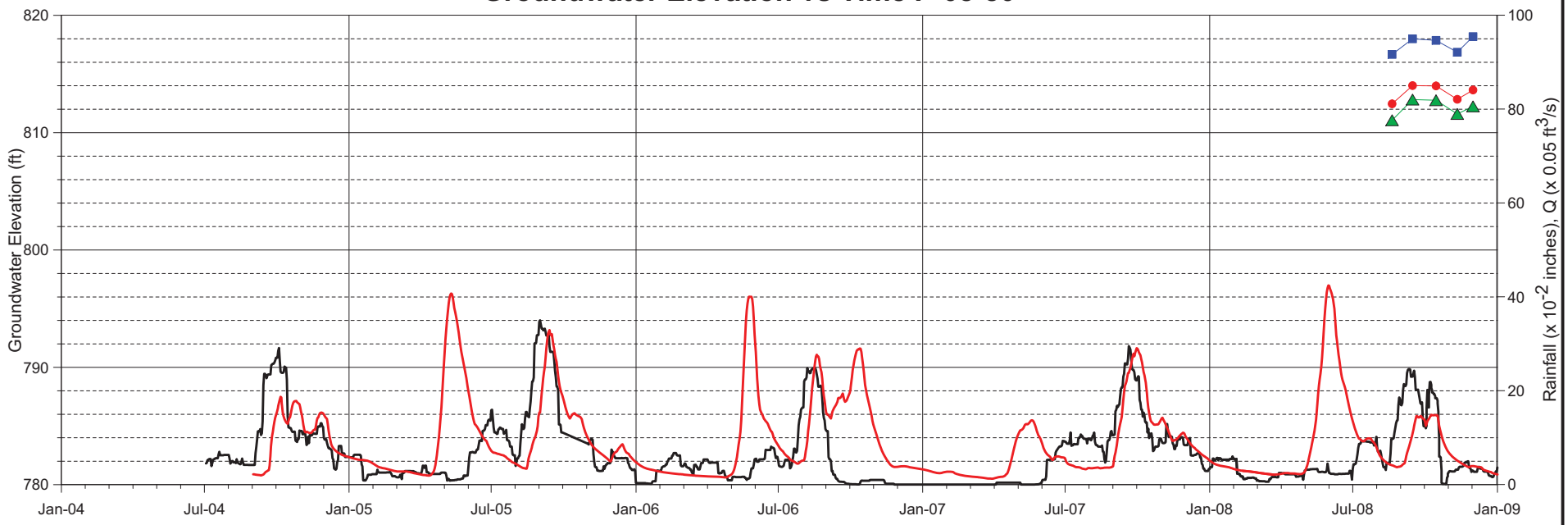


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-80



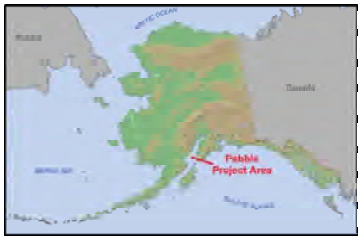
LEGEND:

Groundwater Elevation Plot Legend

- P-08-80S
- P-08-80M
- P-08-80D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

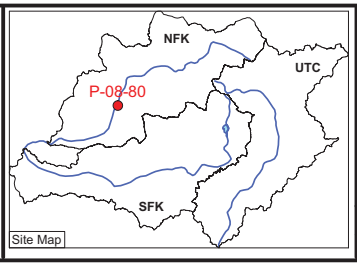
Screens (ft asl):
P-08-80S : 809.8 - 814.1
P-08-80M : 763.5 - 773.3
P-08-80D : 698.8 - 708.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 826.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-80.grf

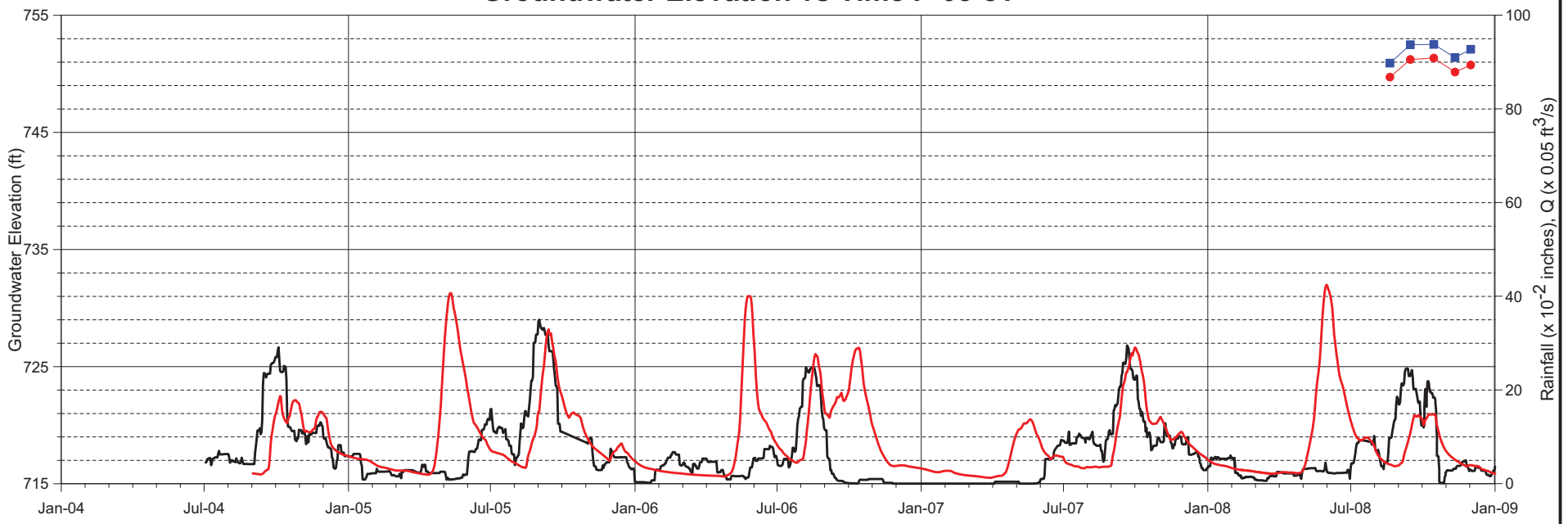


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-81



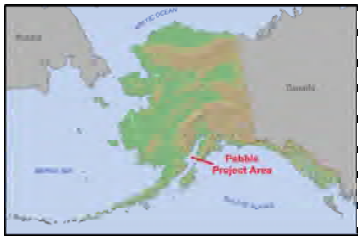
LEGEND:

Groundwater Elevation Plot Legend

- P-08-81S
- P-08-81D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

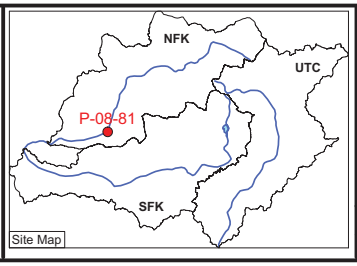
Screens (ft asl):
P-08-81S : 743.3 - 748.3
P-08-81D : 704.5 - 714.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 759.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-81.grf

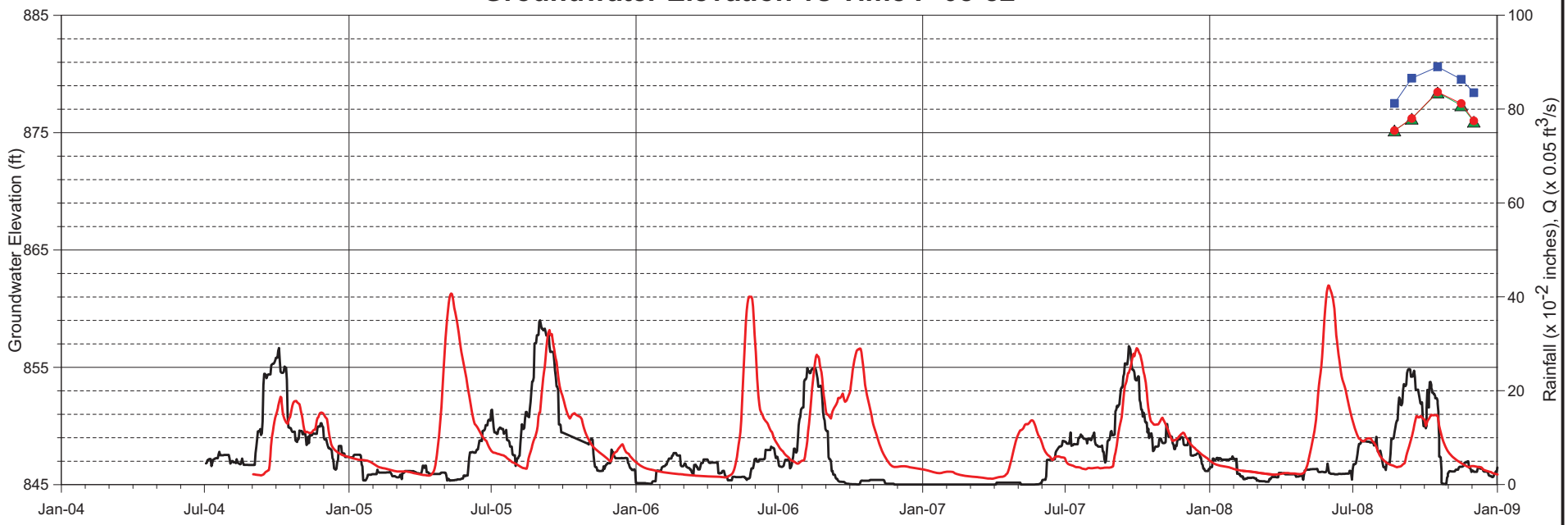


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-82



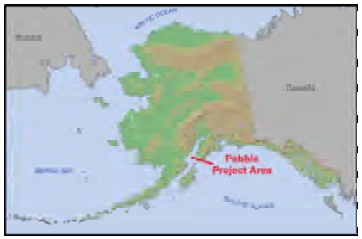
LEGEND:

Groundwater Elevation Plot Legend

- P-08-82S
- P-08-82M
- P-08-82D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

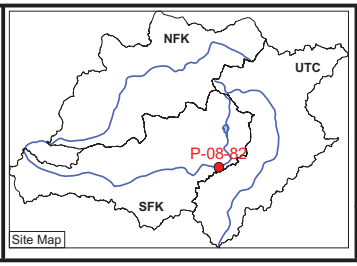
Screens (ft asl):
P-08-82S : 867.2 - 876.4
P-08-82M : 839.0 - 849.0
P-08-82D : 818.2 - 827.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 888.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-82.grf

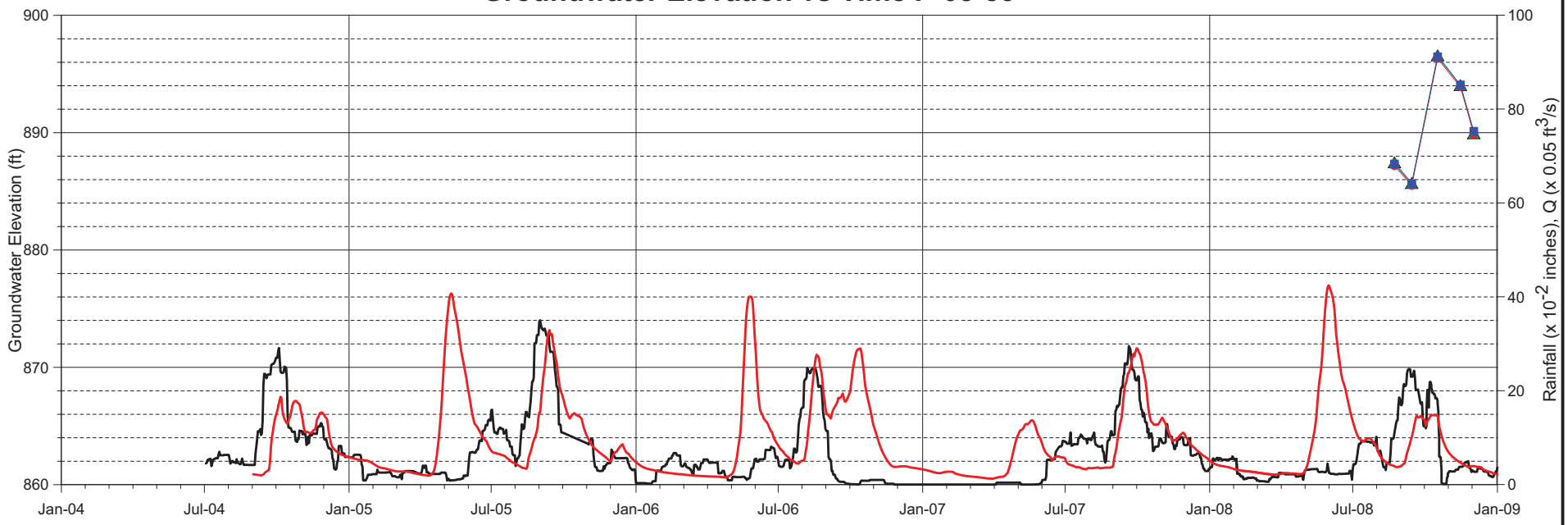


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-83



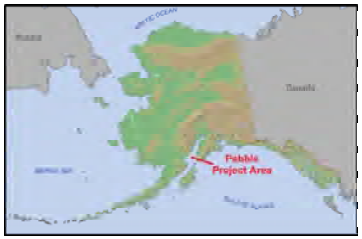
LEGEND:

Groundwater Elevation Plot Legend

- P-08-83S
- P-08-83M
- P-08-83D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

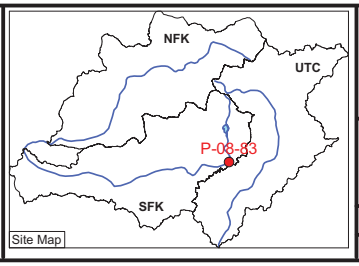
Screens (ft asl):
P-08-83S : 877.1 - 886.7
P-08-83M : 818.5 - 828.3
P-08-83D : 729.5 - 739.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 919.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-83.grf

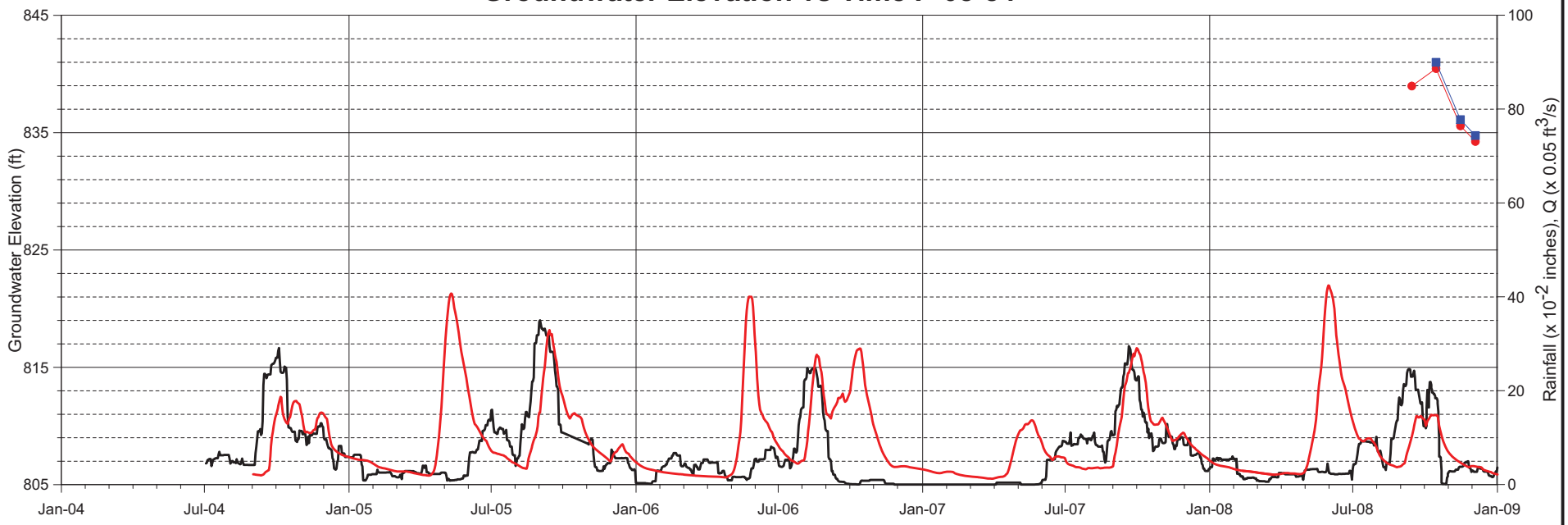


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-84



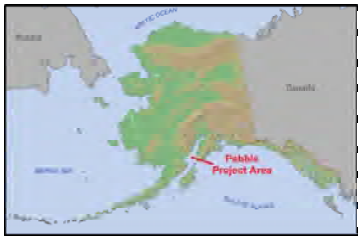
LEGEND:

Groundwater Elevation Plot Legend

- P-08-84S
- P-08-84D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

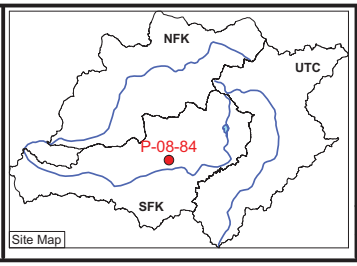
Screens (ft asl):
P-08-84S : 817.3 - 826.9
P-08-84D : 774.1 - 783.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 850.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-84.grf

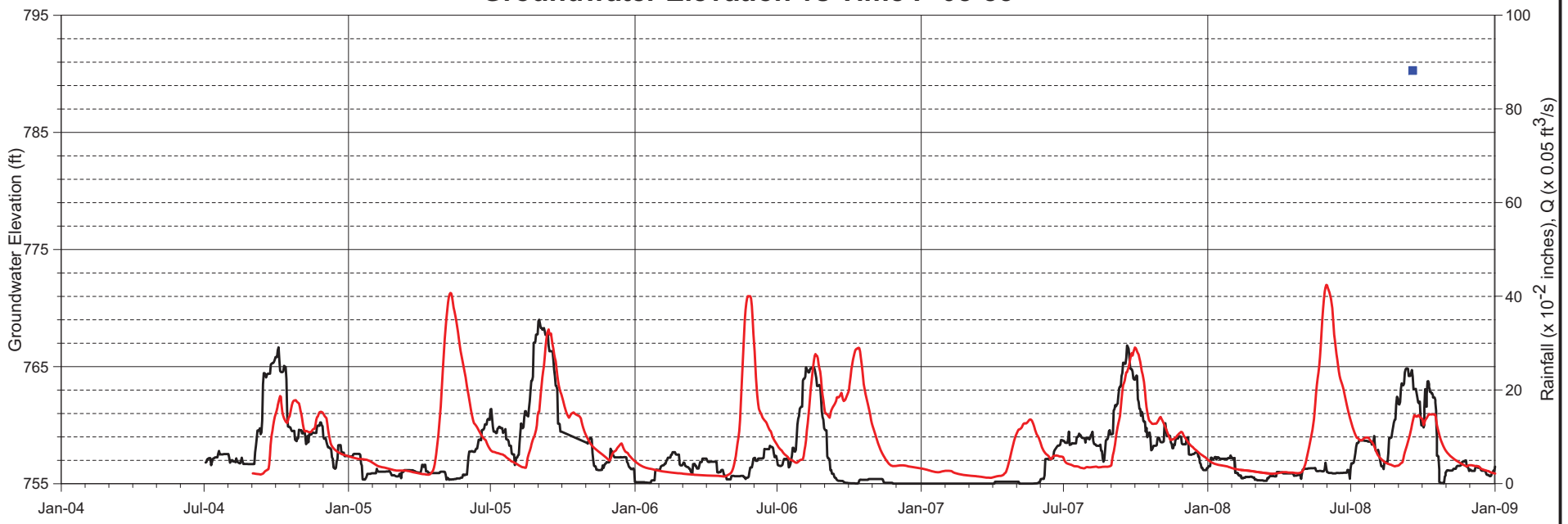


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-85



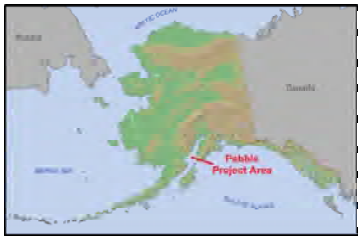
LEGEND:

Groundwater Elevation Plot Legend

- P-08-85S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-08-85S : 758.4 - 768.0
P-08-85D : 654.1 - 663.8

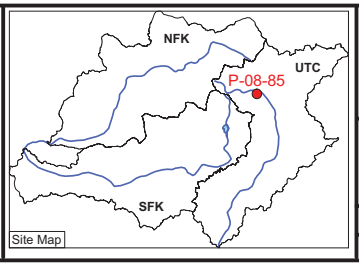


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 790.8 ft asl

P08-85D was flowing, therefore water levels were not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-85.grf

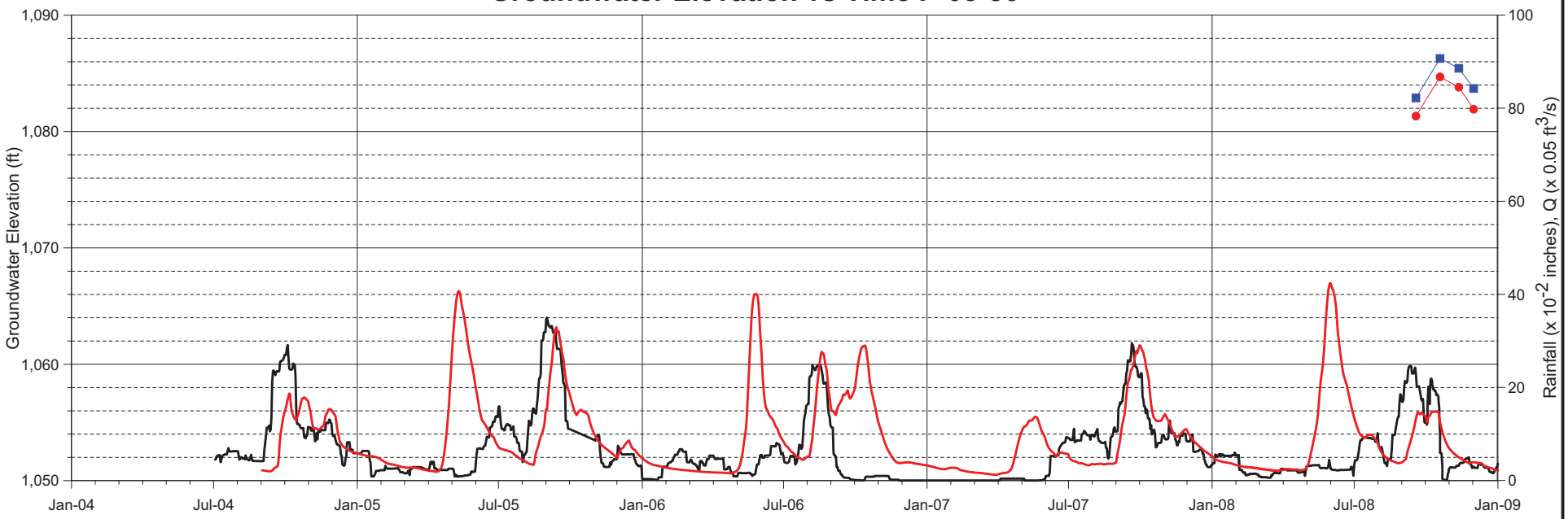


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-86



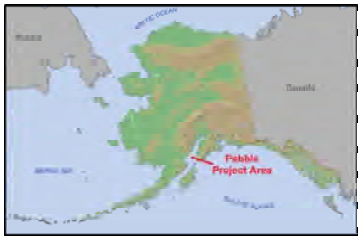
LEGEND:

Groundwater Elevation Plot Legend

- P-08-86S
- P-08-86D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

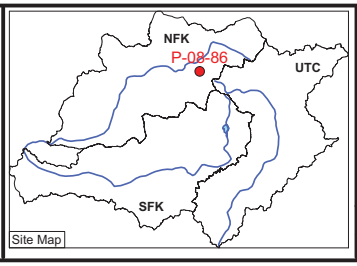
Screens (ft asl):
P-08-86S : 1087.4 - 1097.2
P-08-86D : 1059.5 - 1069.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1133.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-86.grf

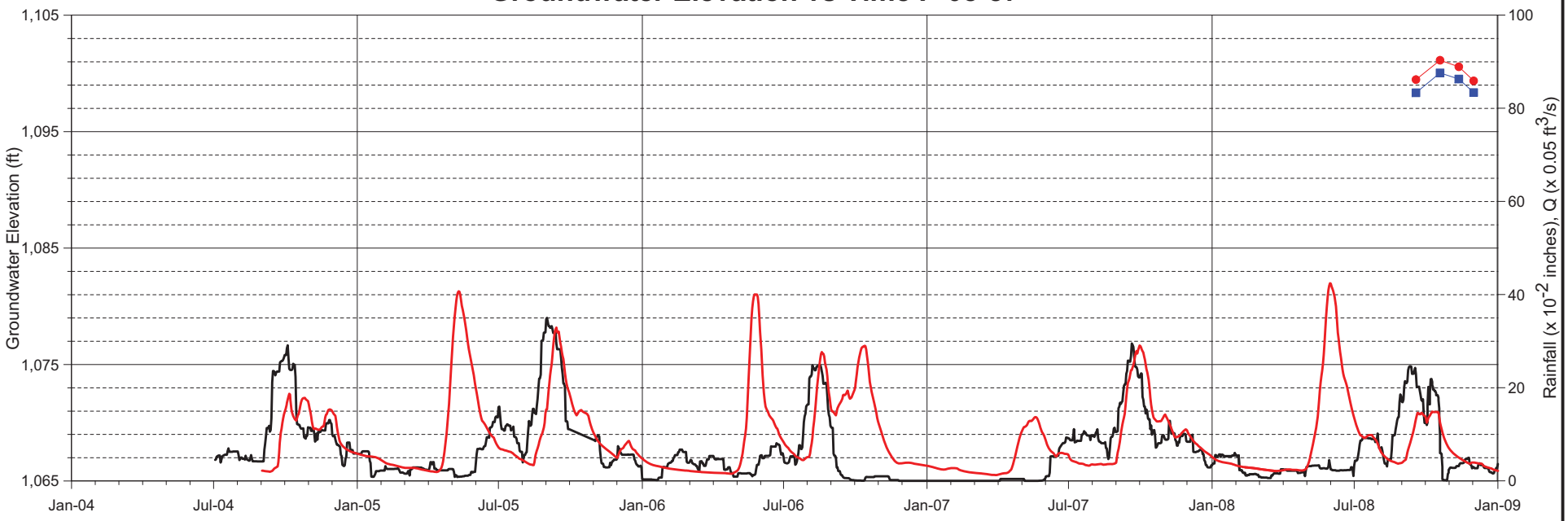


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-87



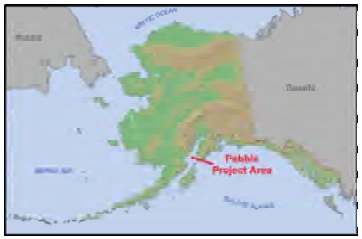
LEGEND:

Groundwater Elevation Plot Legend

- P-08-87S
- P-08-87D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

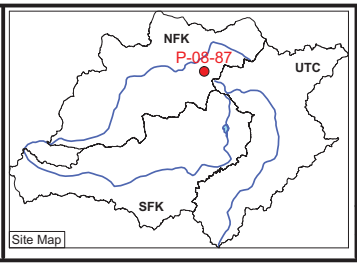
Screens (ft asl):
P-08-87S : 1086.5 - 1096.1
P-08-87D : 1068.5 - 1078.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1138.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-87.grf

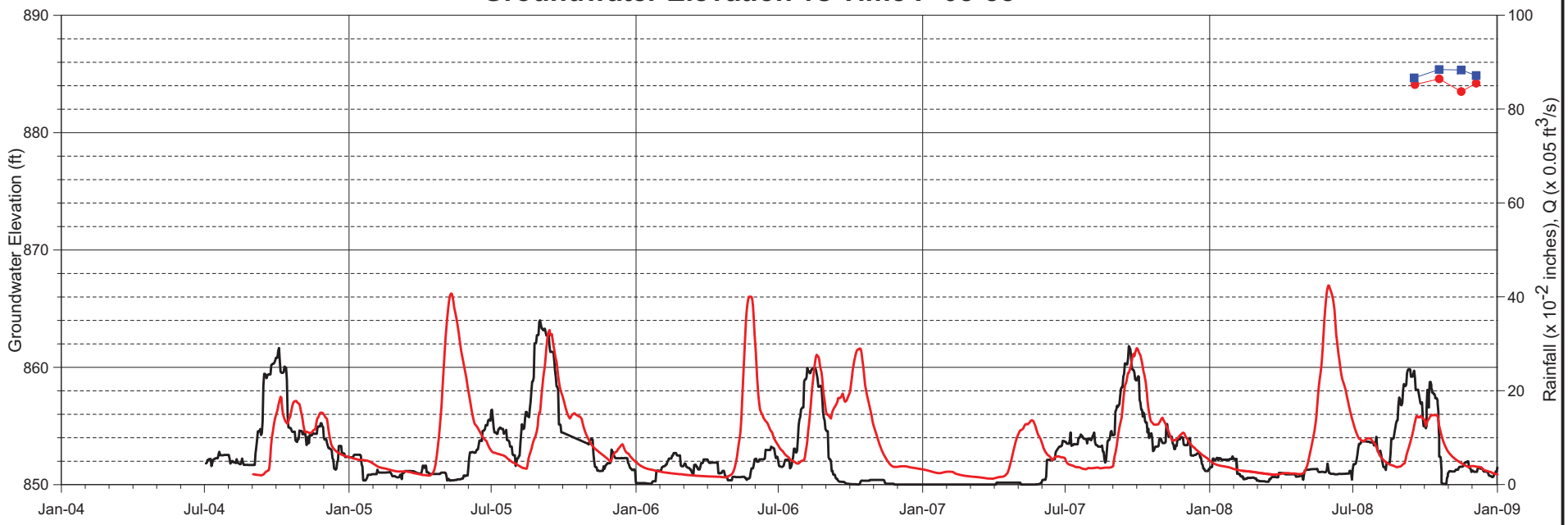


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-88



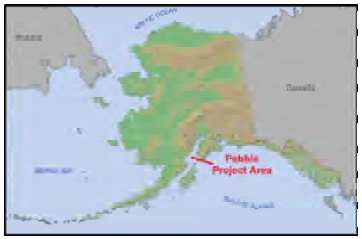
LEGEND:

Groundwater Elevation Plot Legend

- P-08-88S
- P-08-88D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

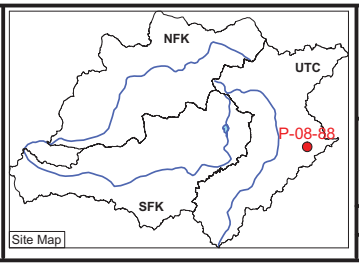
Screens (ft asl):
P-08-88S : 871.9 - 881.8
P-08-88D : 795.8 - 805.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 901.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-88.grf

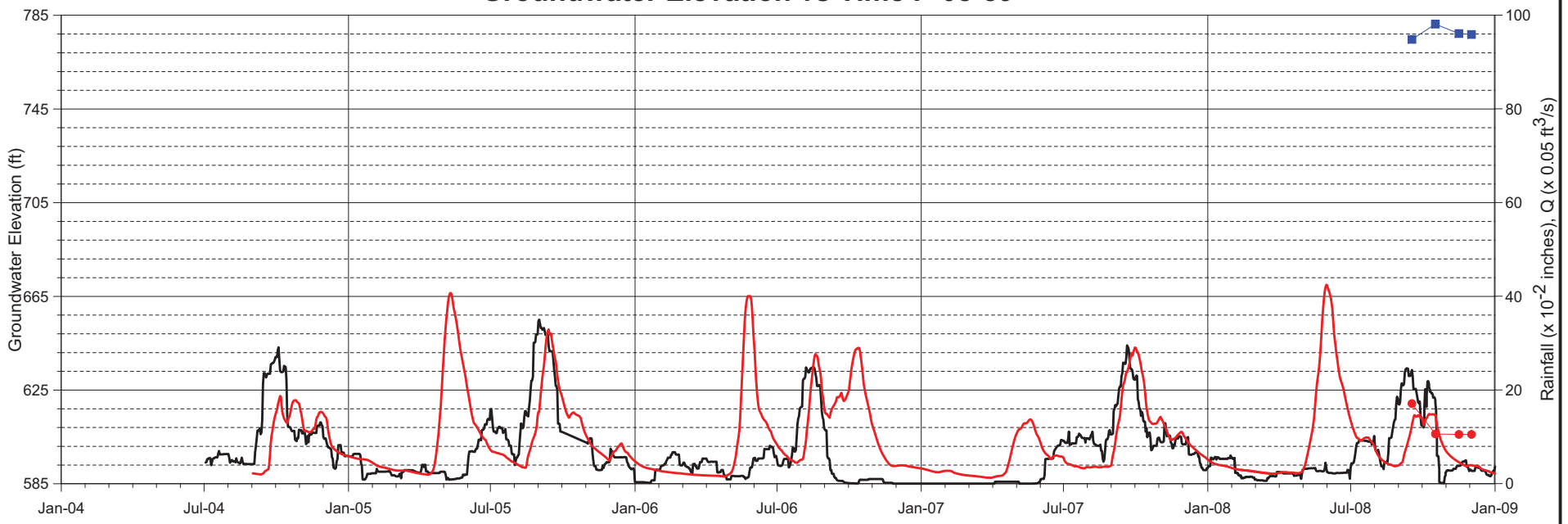


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-89



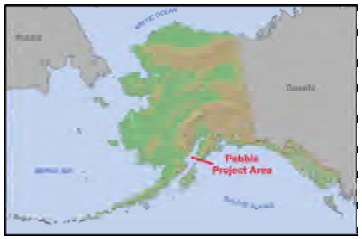
LEGEND:

Groundwater Elevation Plot Legend

- P-08-89S
- P-08-89D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-08-89S : 755.2 - 765.2
P-08-89M : 686.7 - 696.6
P-08-89D : 595.3 - 610.9

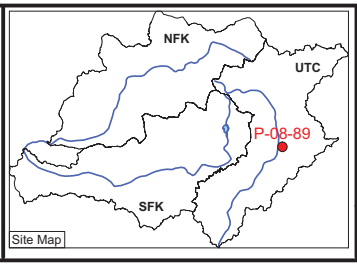


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 841.2 ft asl

The y range for this graph is 200 ft rather than 40 ft which is used on the other graphs

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-89.grf

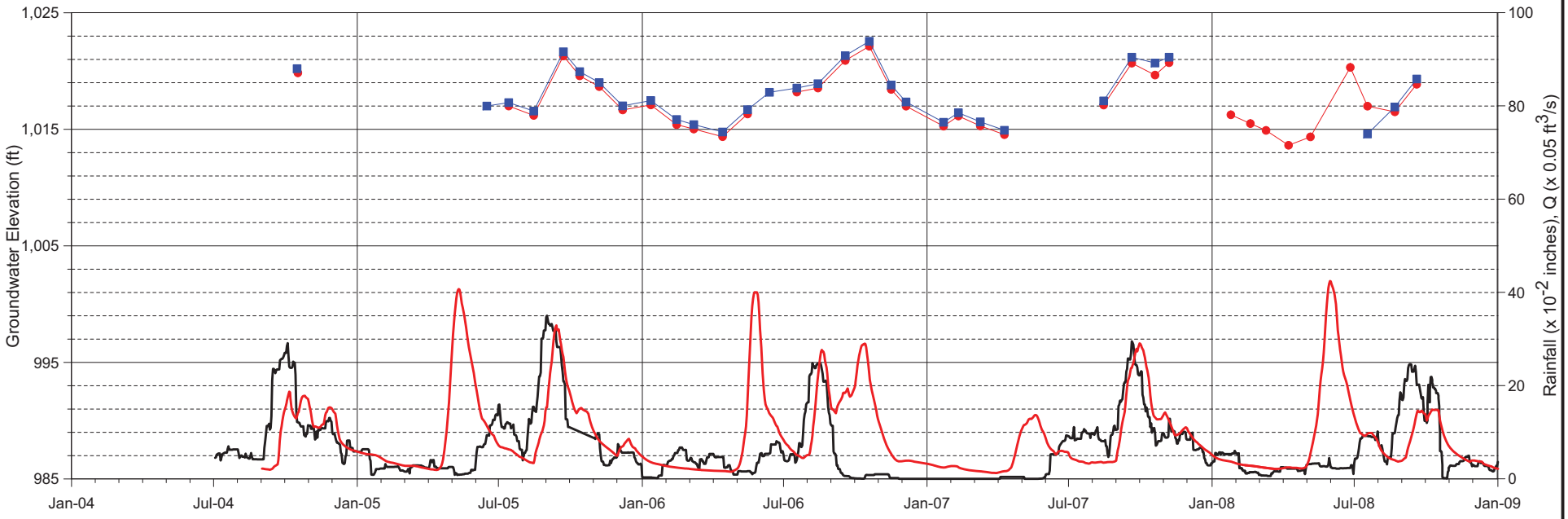


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time P-2



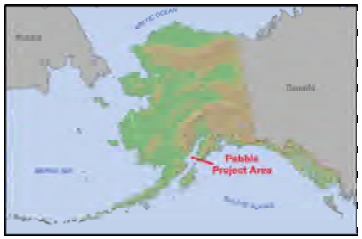
LEGEND:

Groundwater Elevation Plot Legend

- P-2M
- P-2D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

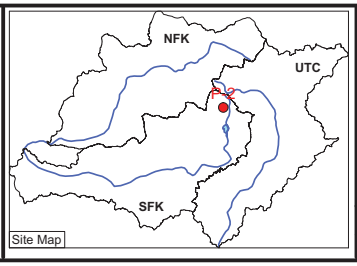
Screens (ft asl):
P-2M : 954.4 - 964.4
P-2D : 935.8 - 945.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1022.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-2.grf

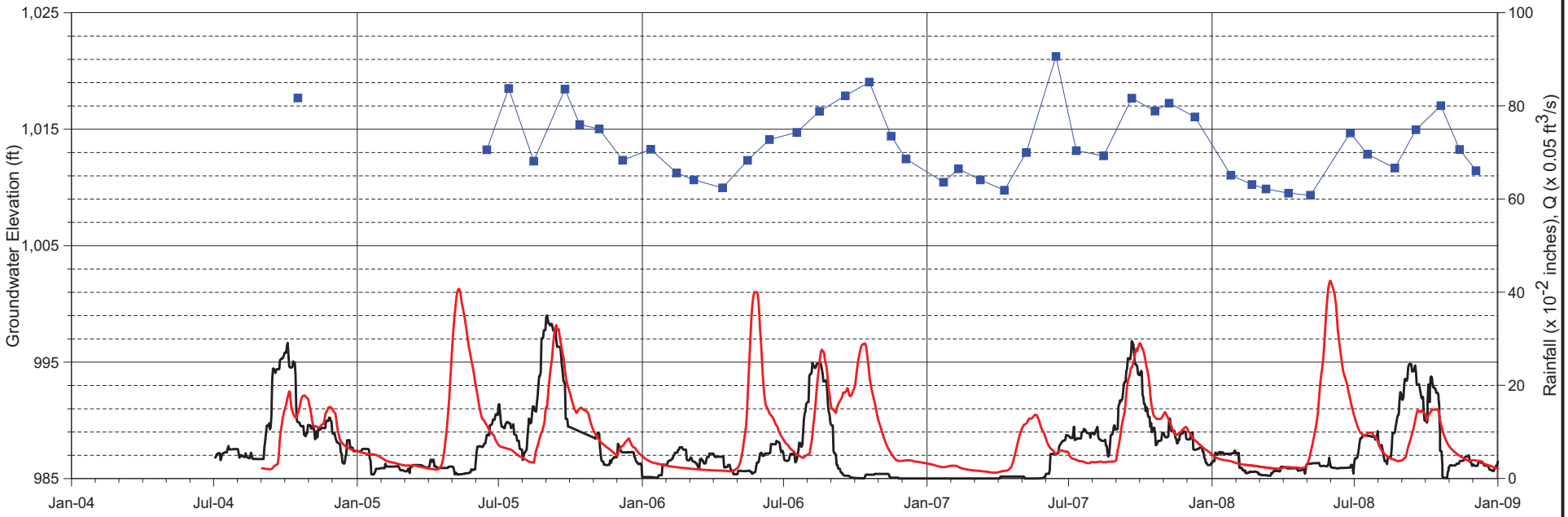


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time P-3



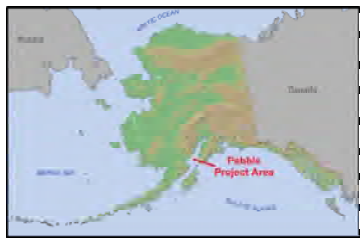
LEGEND:

Groundwater Elevation Plot Legend

- P-3
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

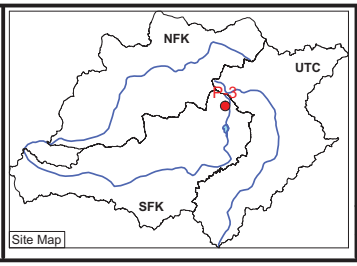
Screens (ft asl):
P-3 : 997.1 - 1007.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1019.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-3.grf

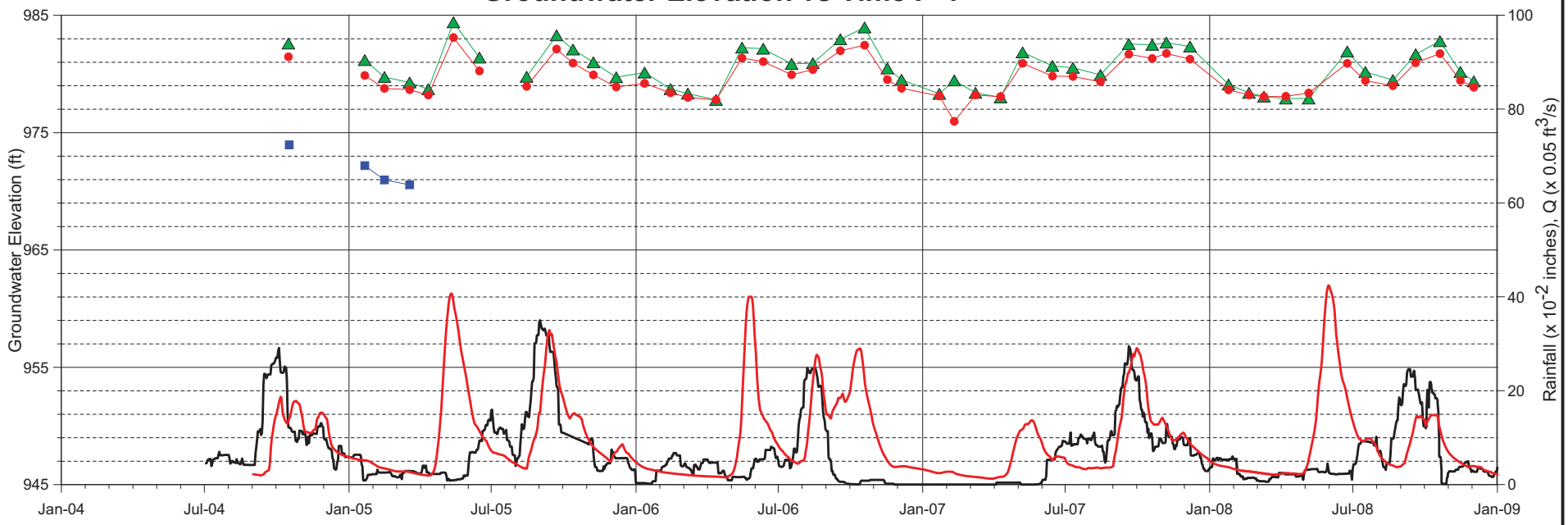


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time P-4



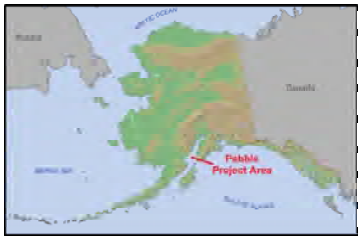
LEGEND:

Groundwater Elevation Plot Legend

- P-4 Mid
- P-4AS
- P-4AD
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

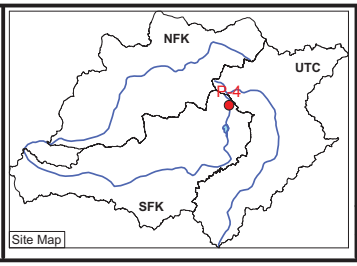
Screens (ft asl):
P-4AS : 947.7 - 957.7
P-4AD : 907.9 - 917.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 990.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-4.grf

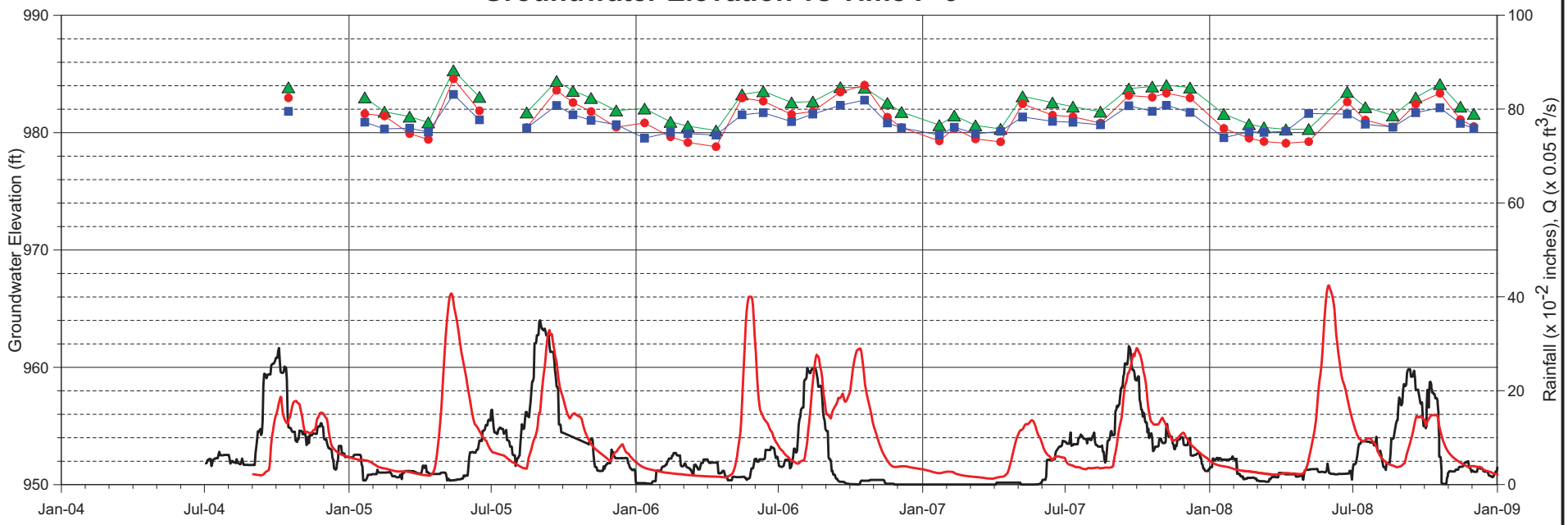


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-6



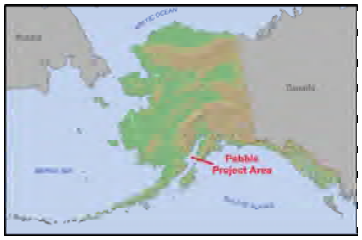
LEGEND:

Groundwater Elevation Plot Legend

- P-6S
- P-6M
- P-6D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

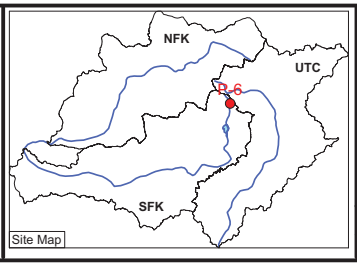
Screens (ft asl):
P-6S : 960.6 - 970.6
P-6M : 909.8 - 914.8
P-6D : 883.5 - 893.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 995.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-6.grf

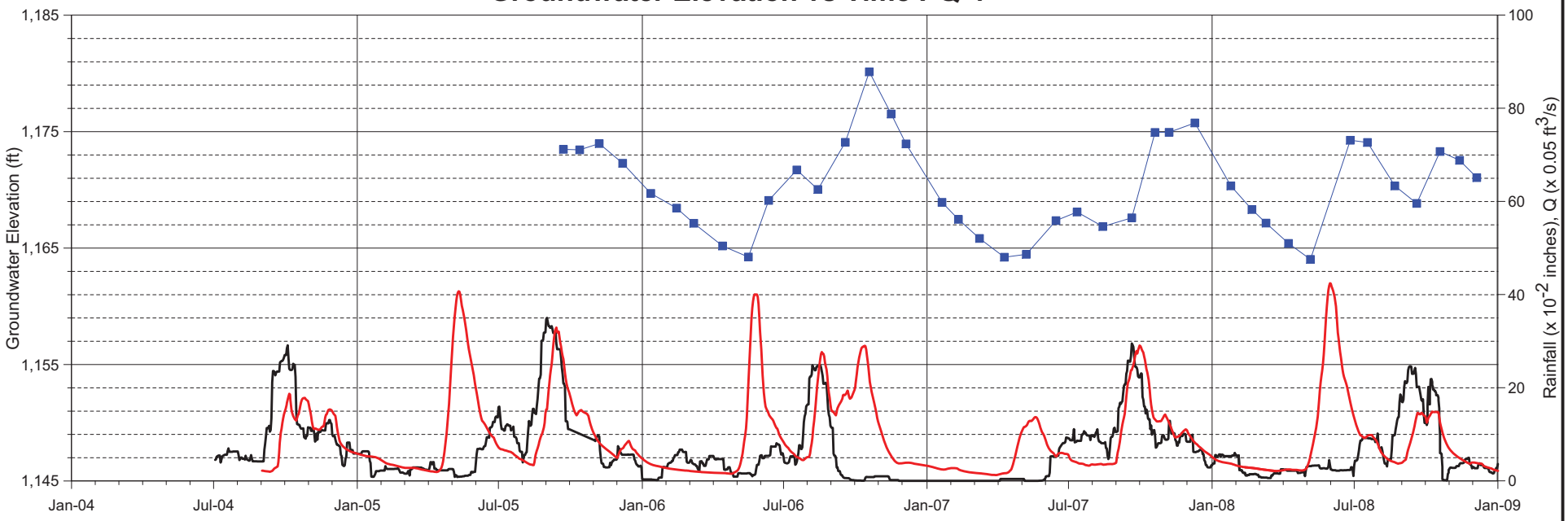


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time PQ-4



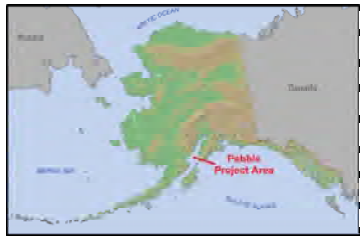
LEGEND:

Groundwater Elevation Plot Legend

- PQ-4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

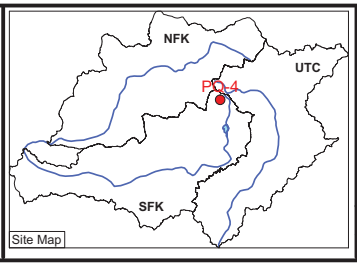
Screens (ft asl):
PQ-4 : 1072.0 - 1082.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\PQ-4.grf

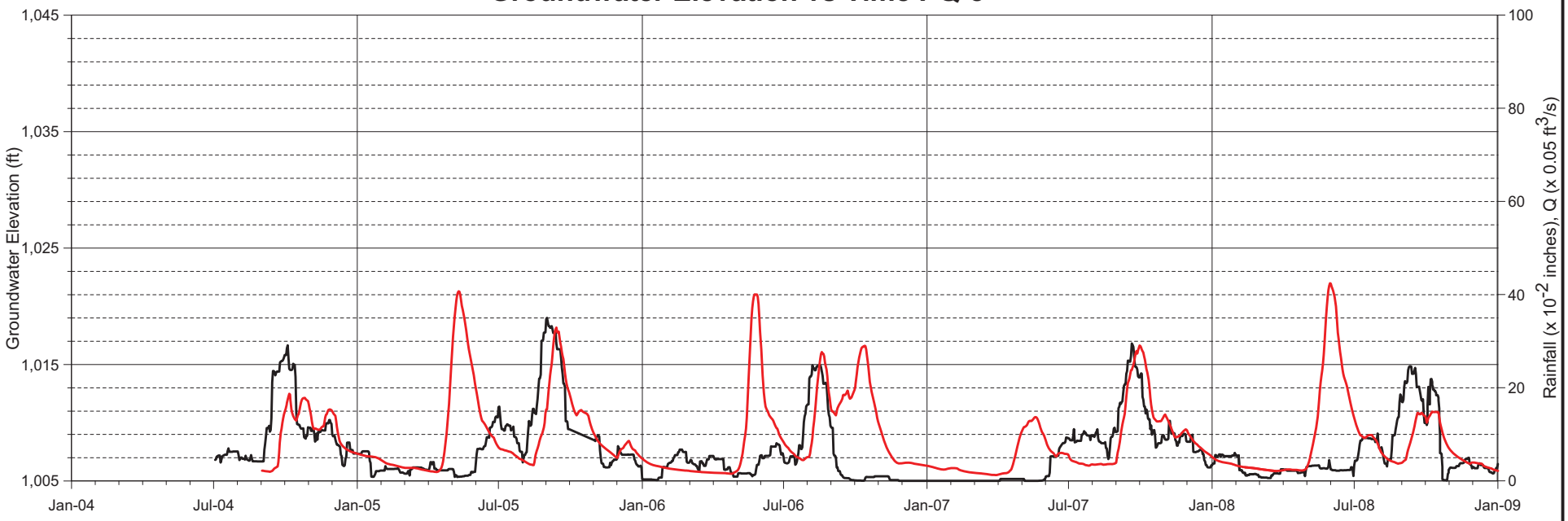


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time PQ-8



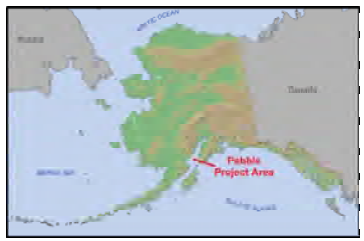
LEGEND:

Groundwater Elevation Plot Legend

- Curve 1
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

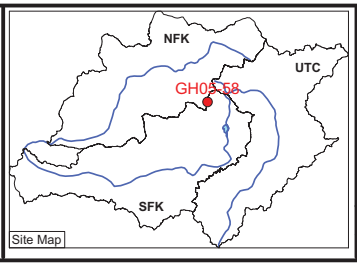
Screens (ft asl):
PQ-8 : 943.7 - 953.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation (ft):

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\PQ-8.grf

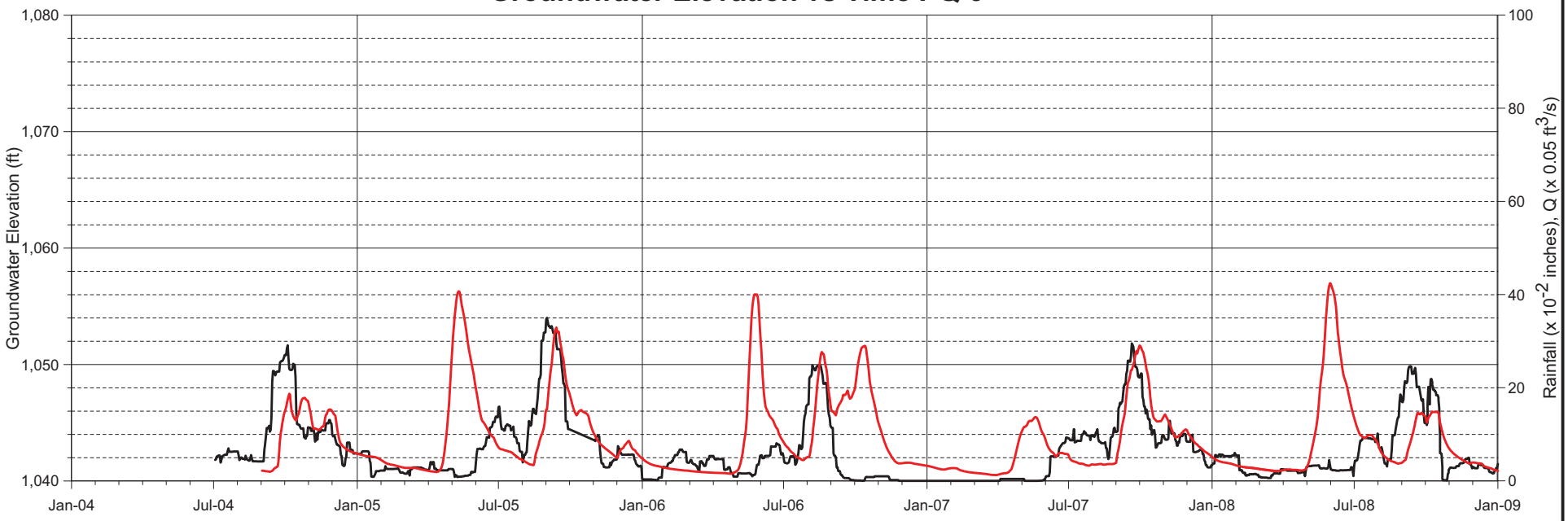


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time PQ-9



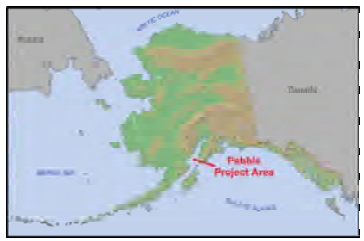
LEGEND:

Groundwater Elevation Plot Legend

- PQ-4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
PQ-9 : 1053.2 - 1063.2

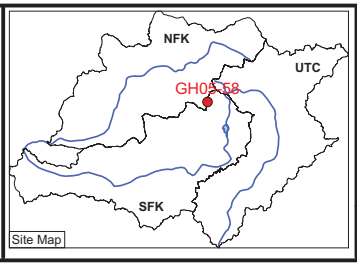


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.6 ft asl

Water levels represent long-term recovery over several years, possibly due to invasion of the monitoring zone by grout. Equilibrium groundwater elevation was not yet reached.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\PQ-9.grf

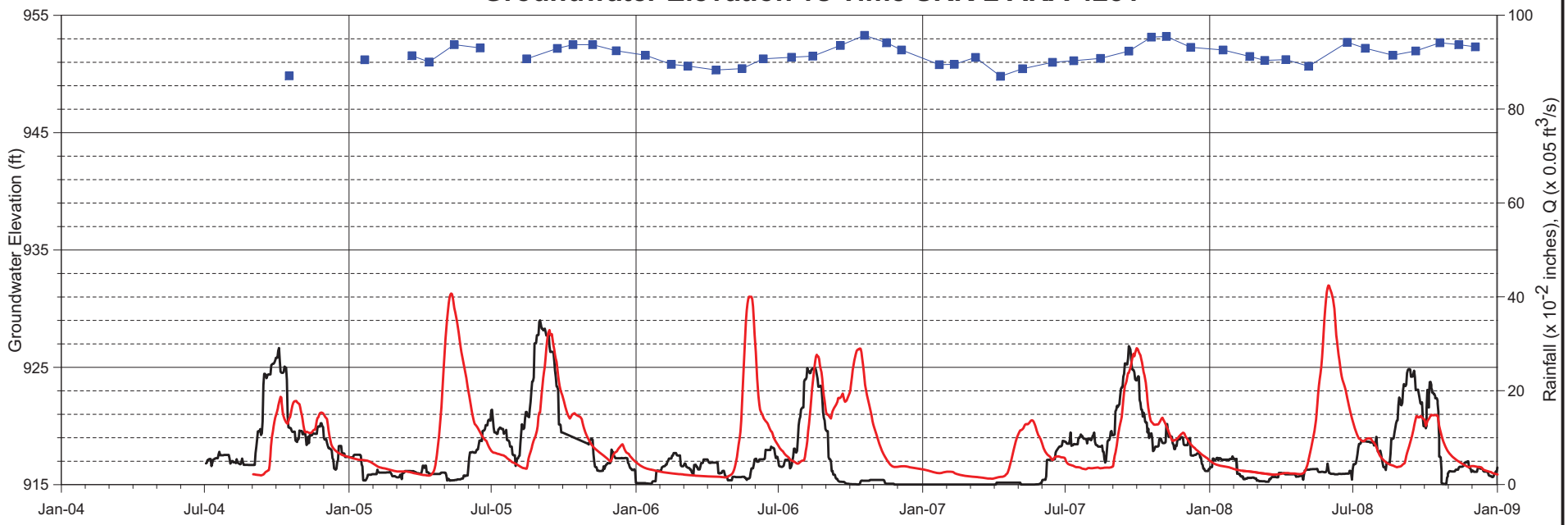


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time SRK-2 AKA 4251



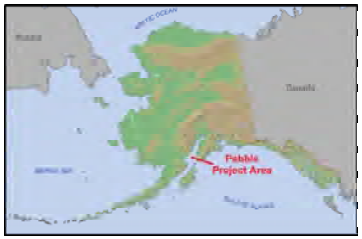
LEGEND:

Groundwater Elevation Plot Legend

- SRK-2 (AKA 4251)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

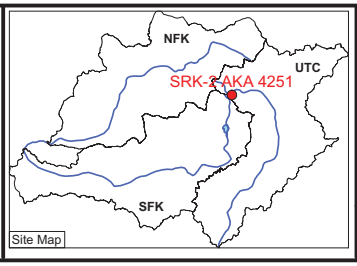
Screens (ft asl):



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 992.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\SRK-2 AKA 4251.grf

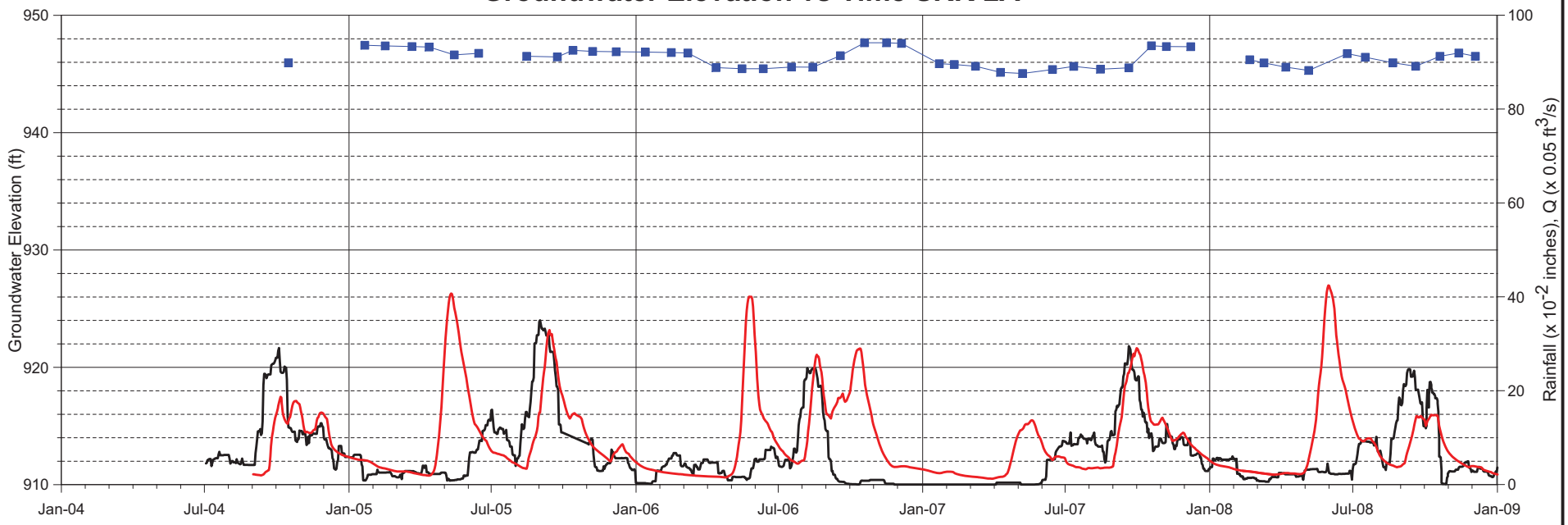


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time SRK-2A



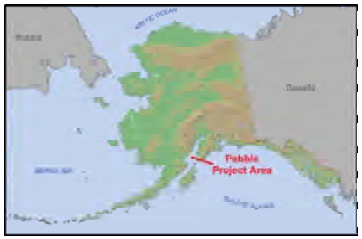
LEGEND:

Groundwater Elevation Plot Legend

- SRK-2A
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

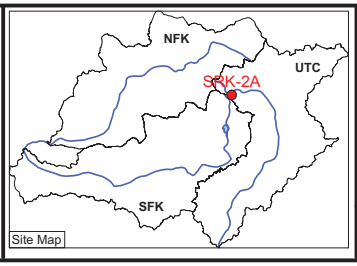
Screens (ft asl):
SRK-2A : 918.2 - 928.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 998.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\SRK-2A.grf

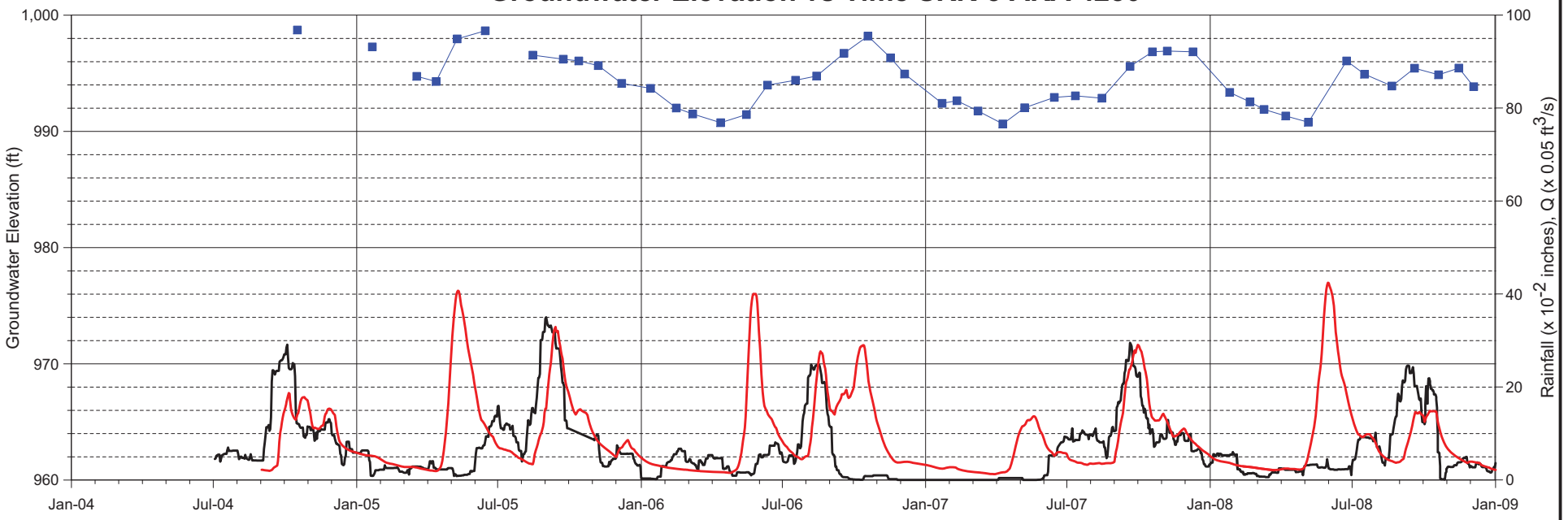


THE pebble PARTNERSHIP

Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time SRK-3 AKA 4250



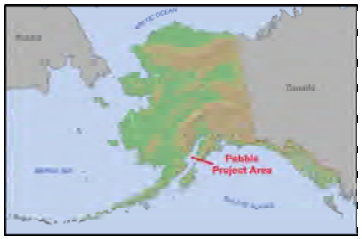
LEGEND:

Groundwater Elevation Plot Legend

- SRK-3 (AKA 4250)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

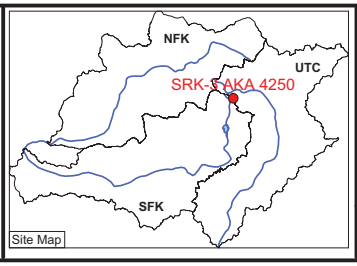
Screens (ft asl):
SRK-3 (AKA 4250) : 950.8 - 960.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1024.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\SRK-3 AKA 4250.grf



THE pebble PARTNERSHIP

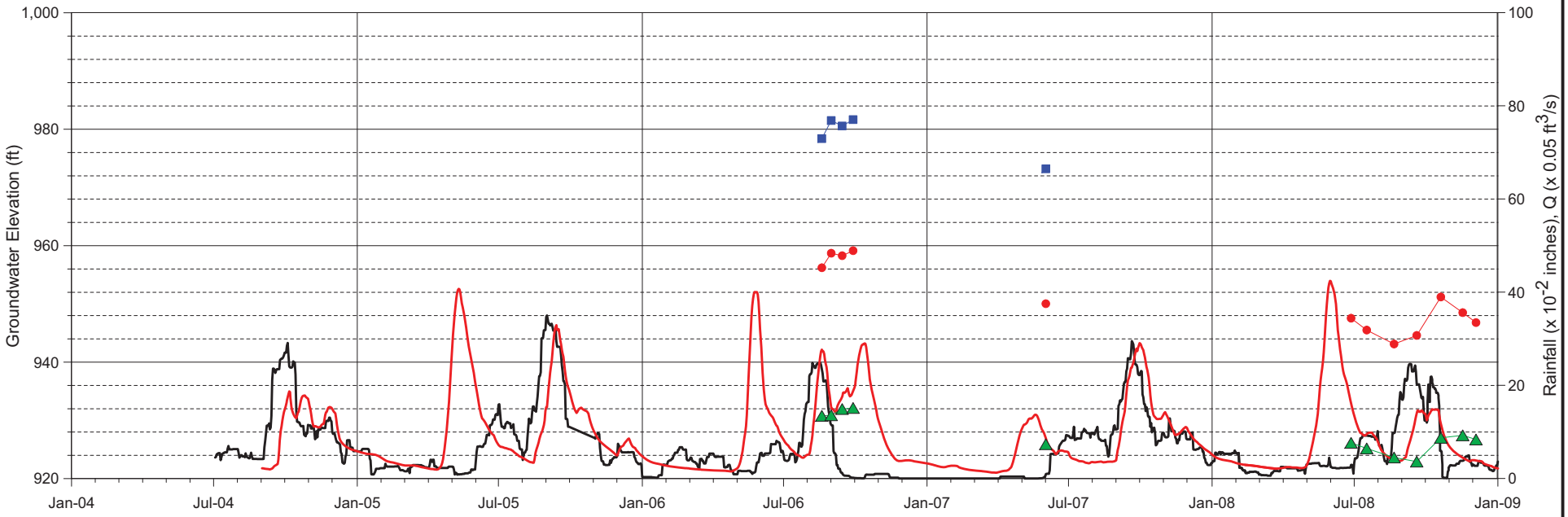
Appendix 8.1G:
Time Series of Piezometric Elevations (uniform scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

APPENDIX 8.1H

Time Series of Piezometric Elevations (Expanded Scale)

Groundwater Elevation vs Time DH-5324



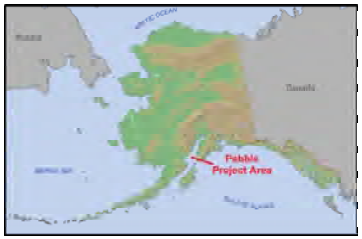
LEGEND:

Groundwater Elevation Plot Legend

- DH-5324C (Vibrating Wire)
- DH-5324B (Vibrating Wire)
- DH-5324A (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

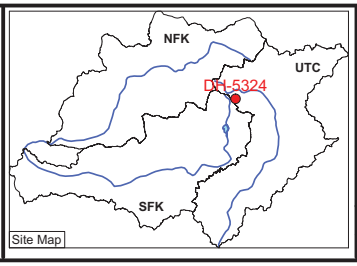
Transducer Elevation (ft asl):
DH-5324C : 645.9
DH-5324B : 413.9
DH-5324A : 150.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 957.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\DH-5324.grf

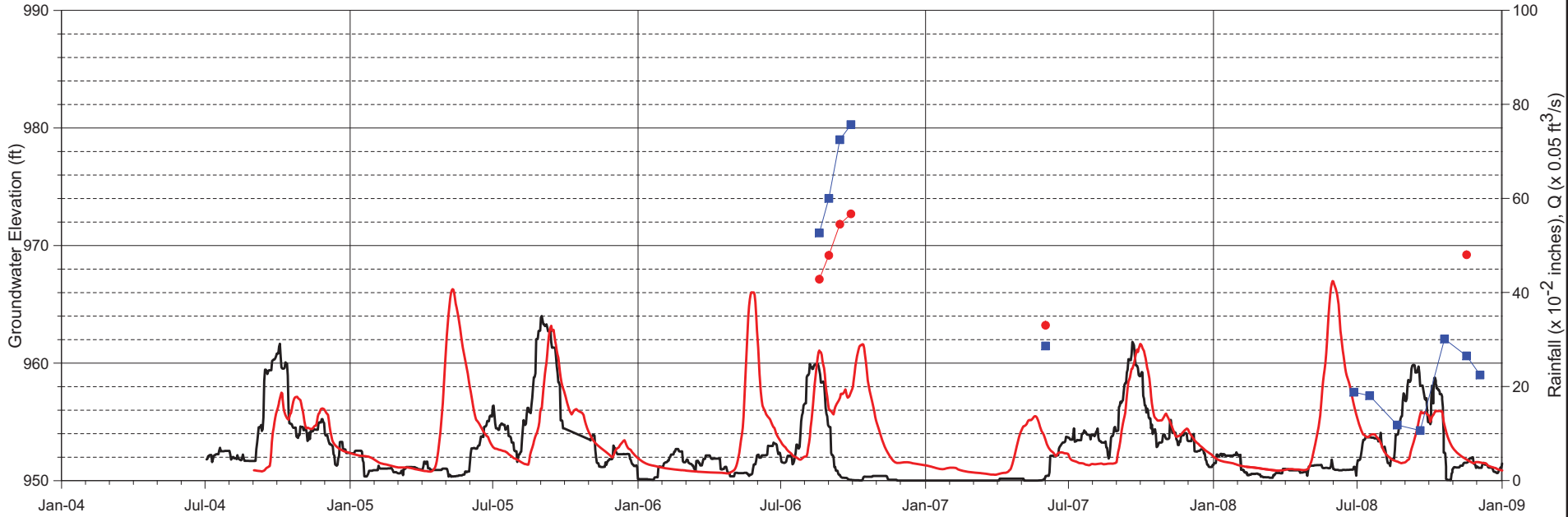


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time DH-5326



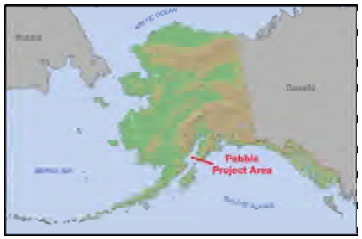
LEGEND:

Groundwater Elevation Plot Legend

- DH-5326B (Vibrating Wire)
- DH-5326A (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

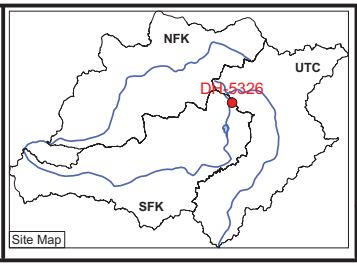
Transducer Elevation (ft asl):
DH-5326B : 863.1
DH-5326A : 351.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1044.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\DH-5326.grf

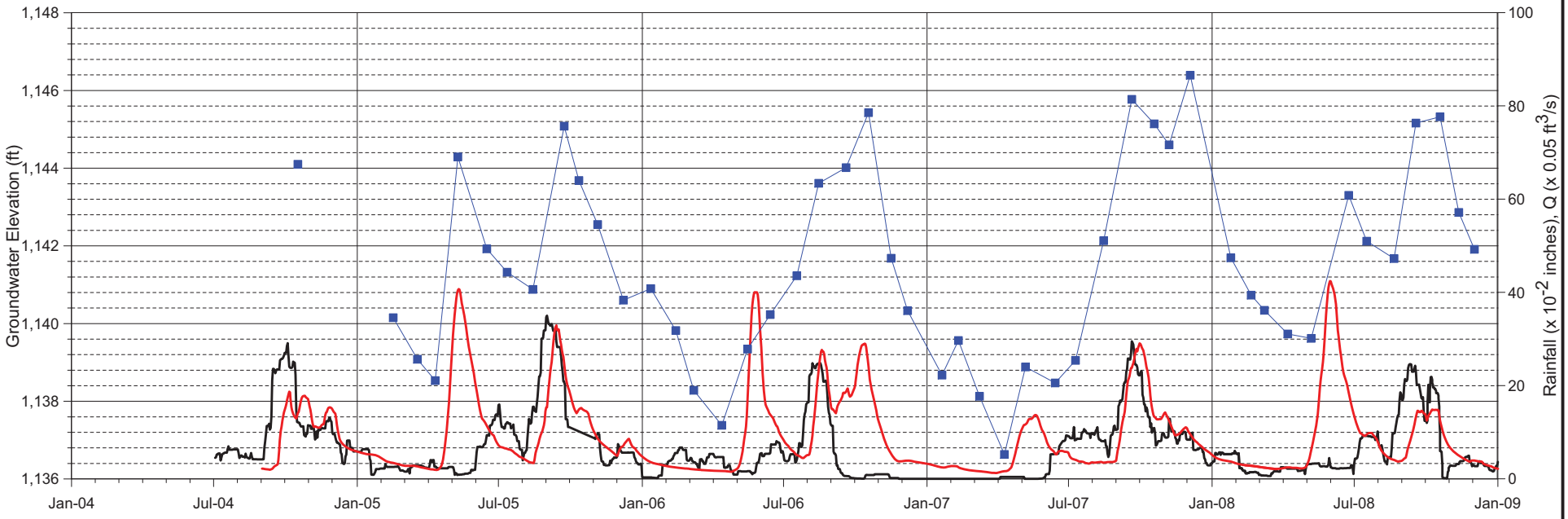


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-02



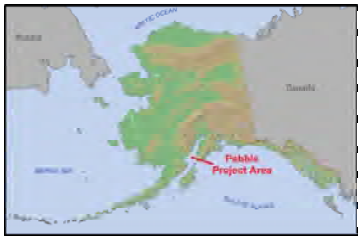
LEGEND:

Groundwater Elevation Plot Legend

- GH04-02
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

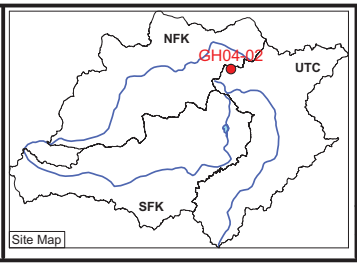
Screens (ft asl):
GH04-02 : 1123.2 - 1133.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1148.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-02.grf

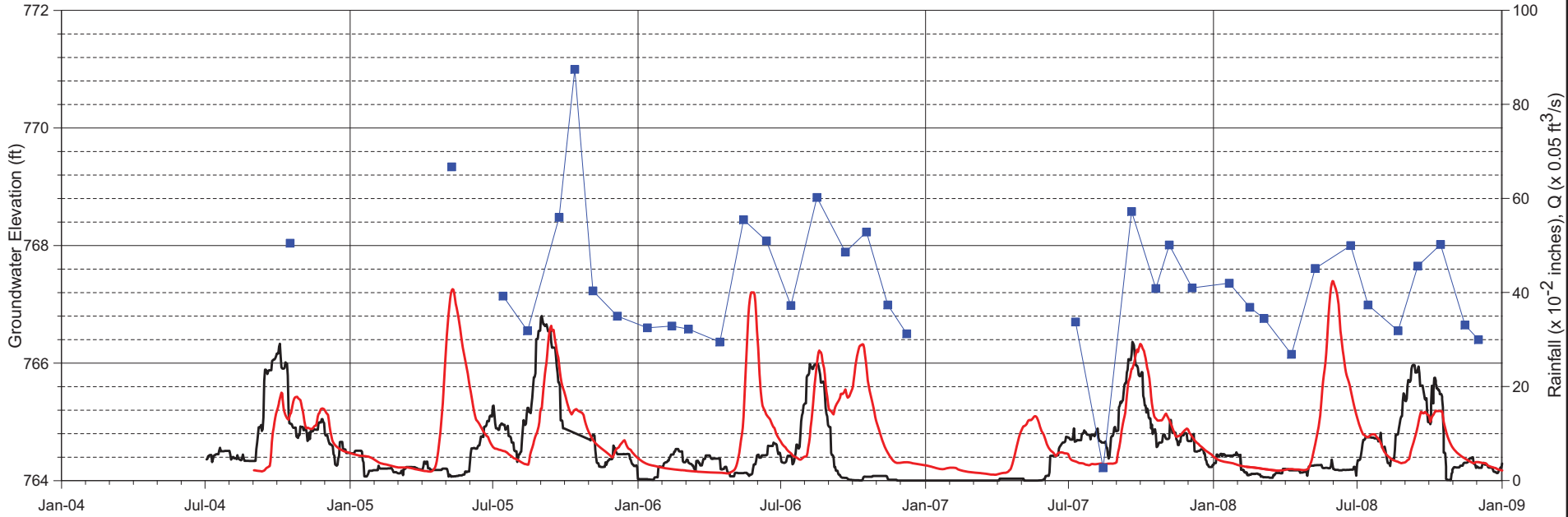


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-05



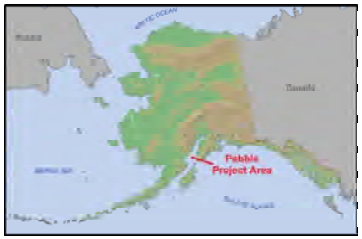
LEGEND:

Groundwater Elevation Plot Legend

- GH04-05
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

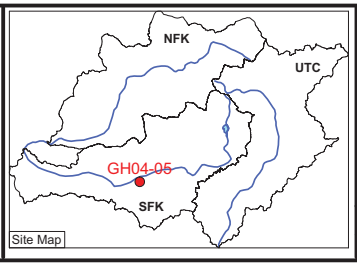
Screens (ft asl):
GH04-05 : 732.9 - 742.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 770.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-05.grf

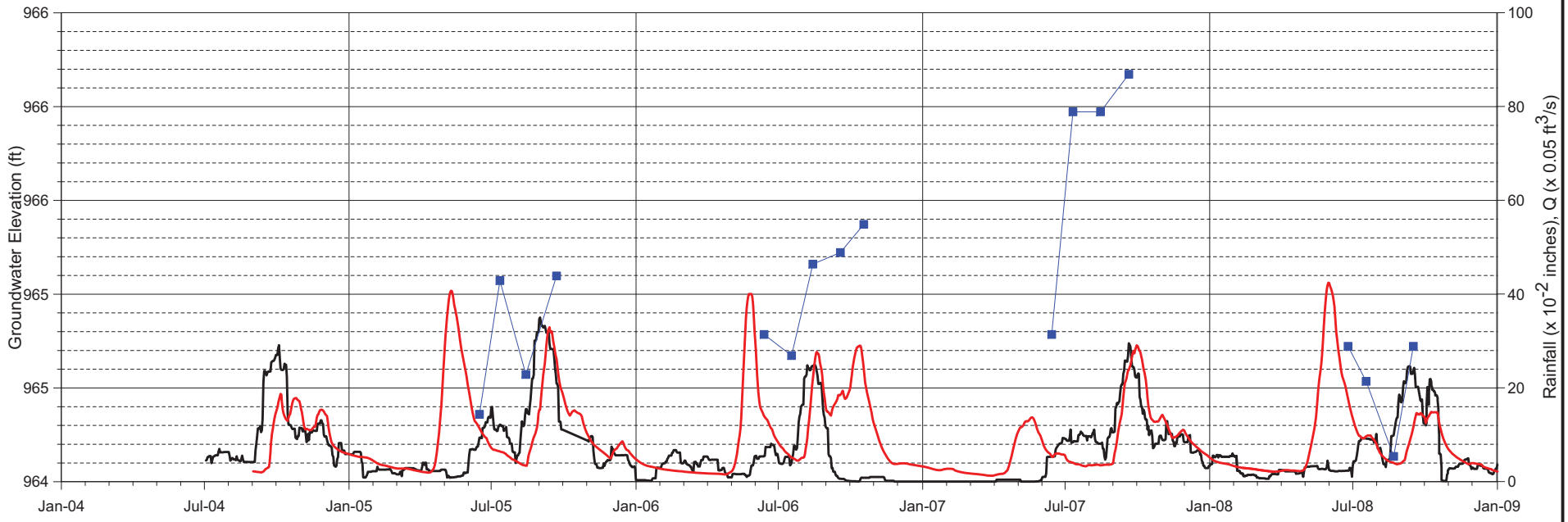


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-06



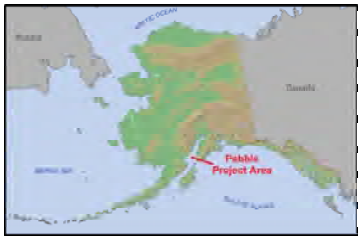
LEGEND:

Groundwater Elevation Plot Legend

- GH04-06
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

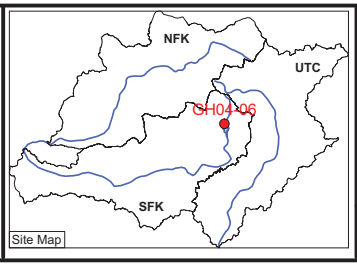
Screens (ft asl):
GH04-06 : 929.4 - 939.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 965.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-06.grf

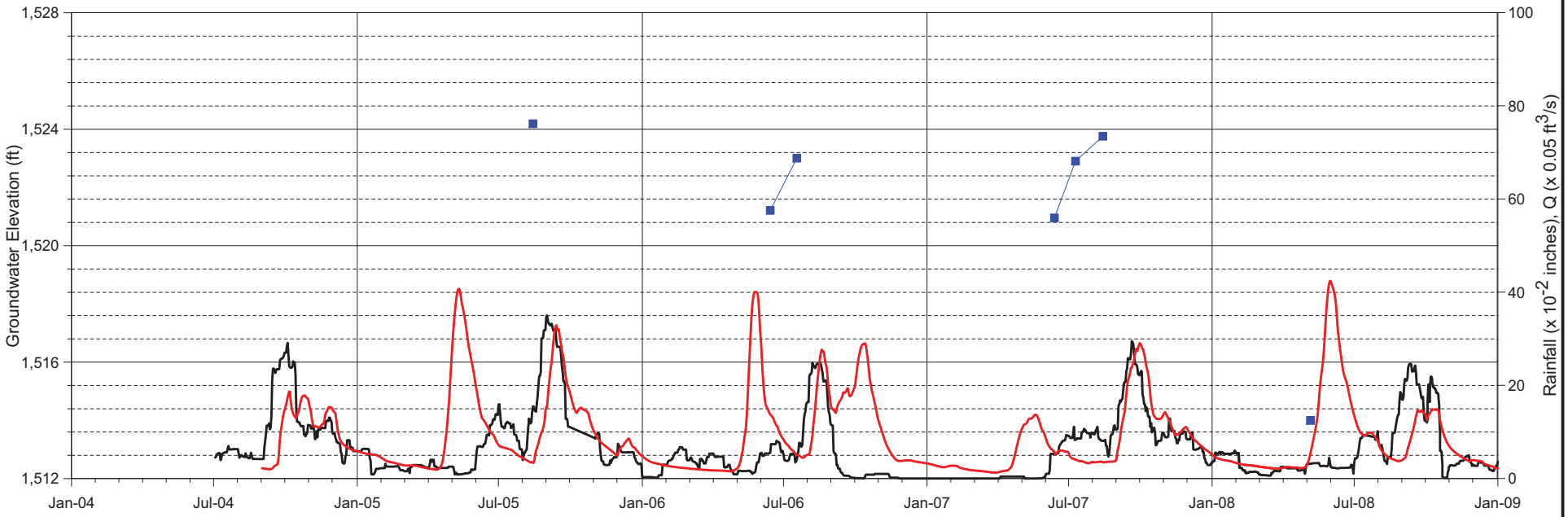


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-08



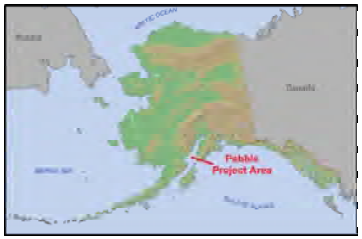
LEGEND:

Groundwater Elevation Plot Legend

- GH04-08
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-08 : 1489.1 - 1499.1

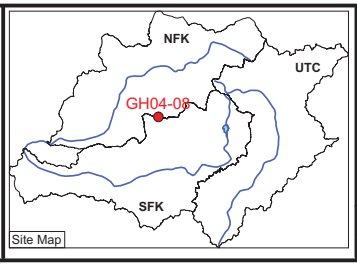


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1525.1 ft asl

GH04-08 was flowing most of the time, water levels were recorded when they fell below top of riser.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-08.grf

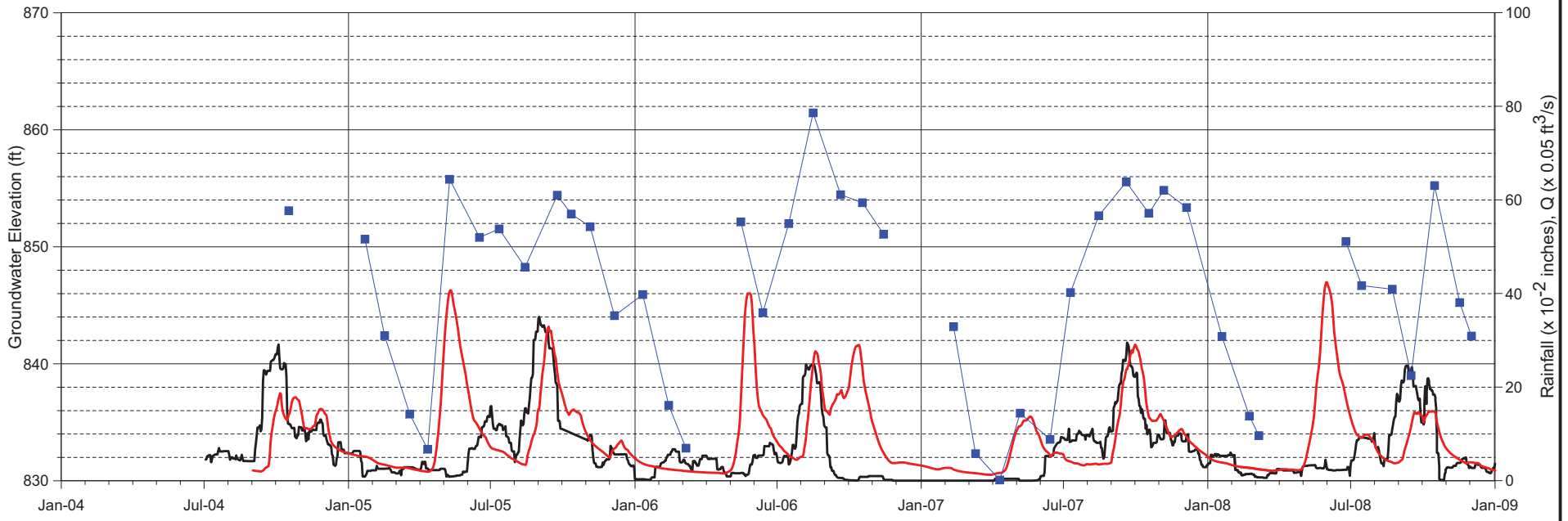


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-12A



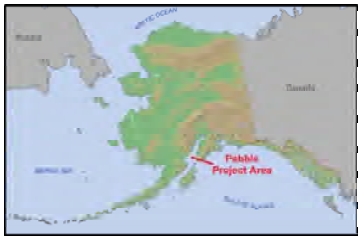
LEGEND:

Groundwater Elevation Plot Legend

- GH04-12A
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

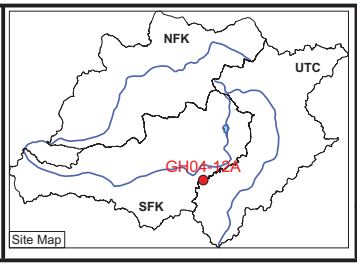
Screens (ft asl):
GH04-12A : 818.9 - 828.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 881.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-12A.grf

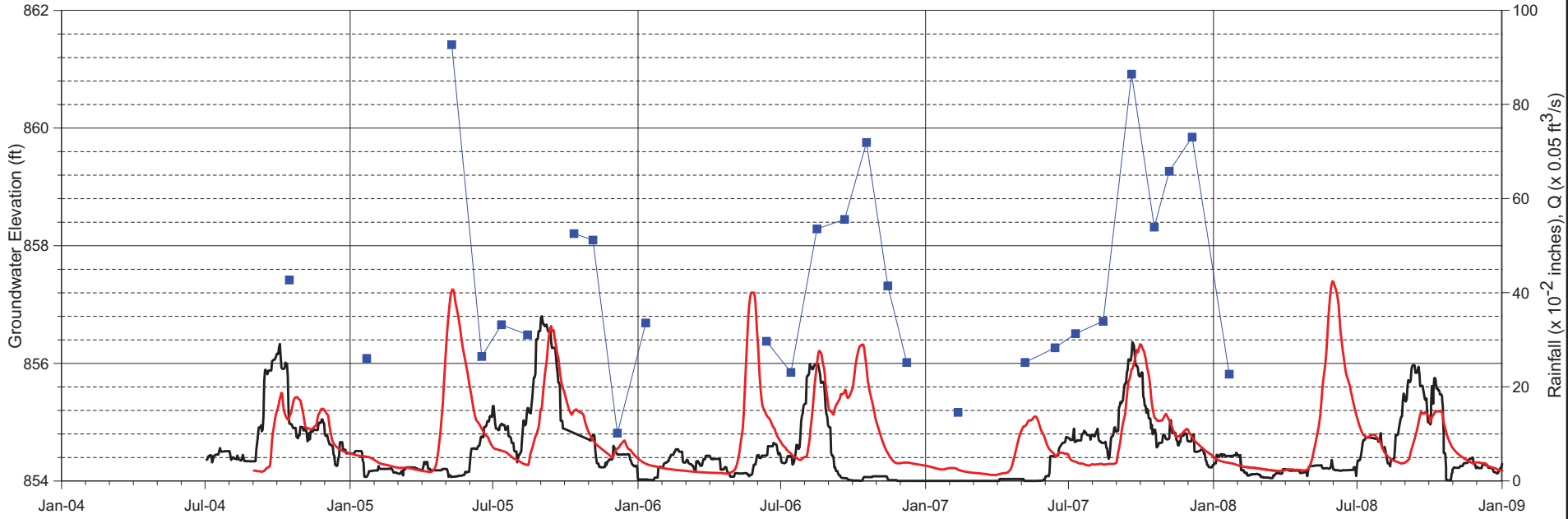


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-14



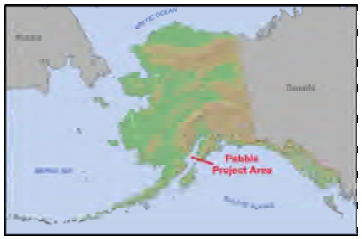
LEGEND:

Groundwater Elevation Plot Legend

- GH04-14
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

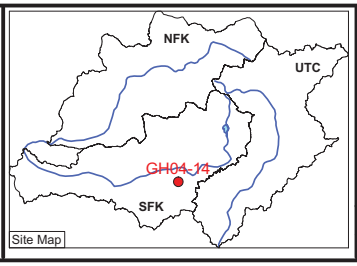
Screens (ft asl):
GH04-14 : 854.0 - 864.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 927 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-14.grf

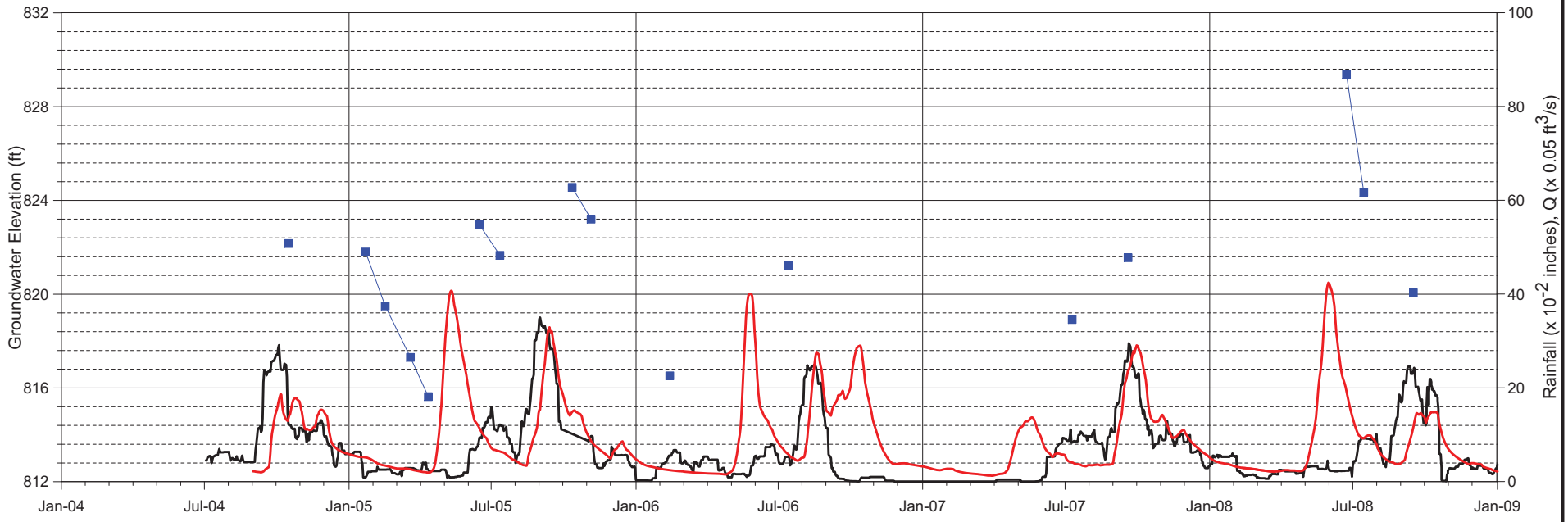


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-16



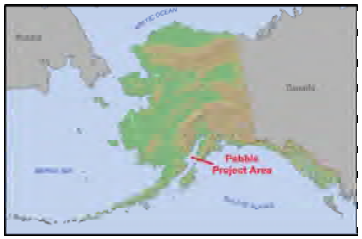
LEGEND:

Groundwater Elevation Plot Legend

- GH04-16
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-16 : 790.5 - 800.5

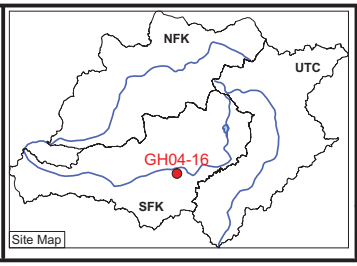


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 889.6 ft asl

PVC was visibly separated at a depth of about 2 ft, water level readings were not always possible.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-16.grf

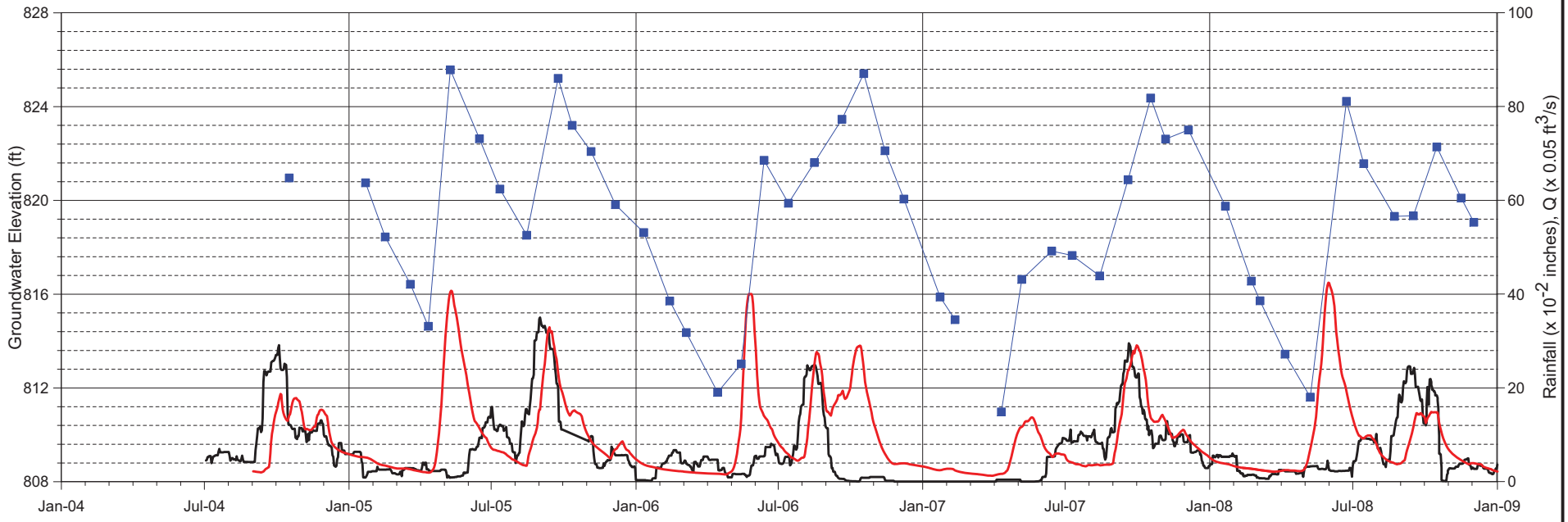


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-17



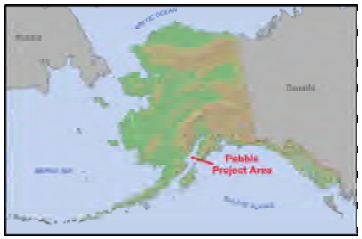
LEGEND:

Groundwater Elevation Plot Legend

- GH04-17
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

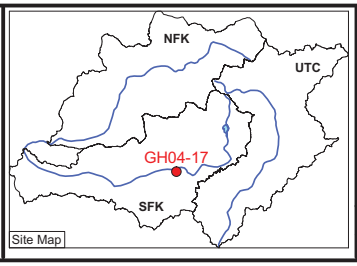
Screens (ft asl):
GH04-17 : 804.2 - 814.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 841.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-17.grf

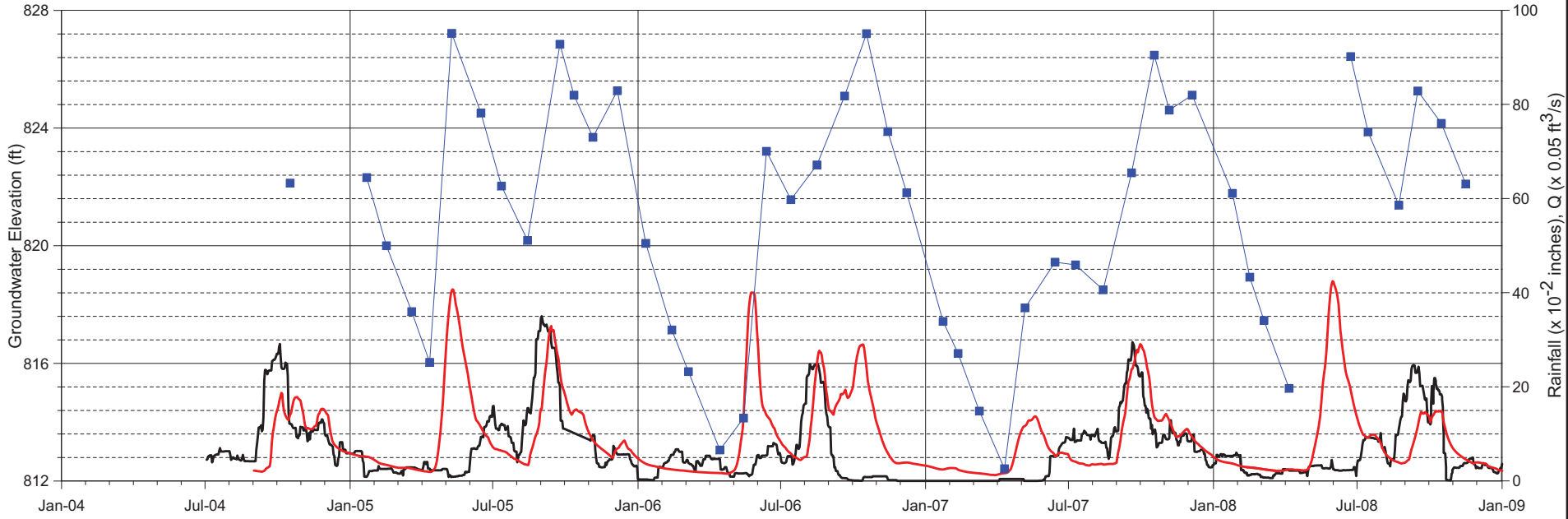


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-18



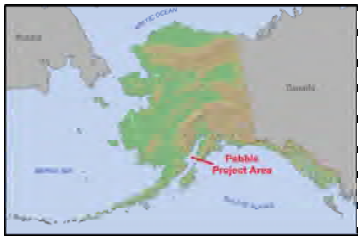
LEGEND:

Groundwater Elevation Plot Legend

- GH04-18
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

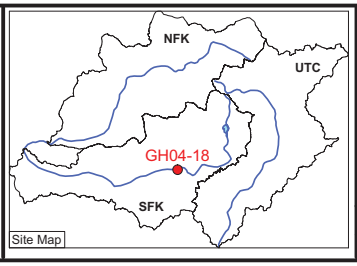
Screens (ft asl):
GH04-18 : 777.5 - 787.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 832 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-18.grf

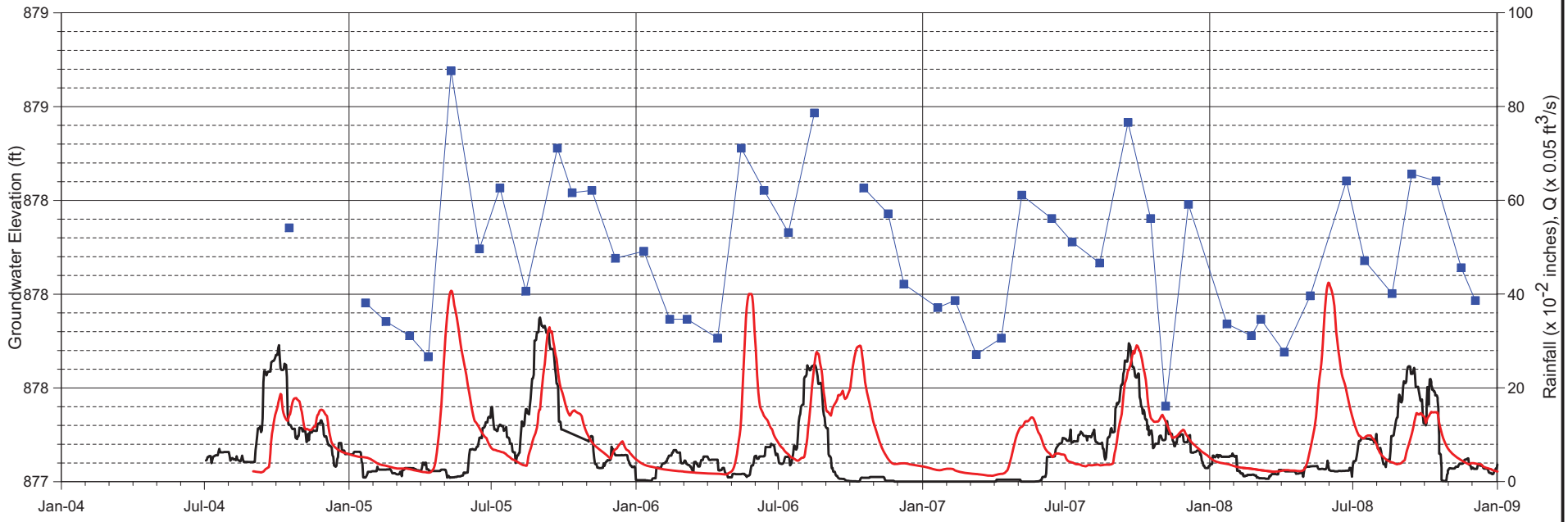


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-19



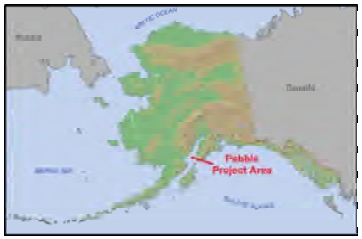
LEGEND:

Groundwater Elevation Plot Legend

- GH04-19
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

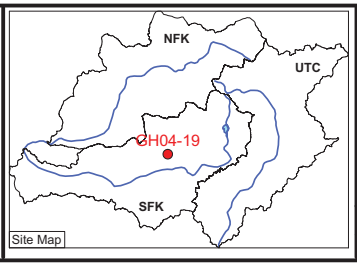
Screens (ft asl):
GH04-19 : 865.0 - 875.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 880 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-19.grf

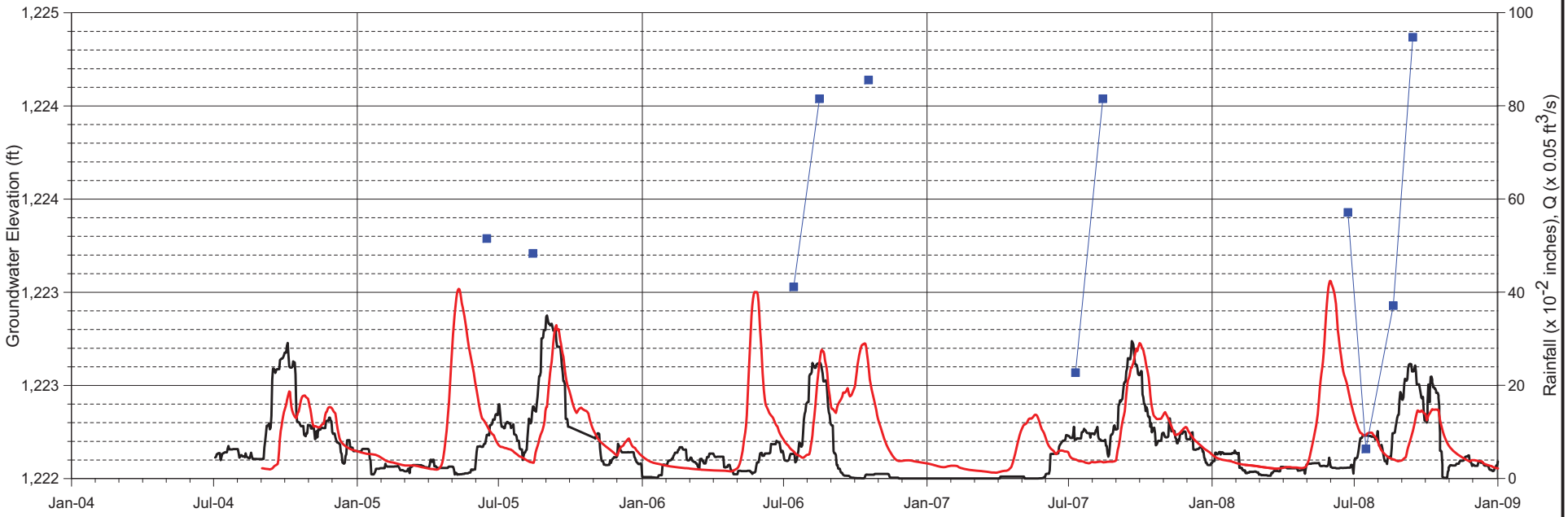


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-20



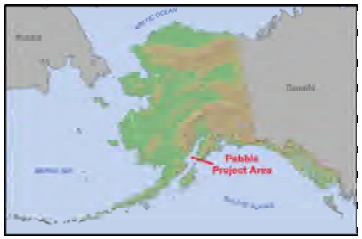
LEGEND:

Groundwater Elevation Plot Legend

- GH04-20
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-20 : 1209.5 - 1219.5

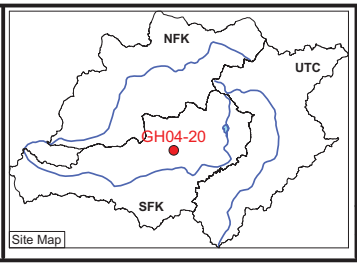


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1223.5 ft asl

GH04-20 was flowing most of the time, water levels recorded when they fall below top of riser.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-20.grf

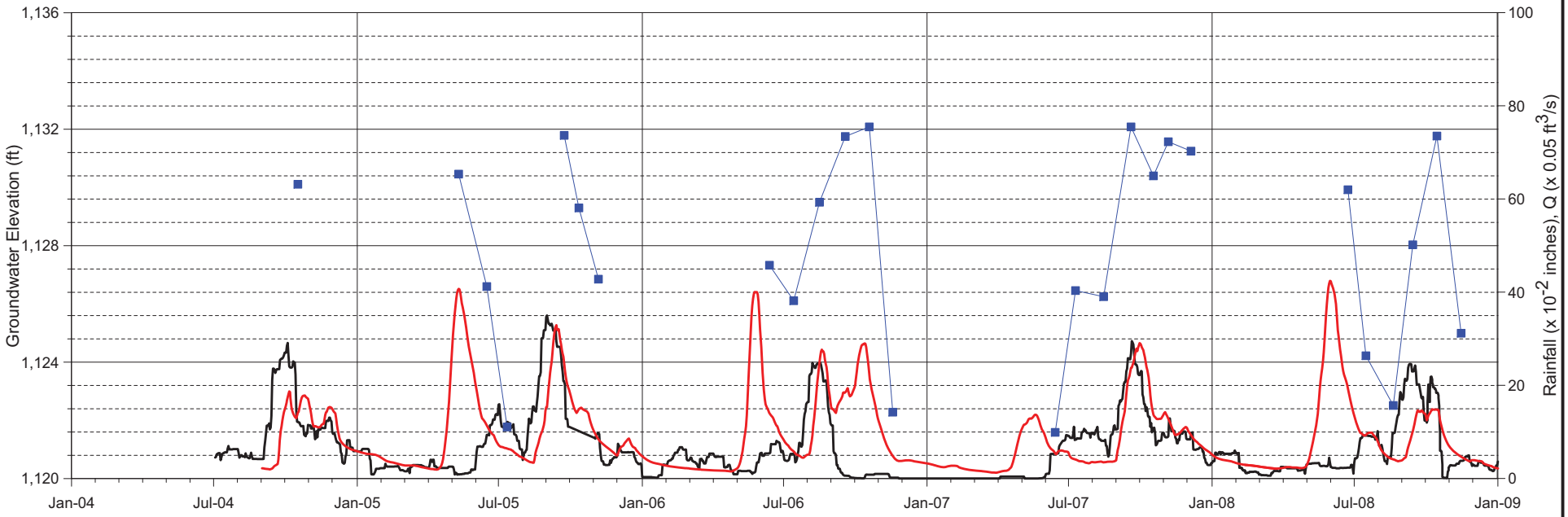


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-22



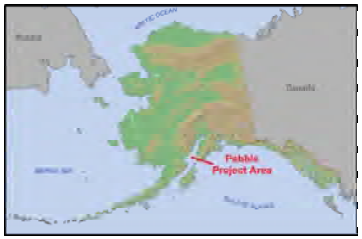
LEGEND:

Groundwater Elevation Plot Legend

- GH04-22
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-22 : 1116.7 - 1127.7

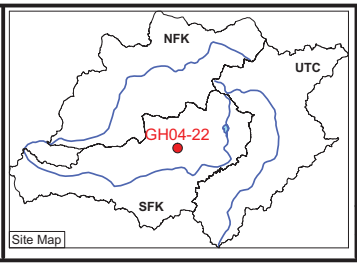


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1132.7 ft asl

GH04-22 dries seasonally during the winter, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-22.grf

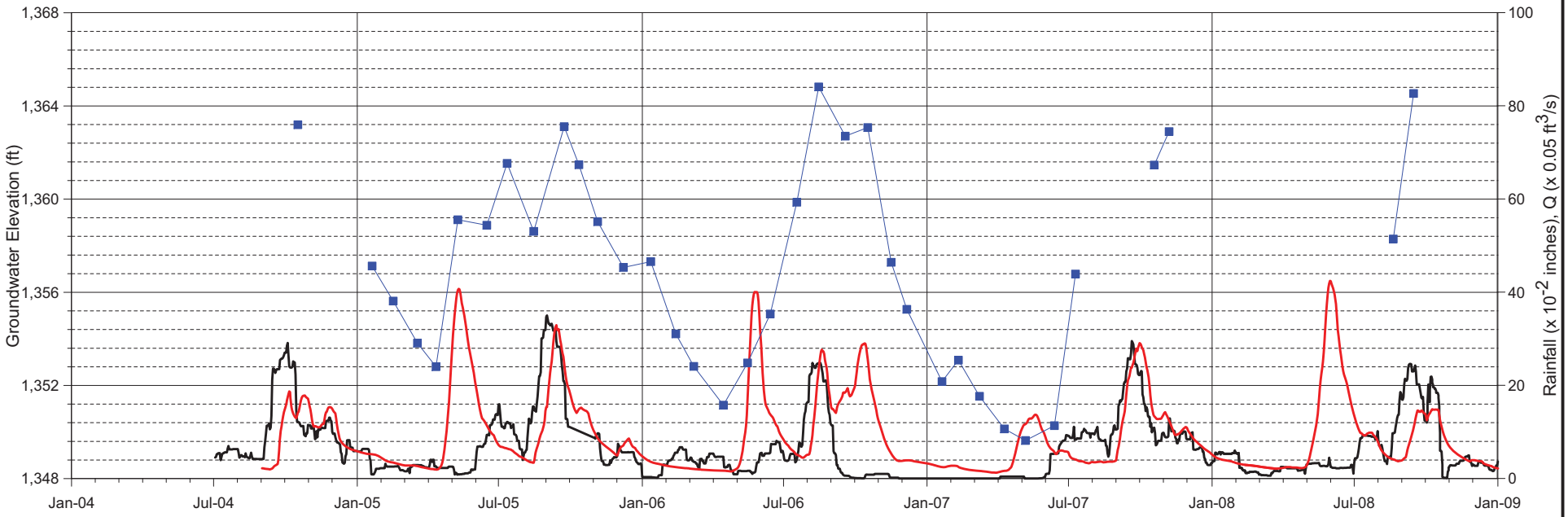


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-23



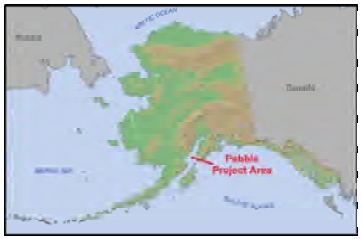
LEGEND:

Groundwater Elevation Plot Legend

- GH04-23
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-23 : 1347.8 - 1357.8

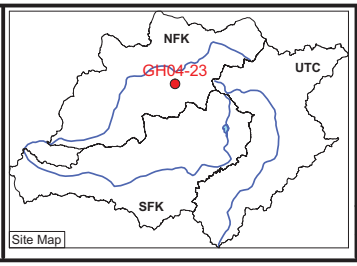


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1364.8 ft asl

Well had infilling with sediment, which was sometimes above the groundwater level since July, 2007. Therefore, few water levels recorded since July, 2007.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-23.grf

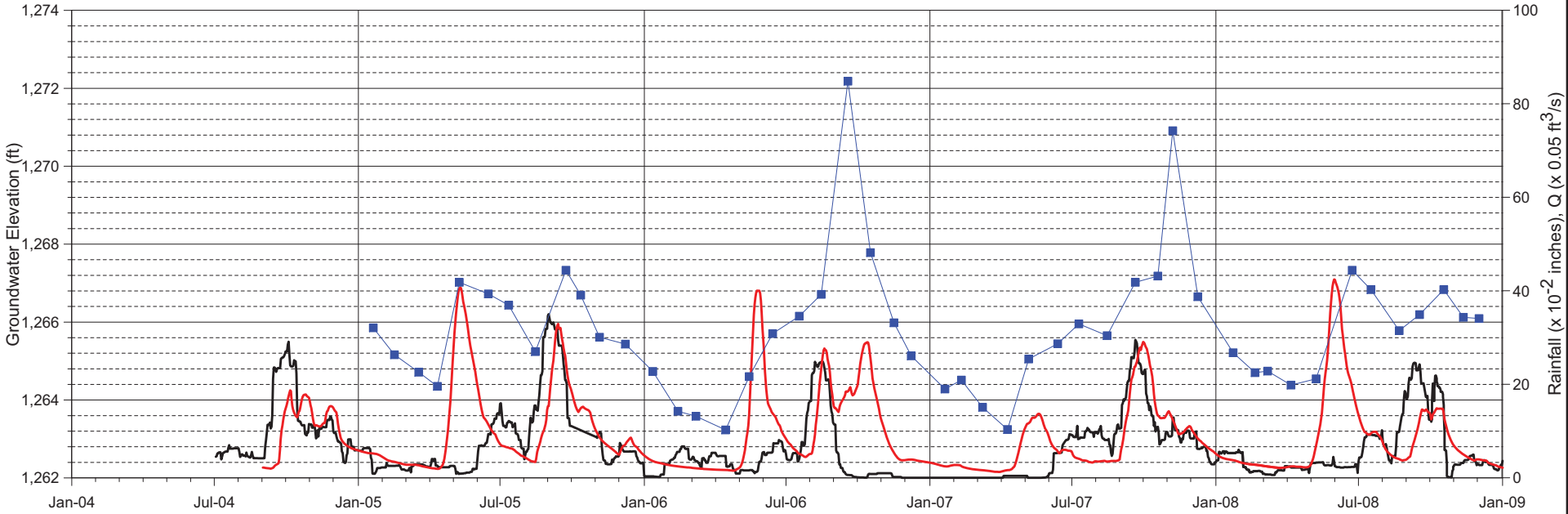


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-25



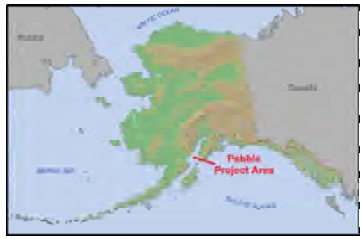
LEGEND:

Groundwater Elevation Plot Legend

- GH04-25
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

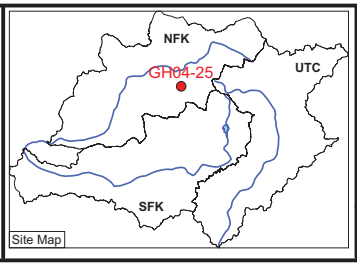
Screens (ft asl):
GH04-25 : 1238.4 - 1248.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1313.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-25.grf

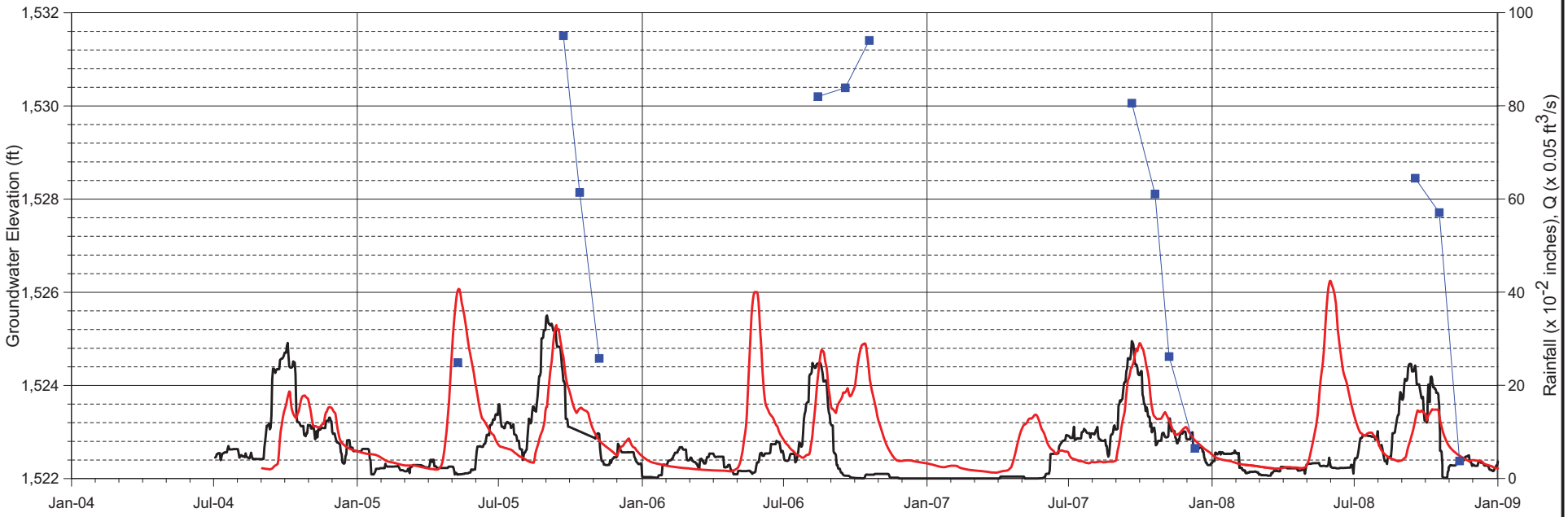


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-27



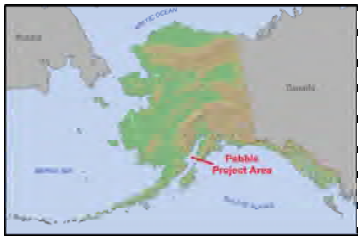
LEGEND:

Groundwater Elevation Plot Legend

- GH04-27
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-27 : 1518.6 - 1528.6

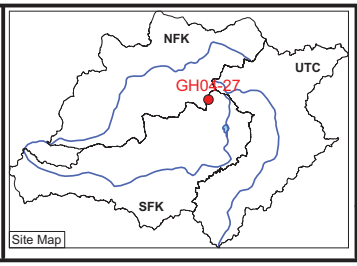


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1550.6 ft asl

GH04-27 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-27.grf

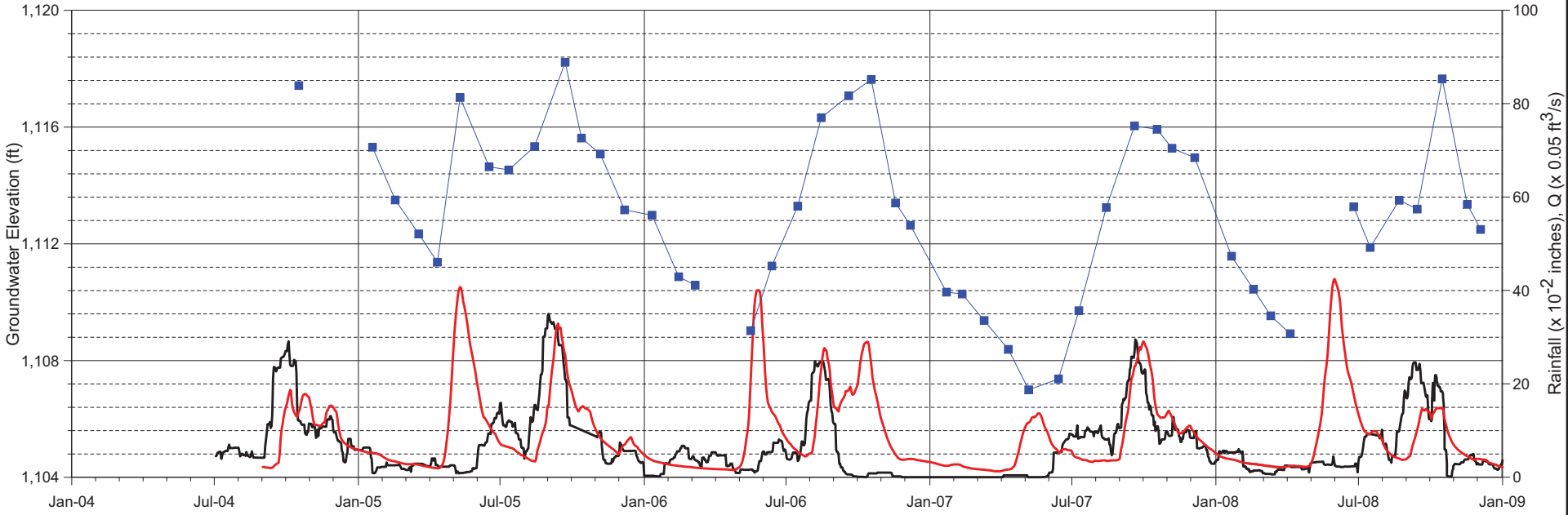


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-28



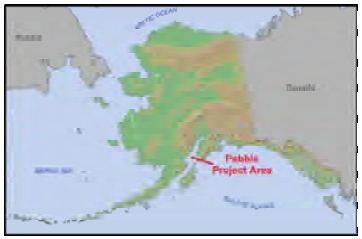
LEGEND:

Groundwater Elevation Plot Legend

- GH04-28
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

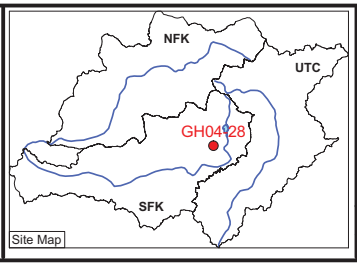
Screens (ft asl):
GH04-28 : 1098.1 - 1108.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1155.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-28.grf

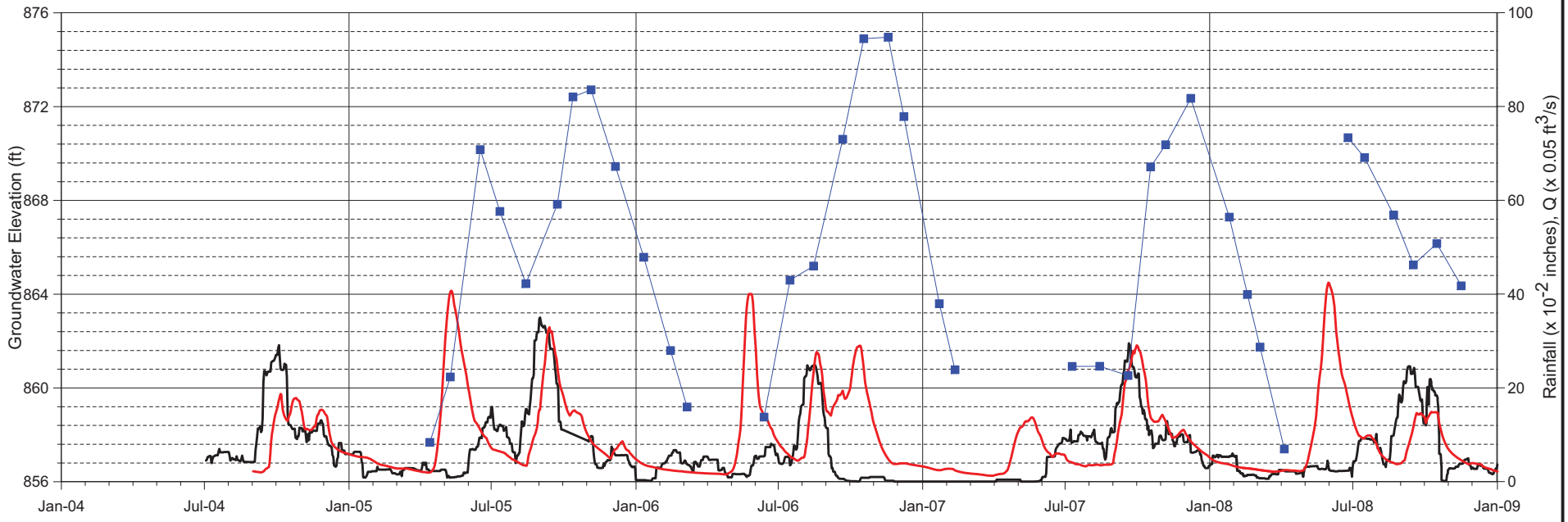


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-30



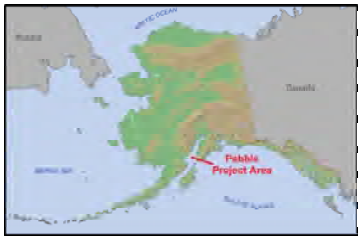
LEGEND:

Groundwater Elevation Plot Legend

- GH04-30
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-30 : 859.8 - 869.8

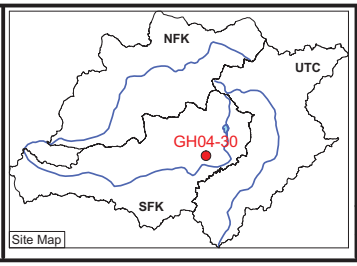


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 936.8 ft asl

GH04-30 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-30.grf

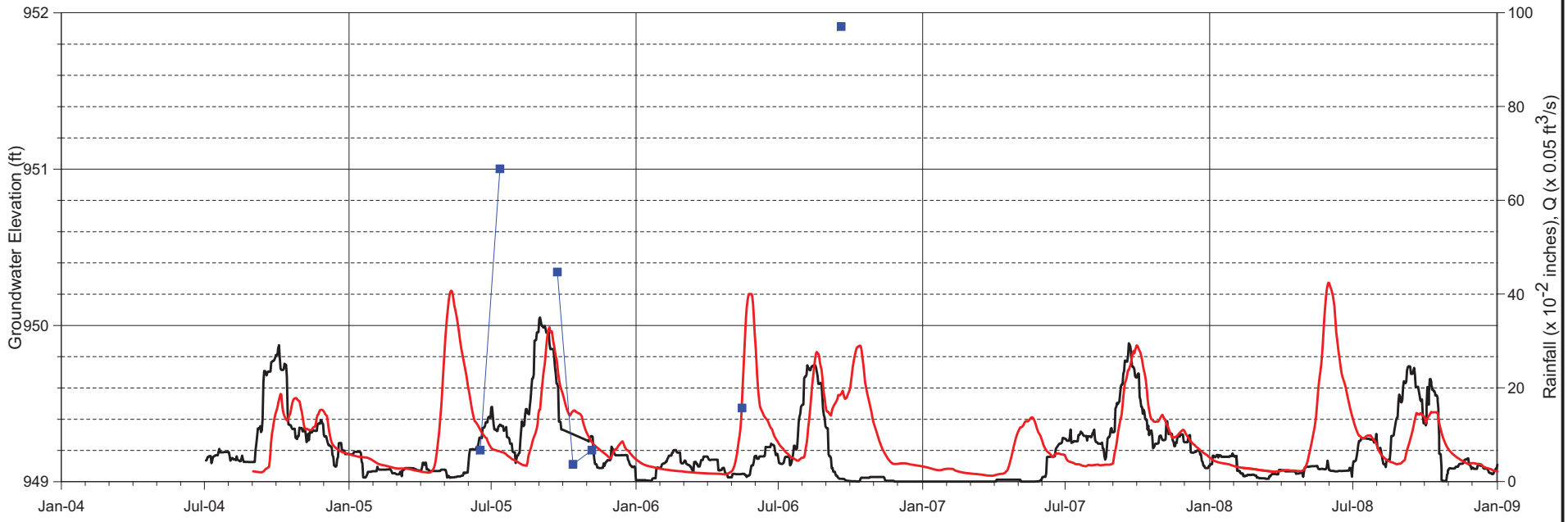


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-31



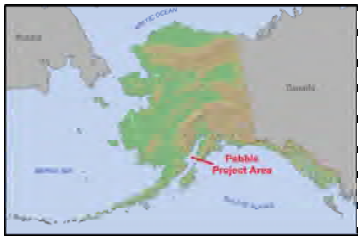
LEGEND:

Groundwater Elevation Plot Legend

- GH04-31
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-31 : 947.6 - 957.6

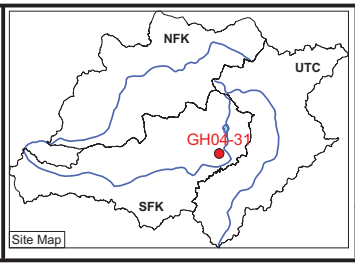


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1009.6 ft asl

Recorded water levels measured water pooled in bottom of the piezometer; actual groundwater level was below bottom of screen.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-31.grf

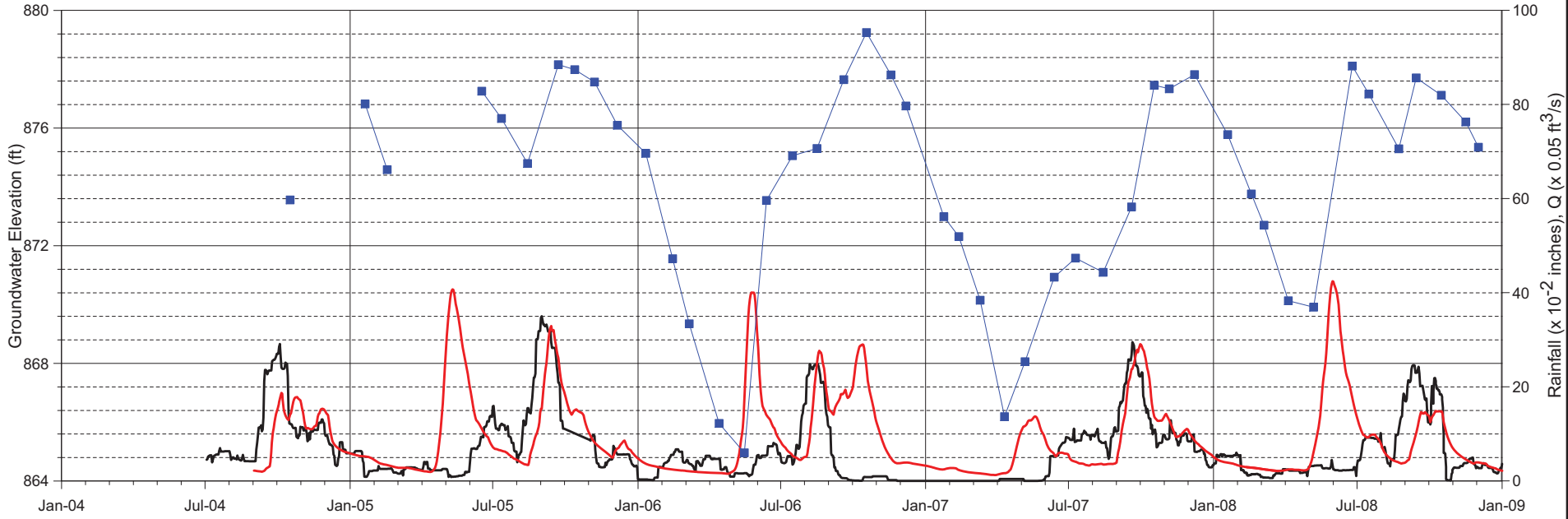


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-33



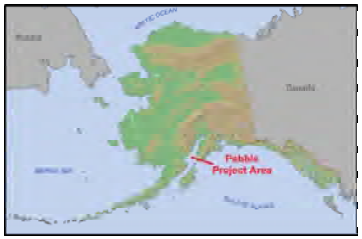
LEGEND:

Groundwater Elevation Plot Legend

- GH04-33
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

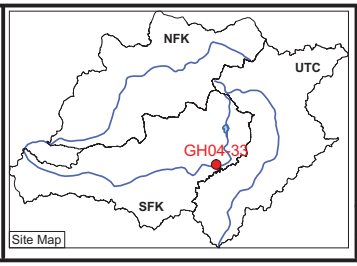
Screens (ft asl):
GH04-33 : 846.4 - 856.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 903.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-33.grf

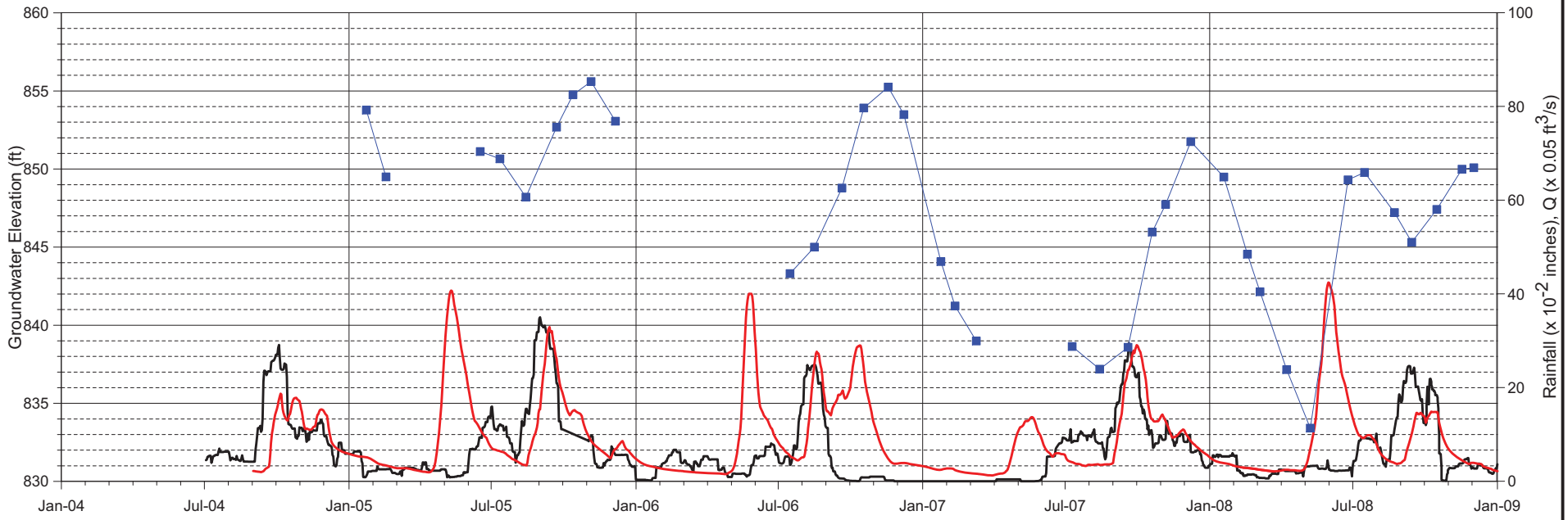


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-35



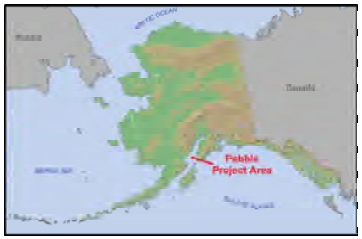
LEGEND:

Groundwater Elevation Plot Legend

- GH04-35
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

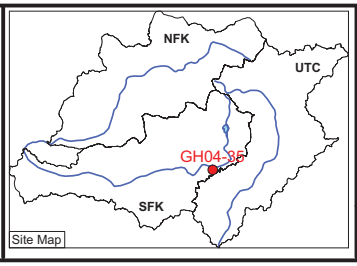
Screens (ft asl):
GH04-35 : 822.7 - 832.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 888.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-35.grf

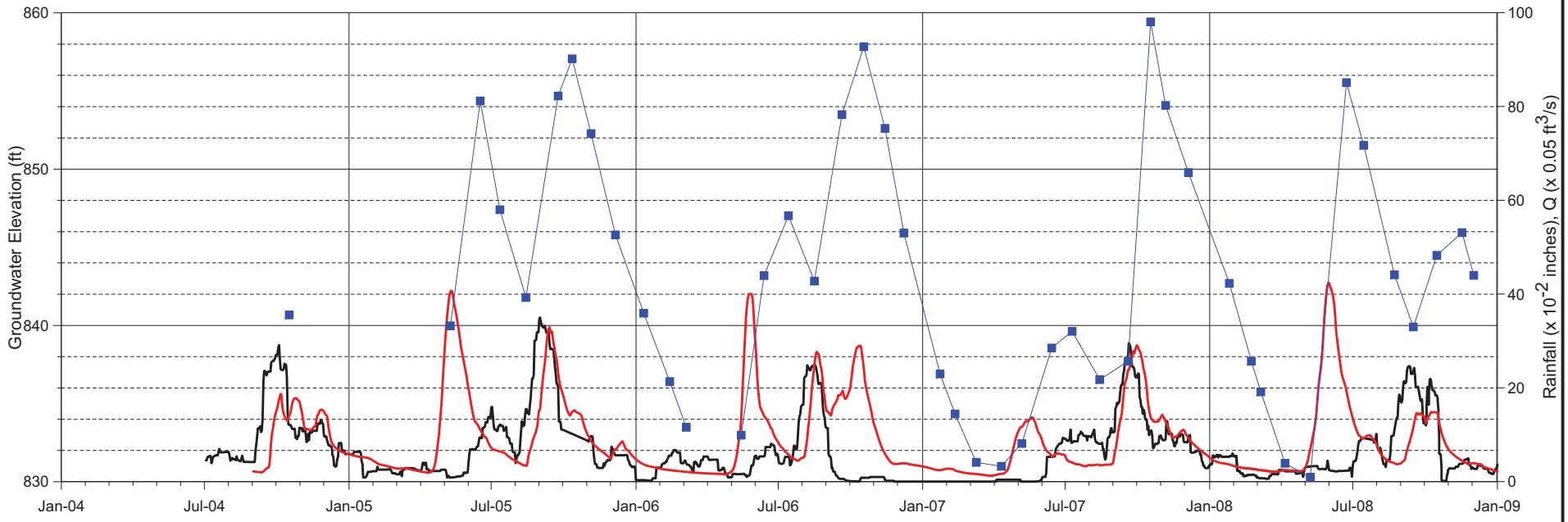


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-37



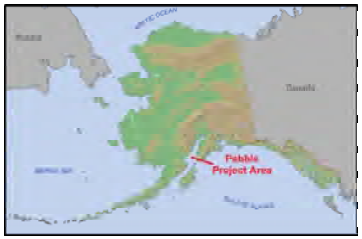
LEGEND:

Groundwater Elevation Plot Legend

- GH04-37
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

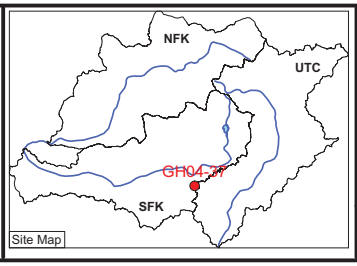
Screens (ft asl):
GH04-37 : 826.6 - 836.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 975.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-37.grf

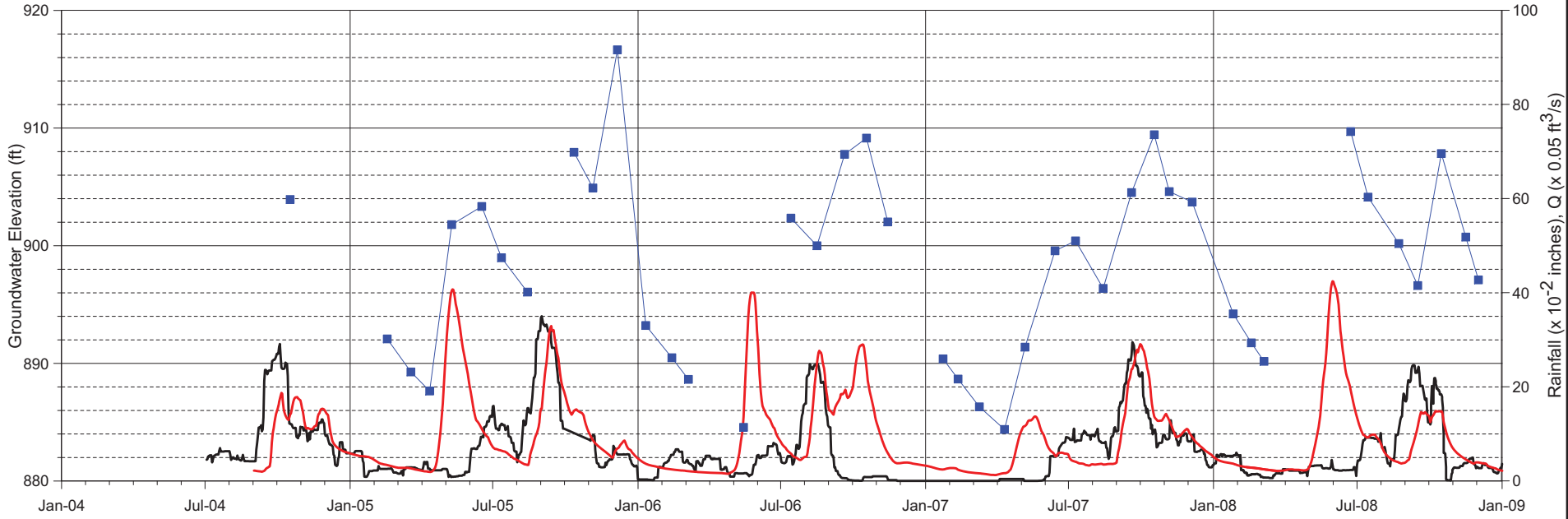


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-38



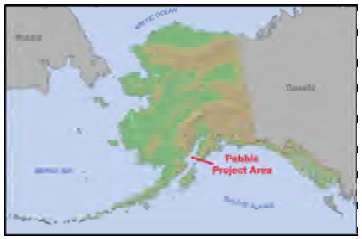
LEGEND:

Groundwater Elevation Plot Legend

- GH04-38
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

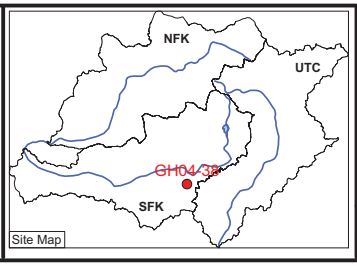
Screens (ft asl):
GH04-38 : 882.2 - 892.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 942.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-38.grf

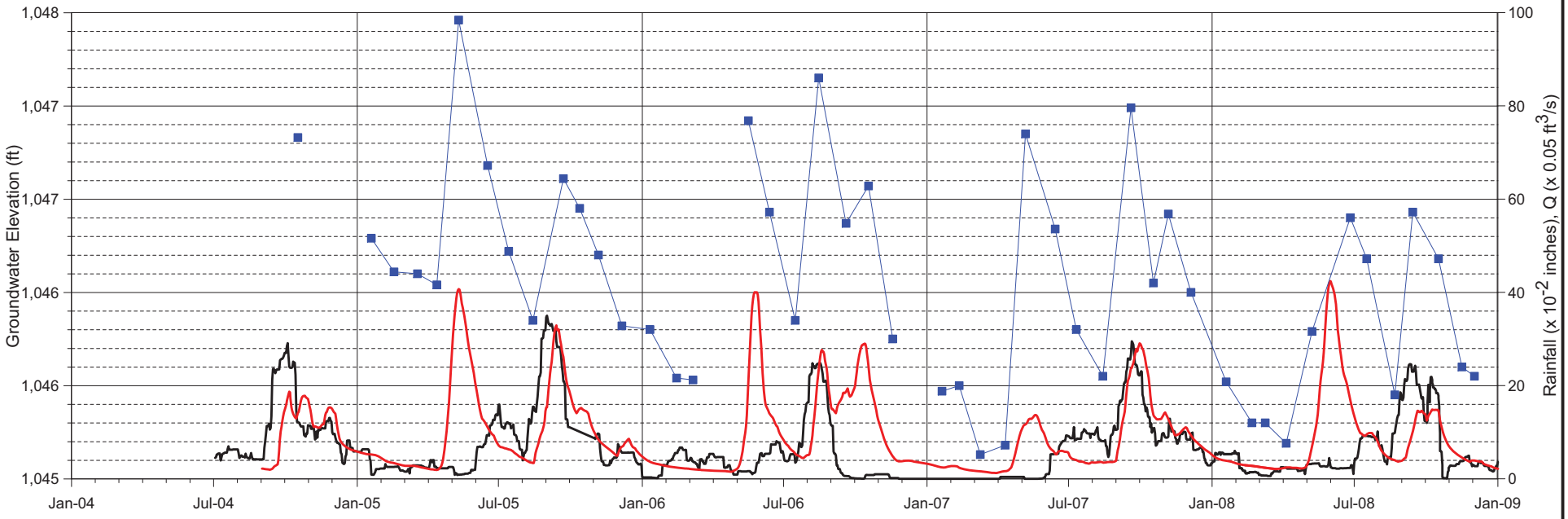


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-43



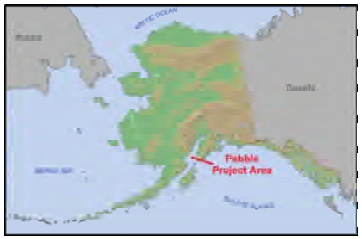
LEGEND:

Groundwater Elevation Plot Legend

- GH04-43
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

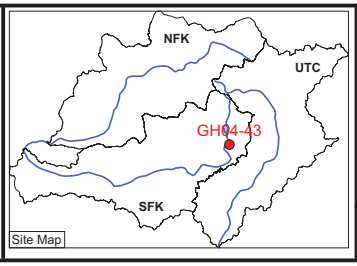
Screens (ft asl):
GH04-43 : 1020.7 - 1030.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1120.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-43.grf

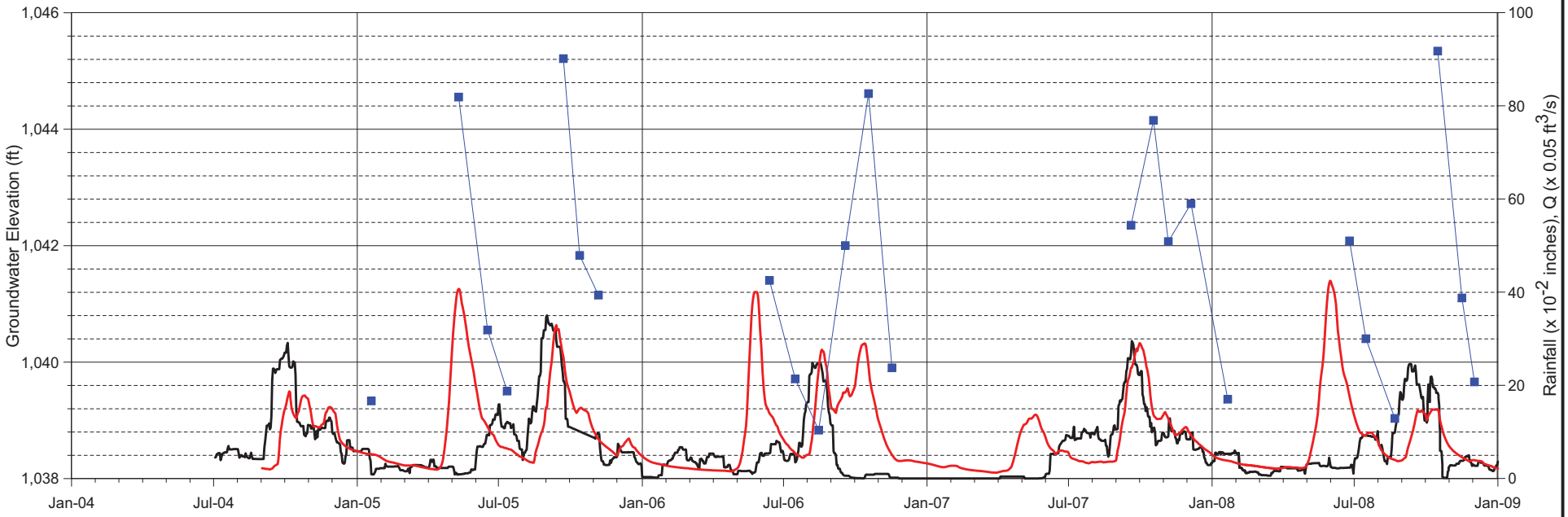


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-45A



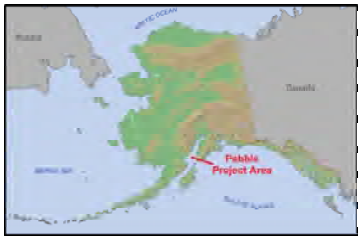
LEGEND:

Groundwater Elevation Plot Legend

- GH04-45A
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH04-45A : 1036.3 - 1047.3

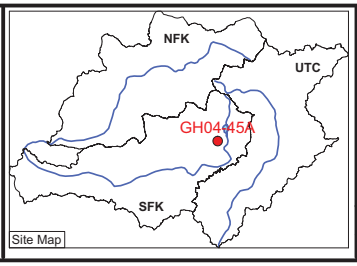


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1120.3 ft asl

GH04-45A dries seasonally during the winter, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-45A.grf

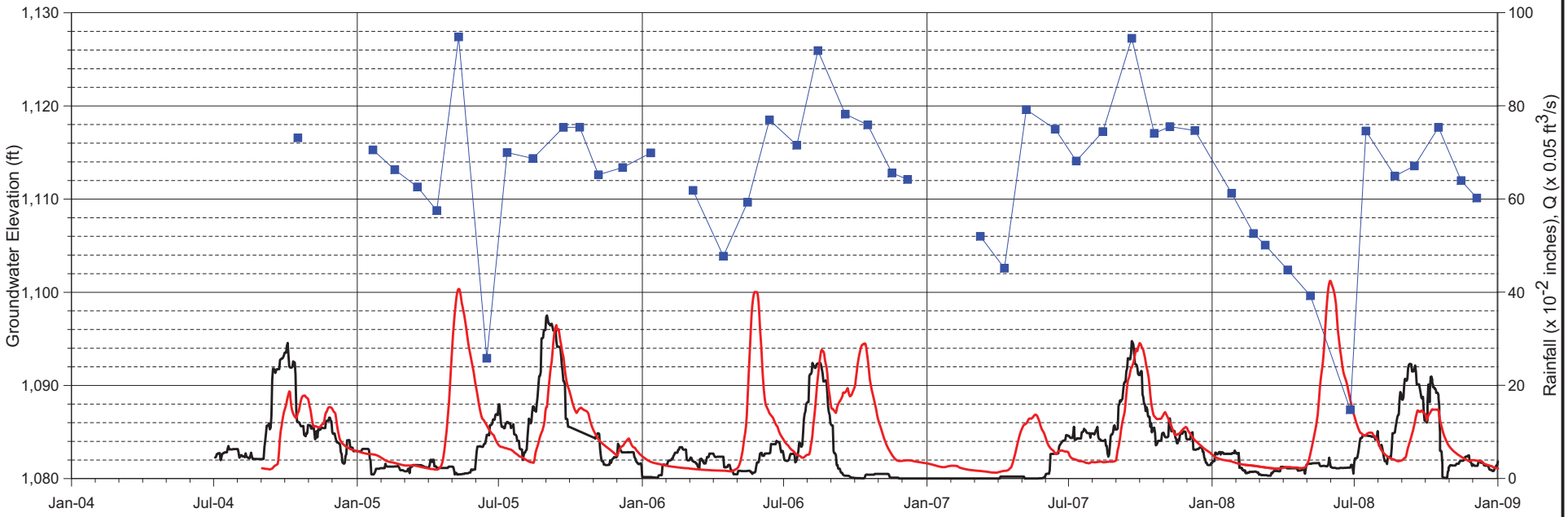


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-46



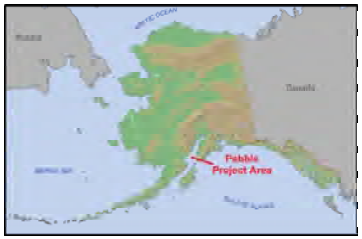
LEGEND:

Groundwater Elevation Plot Legend

- GH04-46
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

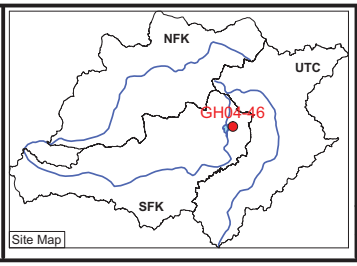
Screens (ft asl):
GH04-46 : 1057.0 - 1068.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1141 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-46.grf

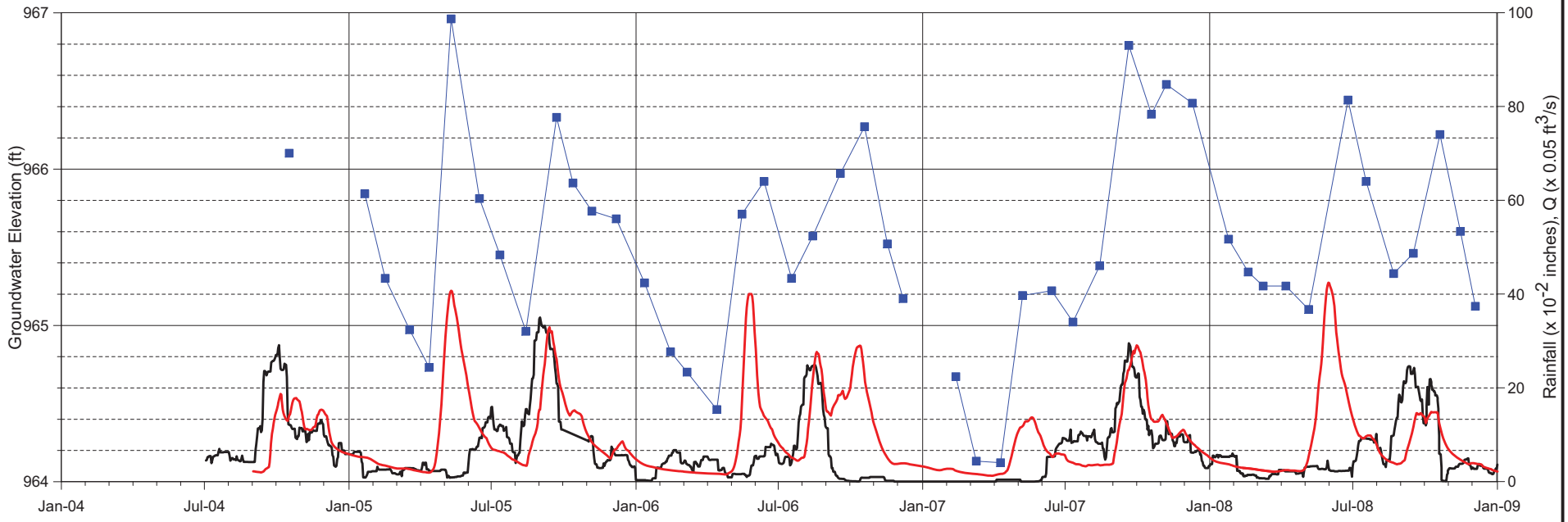


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-47



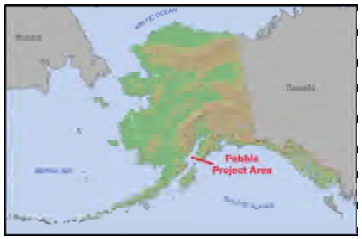
LEGEND:

Groundwater Elevation Plot Legend

- GH04-47
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

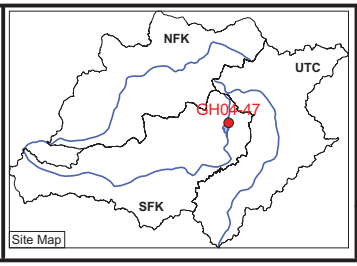
Screens (ft asl):
GH04-47 : 929.7 - 939.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 970.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-47.grf

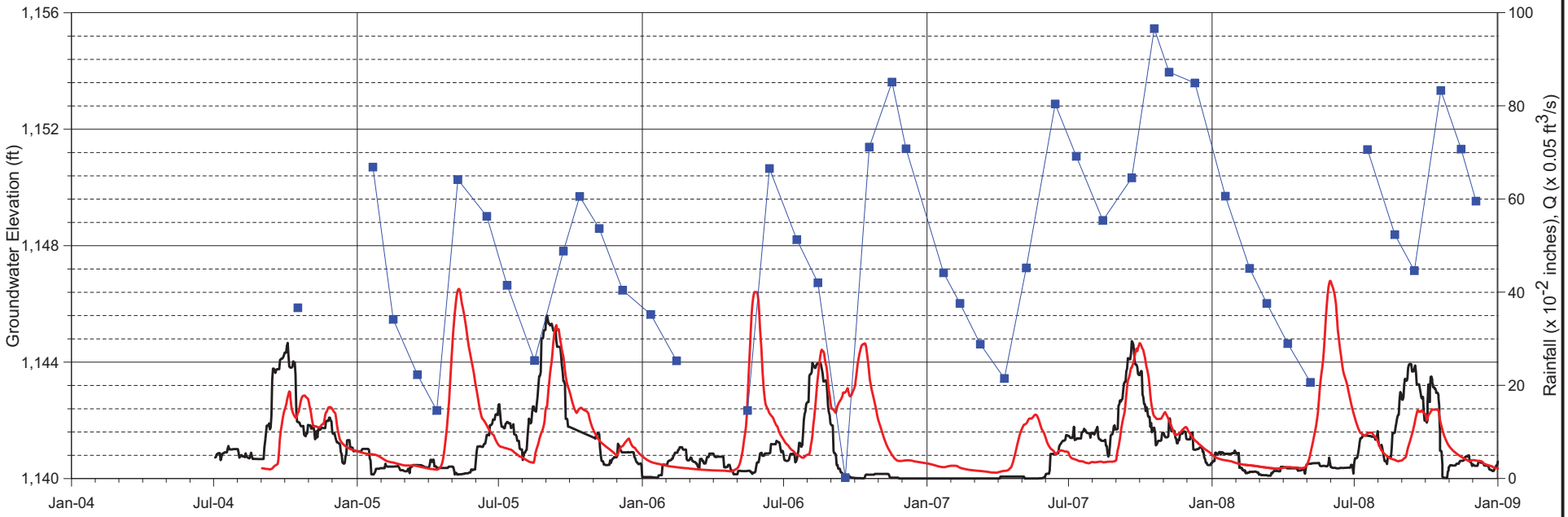


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH04-48



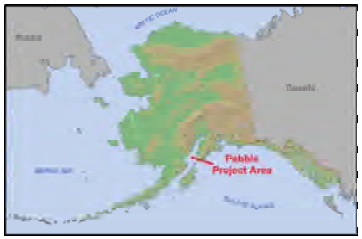
LEGEND:

Groundwater Elevation Plot Legend

- GH04-48
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

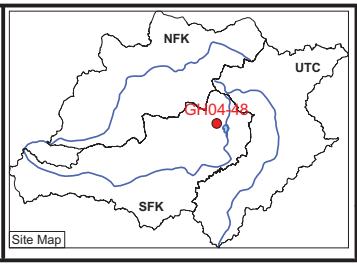
Screens (ft asl):
GH04-48 : 1131.8 - 1141.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1181.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH04-48.grf

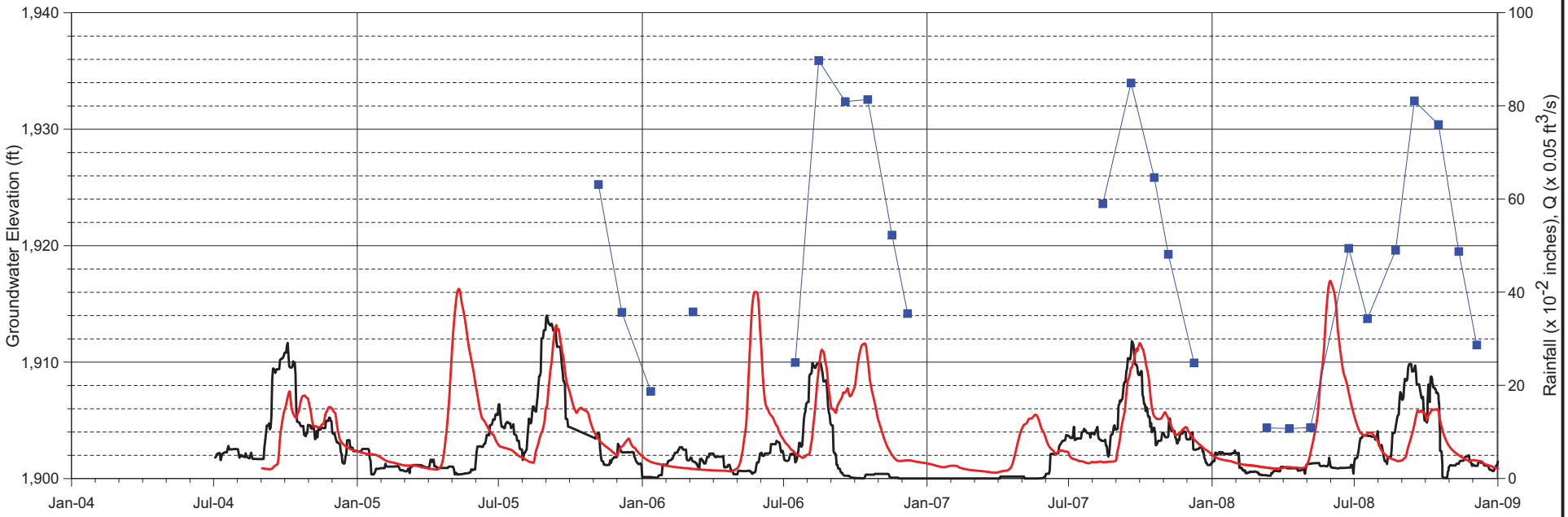


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-53



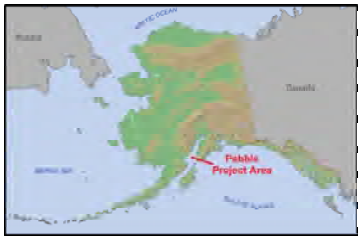
LEGEND:

Groundwater Elevation Plot Legend

- GH05-53
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH05-53 : 1911.5 - 1921.5

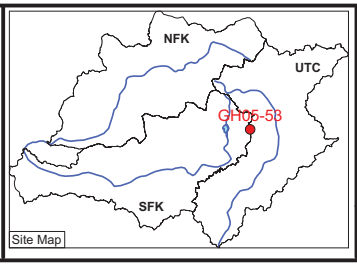


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1941.5 ft asl

GH05-53 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-53.grf

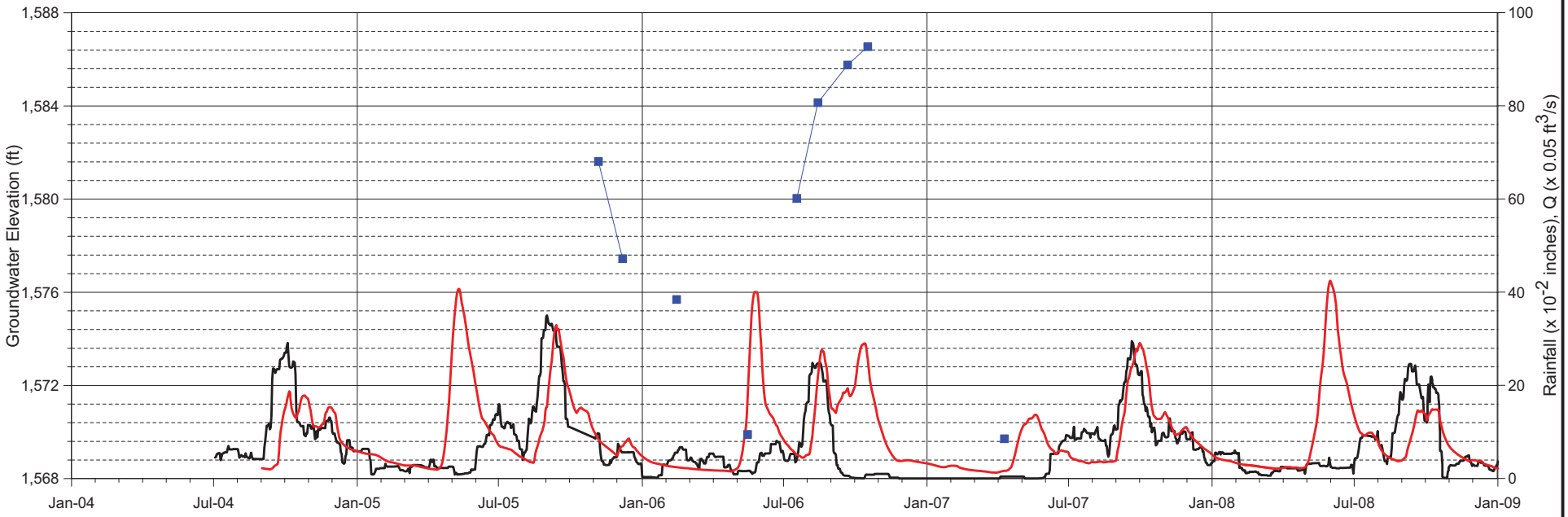


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-55



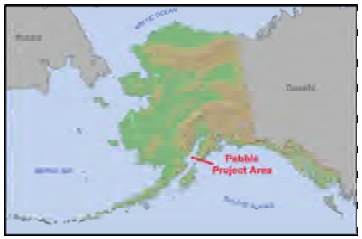
LEGEND:

Groundwater Elevation Plot Legend

- GH05-55
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH05-55 : 1575.6 - 1585.1

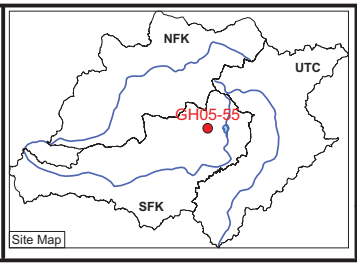


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1588.6 ft asl

GH05-55 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-55.grf

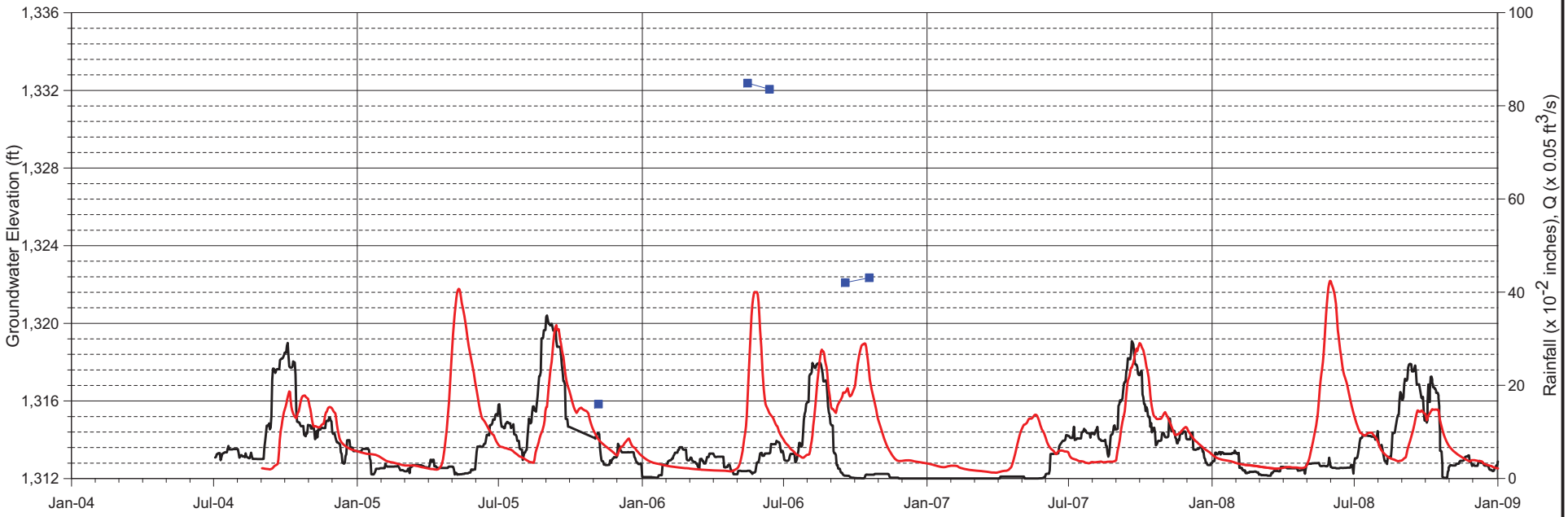


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-56



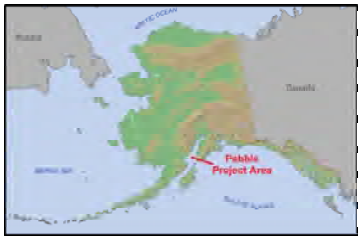
LEGEND:

Groundwater Elevation Plot Legend

- GH05-56
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH05-56 : 1311.6 - 1321.6

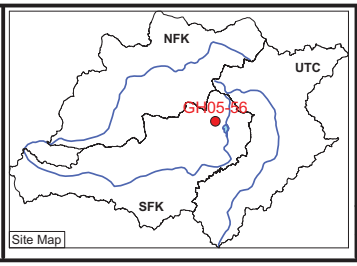


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1356.1 ft asl

GH05-56 dries seasonally during winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-56.grf

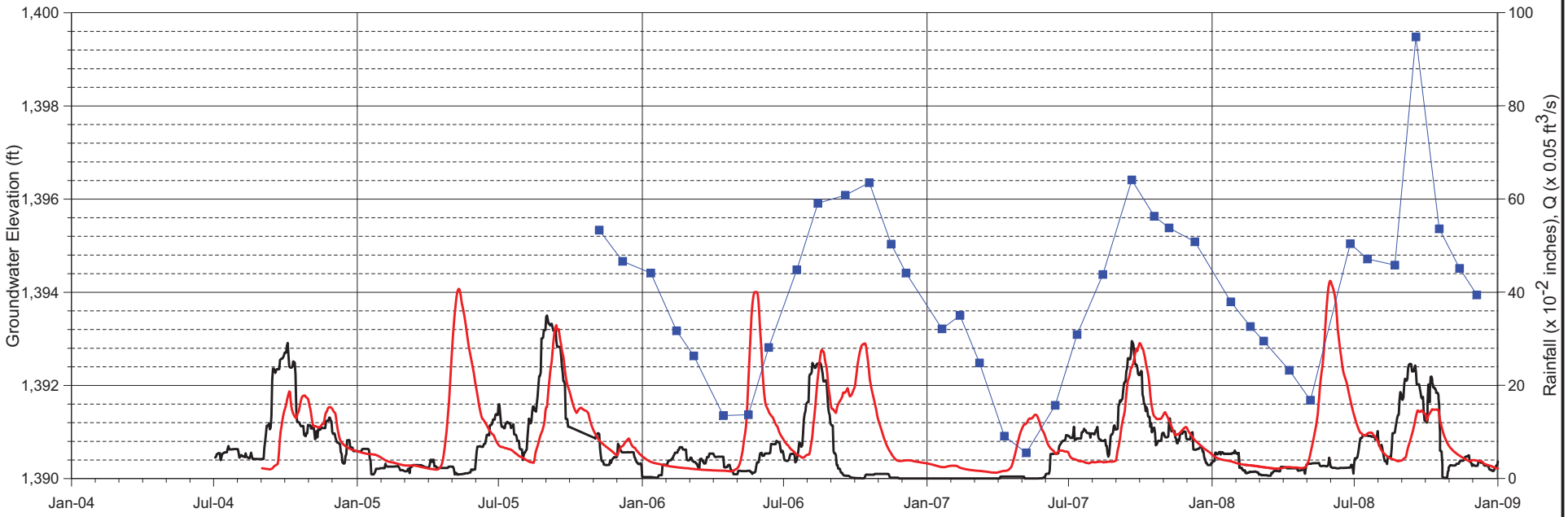


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-57



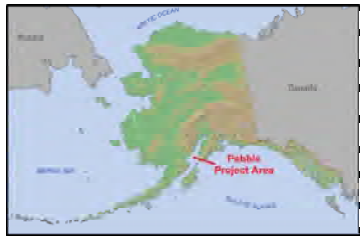
LEGEND:

Groundwater Elevation Plot Legend

- GH05-57
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

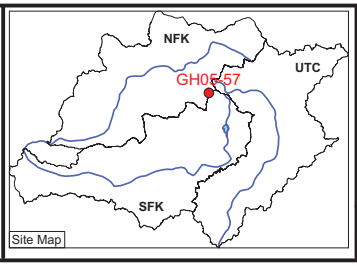
Screens (ft asl):
GH05-57 : 1368.9 - 1379.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1405.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-57.grf

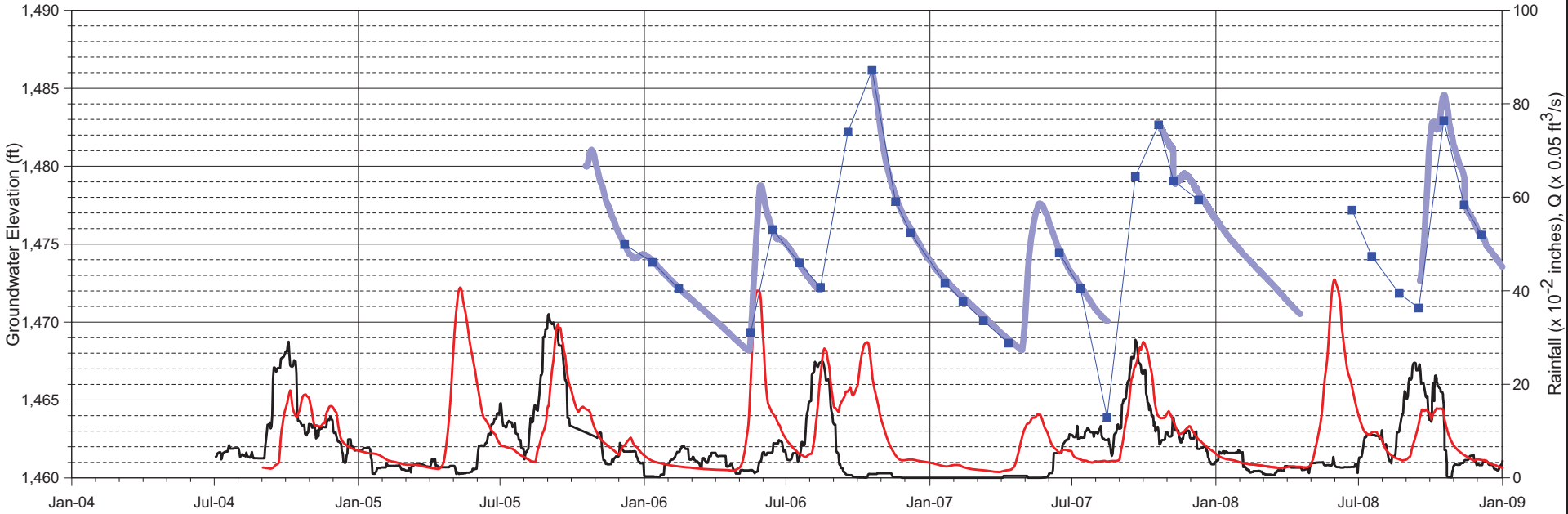


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-58



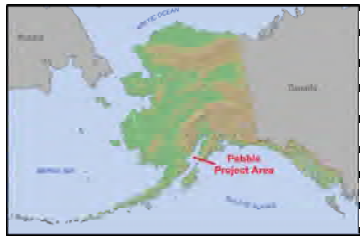
LEGEND:

Groundwater Elevation Plot Legend

- GH05-58
- GH05-58(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

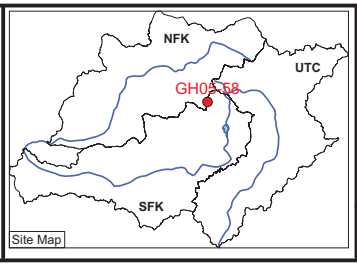
Screens (ft asl):
GH05-58 : 1465.1 - 1475.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1503 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-58.grf

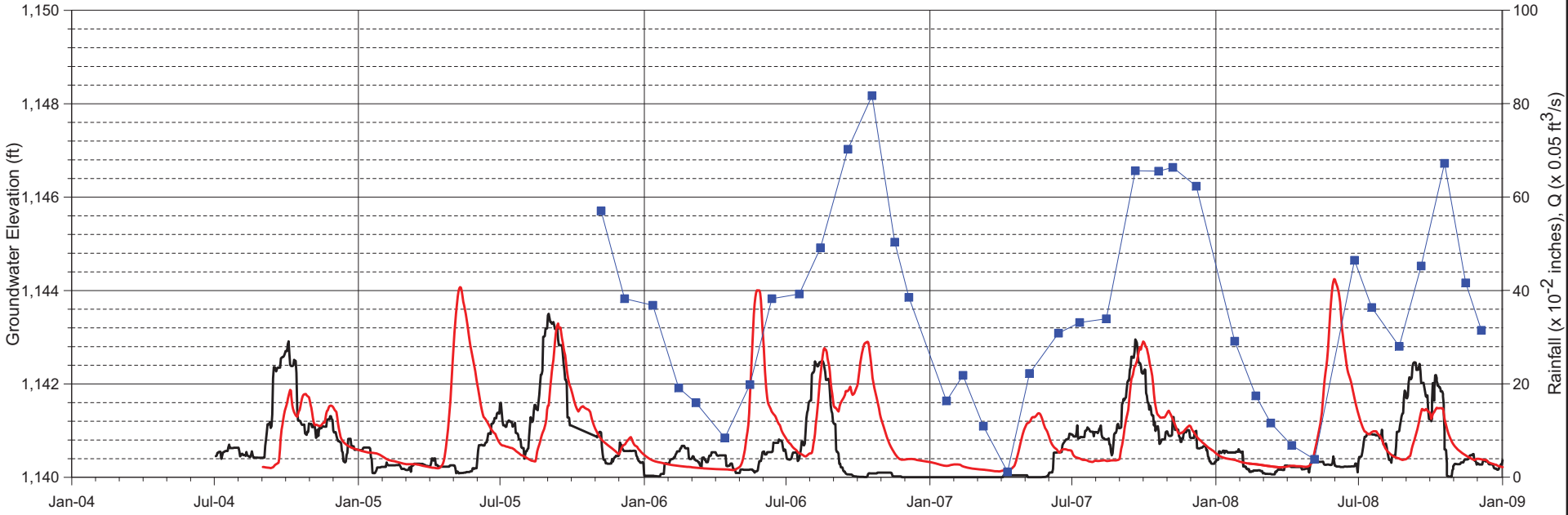


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-59



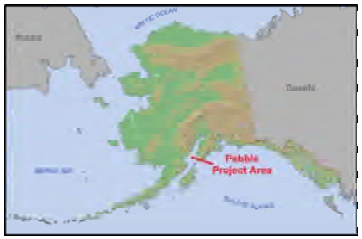
LEGEND:

Groundwater Elevation Plot Legend

- GH05-59
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

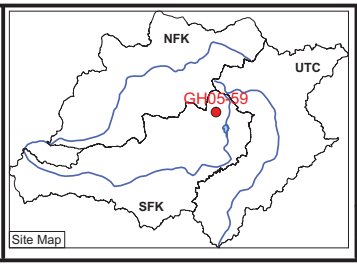
Screens (ft asl):
GH05-59 : 1103.9 - 1113.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1181.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-59.grf

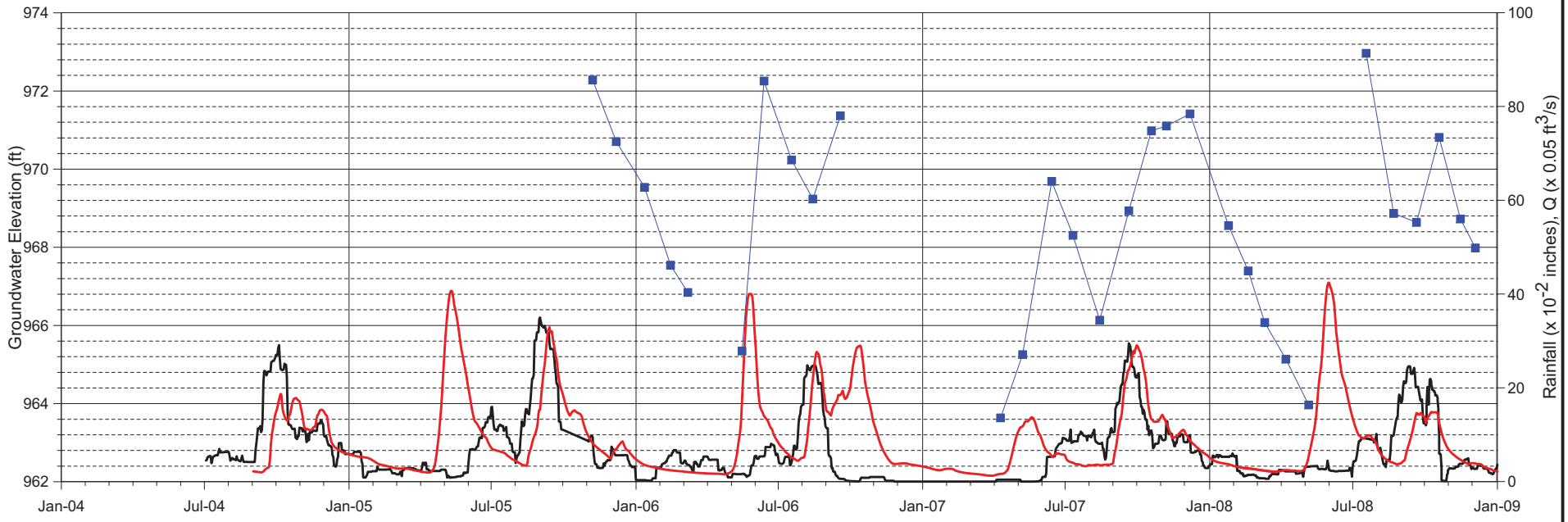


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-61



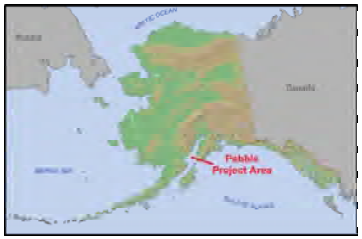
LEGEND:

Groundwater Elevation Plot Legend

- GH05-61
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

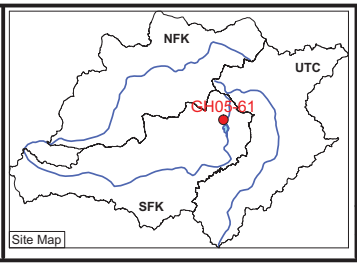
Screens (ft asl):
GH05-61 : 804.8 - 813.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 973.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-61.grf

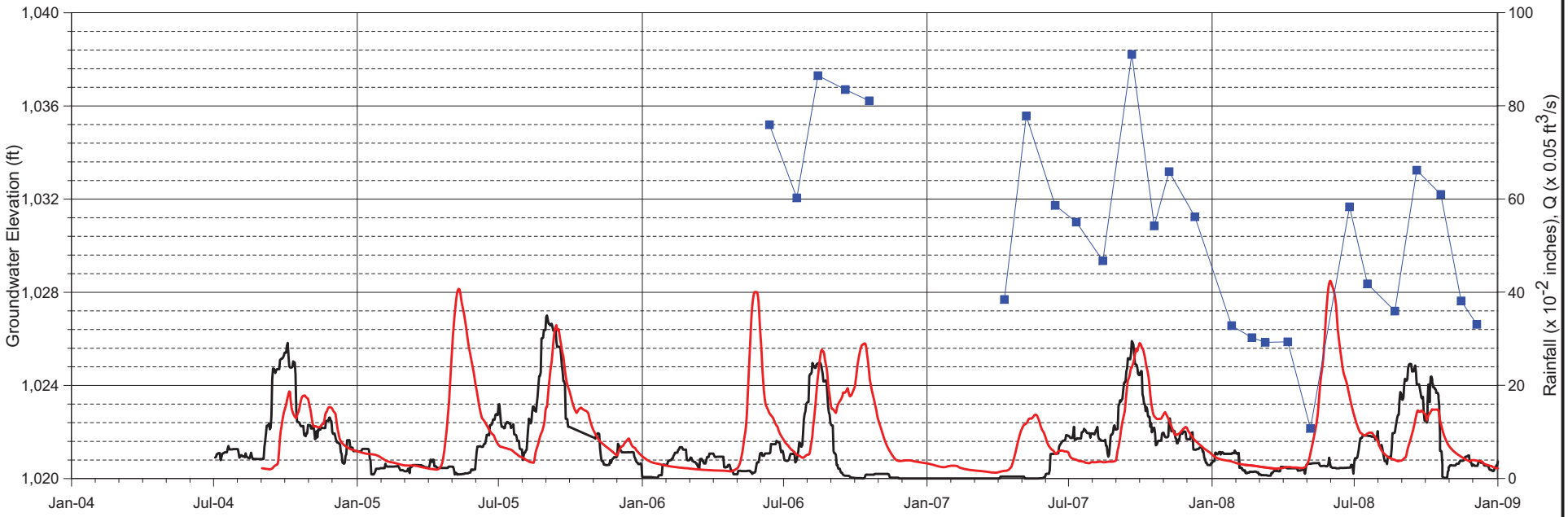


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-63



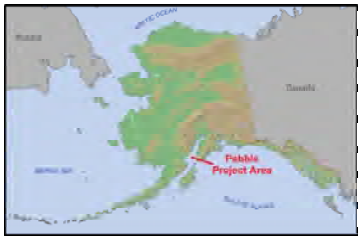
LEGEND:

Groundwater Elevation Plot Legend

- GH05-63
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

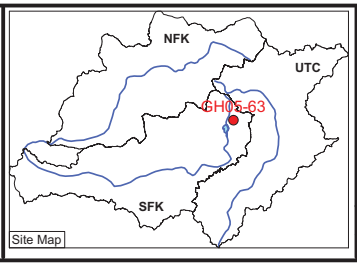
Screens (ft asl):
GH05-63 : 979.3 - 989.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1038.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-63.grf

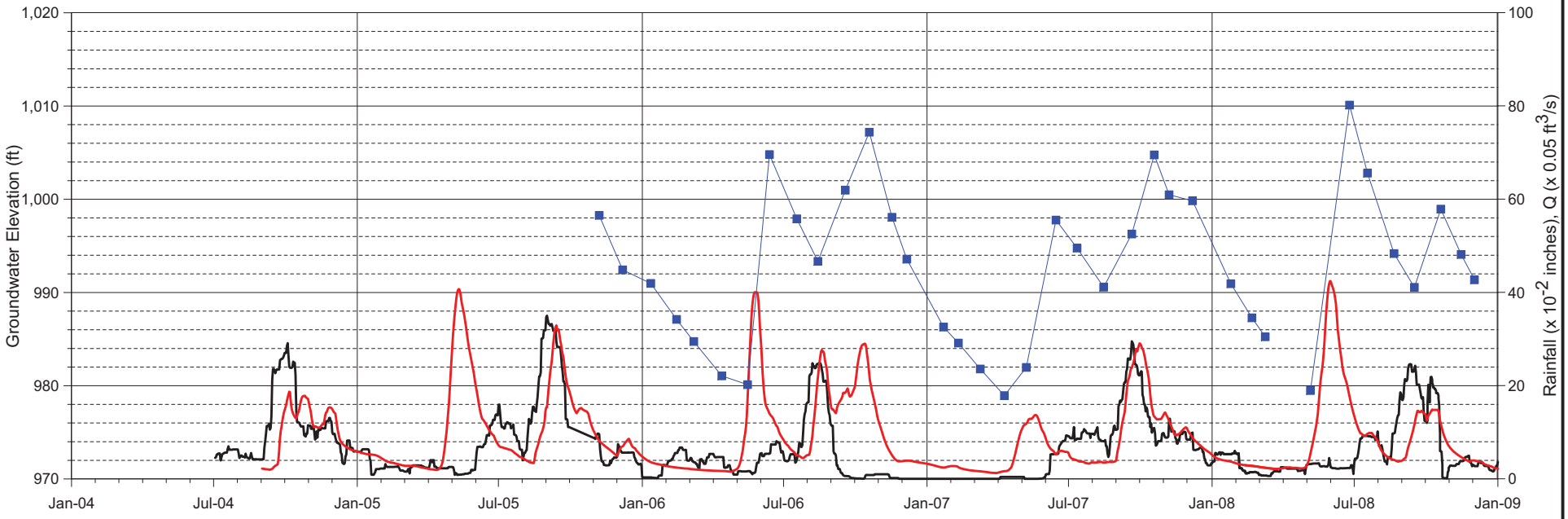


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH05-64



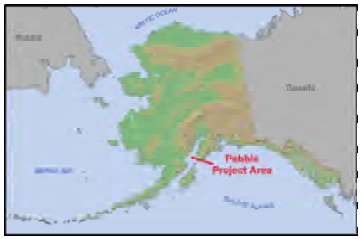
LEGEND:

Groundwater Elevation Plot Legend

- GH05-64
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

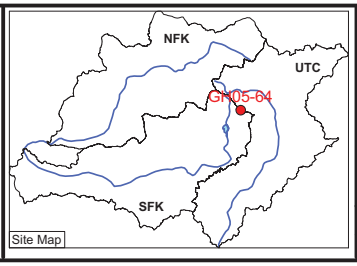
Screens (ft asl):
GH05-64 : 956.9 - 967.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1016.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH05-64.grf

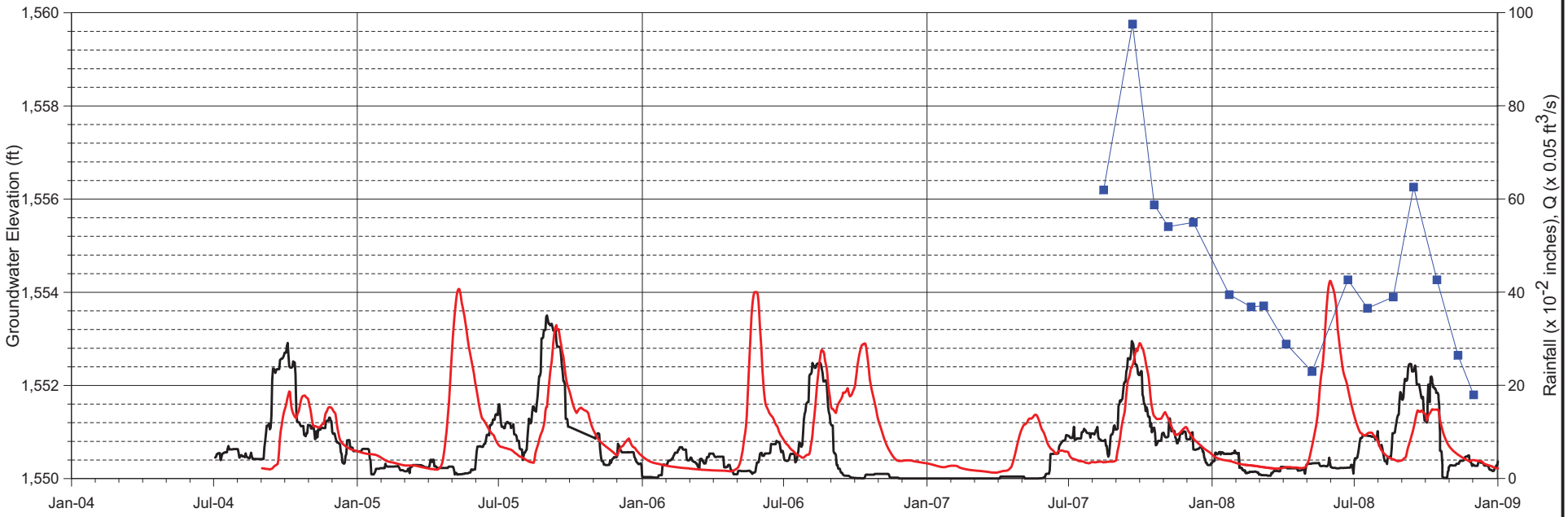


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-65



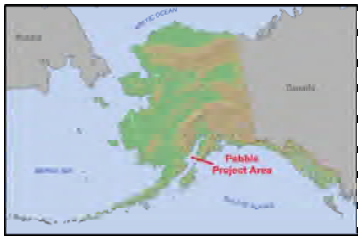
LEGEND:

Groundwater Elevation Plot Legend

- GH06-65
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

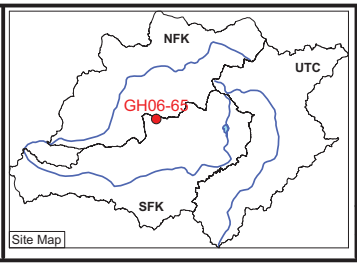
Screens (ft asl):
GH06-65 : 1550.3 - 1560.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1643.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-65.grf

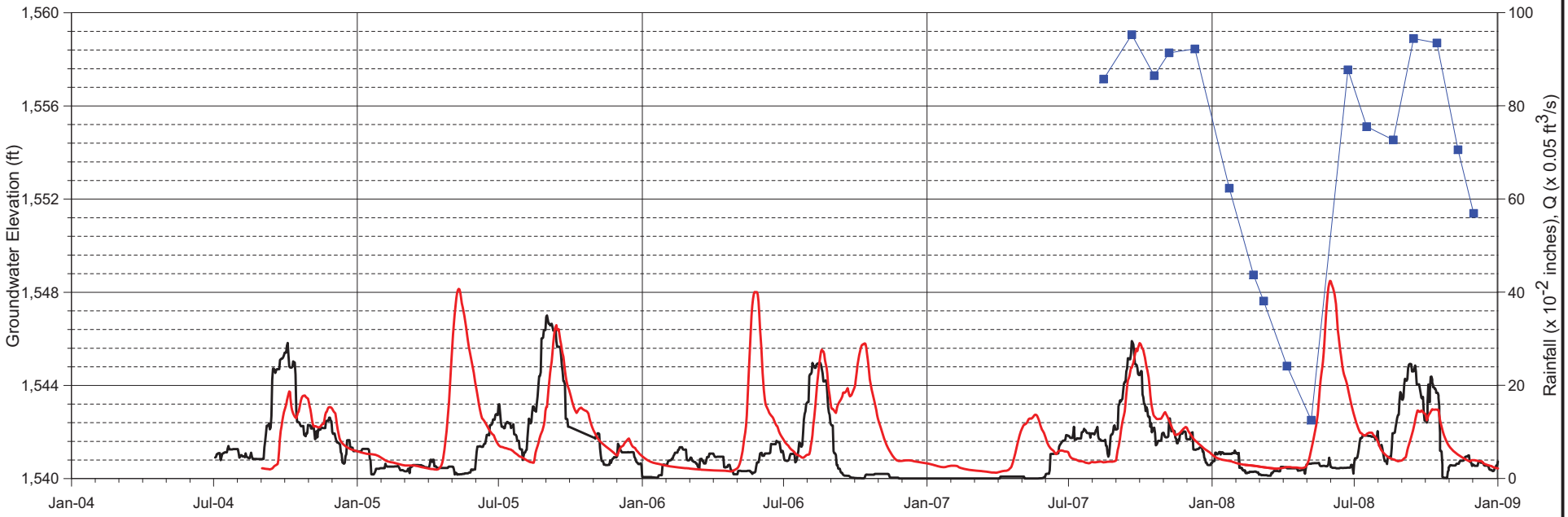


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-66



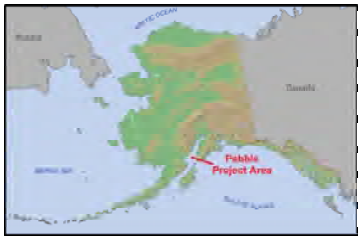
LEGEND:

Groundwater Elevation Plot Legend

- GH06-66
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

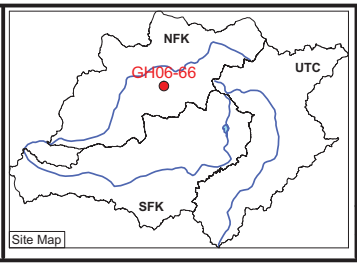
Screens (ft asl):
GH06-66 : 1513.6 - 1523.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1559.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-66.grf

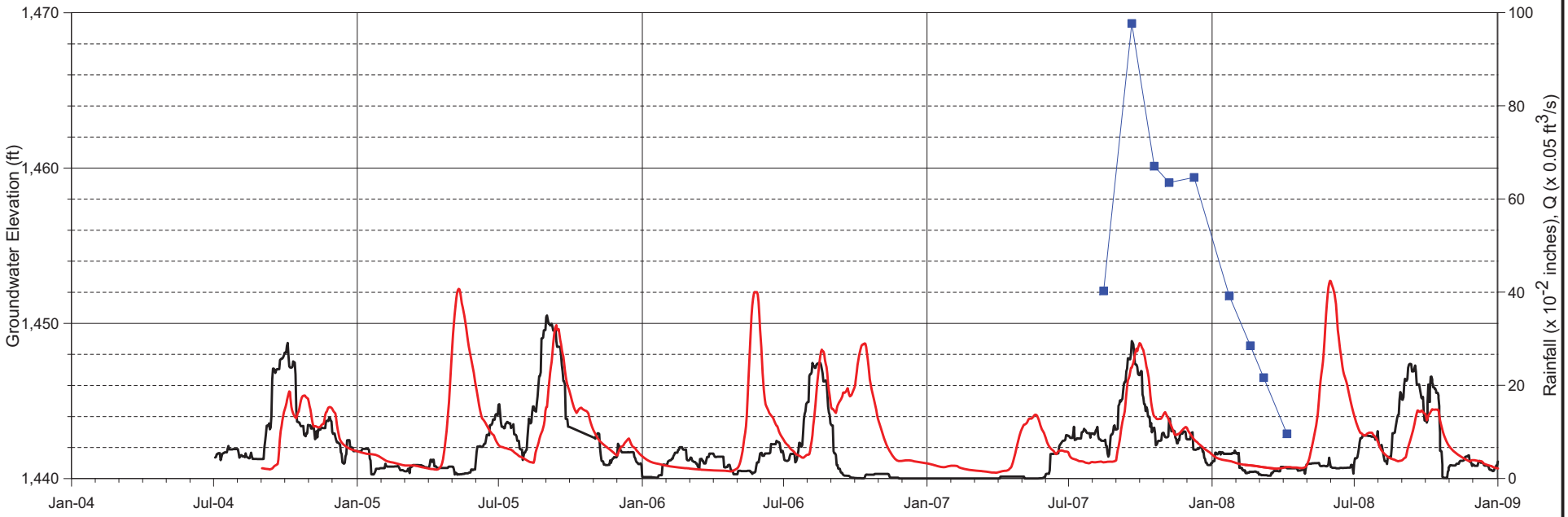


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-67



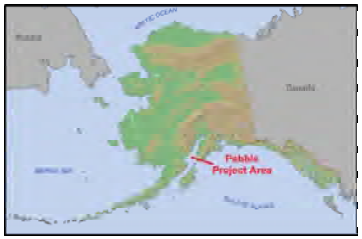
LEGEND:

Groundwater Elevation Plot Legend

- GH06-67
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH06-67 : 1433.7 - 1443.7

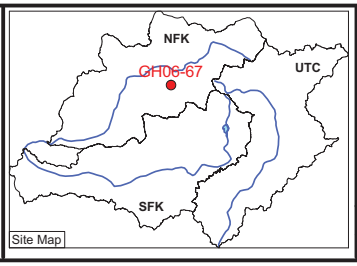


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1476.7 ft asl

The top section of riser broke in 2008, water levels no longer possible to record.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-67.grf

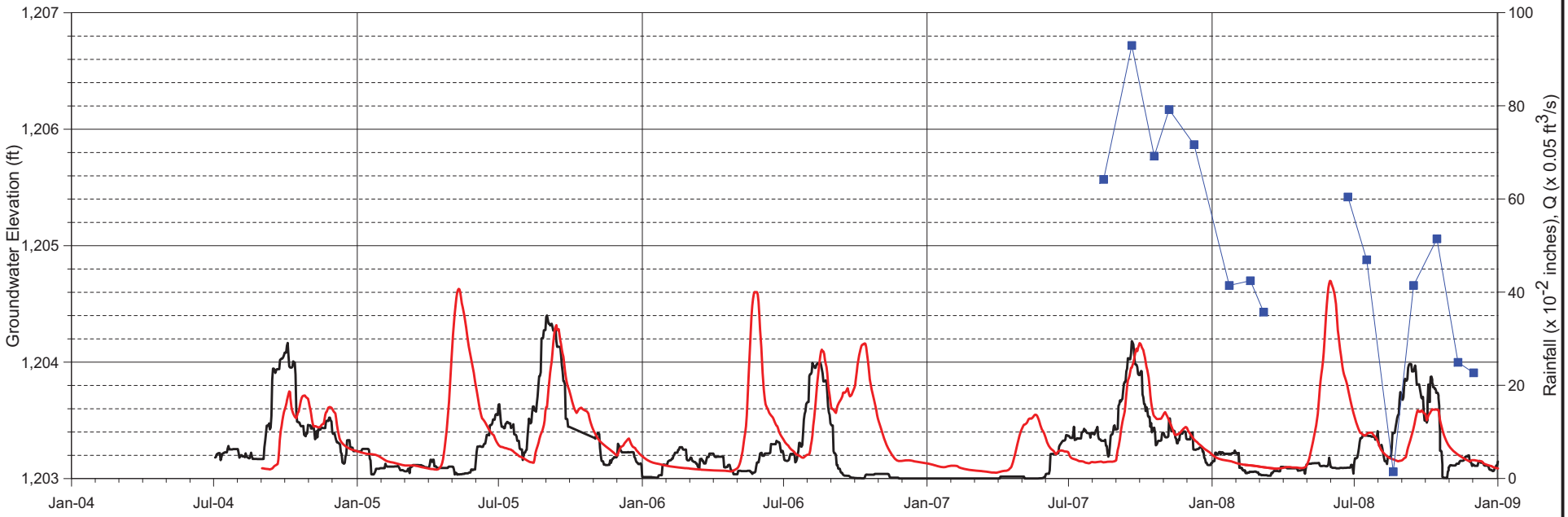


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-68



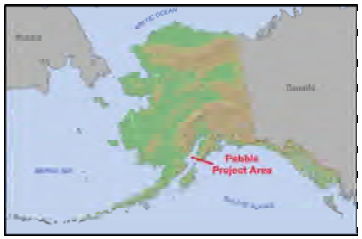
LEGEND:

Groundwater Elevation Plot Legend

- GH06-68
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

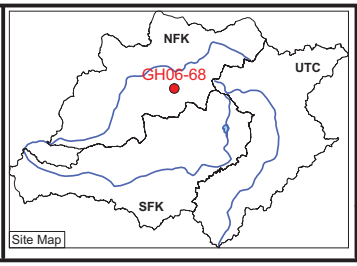
Screens (ft asl):
GH06-68 : 1092.7 - 1112.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1208.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-68.grf

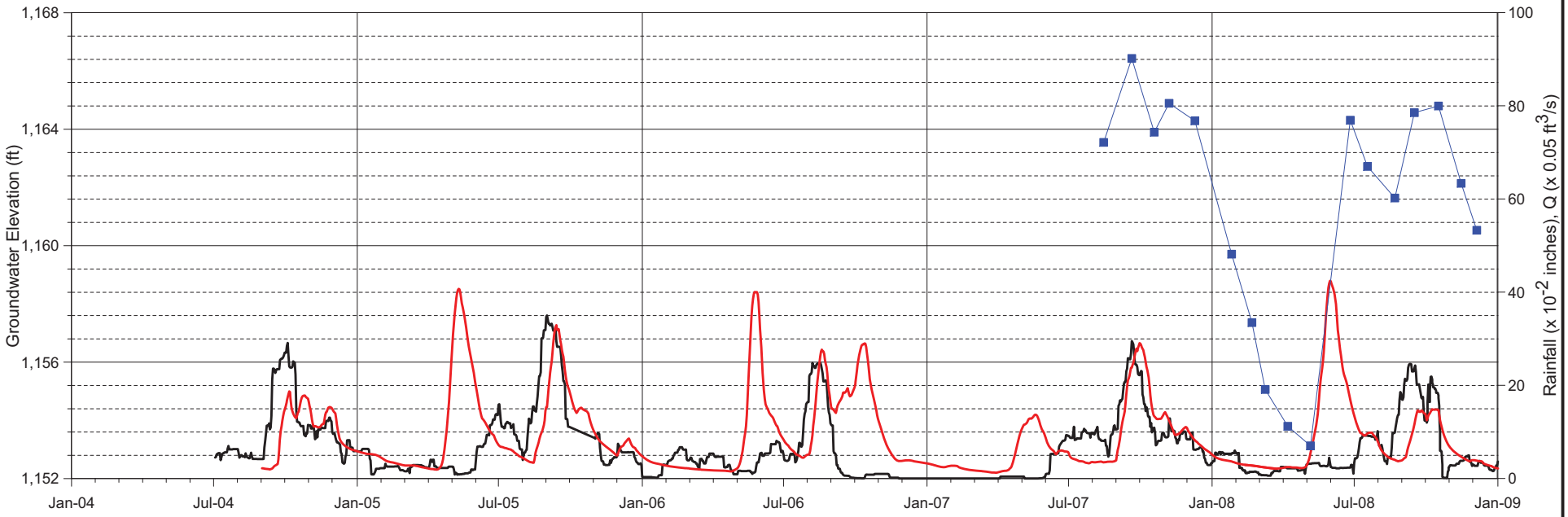


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-74



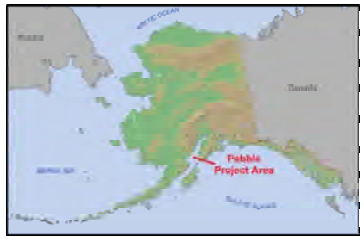
LEGEND:

Groundwater Elevation Plot Legend

- GH06-74
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

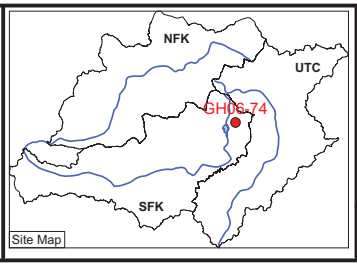
Screens (ft asl):
GH06-74 : 1147.9 - 1157.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1191.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-74.grf

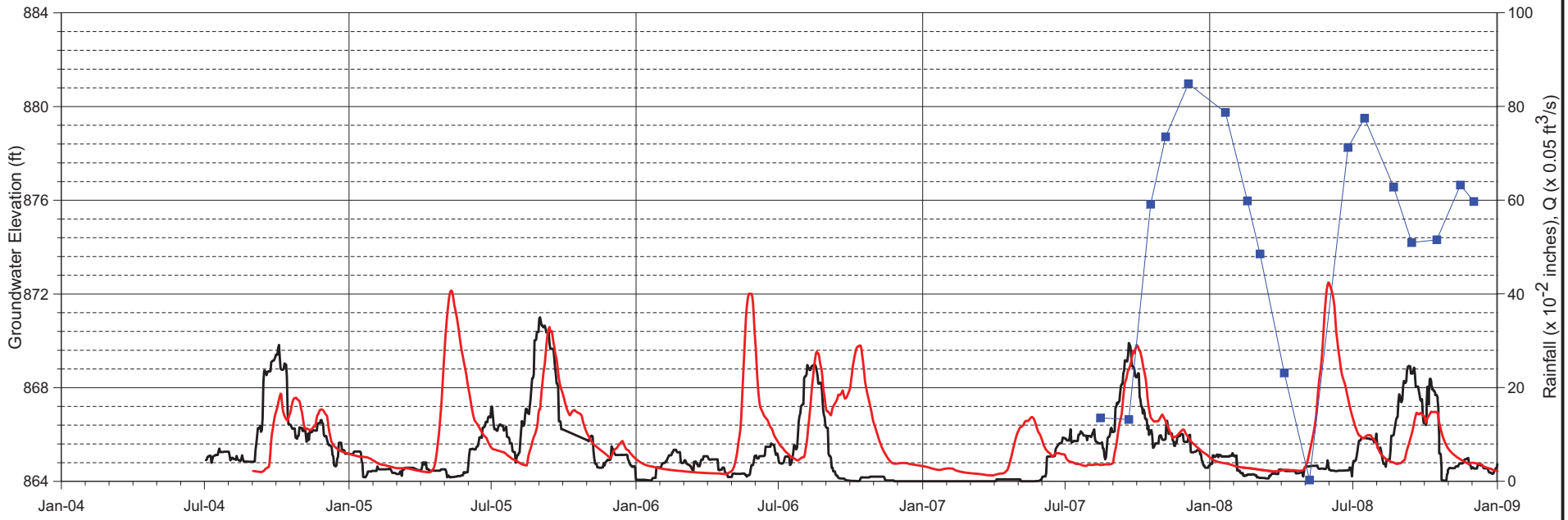


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-75



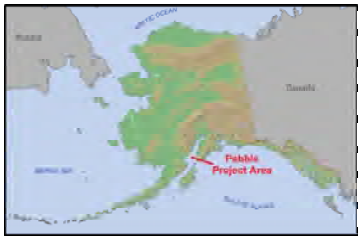
LEGEND:

Groundwater Elevation Plot Legend

- GH06-75
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

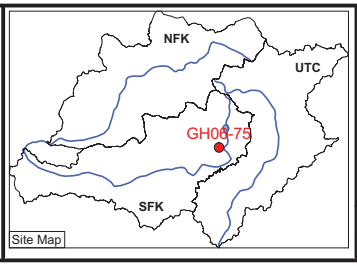
Screens (ft asl):
GH06-75 : 848.4 - 868.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1018.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-75.grf

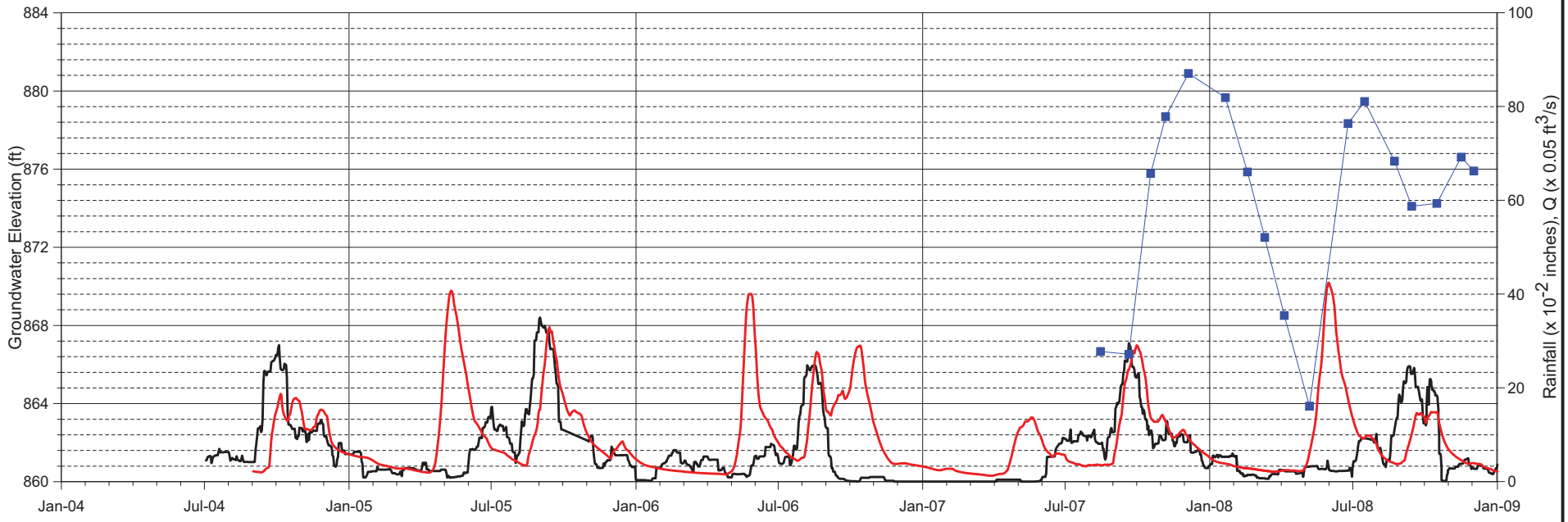


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-76



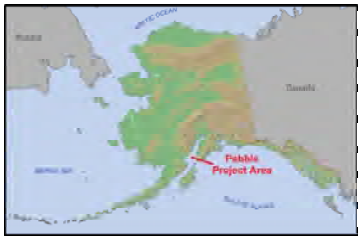
LEGEND:

Groundwater Elevation Plot Legend

- GH06-76
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

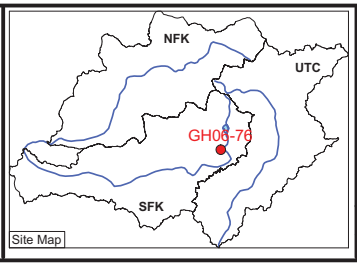
Screens (ft asl):
GH06-76 : 859.7 - 869.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 981.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-76.grf

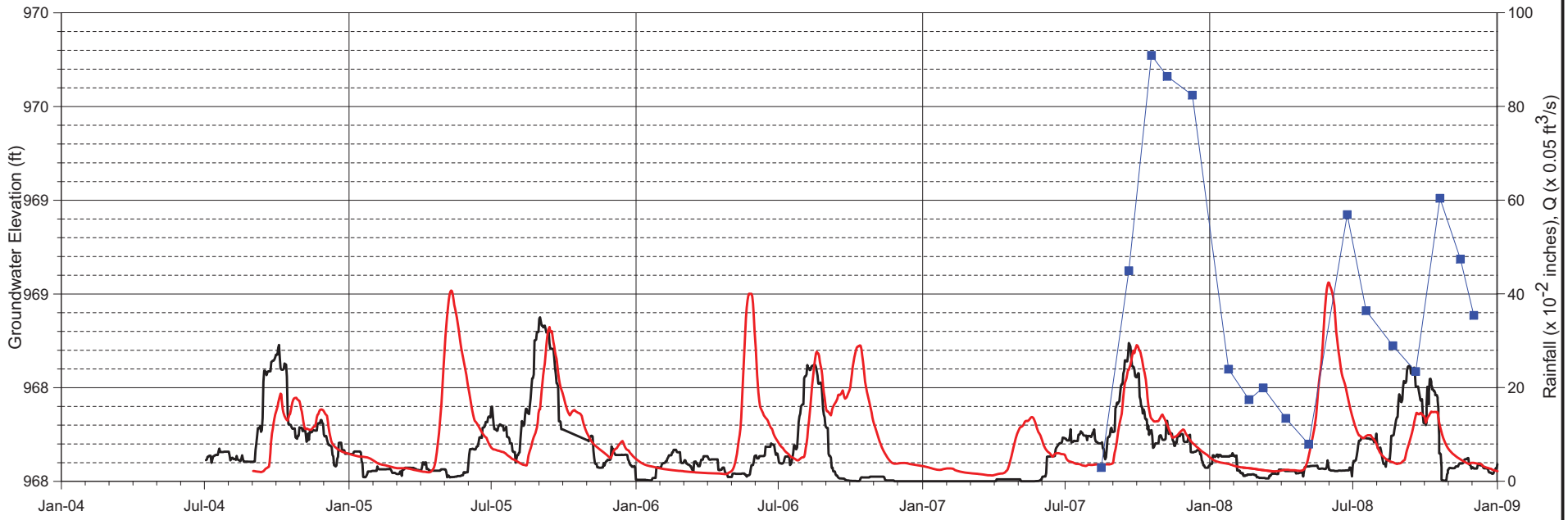


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH06-80



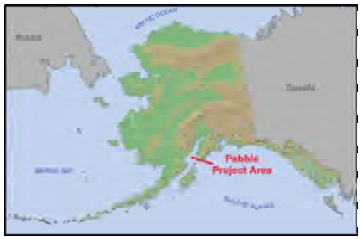
LEGEND:

Groundwater Elevation Plot Legend

- GH06-80
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

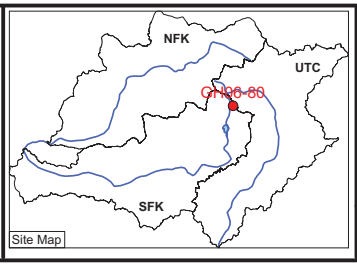
Screens (ft asl):
GH06-80 : 963.1 - 973.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1011.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH06-80.grf

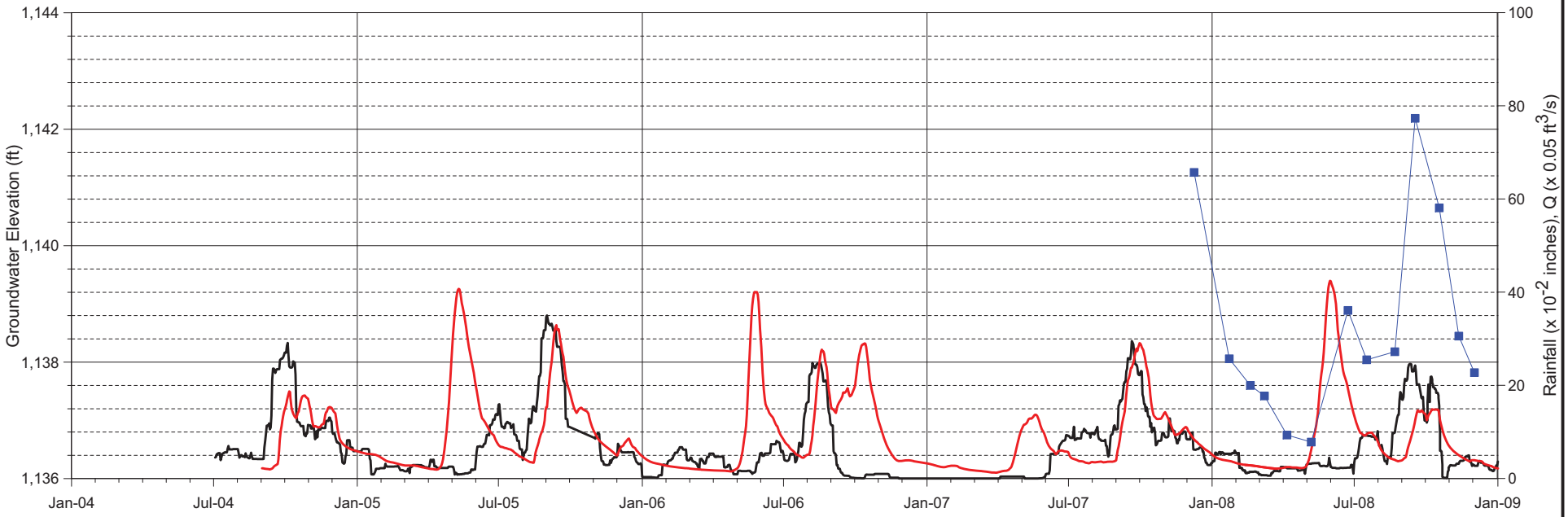


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-101



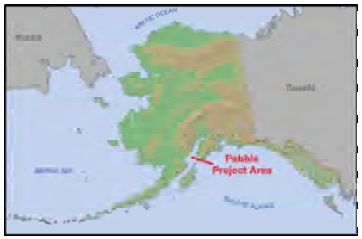
LEGEND:

Groundwater Elevation Plot Legend

- GH07-101
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

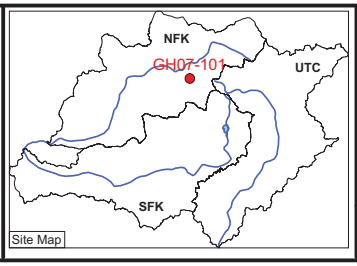
Screens (ft asl):
GH07-101 : 1136.4 - 1146.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1161.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-101.grf

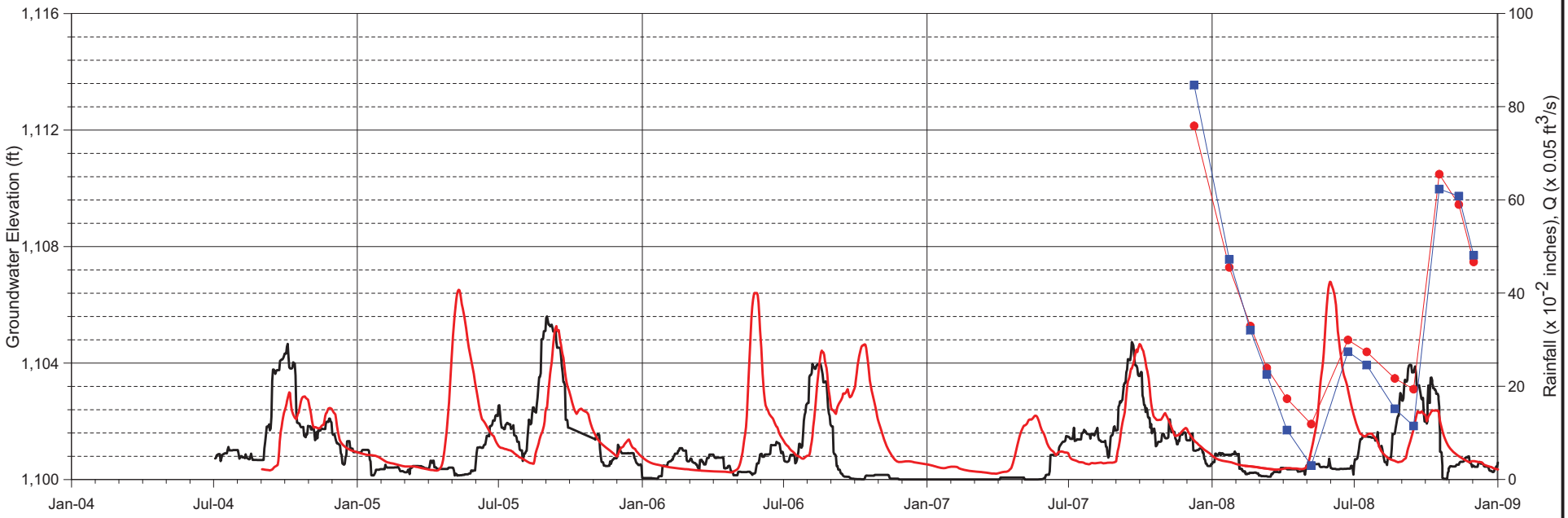


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-102



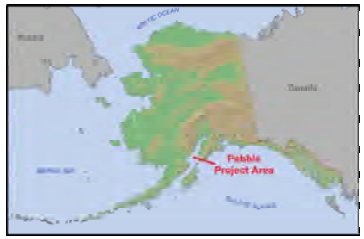
LEGEND:

Groundwater Elevation Plot Legend

- GH07-102S
- GH07-102D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

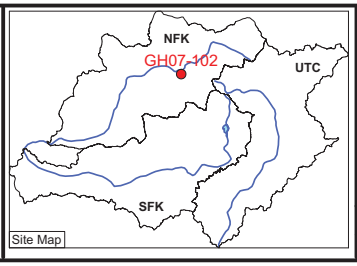
Screens (ft asl):
GH07-102S : 1099.8 - 1109.8
GH07-102D : 1039.8 - 1049.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1139.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-102.grf

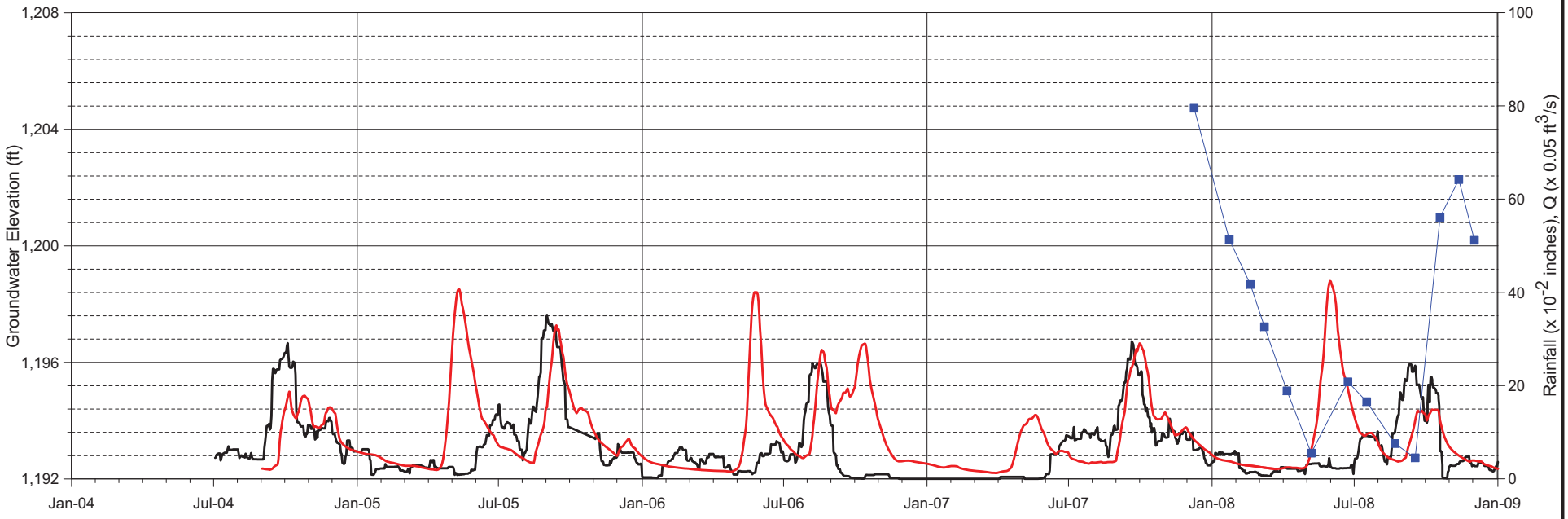


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-103



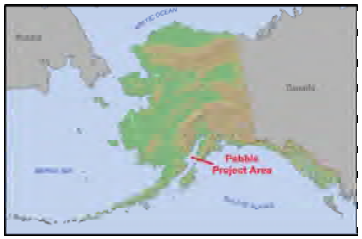
LEGEND:

Groundwater Elevation Plot Legend

- GH07-103D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH07-103S : 1208.3 - 1218.3
GH07-103D : 1149.3 - 1159.3

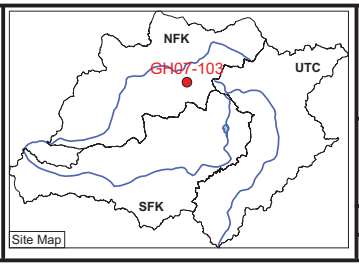


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1234.3 ft asl

GH07-103S was dry for most measurement periods, therefore few water levels were recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-103.grf

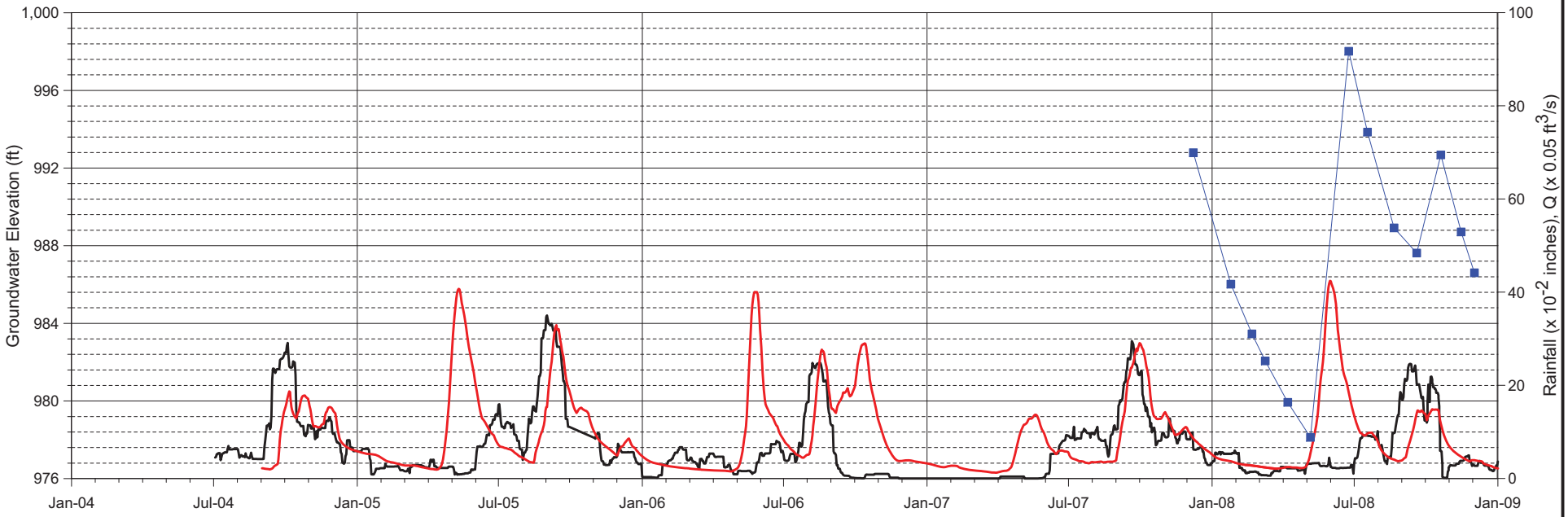


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-104



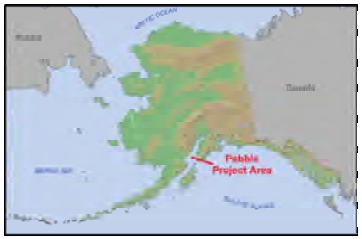
LEGEND:

Groundwater Elevation Plot Legend

- GH07-104
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

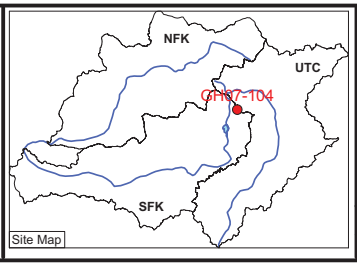
Screens (ft asl):
GH07-104 : 811.4 - 821.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 996.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-104.grf

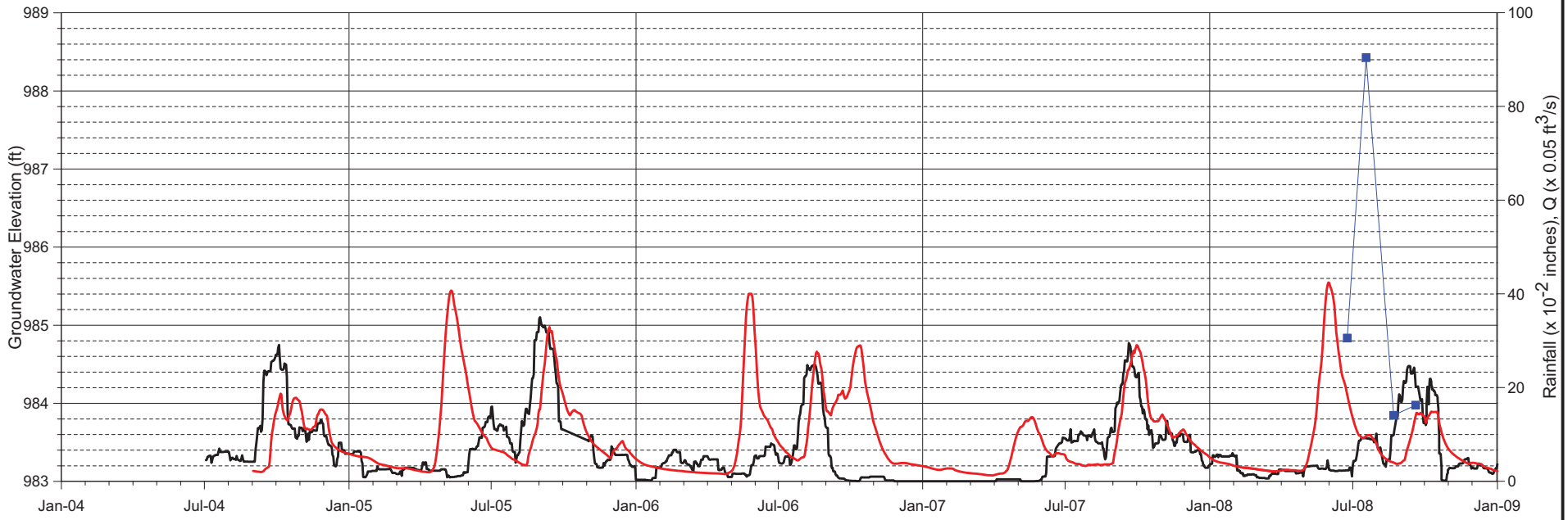


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-105



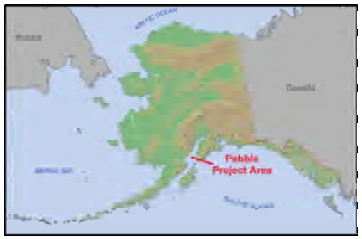
LEGEND:

Groundwater Elevation Plot Legend

- GH07-105
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

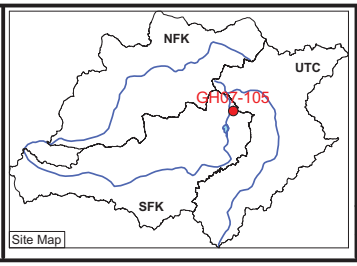
Screens (ft asl):
GH07-105 : 825.8 - 835.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 988.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-105.grf

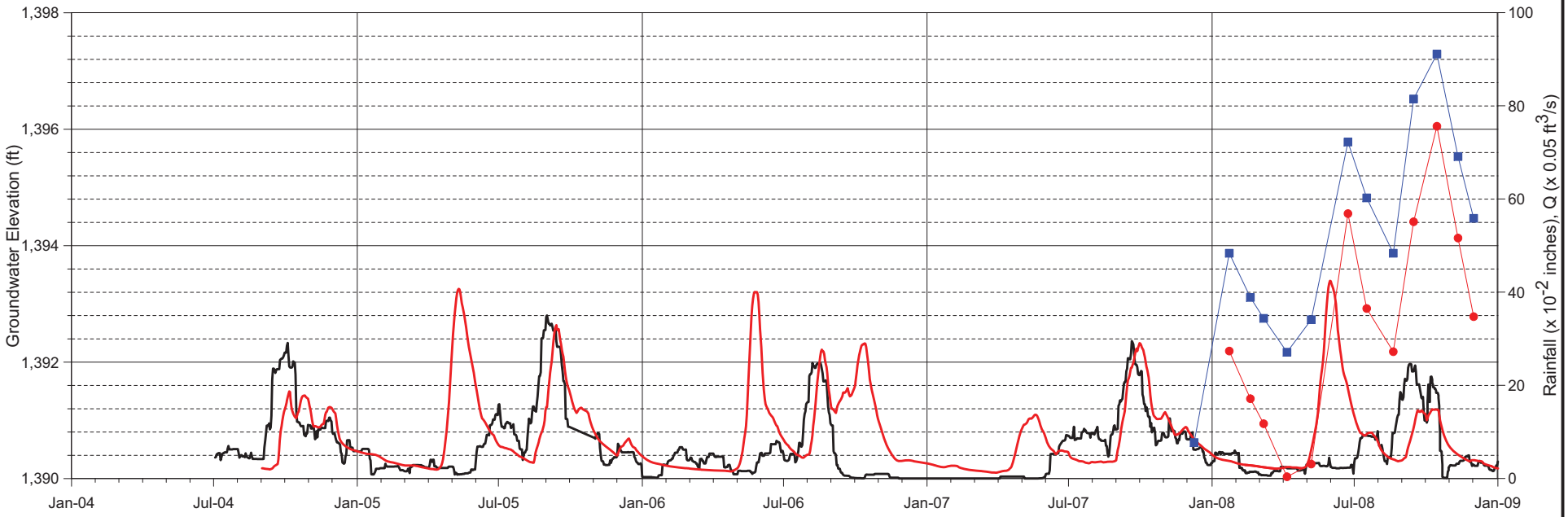


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-82



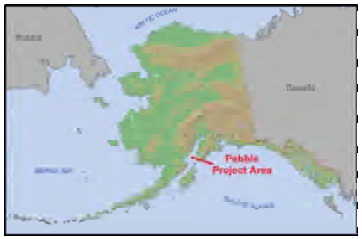
LEGEND:

Groundwater Elevation Plot Legend

- GH07-82S
- GH07-82D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

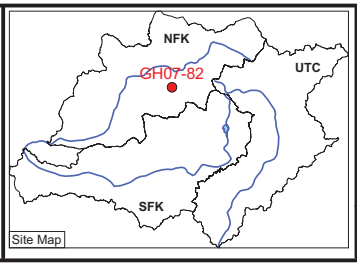
Screens (ft asl):
GH07-82S : 1355.9 - 1365.9
GH07-82D : 1273.8 - 1283.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1400.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-82.grf

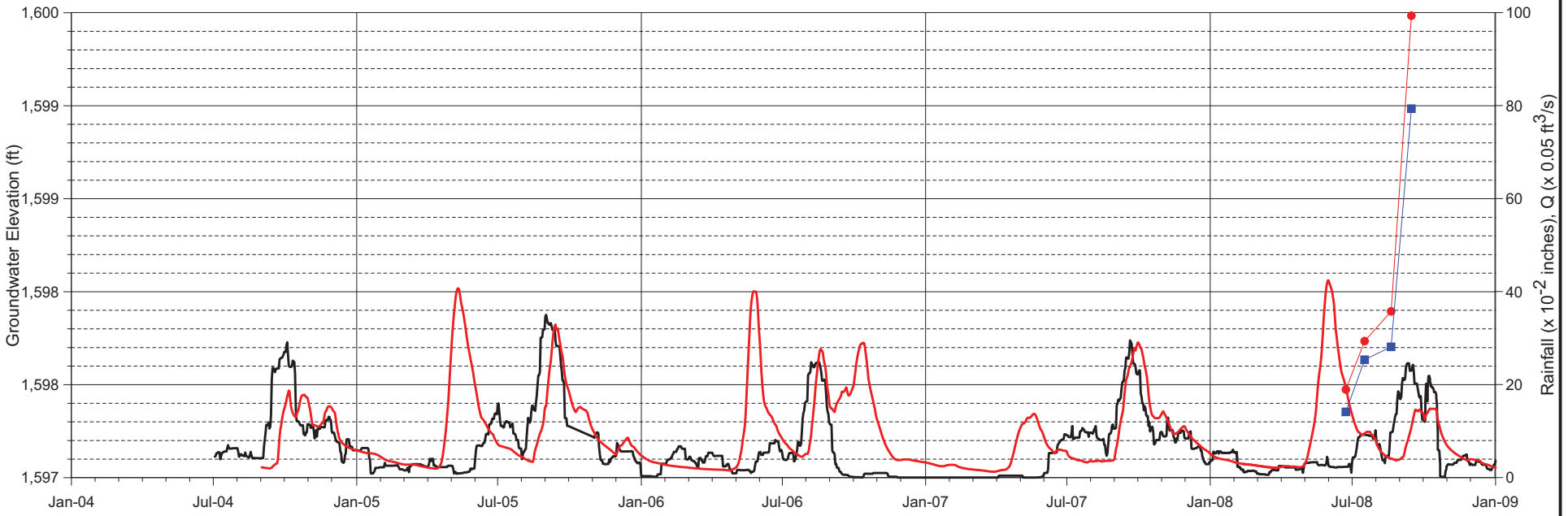


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-83



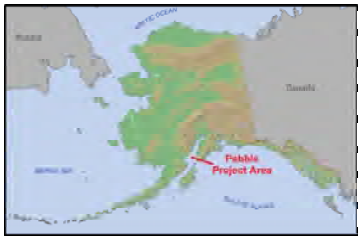
LEGEND:

Groundwater Elevation Plot Legend

- GH07-83S
- GH07-83D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

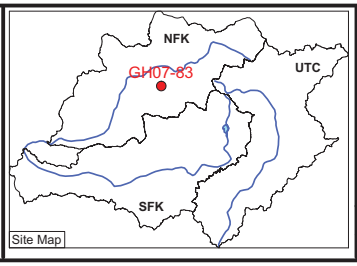
Screens (ft asl):
GH07-83S : 1579.2 - 1589.2
GH07-83D : 1568.2 - 1578.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1598.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-83.grf

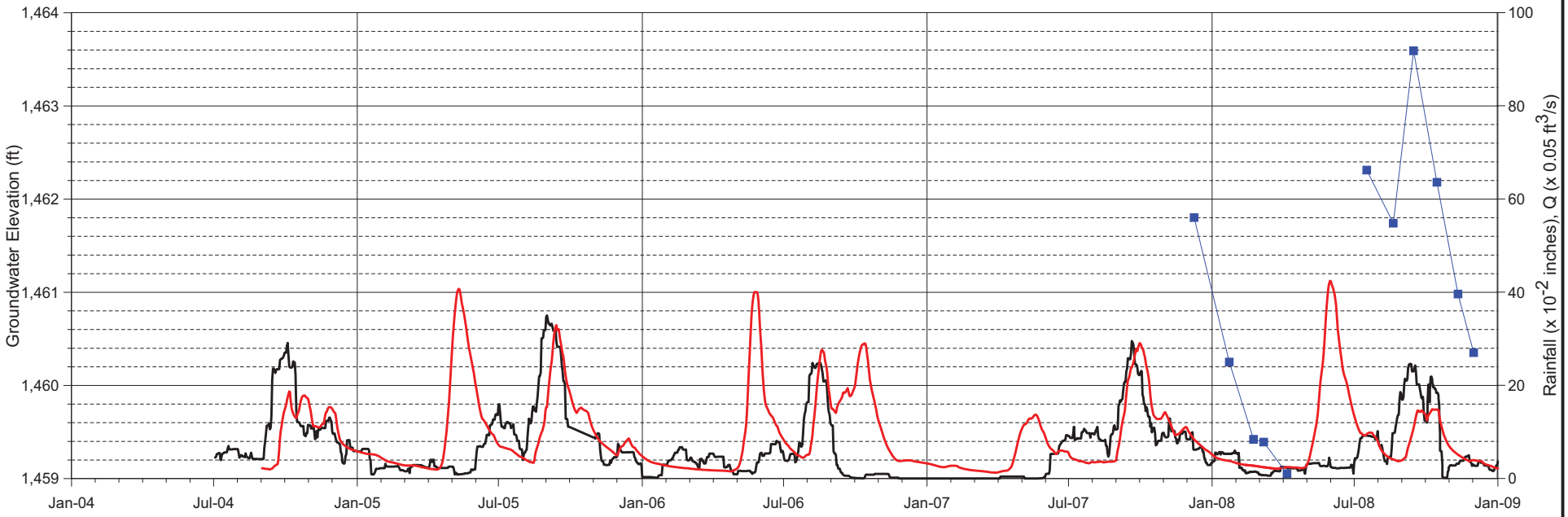


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-84



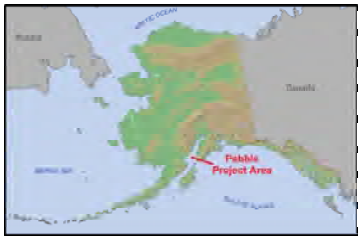
LEGEND:

Groundwater Elevation Plot Legend

- GH07-84
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

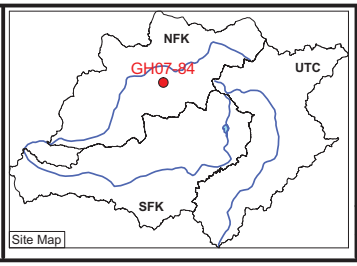
Screens (ft asl):
GH07-84 : 1444.5 - 1454.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1474.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-84.grf

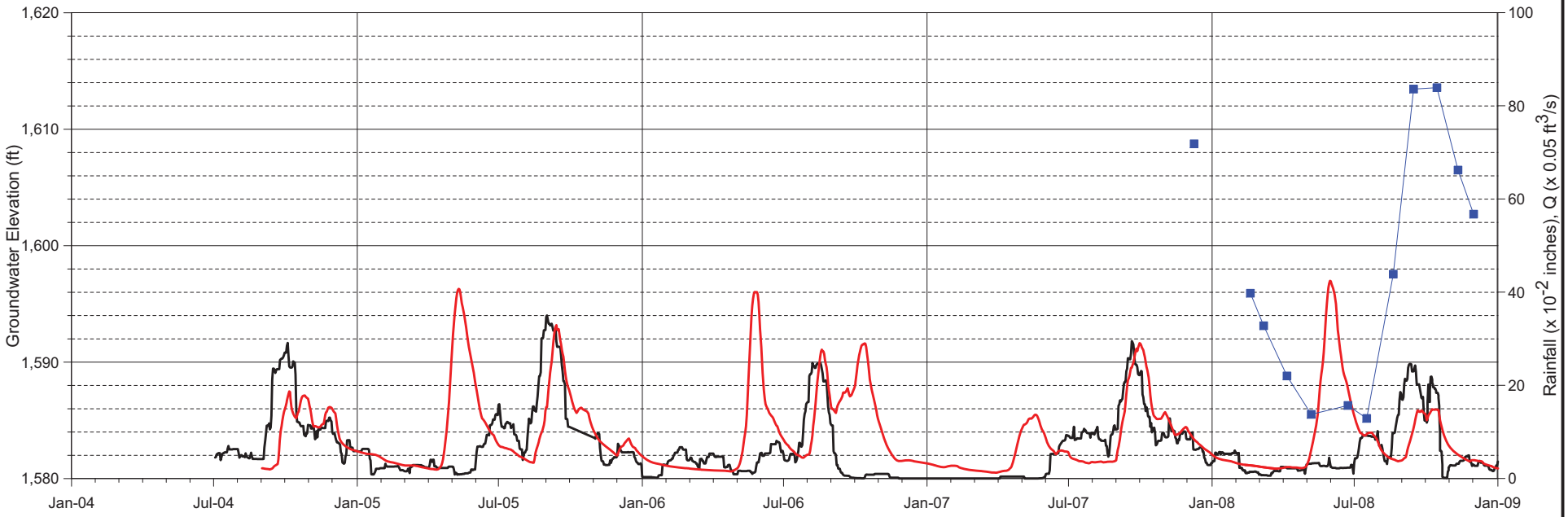


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-85



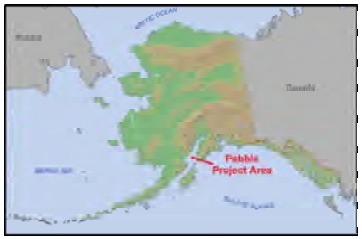
LEGEND:

Groundwater Elevation Plot Legend

- GH07-85
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

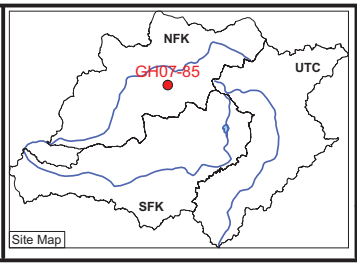
Screens (ft asl):
GH07-85 : 1568.0 - 1578.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1622 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-85.grf

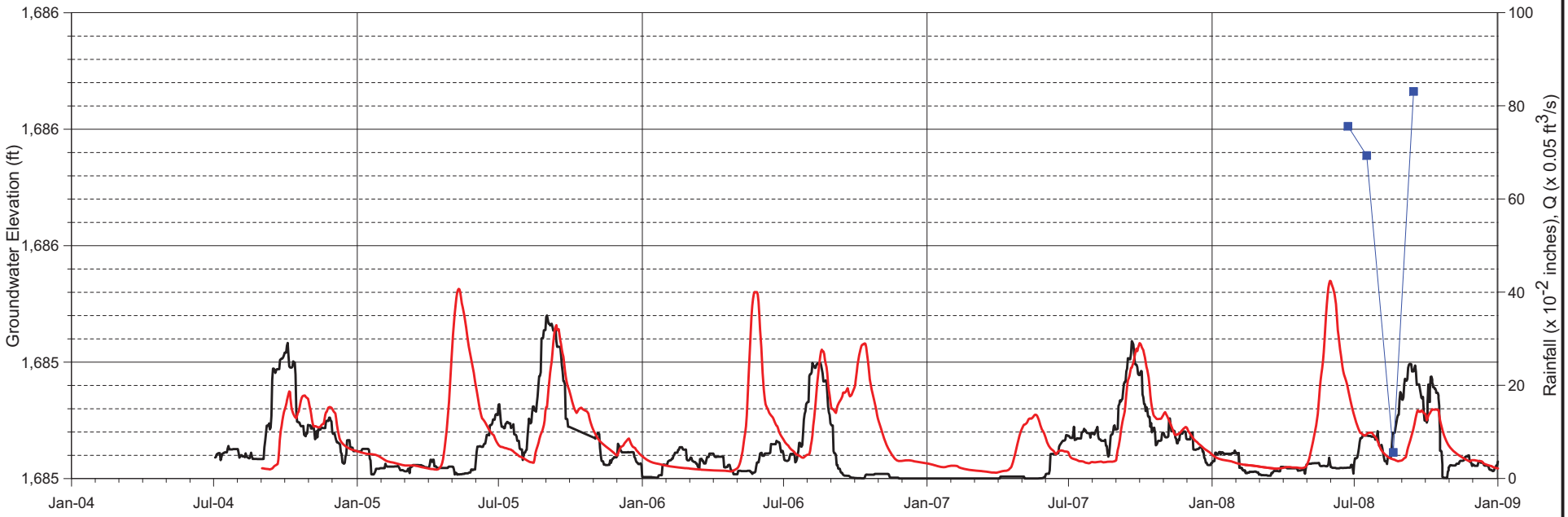


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-86



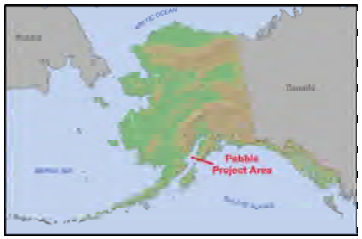
LEGEND:

Groundwater Elevation Plot Legend

- GH07-86
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH07-86 : 1664.0 - 1674.0

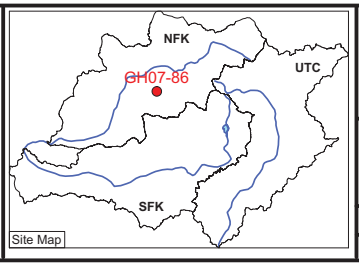


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1684 ft asl

Water was often frozen in riser,
therefore few water levels were recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-86.grf

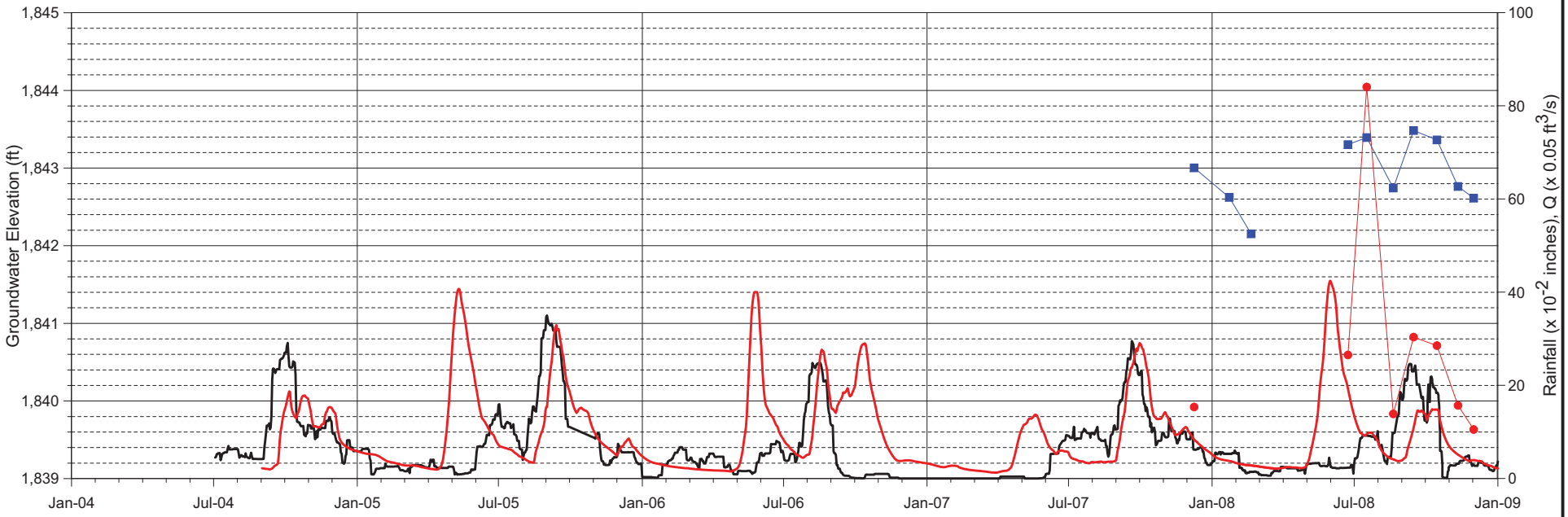


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-87



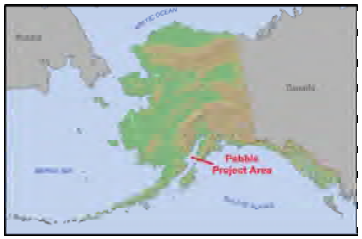
LEGEND:

Groundwater Elevation Plot Legend

- GH07-87S
- GH07-87D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

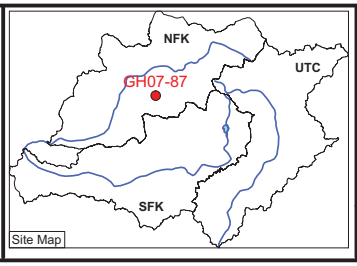
Screens (ft asl):
GH07-87S : 1757.5 - 1767.5
GH07-87D : 1650.5 - 1660.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1849.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-87.grf

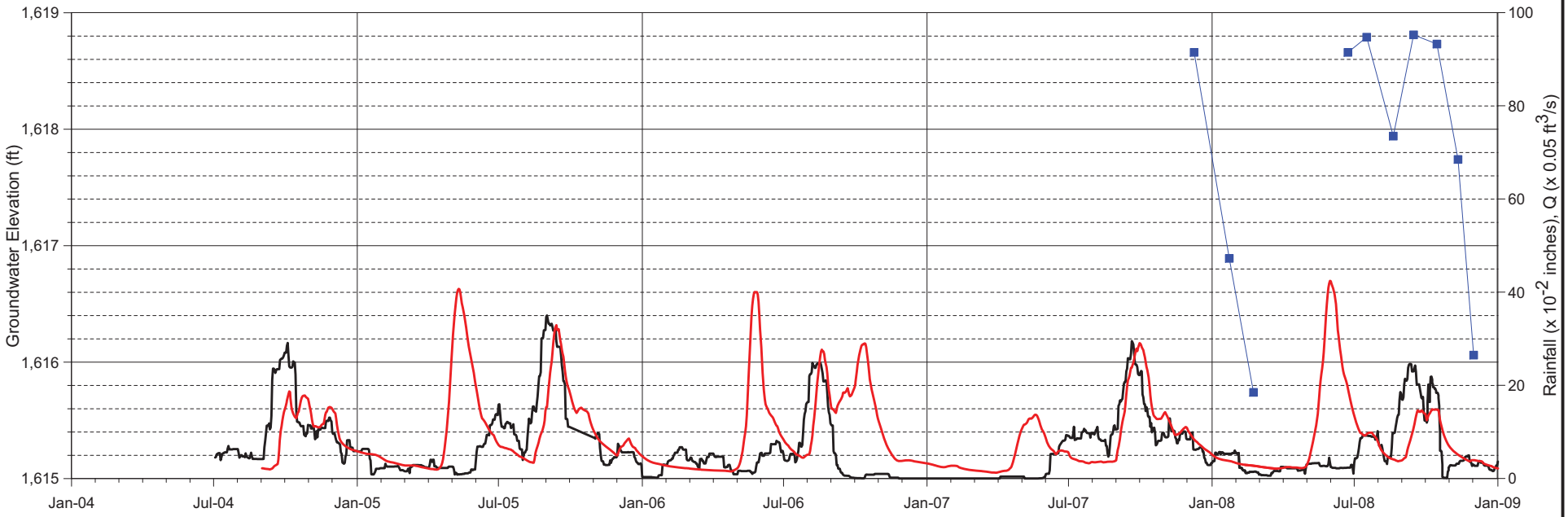


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-88



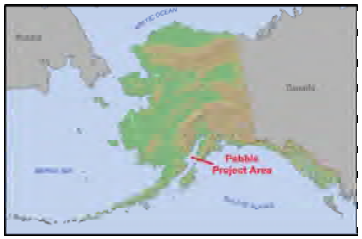
LEGEND:

Groundwater Elevation Plot Legend

- GH07-88
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

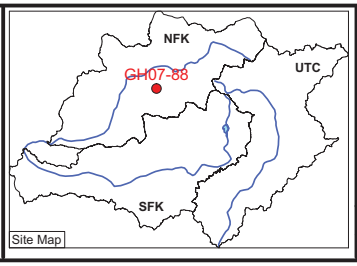
Screens (ft asl):
GH07-88 : 1605.6 - 1616.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1620.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-88.grf

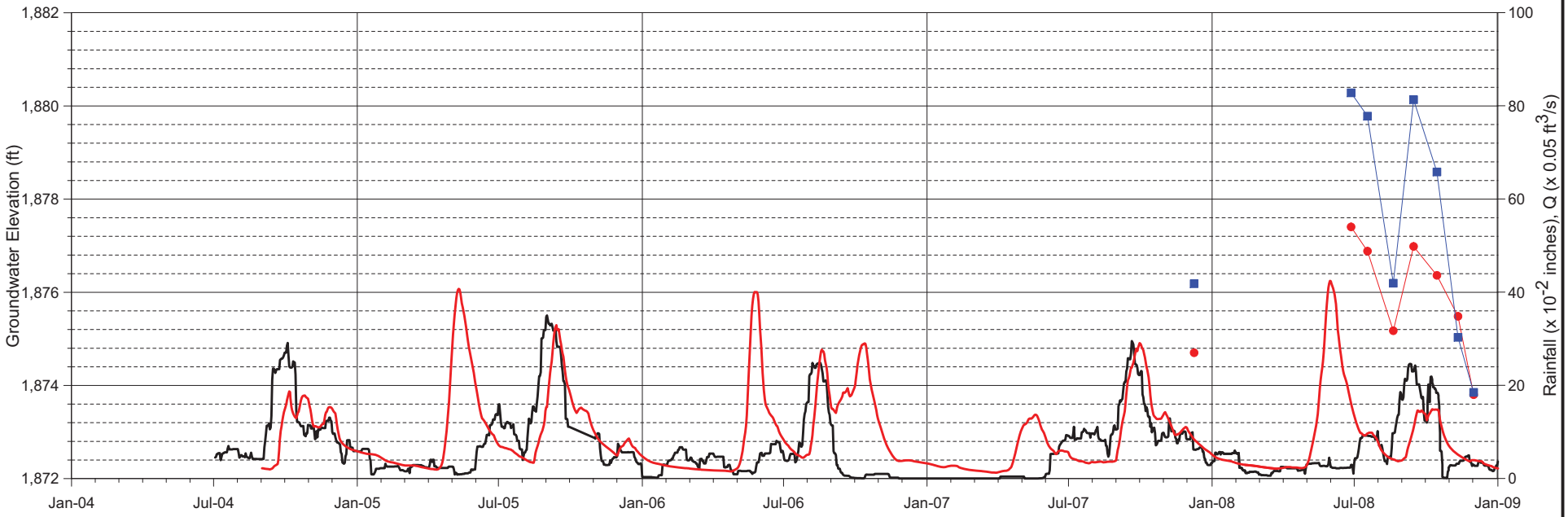


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-89



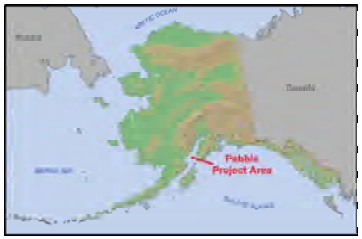
LEGEND:

Groundwater Elevation Plot Legend

- GH07-89S
- GH07-89D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

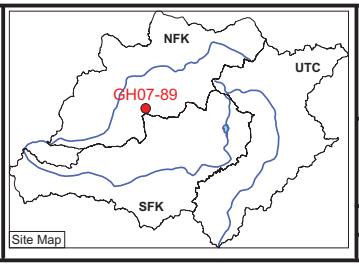
Screens (ft asl):
GH07-89S : 1834.8 - 1844.8
GH07-89D : 1804.8 - 1814.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1884.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-89.grf

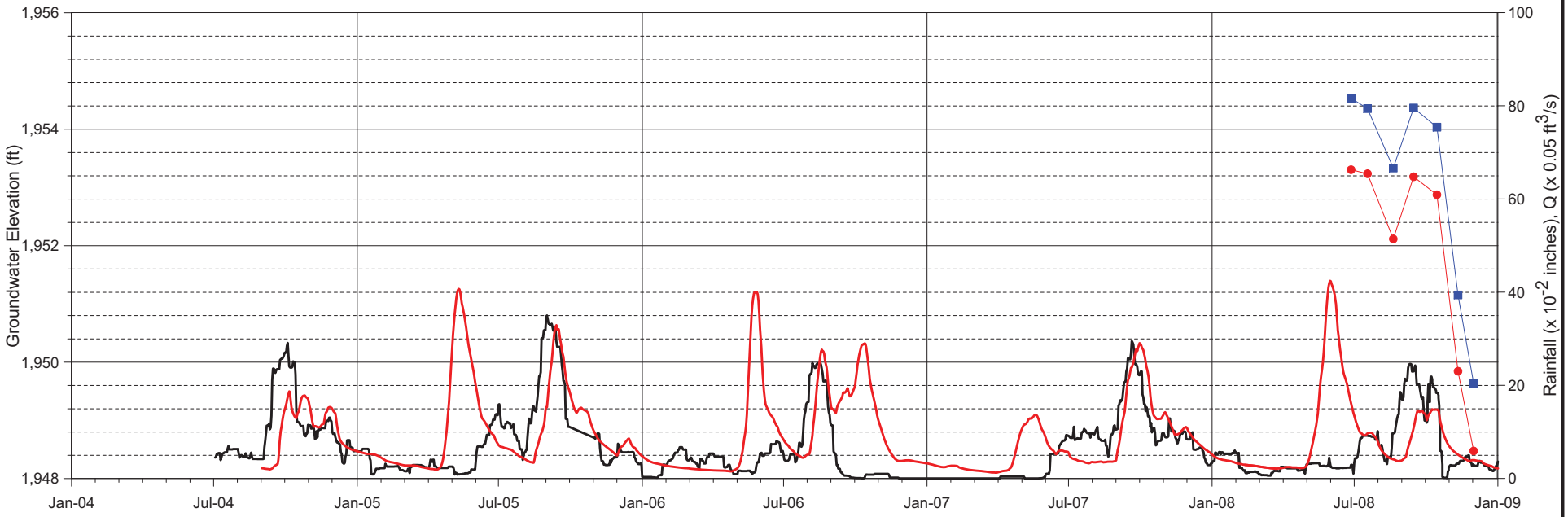


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-90



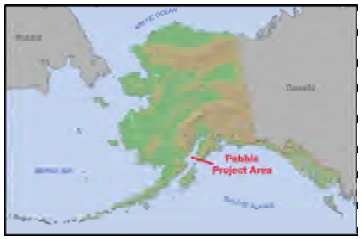
LEGEND:

Groundwater Elevation Plot Legend

- GH07-90S
- GH07-90D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

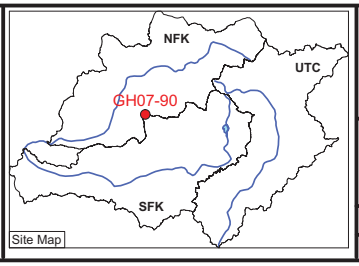
Screens (ft asl):
GH07-90S : 1926.6 - 1936.6
GH07-90D : 1866.6 - 1876.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1956.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-90.grf

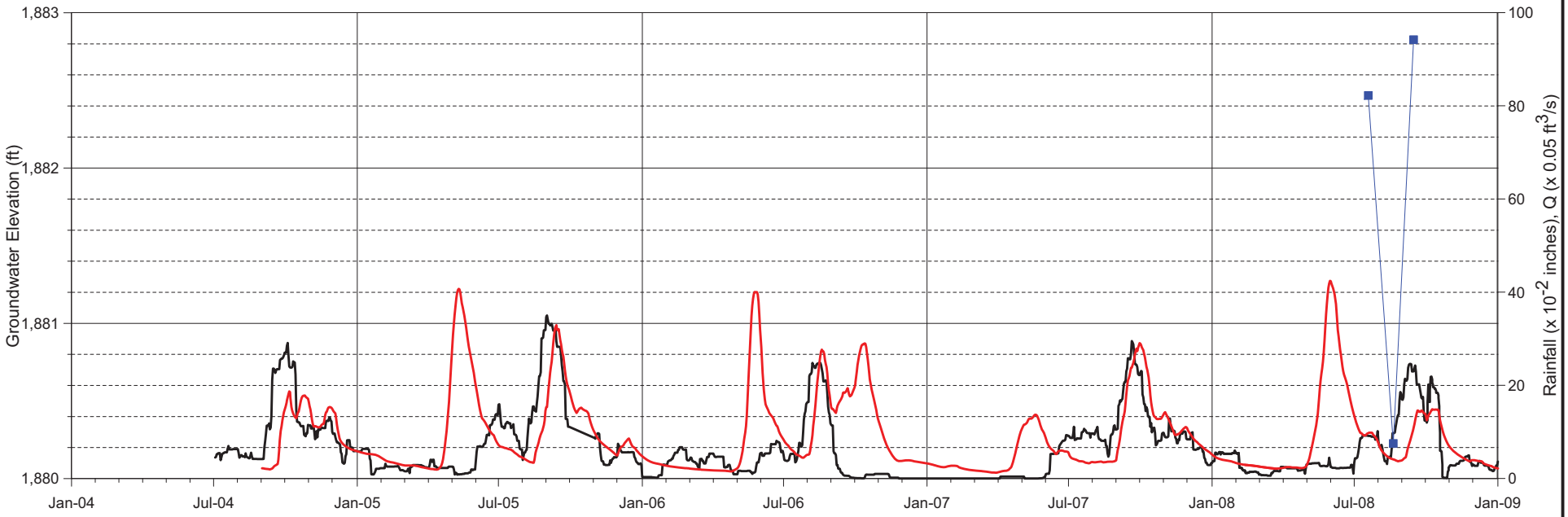


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-91



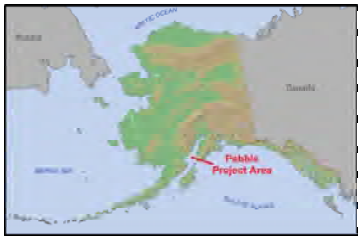
LEGEND:

Groundwater Elevation Plot Legend

- GH07-91
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

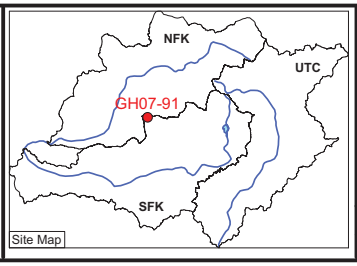
Screens (ft asl):
GH07-91 : 1852.8 - 1862.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1882.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-91.grf

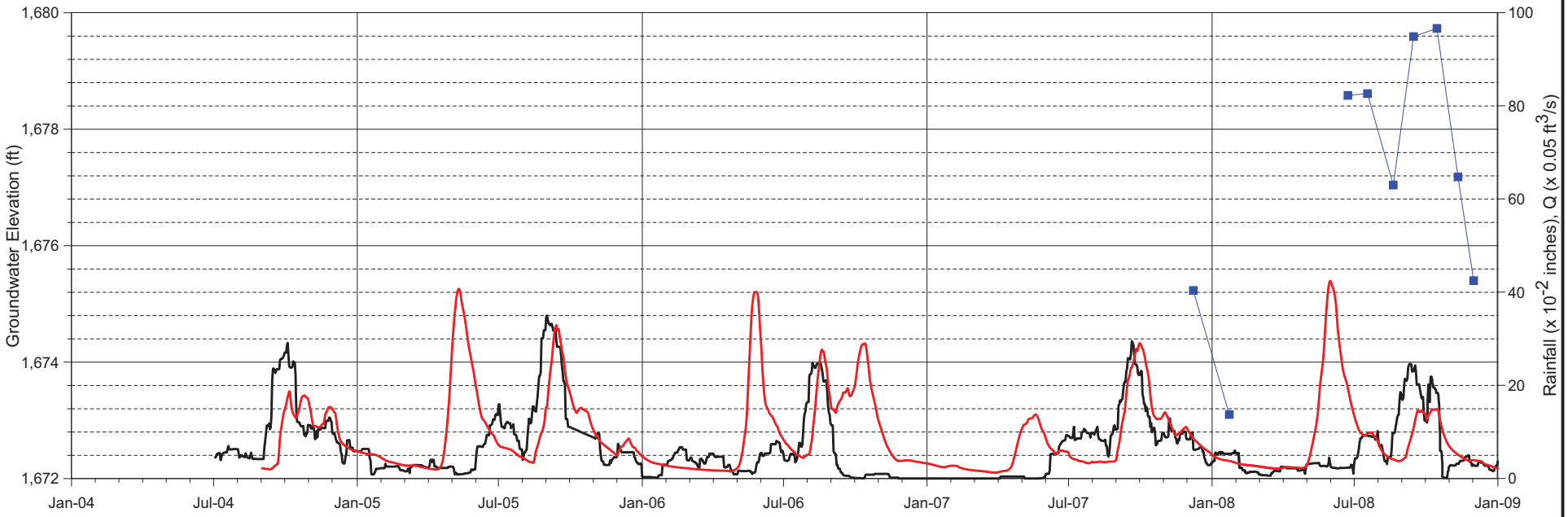


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-92



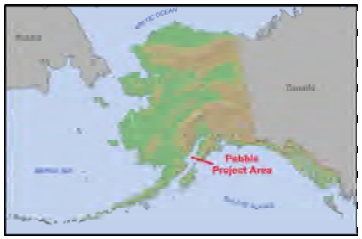
LEGEND:

Groundwater Elevation Plot Legend

- GH07-92D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

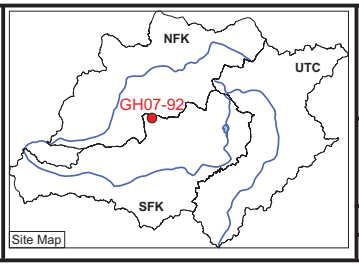
Screens (ft asl):
GH07-92S : 1663.2 - 1673.2
GH07-92D : 1618.2 - 1628.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1693.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-92.grf

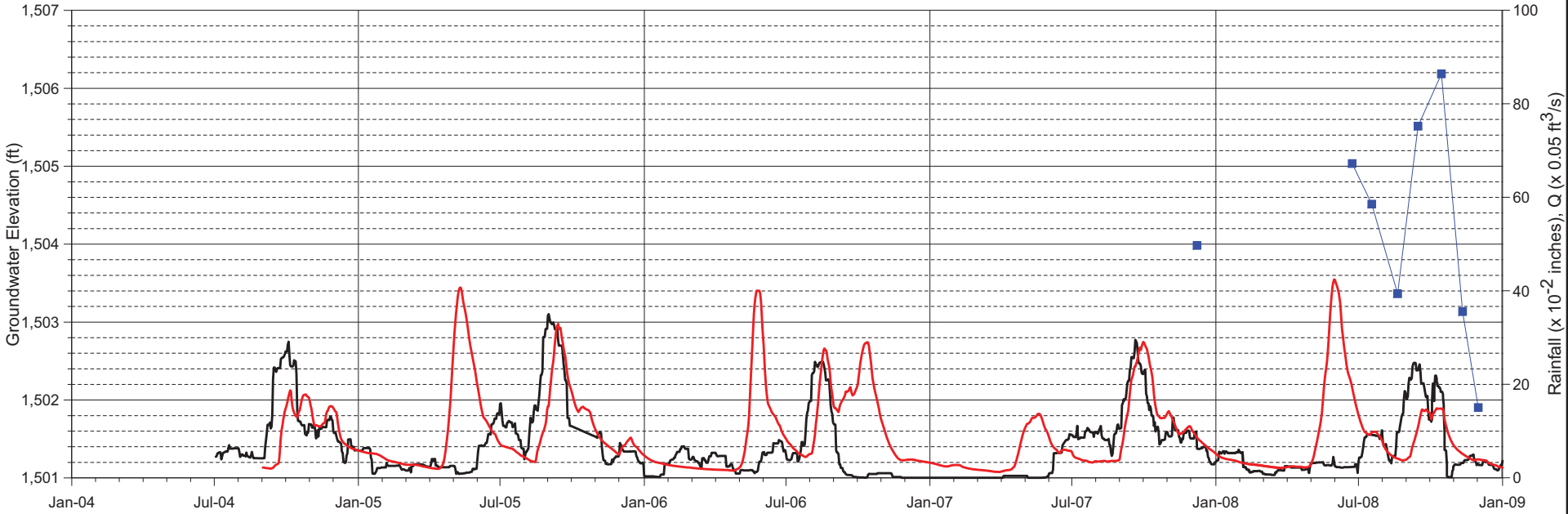


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-93



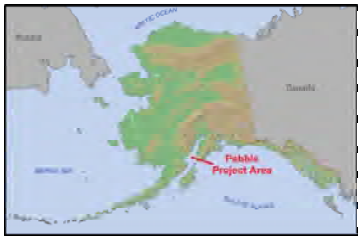
LEGEND:

Groundwater Elevation Plot Legend

- GH07-93
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

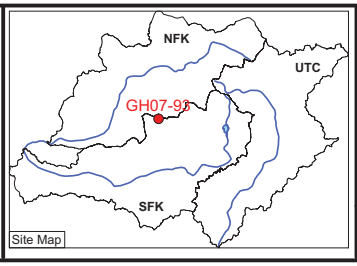
Screens (ft asl):
GH07-93 : 1467.3 - 1477.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1510.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-93.grf

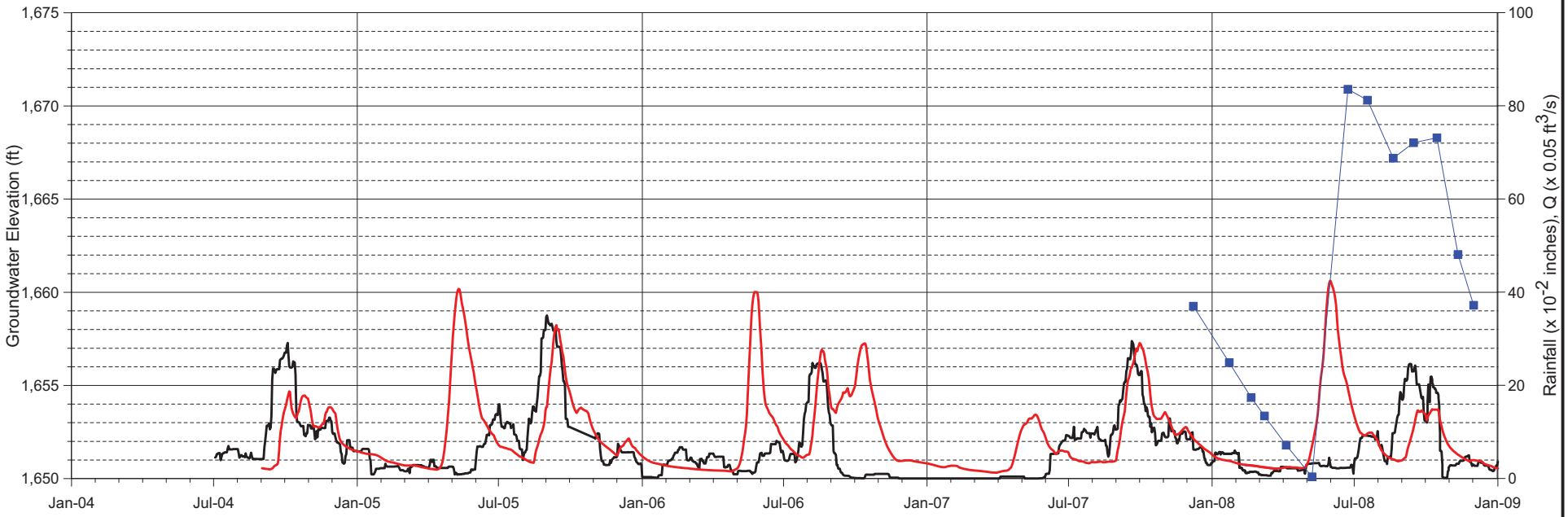


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-94



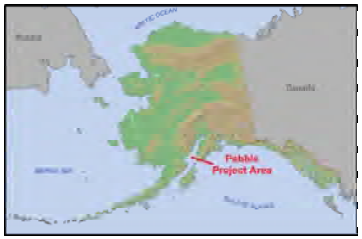
LEGEND:

Groundwater Elevation Plot Legend

- GH07-94
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

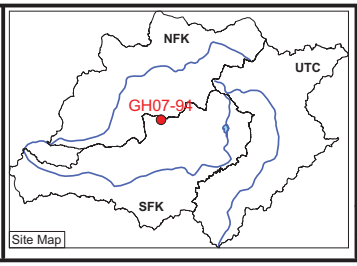
Screens (ft asl):
GH07-94 : 1644.2 - 1654.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1669.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-94.grf

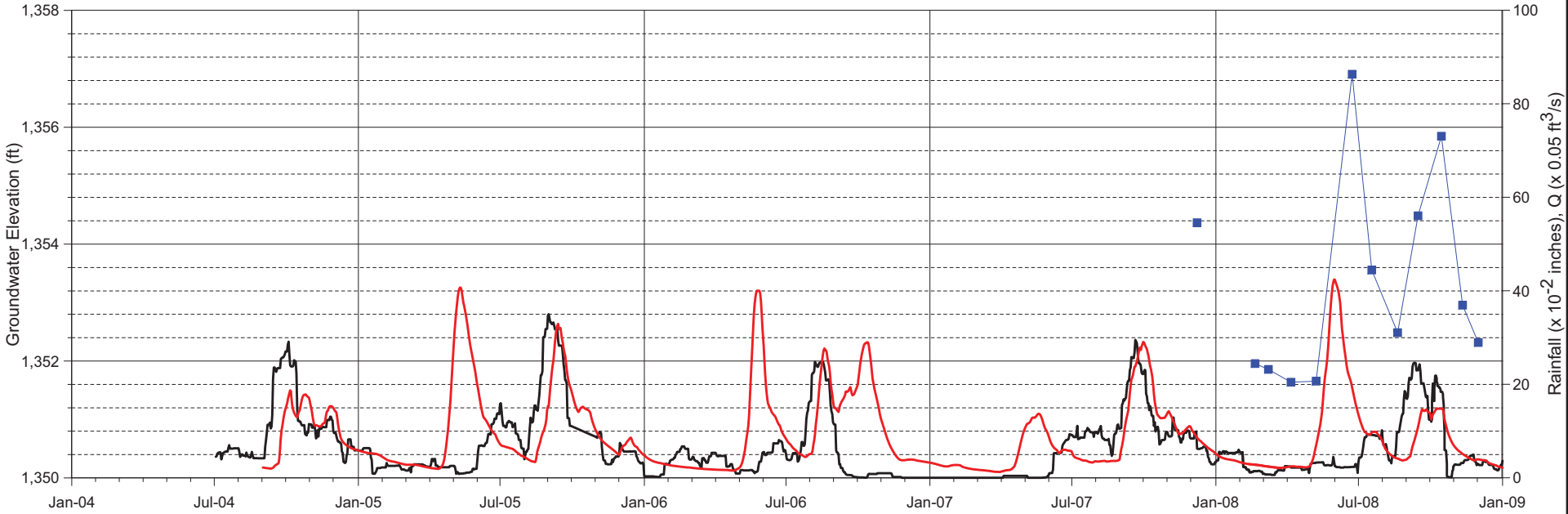


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-95



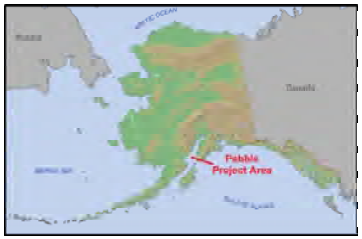
LEGEND:

Groundwater Elevation Plot Legend

- GH07-95
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

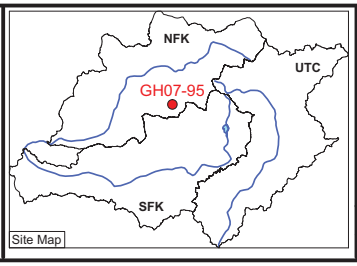
Screens (ft asl):
GH07-95 : 1333.7 - 1343.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1361.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-95.grf

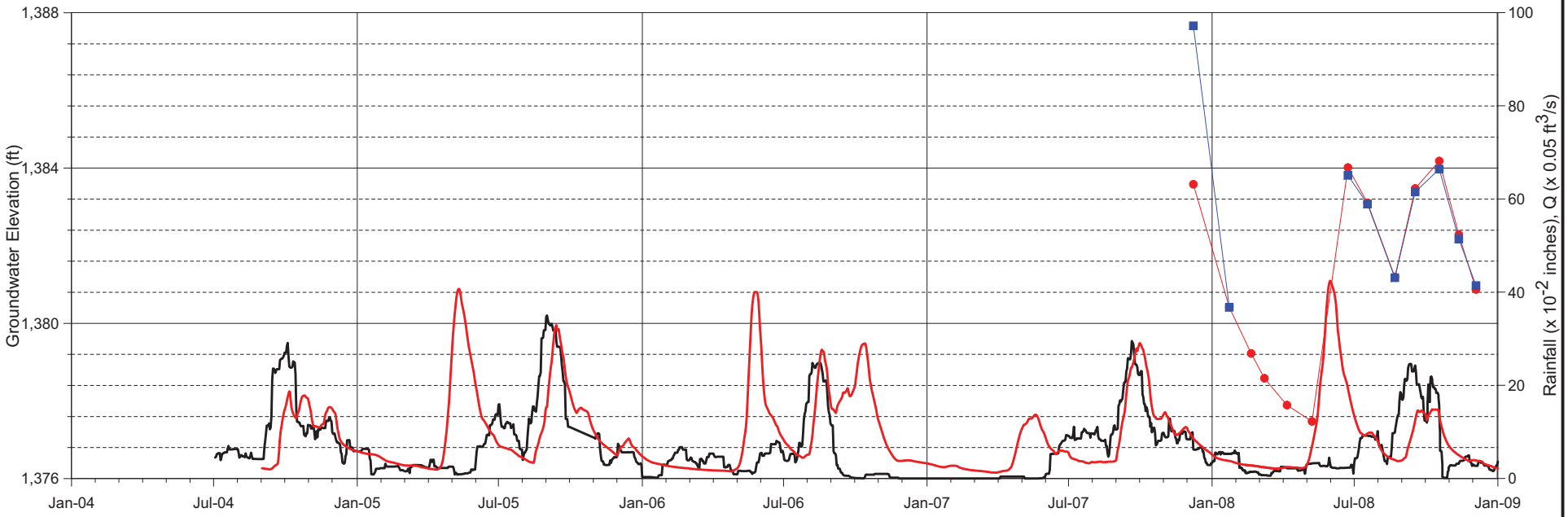


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-96



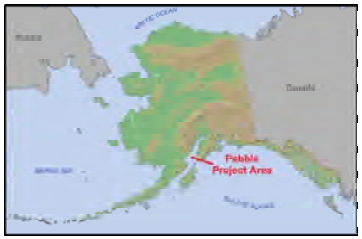
LEGEND:

Groundwater Elevation Plot Legend

- GH07-96S
- GH07-96D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

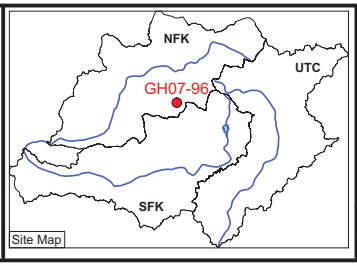
Screens (ft asl):
GH07-96S : 1347.8 - 1357.8
GH07-96D : 1307.8 - 1317.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1387.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-96.grf

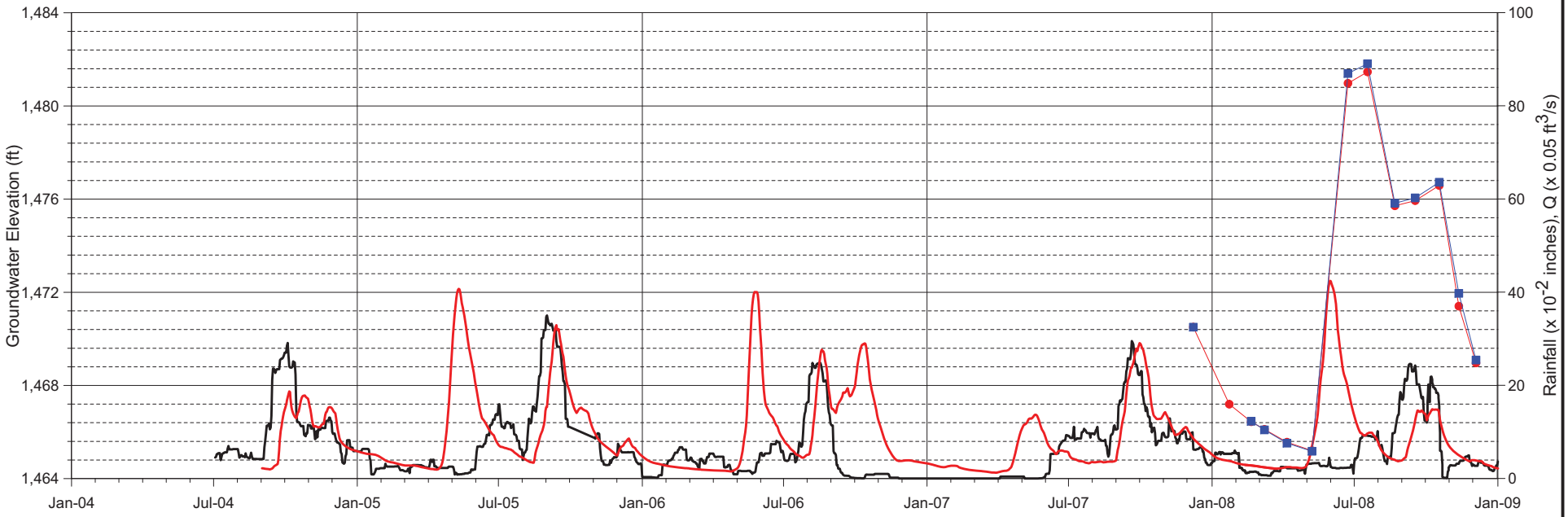


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-97



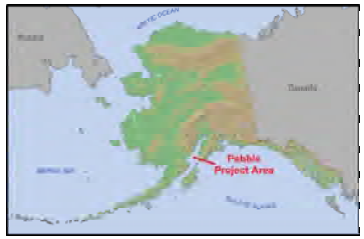
LEGEND:

Groundwater Elevation Plot Legend

- GH07-97S
- GH07-97D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

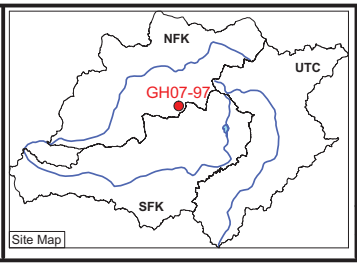
Screens (ft asl):
GH07-97S : 1451.1 - 1461.1
GH07-97D : 1411.1 - 1421.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1491.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-97.grf

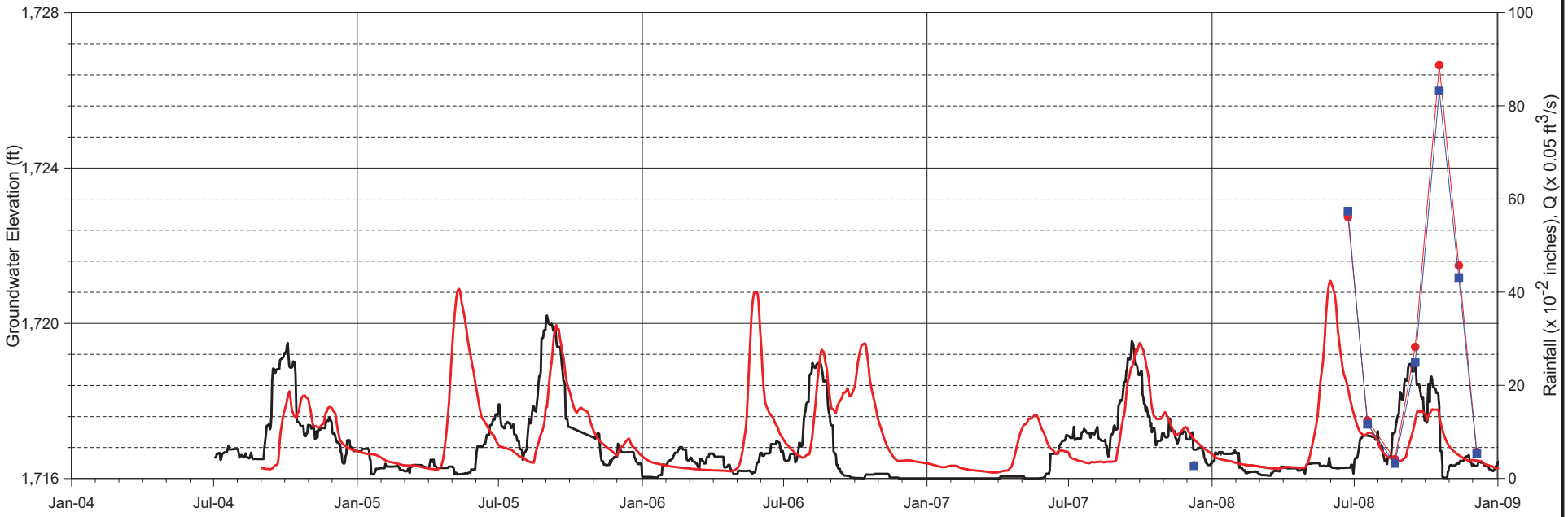


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-98



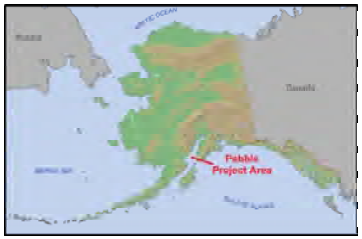
LEGEND:

Groundwater Elevation Plot Legend

- GH07-98S
- GH07-98D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

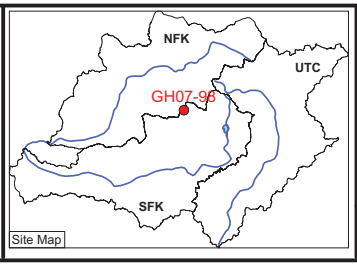
Screens (ft asl):
GH07-98S : 1689.8 - 1699.8
GH07-98D : 1650.3 - 1660.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1739.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-98.grf

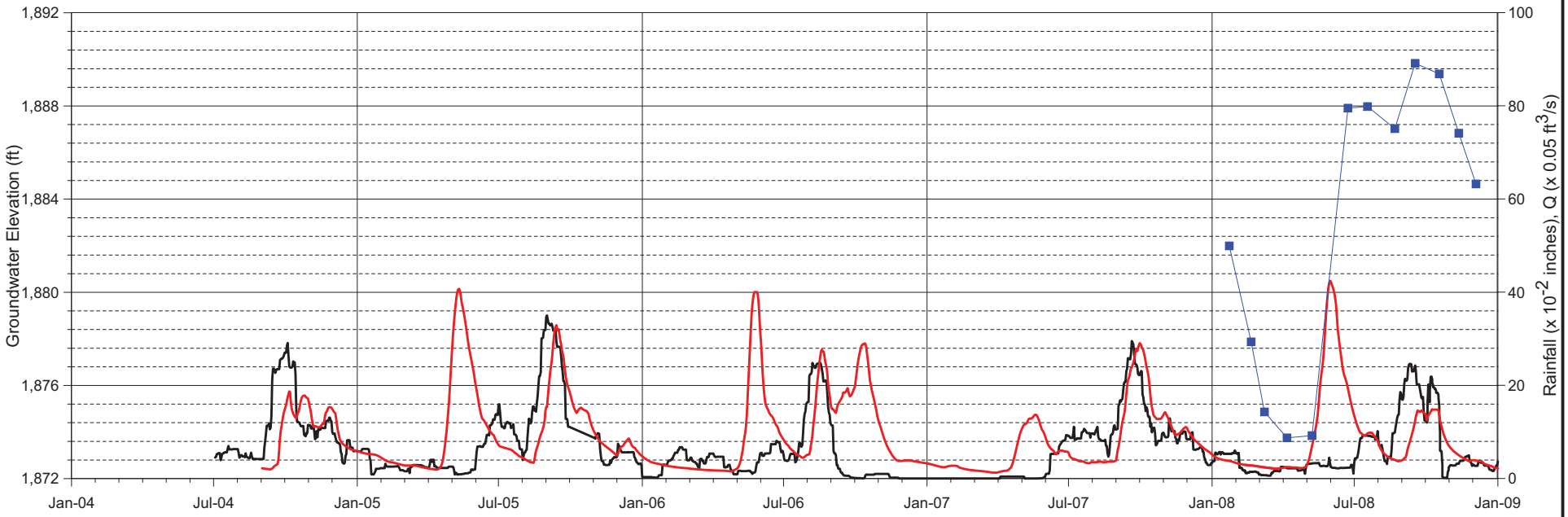


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH07-99



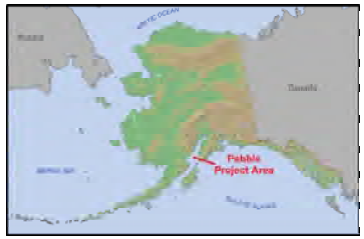
LEGEND:

Groundwater Elevation Plot Legend

- GH07-99
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

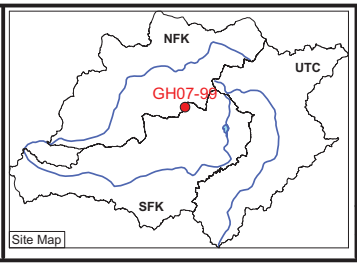
Screens (ft asl):
GH07-99 : 1873.7 - 1883.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1893.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH07-99.grf

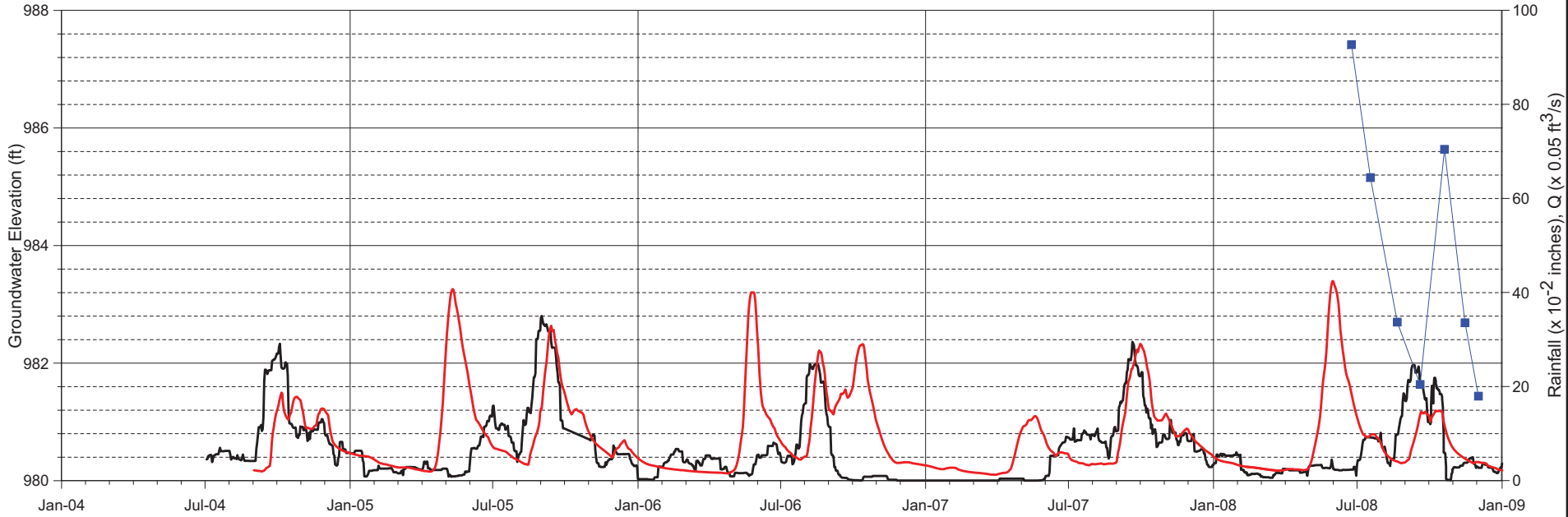


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-107



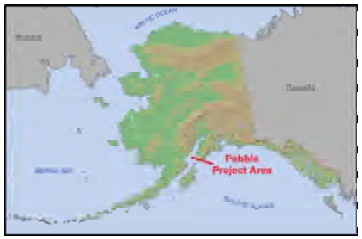
LEGEND:

Groundwater Elevation Plot Legend

- GH08-107
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

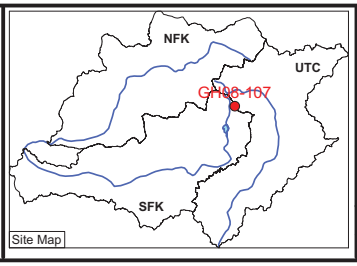
Screens (ft asl):
GH08-107 : 890.5 - 900.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1025.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-107.grf

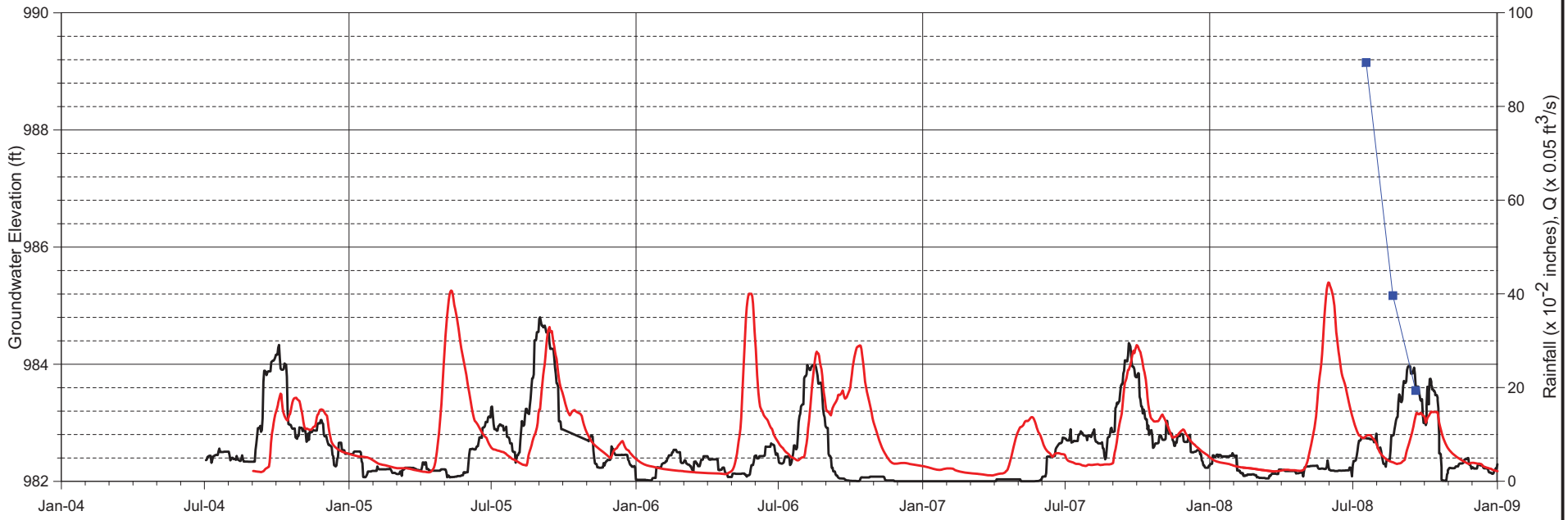


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-109



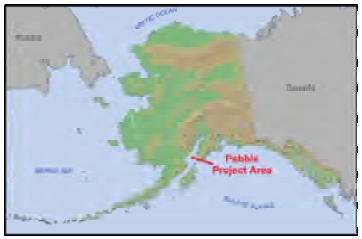
LEGEND:

Groundwater Elevation Plot Legend

- GH08-109
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

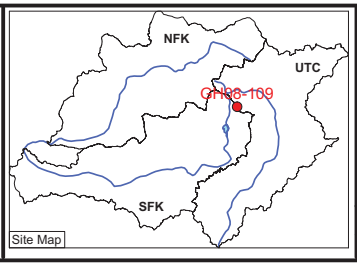
Screens (ft asl):
GH08-109 : 882.1 - 892.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 989.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-109.grf

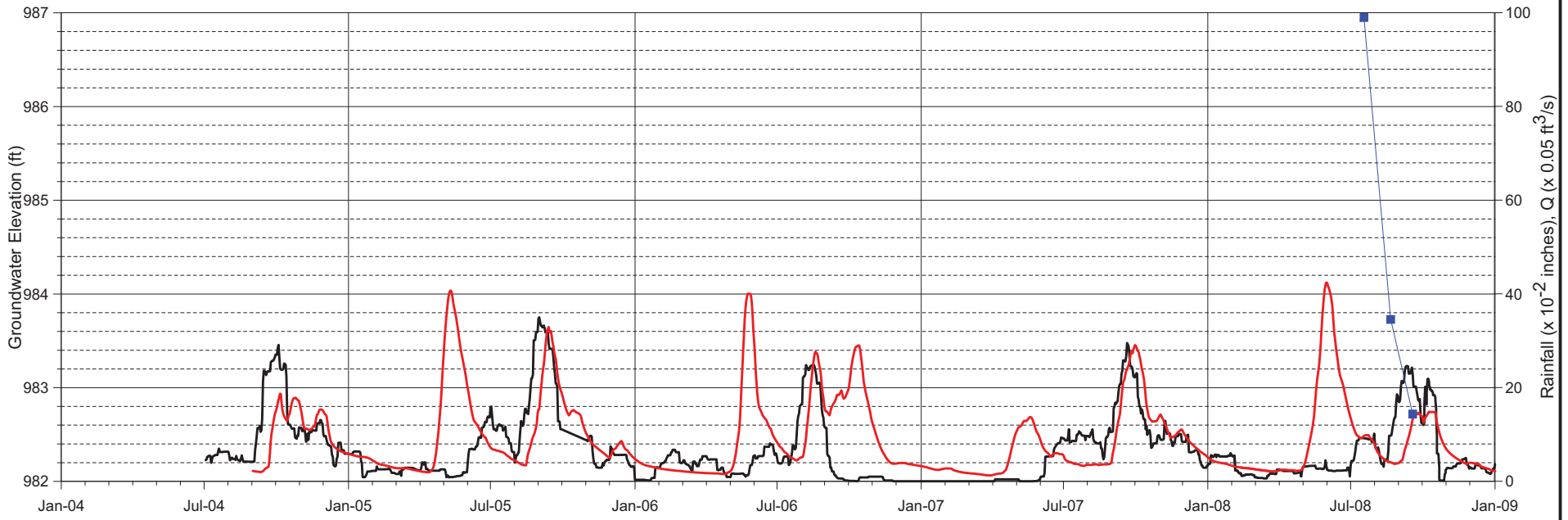


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-111



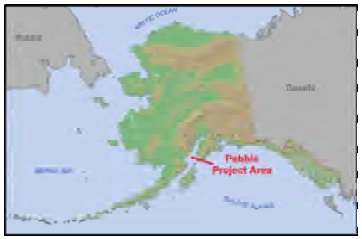
LEGEND:

Groundwater Elevation Plot Legend

- GH08-111
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

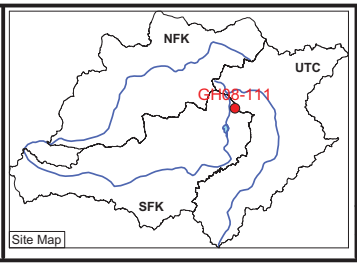
Screens (ft asl):
GH08-111 : 883.7 - 893.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 985.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-111.grf

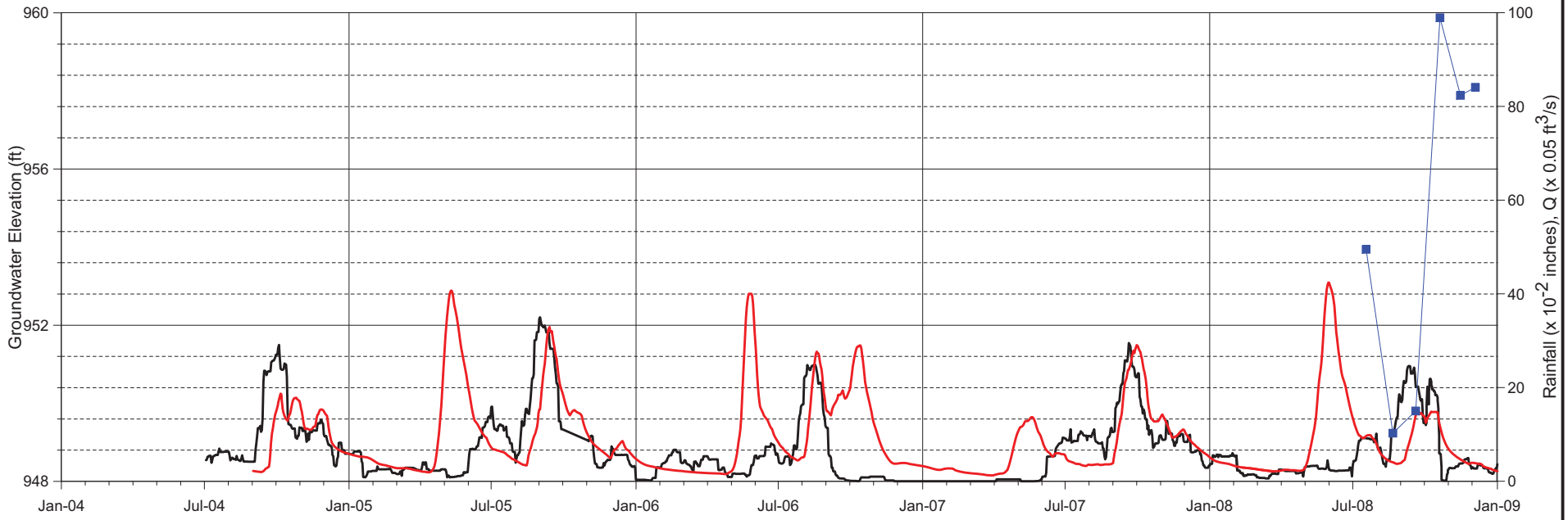


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-112



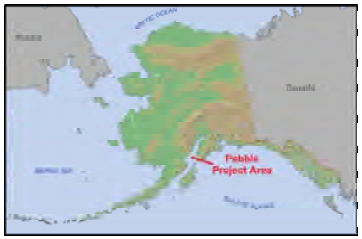
LEGEND:

Groundwater Elevation Plot Legend

- GH08-112
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

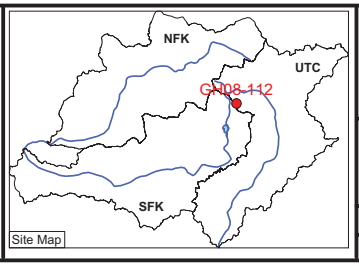
Screens (ft asl):
GH08-112 : 745.5 - 765.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1003.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-112.grf

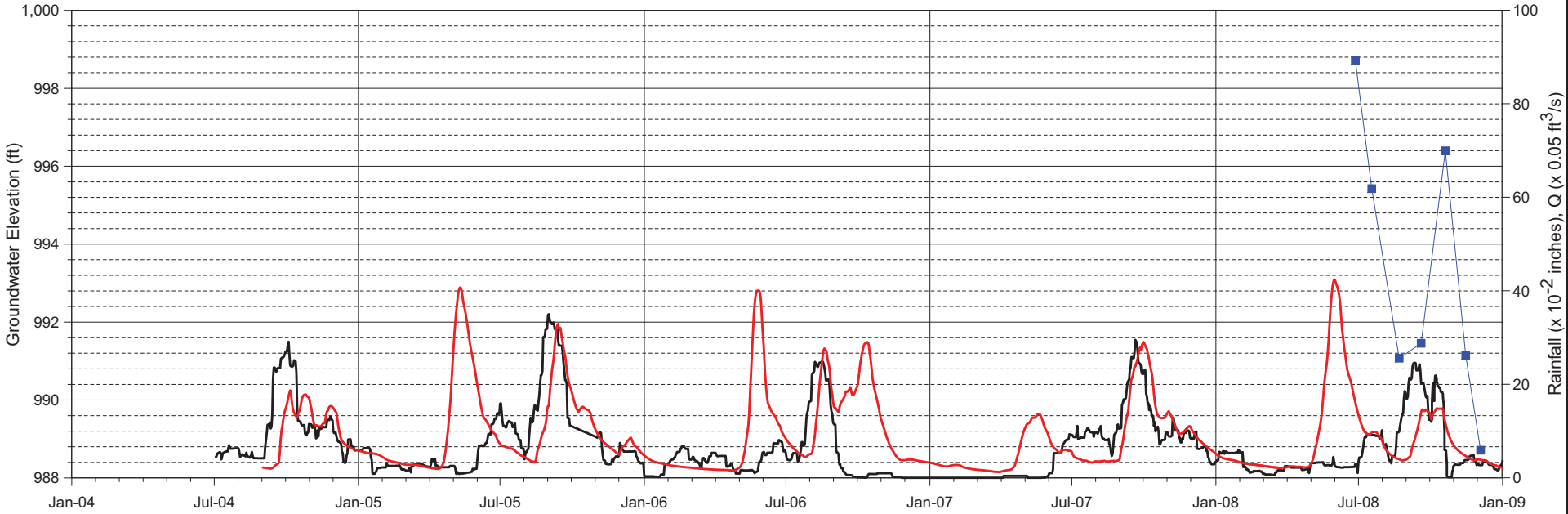


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-113



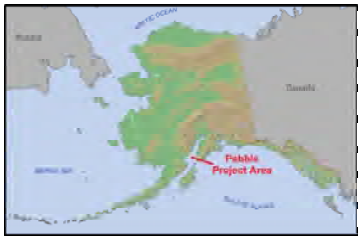
LEGEND:

Groundwater Elevation Plot Legend

- GH08-113
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

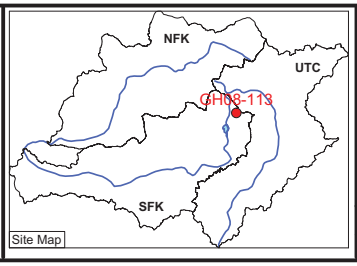
Screens (ft asl):
GH08-113 : 918.7 - 938.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 997.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-113.grf

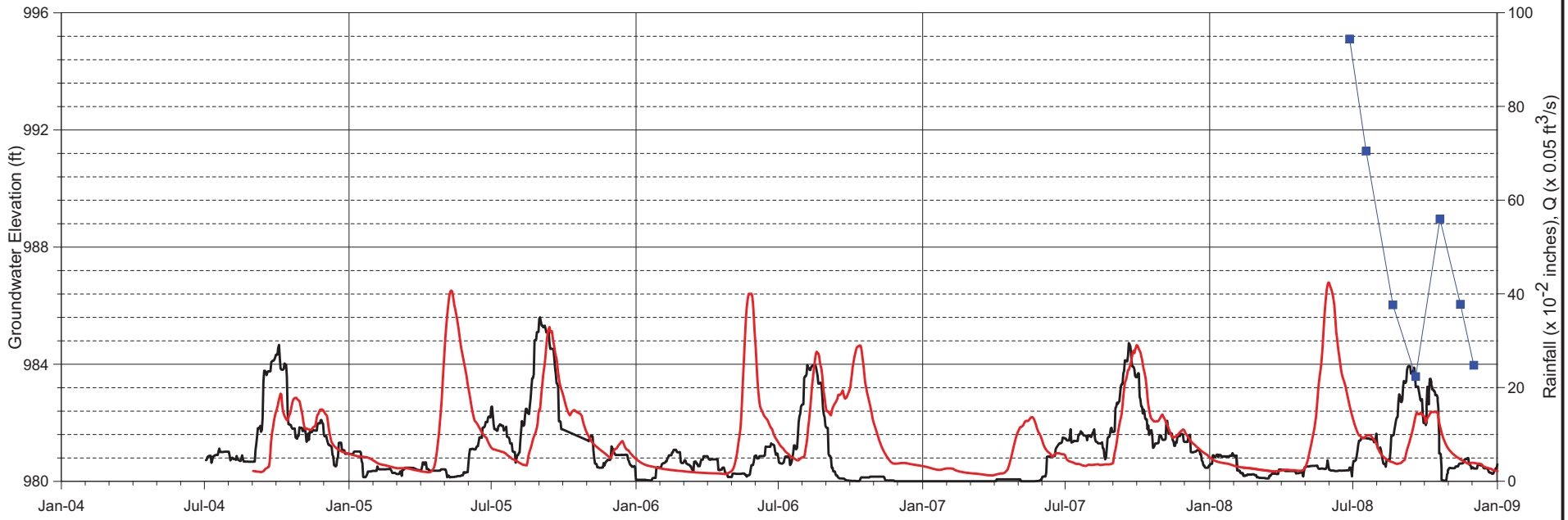


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-115



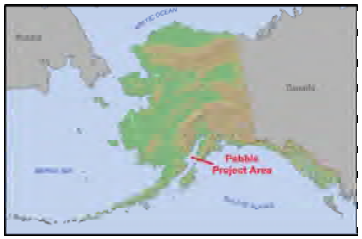
LEGEND:

Groundwater Elevation Plot Legend

- GH08-115
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

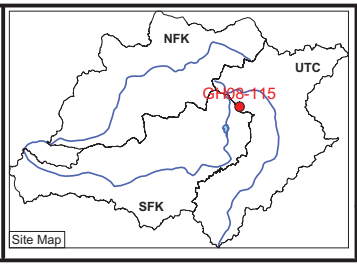
Screens (ft asl):
GH08-115 : 838.2 - 848.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1012.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-115.grf

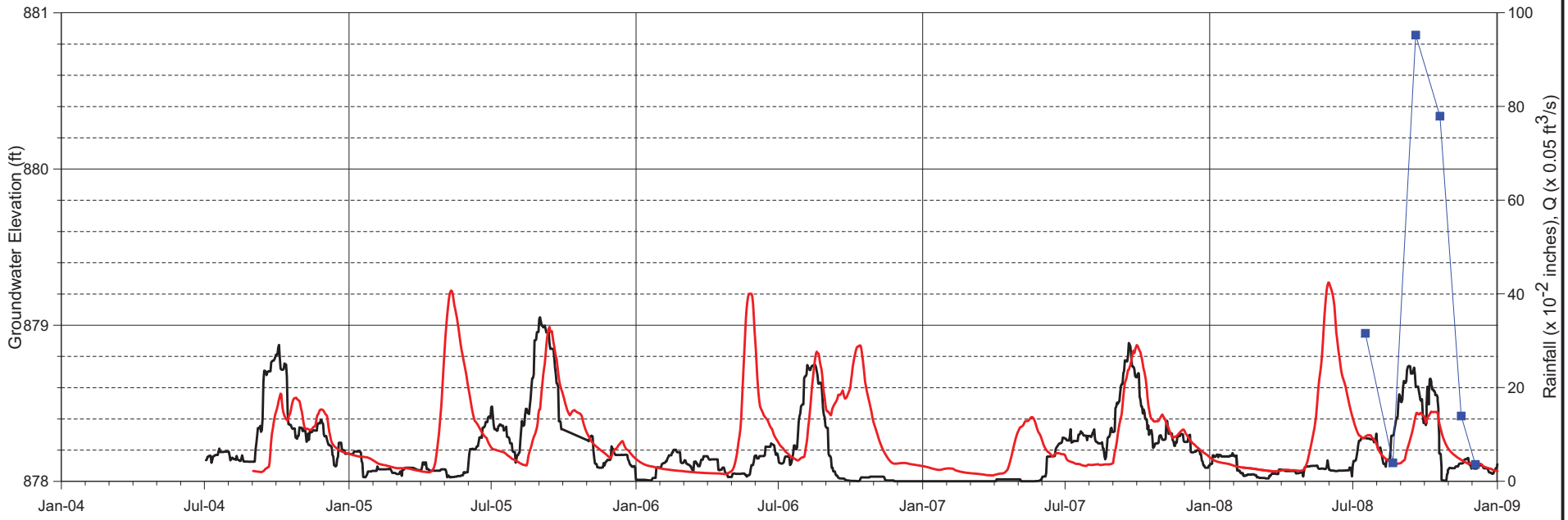


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-116



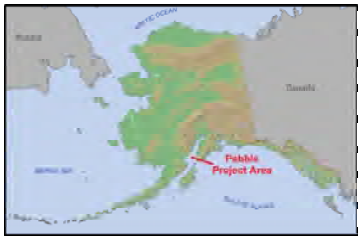
LEGEND:

Groundwater Elevation Plot Legend

- GH08-116
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

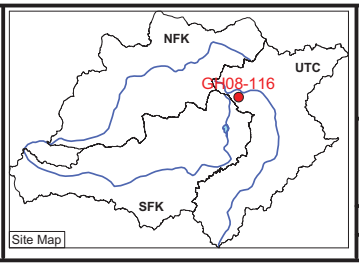
Screens (ft asl):
GH08-116 : 864.2 - 874.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 886.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-116.grf

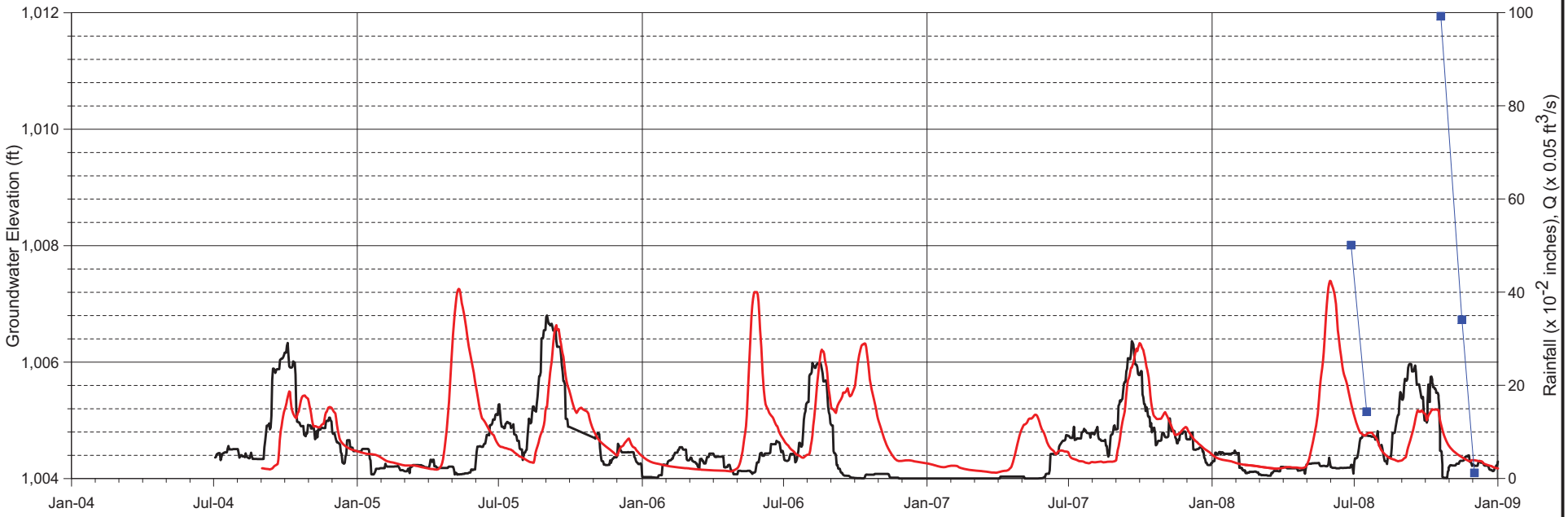


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-117



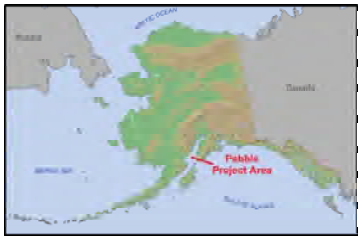
LEGEND:

Groundwater Elevation Plot Legend

- GH08-117
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

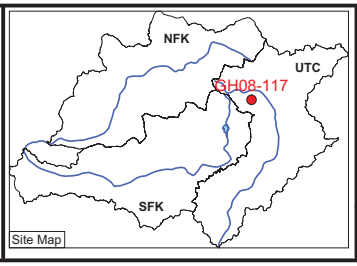
Screens (ft asl):
GH08-117 : 995.7 - 1004.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1039.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-117.grf

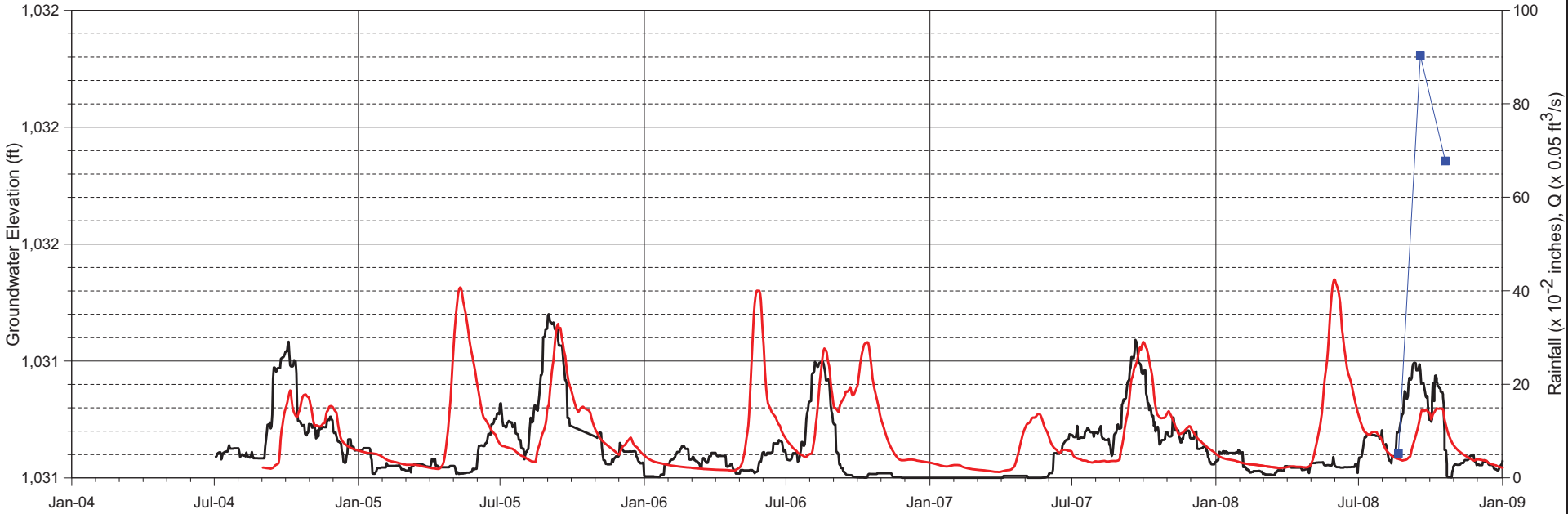


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-118



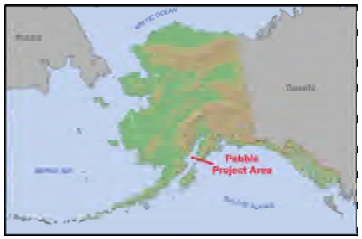
LEGEND:

Groundwater Elevation Plot Legend

- GH08-118
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

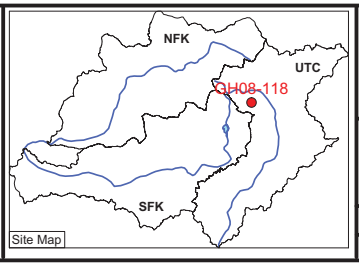
Screens (ft asl):
GH08-118 : 1002.4 - 1012.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1032.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-118.grf

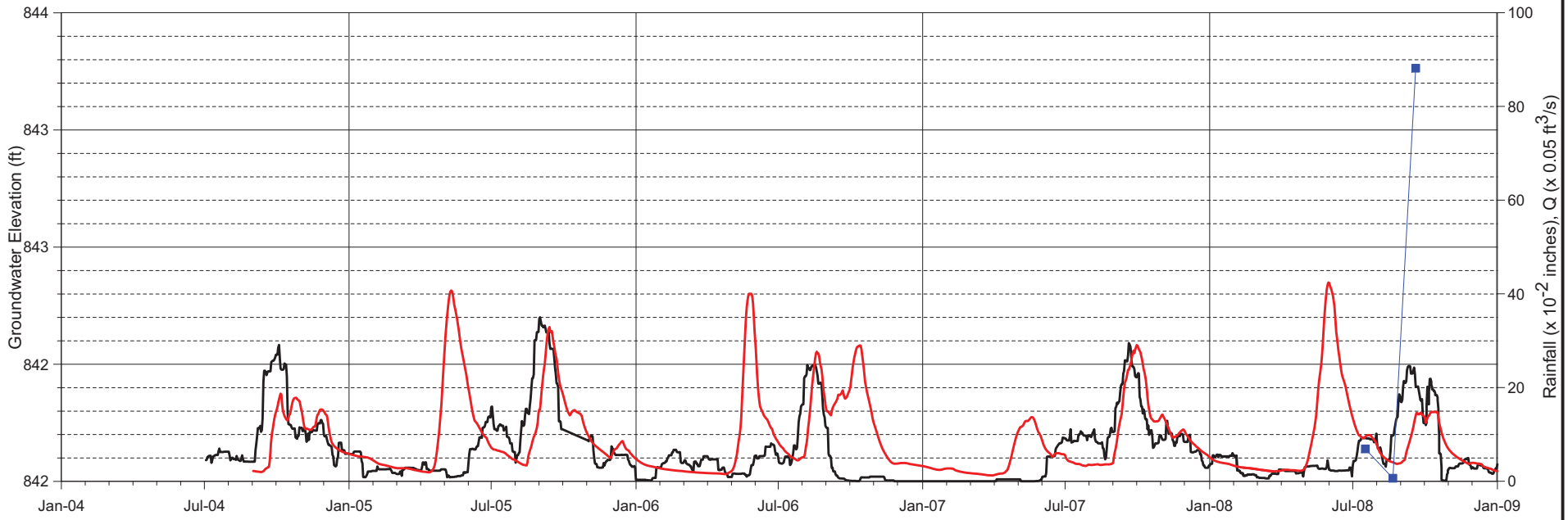


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-119



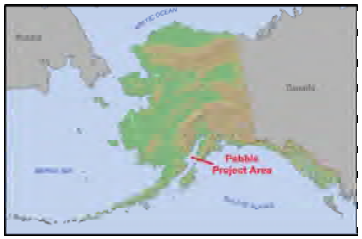
LEGEND:

Groundwater Elevation Plot Legend

- GH08-119
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

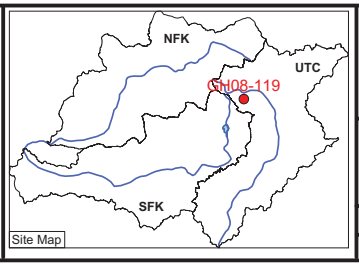
Screens (ft asl):
GH08-119 : 817.2 - 828.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 842.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-119.grf

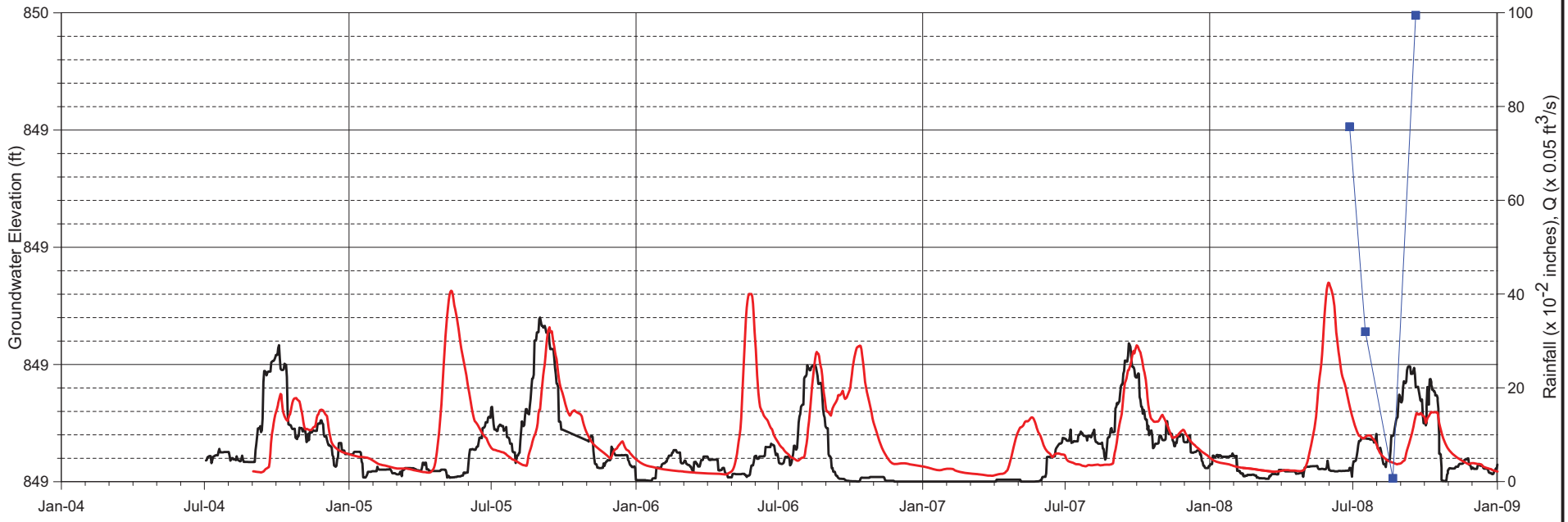


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-120



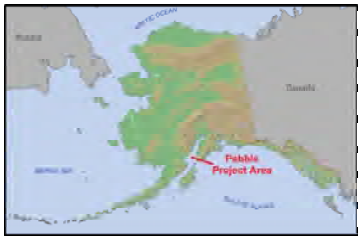
LEGEND:

Groundwater Elevation Plot Legend

- GH08-120
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

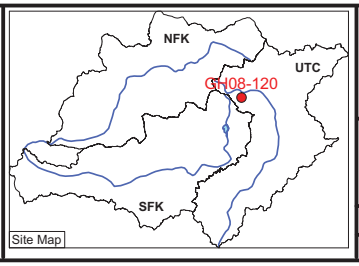
Screens (ft asl):
GH08-120 : 815.7 - 825.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 847.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-120.grf

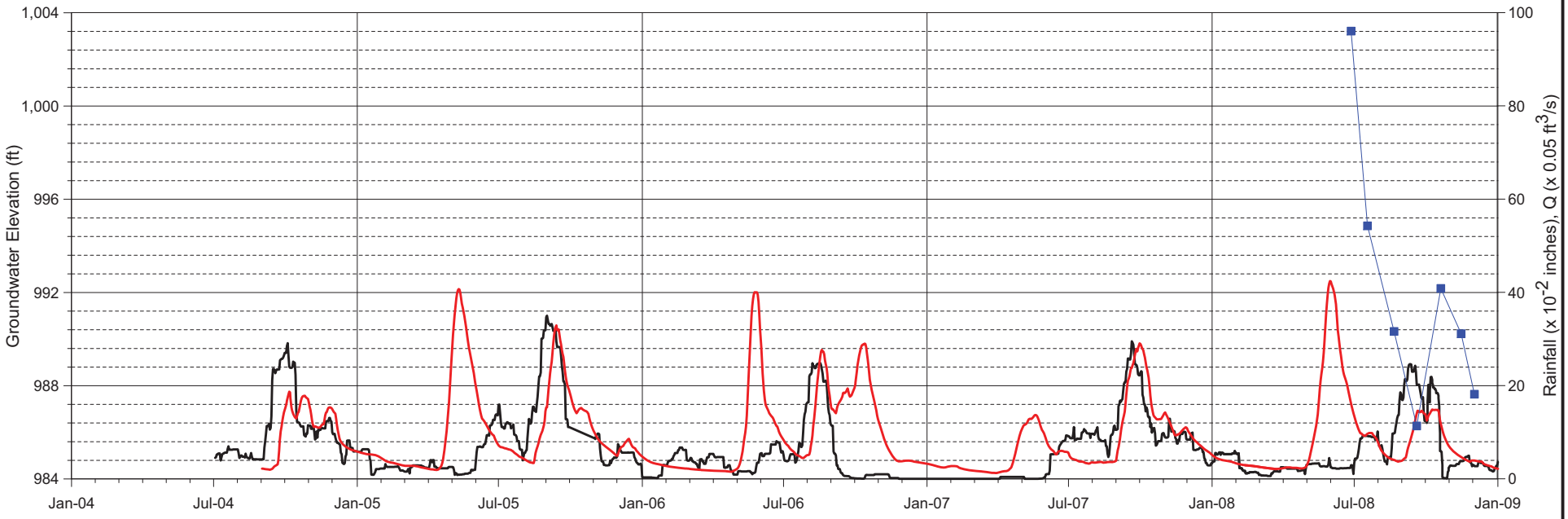


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-121



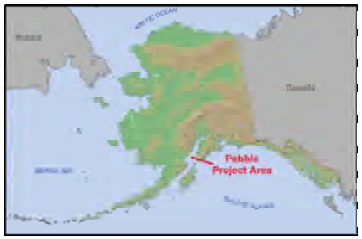
LEGEND:

Groundwater Elevation Plot Legend

- GH08-121
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

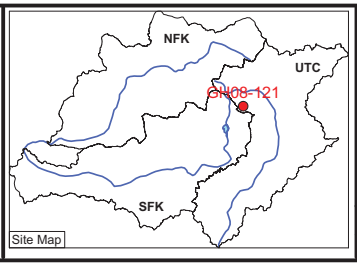
Screens (ft asl):
GH08-121 : 923.0 - 933.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1038 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-121.grf

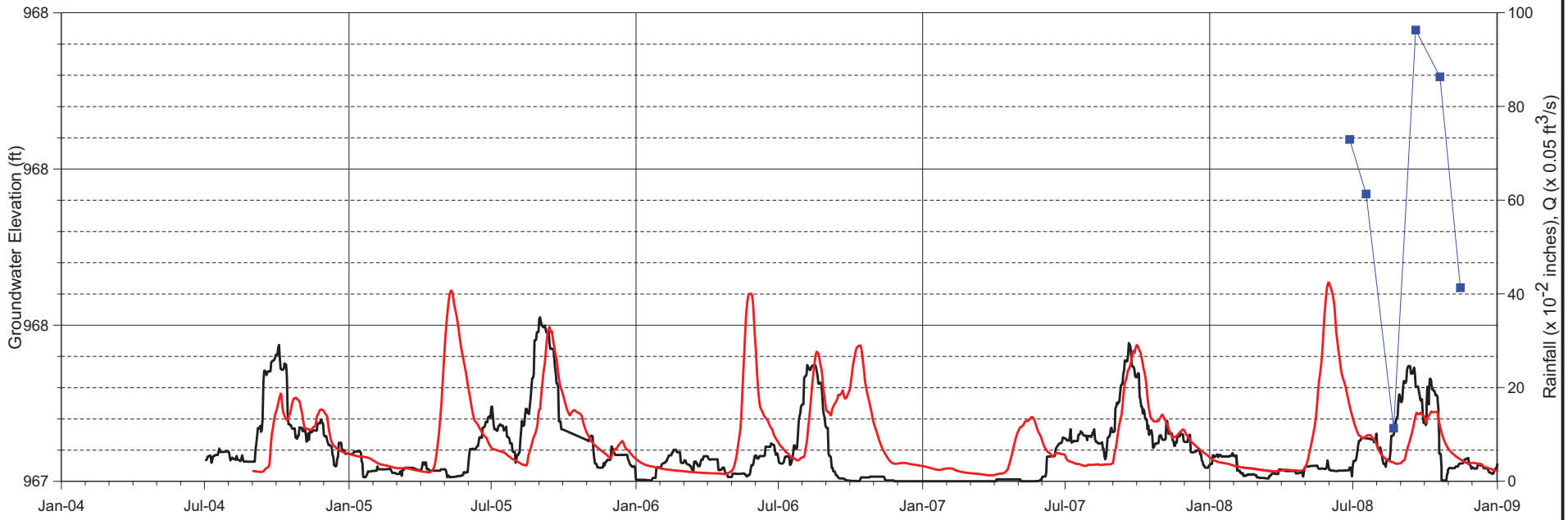


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-123



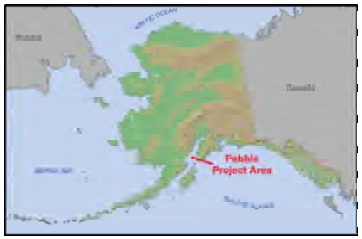
LEGEND:

Groundwater Elevation Plot Legend

- GH08-123
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

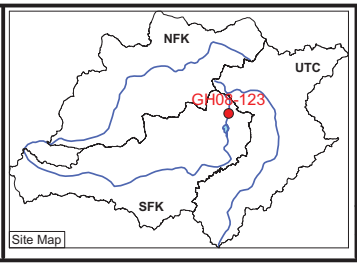
Screens (ft asl):
GH08-123 : 941.1 - 951.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 969.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-123.grf

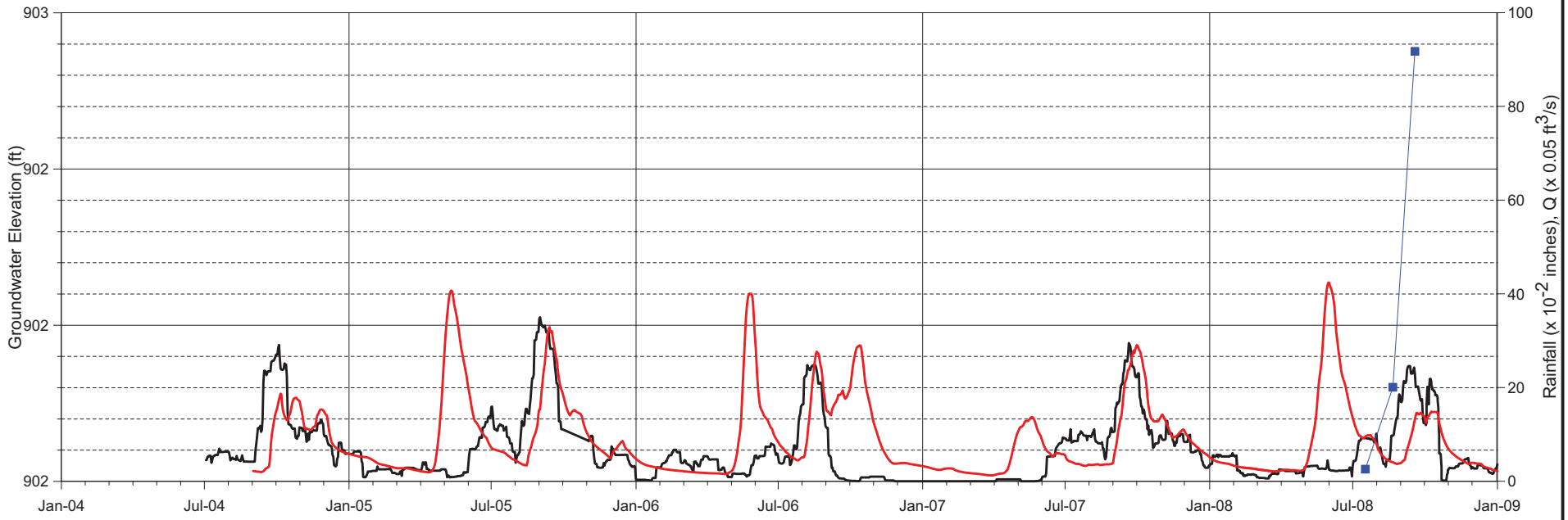


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-124



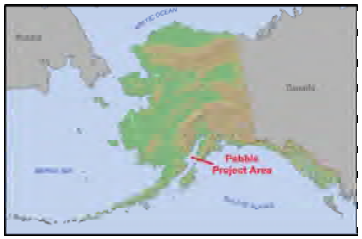
LEGEND:

Groundwater Elevation Plot Legend

- GH08-124
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

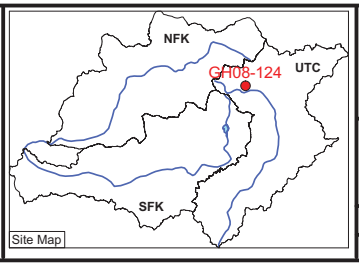
Screens (ft asl):
GH08-124 : 758.0 - 768.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 902.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-124.grf

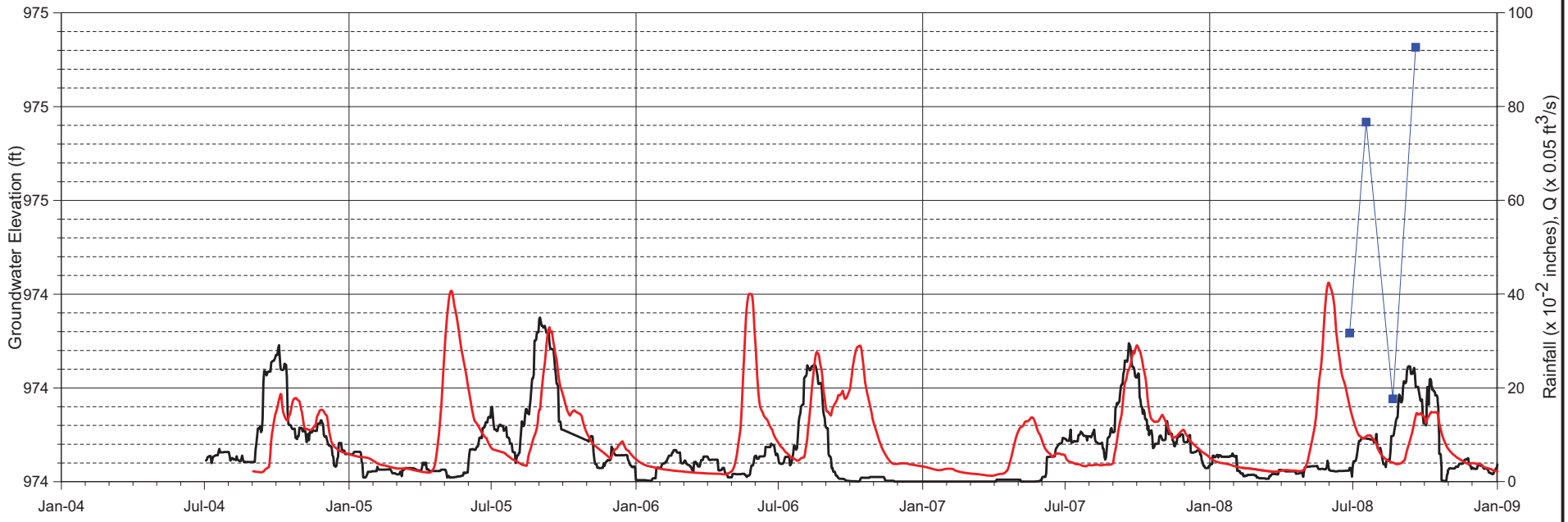


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-125



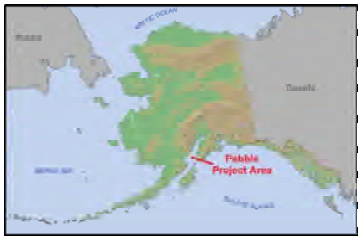
LEGEND:

Groundwater Elevation Plot Legend

- GH08-125
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

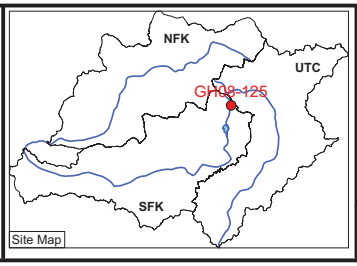
Screens (ft asl):
GH08-125 : 871.8 - 881.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 976.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-125.grf

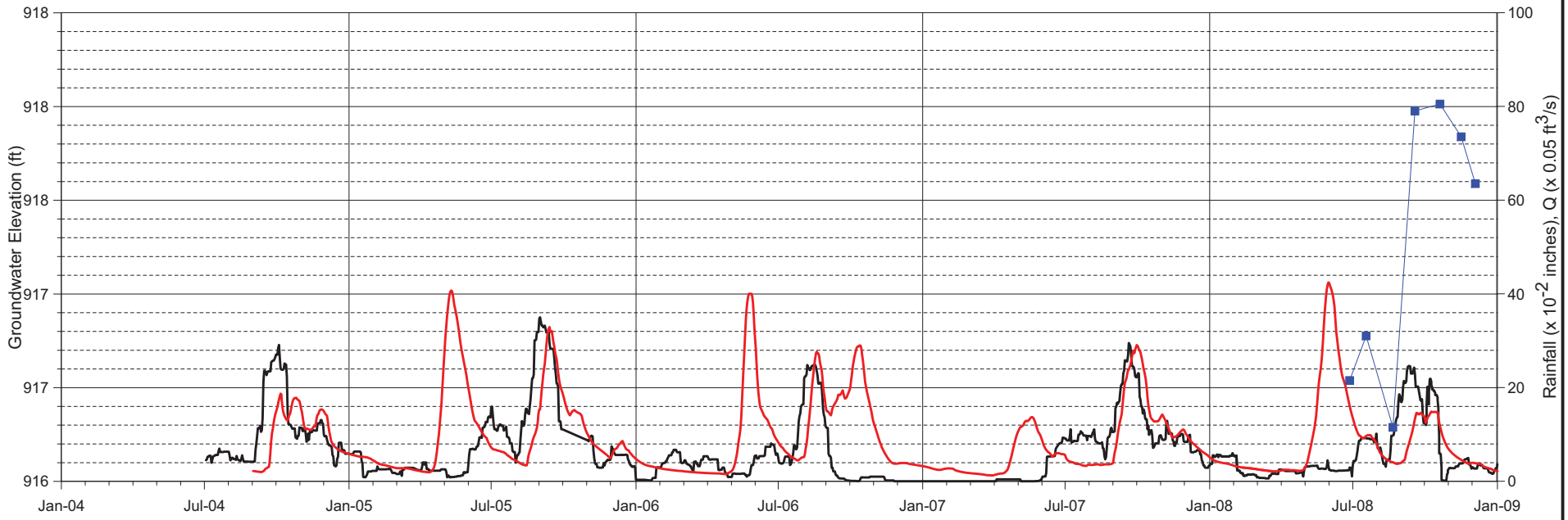


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-126



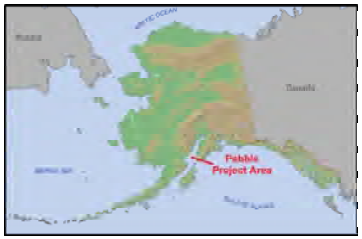
LEGEND:

Groundwater Elevation Plot Legend

- GH08-126
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

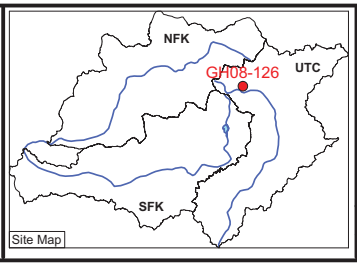
Screens (ft asl):
GH08-126 : 885.8 - 895.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 920.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-126.grf

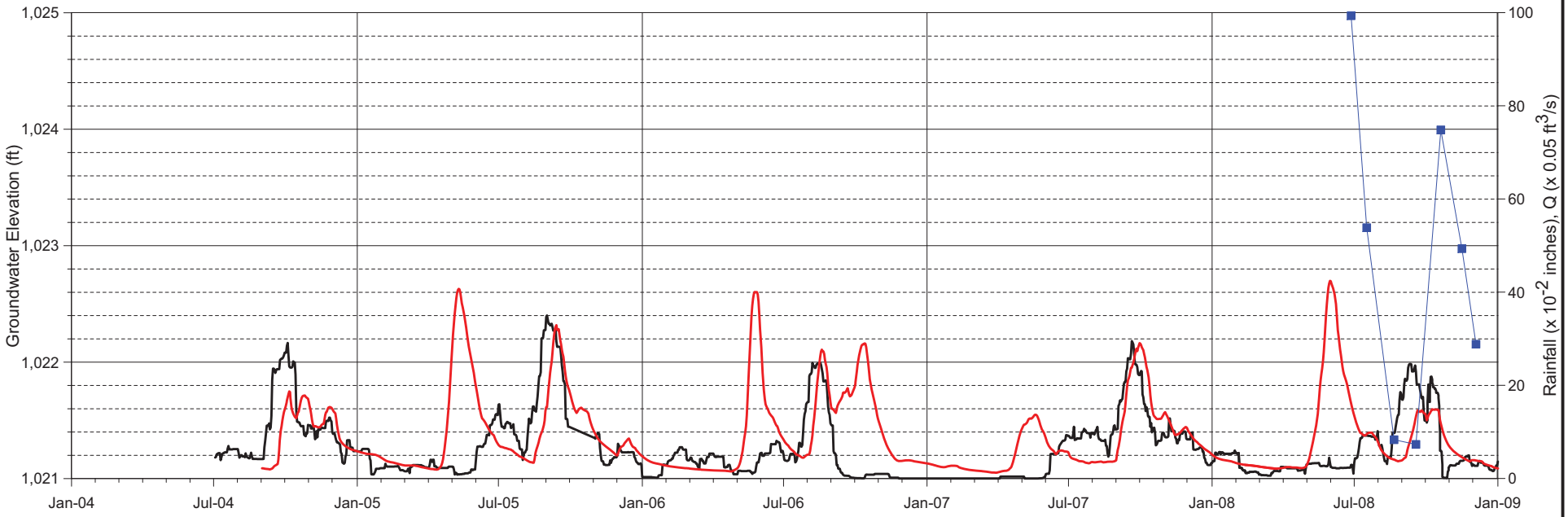


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-127



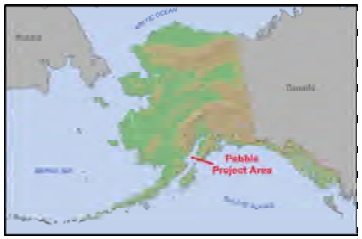
LEGEND:

Groundwater Elevation Plot Legend

- GH08-127
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

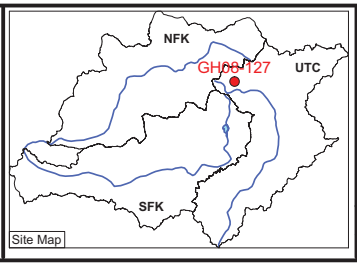
Screens (ft asl):
GH08-127 : 944.3 - 954.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1064.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-127.grf

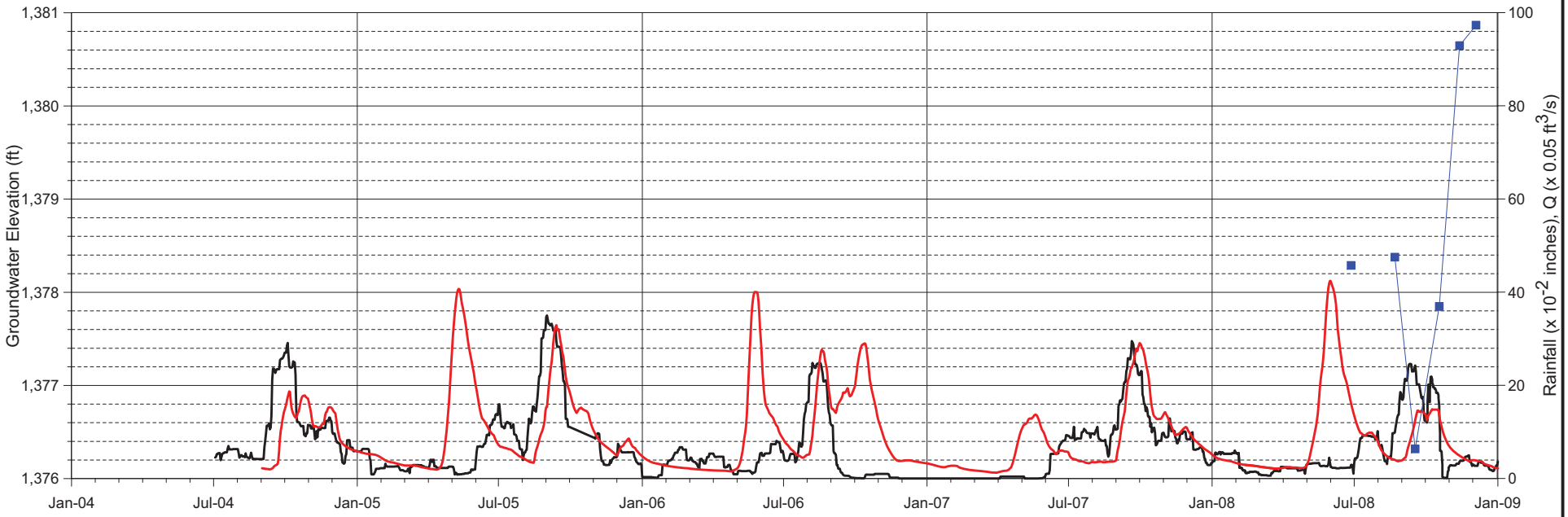


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-128



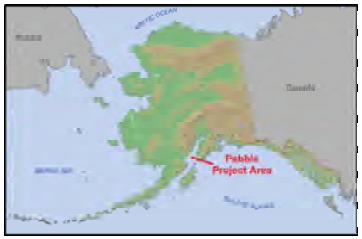
LEGEND:

Groundwater Elevation Plot Legend

- GH08-128
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

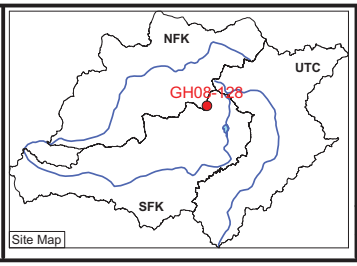
Screens (ft asl):
GH08-128 : 1353.9 - 1363.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1458.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-128.grf

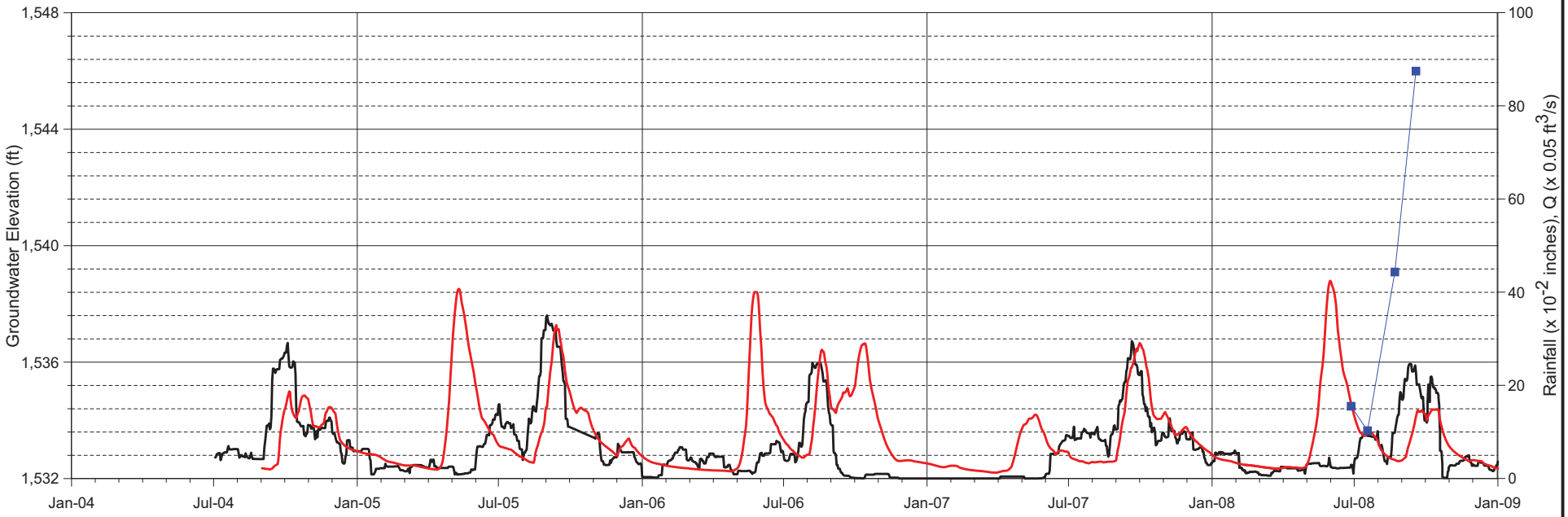


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-129



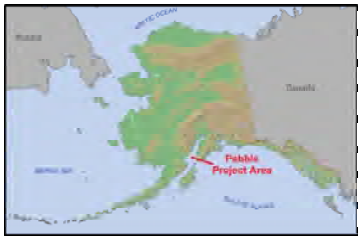
LEGEND:

Groundwater Elevation Plot Legend

- GH08-129
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

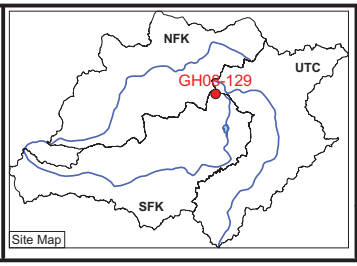
Screens (ft asl):
GH08-129 : 1500.0 - 1510.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1545 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-129.grf

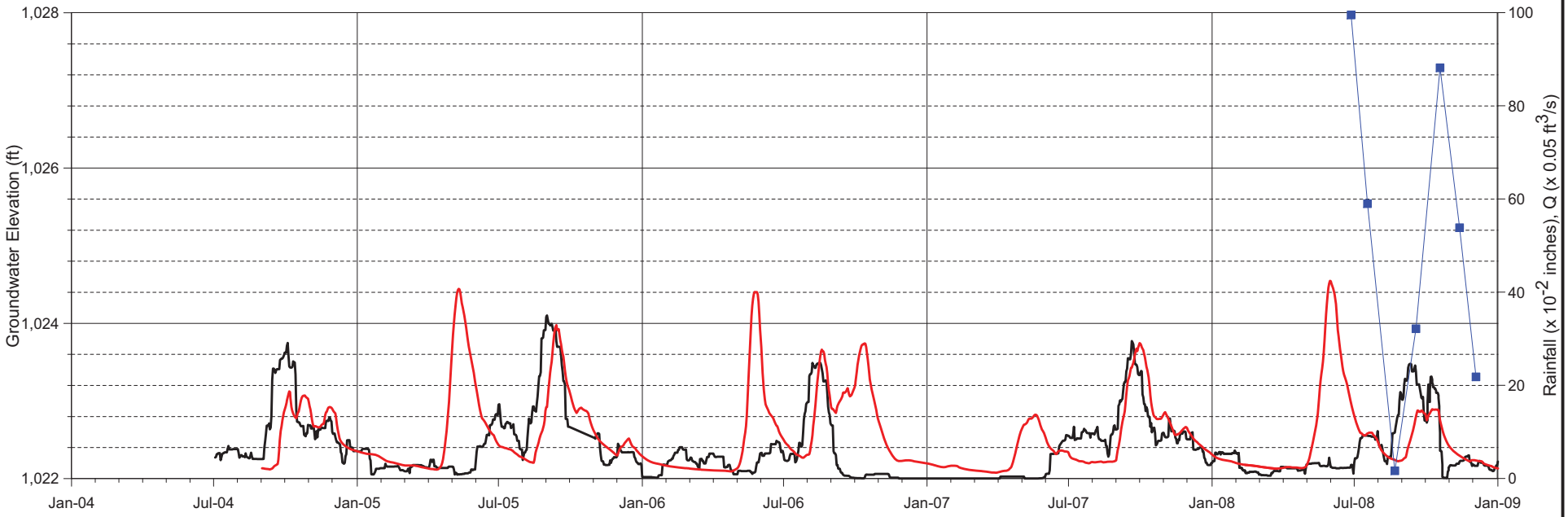


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-131



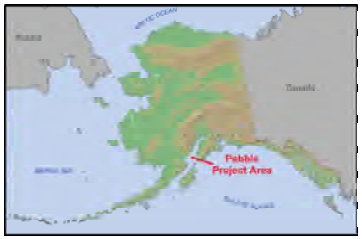
LEGEND:

Groundwater Elevation Plot Legend

- GH08-131
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

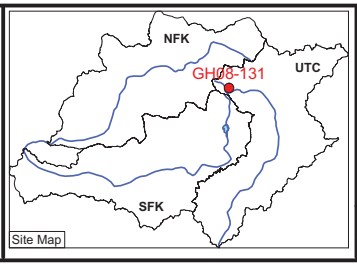
Screens (ft asl):
GH08-131 : 986.3 - 996.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1056.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-131.grf

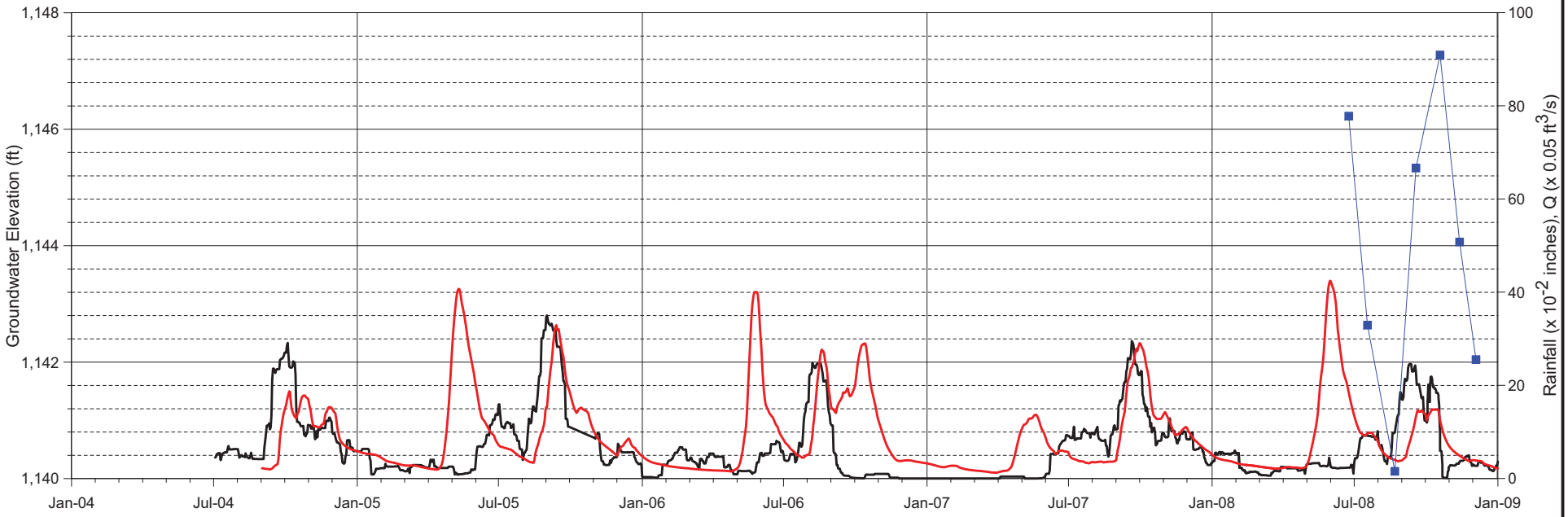


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-132



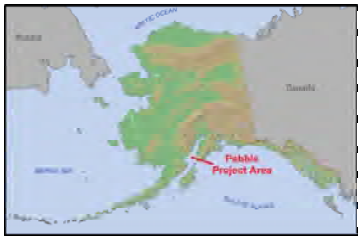
LEGEND:

Groundwater Elevation Plot Legend

- GH08-132
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

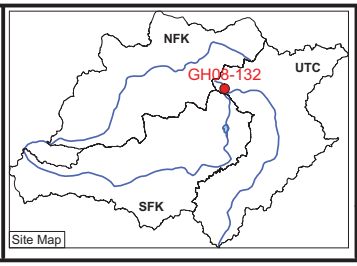
Screens (ft asl):
GH08-132 : 1115.6 - 1126.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1156.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-132.grf

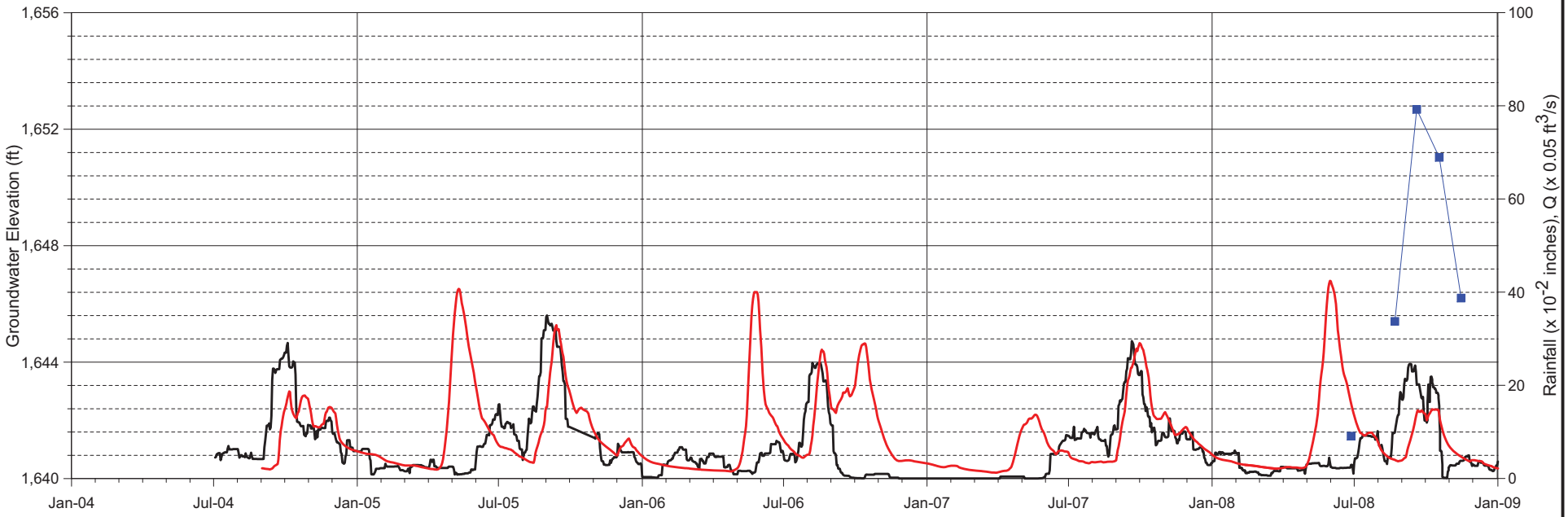


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-133



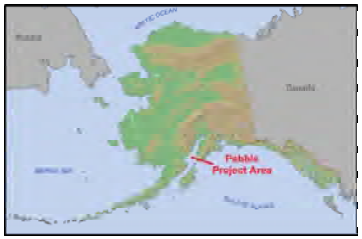
LEGEND:

Groundwater Elevation Plot Legend

- GH08-133
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

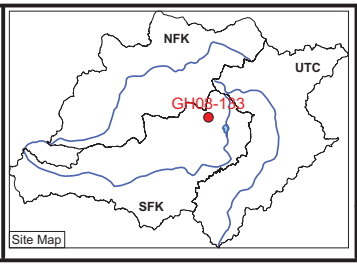
Screens (ft asl):
GH08-133 : 1638.9 - 1648.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1663.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-133.grf

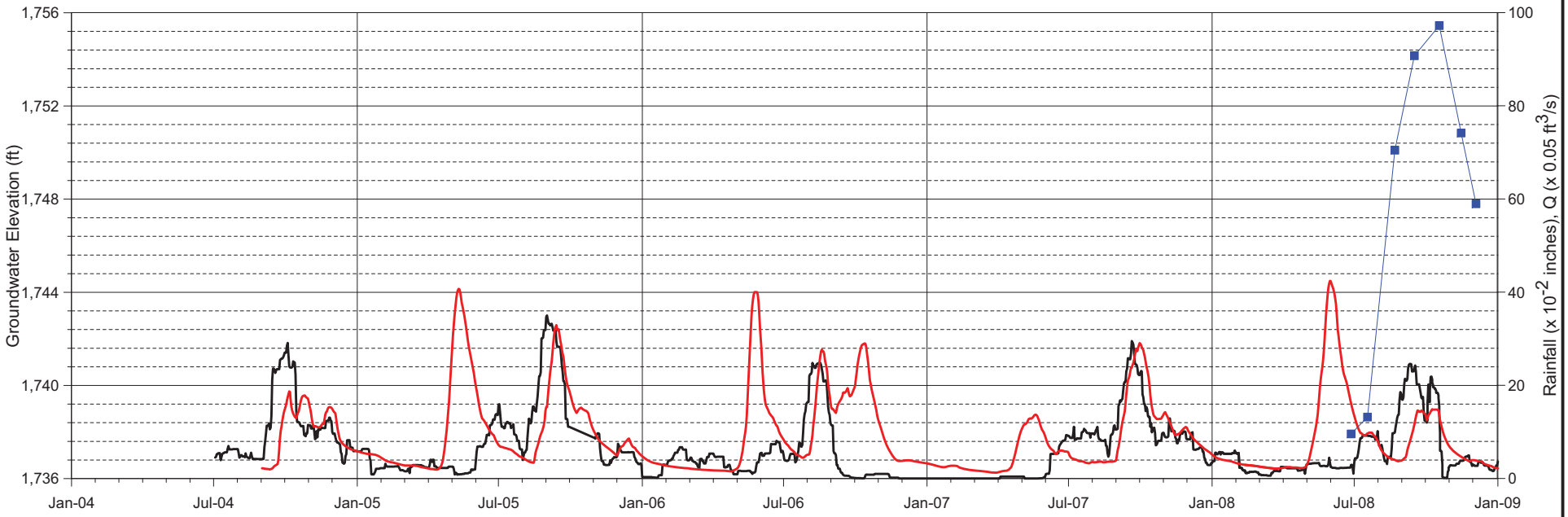


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-135



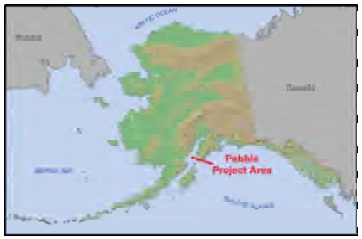
LEGEND:

Groundwater Elevation Plot Legend

- GH08-135
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

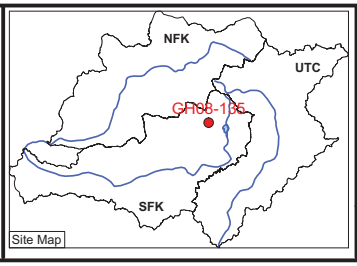
Screens (ft asl):
GH08-135 : 1661.8 - 1671.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1761.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-135.grf

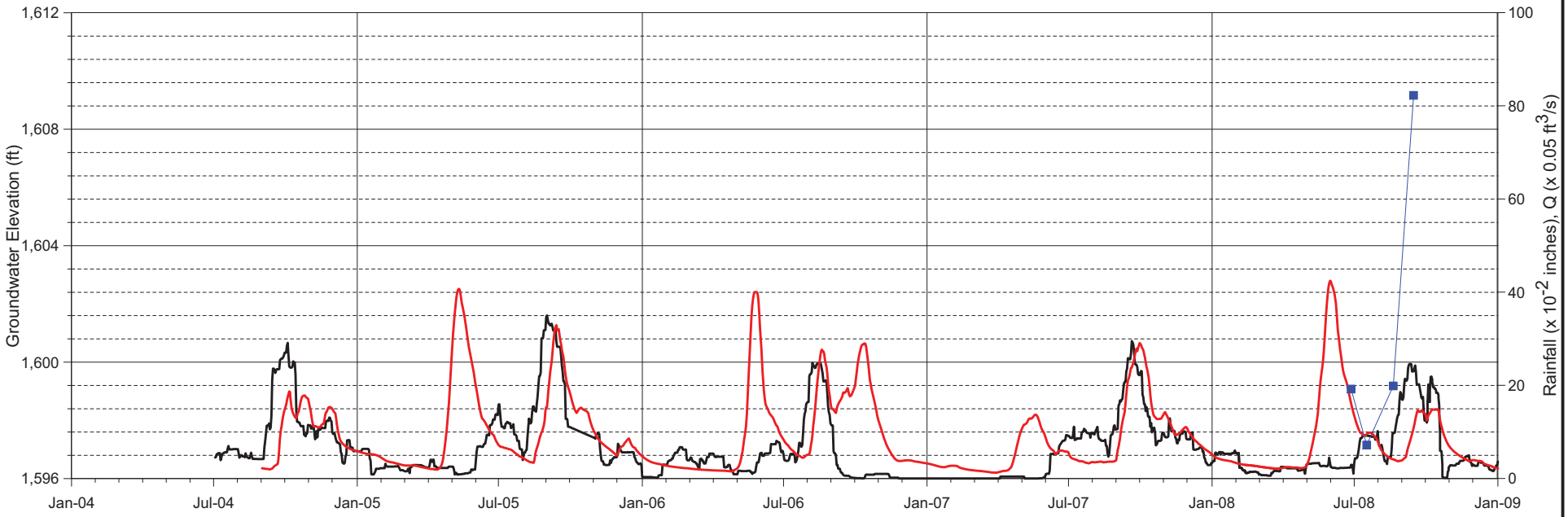


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-136



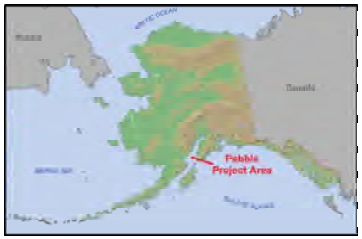
LEGEND:

Groundwater Elevation Plot Legend

- GH08-136
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

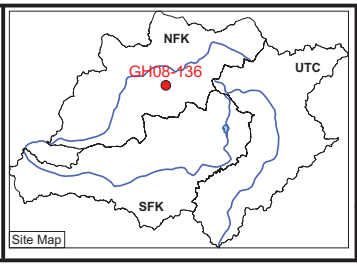
Screens (ft asl):
GH08-136 : 1500.2 - 1510.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1610.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-136.grf

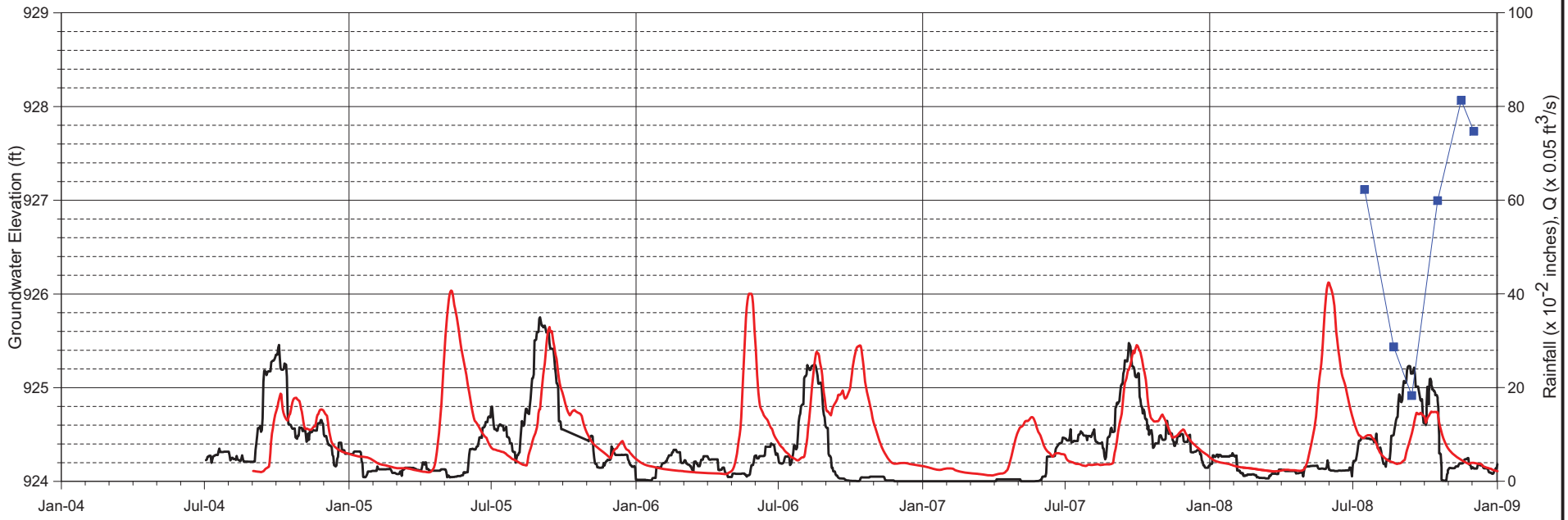


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-137



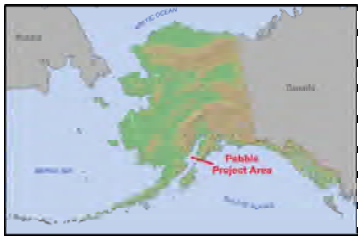
LEGEND:

Groundwater Elevation Plot Legend

- GH08-137
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

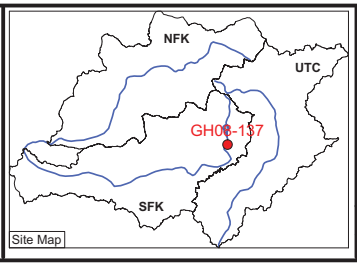
Screens (ft asl):
GH08-137 : 900.1 - 910.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1038.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-137.grf

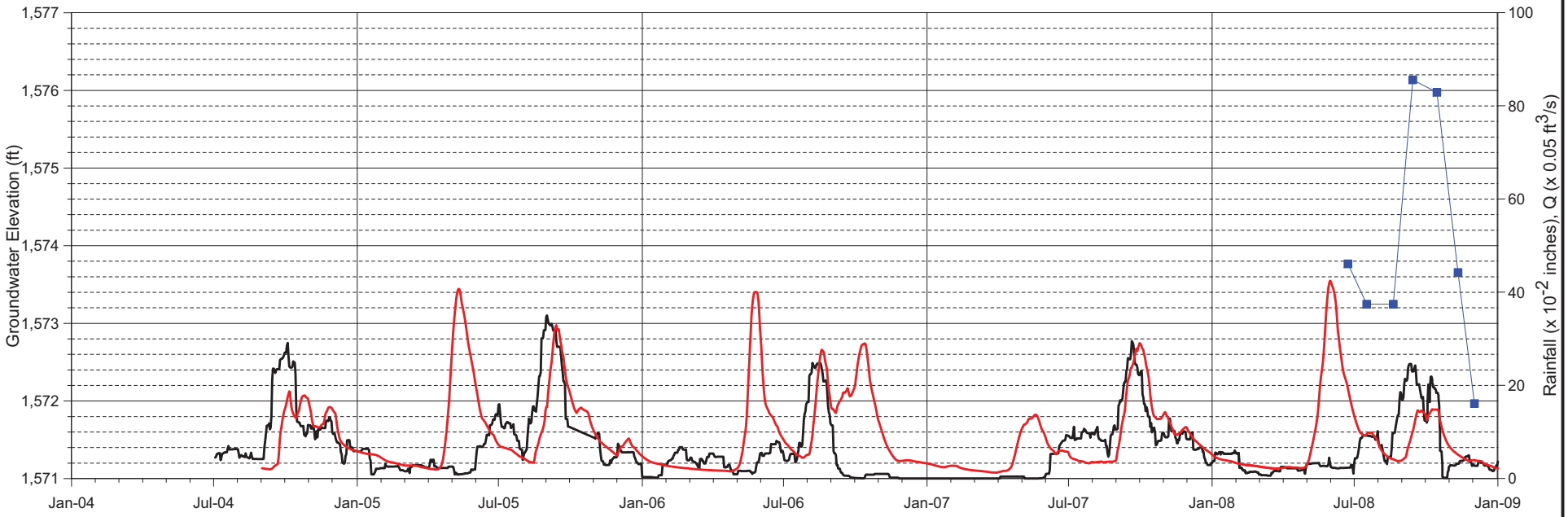


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-138



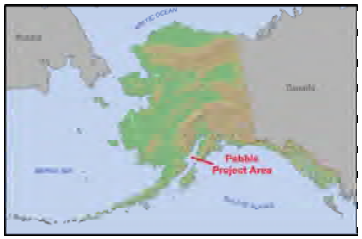
LEGEND:

Groundwater Elevation Plot Legend

- GH08-138
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

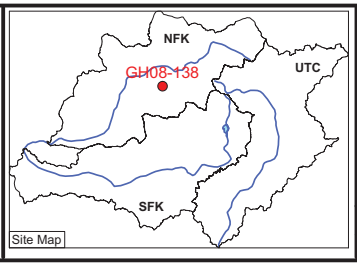
Screens (ft asl):
GH08-138 : 1417.2 - 1437.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1577.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-138.grf

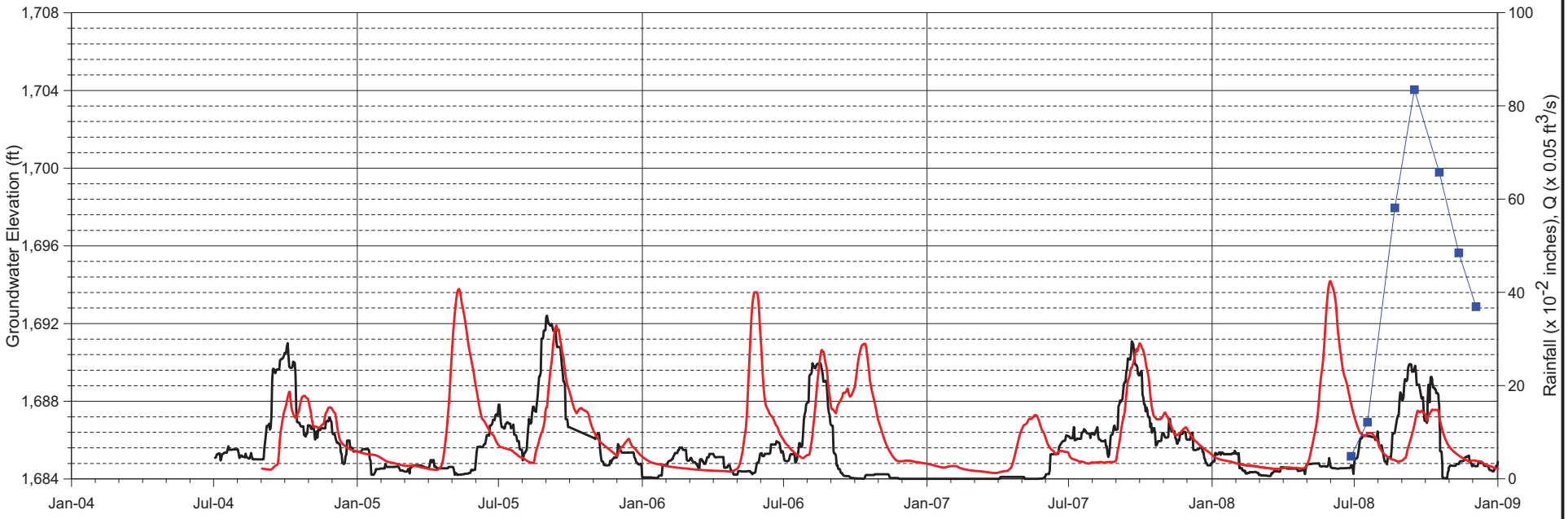


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-139



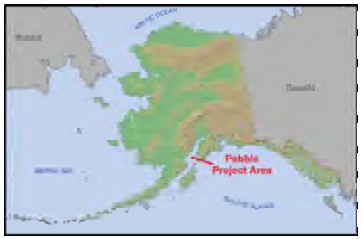
LEGEND:

Groundwater Elevation Plot Legend

- GH08-139
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

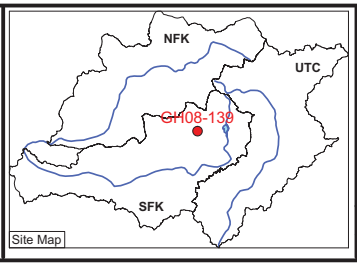
Screens (ft asl):
GH08-139 : 1595.8 - 1605.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1710.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-139.grf

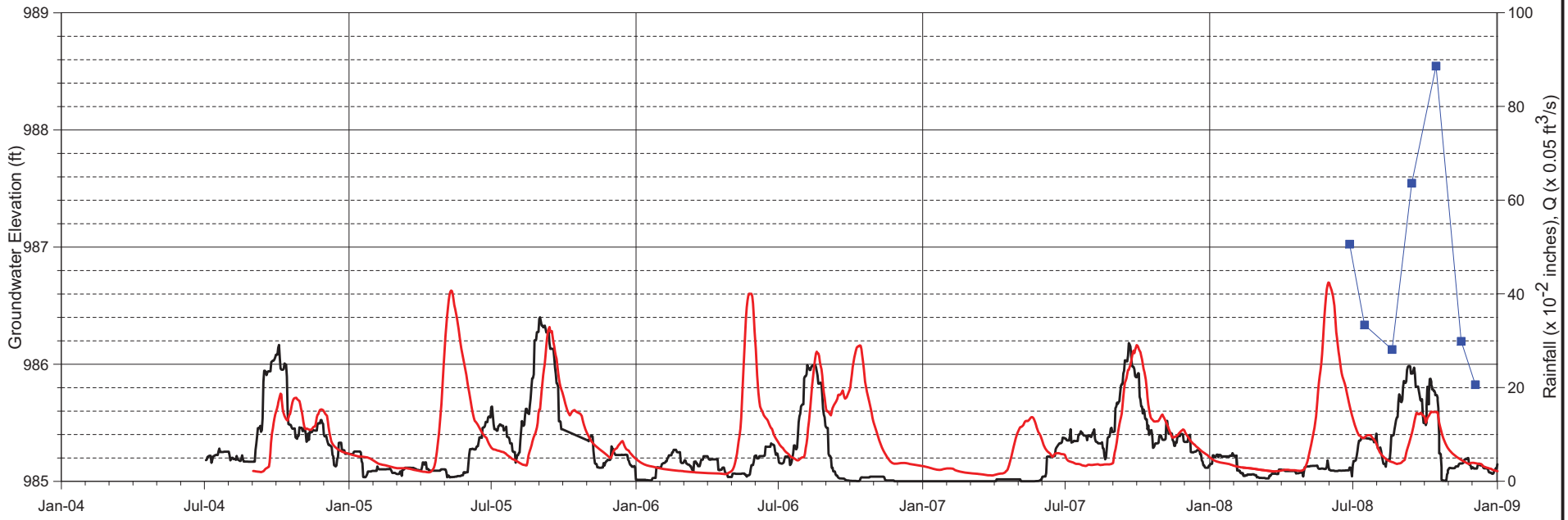


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-140



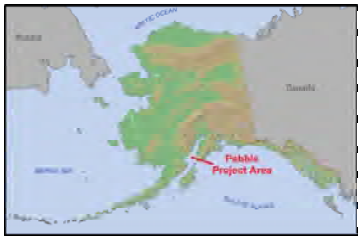
LEGEND:

Groundwater Elevation Plot Legend

- GH08-140
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

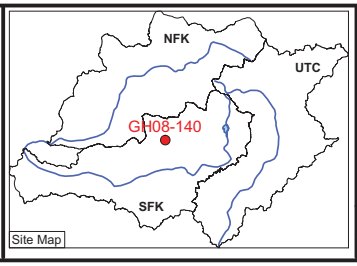
Screens (ft asl):
GH08-140 : 900.7 - 910.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1025.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-140.grf

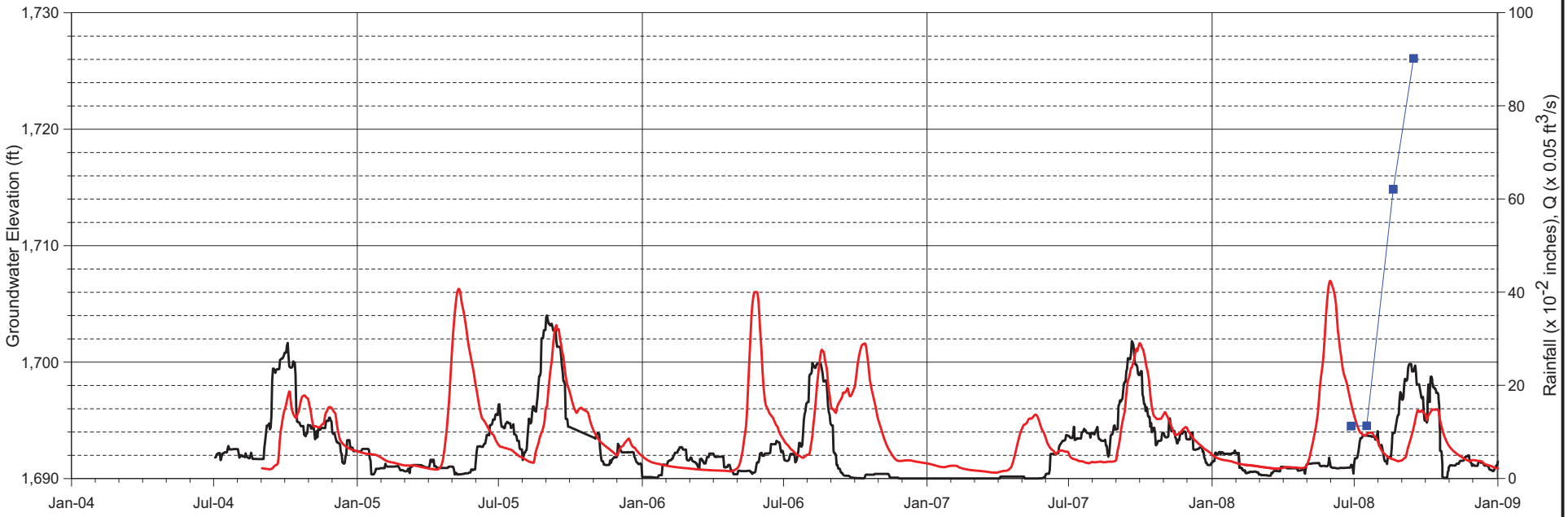


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-141



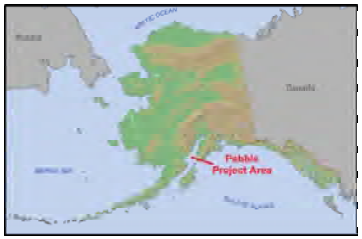
LEGEND:

Groundwater Elevation Plot Legend

- GH08-141
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

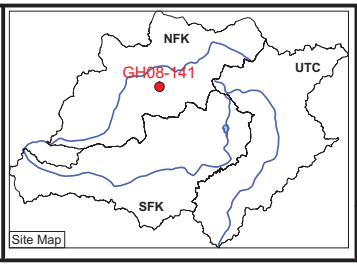
Screens (ft asl):
GH08-141 : 1675.0 - 1685.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1725 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-141.grf

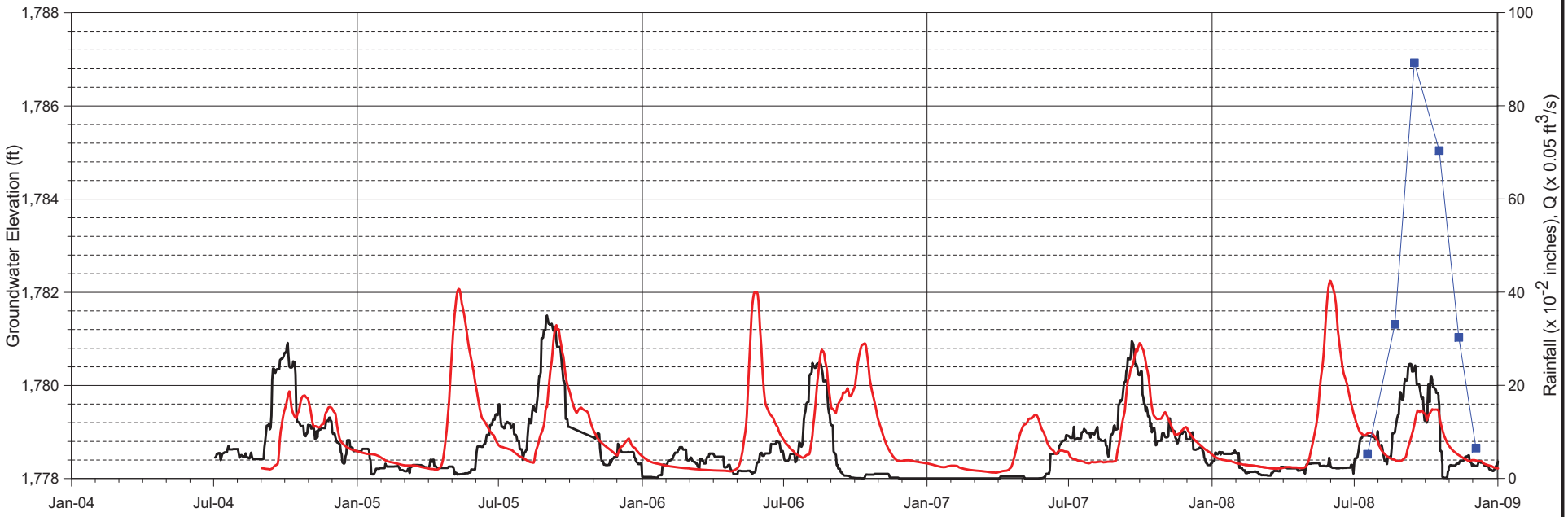


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-142



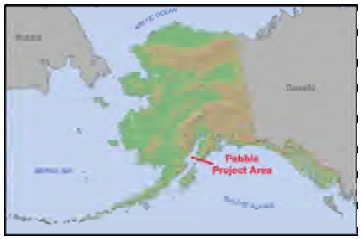
LEGEND:

Groundwater Elevation Plot Legend

- GH08-142
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

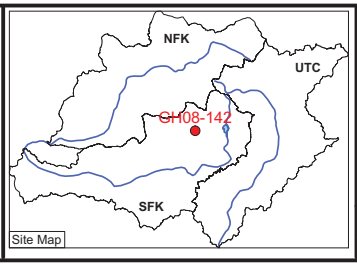
Screens (ft asl):
GH08-142 : 1652.4 - 1662.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1802.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-142.grf

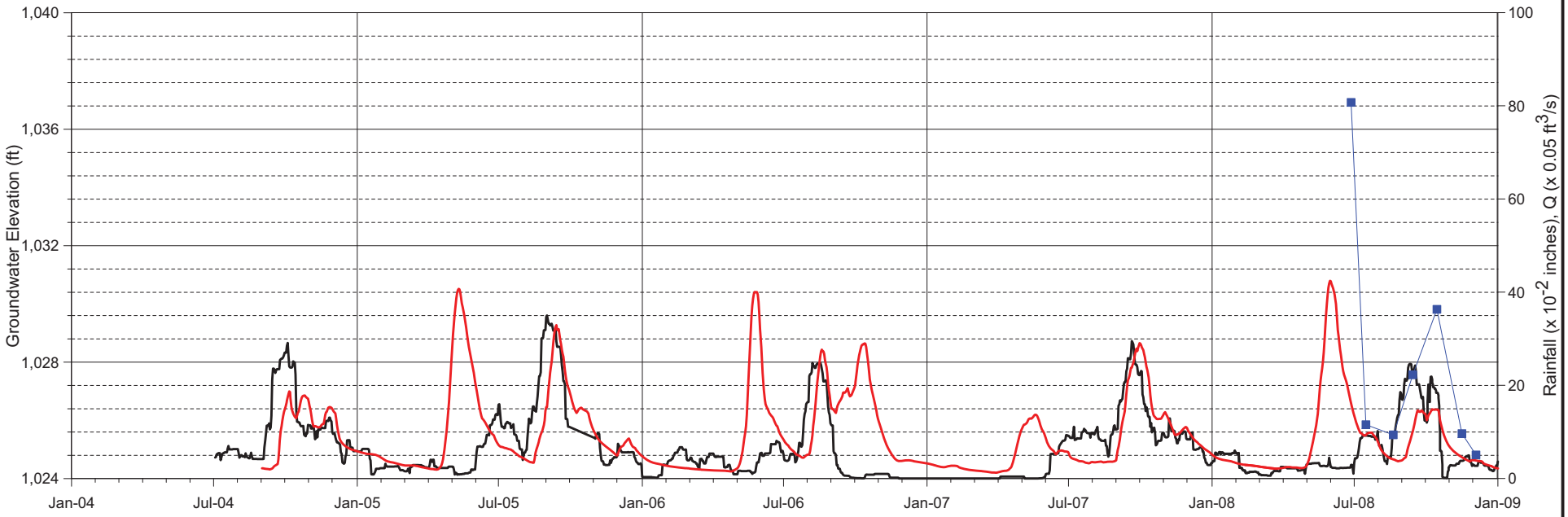


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-143



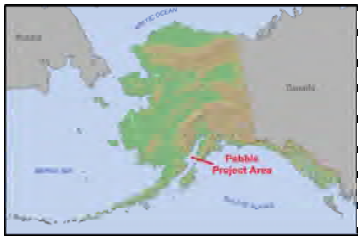
LEGEND:

Groundwater Elevation Plot Legend

- GH08-143
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

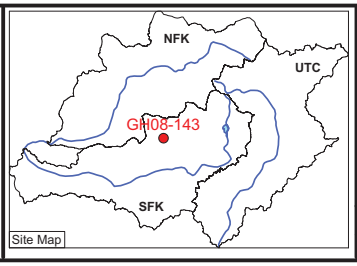
Screens (ft asl):
GH08-143 : 885.7 - 895.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1060.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-143.grf

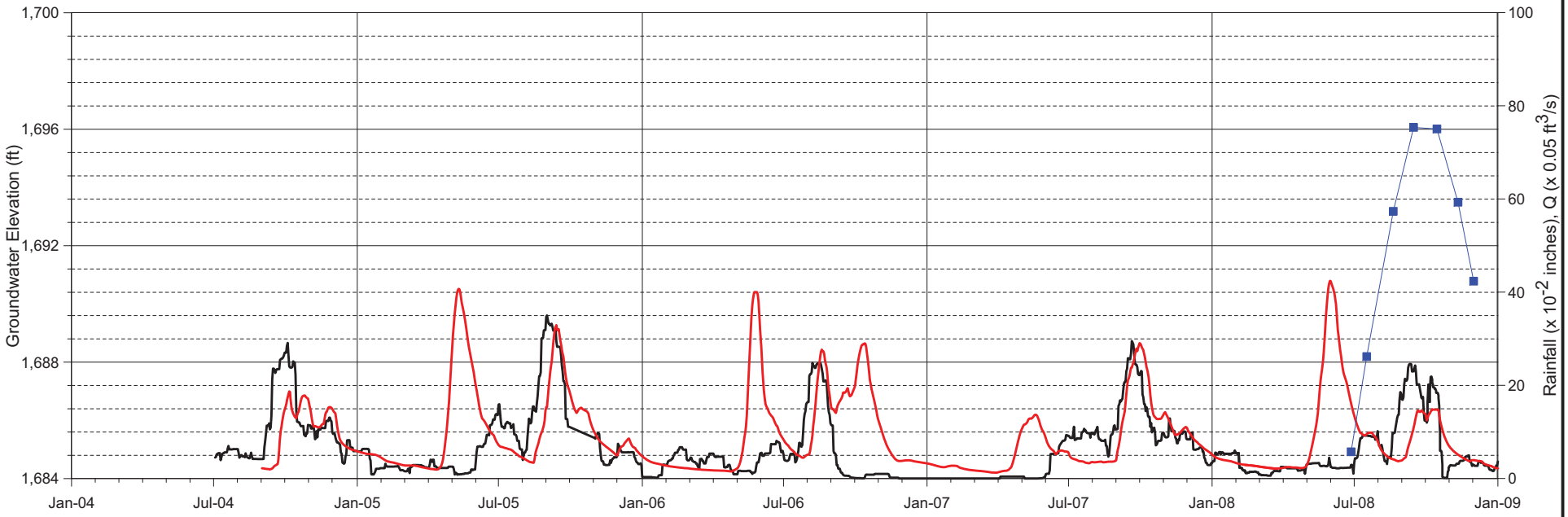


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-144



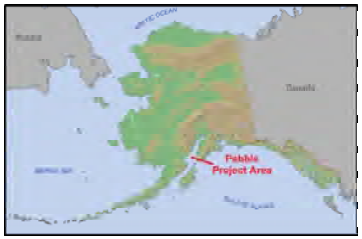
LEGEND:

Groundwater Elevation Plot Legend

- GH08-144
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

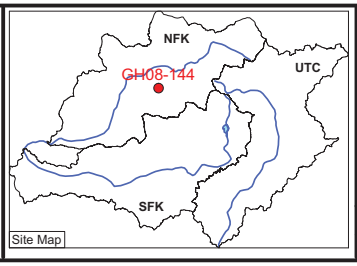
Screens (ft asl):
GH08-144 : 1666.9 - 1676.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1696.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-144.grf

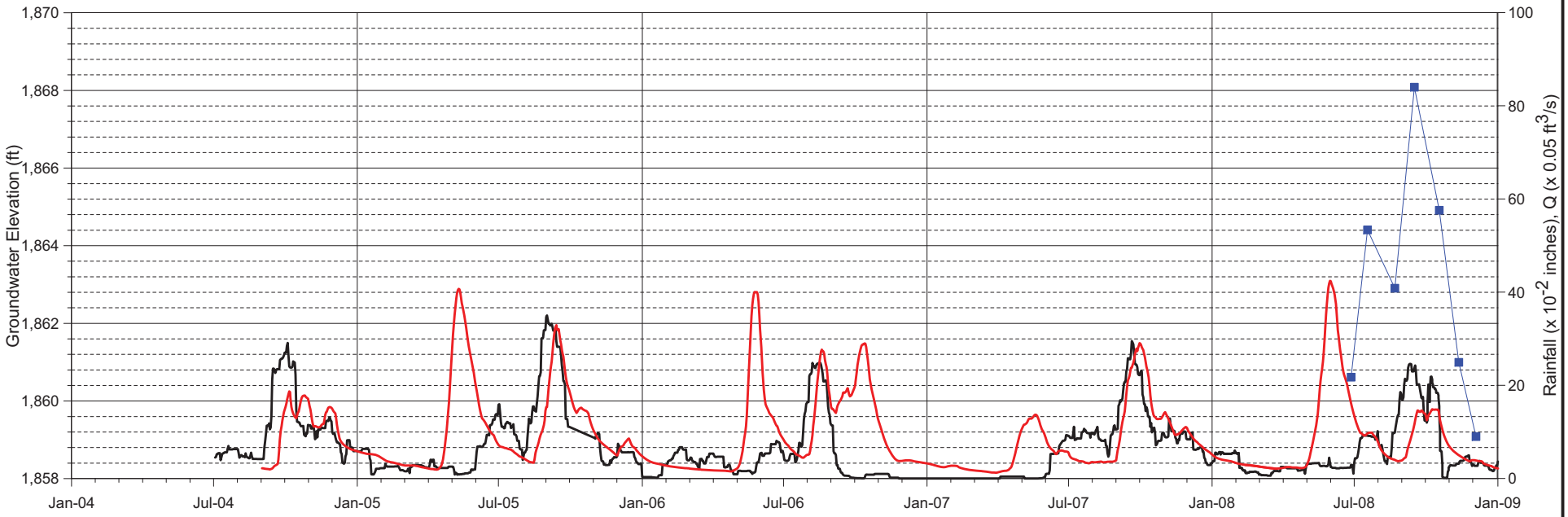


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-145



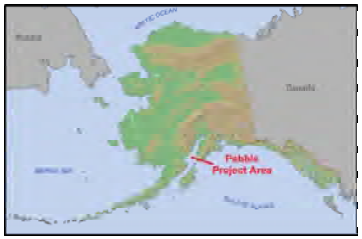
LEGEND:

Groundwater Elevation Plot Legend

- GH08-145
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

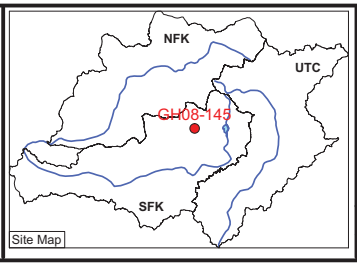
Screens (ft asl):
GH08-145 : 1826.1 - 1836.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1876.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-145.grf

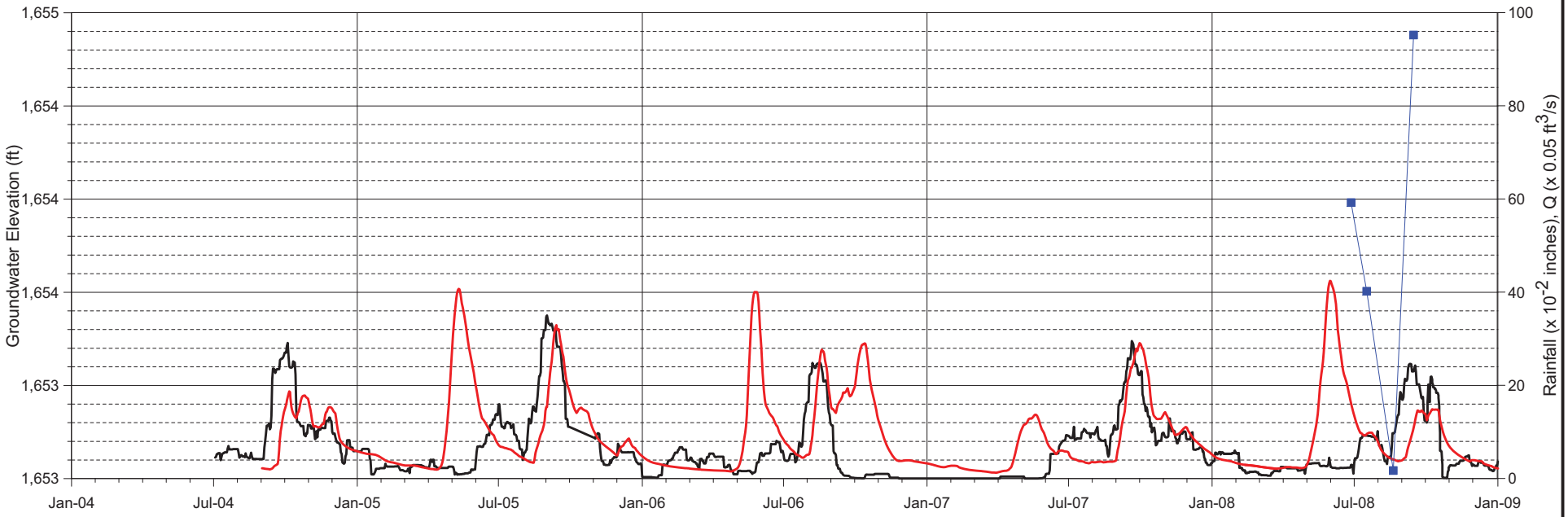


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-146



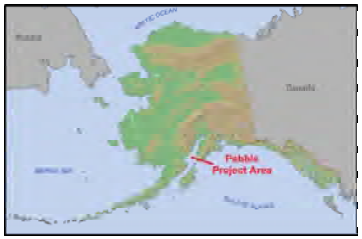
LEGEND:

Groundwater Elevation Plot Legend

- GH08-146
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

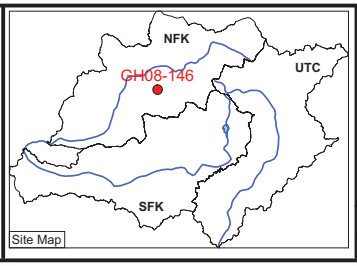
Screens (ft asl):
GH08-146 : 1605.2 - 1615.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1655.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-146.grf

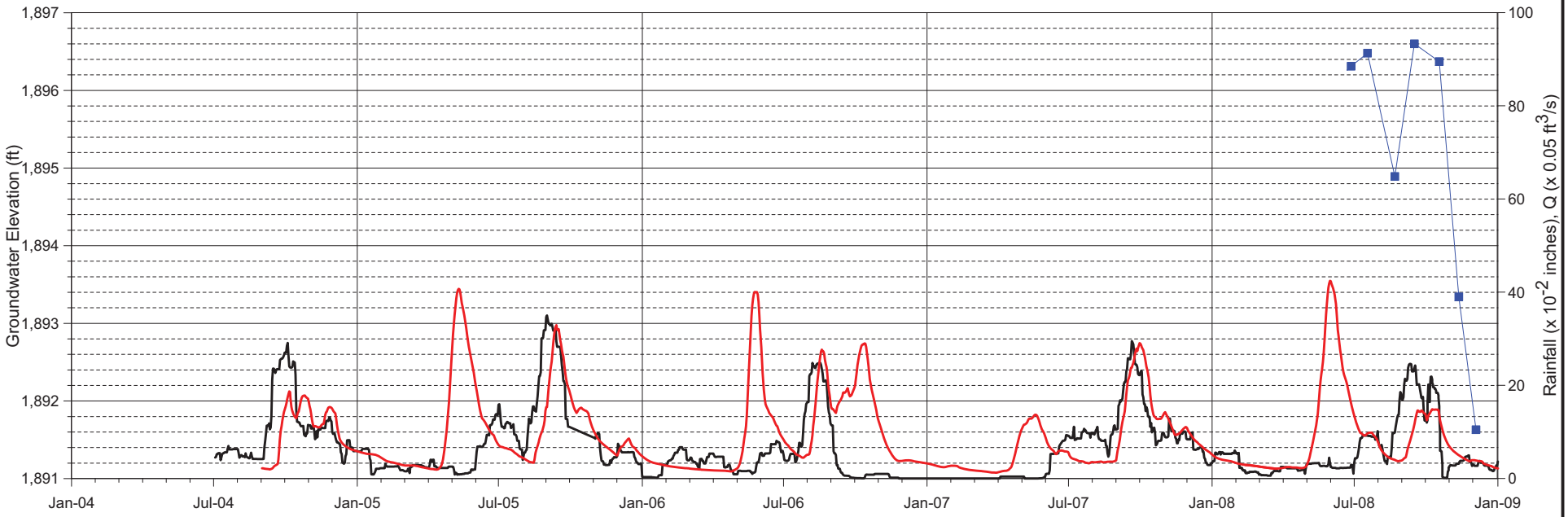


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-147



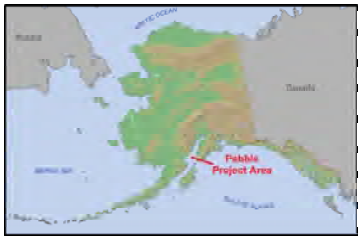
LEGEND:

Groundwater Elevation Plot Legend

- GH08-147
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

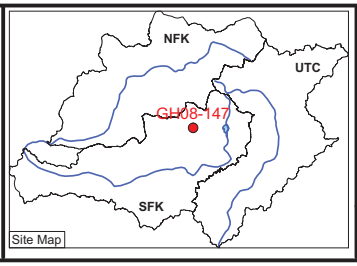
Screens (ft asl):
GH08-147 : 1805.3 - 1815.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1899.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-147.grf

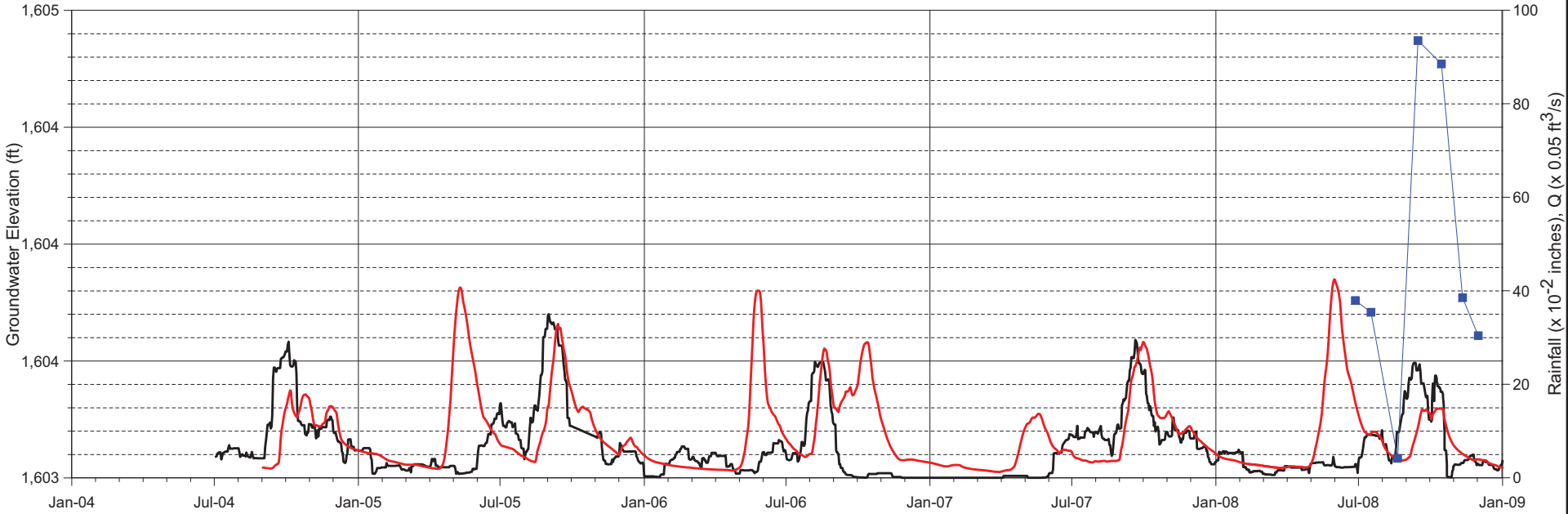


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-148



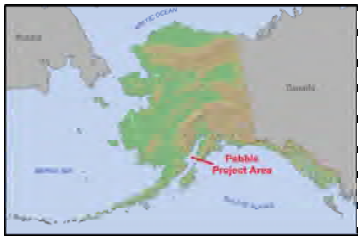
LEGEND:

Groundwater Elevation Plot Legend

- GH08-148
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

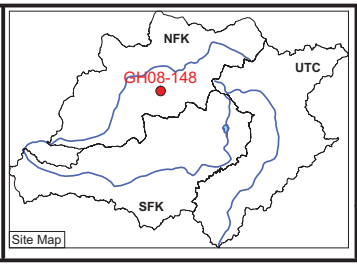
Screens (ft asl):
GH08-148 : 1387.1 - 1407.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1612.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-148.grf

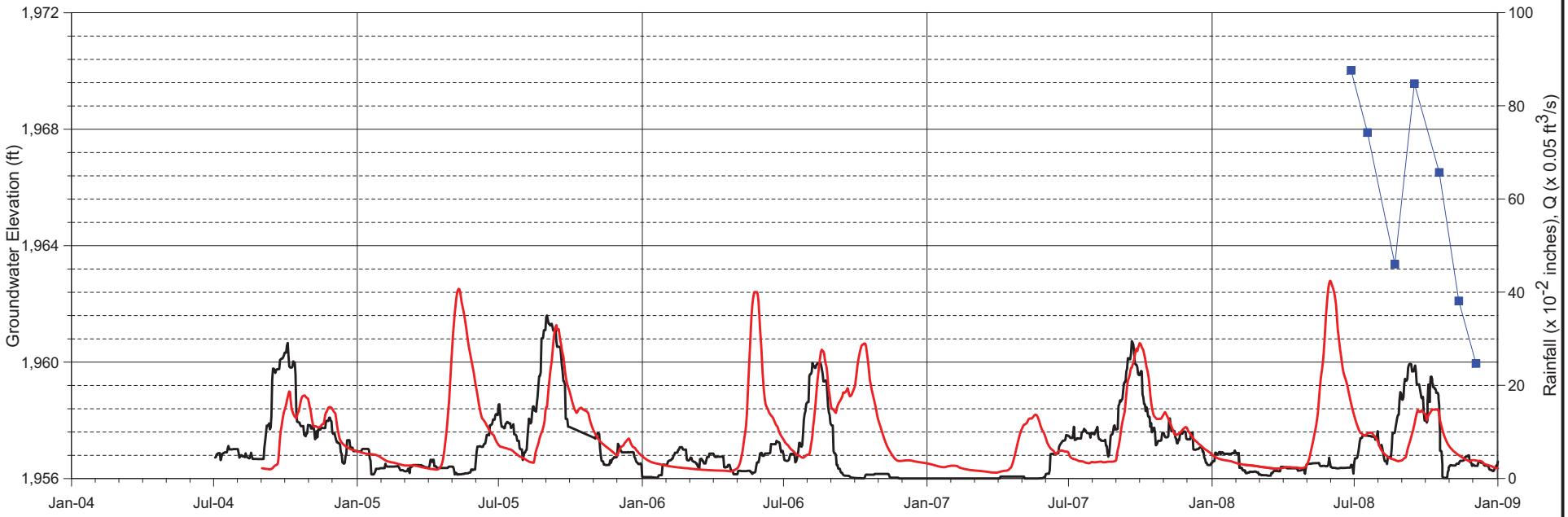


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-149



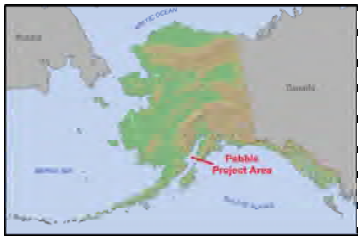
LEGEND:

Groundwater Elevation Plot Legend

- GH08-149
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

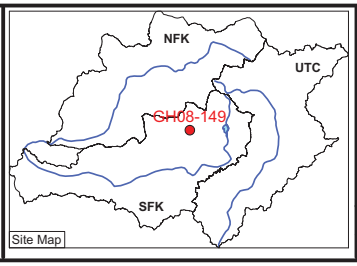
Screens (ft asl):
GH08-149 : 1899.8 - 1909.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1969.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-149.grf

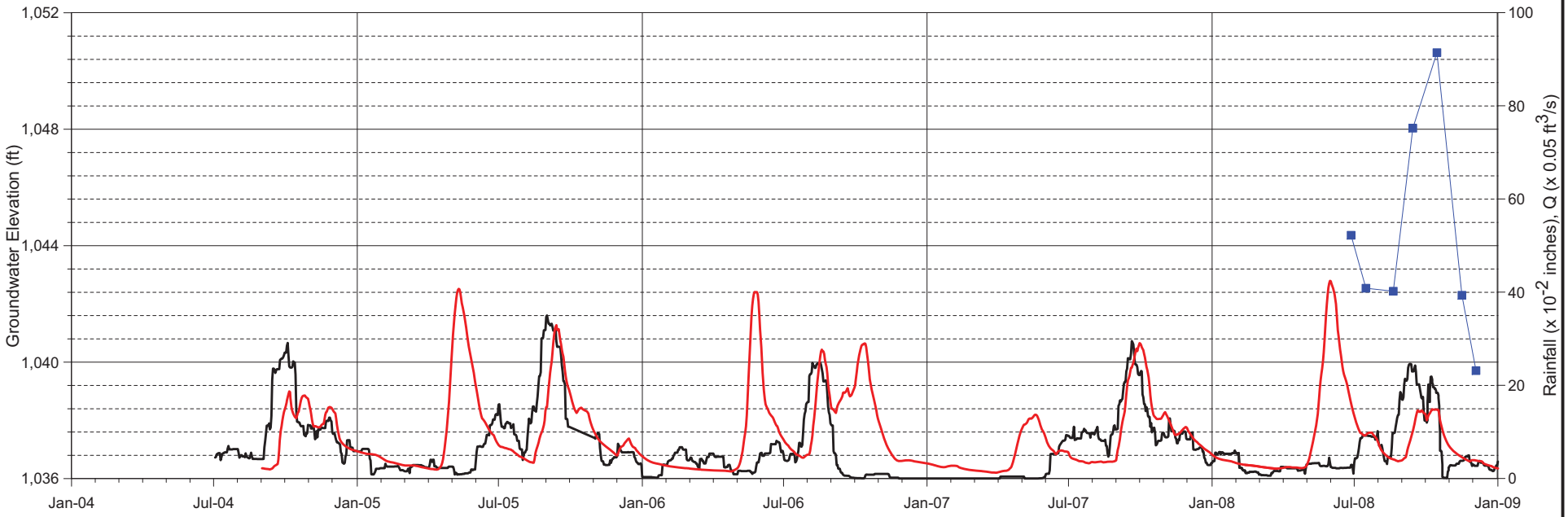


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-150



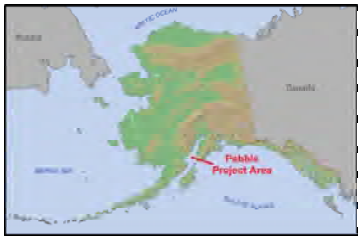
LEGEND:

Groundwater Elevation Plot Legend

- GH08-150
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

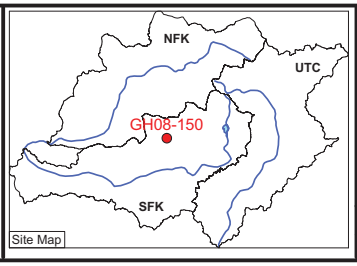
Screens (ft asl):
GH08-150 : 1027.7 - 1037.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1077.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-150.grf

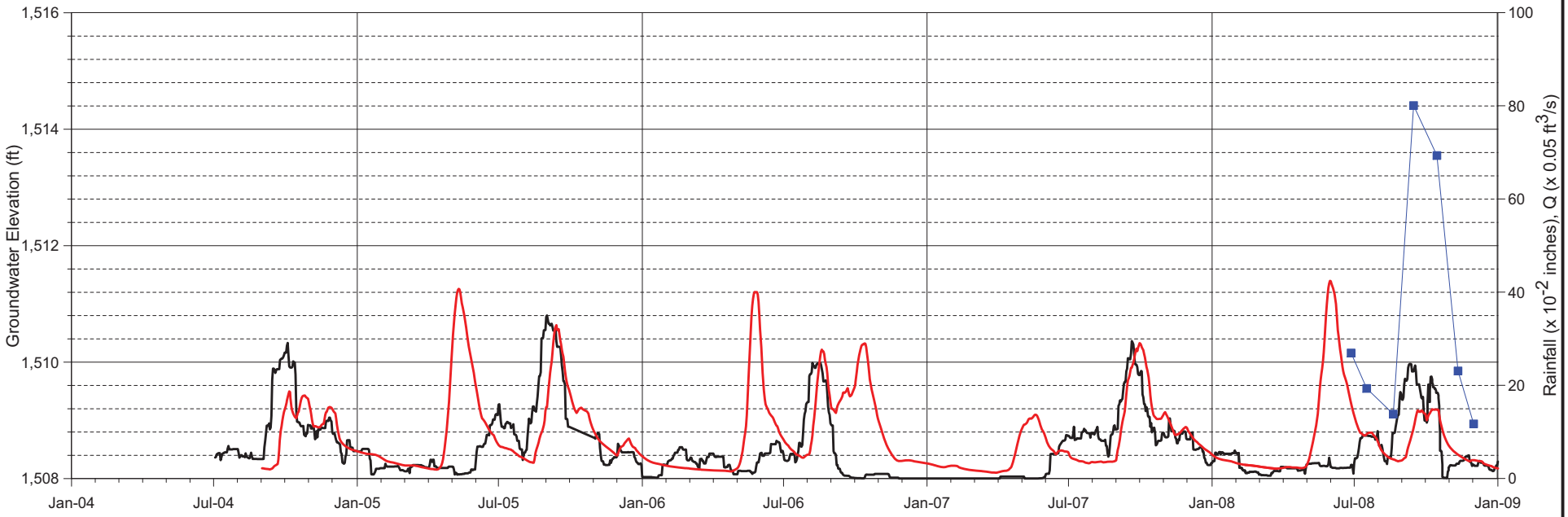


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-151



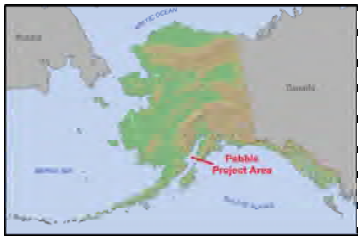
LEGEND:

Groundwater Elevation Plot Legend

- GH08-151
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

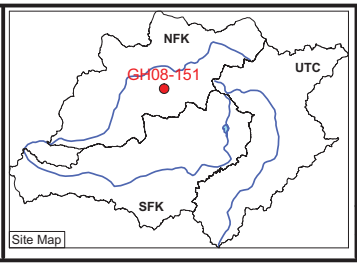
Screens (ft asl):
GH08-151 : 1429.5 - 1439.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1519.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-151.grf

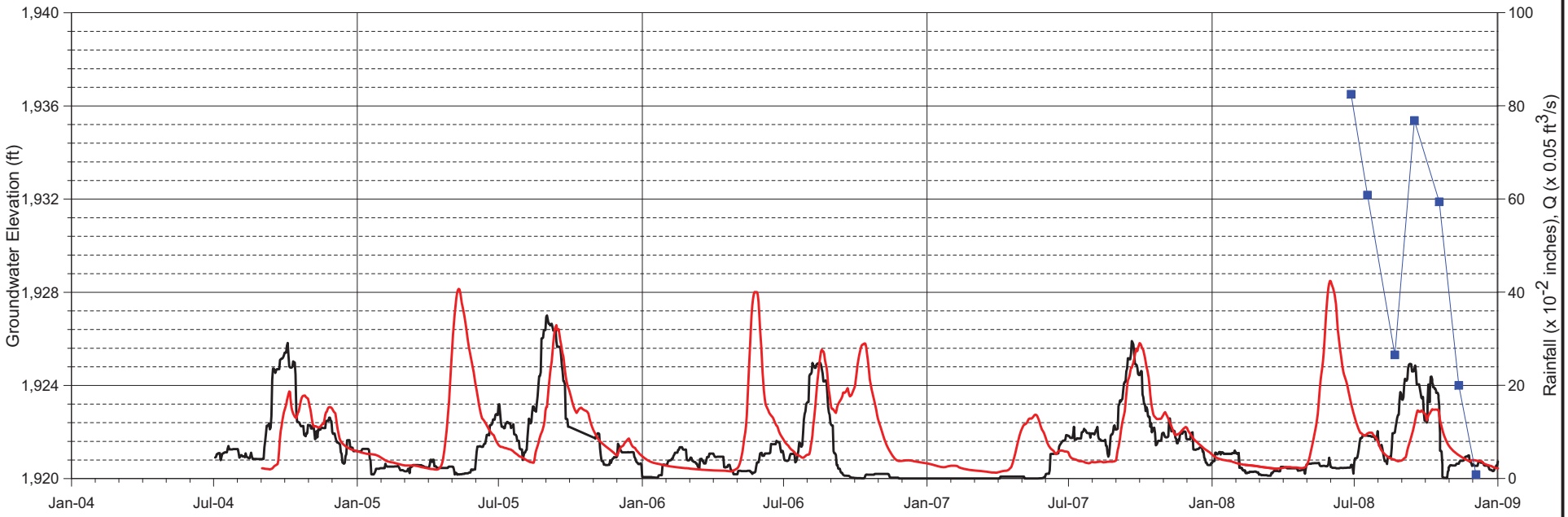


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-152



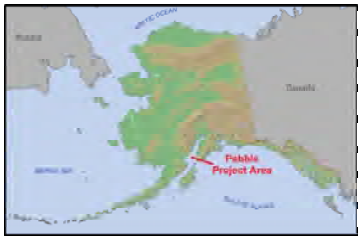
LEGEND:

Groundwater Elevation Plot Legend

- GH08-152
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

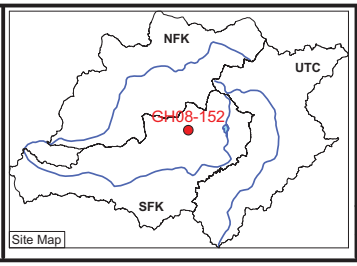
Screens (ft asl):
GH08-152 : 1852.8 - 1862.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1947.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-152.grf

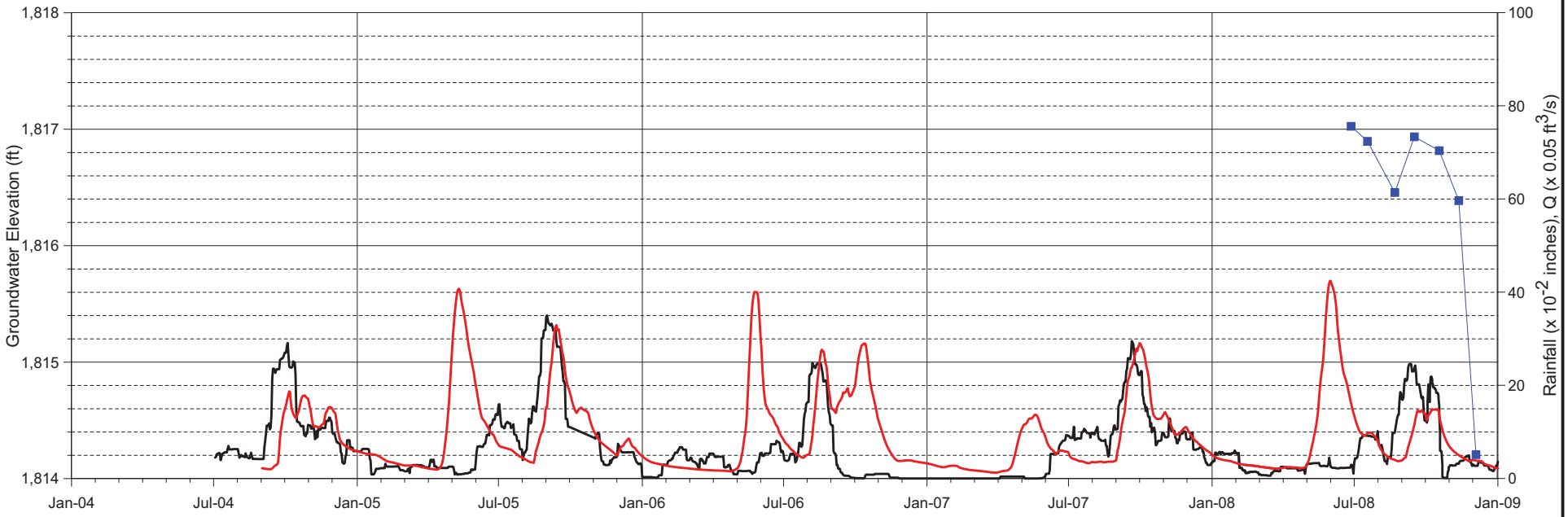


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-153



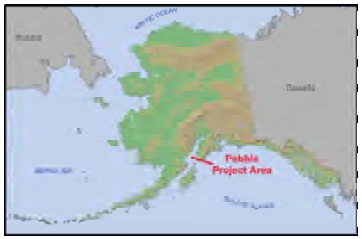
LEGEND:

Groundwater Elevation Plot Legend

- GH08-153
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

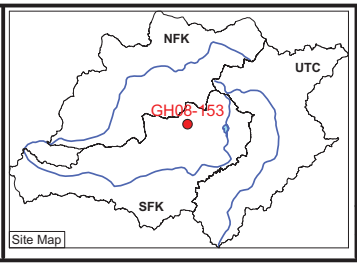
Screens (ft asl):
GH08-153 : 1788.8 - 1798.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1818.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-153.grf

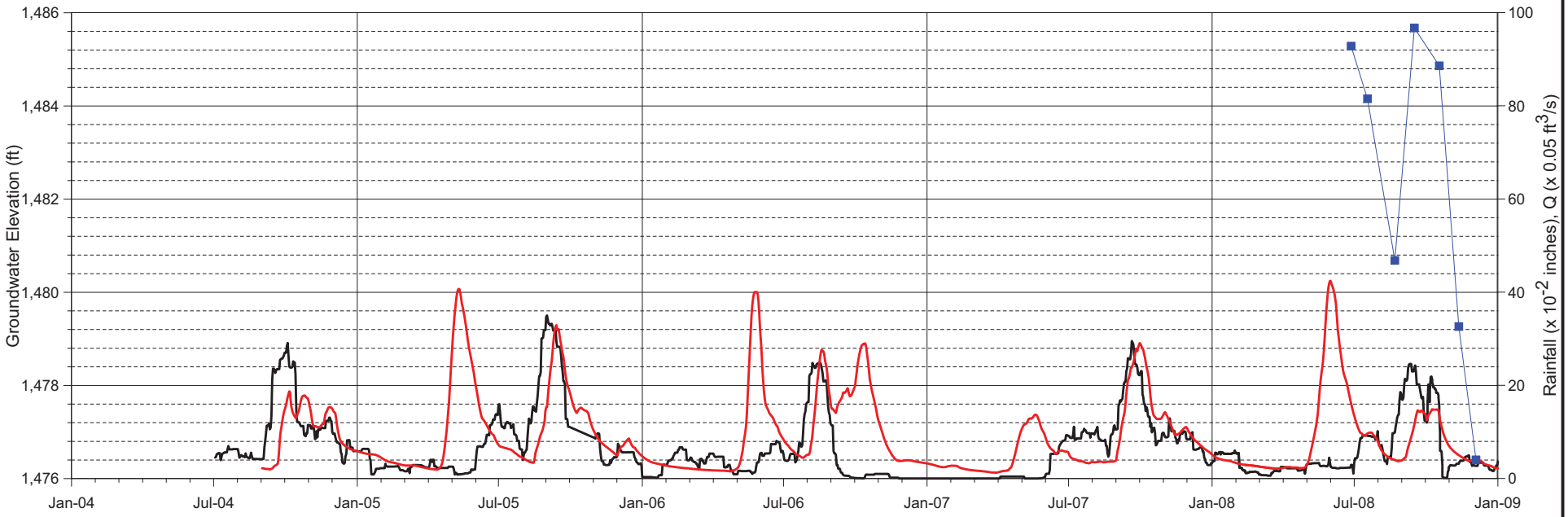


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-154



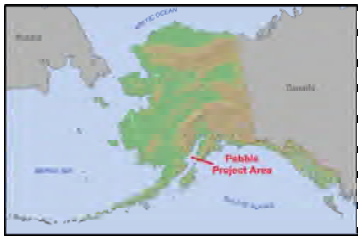
LEGEND:

Groundwater Elevation Plot Legend

- GH08-154
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

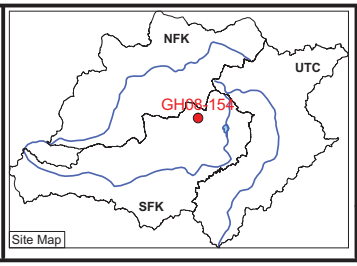
Screens (ft asl):
GH08-154 : 1438.0 - 1448.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1488 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-154.grf

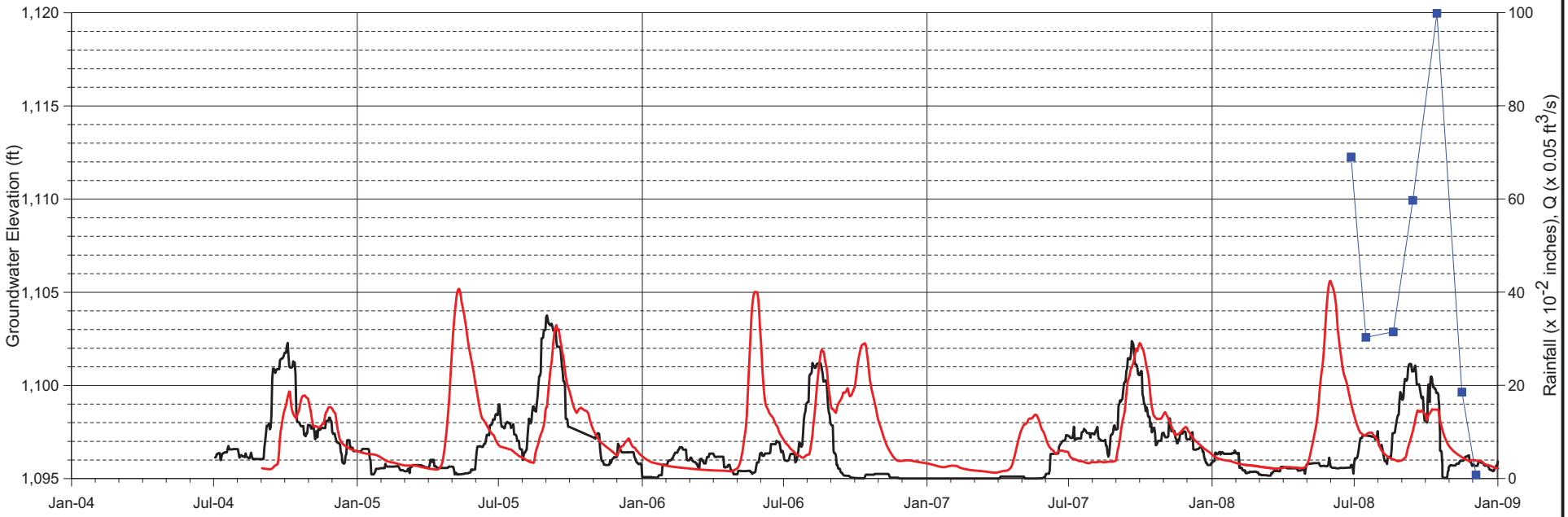


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-155



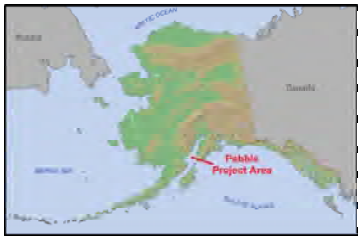
LEGEND:

Groundwater Elevation Plot Legend

- GH08-155
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

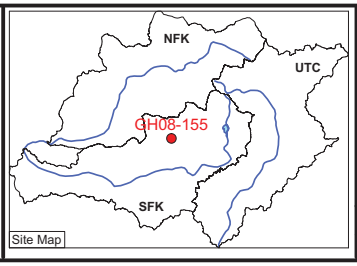
Screens (ft asl):
GH08-155 : 1087.6 - 1107.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1307.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-155.grf

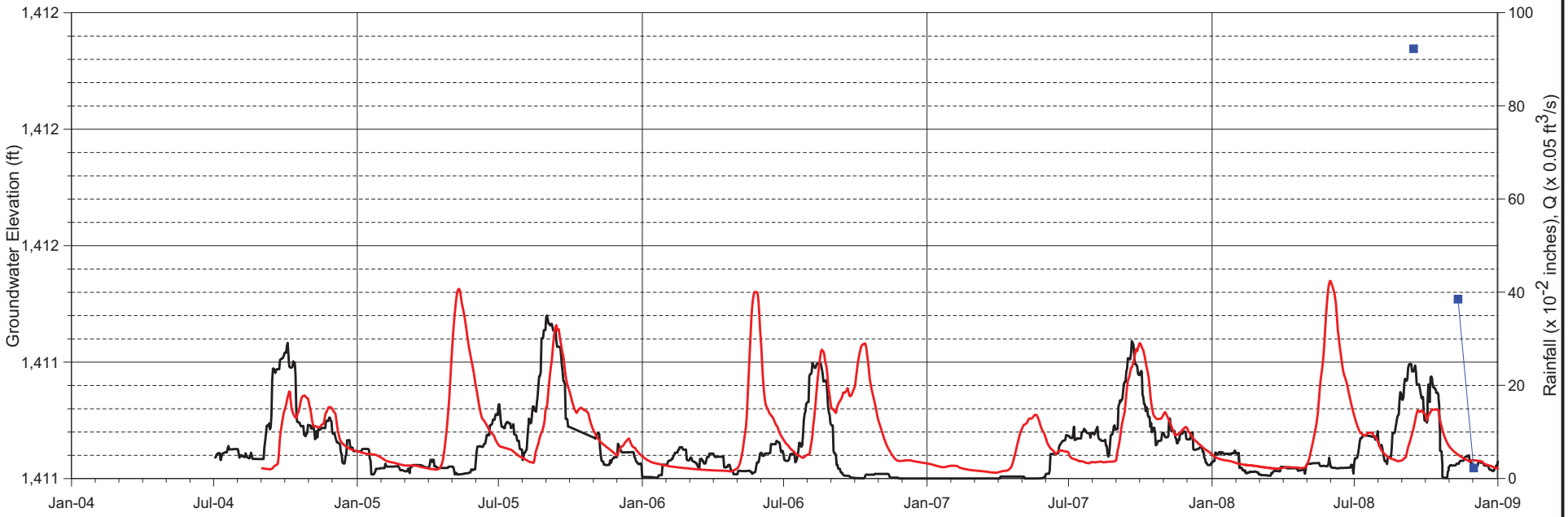


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-156



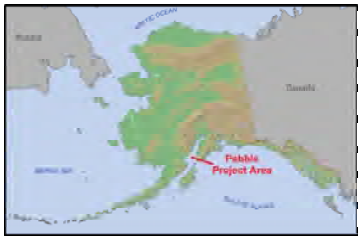
LEGEND:

Groundwater Elevation Plot Legend

- GH08-156
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

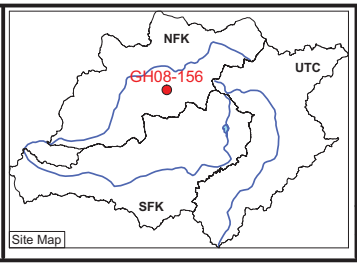
Screens (ft asl):
GH08-156 : 1288.5 - 1298.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1418.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-156.grf

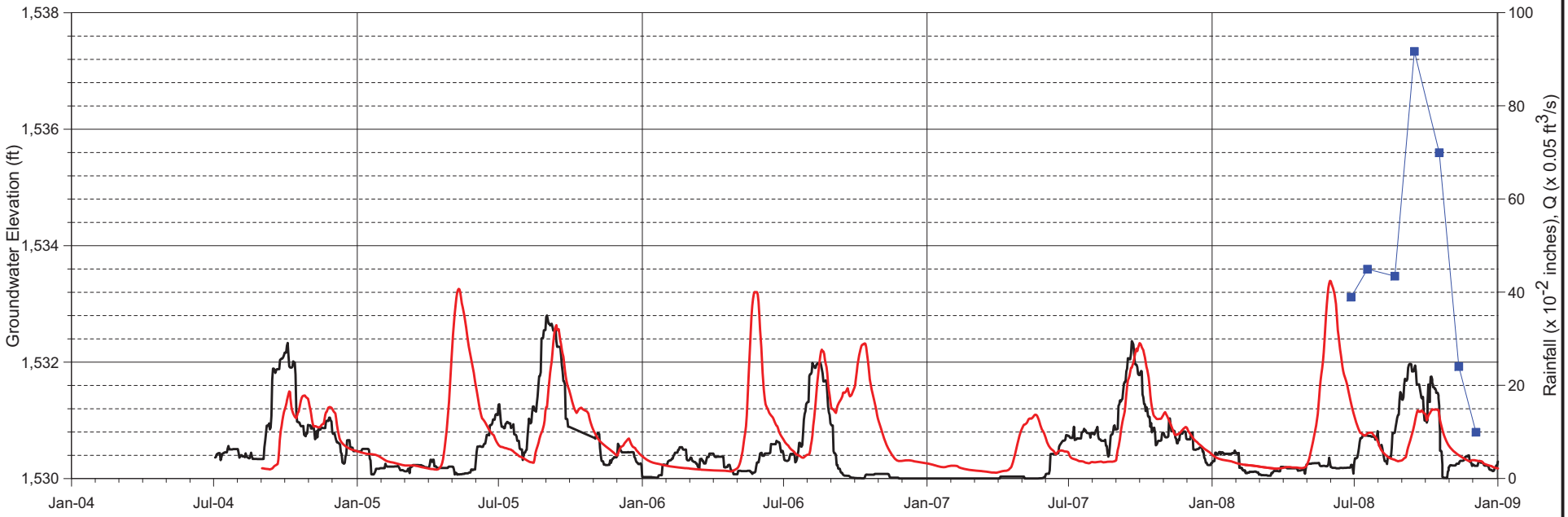


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-157



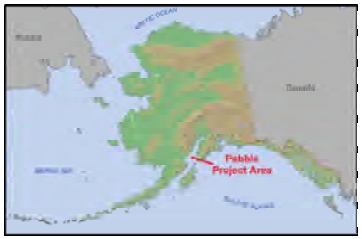
LEGEND:

Groundwater Elevation Plot Legend

- GH08-157
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

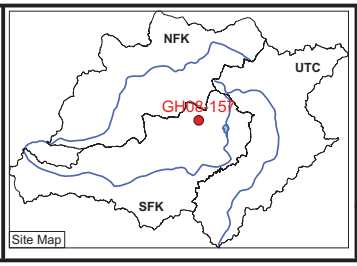
Screens (ft asl):
GH08-157 : 1322.8 - 1332.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1544.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-157.grf

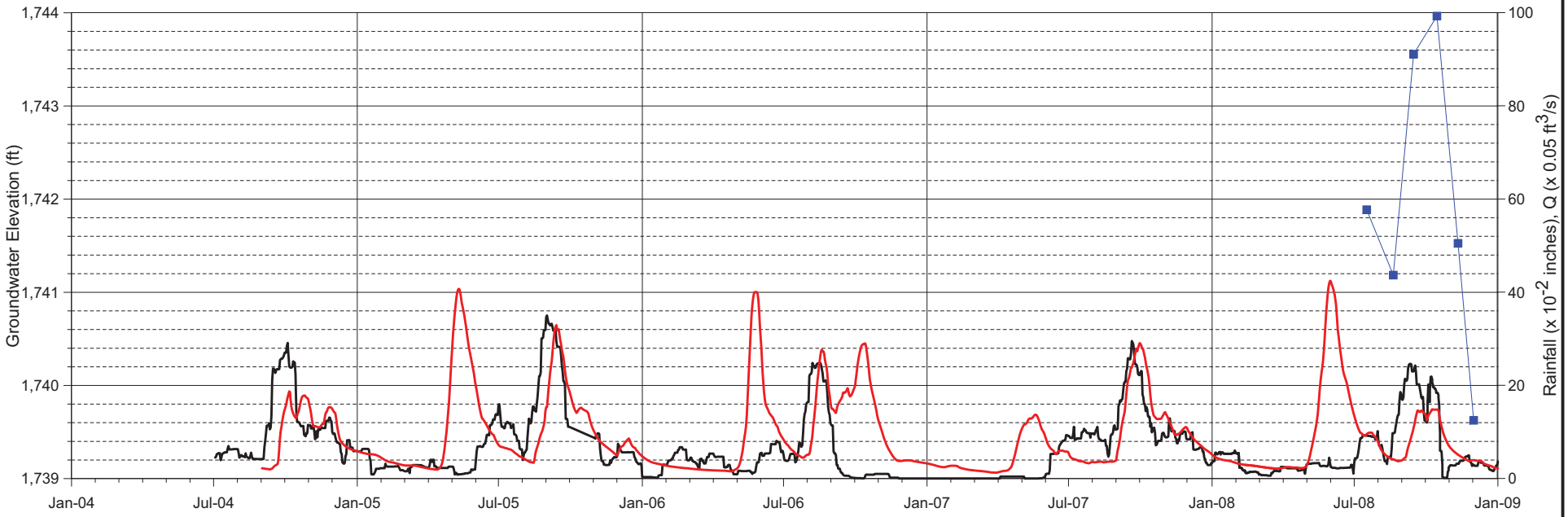


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-158



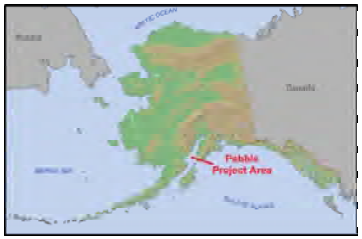
LEGEND:

Groundwater Elevation Plot Legend

- GH08-158
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

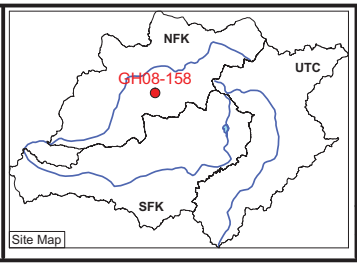
Screens (ft asl):
GH08-158 : 1461.3 - 1471.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1751.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-158.grf

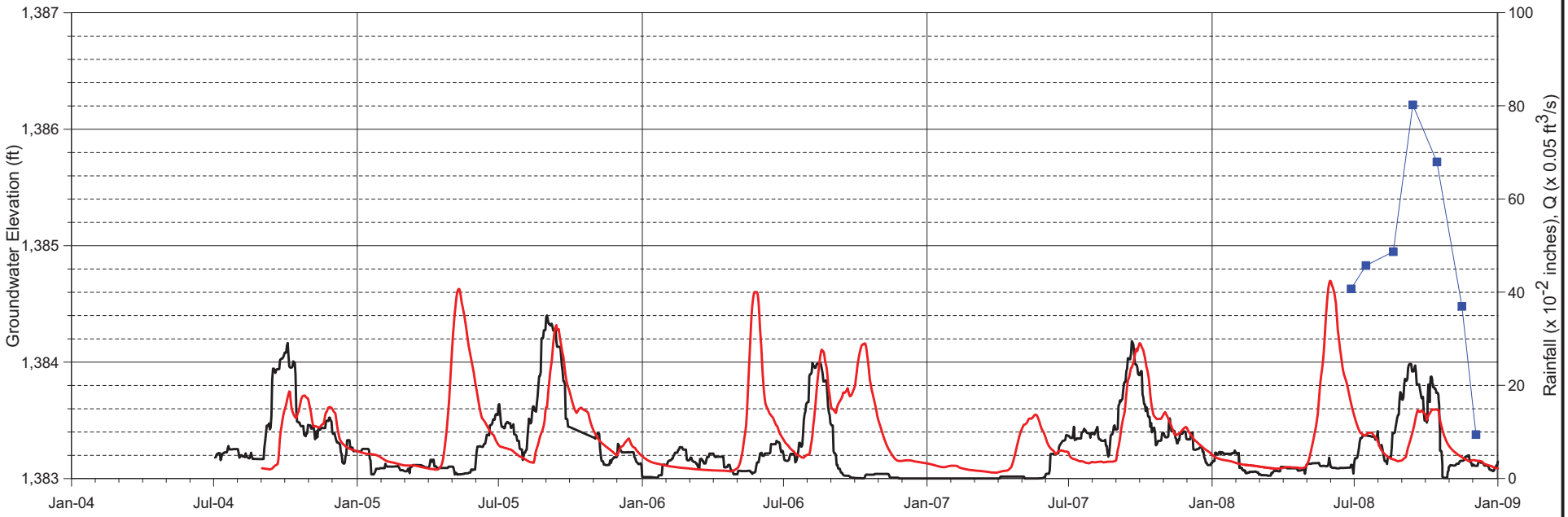


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-159



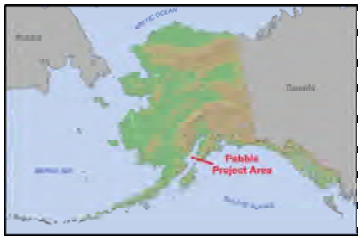
LEGEND:

Groundwater Elevation Plot Legend

- GH08-159
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

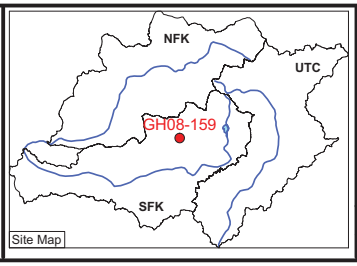
Screens (ft asl):
GH08-159 : 1366.9 - 1376.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1396.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-159.grf

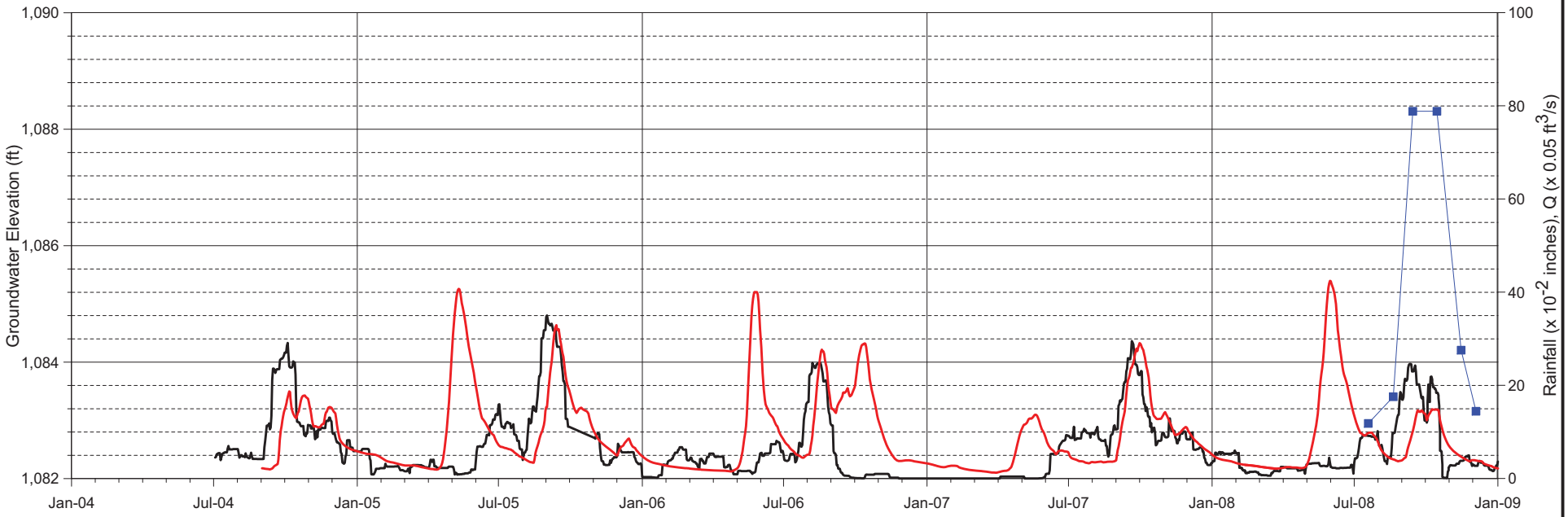


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-160



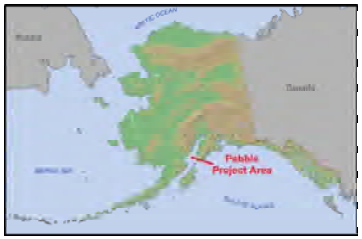
LEGEND:

Groundwater Elevation Plot Legend

- GH08-160
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

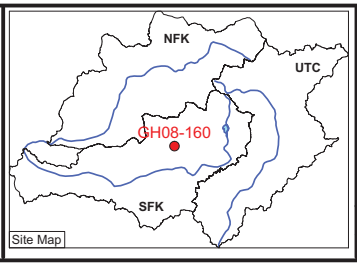
Screens (ft asl):
GH08-160 : 1064.5 - 1074.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1094.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-160.grf

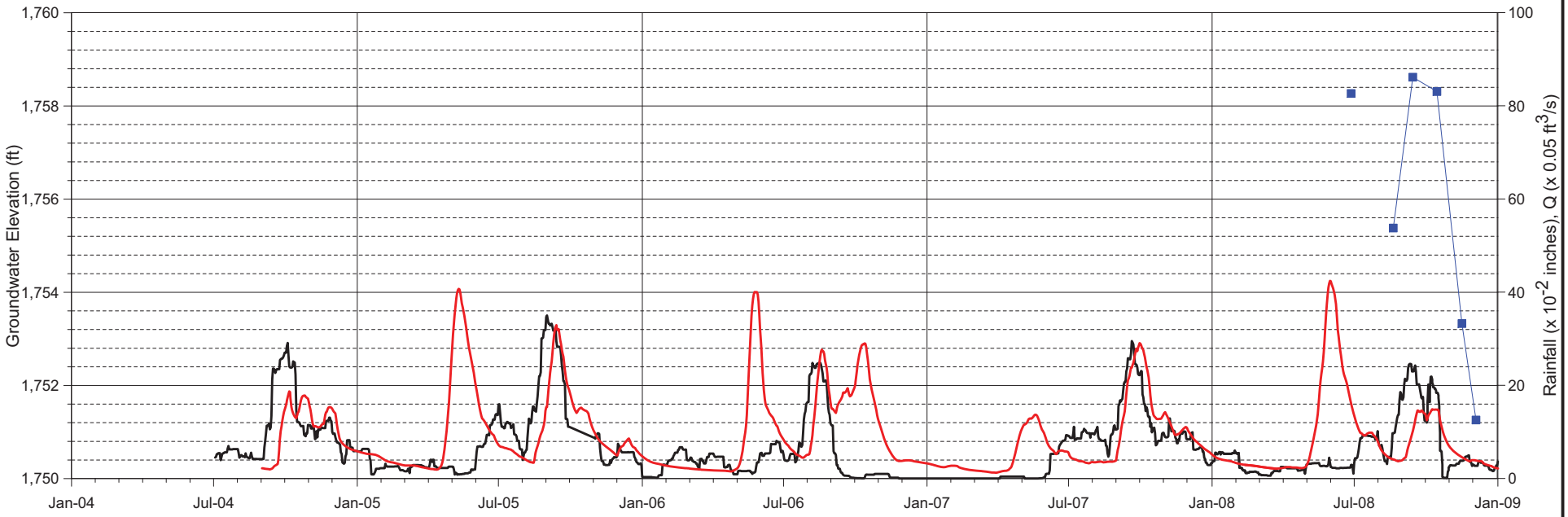


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-161



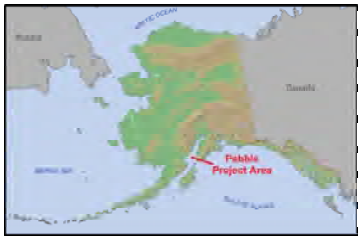
LEGEND:

Groundwater Elevation Plot Legend

- GH08-161
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

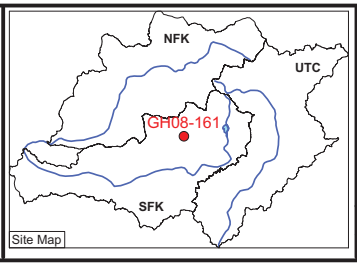
Screens (ft asl):
GH08-161 : 1730.4 - 1740.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1760.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-161.grf

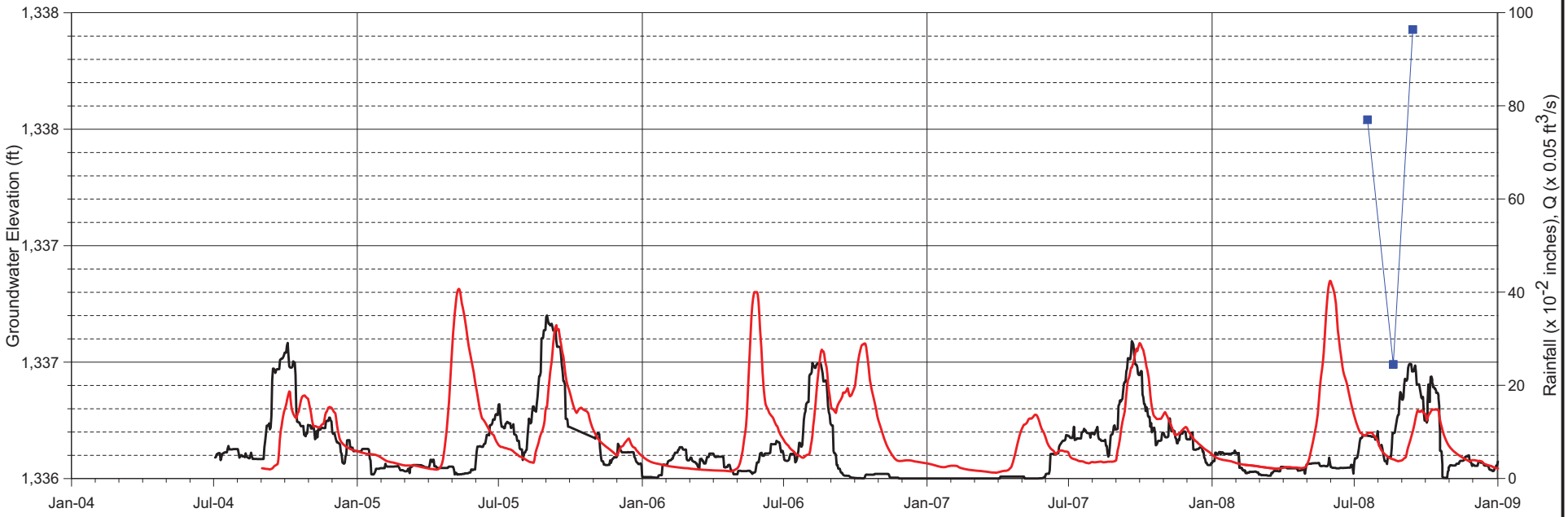


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-162



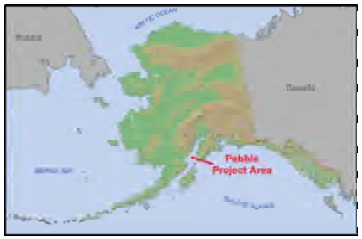
LEGEND:

Groundwater Elevation Plot Legend

- GH08-162
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

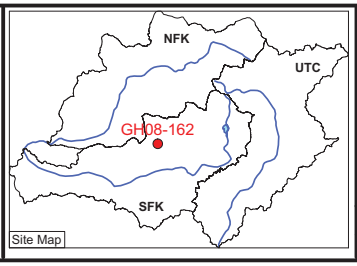
Screens (ft asl):
GH08-162 : 1301.5 - 1311.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1336.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-162.grf

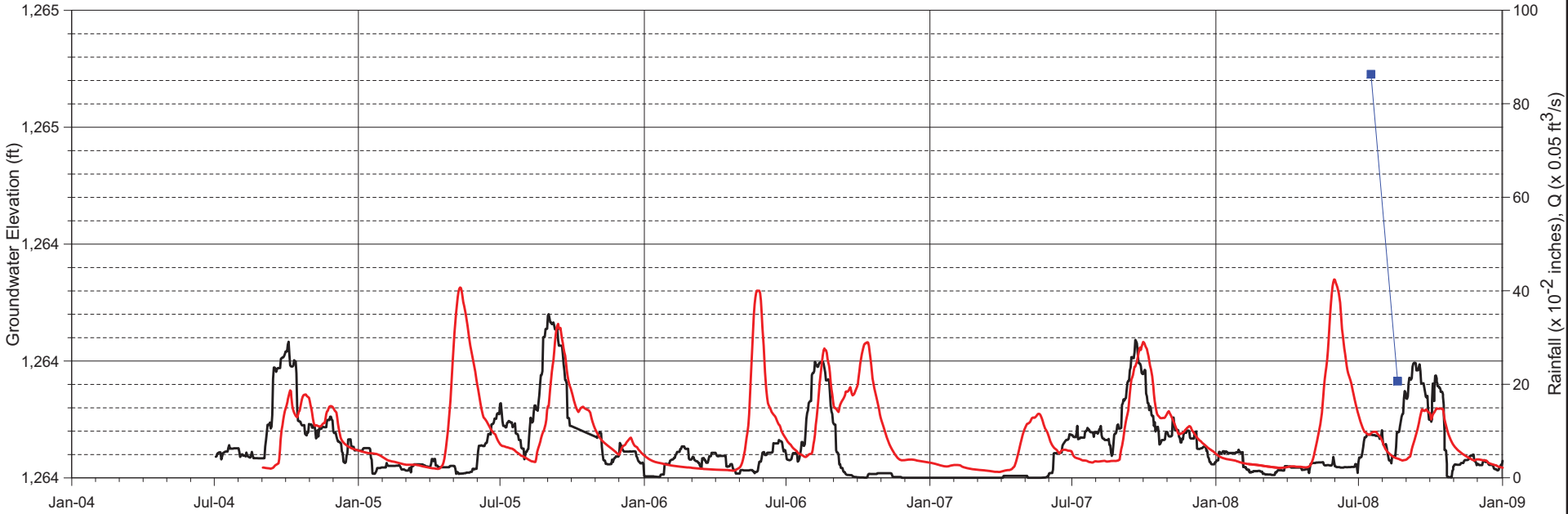


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-163



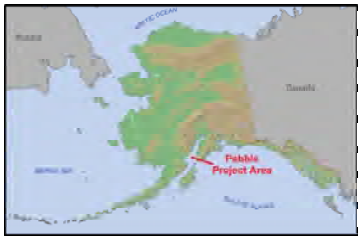
LEGEND:

Groundwater Elevation Plot Legend

- GH08-163
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

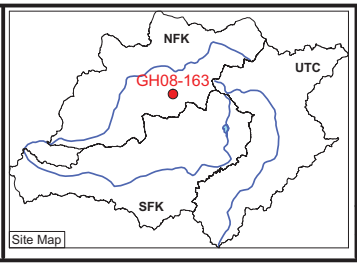
Screens (ft asl):
GH08-163 : 1124.5 - 1139.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1264.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-163.grf

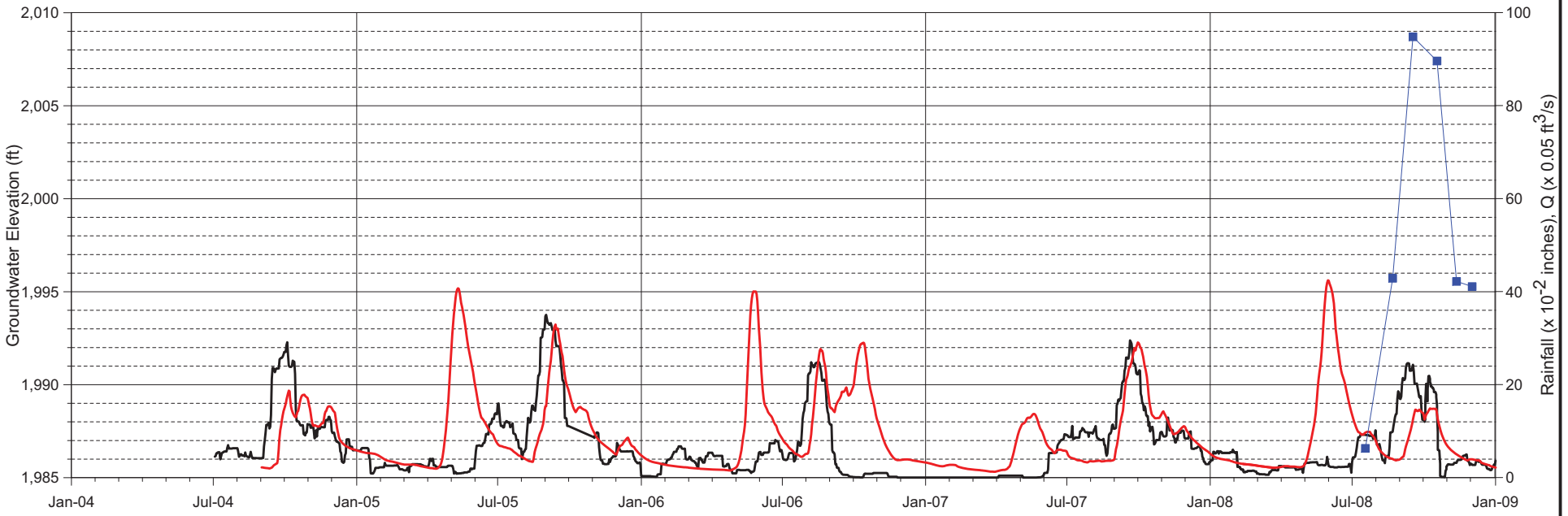


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-164



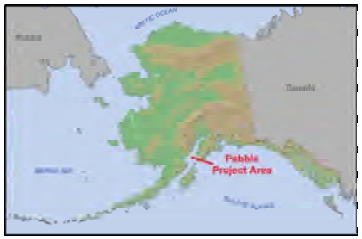
LEGEND:

Groundwater Elevation Plot Legend

- GH08-164
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

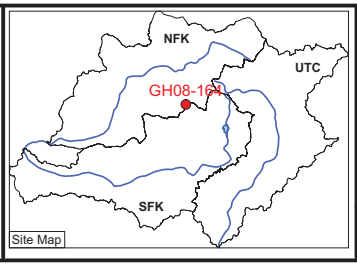
Screens (ft asl):
GH08-164 : 1962.9 - 1972.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 2022.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-164.grf

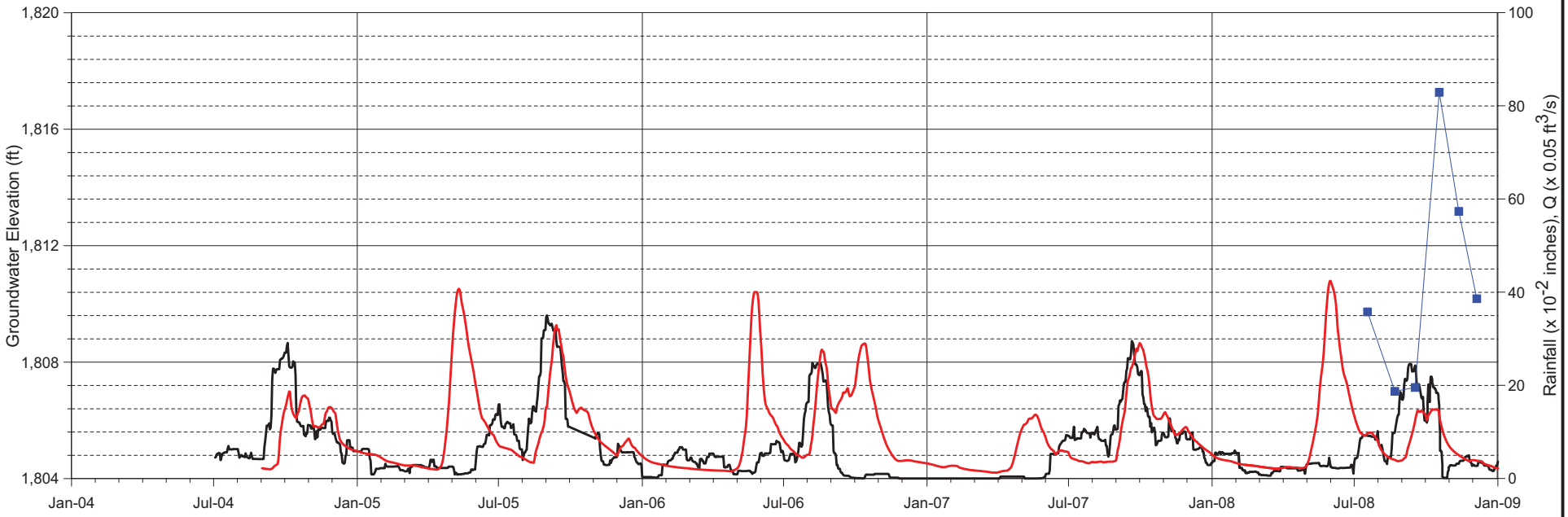


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-165



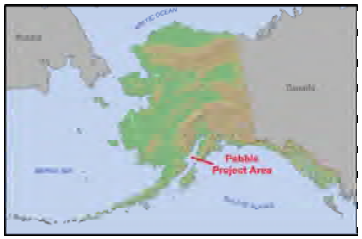
LEGEND:

Groundwater Elevation Plot Legend

- GH08-165
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

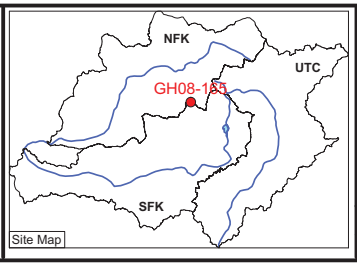
Screens (ft asl):
GH08-165 : 1756.2 - 1766.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1826.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-165.grf

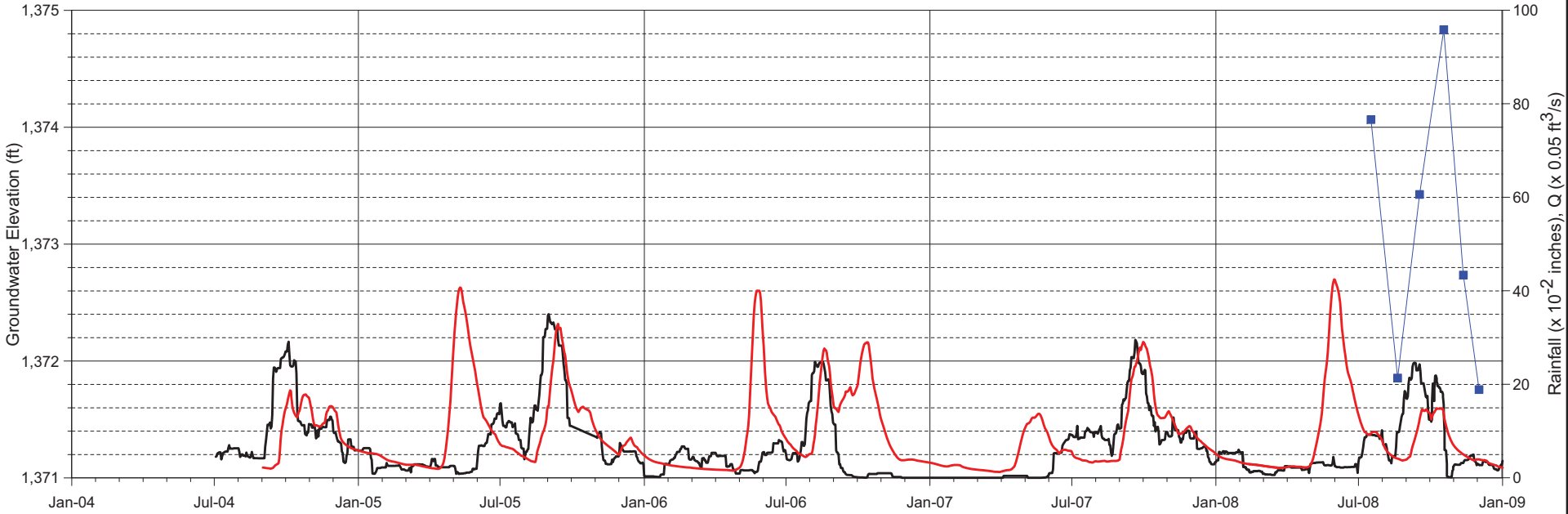


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-166



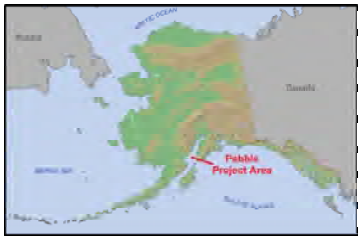
LEGEND:

Groundwater Elevation Plot Legend

- GH08-166
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

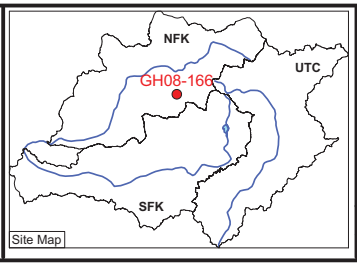
Screens (ft asl):
GH08-166 : 1258.9 - 1278.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1398.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-166.grf

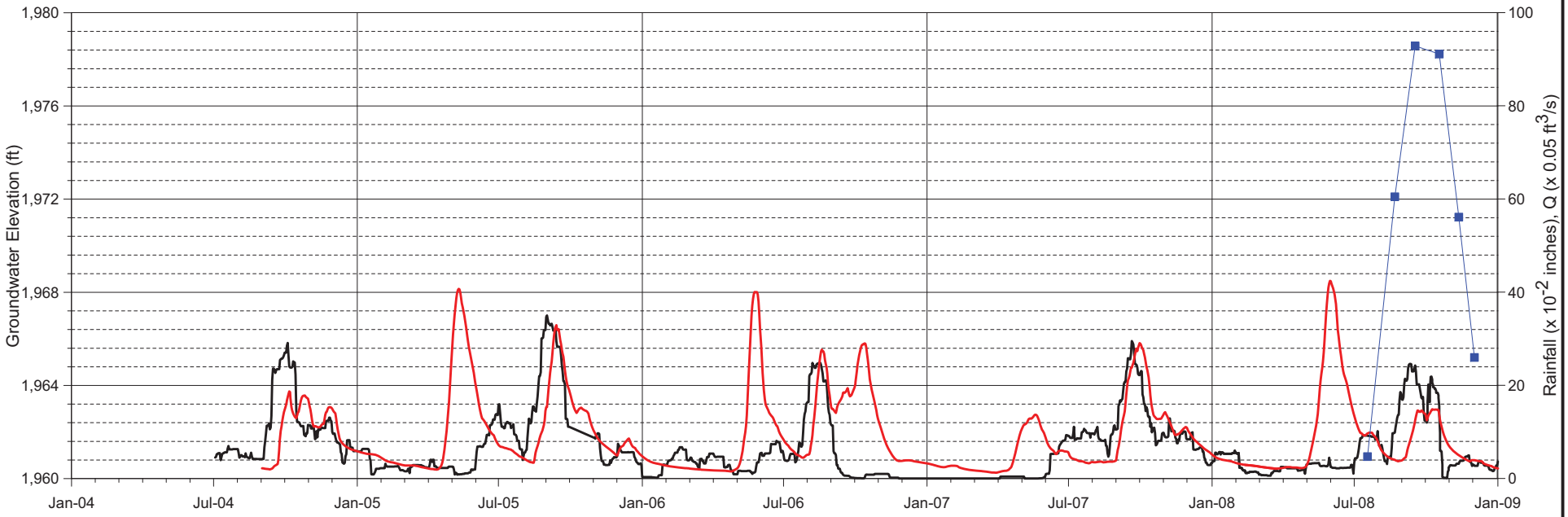


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-167



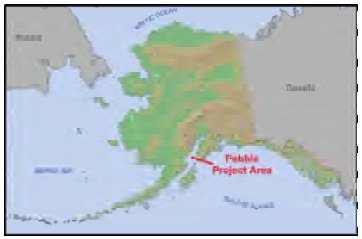
LEGEND:

Groundwater Elevation Plot Legend

- GH08-167
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

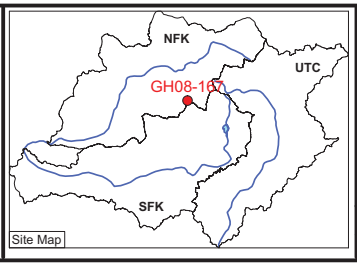
Screens (ft asl):
GH08-167 : 1893.4 - 1903.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1983.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-167.grf

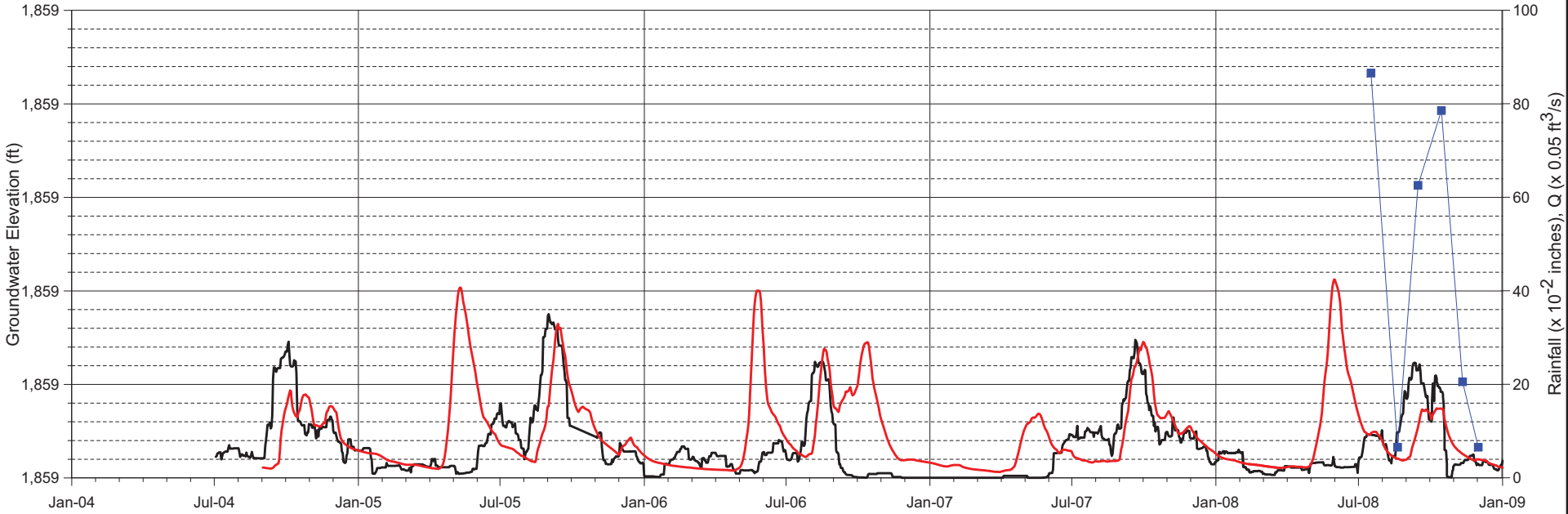


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-168



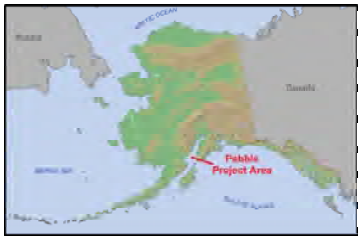
LEGEND:

Groundwater Elevation Plot Legend

- GH08-168
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

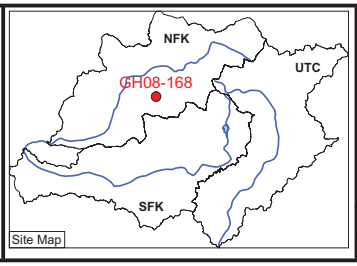
Screens (ft asl):
GH08-168 : 1599.4 - 1619.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1864.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-168.grf

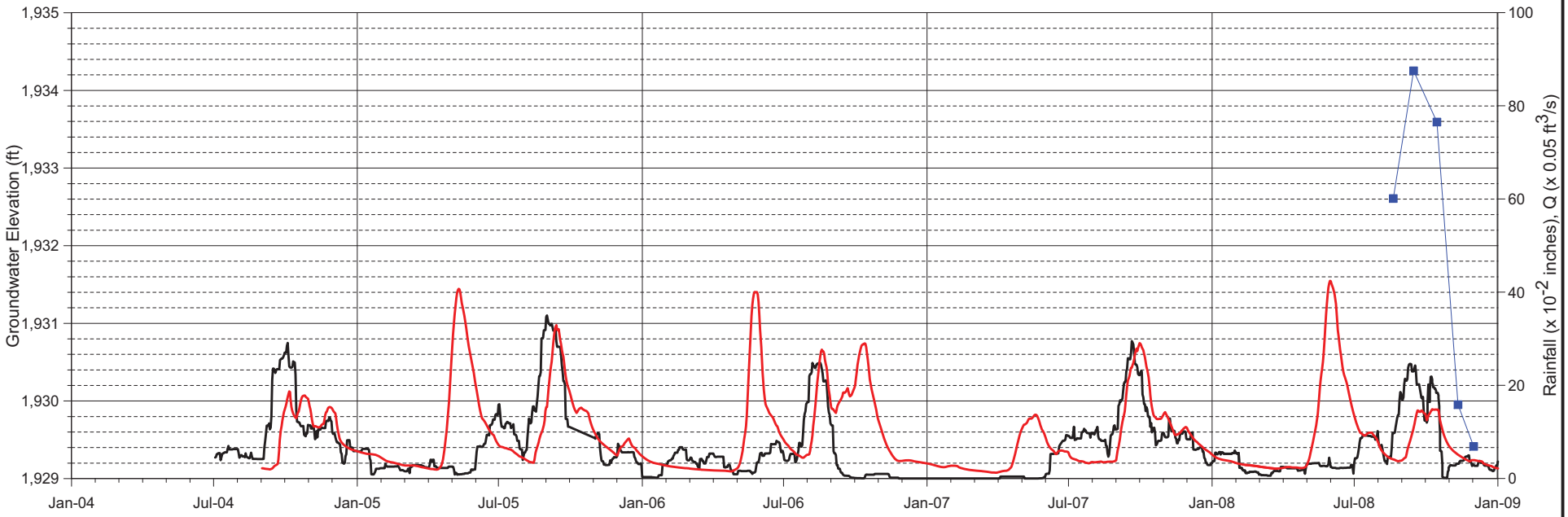


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-169



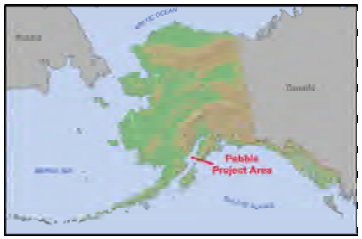
LEGEND:

Groundwater Elevation Plot Legend

- GH08-169 (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

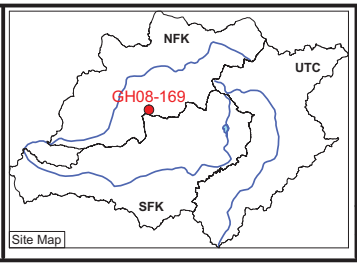
Transducer Elevation (ft asl):
GH08-169 : 1645.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1936.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-169.grf

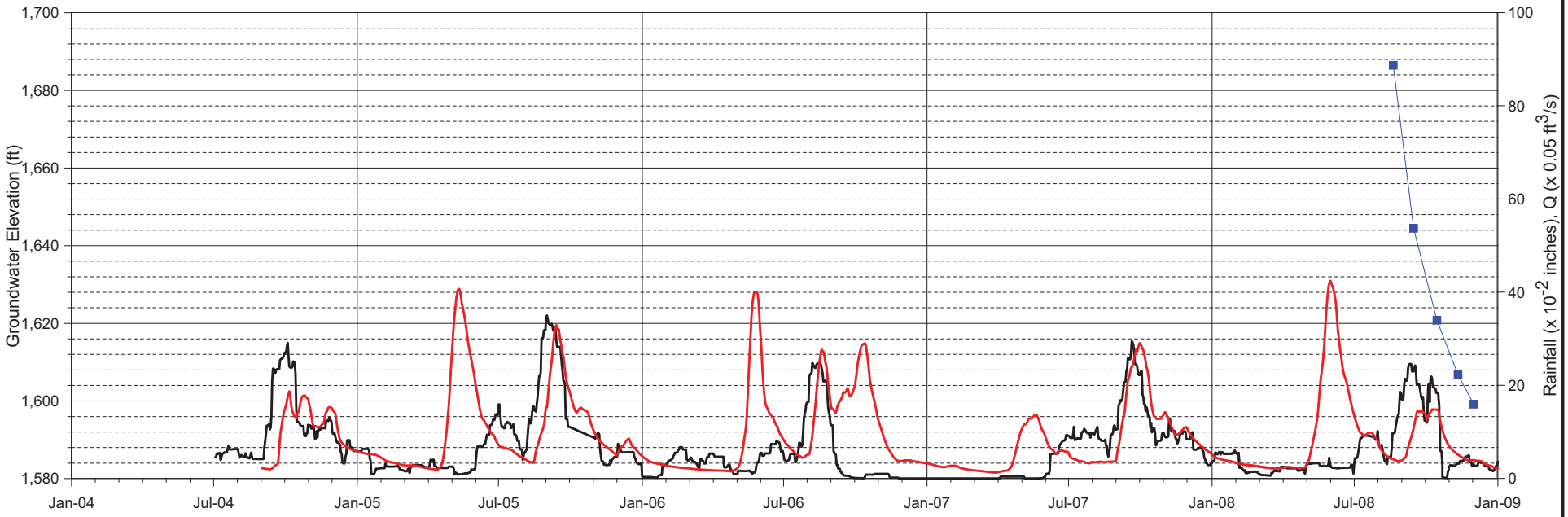


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-170



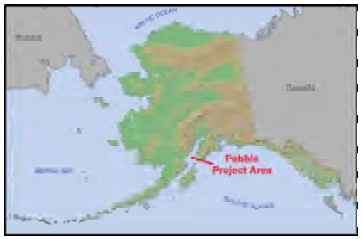
LEGEND:

Groundwater Elevation Plot Legend

- GH08-170 (Vibrating Wire)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

C = Shallow Monitoring Zone
B = Medium Monitoring Zone
A = Deep Monitoring Zone
asl = above sea level

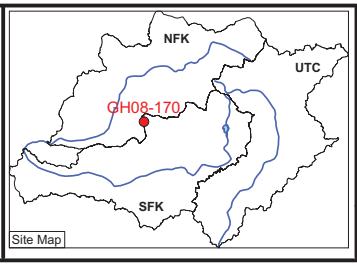
Transducer Elevation (ft asl):
GH08-170 : 1487.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1975.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-170.grf

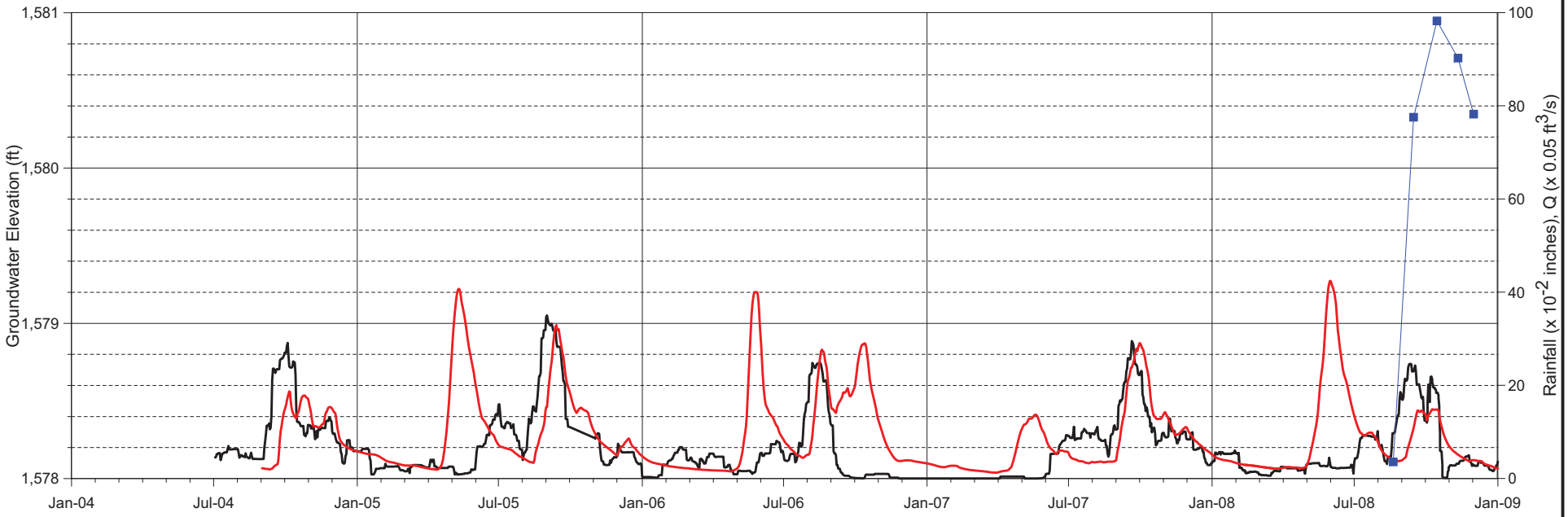


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-171



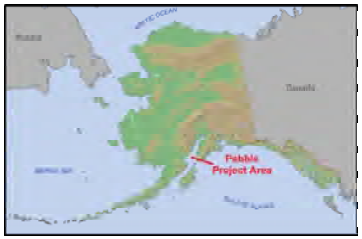
LEGEND:

Groundwater Elevation Plot Legend

- GH08-171
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

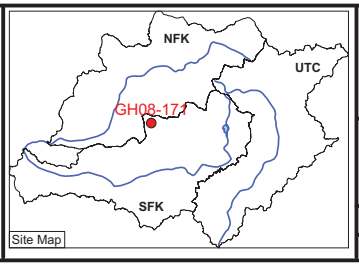
Screens (ft asl):
GH08-171 : 1540.6 - 1550.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1585.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-171.grf

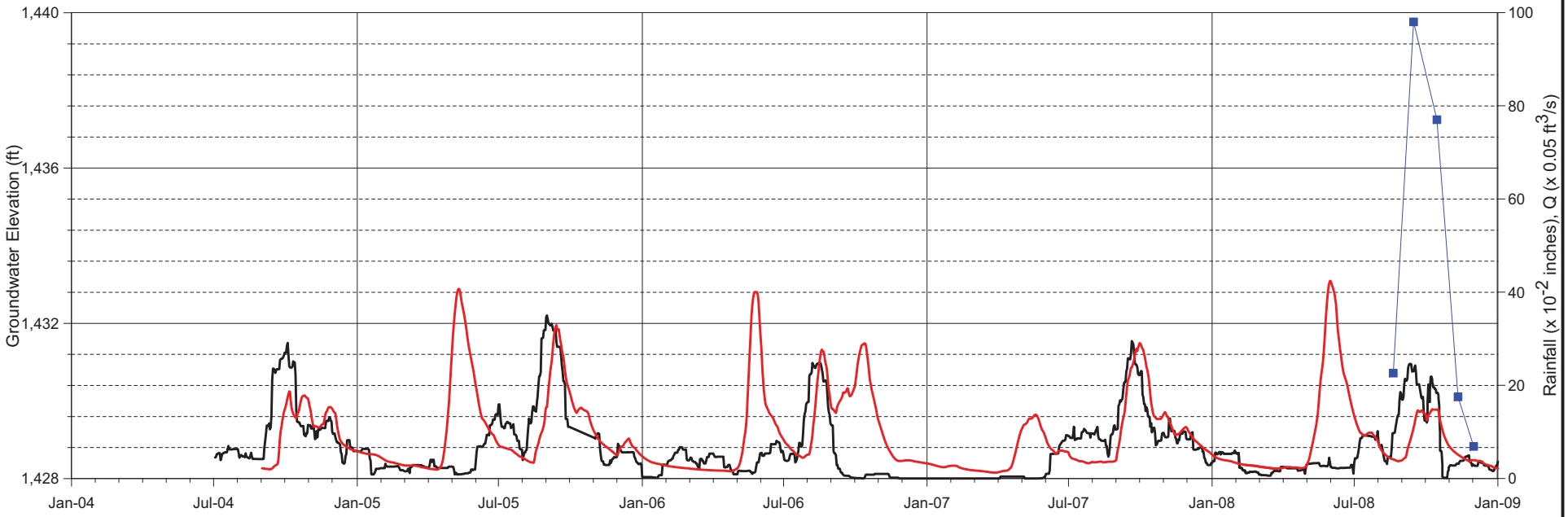


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-172



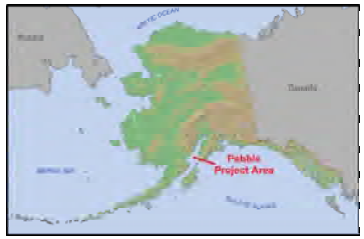
LEGEND:

Groundwater Elevation Plot Legend

- GH08-172
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

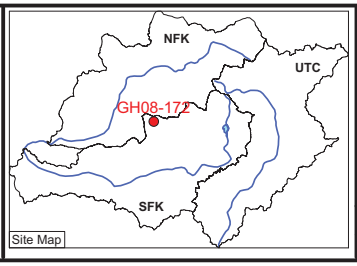
Screens (ft asl):
GH08-172 : 1389.0 - 1399.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1454 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-172.grf

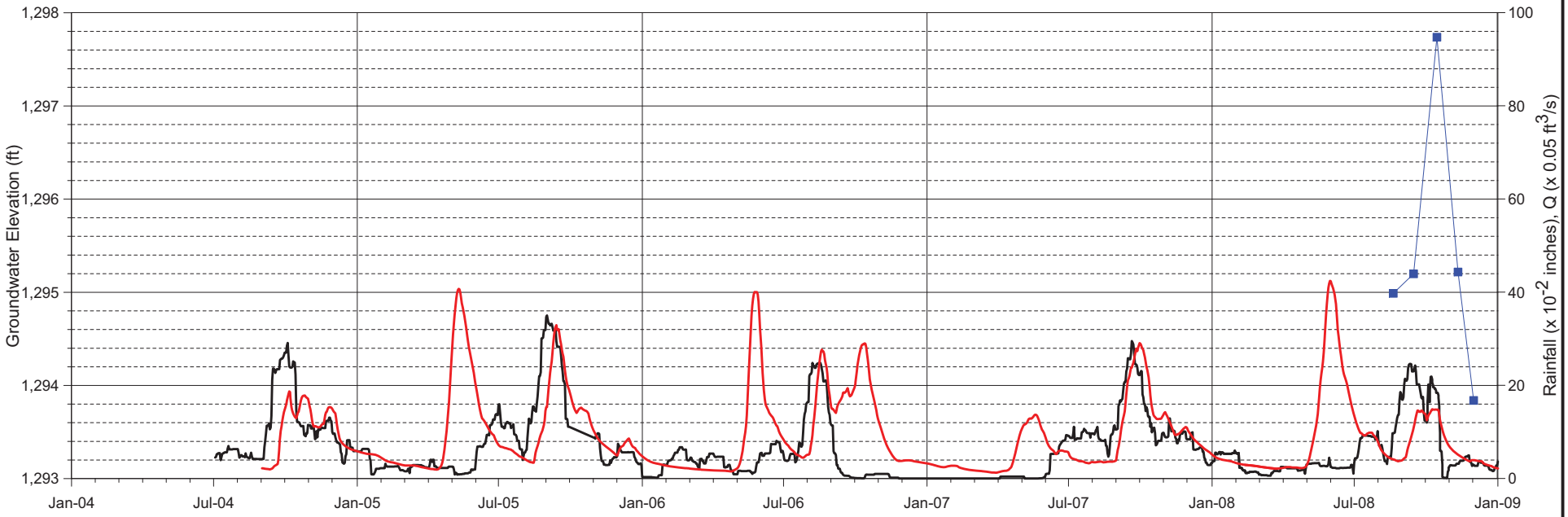


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-173



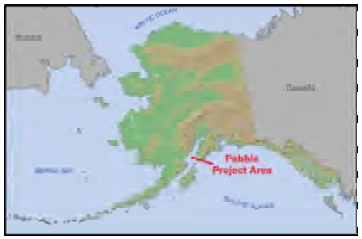
LEGEND:

Groundwater Elevation Plot Legend

- GH08-173
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

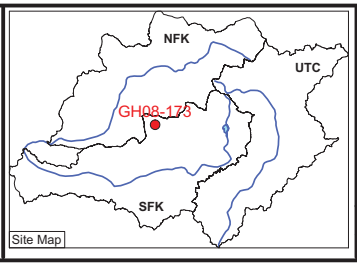
Screens (ft asl):
GH08-173 : 1198.4 - 1208.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1338.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-173.grf

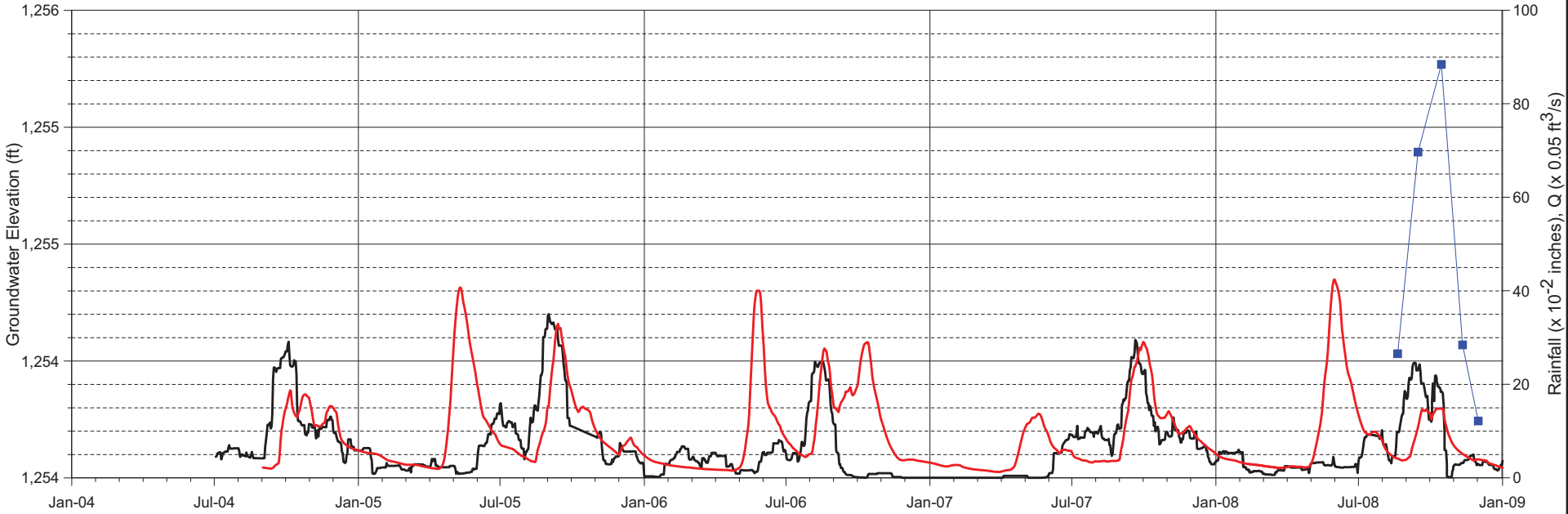


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-174



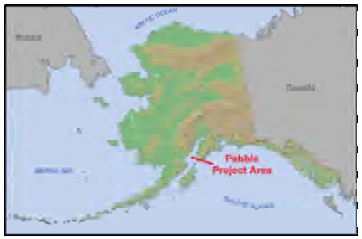
LEGEND:

Groundwater Elevation Plot Legend

- GH08-174
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

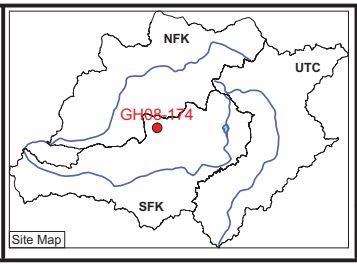
Screens (ft asl):
GH08-174 : 1100.2 - 1110.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1260.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-174.grf

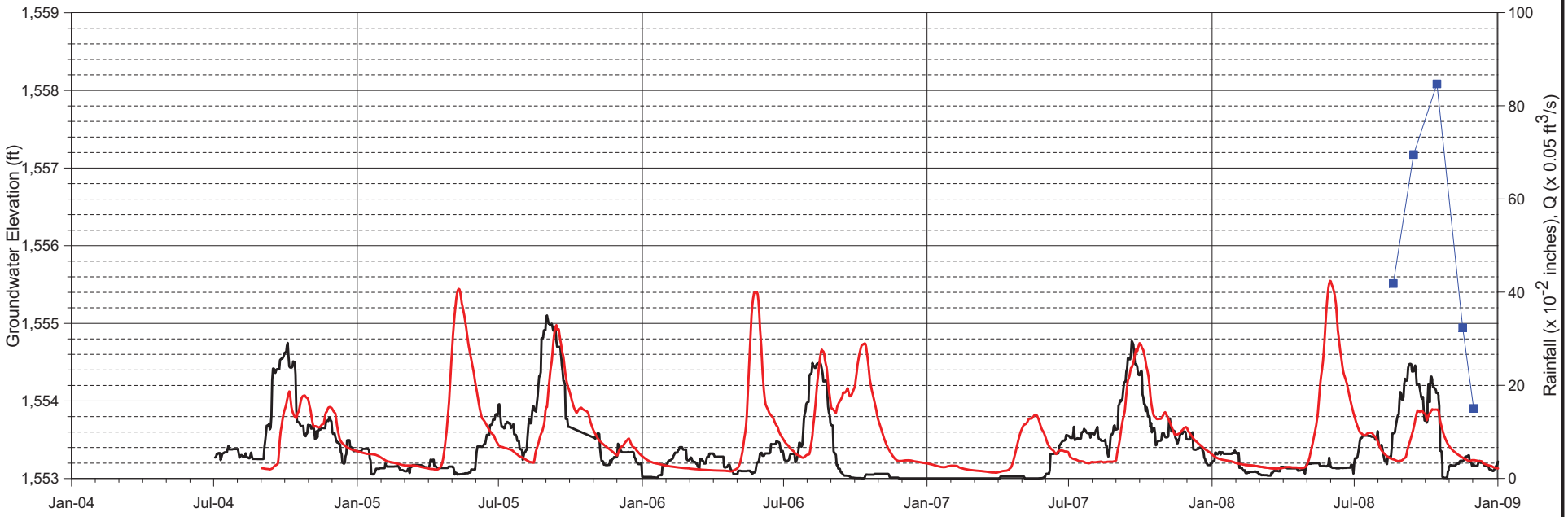


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-175



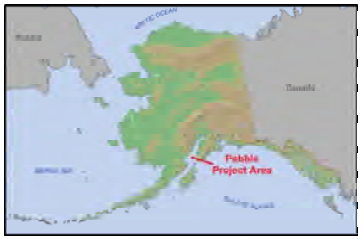
LEGEND:

Groundwater Elevation Plot Legend

- GH08-175
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

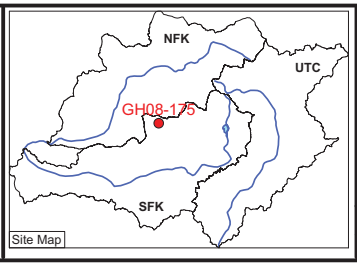
Screens (ft asl):
GH08-175 : 1427.8 - 1437.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1562.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-175.grf

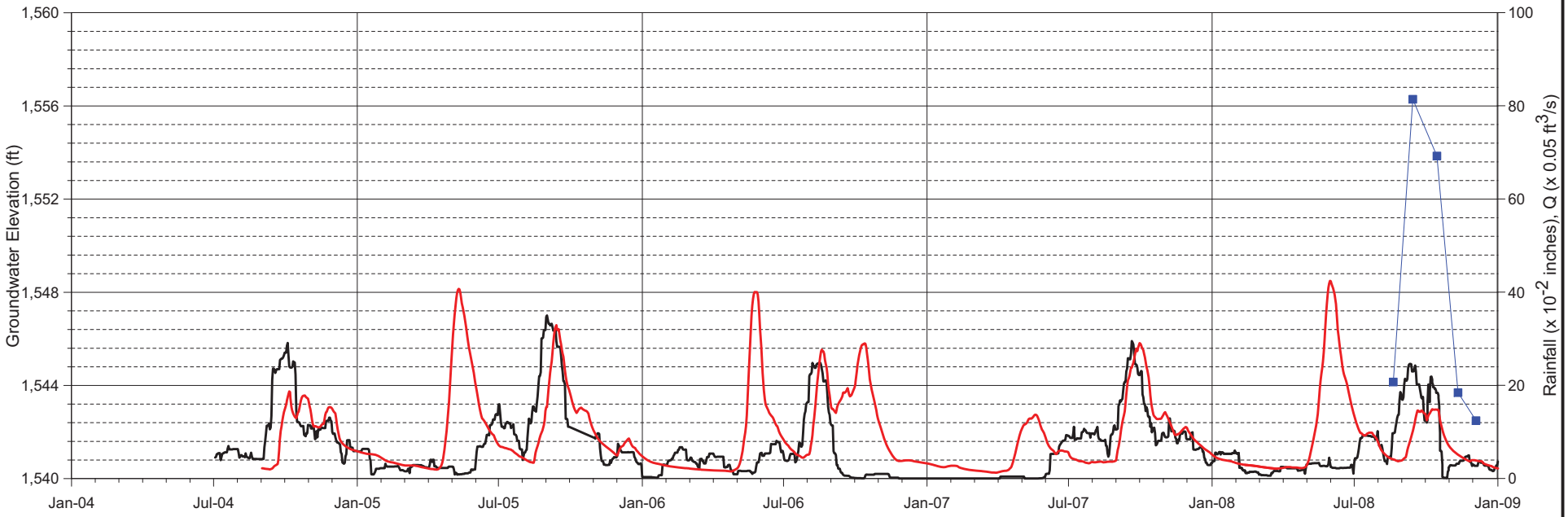


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-176



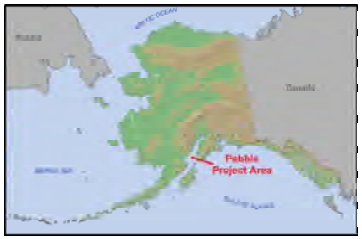
LEGEND:

Groundwater Elevation Plot Legend

- GH08-176
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

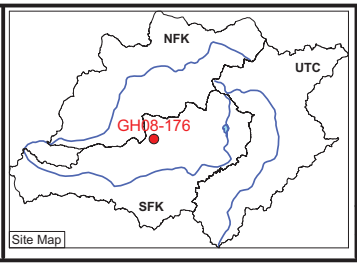
Screens (ft asl):
GH08-176 : 1501.8 - 1511.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1571.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-176.grf

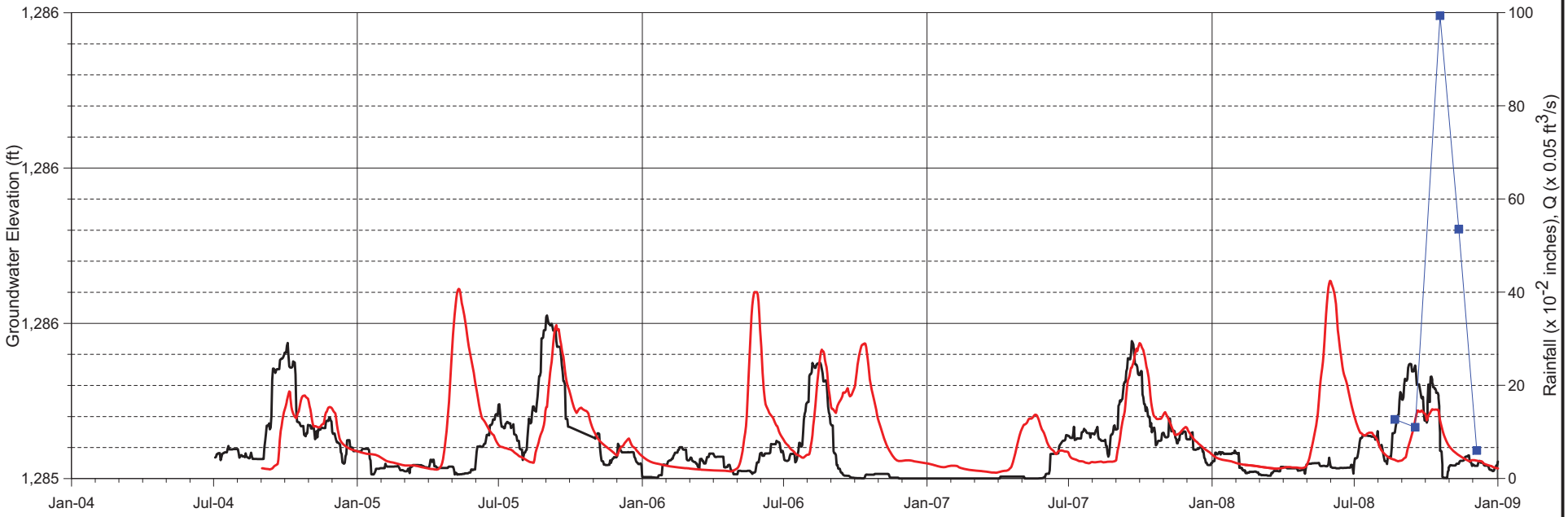


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-177



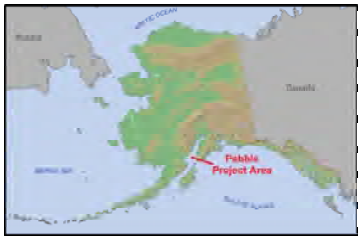
LEGEND:

Groundwater Elevation Plot Legend

- GH08-177
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

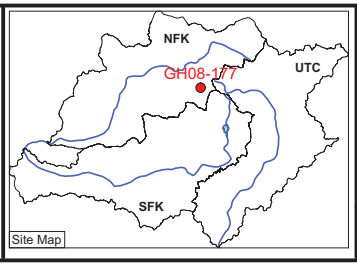
Screens (ft asl):
GH08-177 : 1127.9 - 1137.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1332.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-177.grf

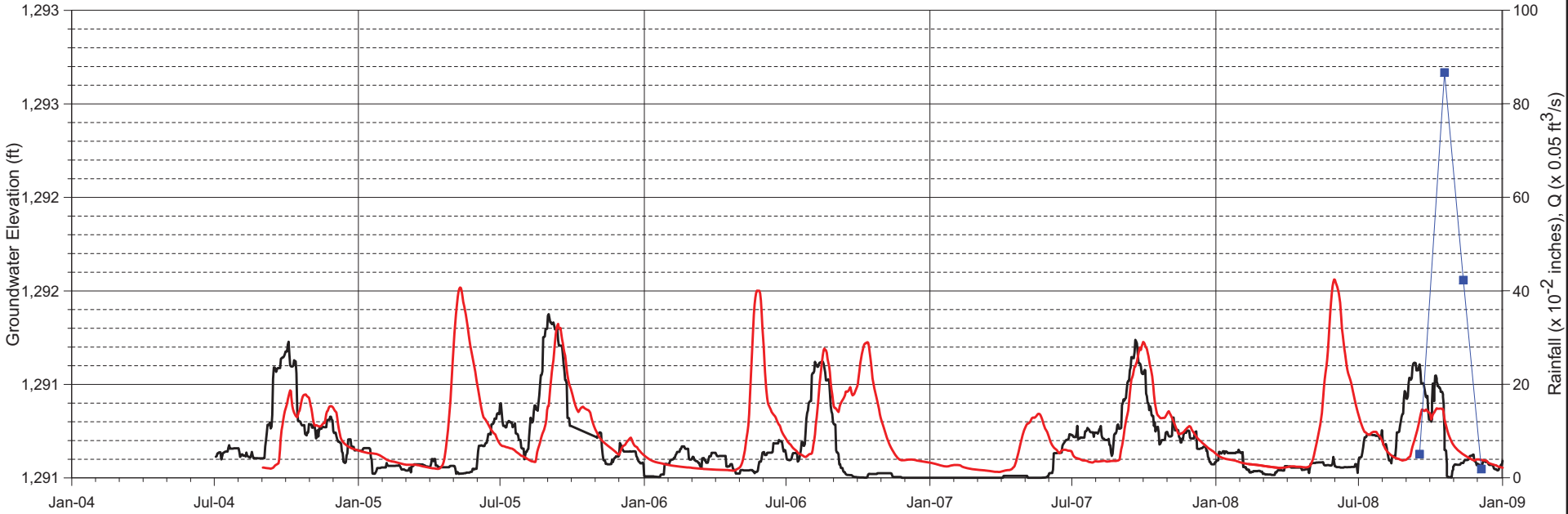


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-178



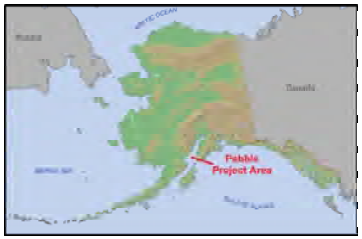
LEGEND:

Groundwater Elevation Plot Legend

- GH08-178
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

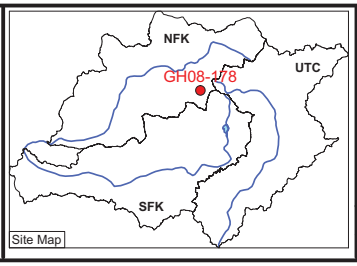
Screens (ft asl):
GH08-178 : 1227.4 - 1237.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1342.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-178.grf

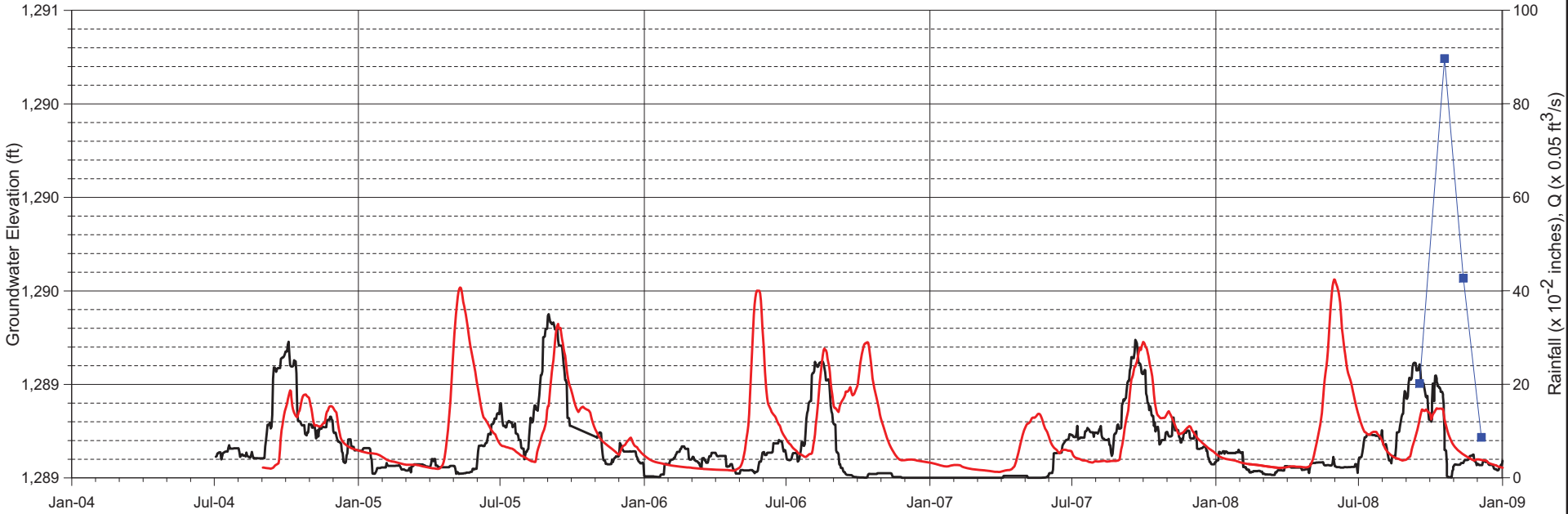


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-179



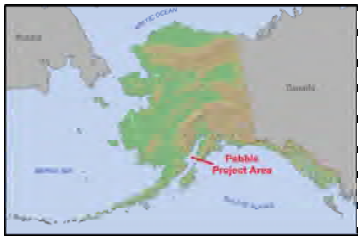
LEGEND:

Groundwater Elevation Plot Legend

- GH08-179
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

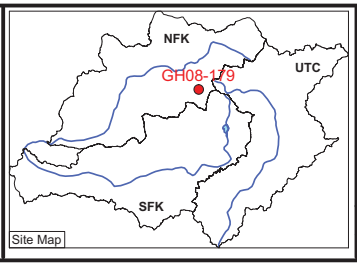
Screens (ft asl):
GH08-179 : 1190.6 - 1200.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1305.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-179.grf

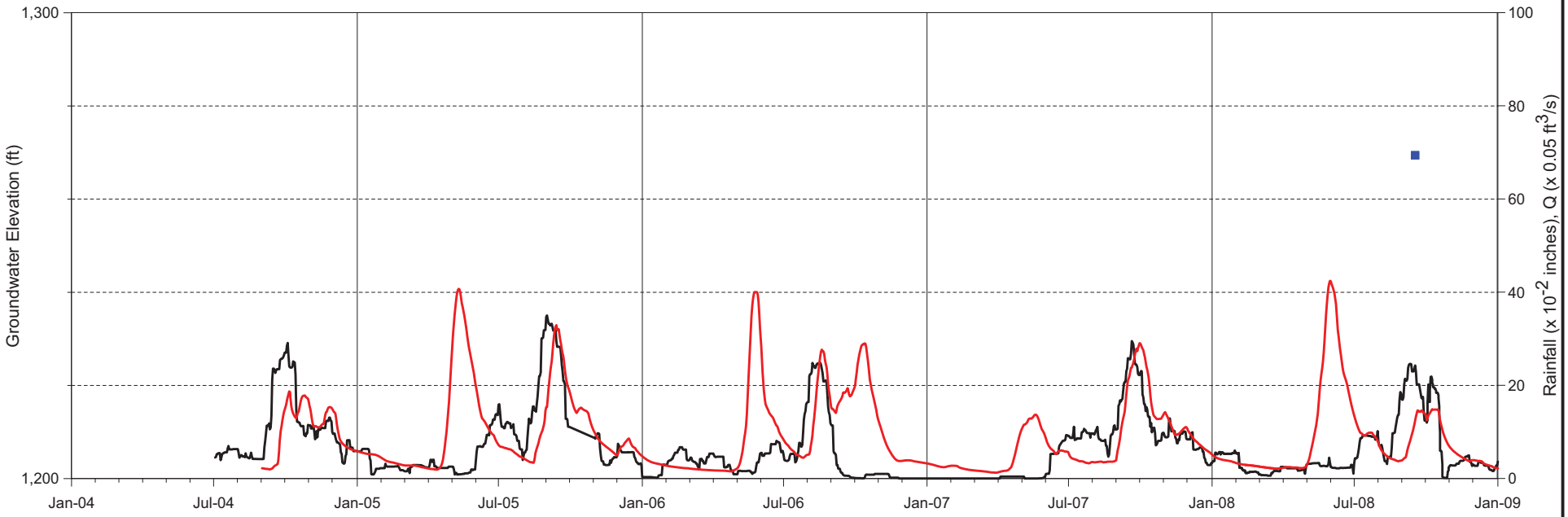


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-180



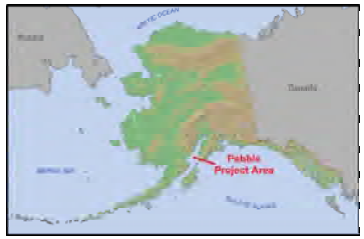
LEGEND:

Groundwater Elevation Plot Legend

- GH08-180
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

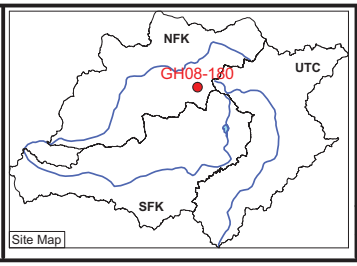
Screens (ft asl):
GH08-180 : 1202.2 - 1222.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1269.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-180.grf

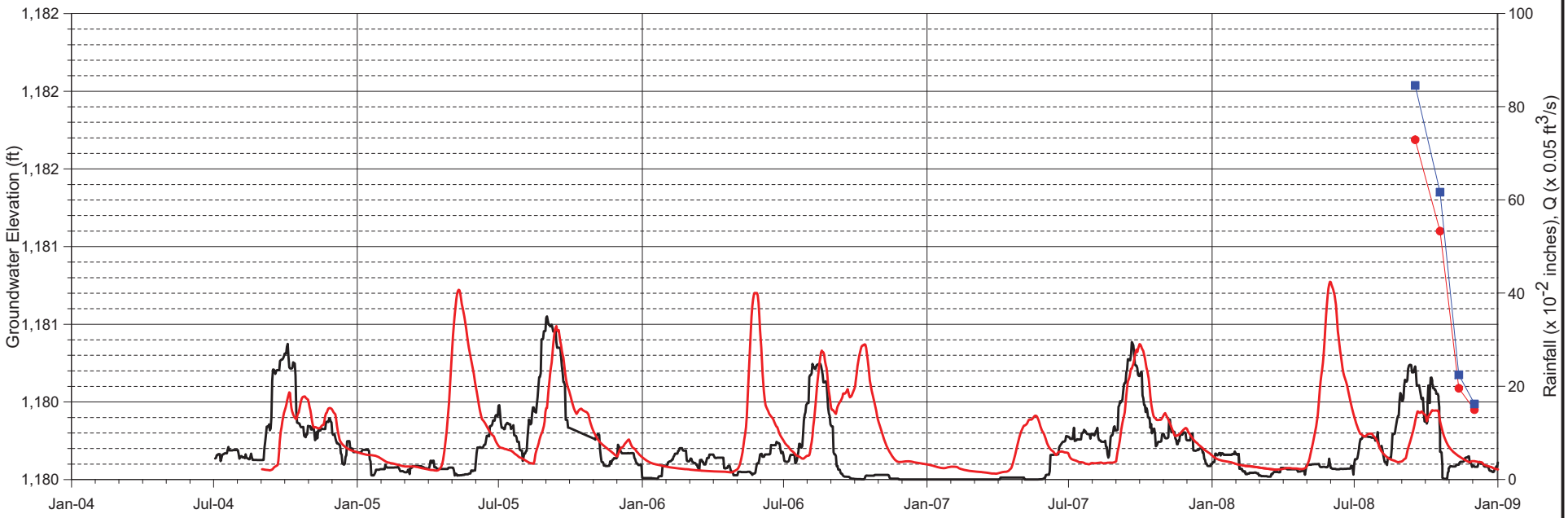


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-181



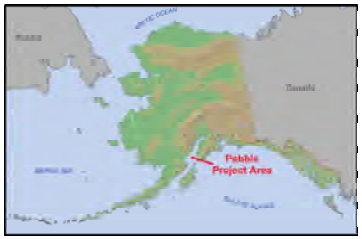
LEGEND:

Groundwater Elevation Plot Legend

- GH08-181S
- GH08-181D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

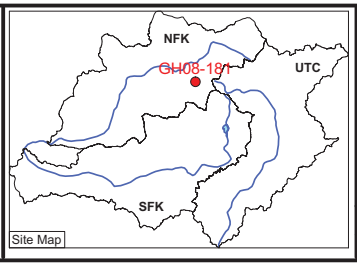
Screens (ft asl):
GH08-181S : 1171.9 - 1181.9
GH08-181D : 1136.9 - 1146.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1196.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-181.grf

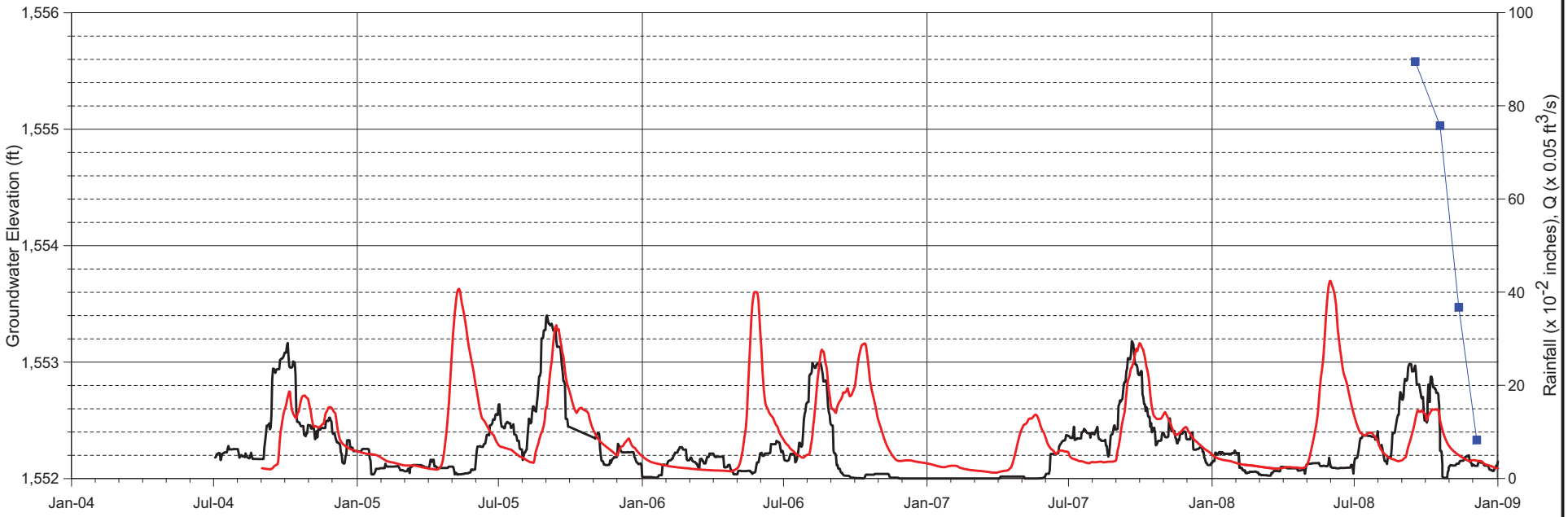


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-182



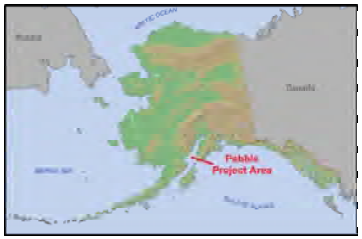
LEGEND:

Groundwater Elevation Plot Legend

- GH08-182
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

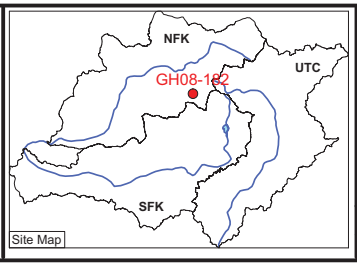
Screens (ft asl):
GH08-182 : 1525.9 - 1535.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1560.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-182.grf

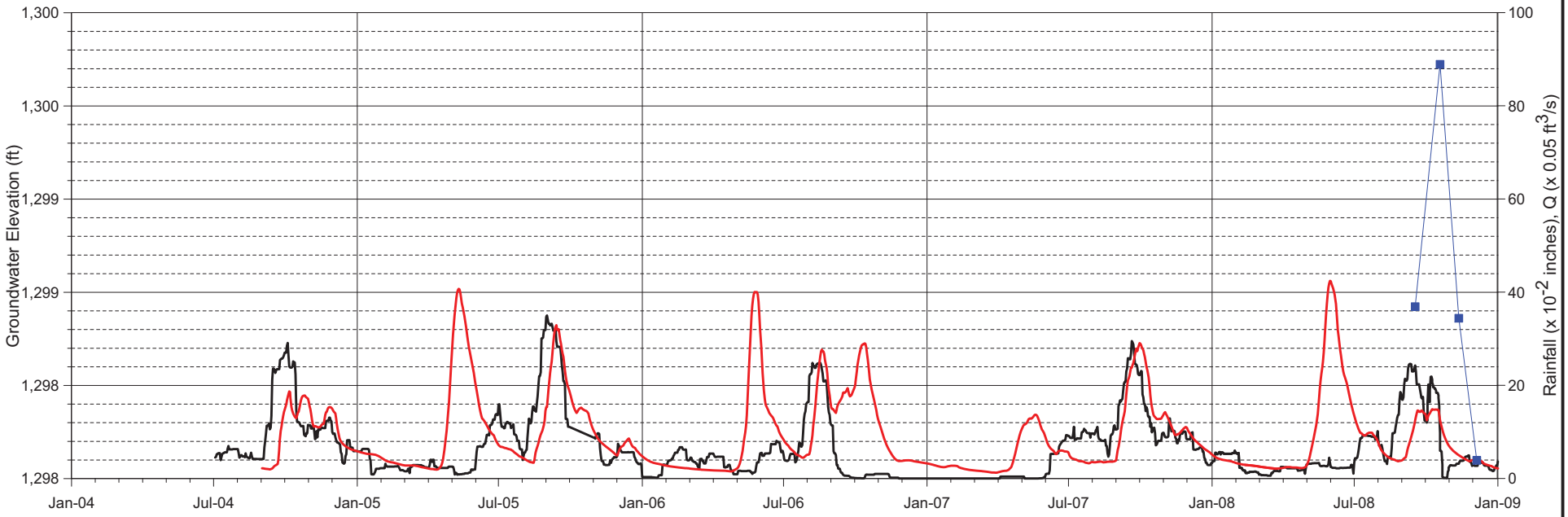


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-183



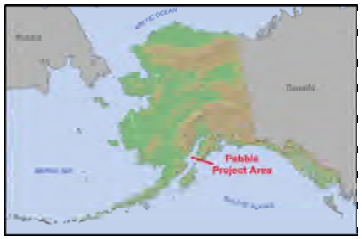
LEGEND:

Groundwater Elevation Plot Legend

- GH08-183
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

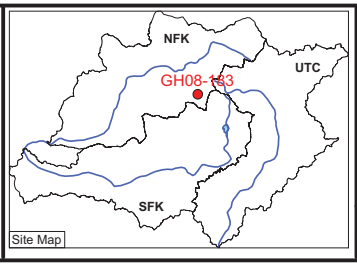
Screens (ft asl):
GH08-183 : 1125.7 - 1135.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1305.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-183.grf

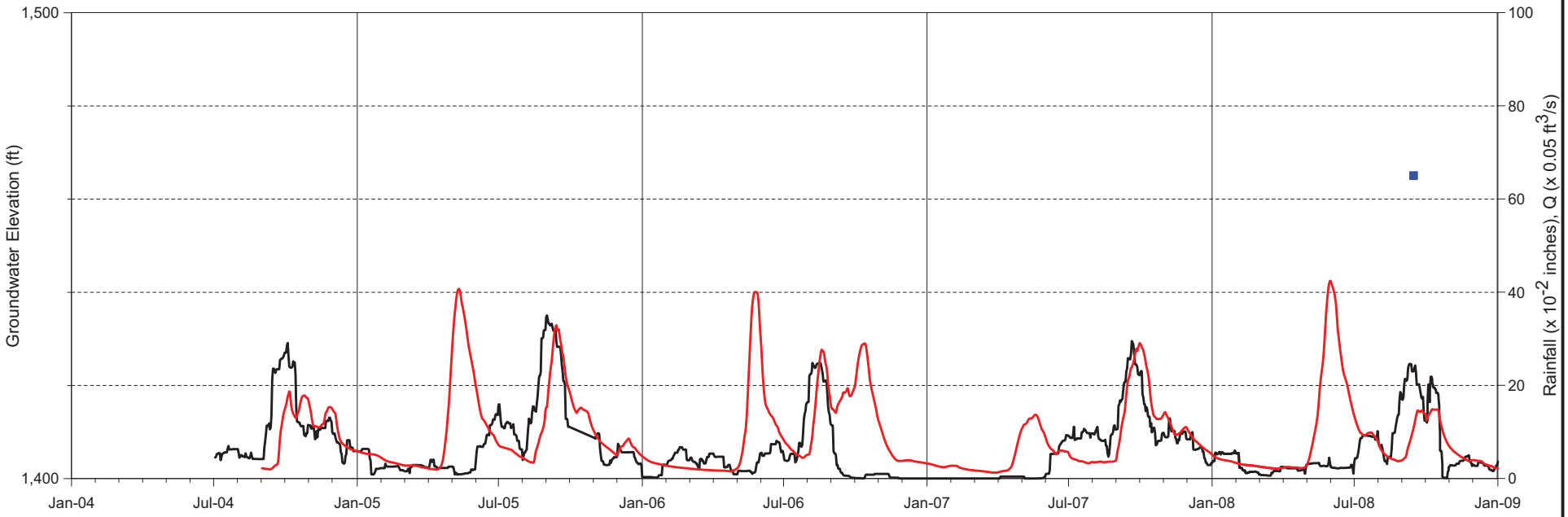


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-184



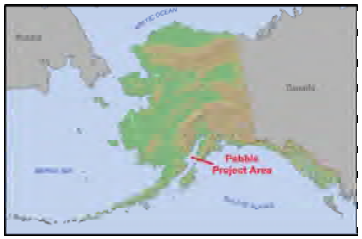
LEGEND:

Groundwater Elevation Plot Legend

- GH08-184
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH08-184 : 1424.0 - 1434.0

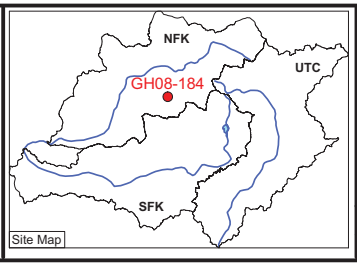


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1464 ft asl

Water was frozen in riser for most measurement periods.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-184.grf

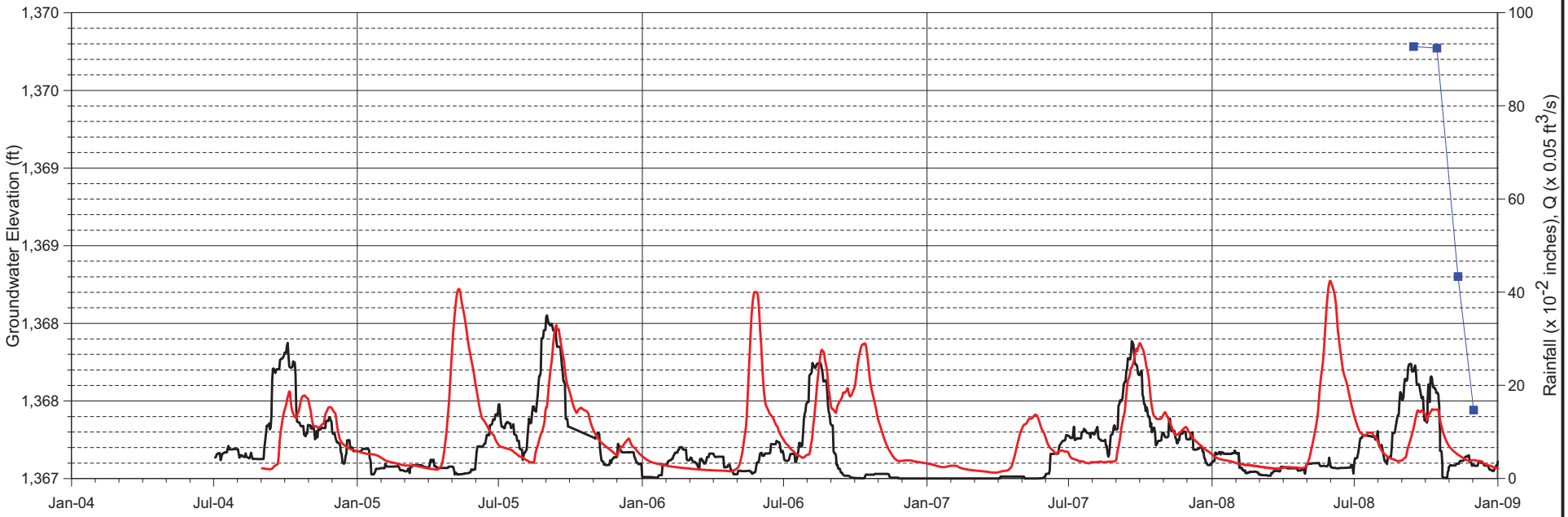


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-185



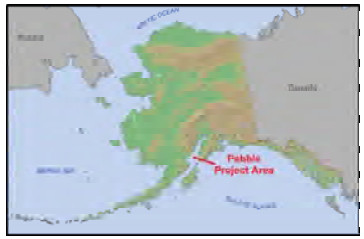
LEGEND:

Groundwater Elevation Plot Legend

- GH08-185
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

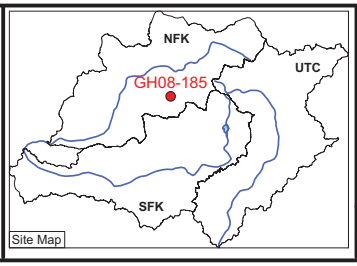
Screens (ft asl):
GH08-185 : 1319.7 - 1329.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1369.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-185.grf

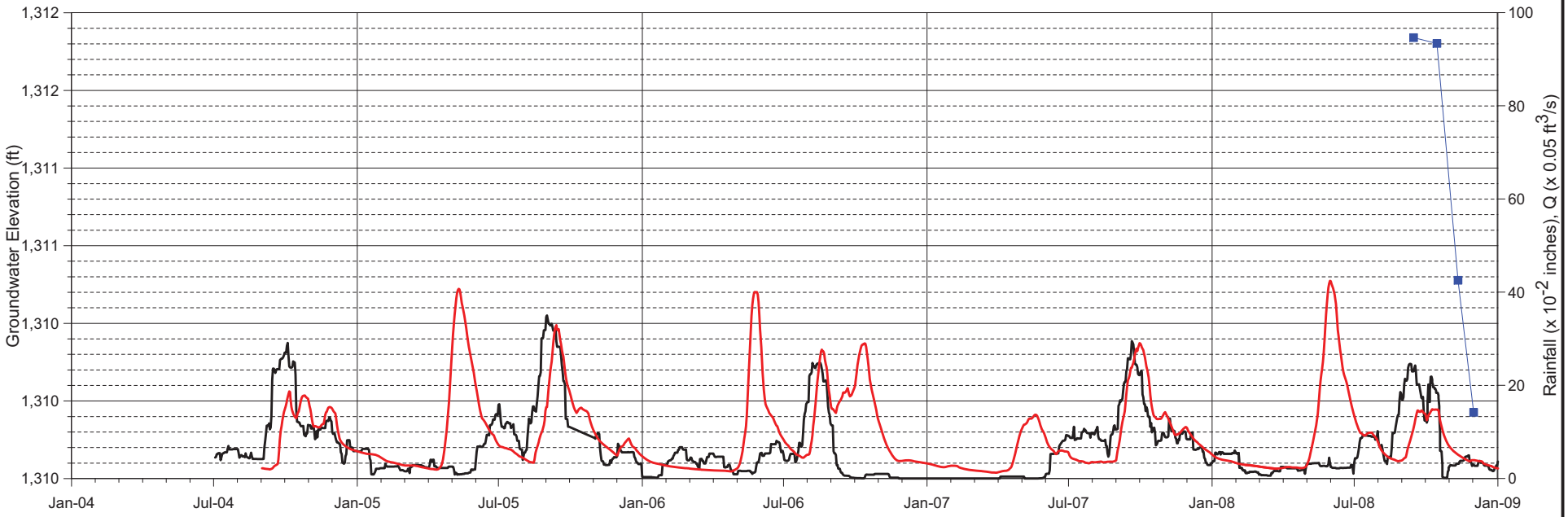


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-186



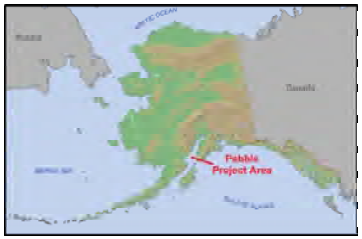
LEGEND:

Groundwater Elevation Plot Legend

- GH08-186
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

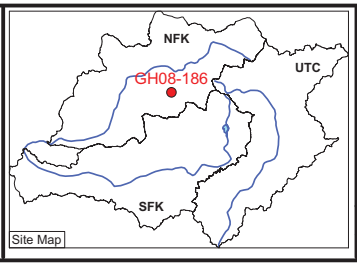
Screens (ft asl):
GH08-186 : 1292.6 - 1302.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1312.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-186.grf

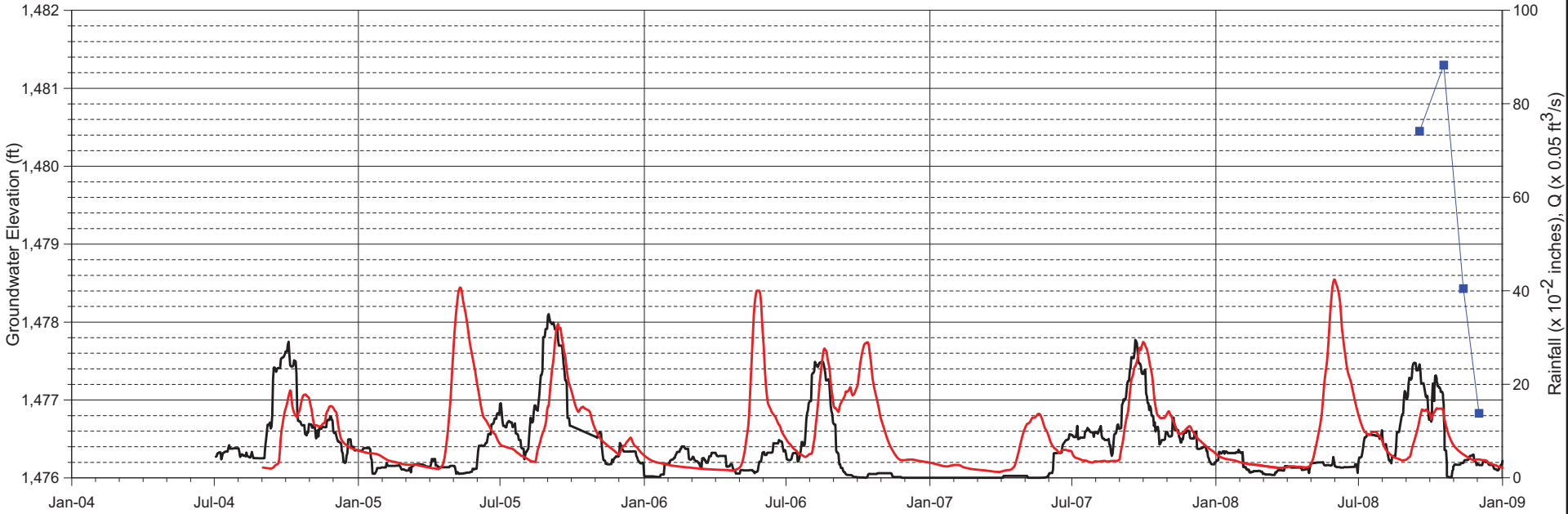


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-187



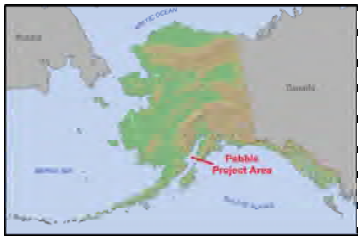
LEGEND:

Groundwater Elevation Plot Legend

- GH08-187
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

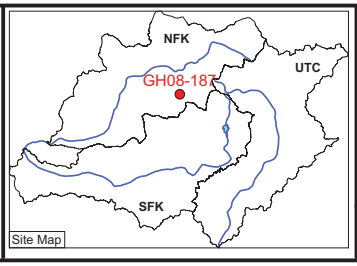
Screens (ft asl):
GH08-187 : 1433.9 - 1443.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1493.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-187.grf

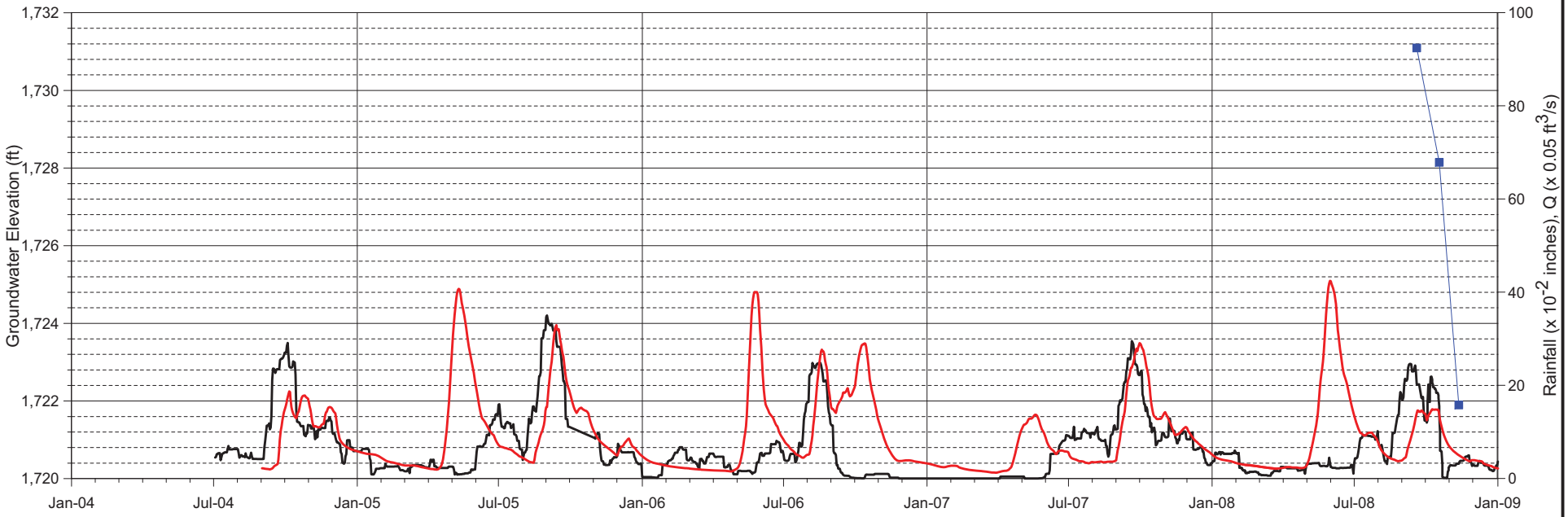


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-188



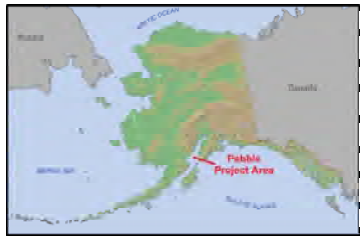
LEGEND:

Groundwater Elevation Plot Legend

- GH08-188
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

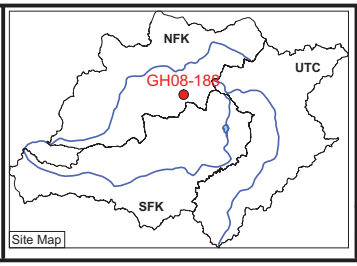
Screens (ft asl):
GH08-188 : 1715.8 - 1725.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1760.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-188.grf

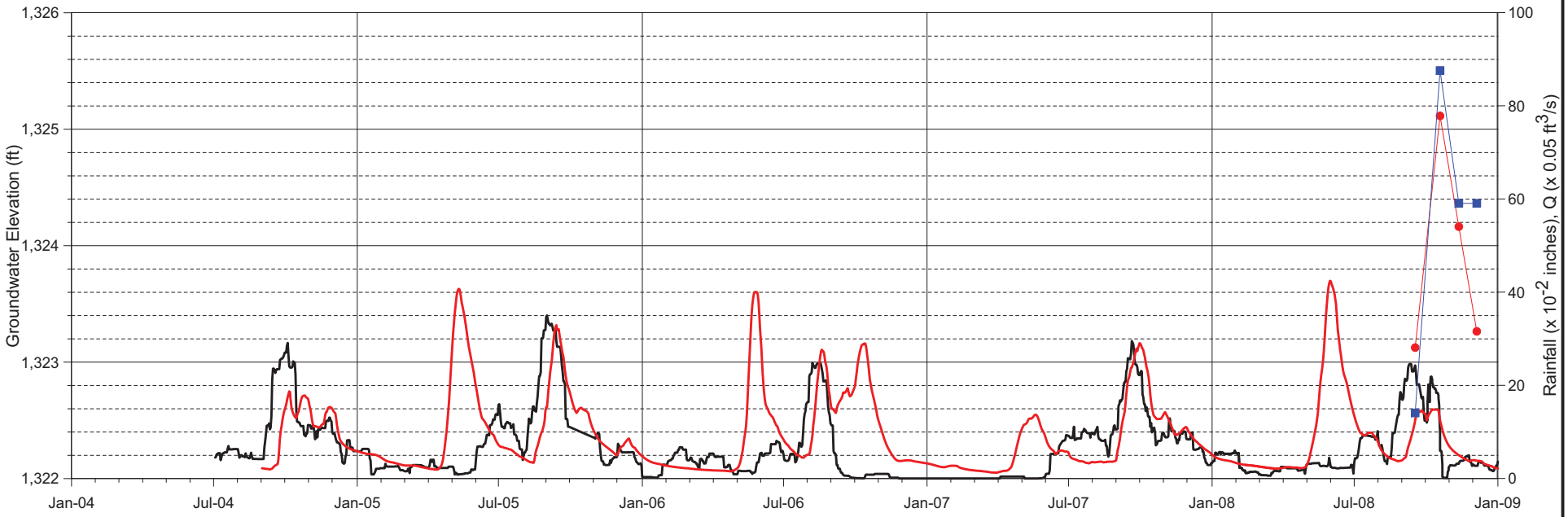


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-189



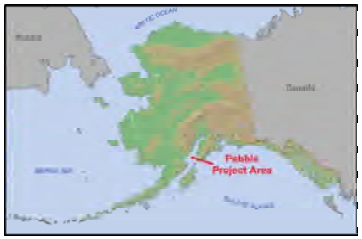
LEGEND:

Groundwater Elevation Plot Legend

- GH08-189S
- GH08-189D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

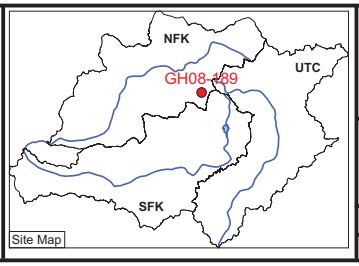
Screens (ft asl):
GH08-189S : 1186.2 - 1191.2
GH08-189D : 1151.2 - 1161.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1371.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-189.grf

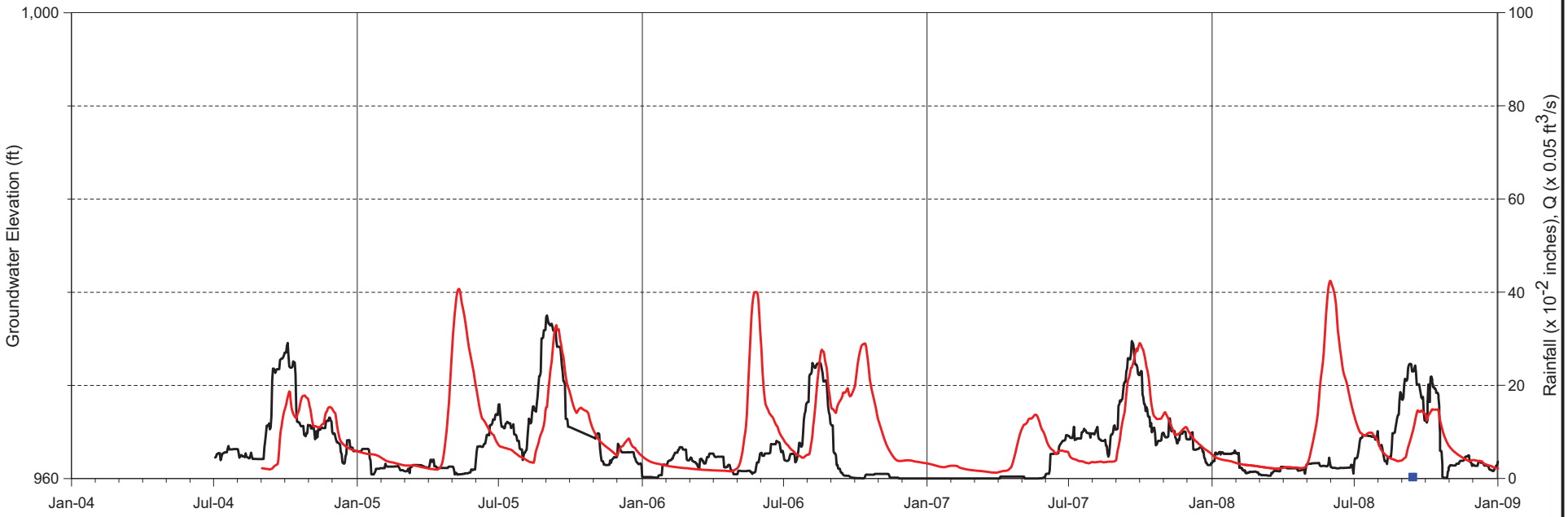


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-190



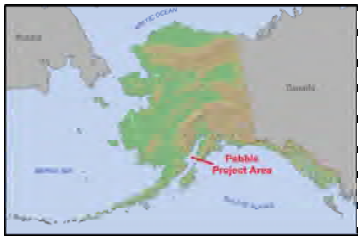
LEGEND:

Groundwater Elevation Plot Legend

- GH08-190
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
GH08-190 : 894.3 - 904.3

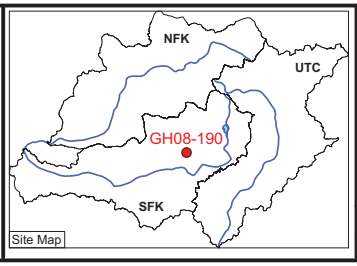


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 959.3 ft asl

Water was frozen in riser for most measurement periods.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-190.grf

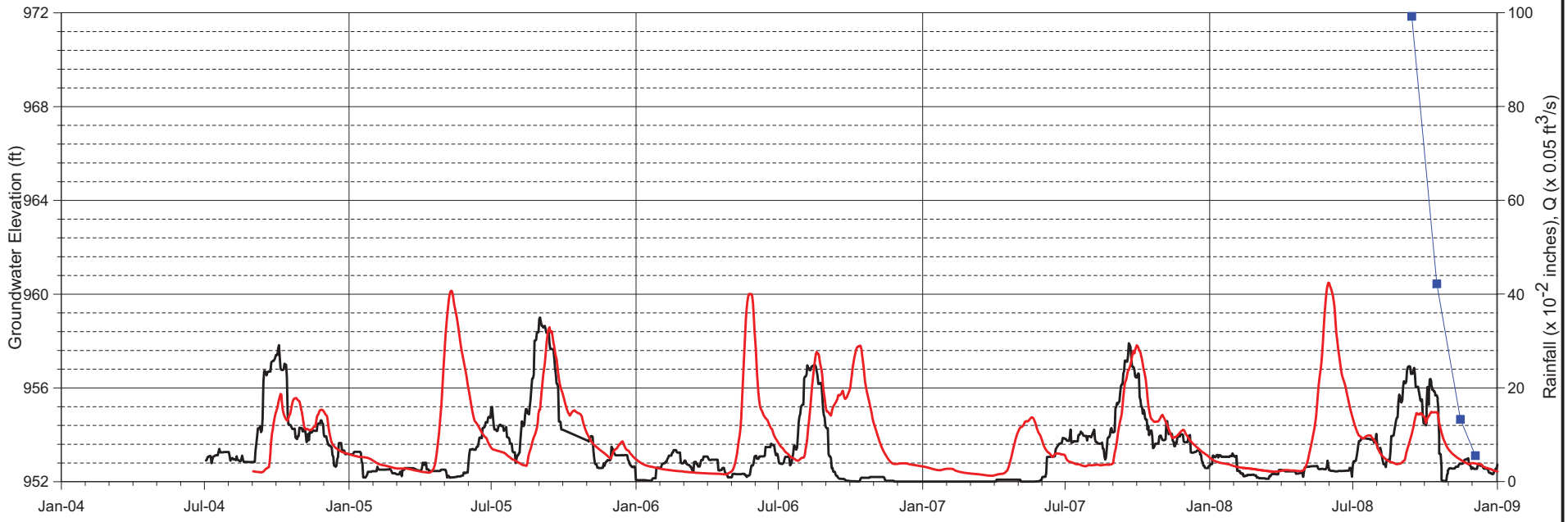


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-191



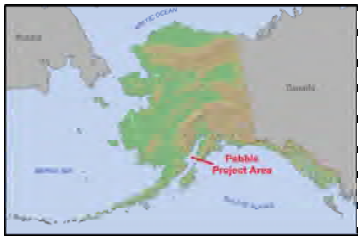
LEGEND:

Groundwater Elevation Plot Legend

- GH08-191
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

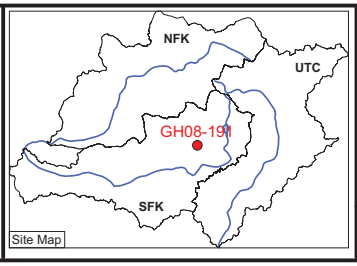
Screens (ft asl):
GH08-191 : 919.3 - 929.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1004.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-191.grf

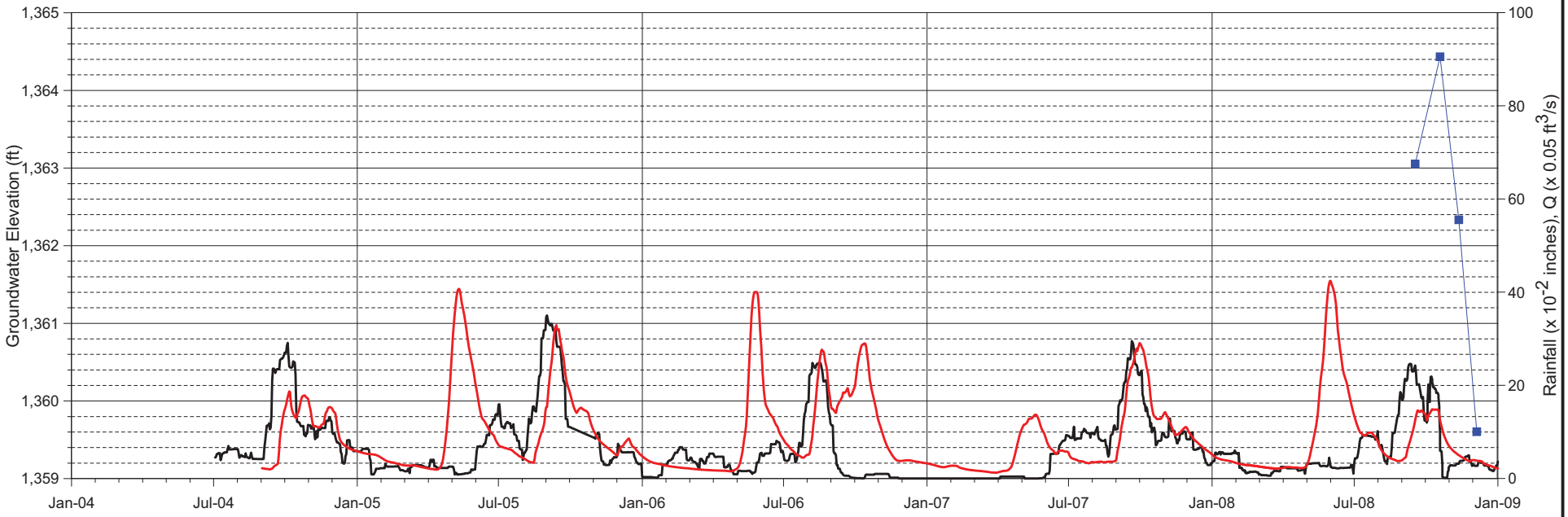


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-192



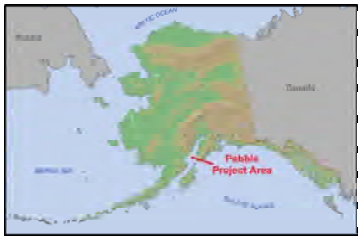
LEGEND:

Groundwater Elevation Plot Legend

- GH08-192
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

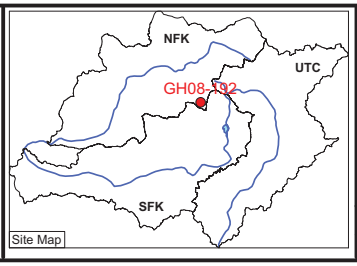
Screens (ft asl):
GH08-192 : 1206.4 - 1216.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1371.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-192.grf

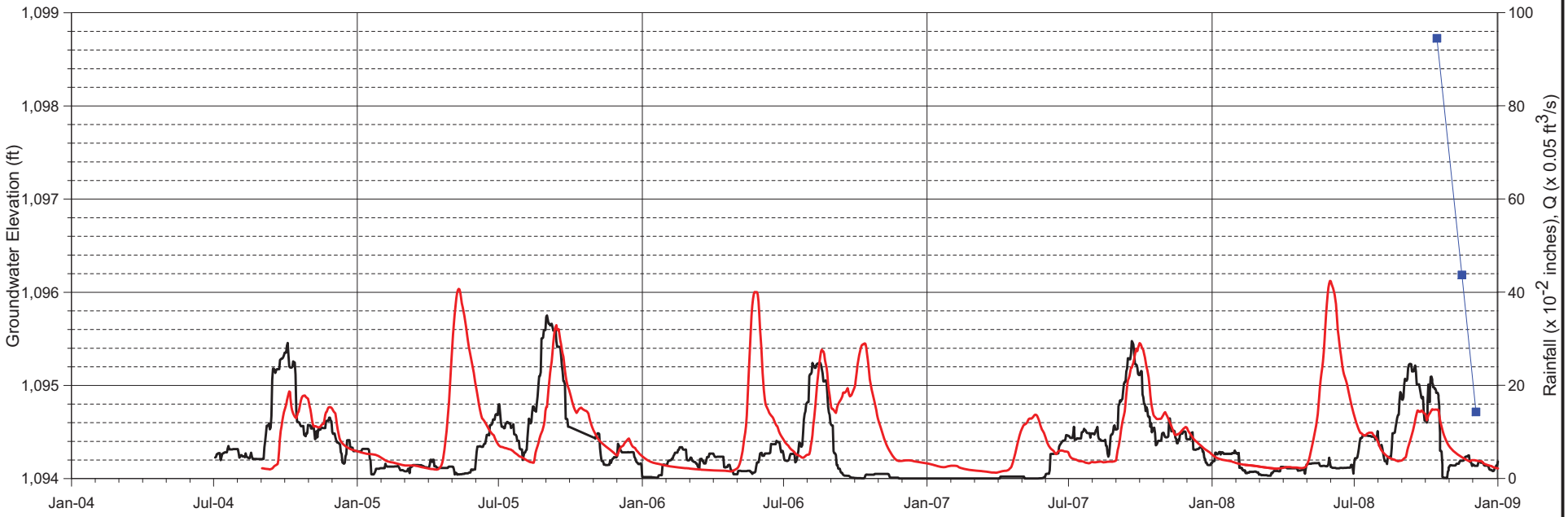


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-193



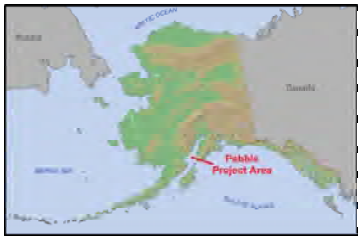
LEGEND:

Groundwater Elevation Plot Legend

- GH08-193
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

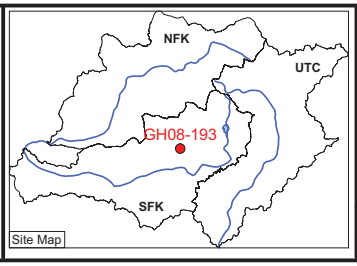
Screens (ft asl):
GH08-193 : 1062.5 - 1072.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1102.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-193.grf

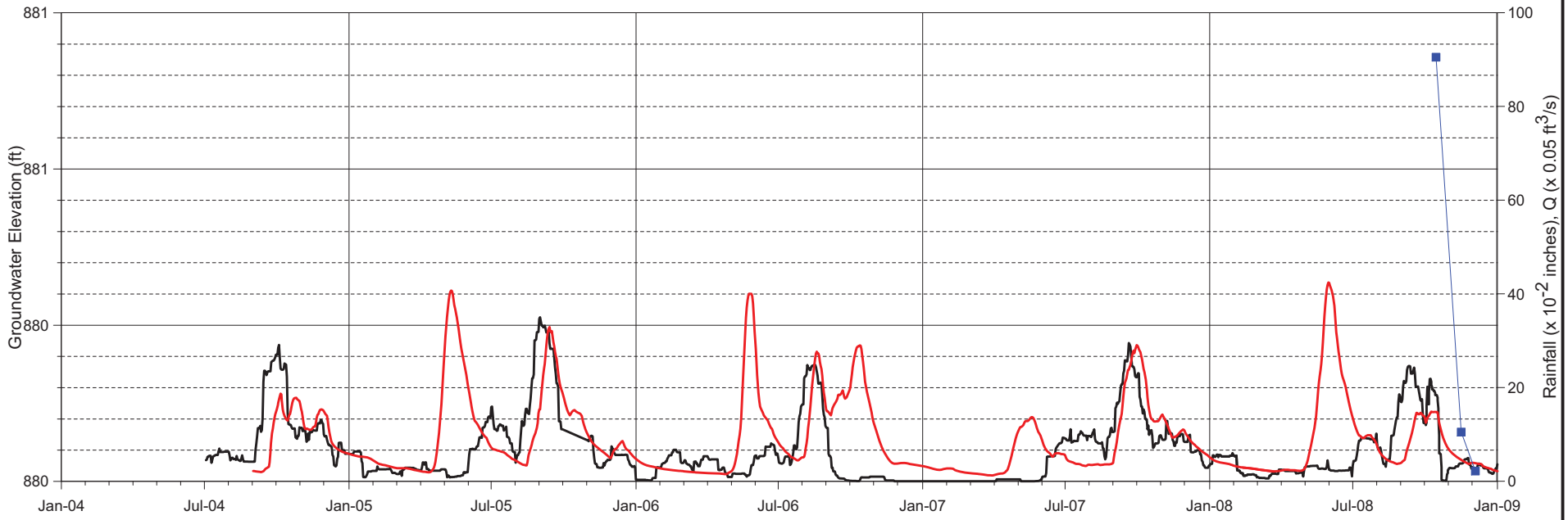


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-195



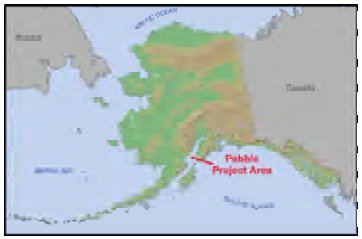
LEGEND:

Groundwater Elevation Plot Legend

- GH08-195
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

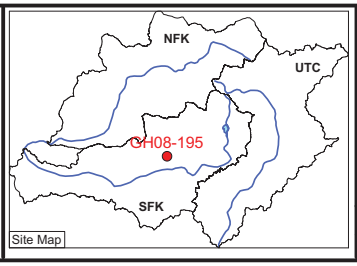
Screens (ft asl):
GH08-195 : 848.3 - 858.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 883.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-195.grf

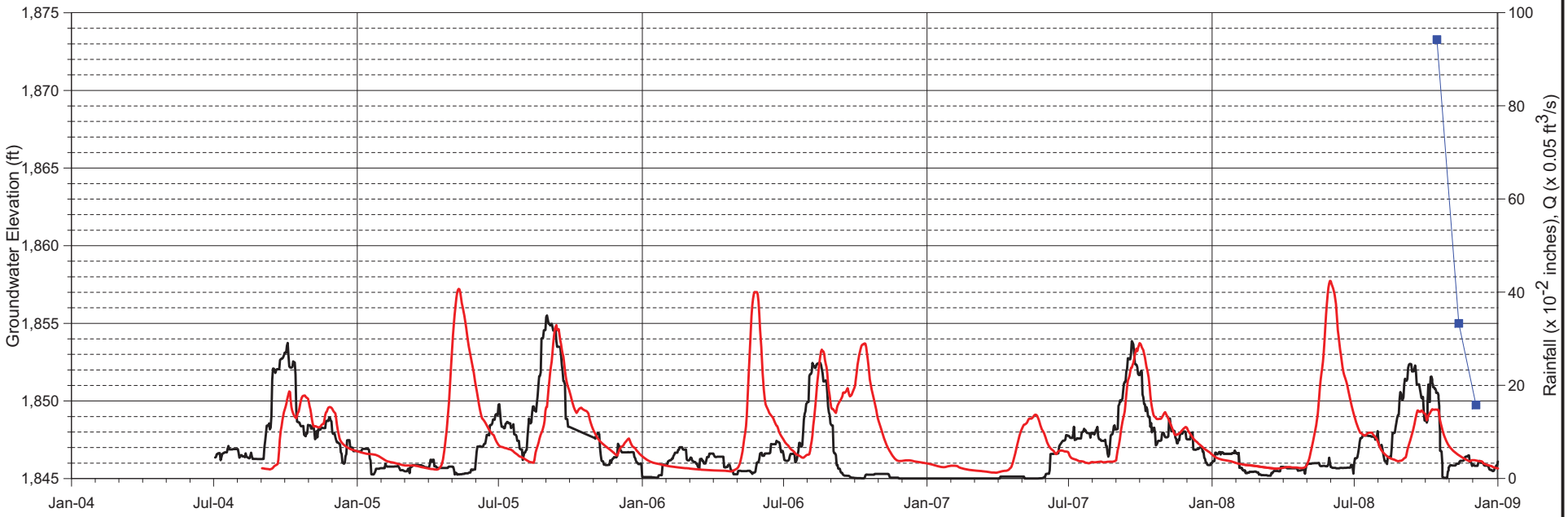


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-196



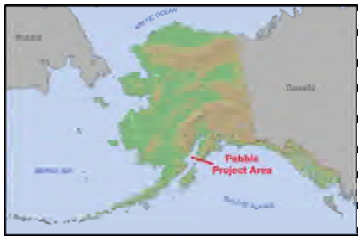
LEGEND:

Groundwater Elevation Plot Legend

- GH08-196
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

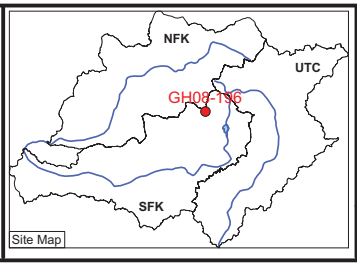
Screens (ft asl):
GH08-196 : 1841.6 - 1851.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1903.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-196.grf

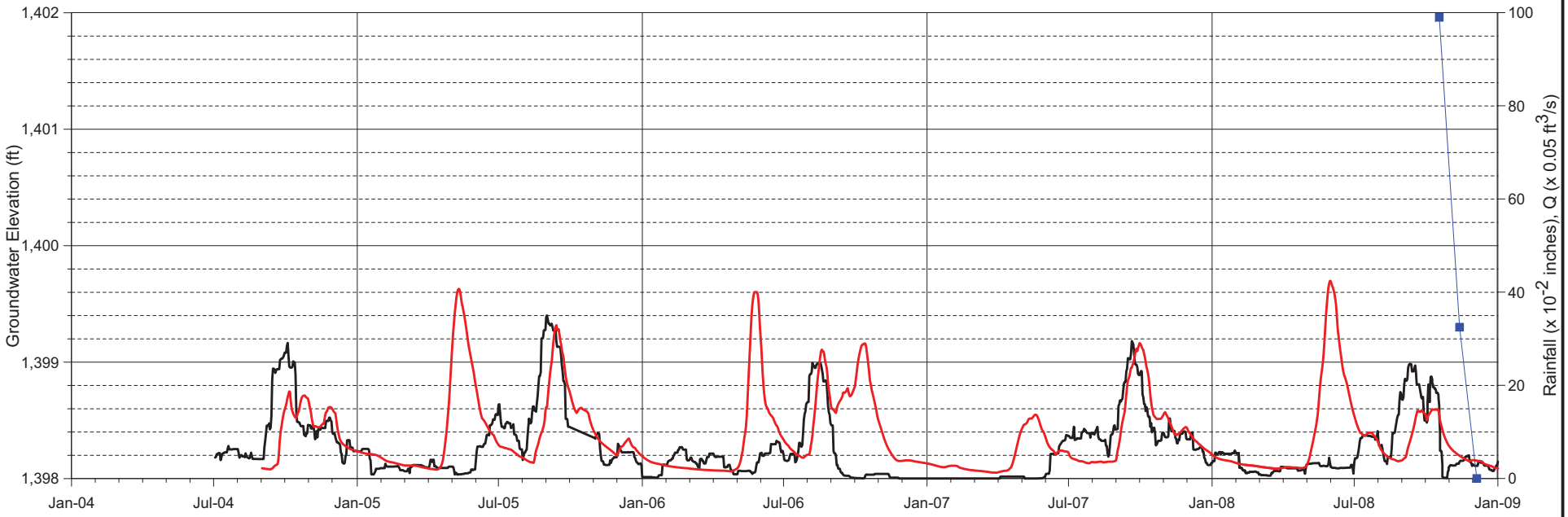


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-198



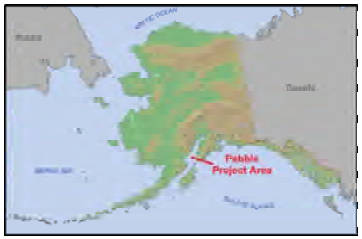
LEGEND:

Groundwater Elevation Plot Legend

- GH08-198
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

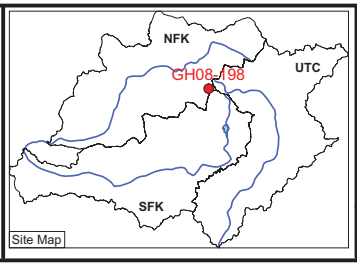
Screens (ft asl):
GH08-198 : 1367.9 - 1377.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1412.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-198.grf

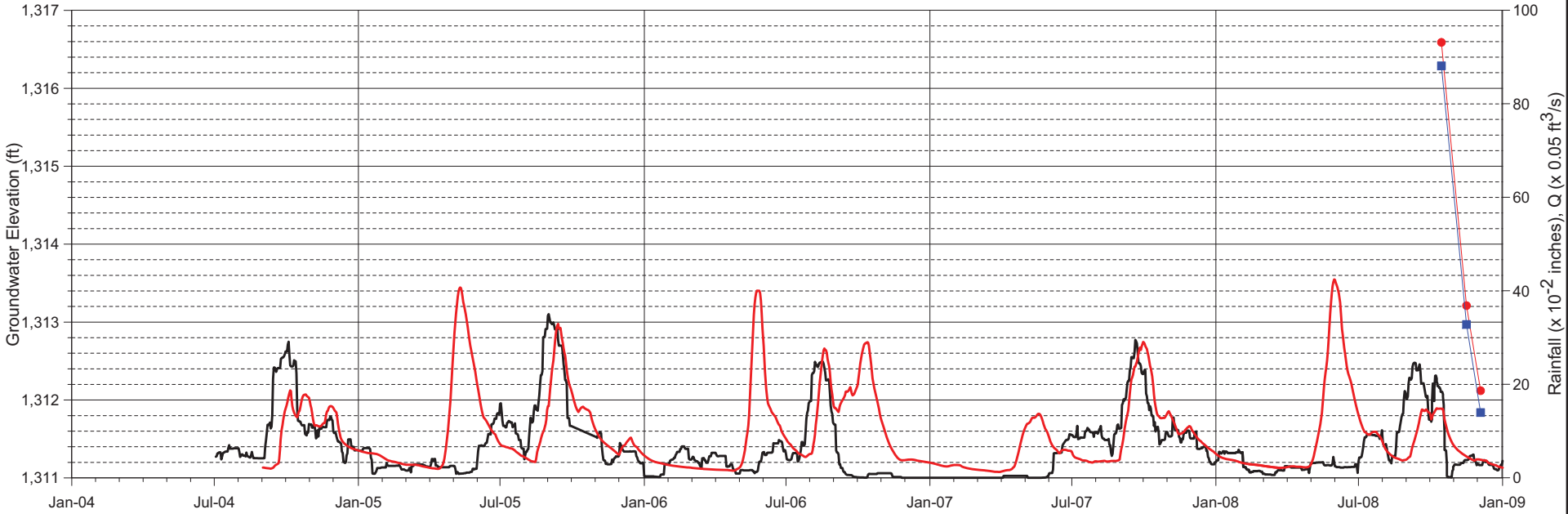


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-199



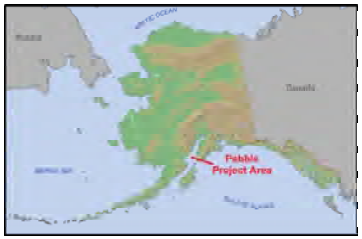
LEGEND:

Groundwater Elevation Plot Legend

- GH08-199S
- GH08-199D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

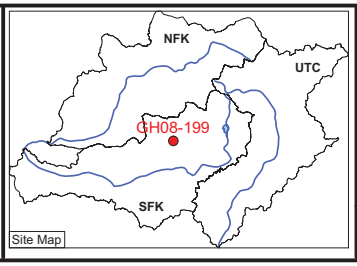
Screens (ft asl):
GH08-199S : 1242.2 - 1257.2
GH08-199D : 1197.2 - 1217.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1327.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-199.grf

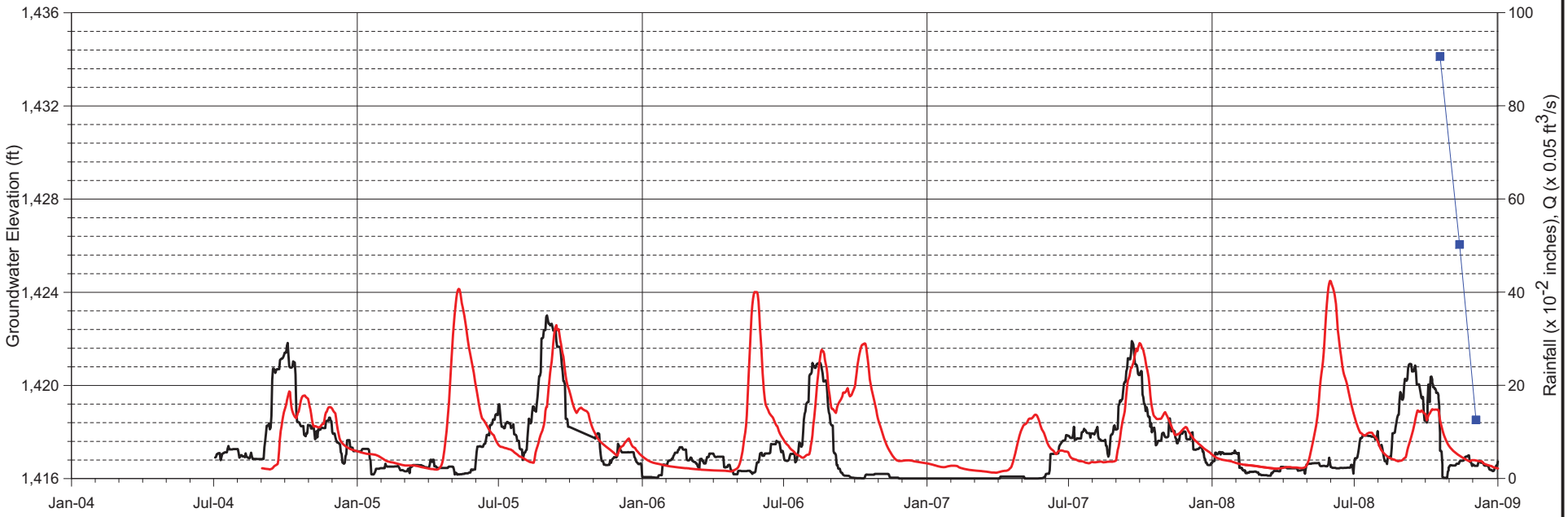


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-200



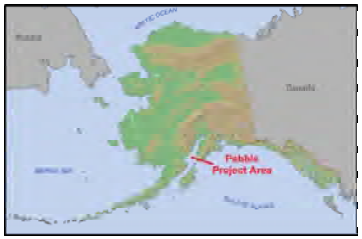
LEGEND:

Groundwater Elevation Plot Legend

- GH08-200
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

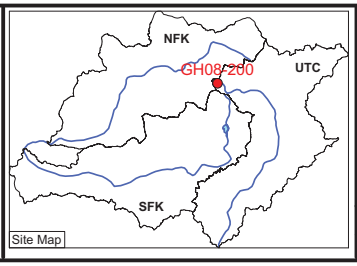
Screens (ft asl):
GH08-200 : 1368.9 - 1378.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1438.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-200.grf

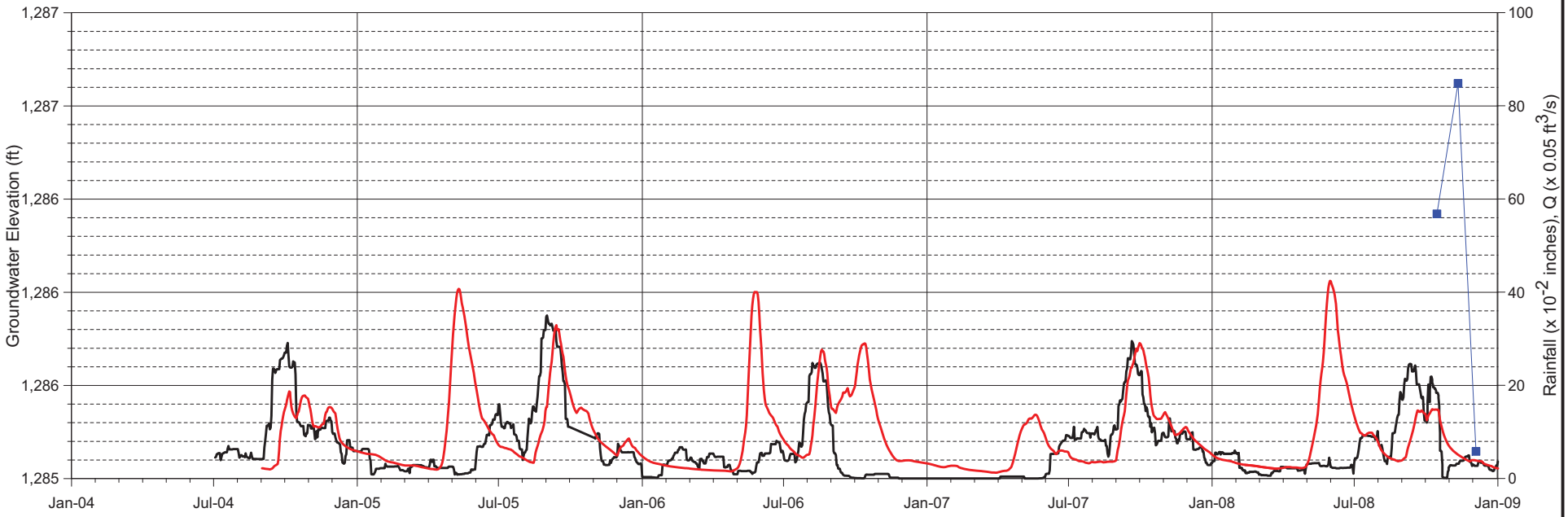


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-203



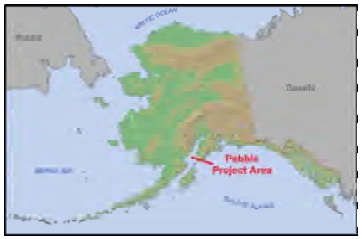
LEGEND:

Groundwater Elevation Plot Legend

- GH08-203
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

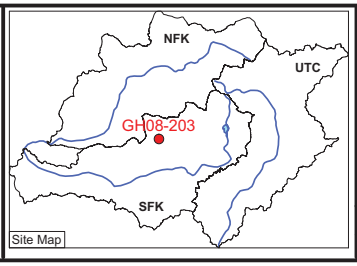
Screens (ft asl):
GH08-203 : 1255.8 - 1265.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1298.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-203.grf

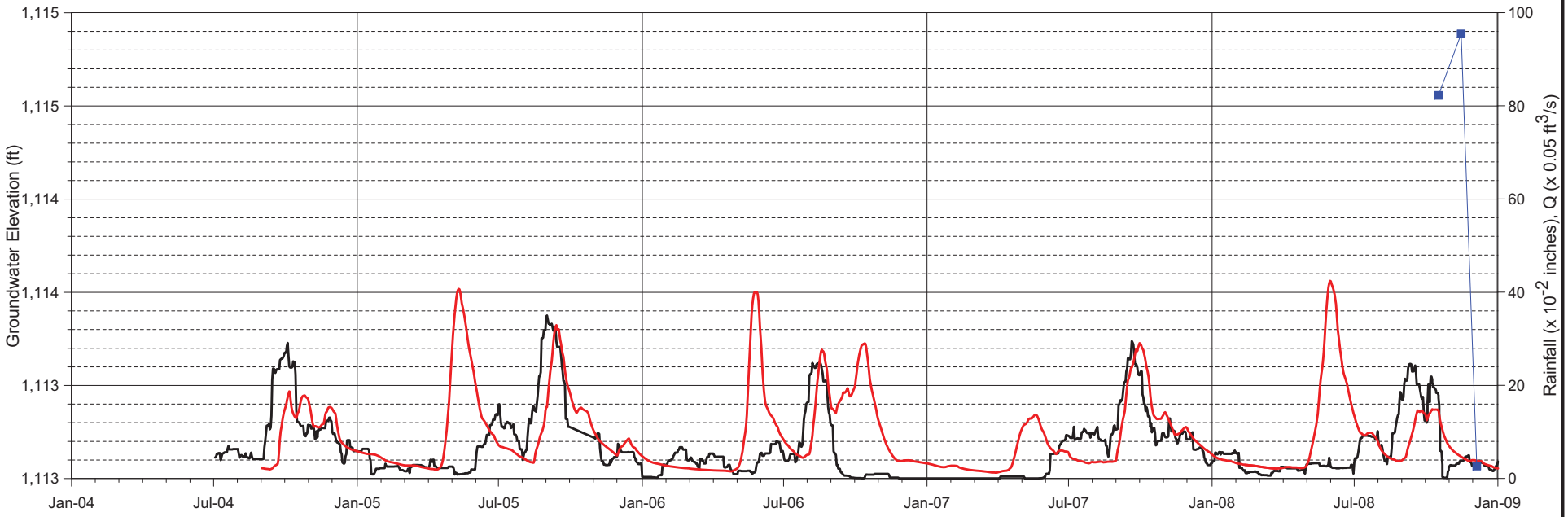


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-204



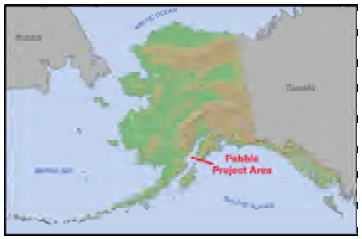
LEGEND:

Groundwater Elevation Plot Legend

- GH08-204
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

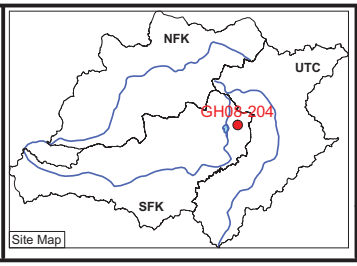
Screens (ft asl):
GH08-204 : 1072.2 - 1082.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-204.grf

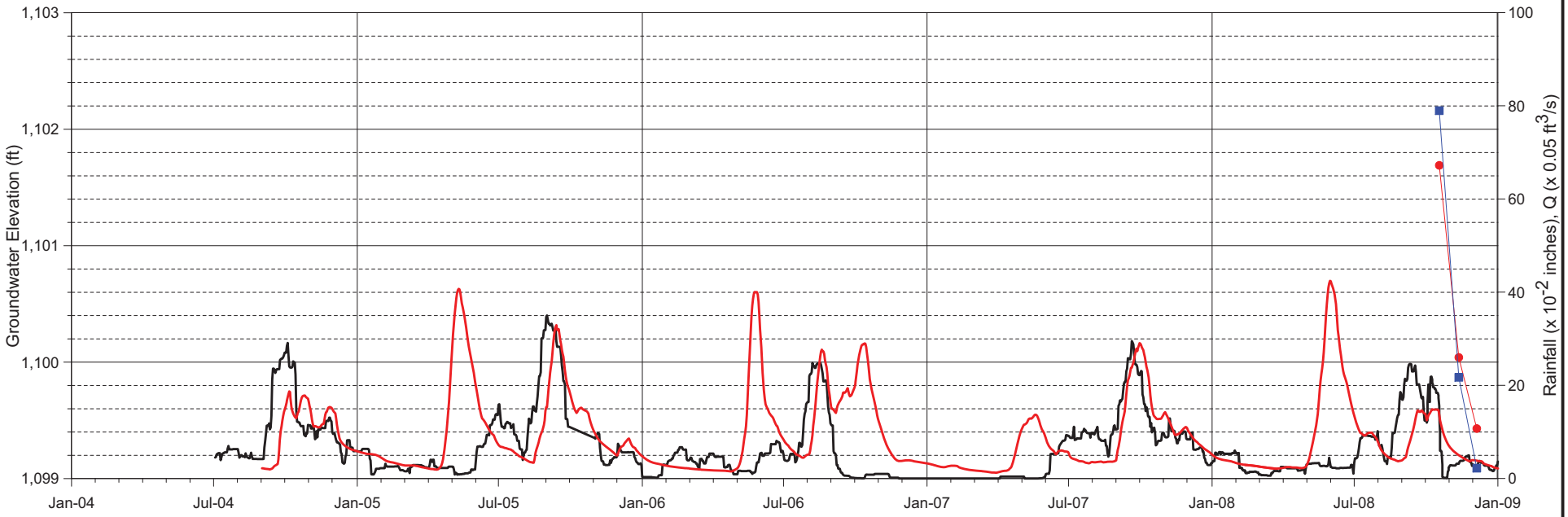


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-205



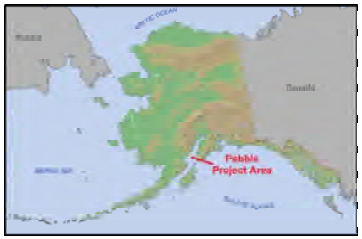
LEGEND:

Groundwater Elevation Plot Legend

- GH08-205S
- GH08-205D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

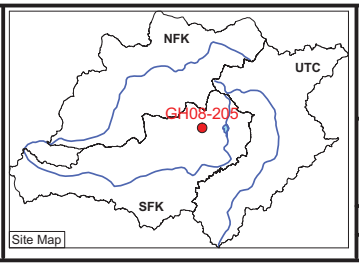
Screens (ft asl):
GH08-205S : 1058.1 - 1078.1
GH08-205D : 1011.6 - 1031.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1108.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-205.grf

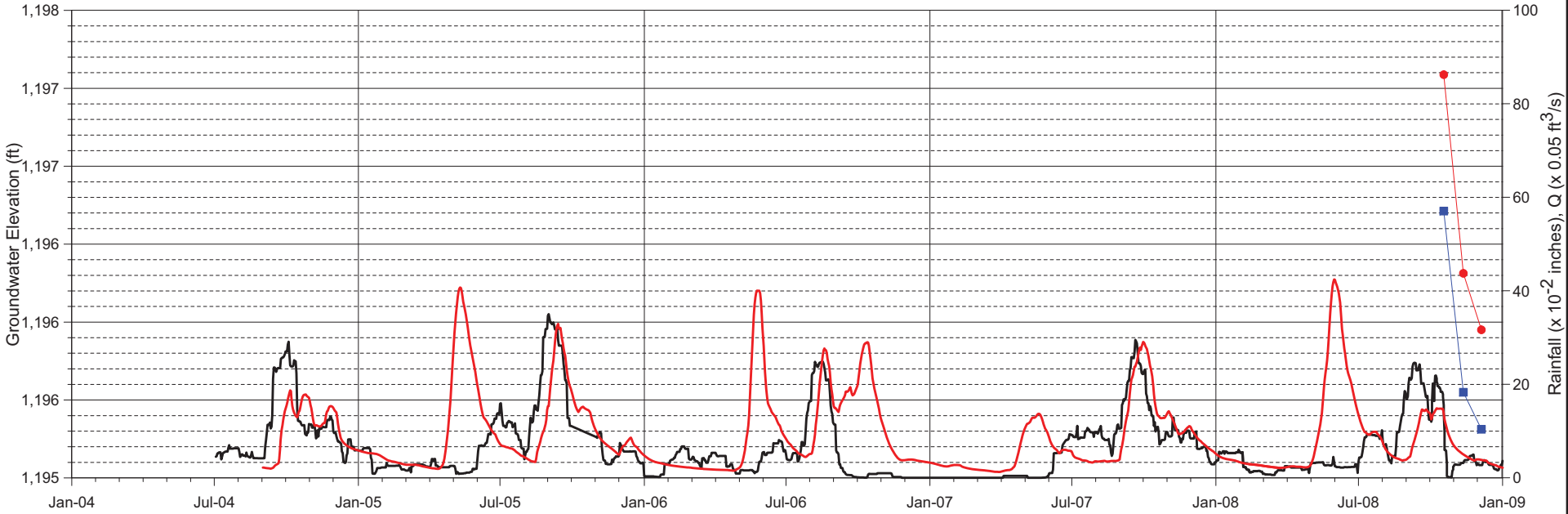


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-206



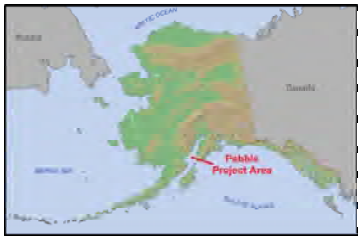
LEGEND:

Groundwater Elevation Plot Legend

- GH08-206S
- GH08-206D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

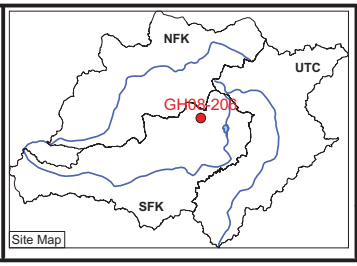
Screens (ft asl):
GH08-206S : 1089.6 - 1099.6
GH08-206D : 1034.6 - 1044.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1199.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-206.grf

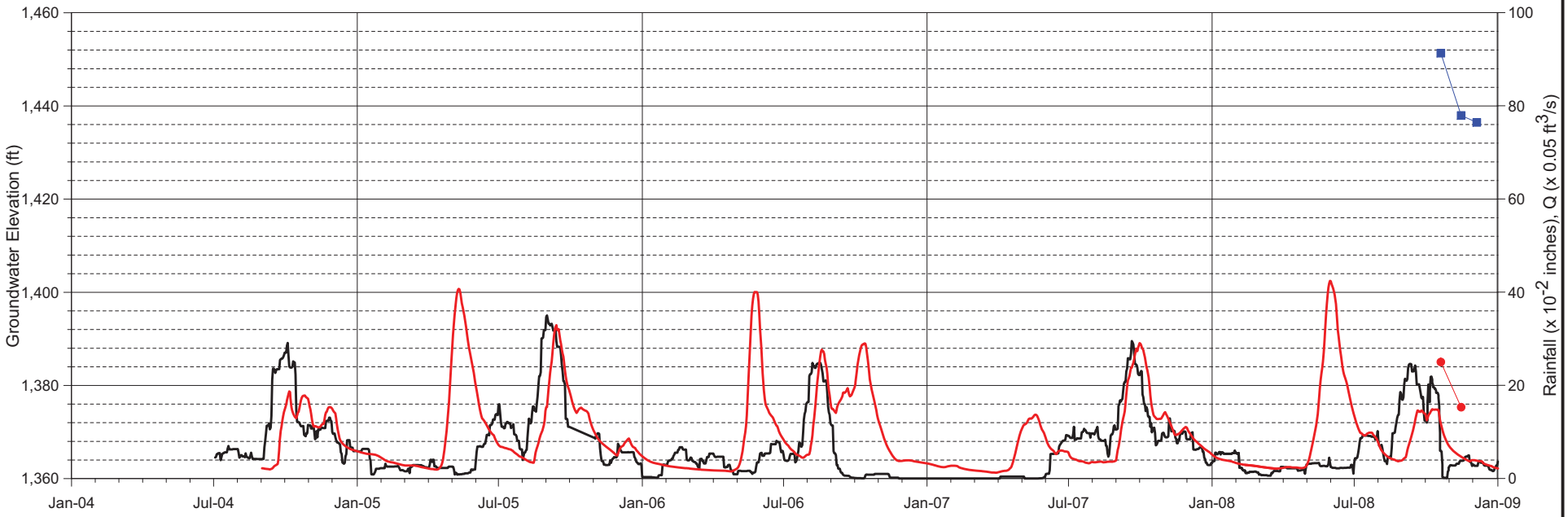


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-207



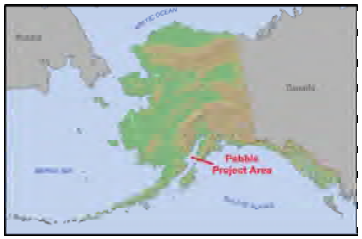
LEGEND:

Groundwater Elevation Plot Legend

- GH08-207S
- GH08-207D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

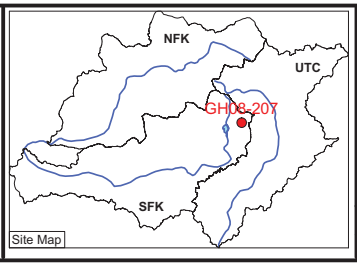
Screens (ft asl):
GH08-207S : 1433.8 - 1443.8
GH08-207D : 1374.8 - 1384.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1478.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-207.grf

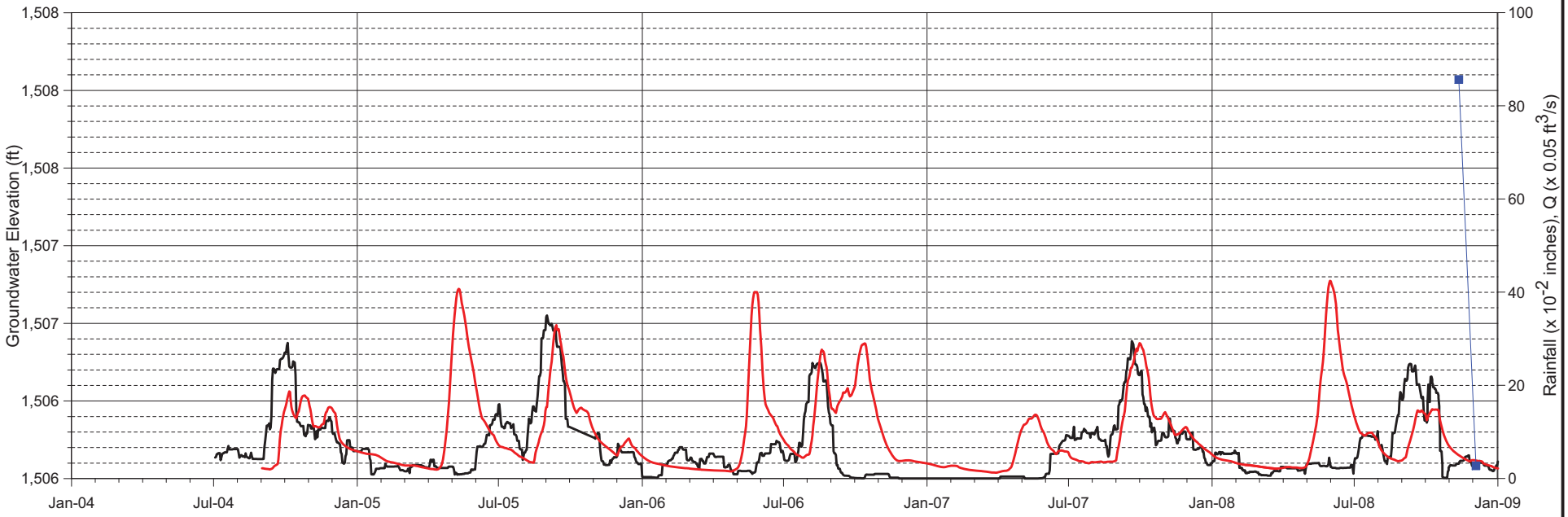


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-208



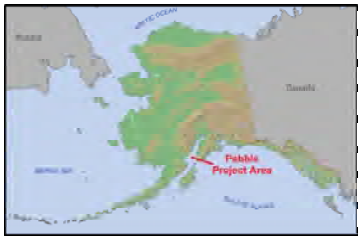
LEGEND:

Groundwater Elevation Plot Legend

- GH08-208
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

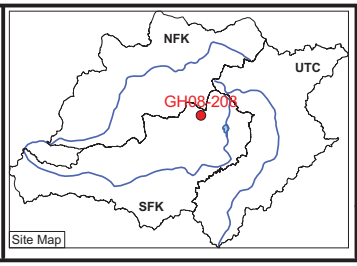
Screens (ft asl):
GH08-208 : 1451.2 - 1461.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1515.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-208.grf

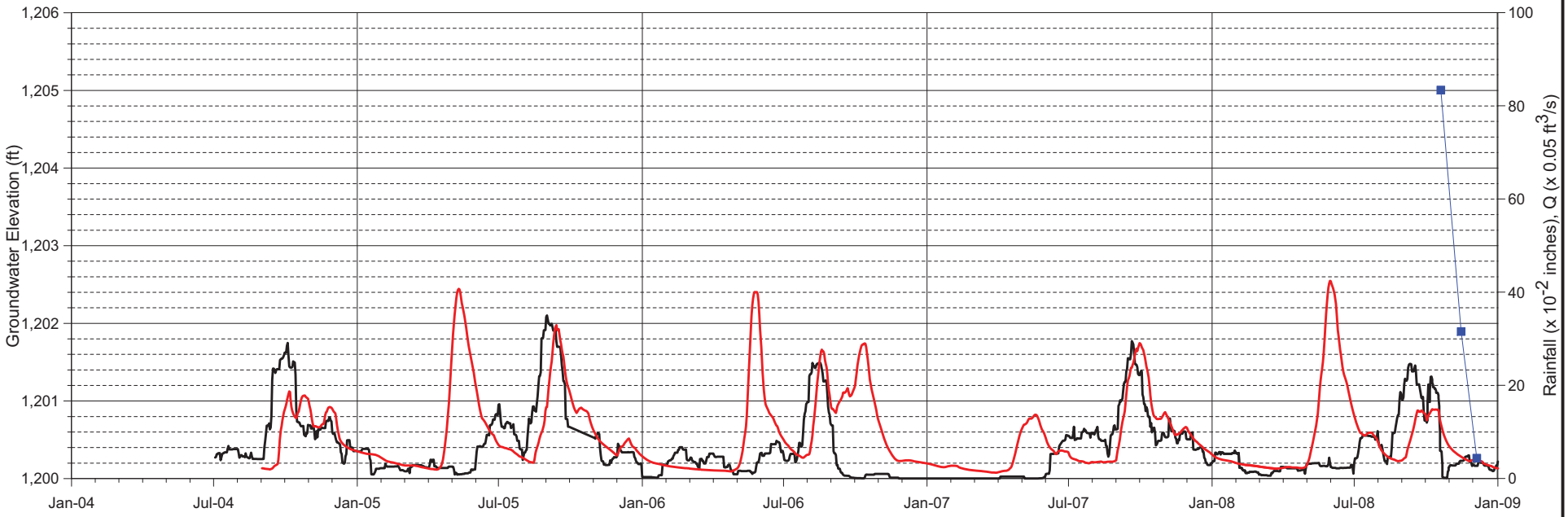


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-209



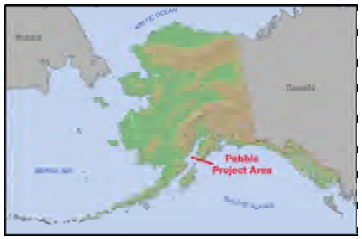
LEGEND:

Groundwater Elevation Plot Legend

- GH08-209
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

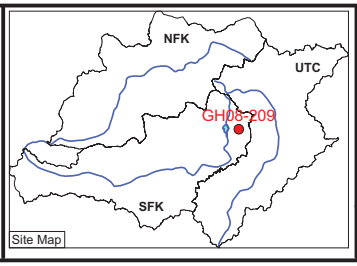
Screens (ft asl):
GH08-209 : 1147.9 - 1157.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1221.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-209.grf

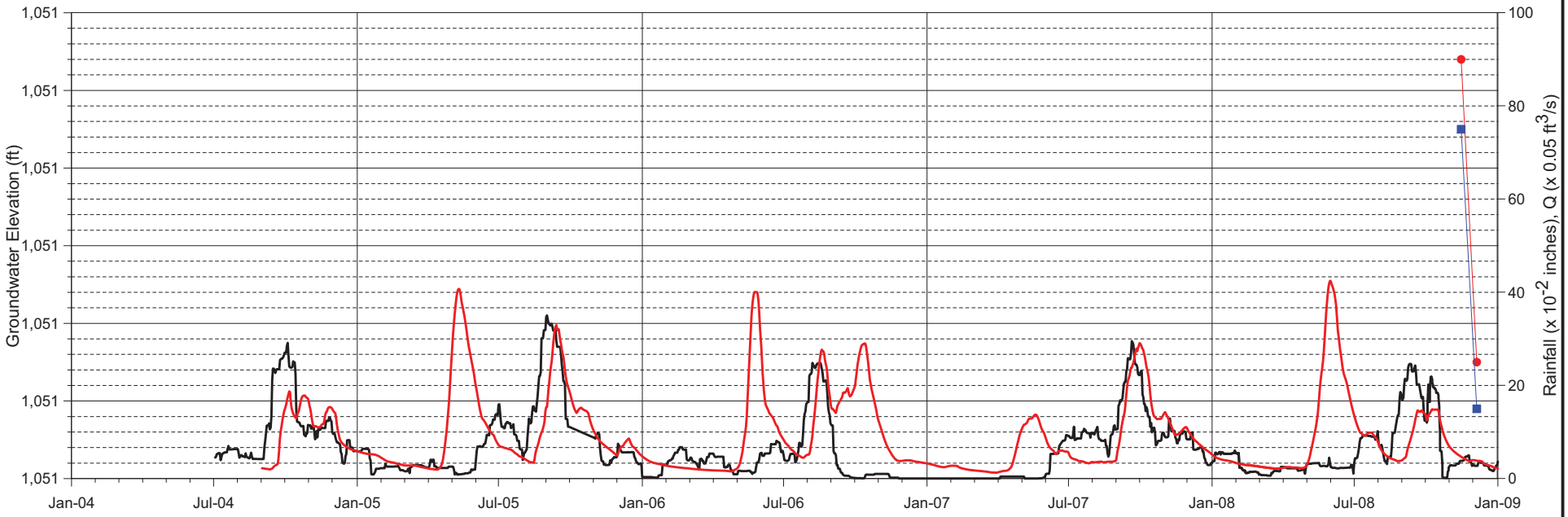


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time GH08-210



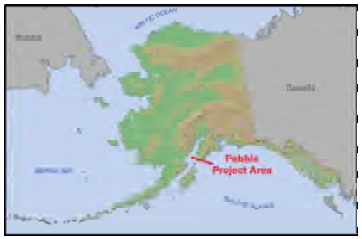
LEGEND:

Groundwater Elevation Plot Legend

- GH08-210S
- GH08-210D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

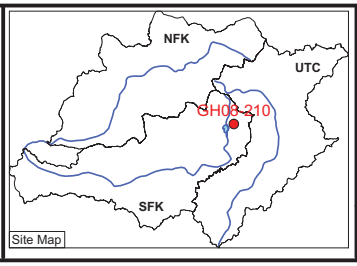
Screens (ft asl):
GH08-210S : 1007.5 - 1017.5
GH08-210D : 962.5 - 972.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1092.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\GH08-210.grf

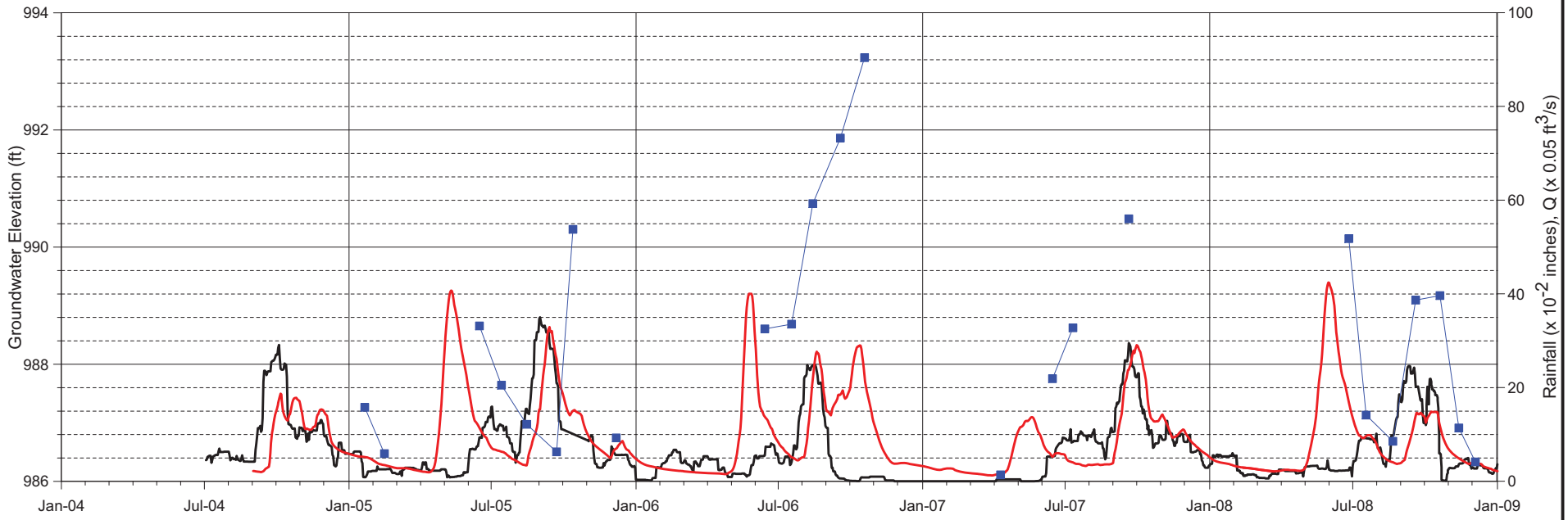


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time I-125



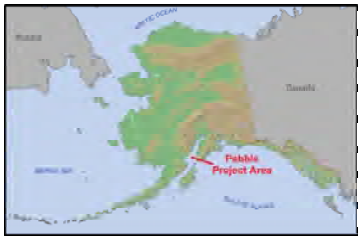
LEGEND:

Groundwater Elevation Plot Legend

- I-125
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

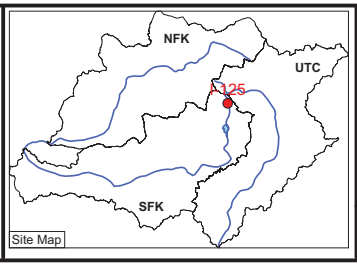
Screens (ft asl):
I-125 : 926.5 - 936.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1005.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\I-125.grf

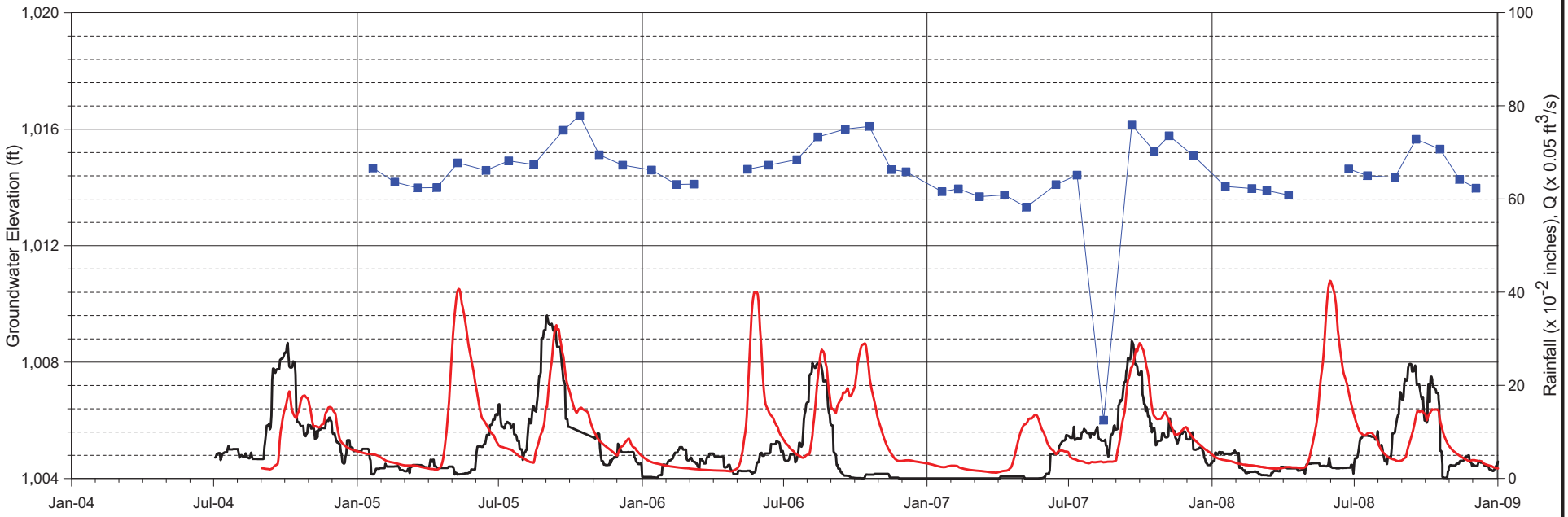


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time I-172



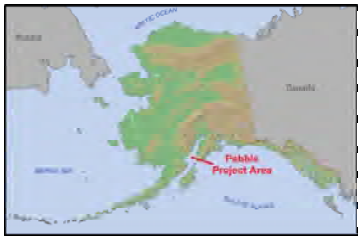
LEGEND:

Groundwater Elevation Plot Legend

- I-172
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

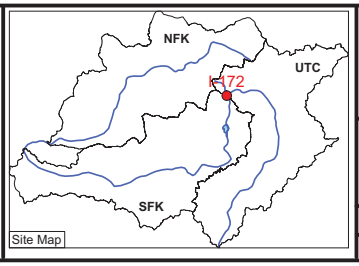
Screens (ft asl):
I-172 : 896.3 - 906.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1023.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\I-172.grf

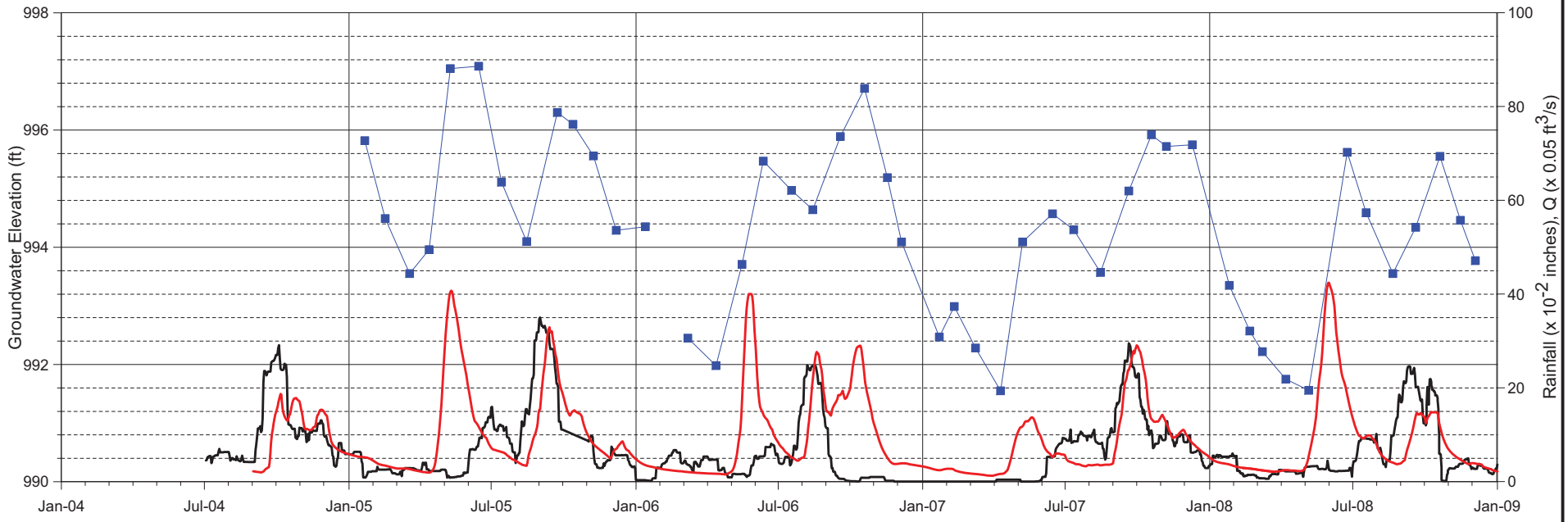


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time I-201



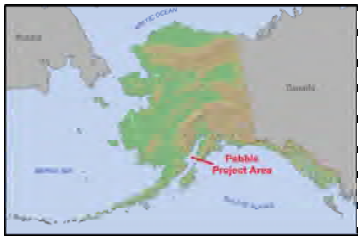
LEGEND:

Groundwater Elevation Plot Legend

- I-201
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

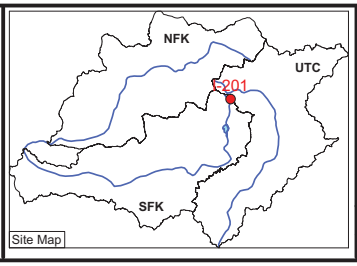
Screens (ft asl):
I-201 : 902.1 - 912.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1055.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\I-201.grf

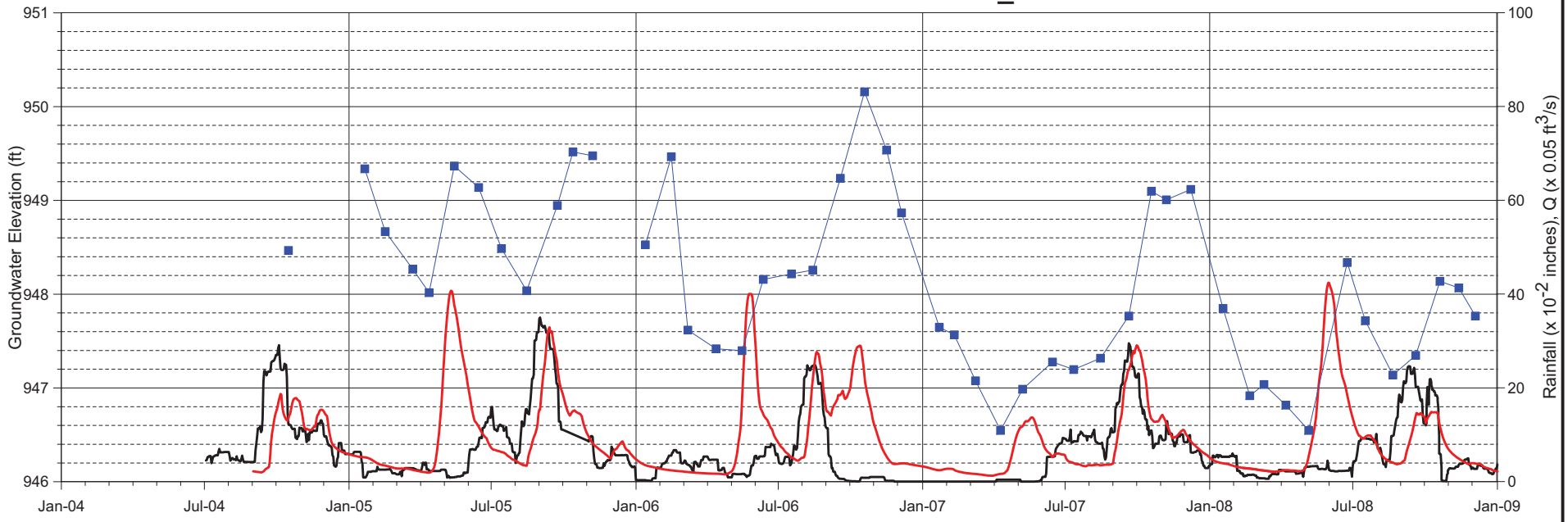


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time KP-P1_SRK-2



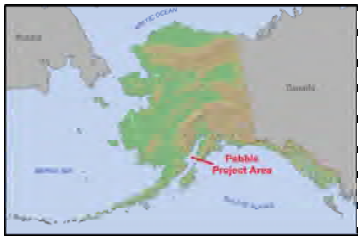
LEGEND:

Groundwater Elevation Plot Legend

- KP-P1/SRK-2
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

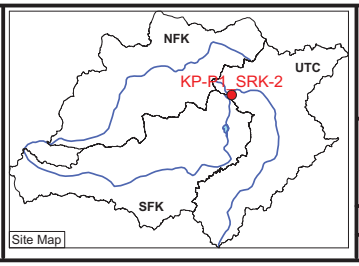
Screens (ft asl):
KP-P1/SRK-2 : 863.8 - 873.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 997.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\KP-P1_SRK-2.grf

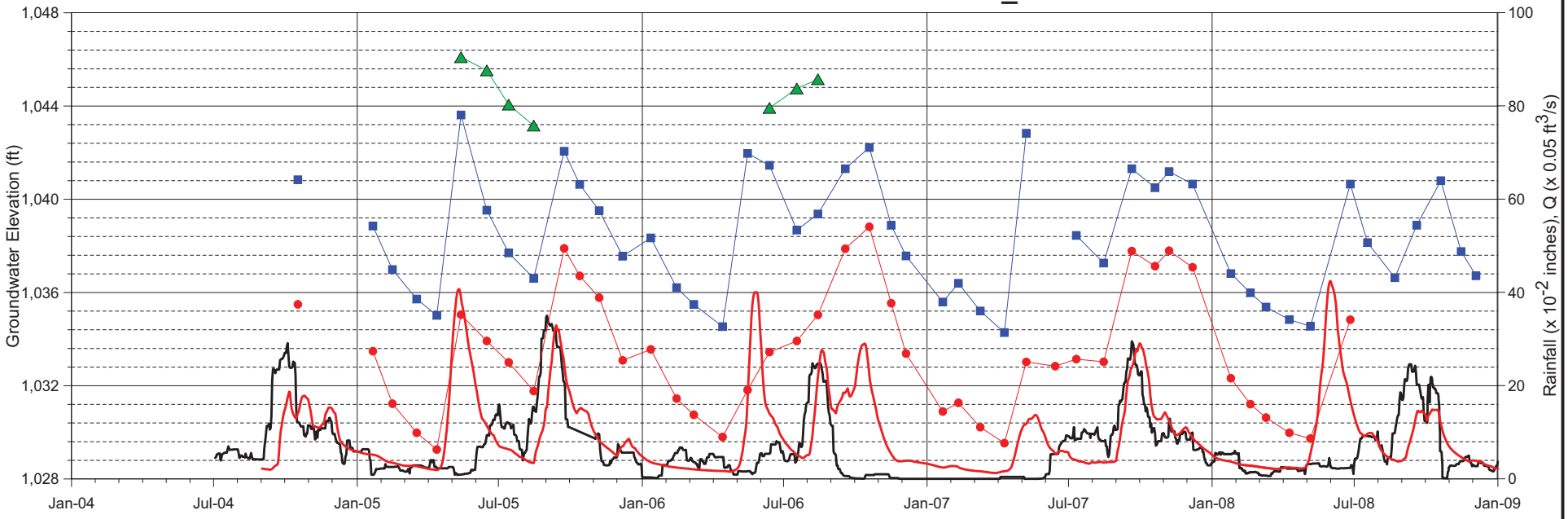


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time KP-P3_SRK-5



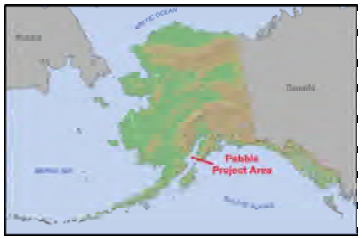
LEGEND:

Groundwater Elevation Plot Legend

- KP-P3S/SRK-5S
- KP-P3M/SRK-5M
- KP-P3D/SRK-5D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
KP-P3S/SRK-5S : 1024.6 - 1034.6
KP-P3M/SRK-5M : 992.1 - 1002.1
KP-P3D/SRK-5D : 965.1 - 975.1

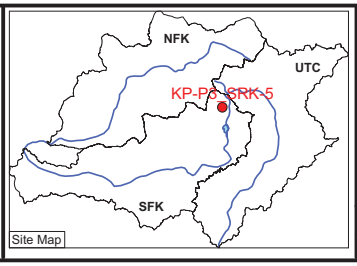


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1042.6 ft asl

KP-P3D is a flowing well. Water levels were recorded occasionally when an extension was placed on the well.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\KP-P3_SRK-5.grf

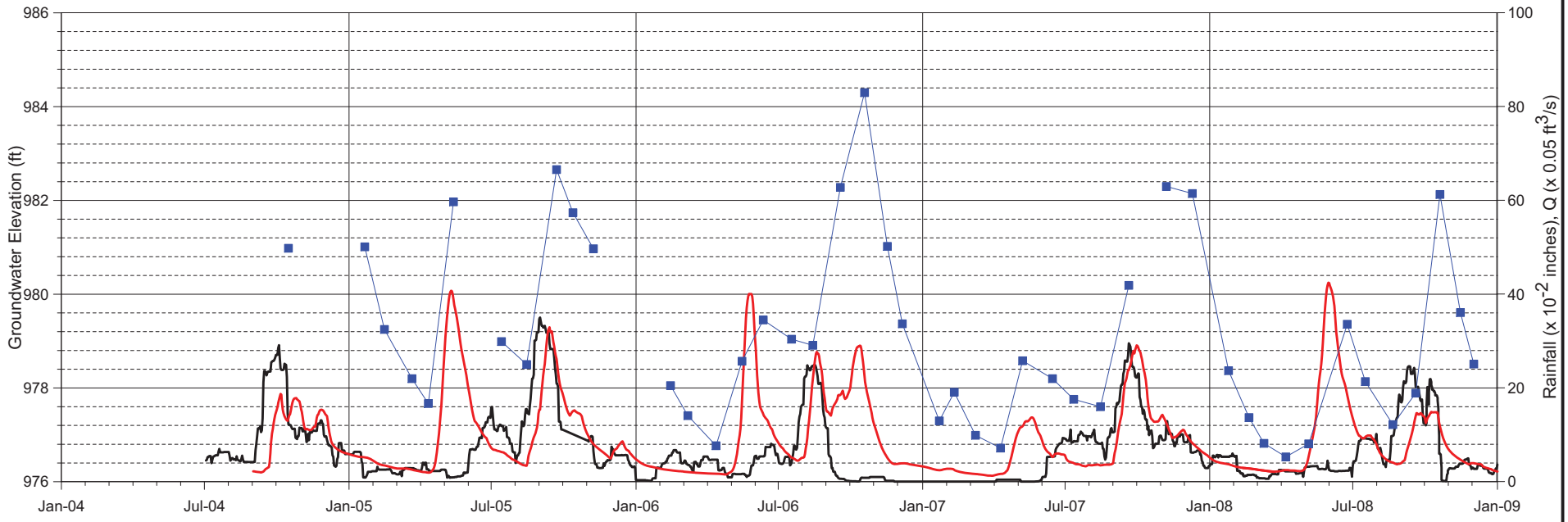


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time KP-P4



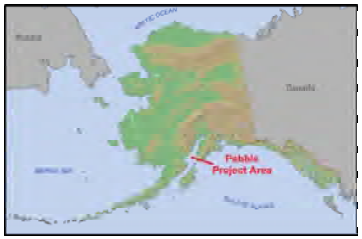
LEGEND:

Groundwater Elevation Plot Legend

- KP-P4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

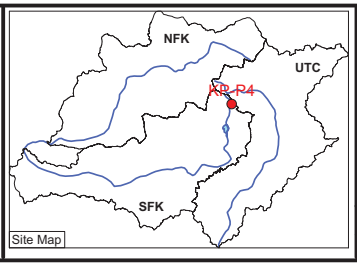
Screens (ft asl):



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 999.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\KP-P4.grf

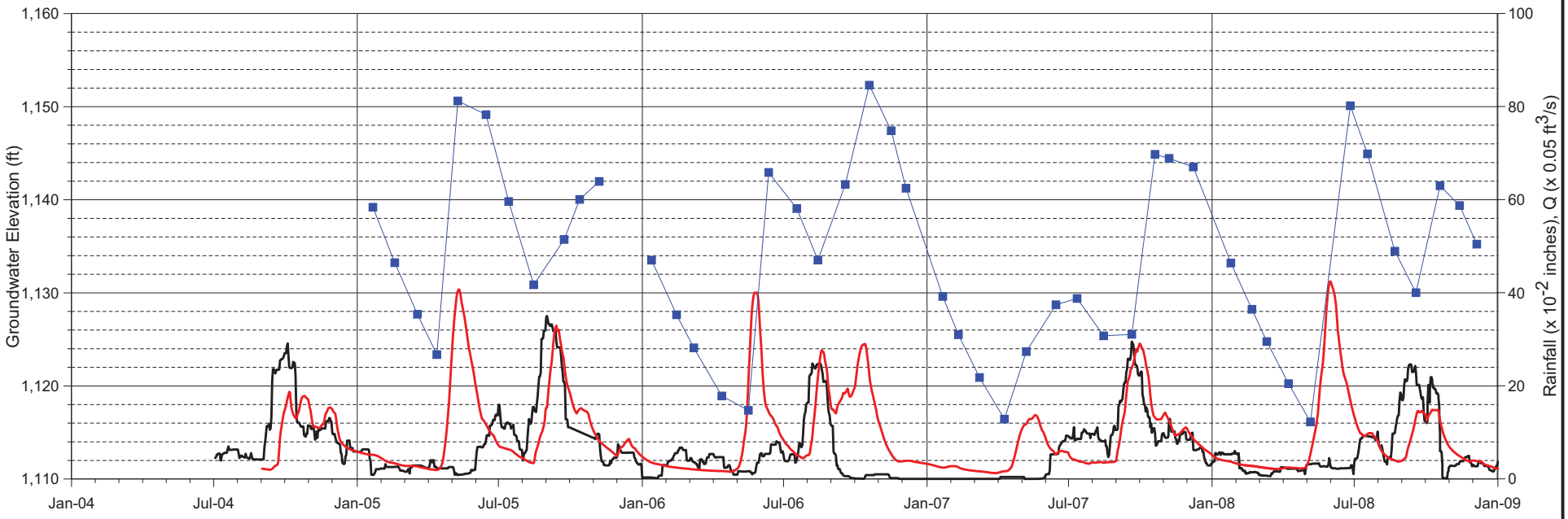


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-110



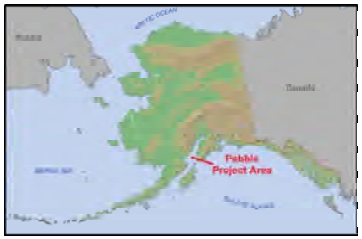
LEGEND:

Groundwater Elevation Plot Legend

- M-110
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

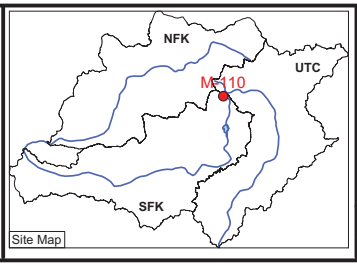
Screens (ft asl):
M-110 : 1082.1 - 1092.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1179.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-110.grf

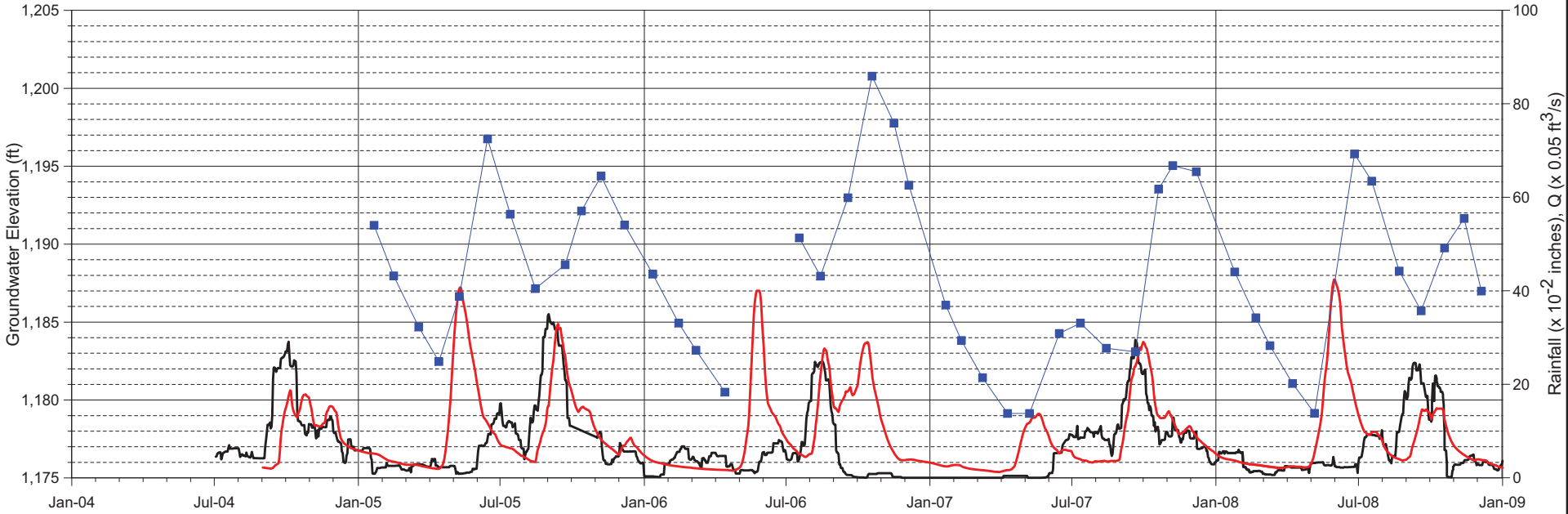


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-12



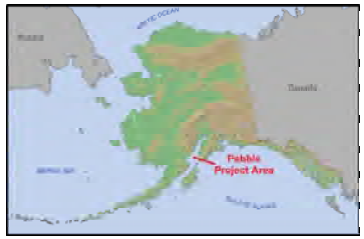
LEGEND:

Groundwater Elevation Plot Legend

- M-12
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

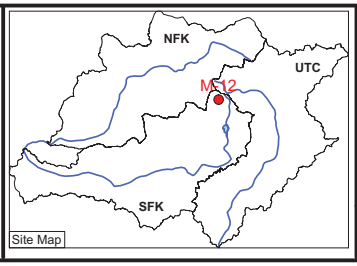
Screens (ft asl):
M-12 : 1155.2 - 1165.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1201.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-12.grf

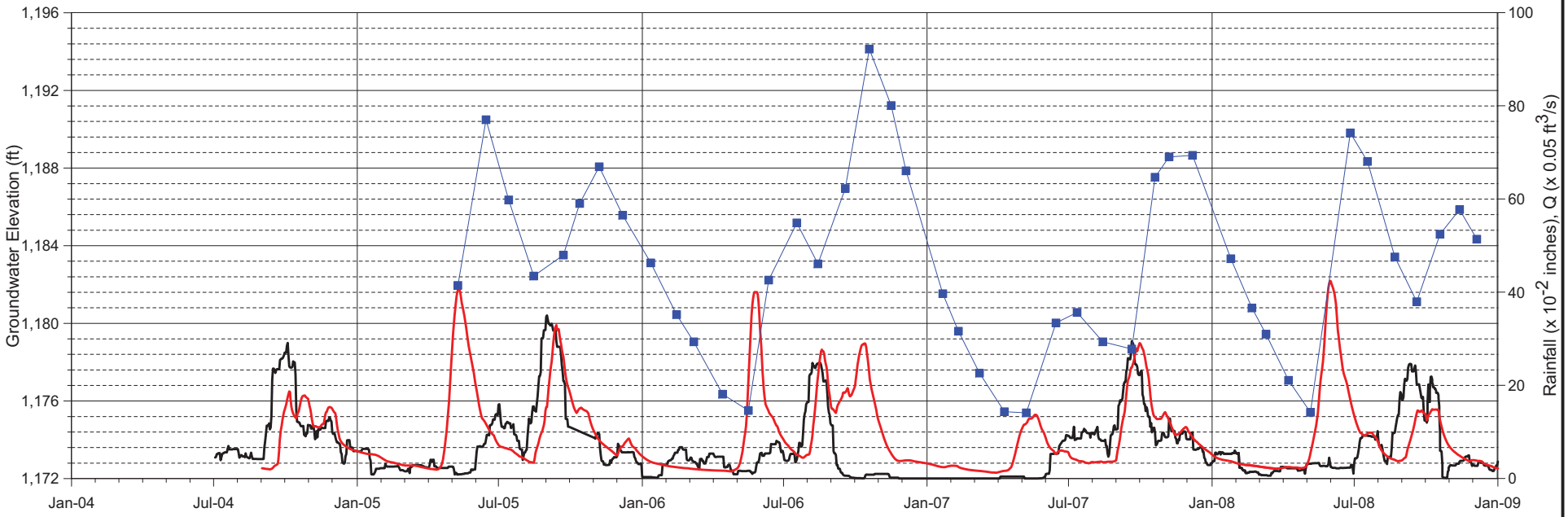


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-21



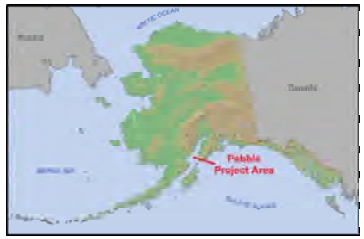
LEGEND:

Groundwater Elevation Plot Legend

- M-21
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

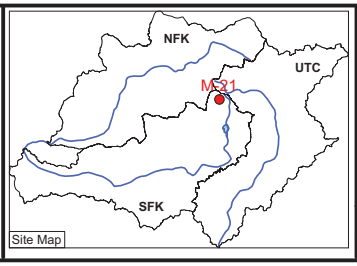
Screens (ft asl):
M-21 : 1126.4 - 1136.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1215.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-21.grf

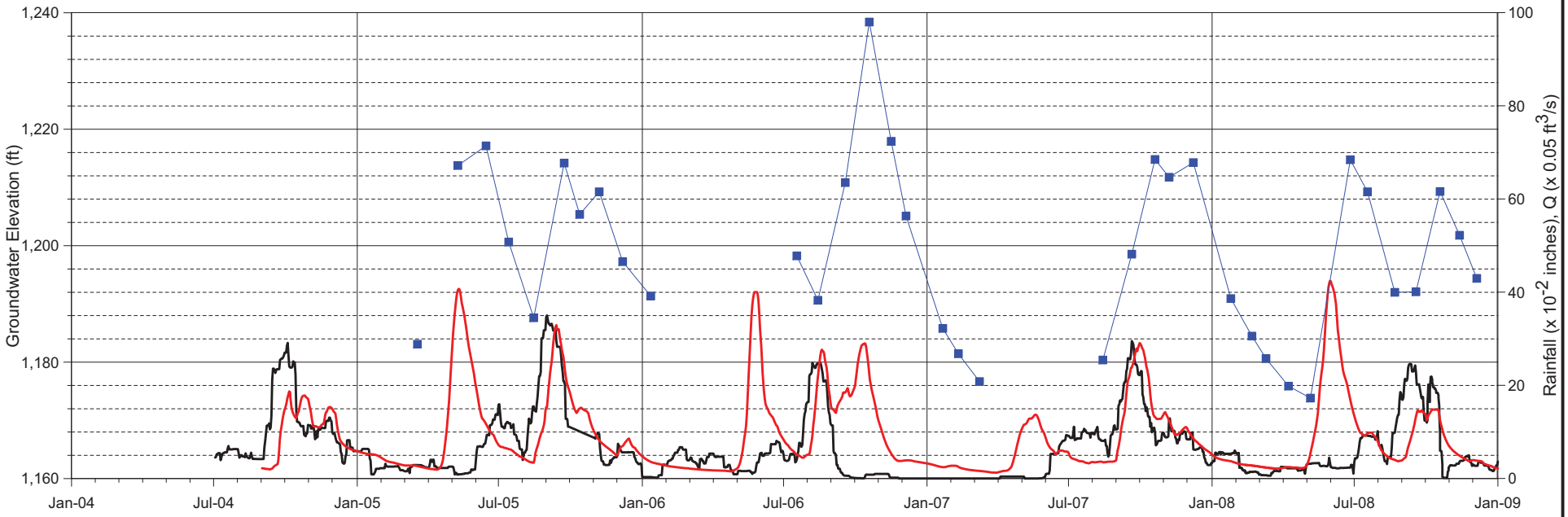


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time M-62



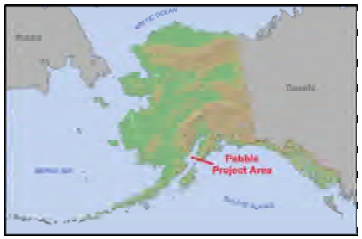
LEGEND:

Groundwater Elevation Plot Legend

- M-62
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

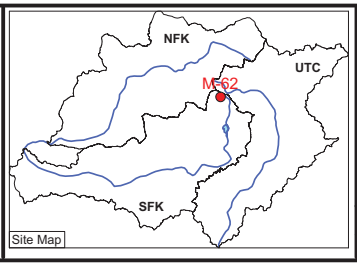
Screens (ft asl):
M-62 : 1157.4 - 1177.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1320.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\M-62.grf

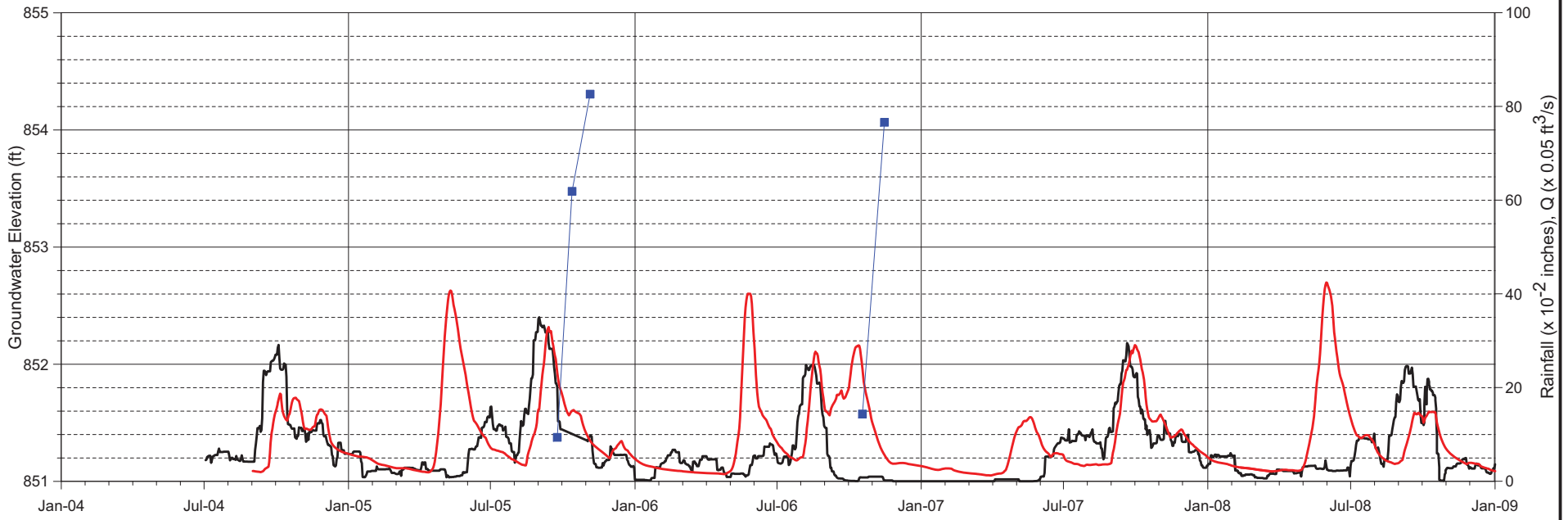


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-11



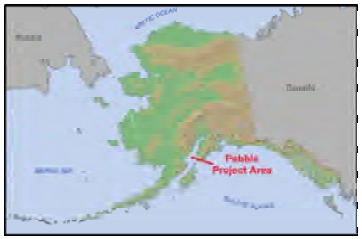
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-11SS
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-05-11SS : 849.0 - 859.0

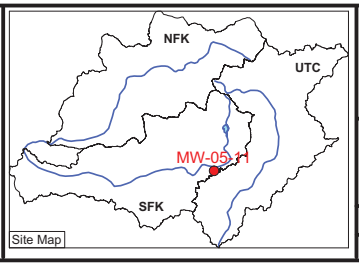


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 880.3 ft asl

MW-05-11 was dry for most of the period of record.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-11.grf

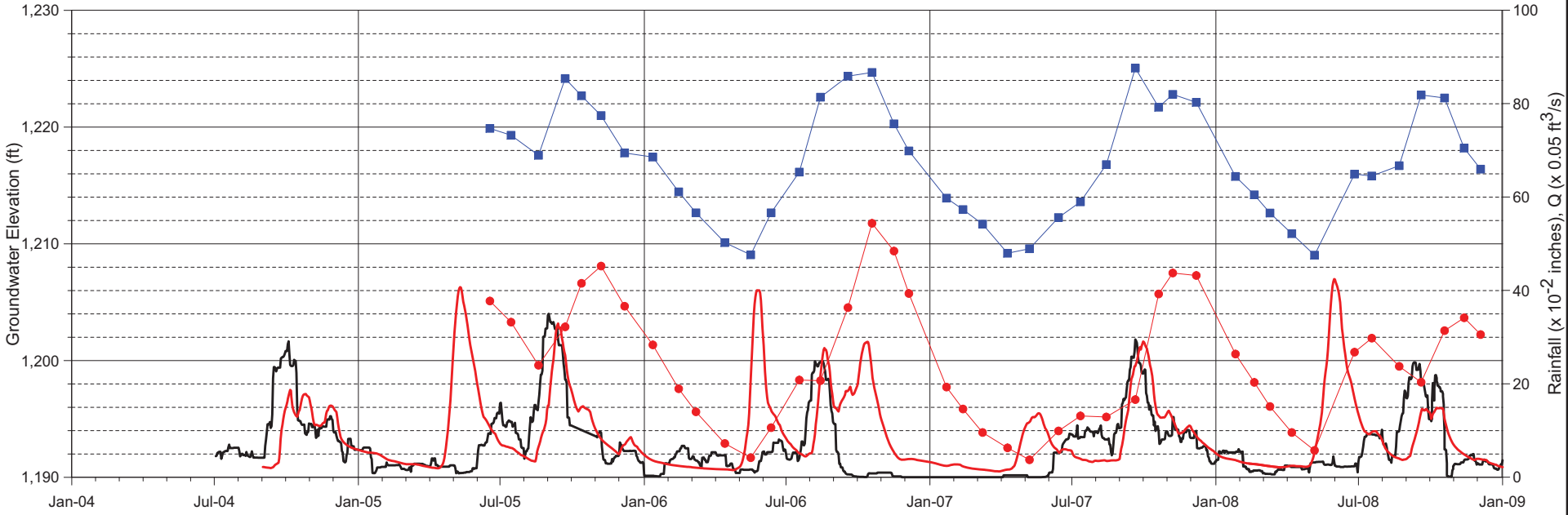


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time MW-05-12



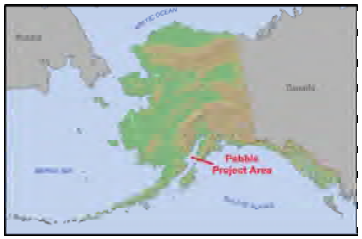
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-12S
- MW-05-12D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

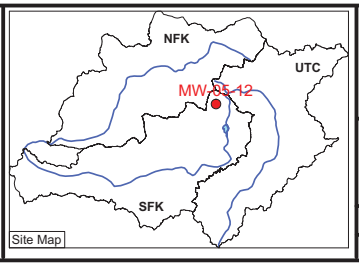
Screens (ft asl):
MW-05-12S : 1184.9 - 1189.9
MW-05-12D : 1104.6 - 1124.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1225.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-12.grf

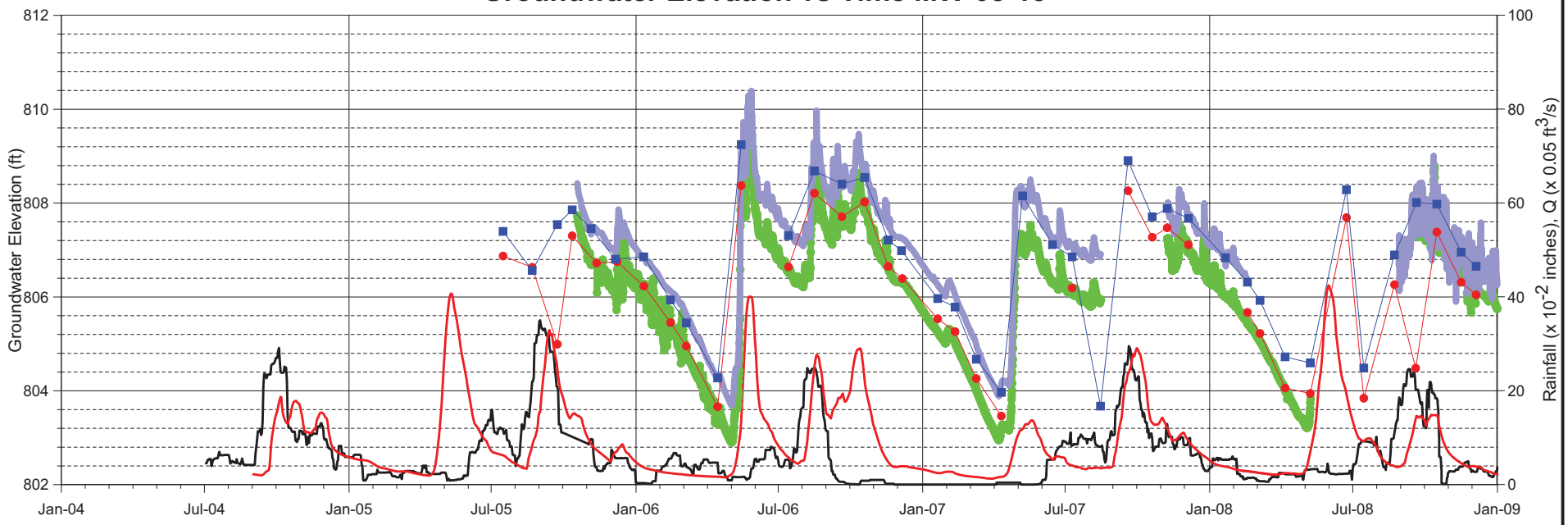


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-13



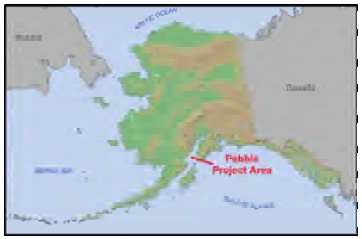
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-13S
- MW-05-13D
- MW-05-13S(Transducer)
- MW-05-13D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

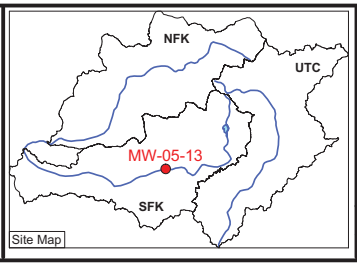
Screens (ft asl):
MW-05-13S : 780.5 - 795.5
MW-05-13D : 701.3 - 716.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 811.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-13.grf

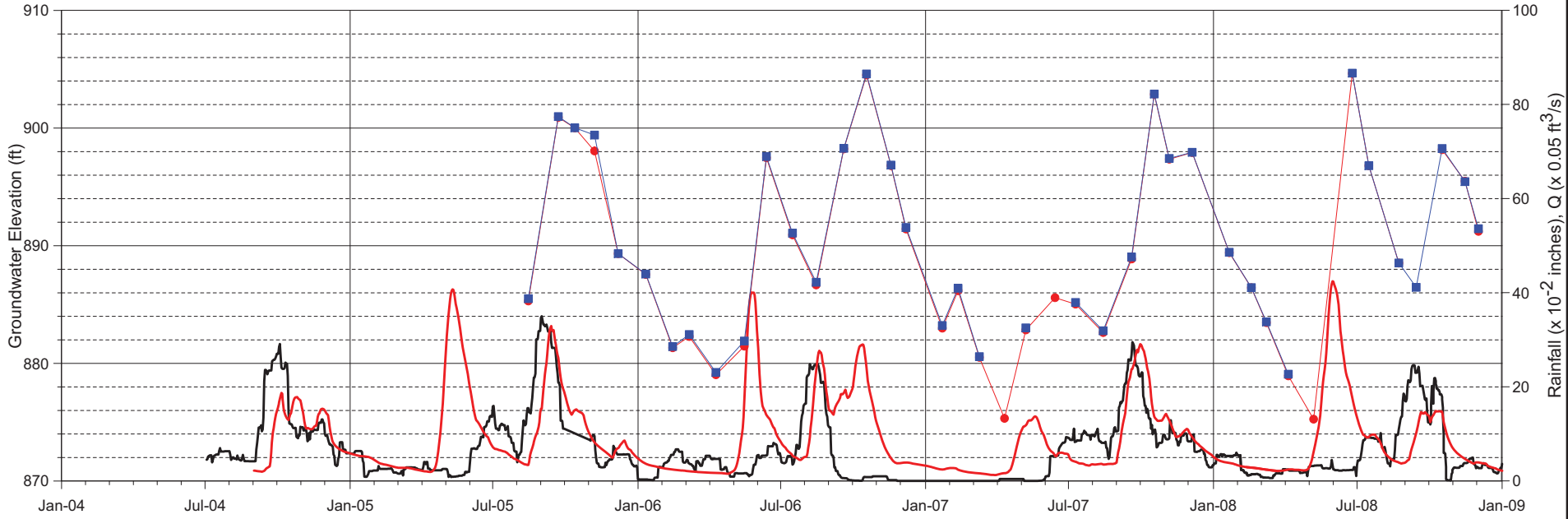


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-14



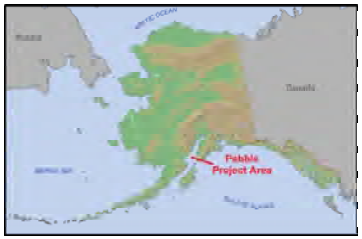
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-14S
- MW-05-14D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

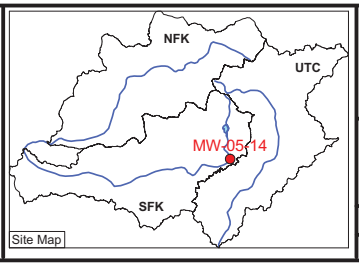
Screens (ft asl):
MW-05-14S : 876.8 - 881.8
MW-05-14D : 821.7 - 831.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 922.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-14.grf

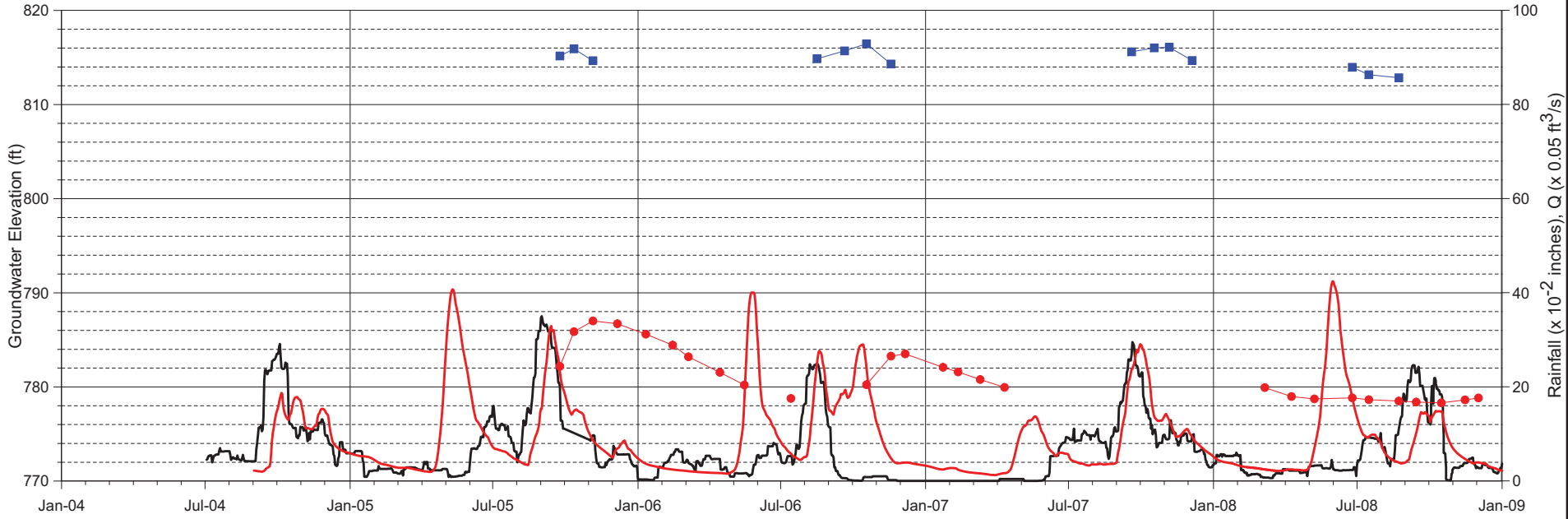


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-05-2



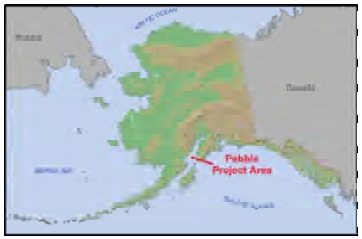
LEGEND:

Groundwater Elevation Plot Legend

- MW-05-2SR
- MW-05-02M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

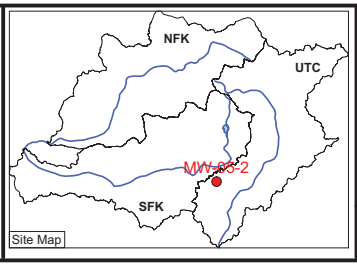
Screens (ft asl):
MW-05-2SR : 812.2 - 817.2
MW-05-2SR : 812.2 - 817.2
MW-05-02M : 768.8 - 778.8
MW-05-02M : 768.8 - 778.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 830.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-05-2.grf

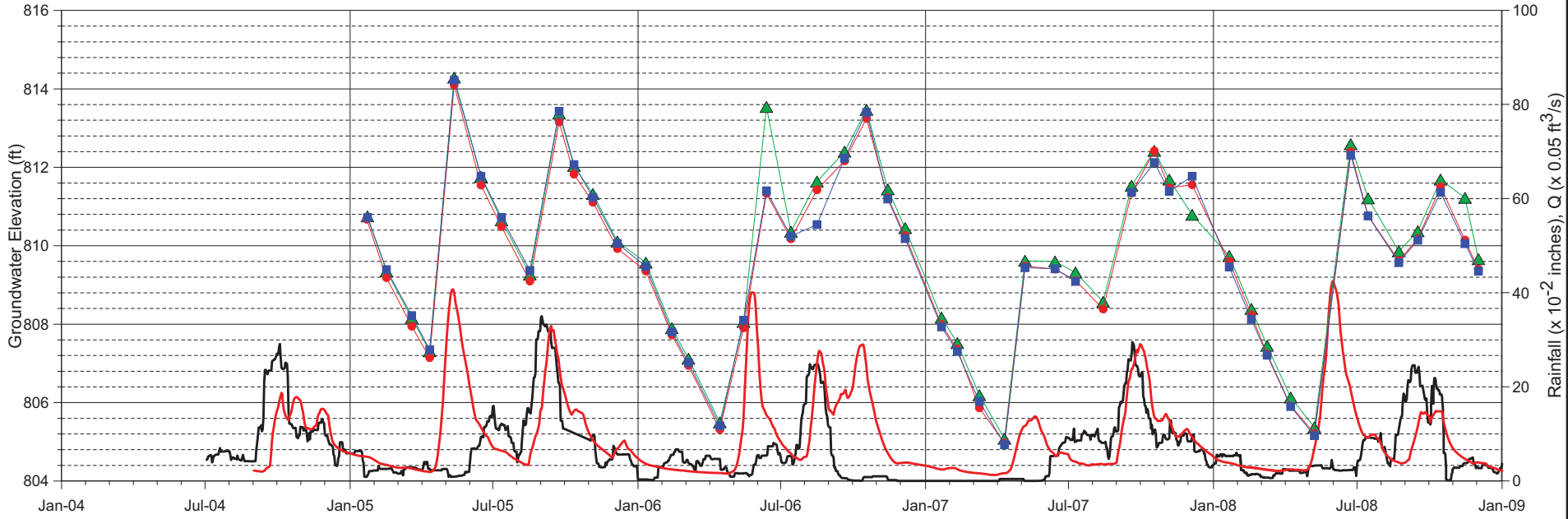


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-1



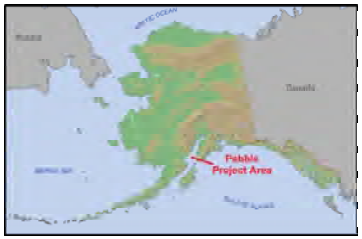
LEGEND:

Groundwater Elevation Plot Legend

- MW-1S
- MW-1M
- MW-1D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

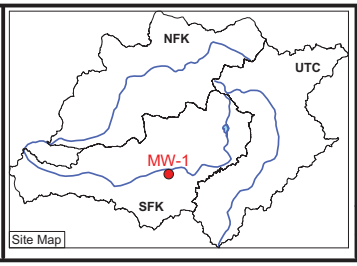
Screens (ft asl):
MW-1S : 791.2 - 801.2
MW-1M : 745.3 - 755.3
MW-1D : 682.1 - 692.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 816.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-1.grf

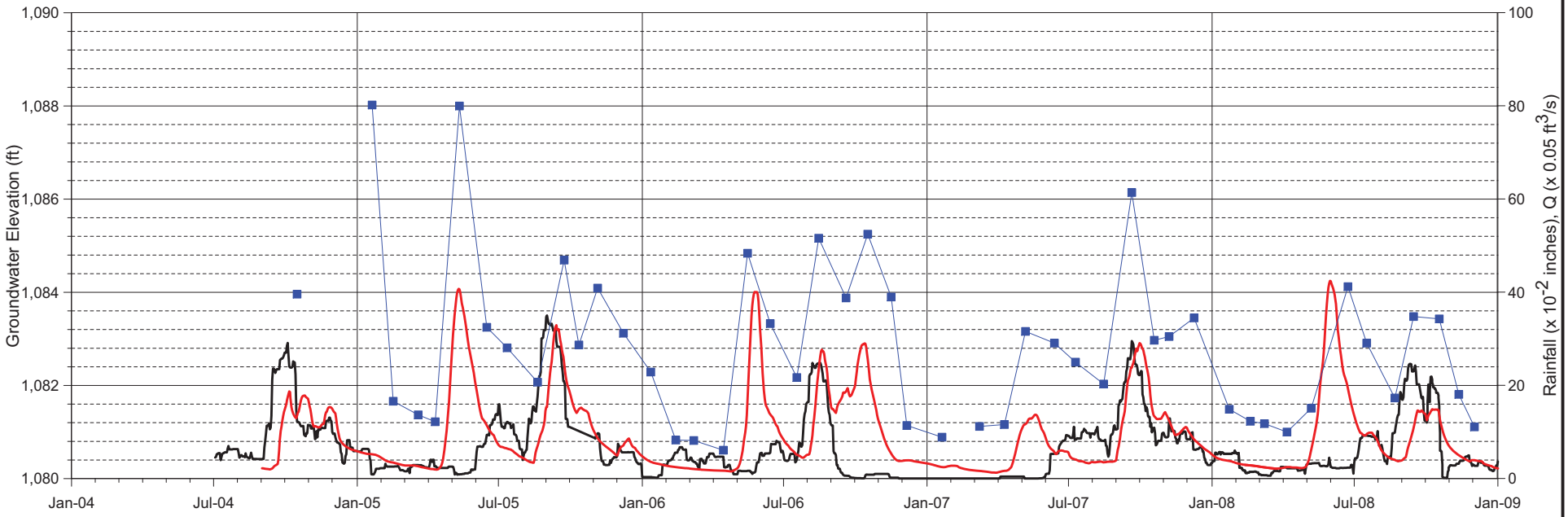


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-10



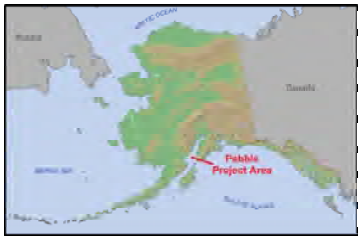
LEGEND:

Groundwater Elevation Plot Legend

- MW-10
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

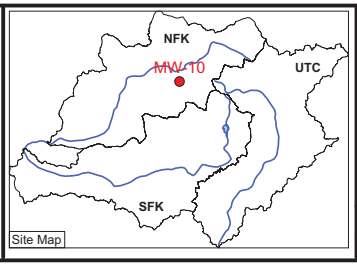
Screens (ft asl):
MW-10 : 1067.8 - 1077.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1107.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-10.grf

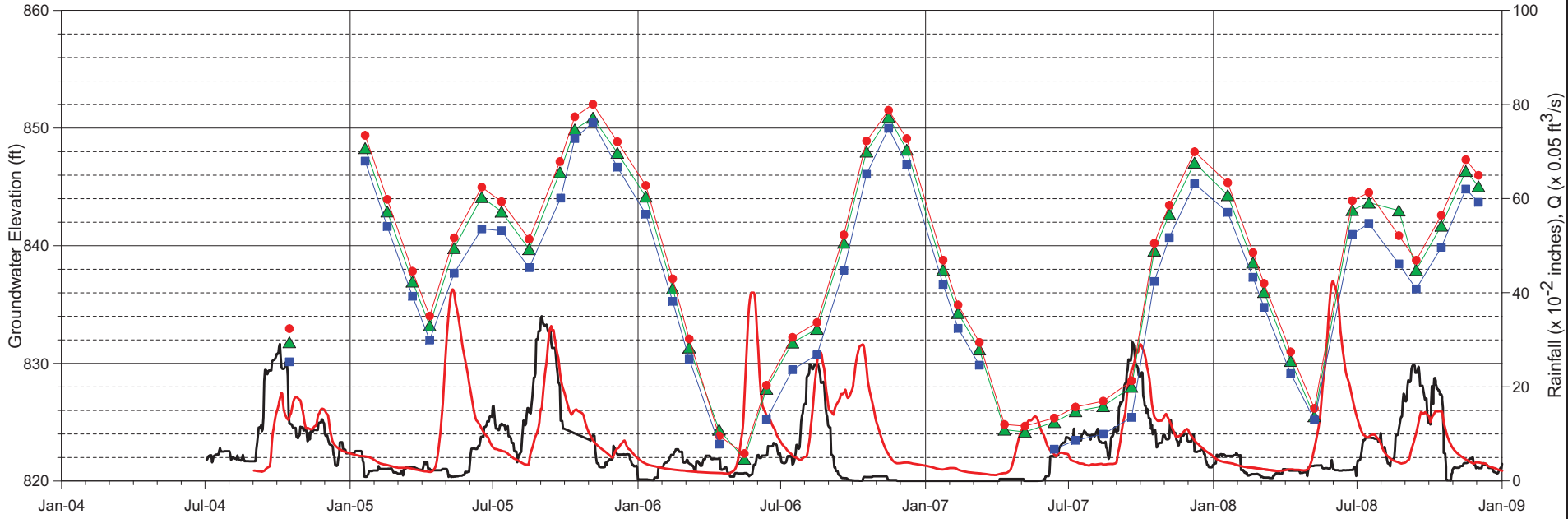


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-11



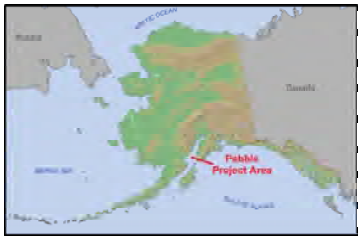
LEGEND:

Groundwater Elevation Plot Legend

- MW-11S
- MW-11M
- MW-11D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

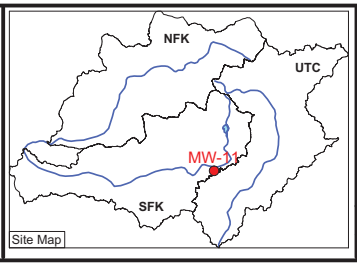
Screens (ft asl):
MW-11S : 810.4 - 830.4
MW-11M : 769.3 - 779.3
MW-11D : 745.2 - 755.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 881.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-11.grf

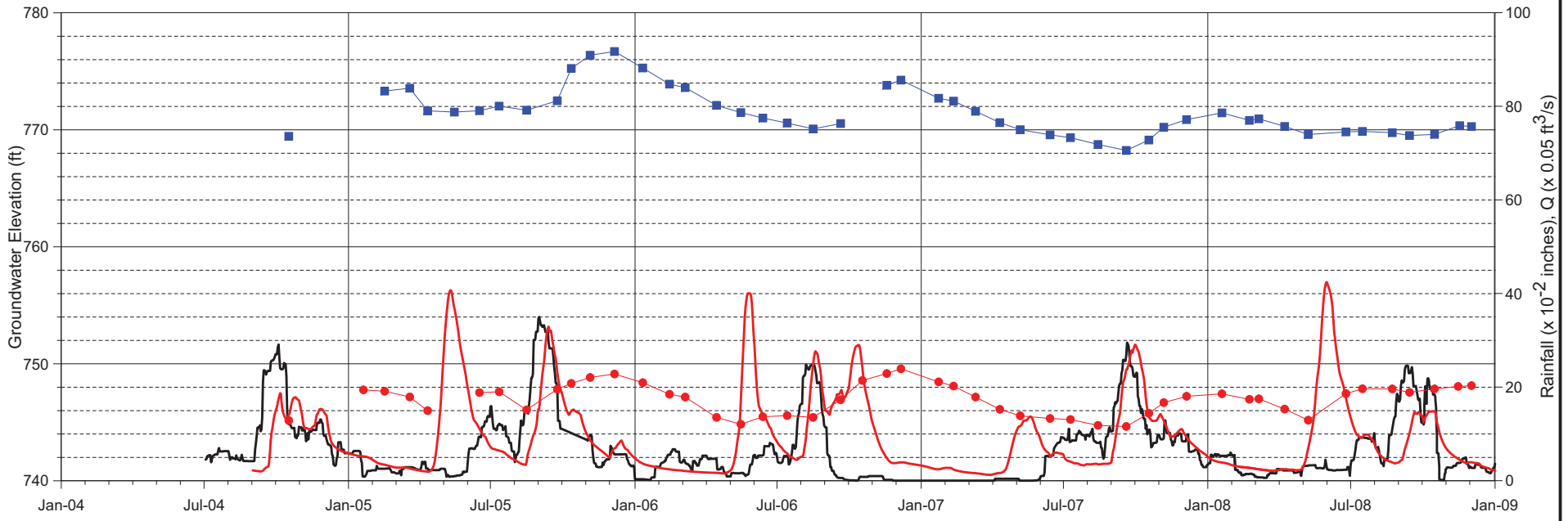


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-2



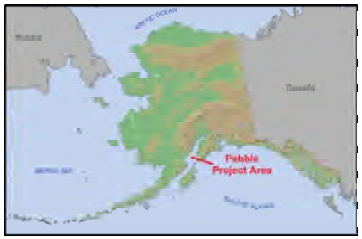
LEGEND:

Groundwater Elevation Plot Legend

- MW-2S
- MW-2D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-2S : 755.0 - 765.0
MW-2D : 695.4 - 710.4

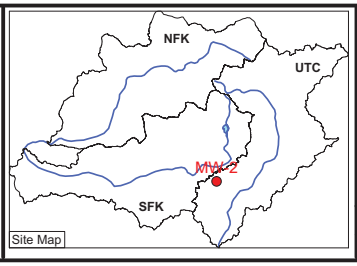


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 830 ft asl

MW05-02M and MW-05-2SR were dry seasonally during the winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-2.grf

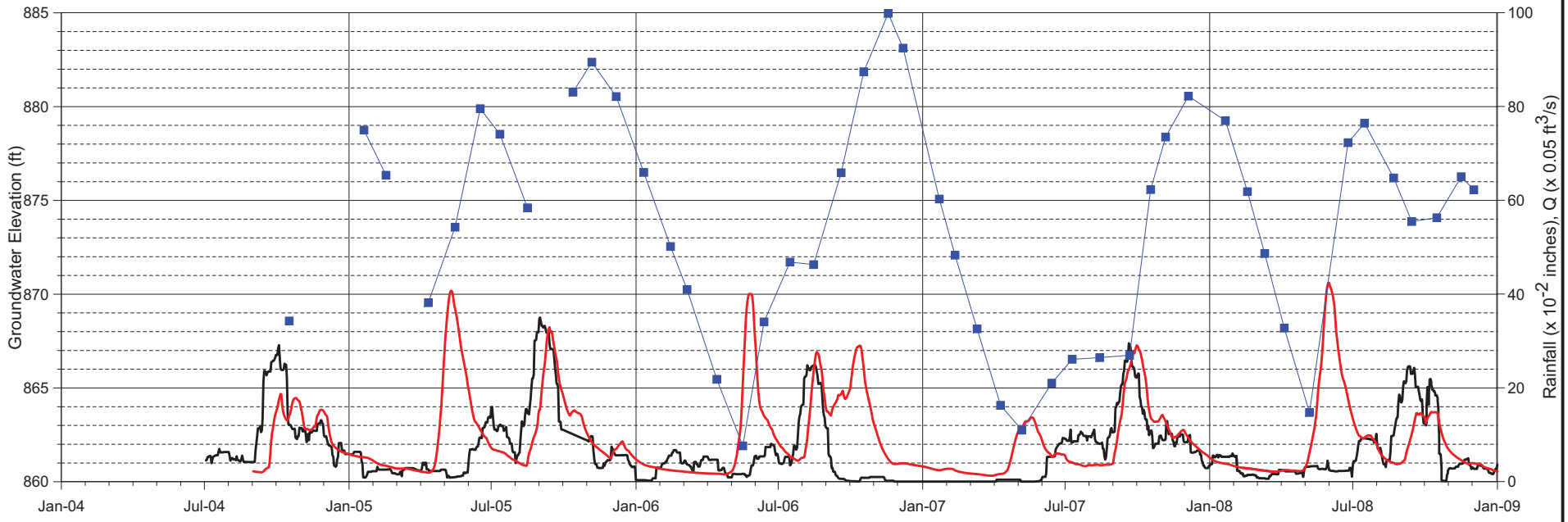


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-3D



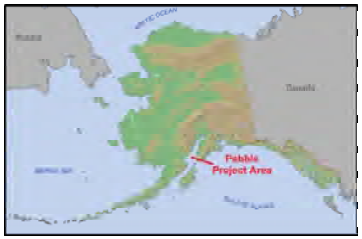
LEGEND:

Groundwater Elevation Plot Legend

- MW-3D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

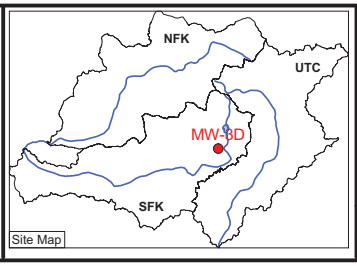
Screens (ft asl):
MW-3D : 830.1 - 845.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1024.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-3D.grf

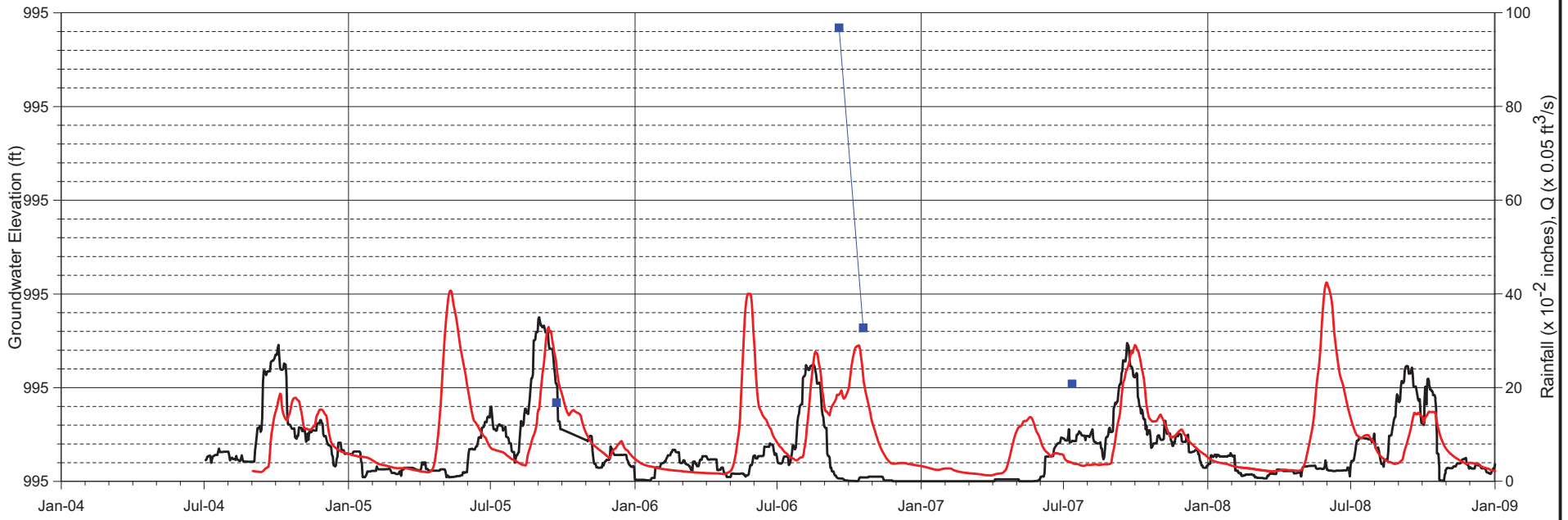


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-4S



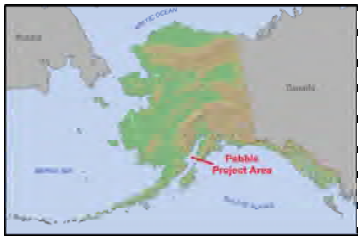
LEGEND:

Groundwater Elevation Plot Legend

- MW-4S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-4S : 983.9 - 993.9

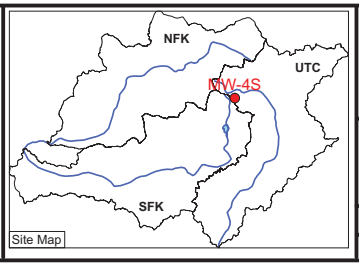


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1008.9 ft asl

MW-4S was dry, recorded water levels do not represent true groundwater elevations.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-4S.grf

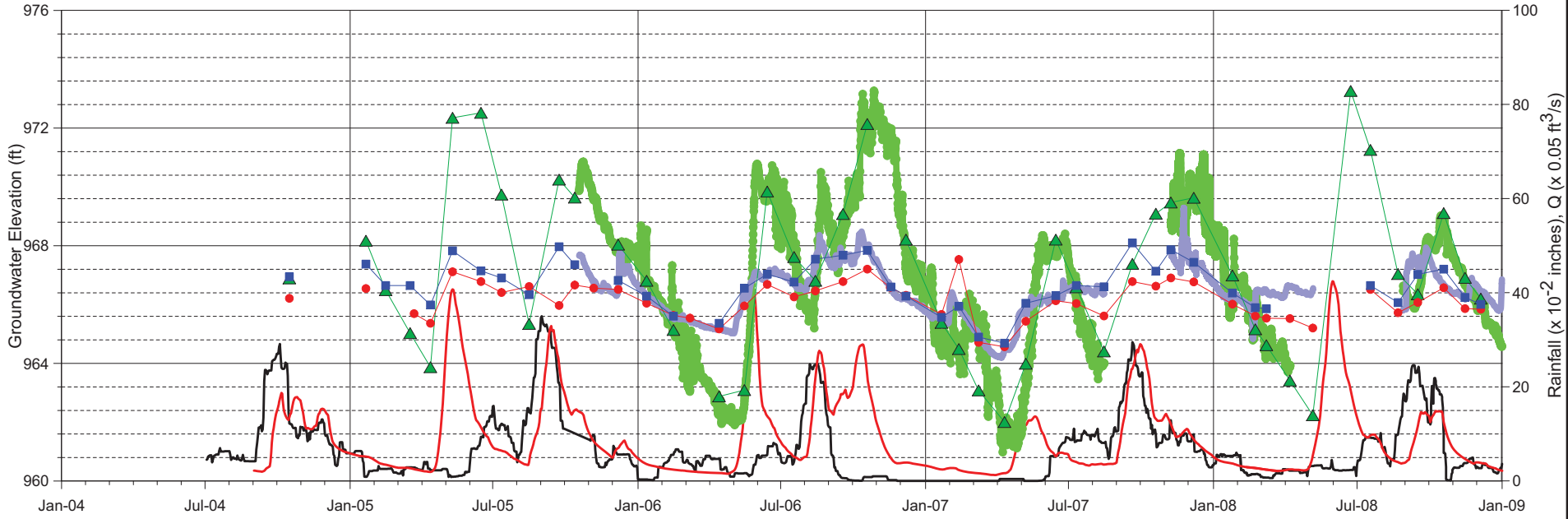


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time MW-5



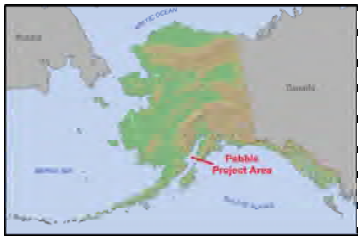
LEGEND:

Groundwater Elevation Plot Legend

- MW-5S
- MW-5M
- MW-5D
- MW-5S(Transducer)
- MW-5D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

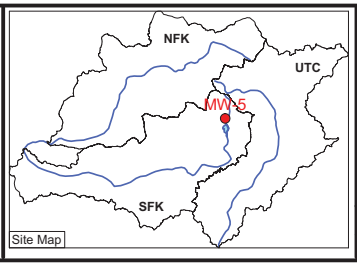
Screens (ft asl):
MW-5S : 936.6 - 946.6
MW-5M : 912.9 - 922.9
MW-5D : 873.0 - 888.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 977.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-5.grf

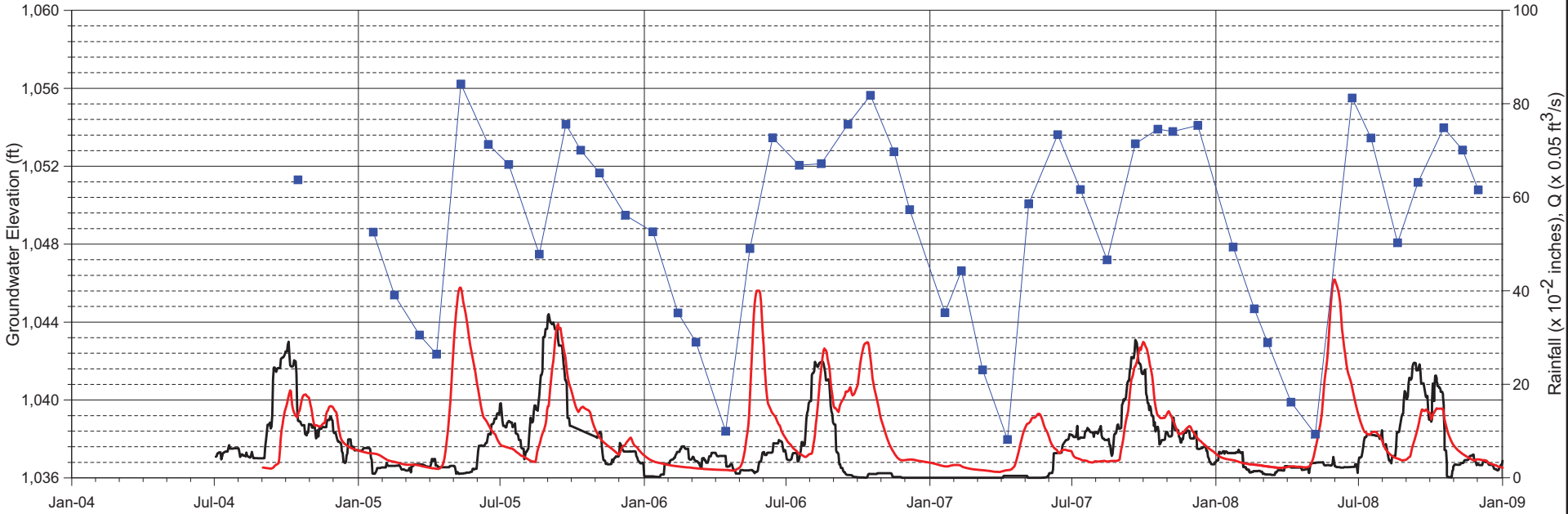


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-6D



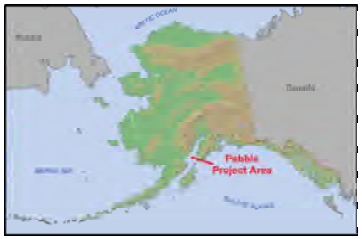
LEGEND:

Groundwater Elevation Plot Legend

- MW-6D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

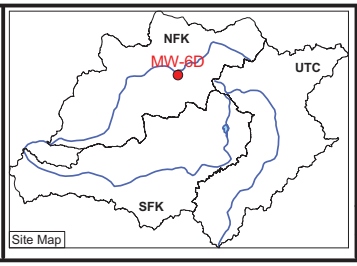
Screens (ft asl):
MW-6D : 1027.0 - 1037.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1118 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-6D.grf

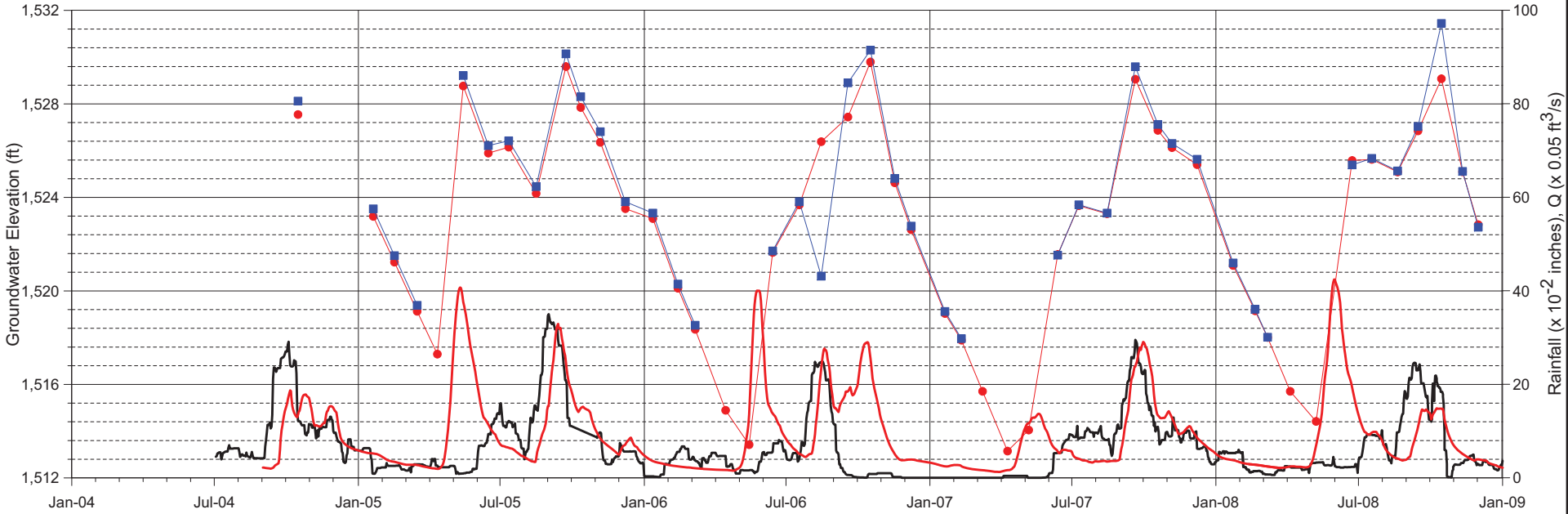


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-7



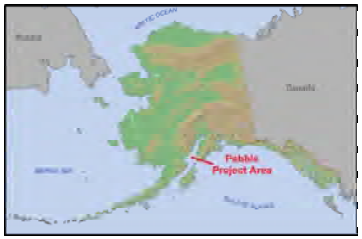
LEGEND:

Groundwater Elevation Plot Legend

- MW-7S
- MW-7D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

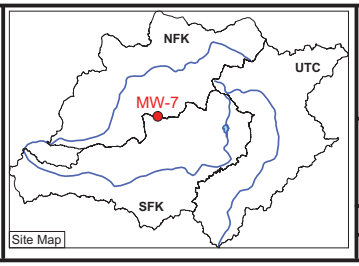
Screens (ft asl):
MW-7S : 1514.5 - 1524.5
MW-7D : 1471.8 - 1481.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1544.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-7.grf

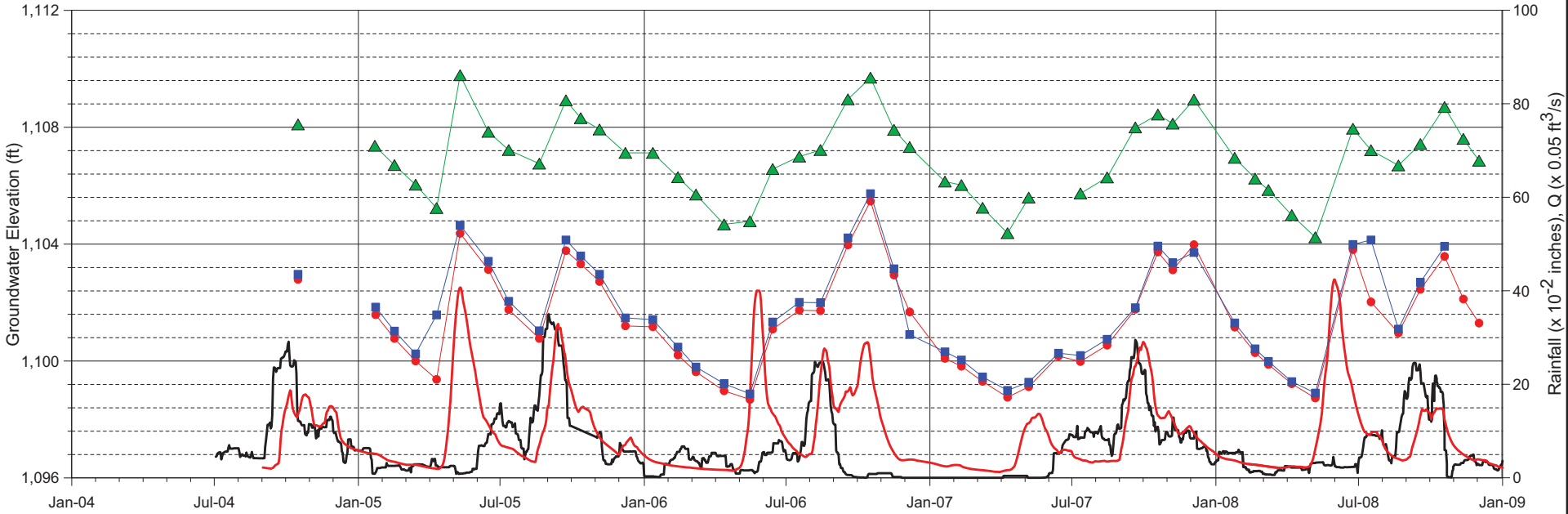


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-8



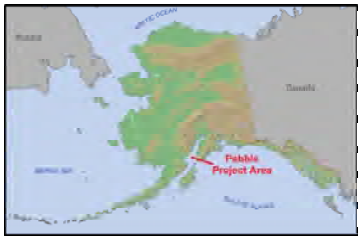
LEGEND:

Groundwater Elevation Plot Legend

- MW-8S
- MW-8M
- MW-8D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

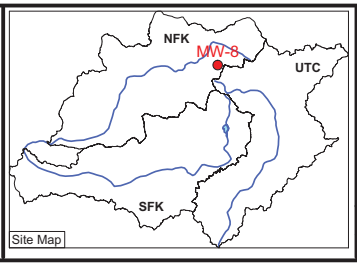
Screens (ft asl):
MW-8S : 1096.4 - 1106.4
MW-8M : 1067.6 - 1082.6
MW-8D : 1017.6 - 1027.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1114.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-8.grf

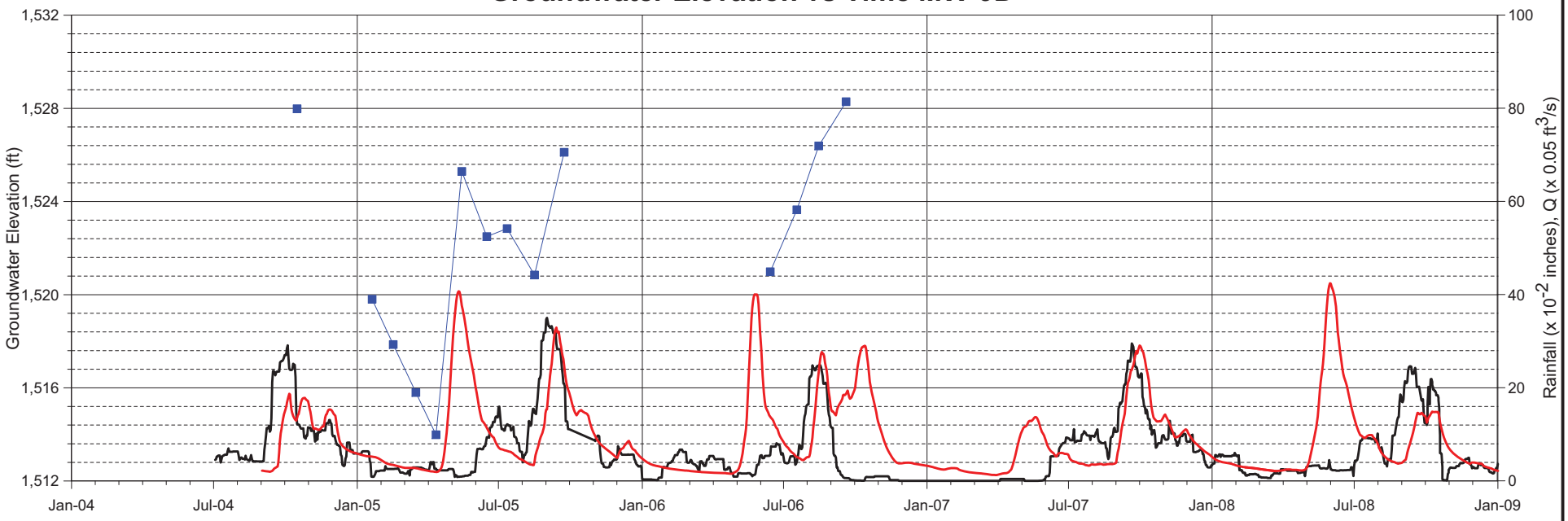


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time MW-9D



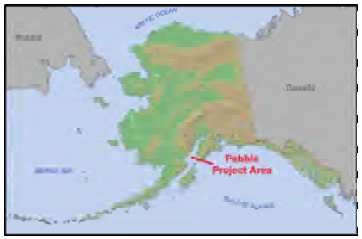
LEGEND:

Groundwater Elevation Plot Legend

- MW-9D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
MW-9D : 1453.3 - 1467.3

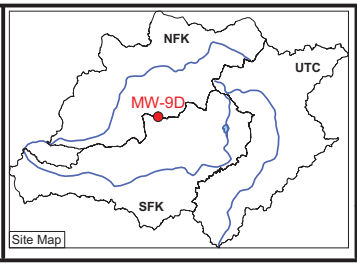


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1525.3 ft asl

MW-9D is a flowing well. Water levels were recorded occasionally when an extension was in place and the water was not frozen.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\MW-9D.grf

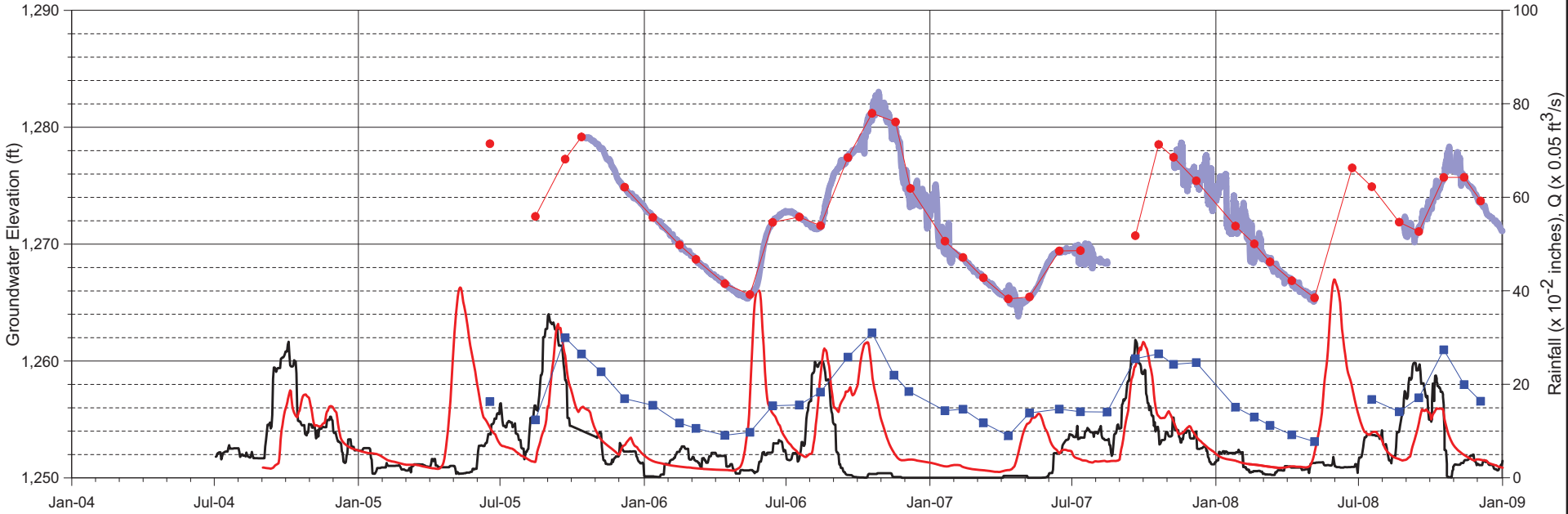


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-07



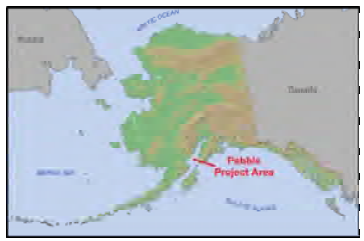
LEGEND:

Groundwater Elevation Plot Legend

- P-05-07S
- P-05-07D
- P-05-07D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

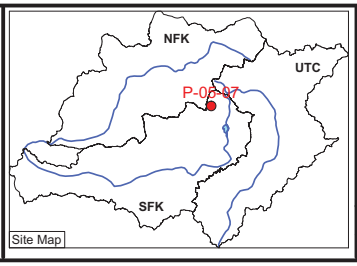
Screens (ft asl):
P-05-07S : 1214.8 - 1224.8
P-05-07D : 1094.6 - 1104.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1290.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-07.grf

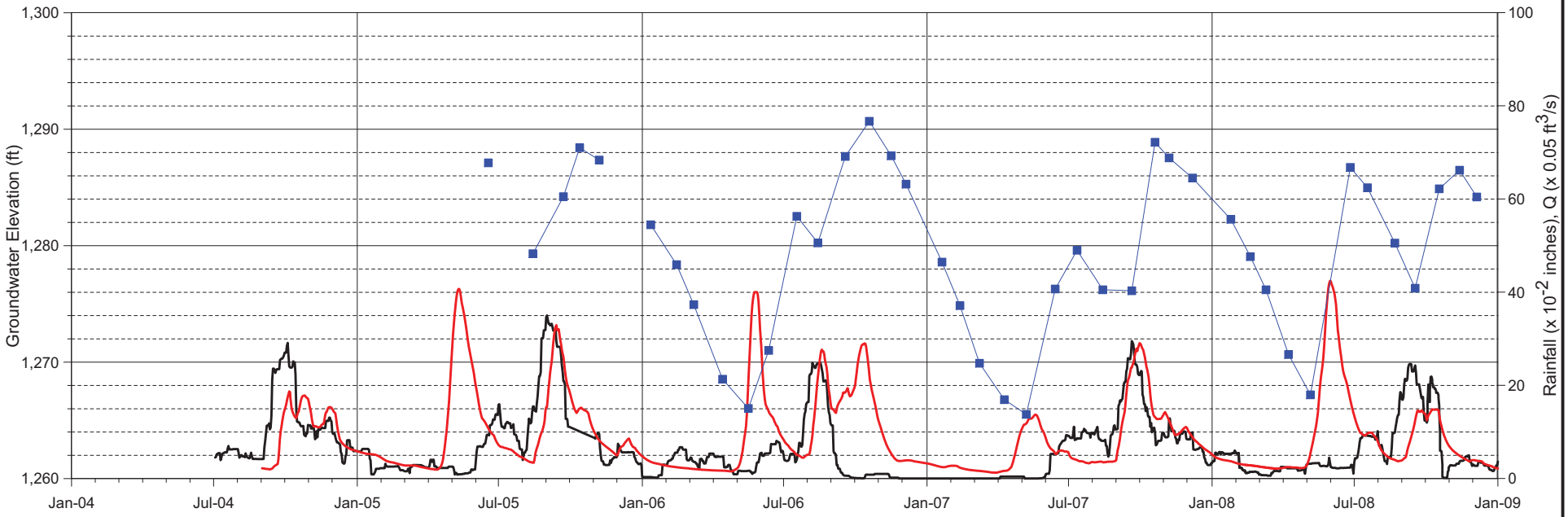


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-08



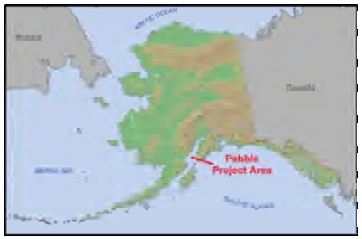
LEGEND:

Groundwater Elevation Plot Legend

- P-05-08
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

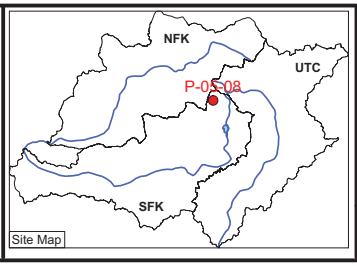
Screens (ft asl):
P-05-08 : 1248.1 - 1258.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1320 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-08.grf

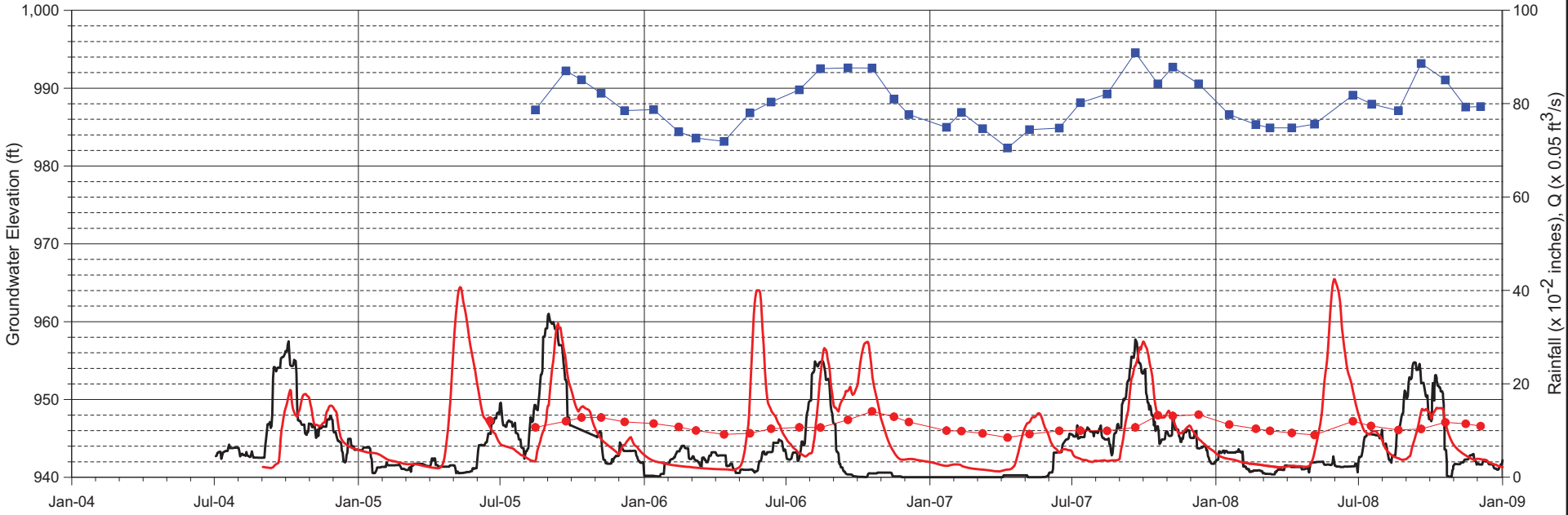


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-09



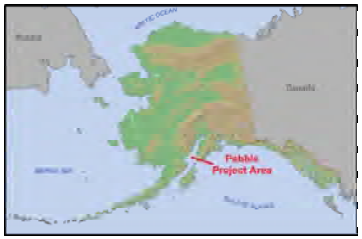
LEGEND:

Groundwater Elevation Plot Legend

- P-05-09S
- P-05-09D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

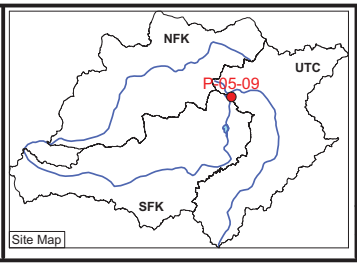
Screens (ft asl):
P-05-09S : 977.4 - 980.4
P-05-09D : 901.1 - 916.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 997.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-09.grf

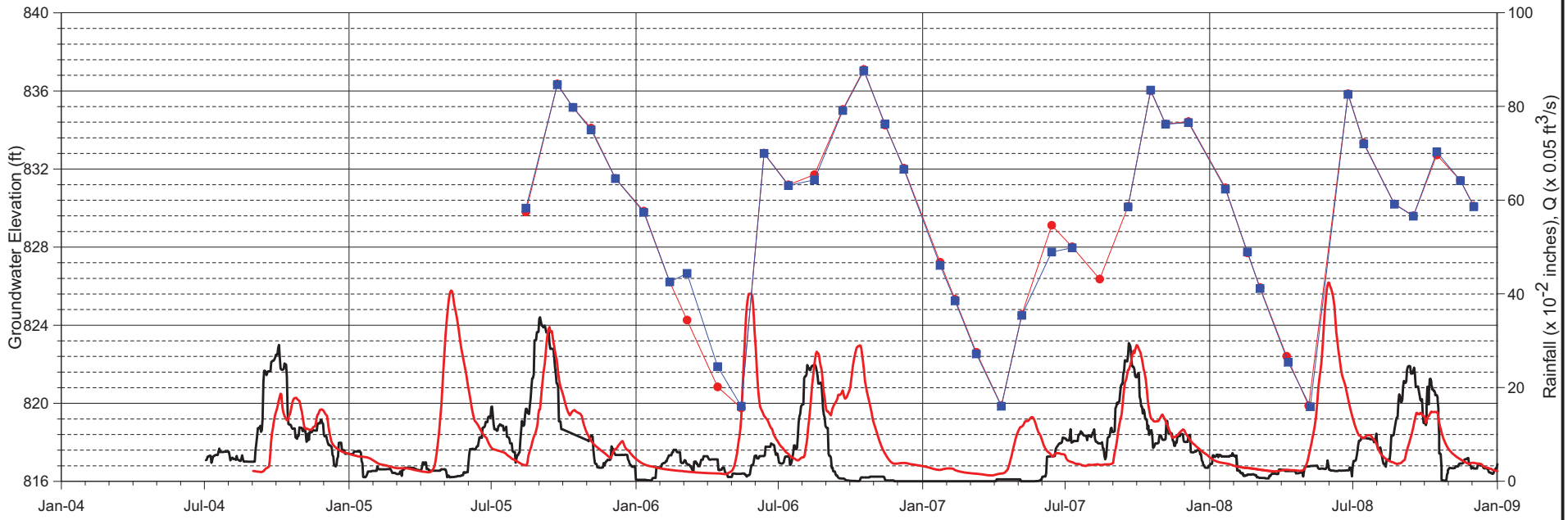


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-10



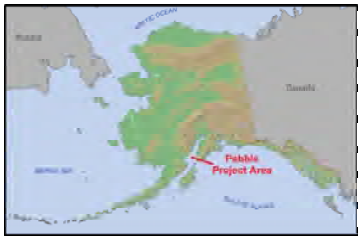
LEGEND:

Groundwater Elevation Plot Legend

- P-05-10S
- P-05-10D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

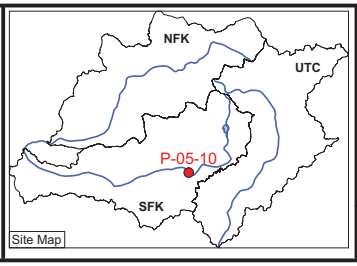
Screens (ft asl):
P-05-10S : 811.2 - 821.2
P-05-10D : 705.4 - 715.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 841.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-10.grf

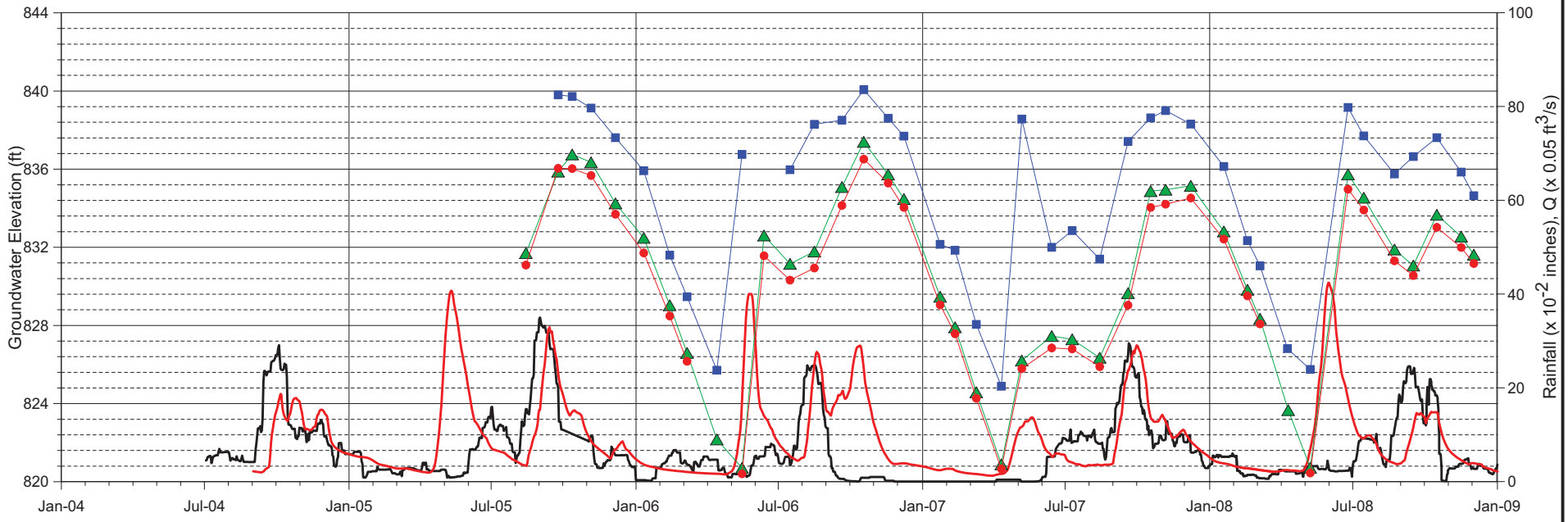


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-11



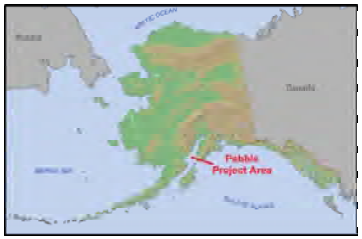
LEGEND:

Groundwater Elevation Plot Legend

- P-05-11S
- P-05-11M
- P-05-11D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

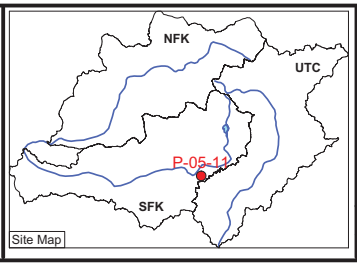
Screens (ft asl):
P-05-11S : 823.4 - 828.4
P-05-11M : 769.3 - 779.3
P-05-11D : 680.4 - 695.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 844.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-11.grf

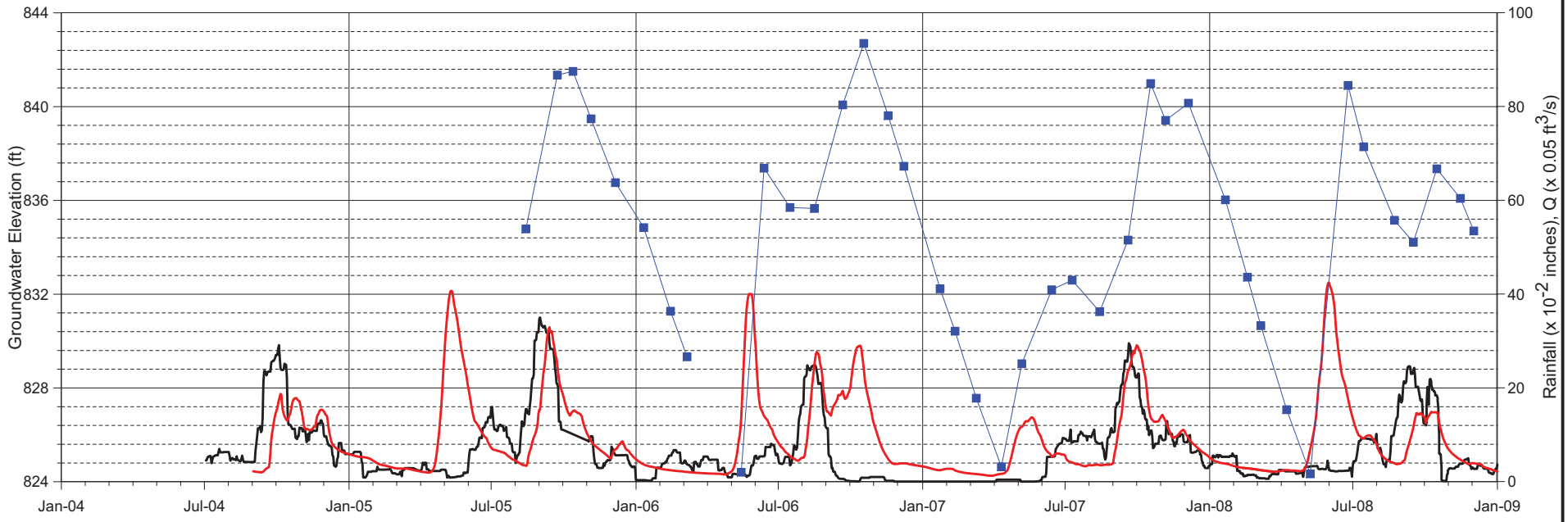


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-12



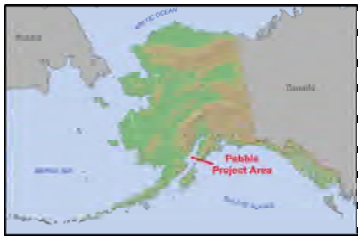
LEGEND:

Groundwater Elevation Plot Legend

- P-05-12
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

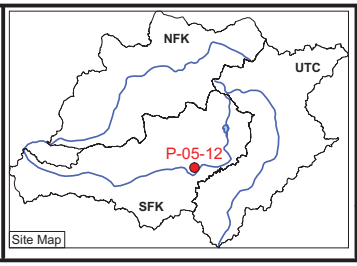
Screens (ft asl):
P-05-12 : 787.9 - 807.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 868.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-12.grf

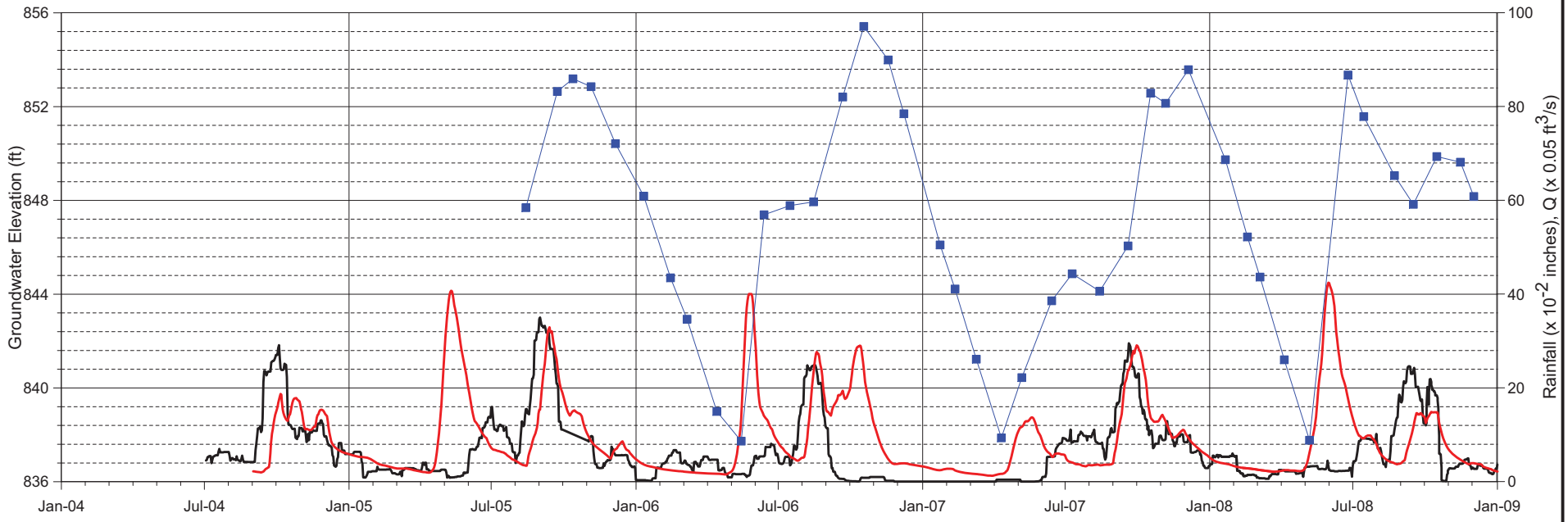


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-13



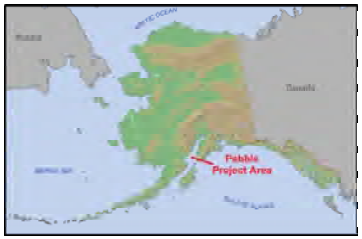
LEGEND:

Groundwater Elevation Plot Legend

- P-05-13
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

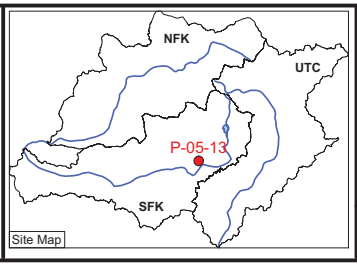
Screens (ft asl):
P-05-13 : 763.8 - 773.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 877.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-13.grf

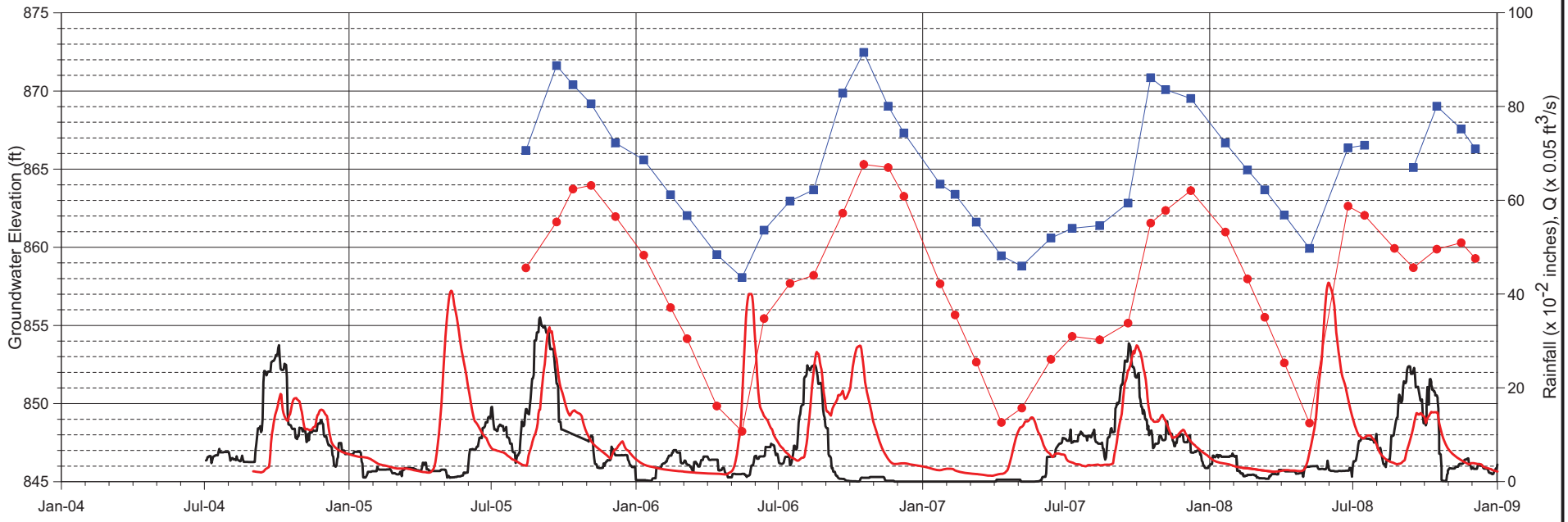


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-14



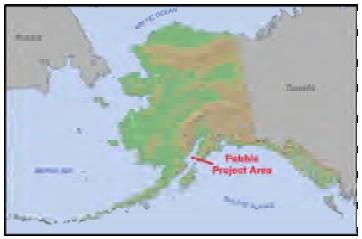
LEGEND:

Groundwater Elevation Plot Legend

- P-05-14S
- P-05-14D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

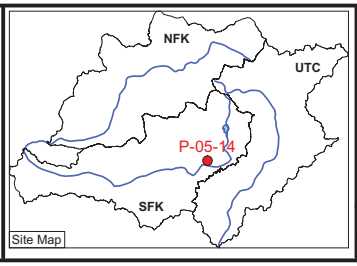
Screens (ft asl):
P-05-14S : 848.3 - 863.3
P-05-14D : 770.6 - 780.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 884.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-14.grf

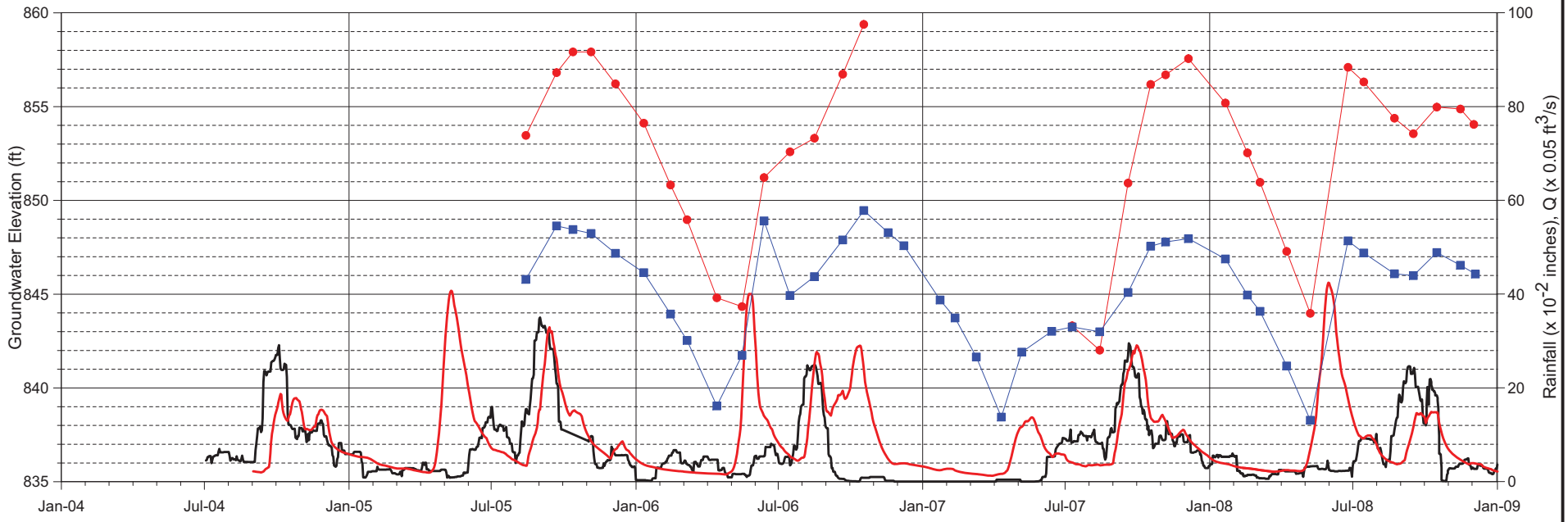


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-15



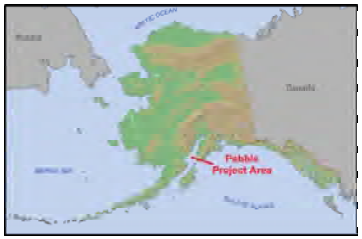
LEGEND:

Groundwater Elevation Plot Legend

- P-05-15S
- P-05-15D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

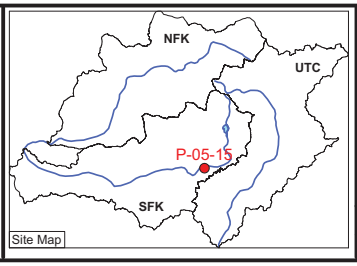
Screens (ft asl):
P-05-15S : 784.7 - 794.7
P-05-15D : 738.7 - 748.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 862 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-15.grf

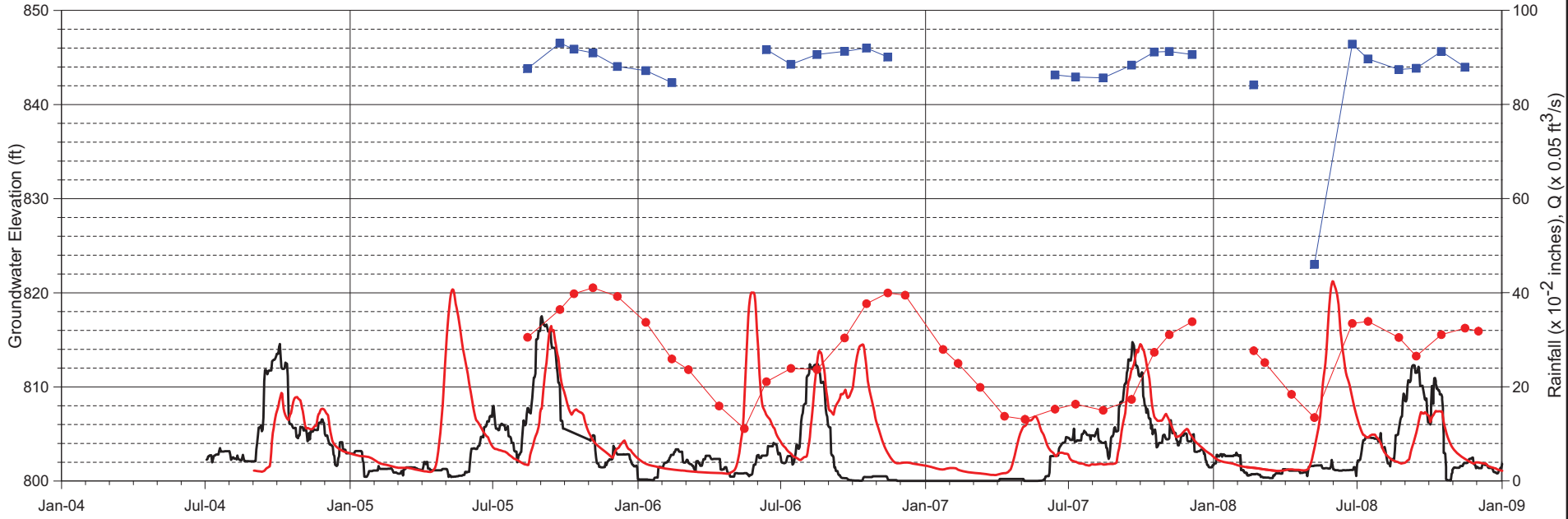


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-16



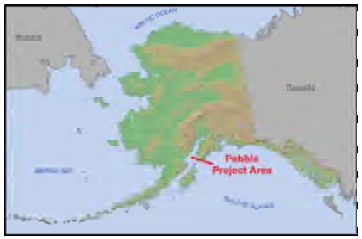
LEGEND:

Groundwater Elevation Plot Legend

- P-05-16SS
- P-05-16M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-16SS : 840.4 - 845.4
P-05-16S : 803.1 - 808.1
P-05-16M : 773.6 - 778.6
P-05-16D : 722.7 - 732.7

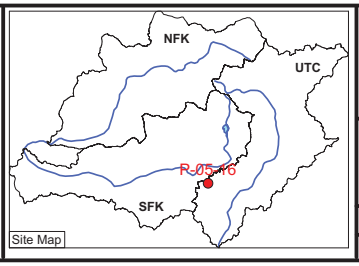


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 856.4 ft asl

P05-16SS dries seasonally during the winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-16.grf

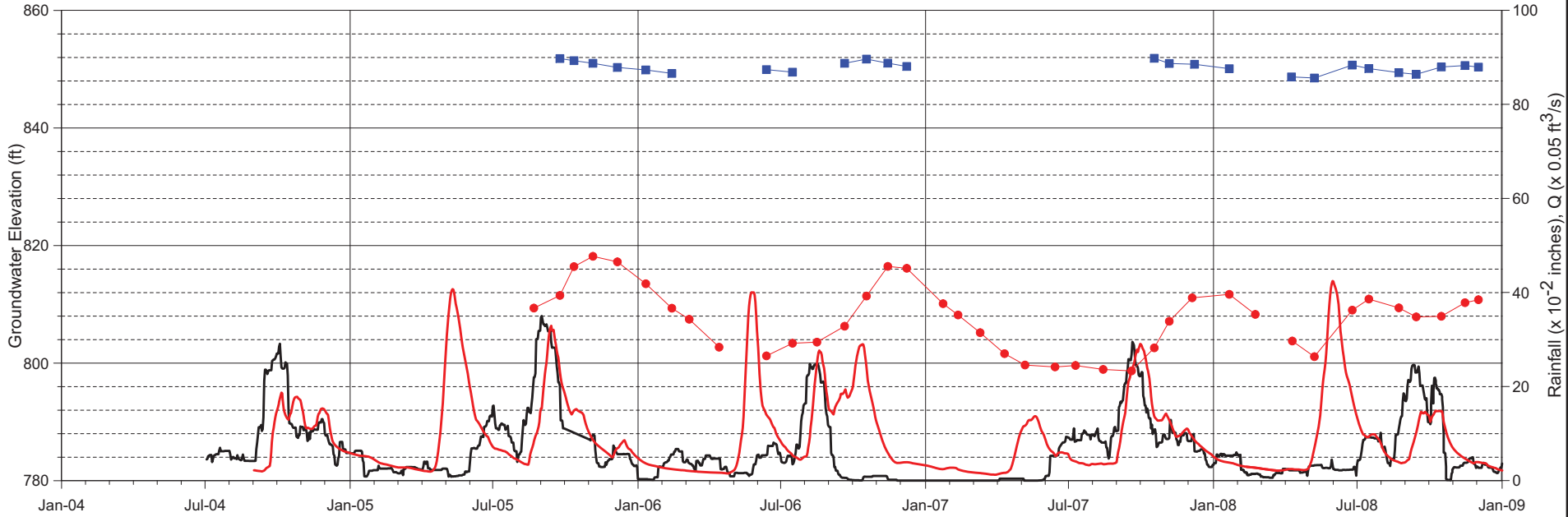


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-17



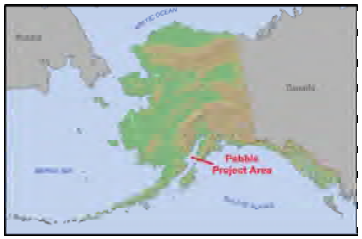
LEGEND:

Groundwater Elevation Plot Legend

- P-05-17S
- P-05-17D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-17S : 848.3 - 853.3
P-05-17D : 772.6 - 777.6

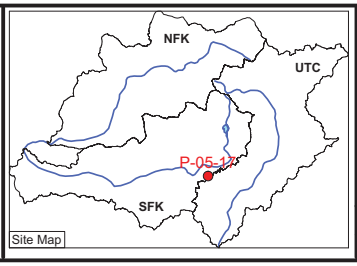


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 907.1 ft asl

P05-17S dries seasonally during the winter and spring, water levels were not recorded during this period.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-17.grf

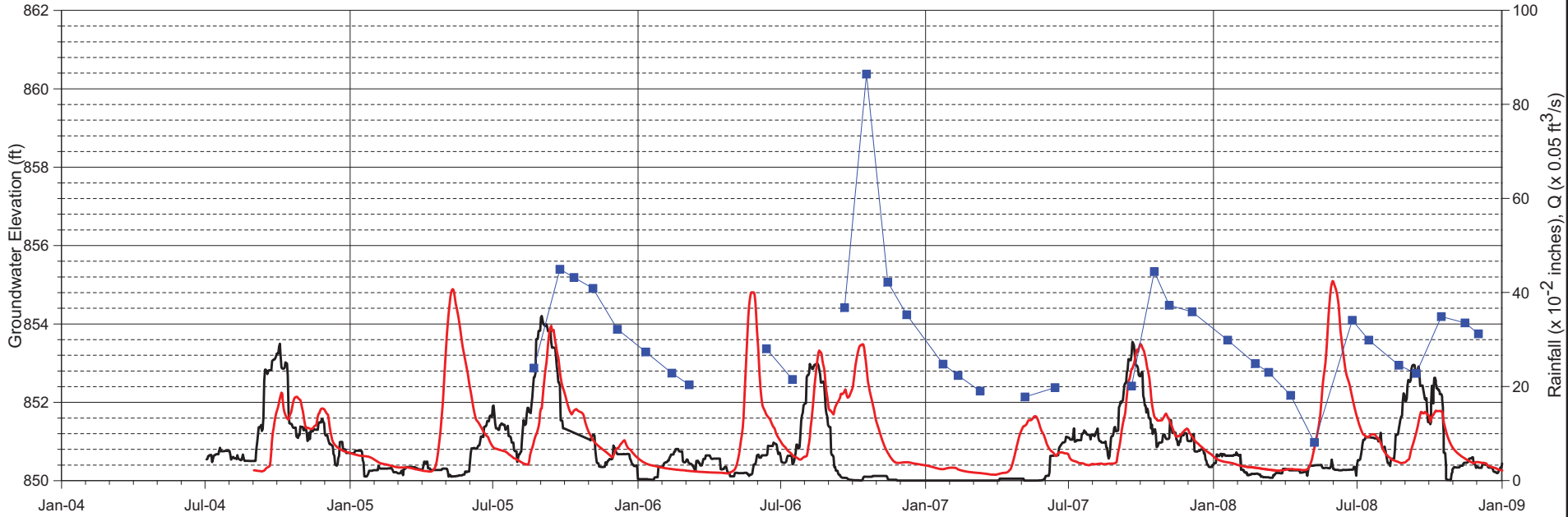


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-18



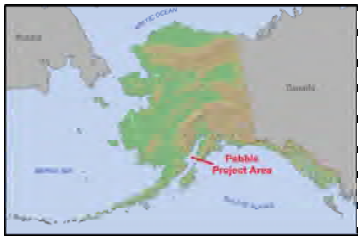
LEGEND:

Groundwater Elevation Plot Legend

- P-05-18
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

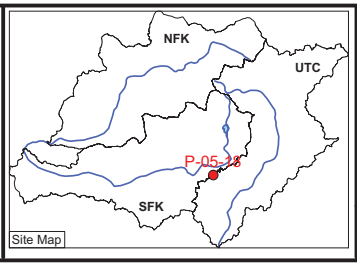
Screens (ft asl):
P-05-18 : 850.4 - 860.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 912.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-18.grf

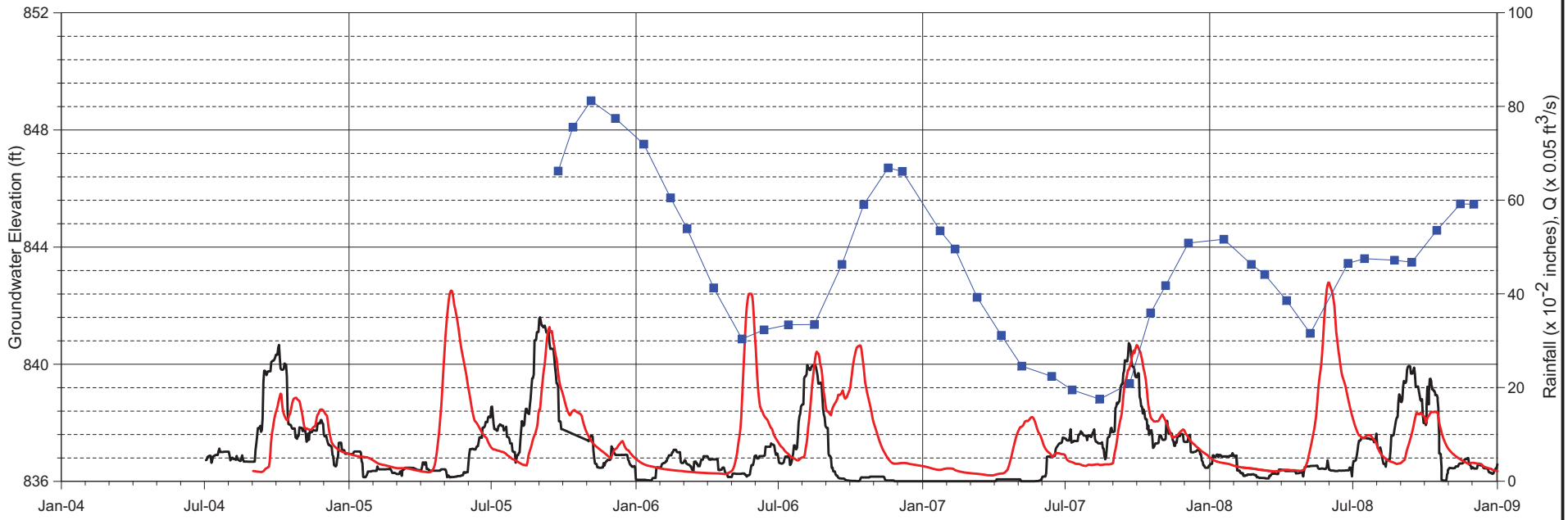


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-19



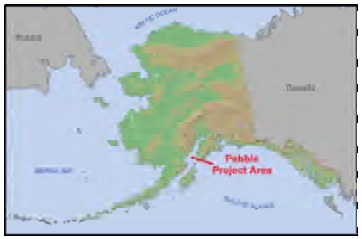
LEGEND:

Groundwater Elevation Plot Legend

- P-05-19M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-19S : 843.5 - 853.5
P-05-19M : 800.1 - 810.1

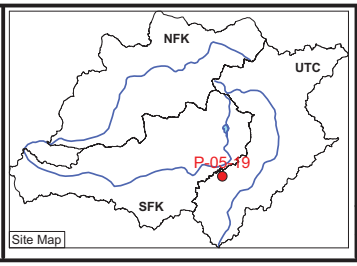


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 881.1 ft asl

P05-19S dries seasonally during the winter and spring, and during all of 2008; water levels were not recorded during these periods.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-19.grf

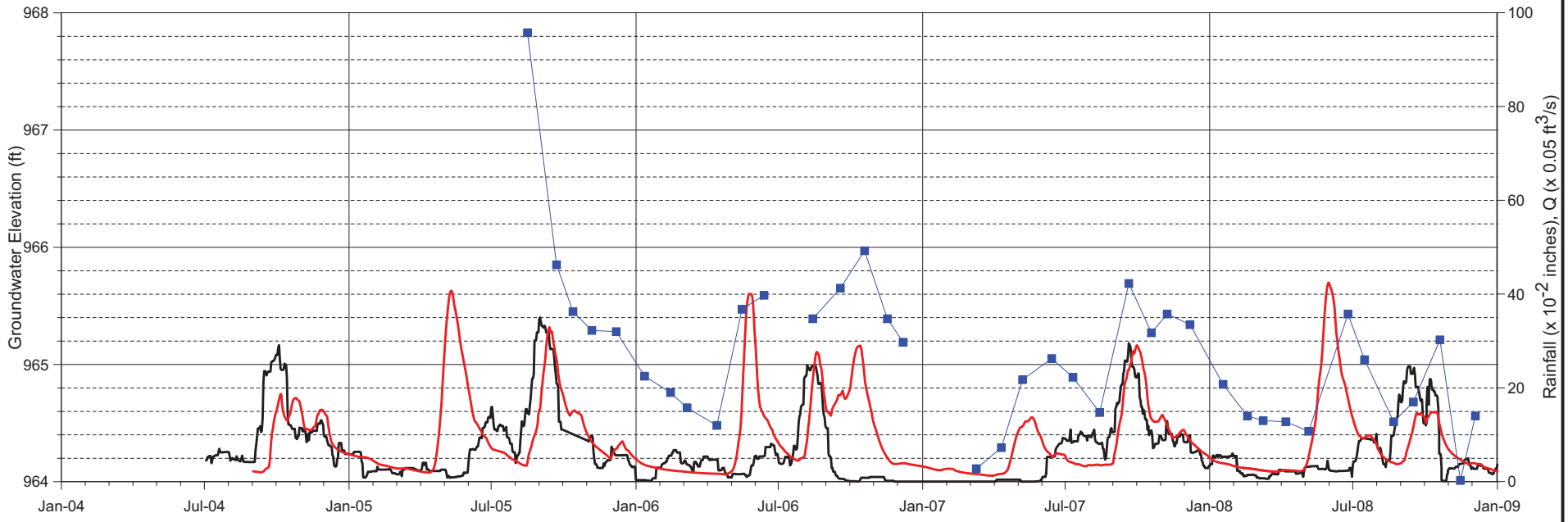


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-20



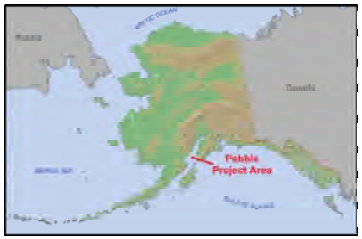
LEGEND:

Groundwater Elevation Plot Legend

- P-05-20S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-20S : 941.3 - 946.3
P-05-20D : 908.9 - 918.9

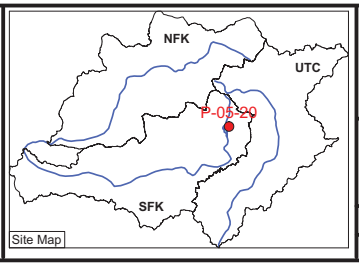


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 970.2 ft asl

P05-20D was flowing, therefore water levels were not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-20.grf

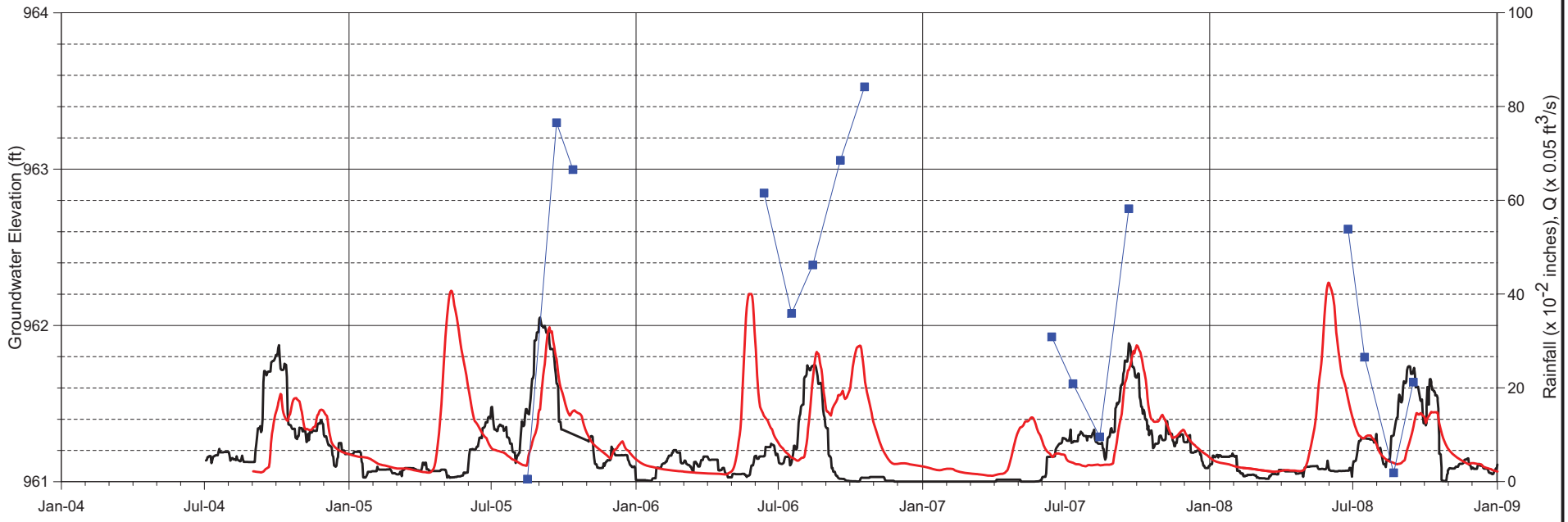


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-21



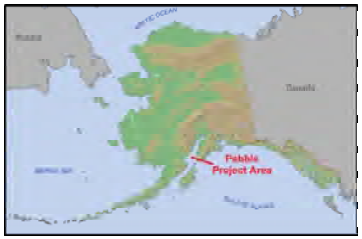
LEGEND:

Groundwater Elevation Plot Legend

- P-05-21S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-21S : 946.3 - 951.3
P-05-21M : 872.5 - 882.5
P-05-21D : 789.3 - 809.3

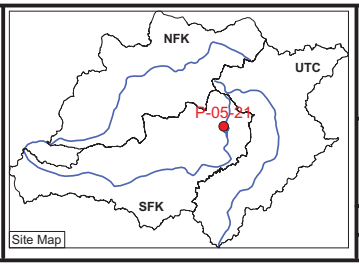


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 962.2 ft asl

P05-21D and P05-21M were flowing, therefore water levels not recorded

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-21.grf

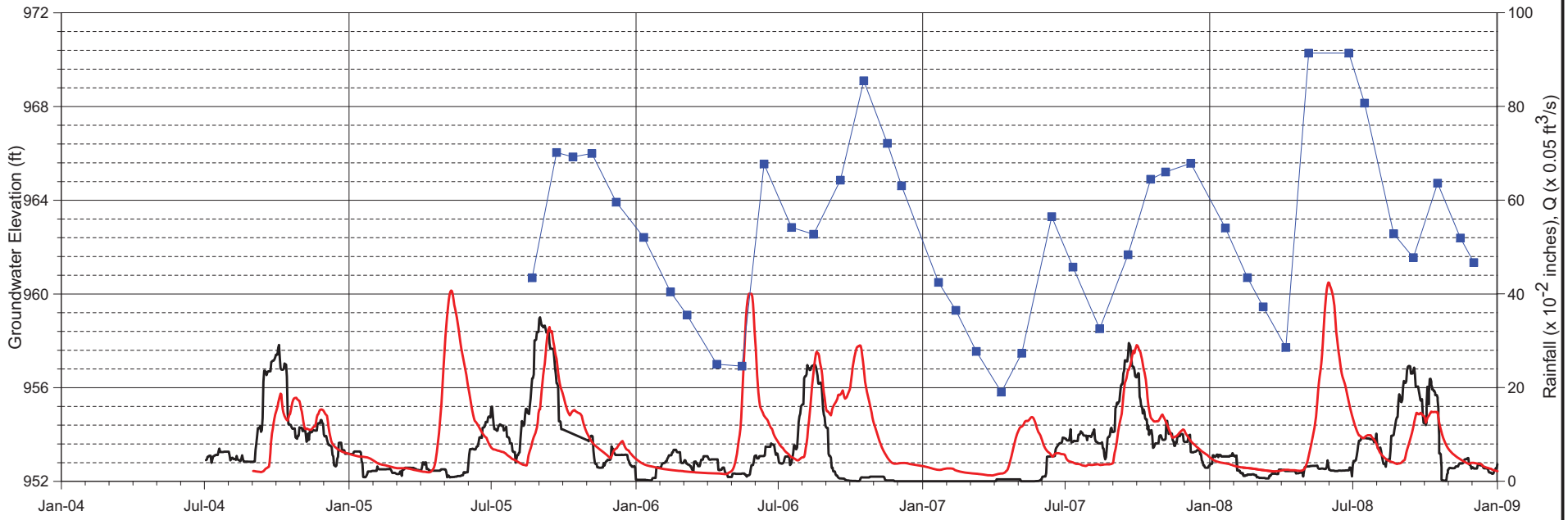


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-22D



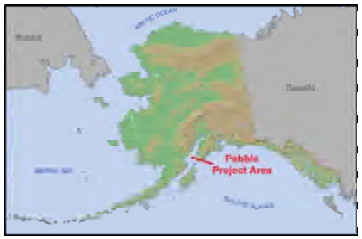
LEGEND:

Groundwater Elevation Plot Legend

- P-05-22D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

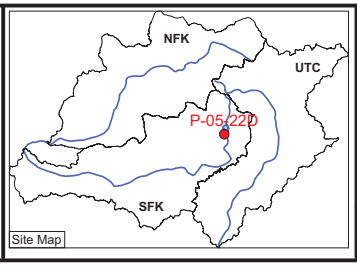
Screens (ft asl):
P-05-22D : 766.4 - 776.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 991.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-22D.grf

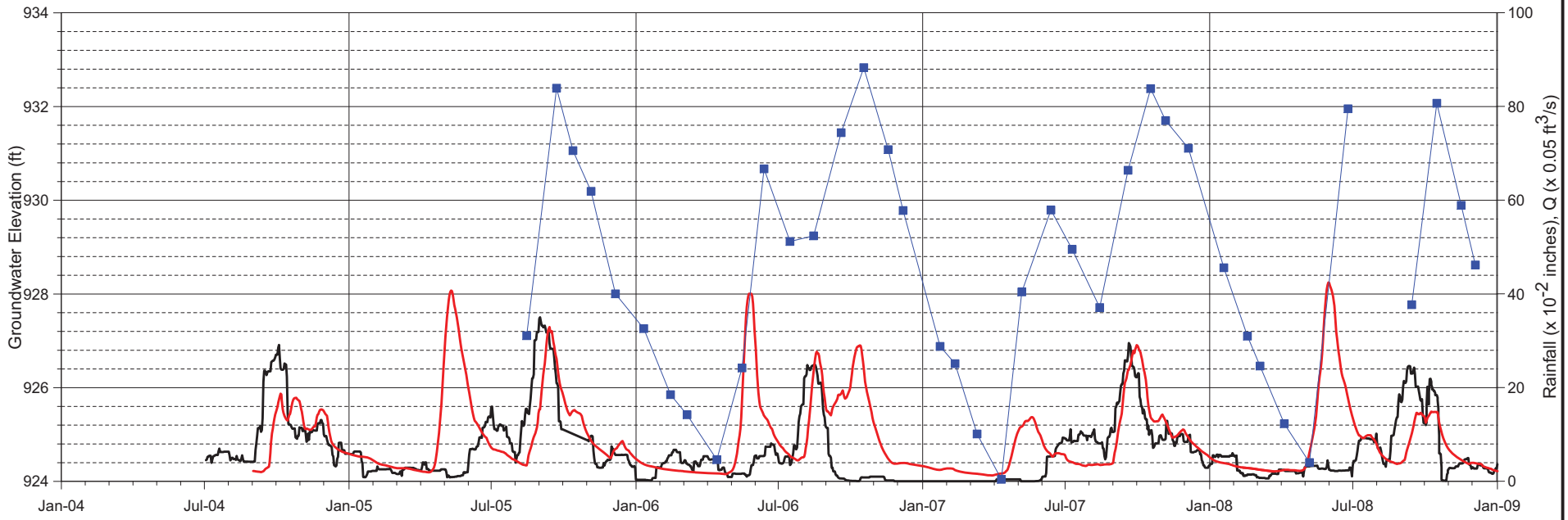


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-23



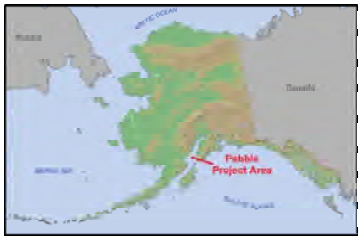
LEGEND:

Groundwater Elevation Plot Legend

- P-05-23
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

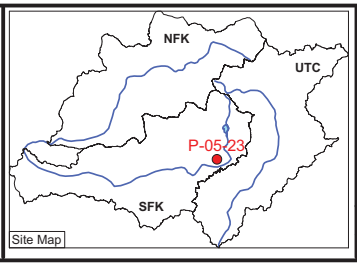
Screens (ft asl):
P-05-23 : 892.2 - 902.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 950.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-23.grf

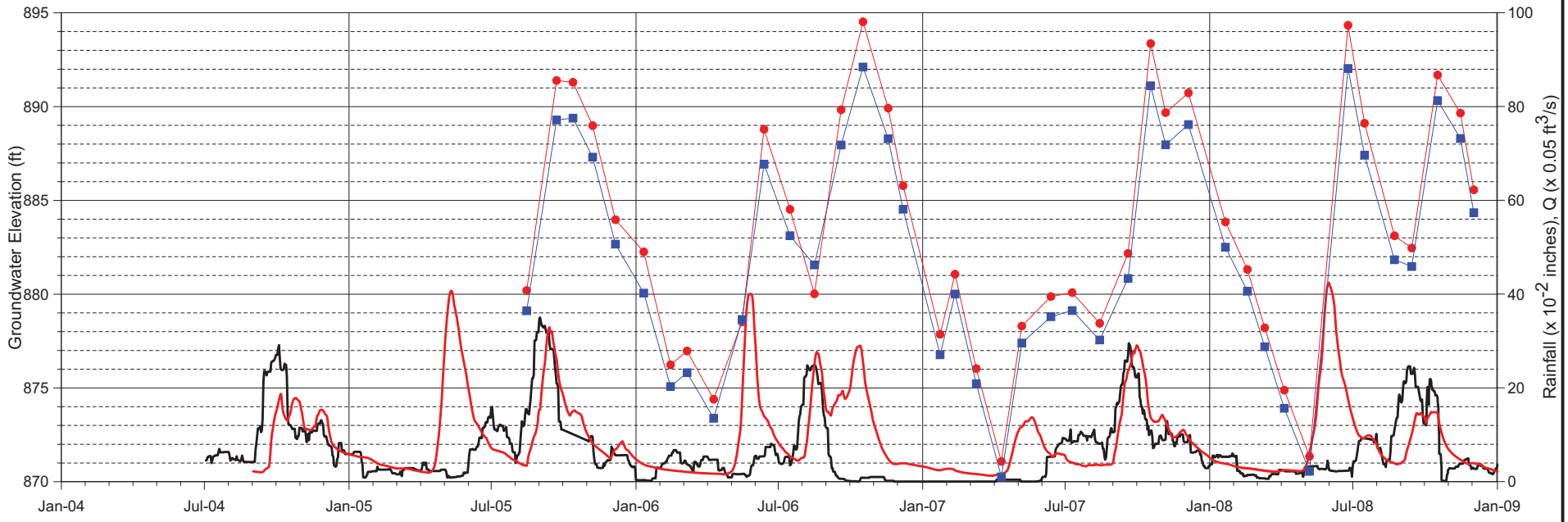


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-24



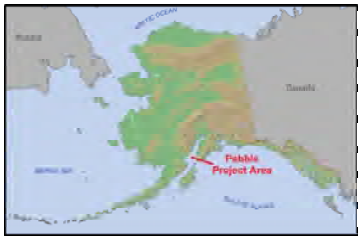
LEGEND:

Groundwater Elevation Plot Legend

- P-05-24S
- P-05-24D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

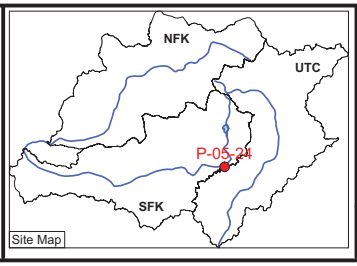
Screens (ft asl):
P-05-24S : 863.9 - 868.9
P-05-24D : 760.9 - 770.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 901.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-24.grf

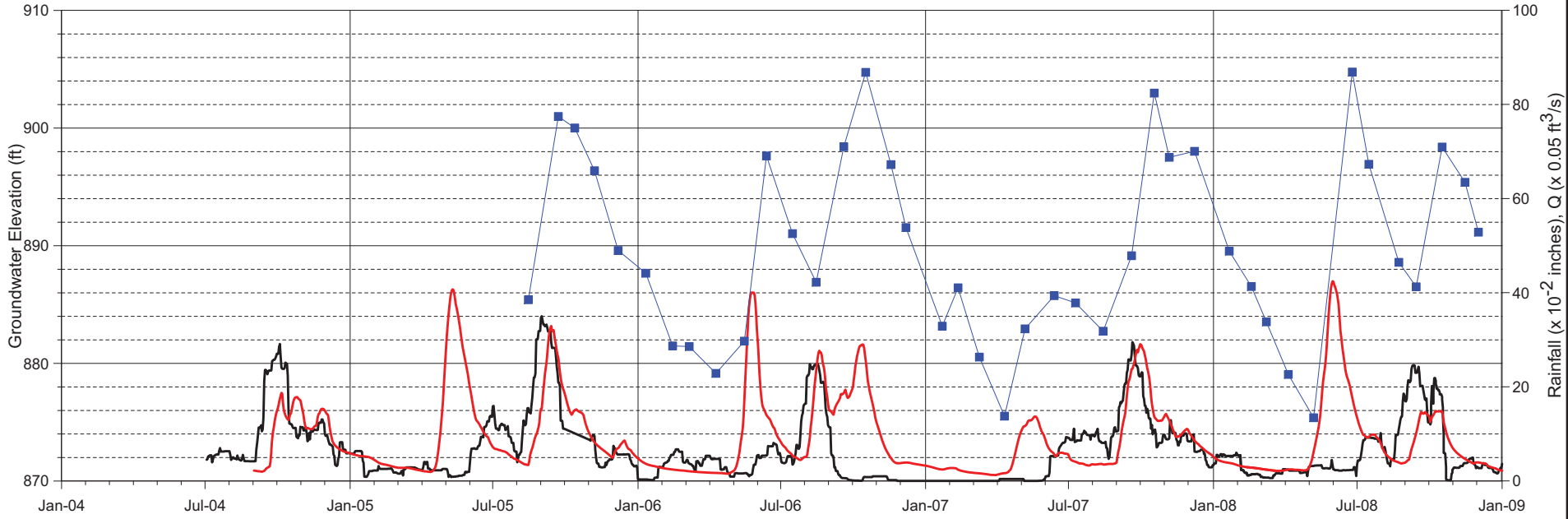


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-25



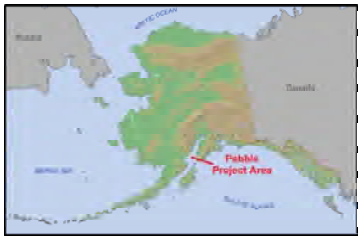
LEGEND:

Groundwater Elevation Plot Legend

- P-05-25
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

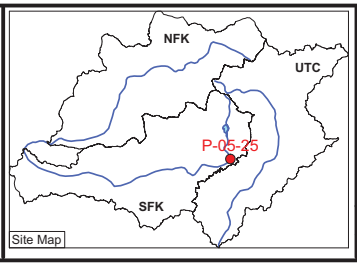
Screens (ft asl):
P-05-25 : 861.4 - 871.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 922.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-25.grf

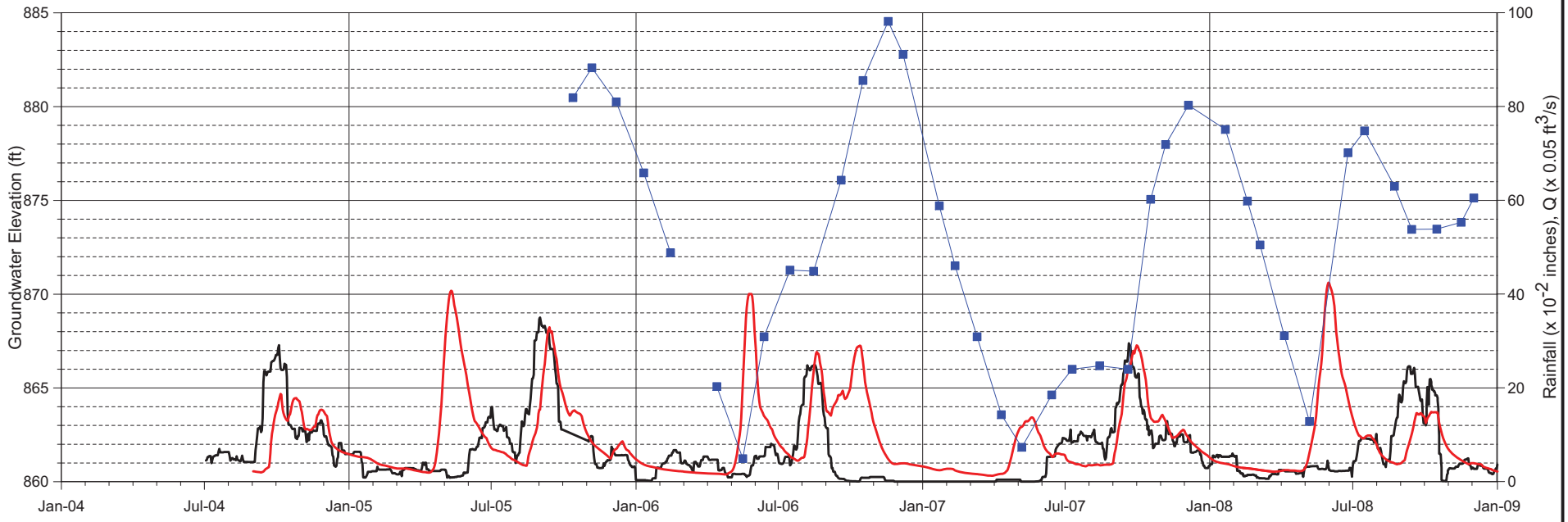


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-26



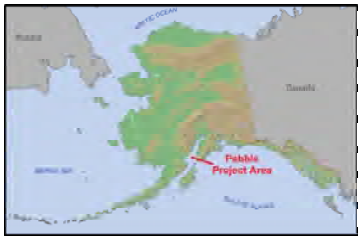
LEGEND:

Groundwater Elevation Plot Legend

- P-05-26D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-26S : 979.7 - 989.7
P-05-26M : 910.6 - 920.6
P-05-26D : 834.5 - 849.2

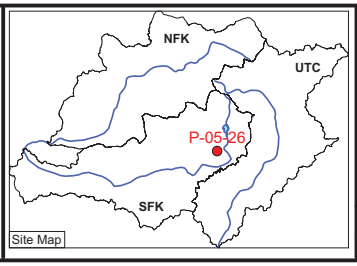


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1010.1 ft asl

Water levels recorded for P05-26M represent water pooled in bottom of piezometer; actual groundwater level below bottom of screen.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-26.grf

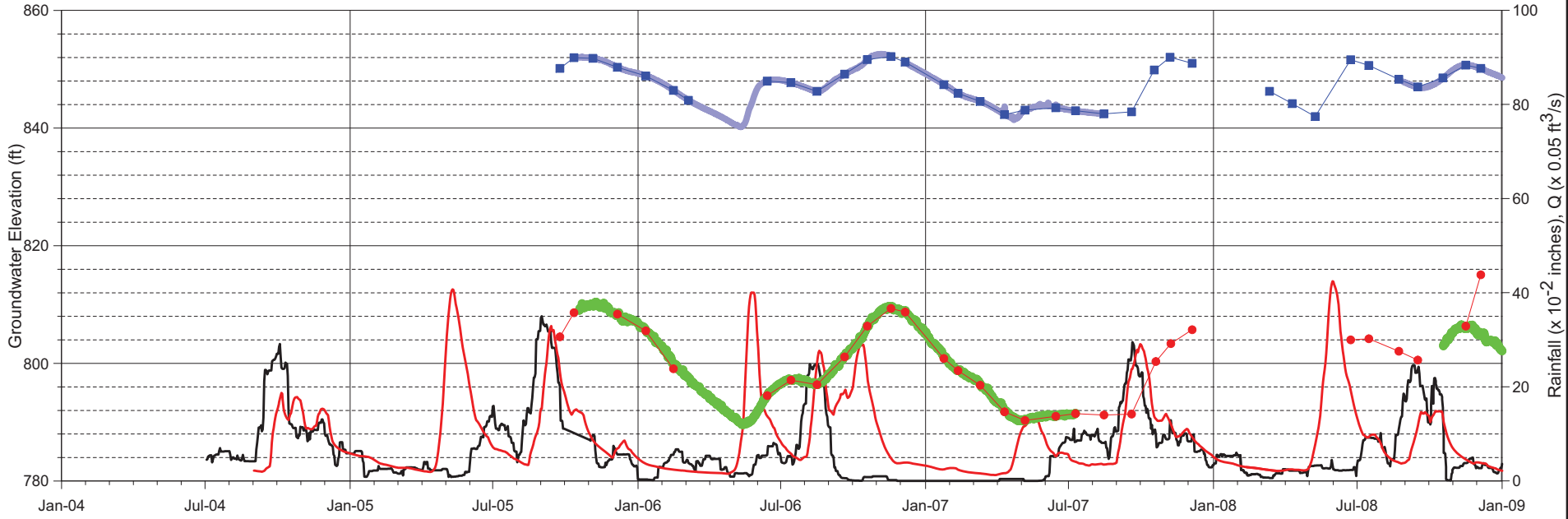


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-27



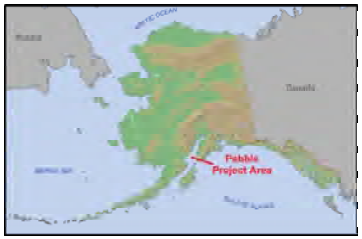
LEGEND:

Groundwater Elevation Plot Legend

- P-05-27S
- P-05-27D
- P-05-27S(Transducer)
- P-05-27D(Transducer)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

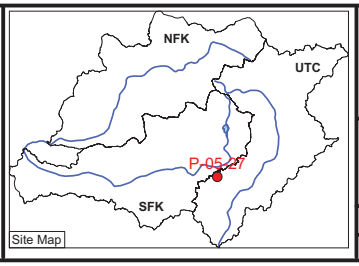
Screens (ft asl):
P-05-27S : 835.9 - 840.9
P-05-27M : 801.6 - 811.6
P-05-27D : 727.2 - 737.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 871.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-27.grf

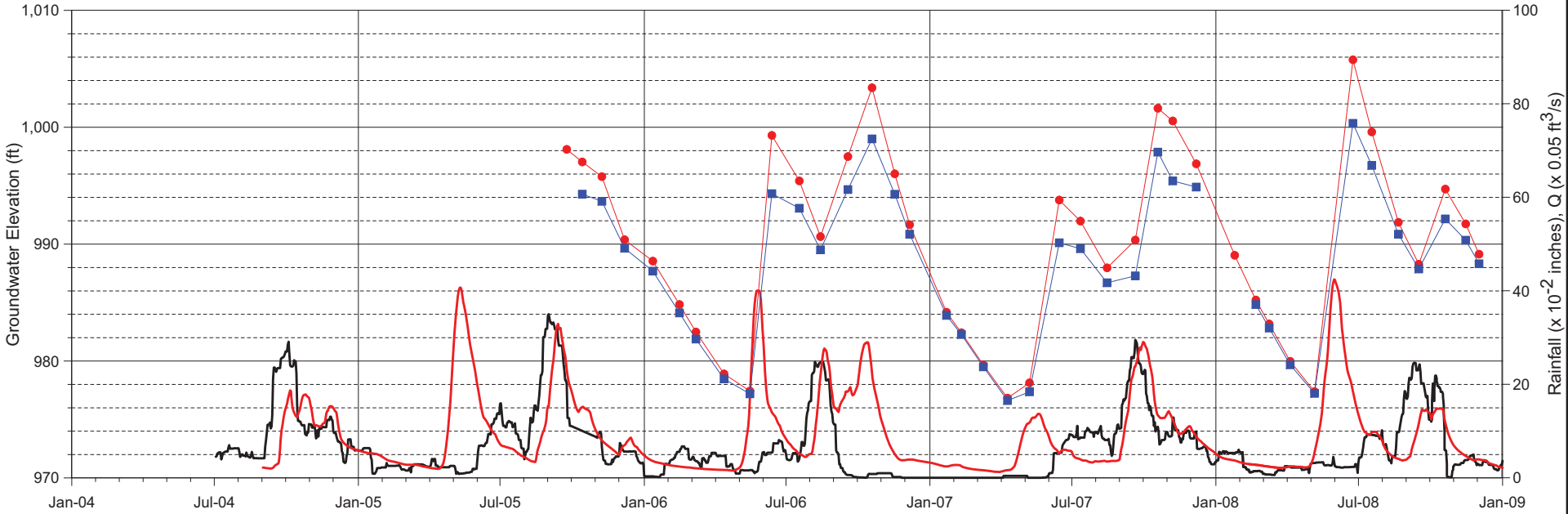


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-28



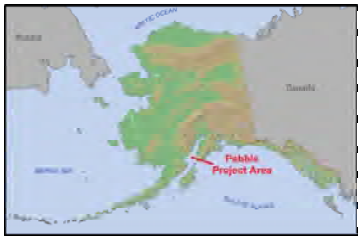
LEGEND:

Groundwater Elevation Plot Legend

- P-05-28S
- P-05-28D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

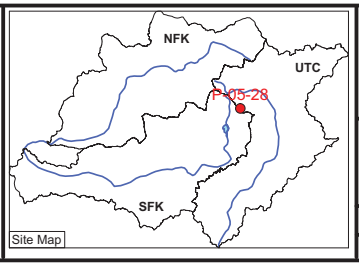
Screens (ft asl):
P-05-28S : 955.1 - 965.1
P-05-28D : 869.8 - 889.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1030.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-28.grf

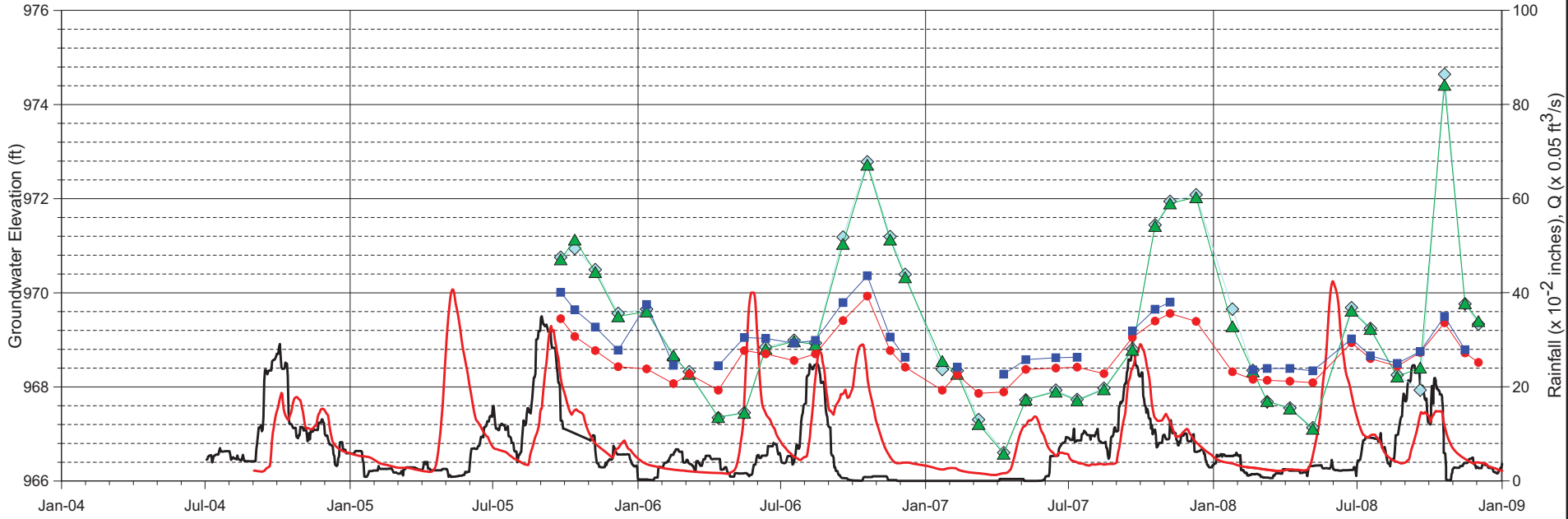


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-29



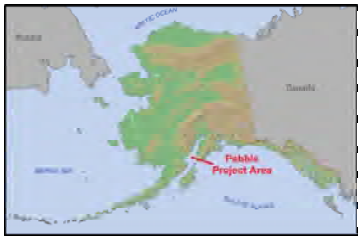
LEGEND:

Groundwater Elevation Plot Legend

- P-05-29S
- P-05-29M
- P-05-29D2
- P-05-29D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

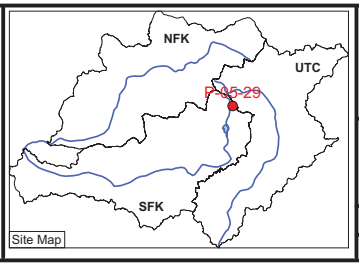
Screens (ft asl):
P-05-29S : 968.3 - 973.3
P-05-29M : 940.0 - 950.0
P-05-29D2 : 873.0 - 883.0
P-05-29D : 867.2 - 877.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 995.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-29.grf

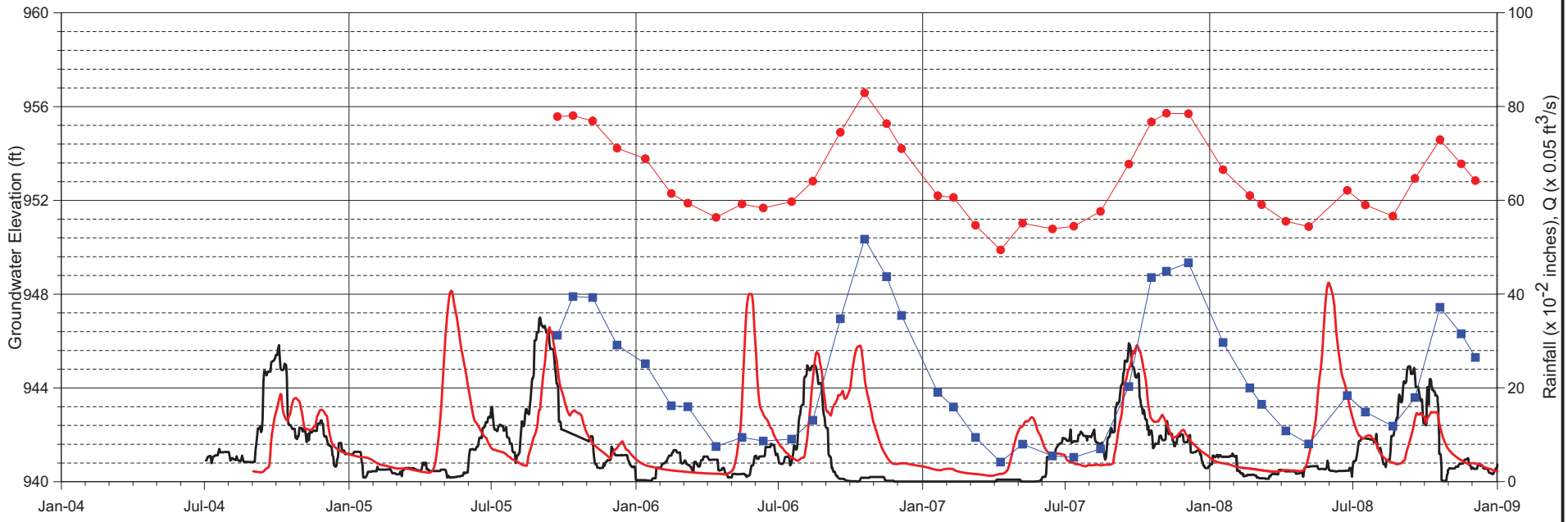


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-30



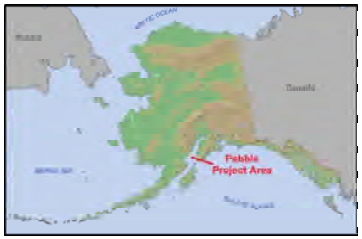
LEGEND:

Groundwater Elevation Plot Legend

- P-05-30S
- P-05-30D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

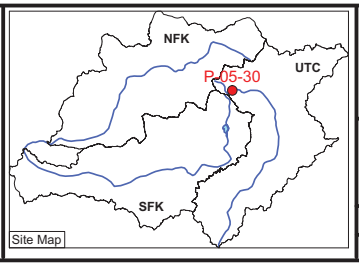
Screens (ft asl):
P-05-30S : 898.3 - 903.3
P-05-30D : 865.5 - 875.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 971.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-30.grf

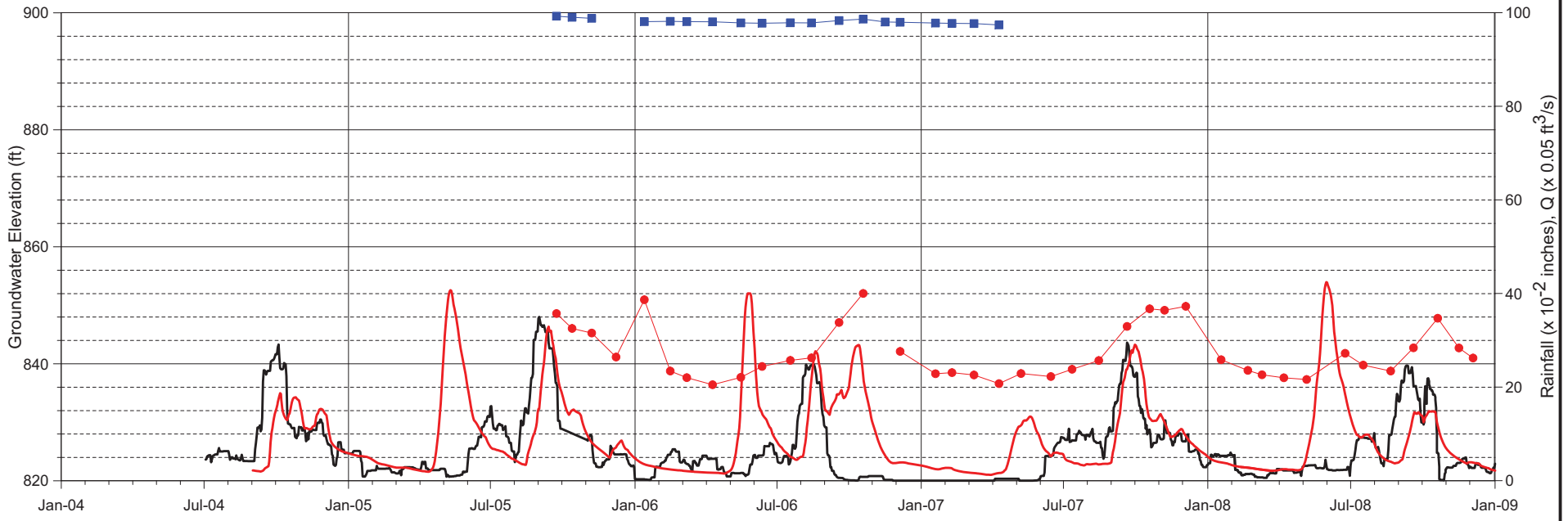


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-31



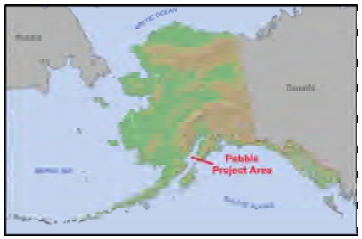
LEGEND:

Groundwater Elevation Plot Legend

- P-05-31S
- P-05-31D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-05-31S : 894.5 - 899.5
P-05-31D : 772.7 - 782.7

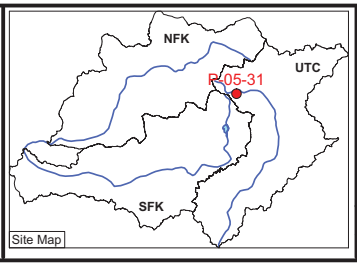


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 919.3 ft asl

P05-31S gradually infilled with sediment to same level as water. No water levels could be recorded after April, 2007.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-31.grf

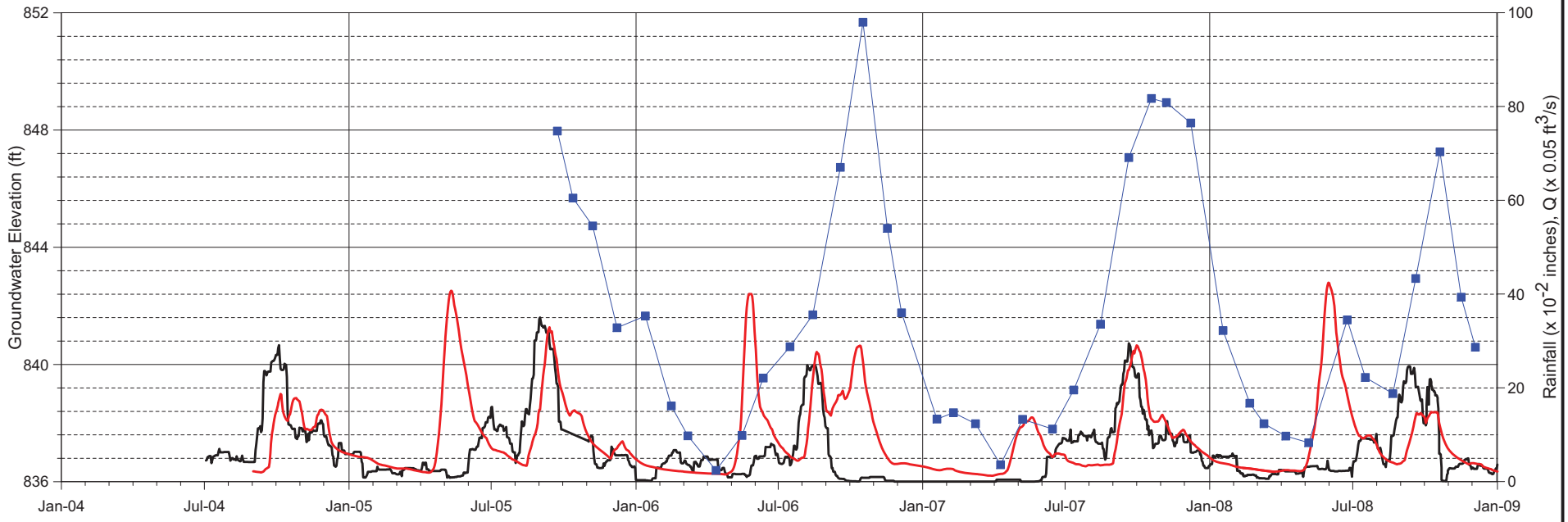


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-32D



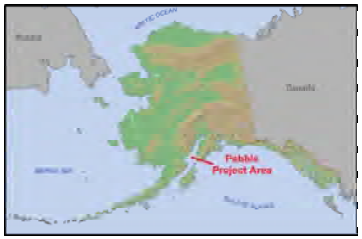
LEGEND:

Groundwater Elevation Plot Legend

- P-05-32D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

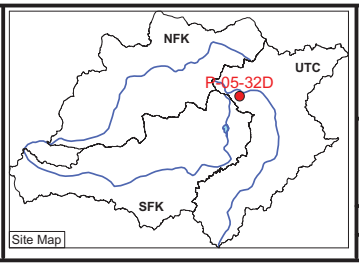
Screens (ft asl):
P-05-32D : 787.5 - 807.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 887.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-32D.grf

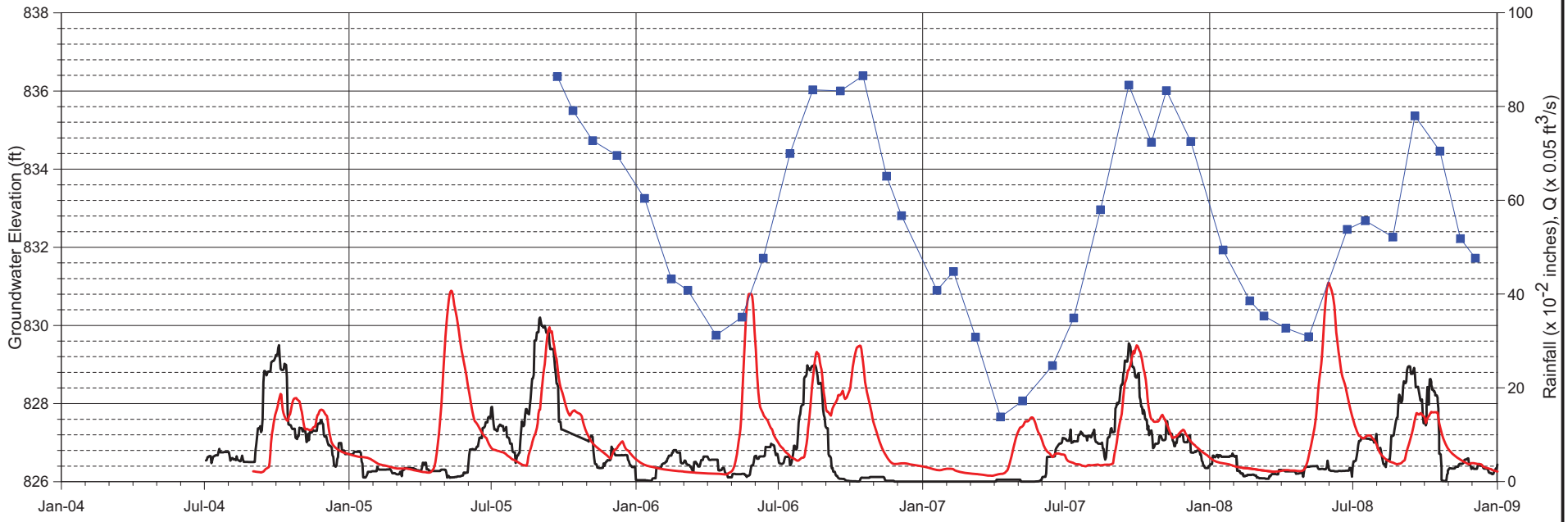


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-33D



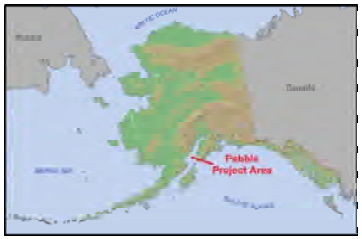
LEGEND:

Groundwater Elevation Plot Legend

- P-05-33D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

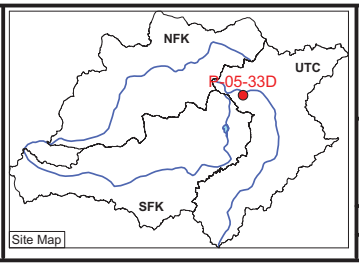
Screens (ft asl):
P-05-33D : 793.1 - 803.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 837.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-33D.grf

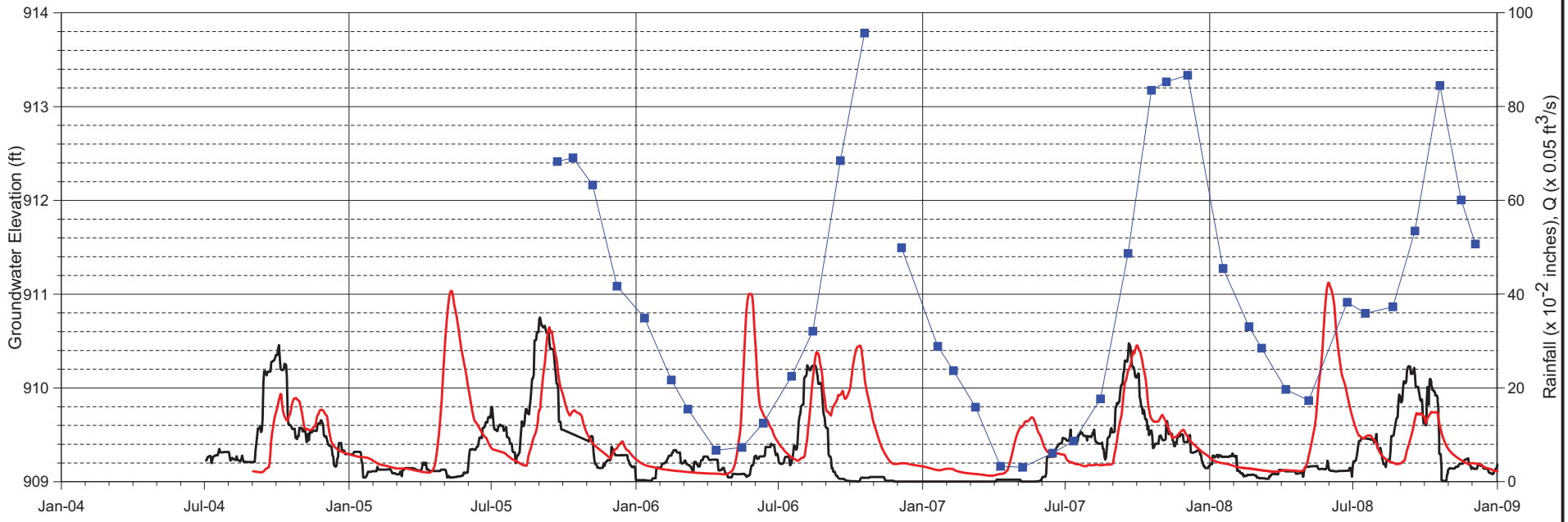


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-35D



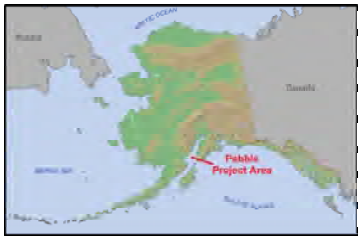
LEGEND:

Groundwater Elevation Plot Legend

- P-05-35D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

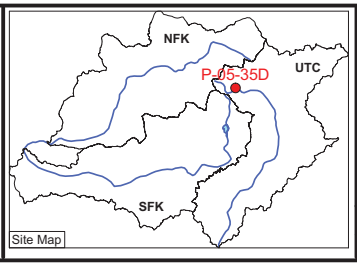
Screens (ft asl):
P-05-35D : 876.5 - 881.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 933.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-35D.grf

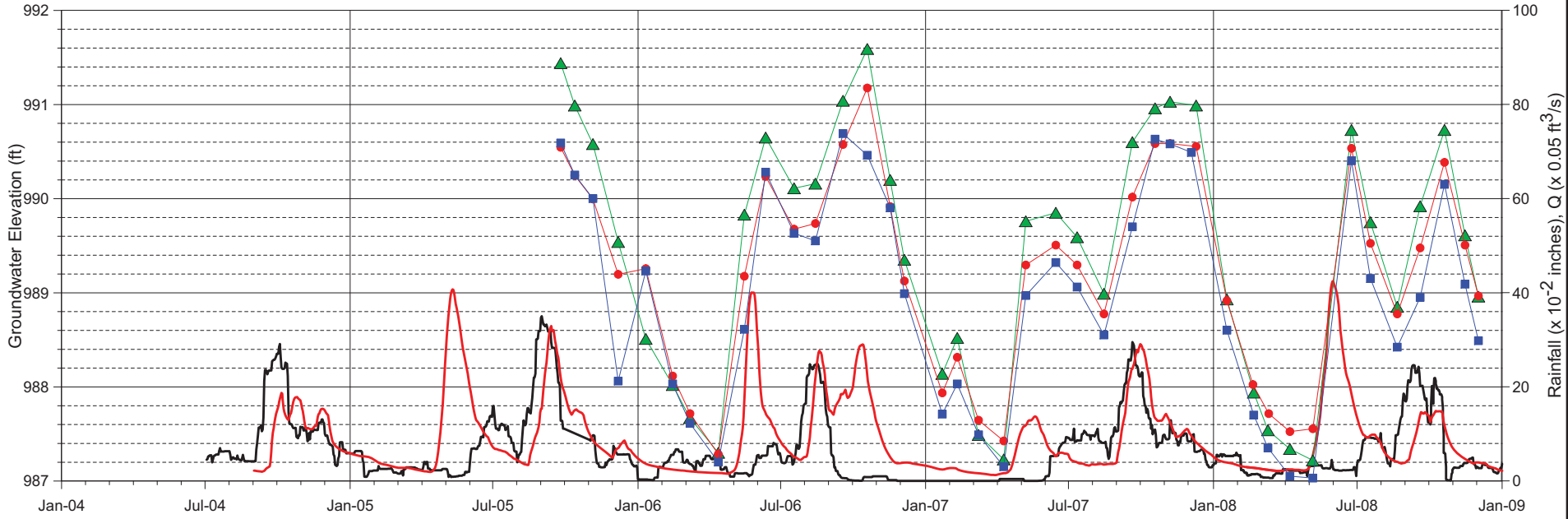


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-05-36



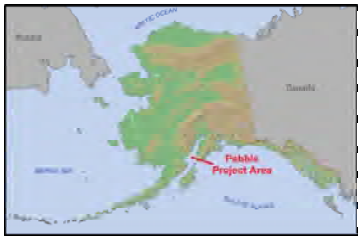
LEGEND:

Groundwater Elevation Plot Legend

- P-05-36S
- P-05-36M
- P-05-36D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

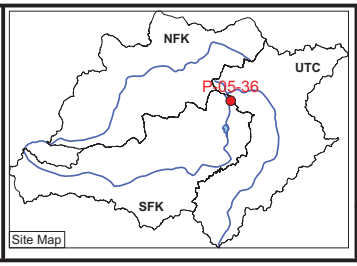
Screens (ft asl):
P-05-36S : 975.5 - 985.5
P-05-36M : 919.2 - 929.2
P-05-36D : 861.4 - 871.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1008.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-05-36.grf

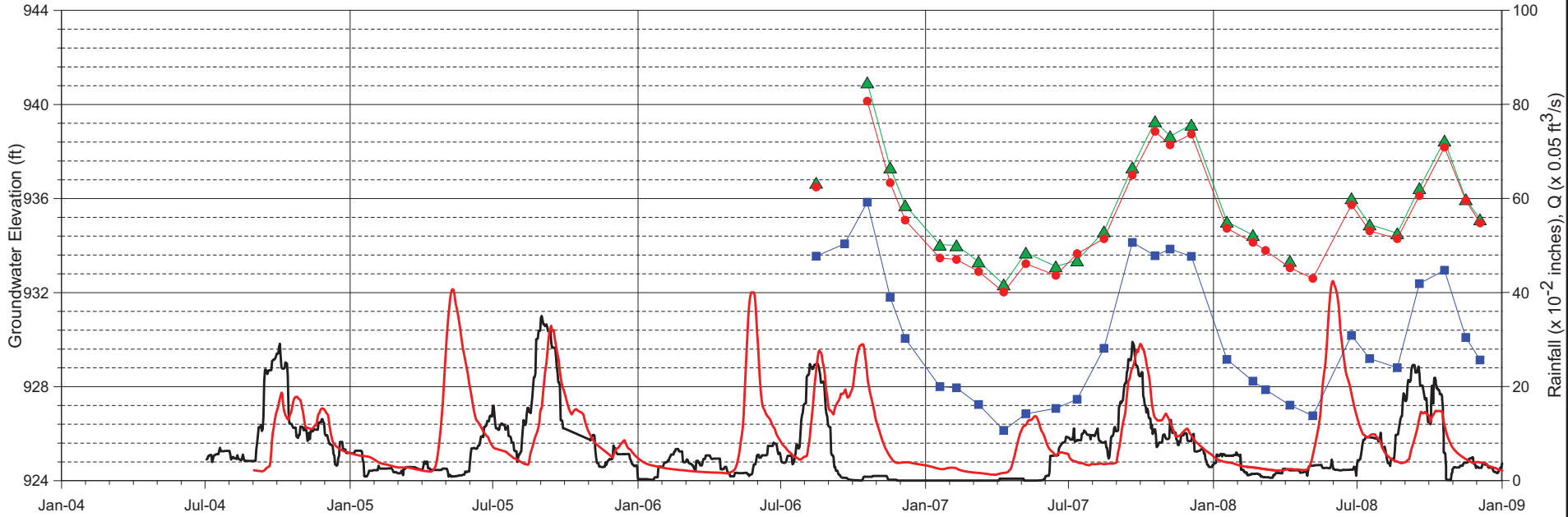


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-37



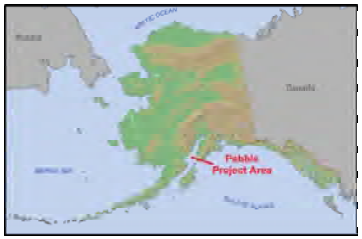
LEGEND:

Groundwater Elevation Plot Legend

- P-06-37S
- P-06-37M
- P-06-37D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

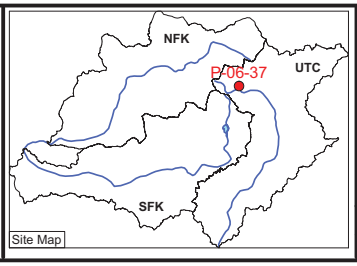
Screens (ft asl):
P-06-37S : 919.1 - 924.1
P-06-37M : 854.0 - 869.5
P-06-37D : 745.3 - 765.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 944.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-37.grf

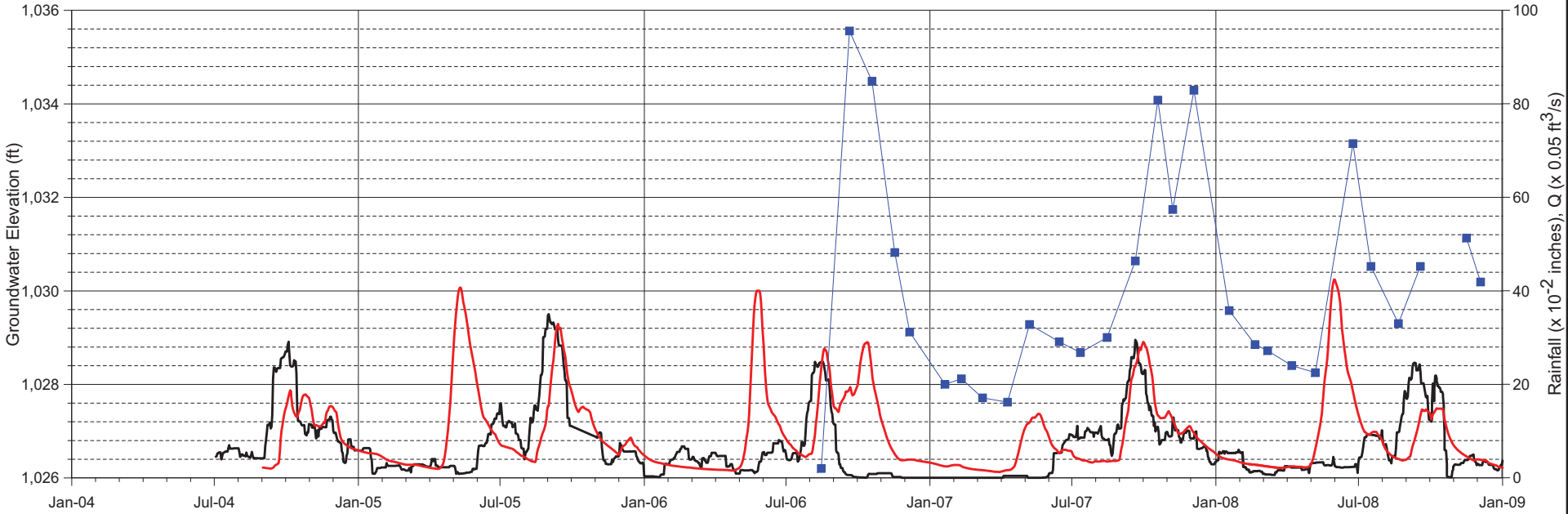


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-38



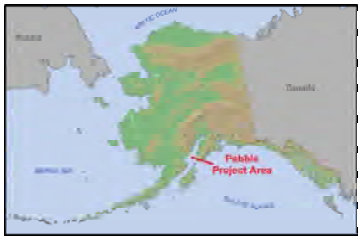
LEGEND:

Groundwater Elevation Plot Legend

- P-06-38M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-06-38M : 995.8 - 1005.8
P-06-38D : 893.2 - 908.2

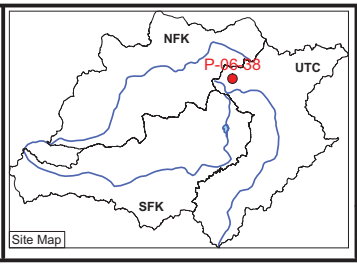


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1063.3 ft asl

P-06-38D was flowing,
therefore water levels not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-38.grf

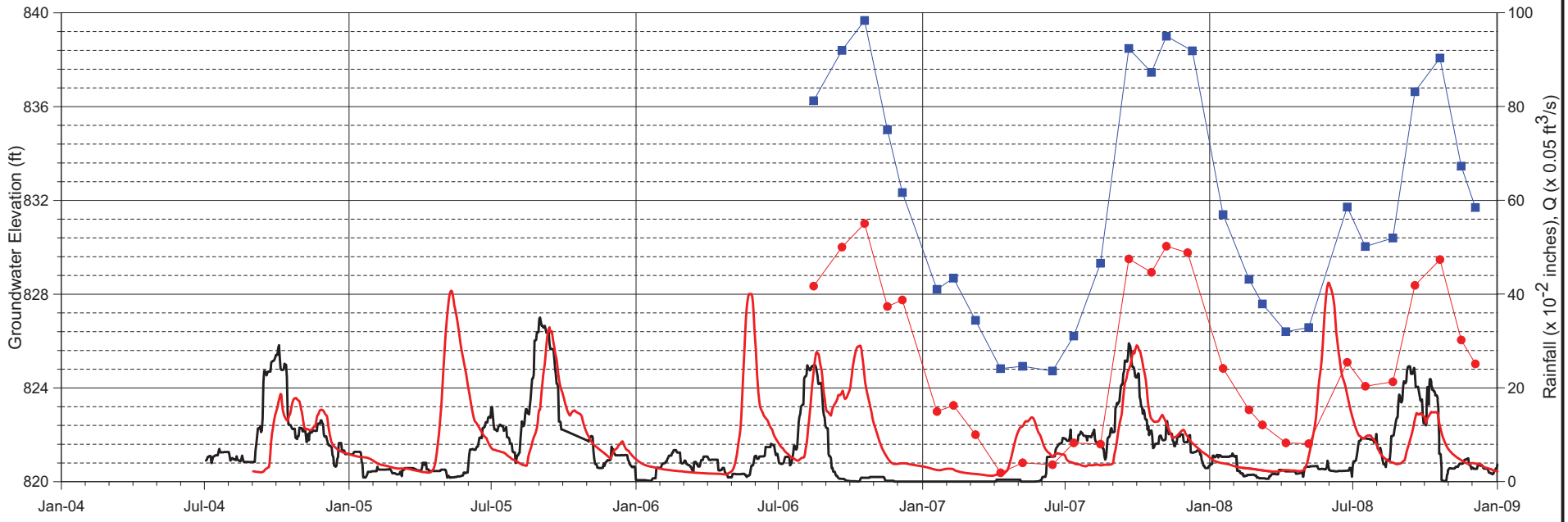


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-39



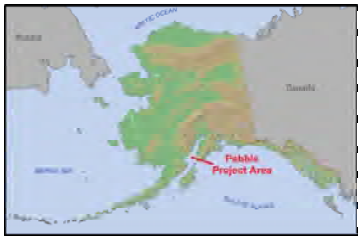
LEGEND:

Groundwater Elevation Plot Legend

- P-06-39S
- P-06-39D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

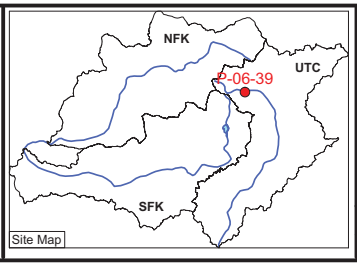
Screens (ft asl):
P-06-39S : 807.7 - 812.7
P-06-39D : 730.5 - 750.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 842.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-39.grf

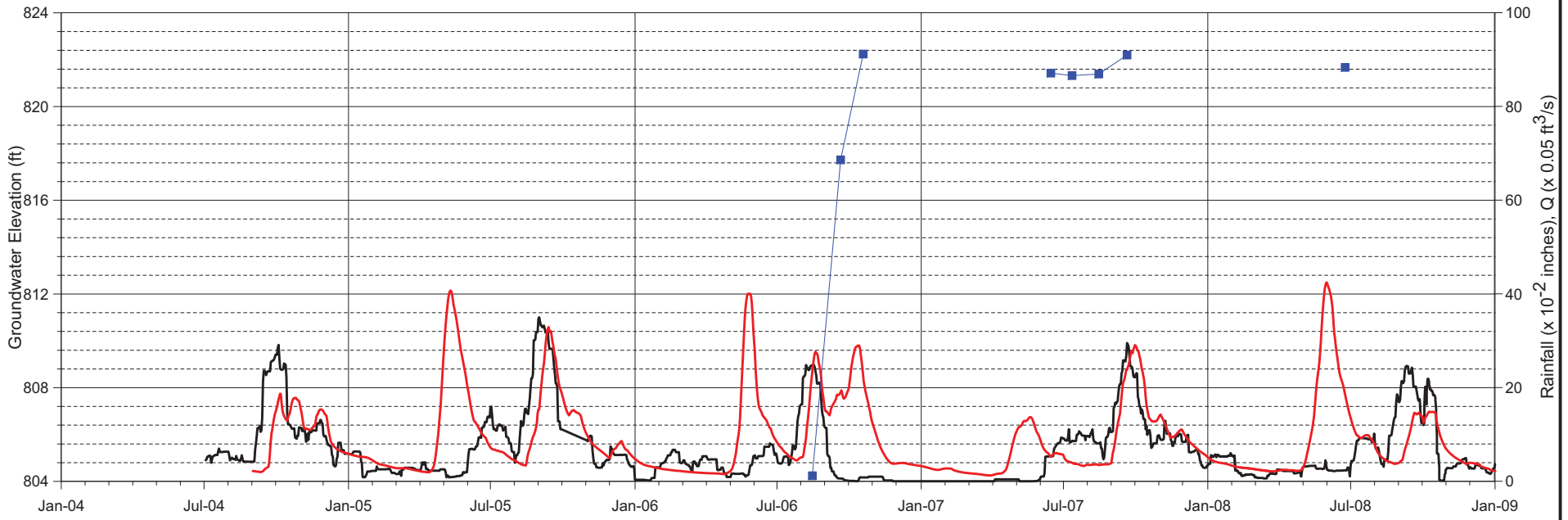


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-40



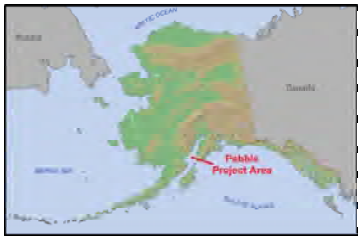
LEGEND:

Groundwater Elevation Plot Legend

- P-06-40S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-06-40S : 800.7 - 805.7
P-06-40M : 757.0 - 767.0
P-06-40D : 675.0 - 685.0

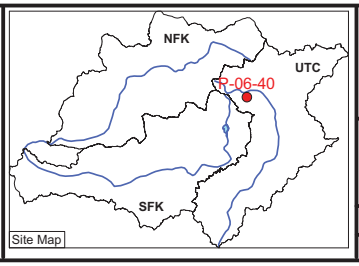


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 819.9 ft asl

P06-40D and P06-40M were flowing, therefore water levels not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-40.grf

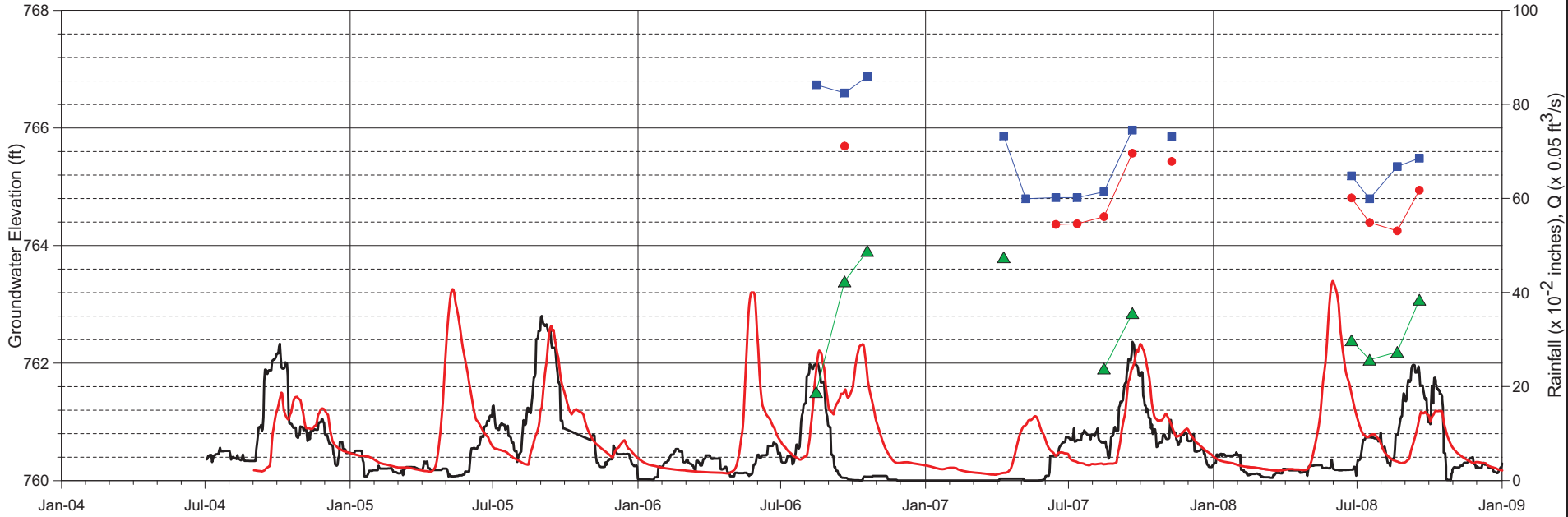


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-06-41



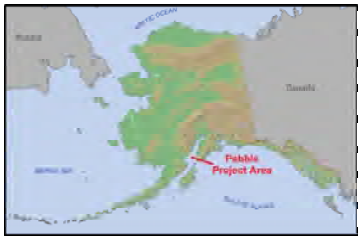
LEGEND:

Groundwater Elevation Plot Legend

- P-06-41S
- P-06-41M
- P-06-41D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

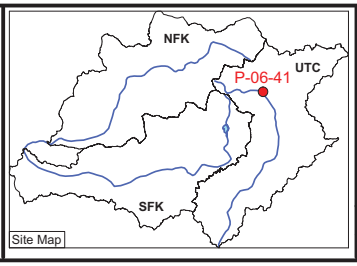
Screens (ft asl):
P-06-41S : 722.7 - 727.7
P-06-41M : 700.9 - 710.9
P-06-41D : 563.1 - 573.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 764.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-06-41.grf

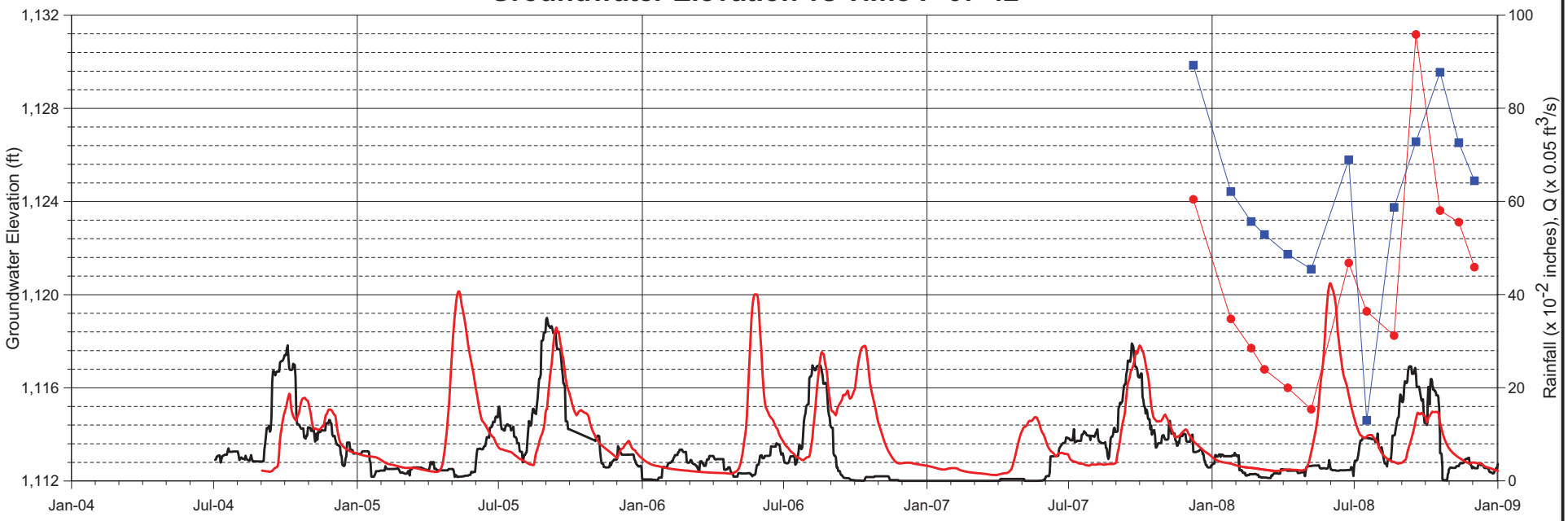


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-42



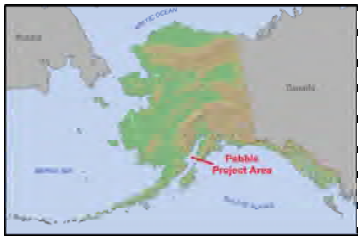
LEGEND:

Groundwater Elevation Plot Legend

- P-07-42S
- P-07-42D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

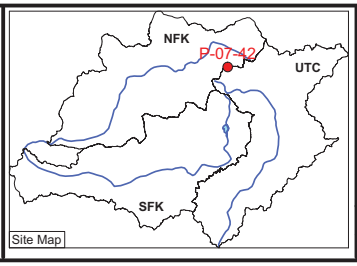
Screens (ft asl):
P-07-42S : 1107.5 - 1116.5
P-07-42D : 1035.3 - 1045.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1156.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-42.grf

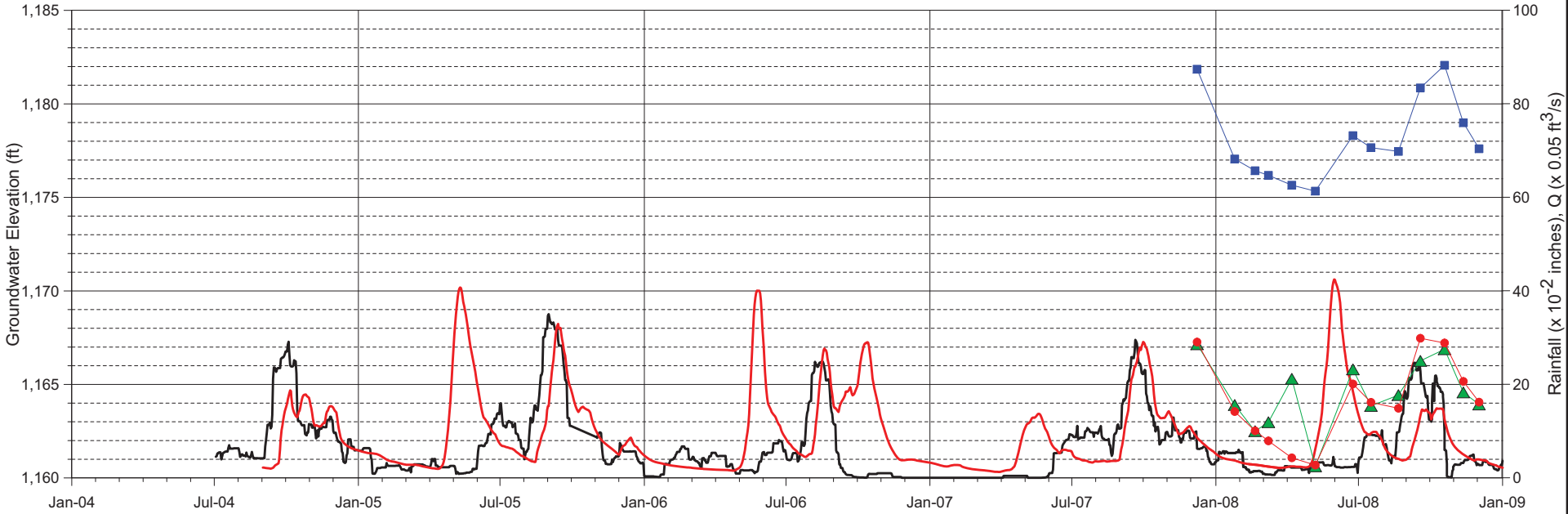


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-43



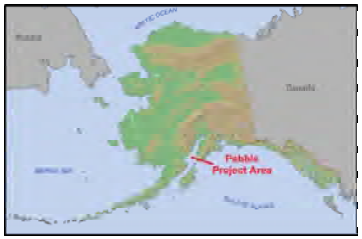
LEGEND:

Groundwater Elevation Plot Legend

- P-07-43S
- P-07-43M
- P-07-43D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

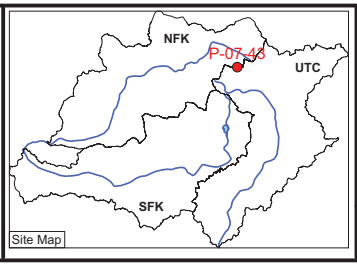
Screens (ft asl):
P-07-43S : 1161.4 - 1170.4
P-07-43M : 1122.0 - 1132.0
P-07-43D : 1058.2 - 1063.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1191.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-43.grf

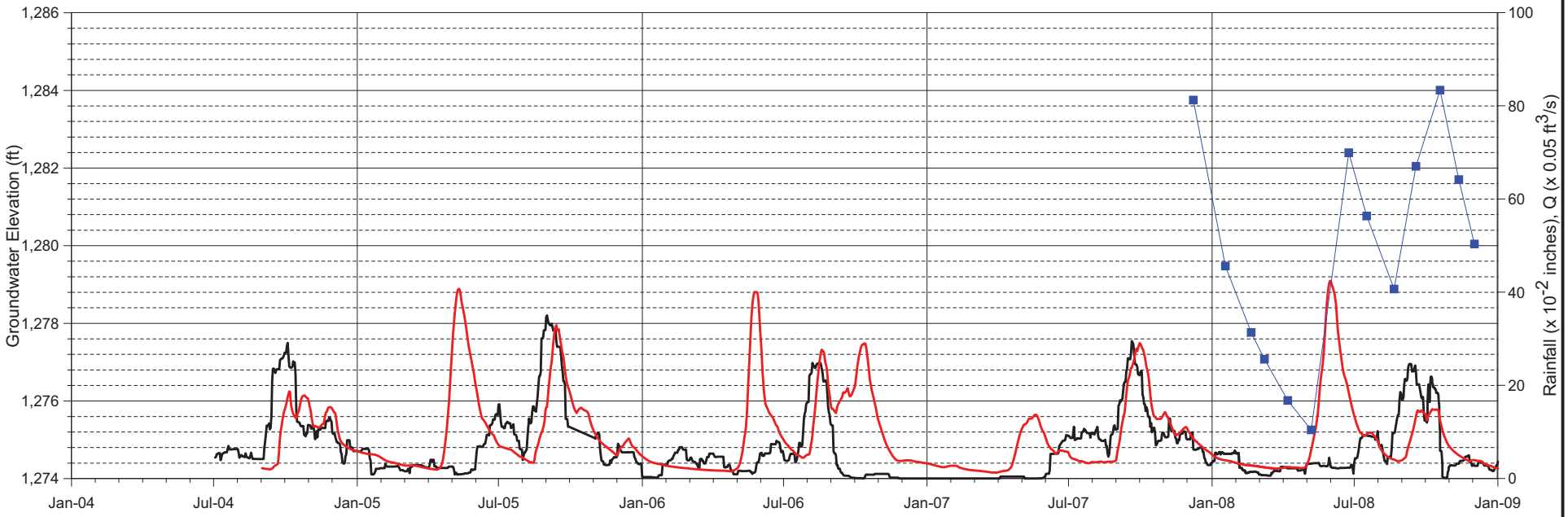


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-45D



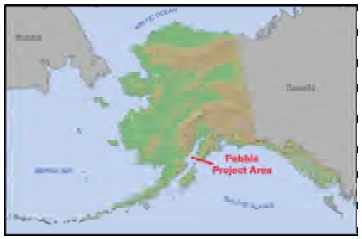
LEGEND:

Groundwater Elevation Plot Legend

- P-07-45D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

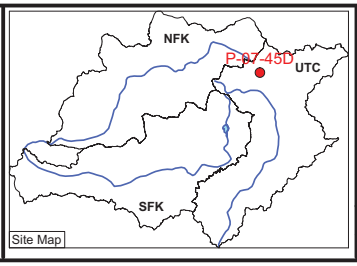
Screens (ft asl):
P-07-45D : 1253.0 - 1268.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1313 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-45D.grf

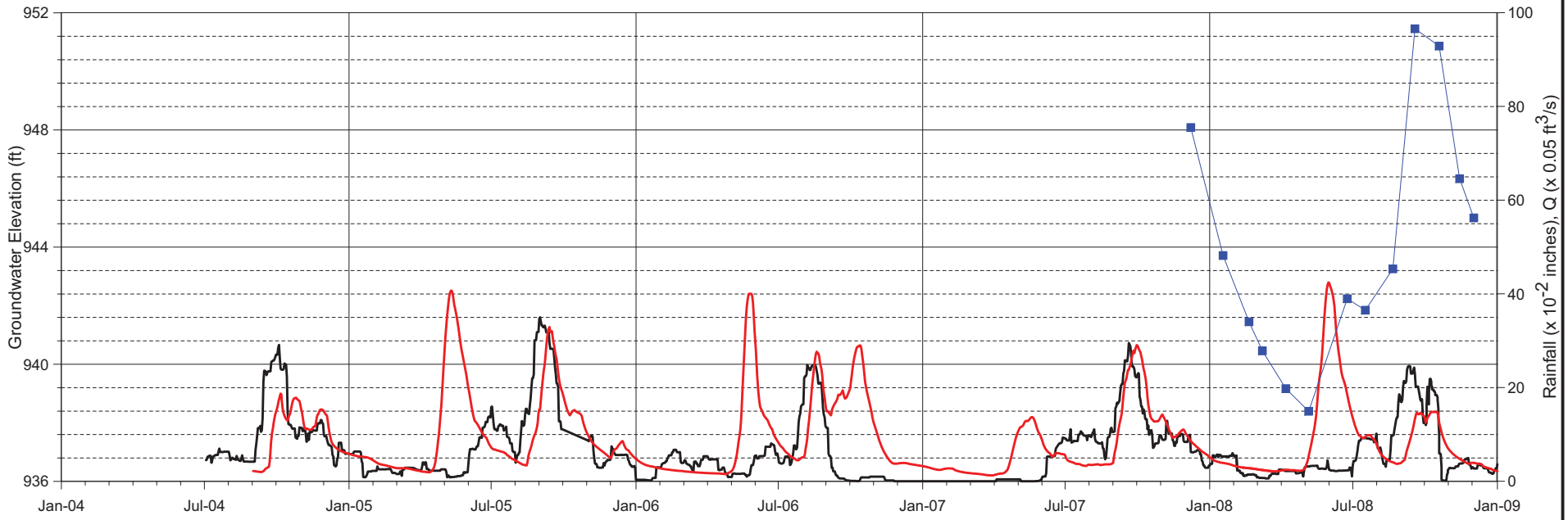


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-46D



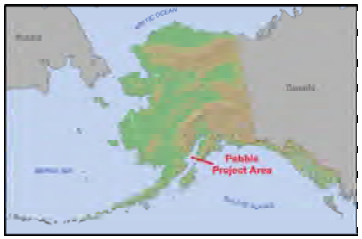
LEGEND:

Groundwater Elevation Plot Legend

- P-07-46D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

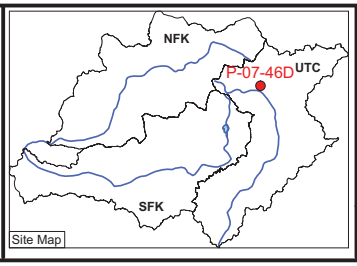
Screens (ft asl):
P-07-46D : 920.0 - 925.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 962.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-46D.grf

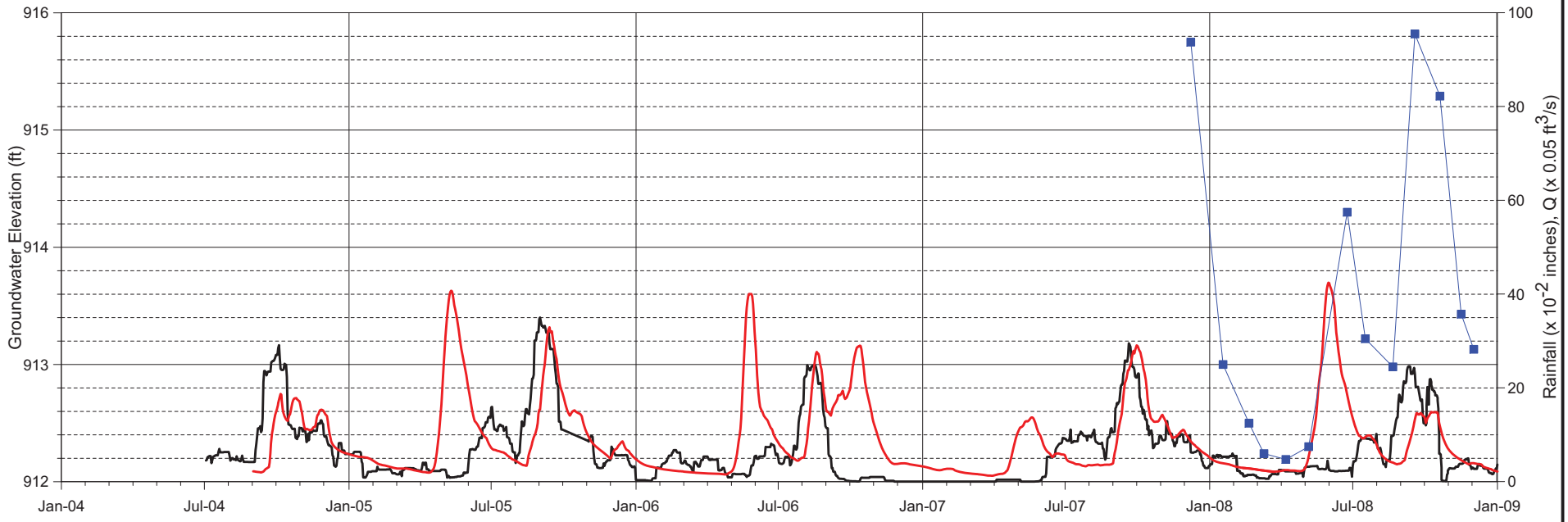


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-47D



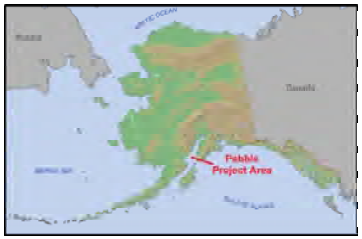
LEGEND:

Groundwater Elevation Plot Legend

- P-07-47D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

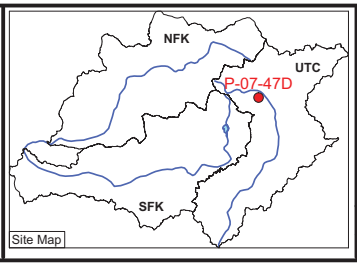
Screens (ft asl):
P-07-47D : 837.4 - 842.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 917 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-47D.grf

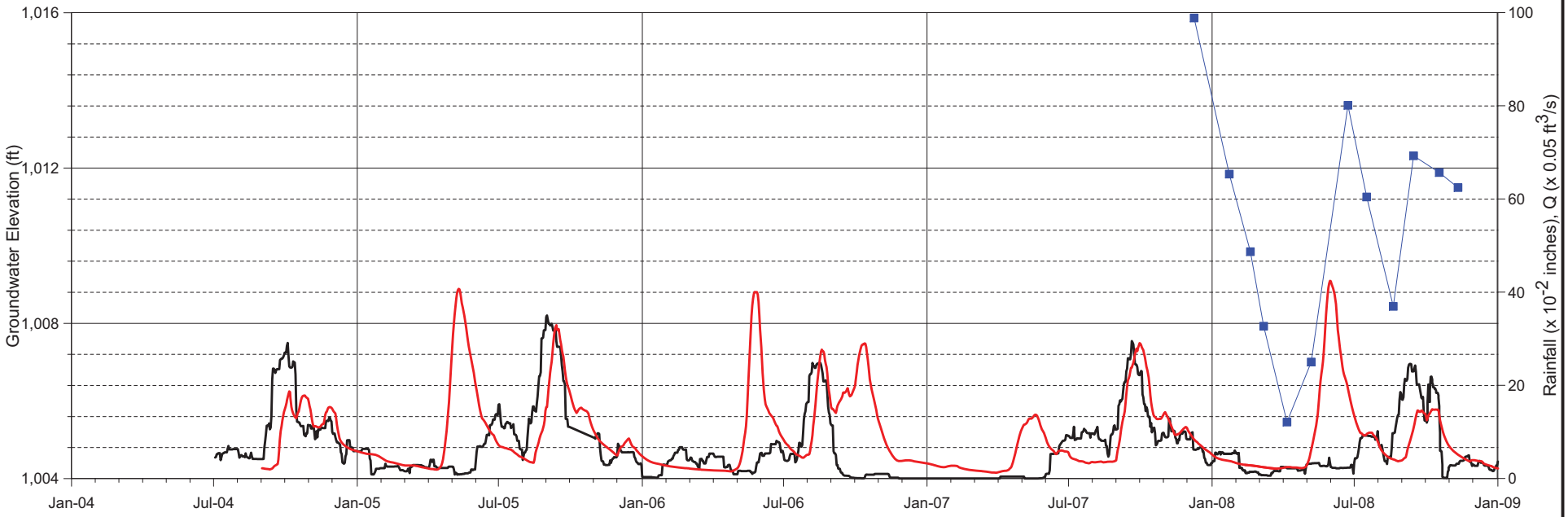


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-48



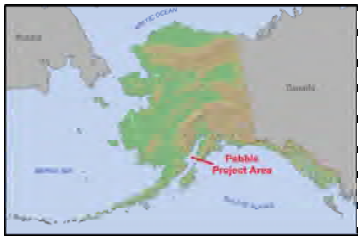
LEGEND:

Groundwater Elevation Plot Legend

- P-07-48D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

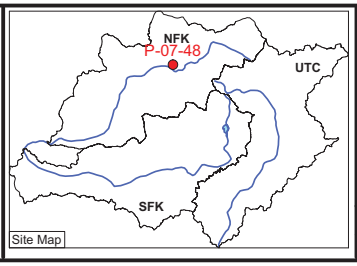
Screens (ft asl):
P-07-48S : 1021.4 - 1026.4
P-07-48D : 988.6 - 998.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1045.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-48.grf

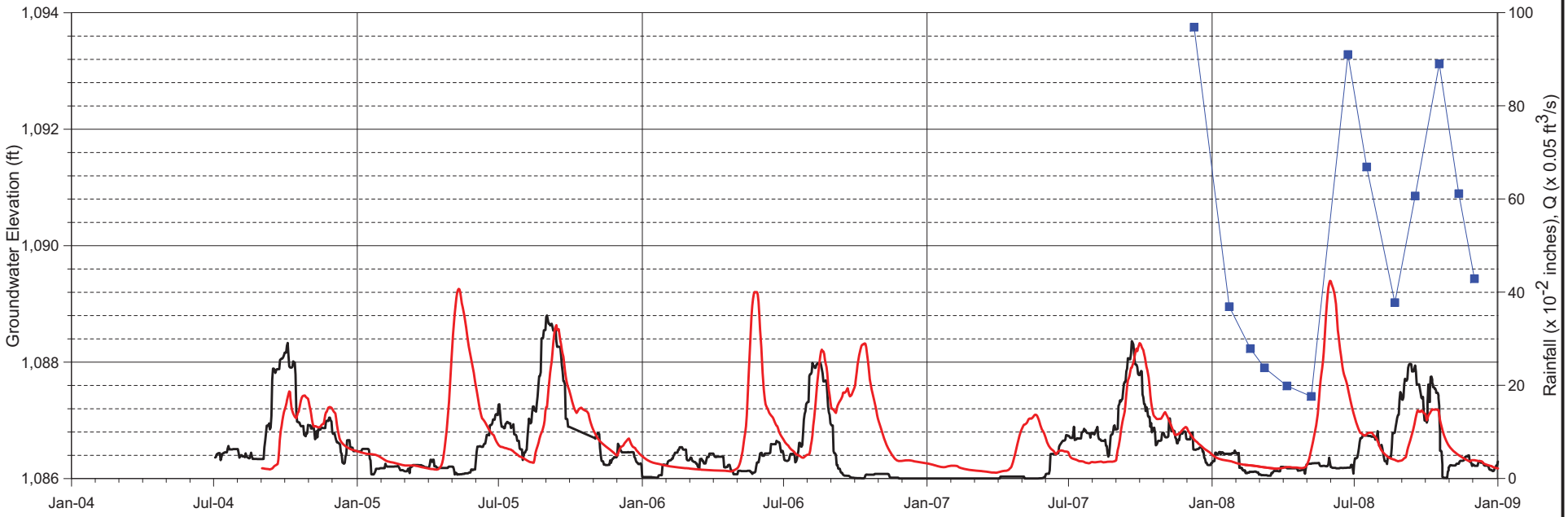


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-49



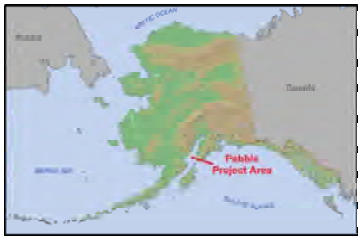
LEGEND:

Groundwater Elevation Plot Legend

- P-07-49D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

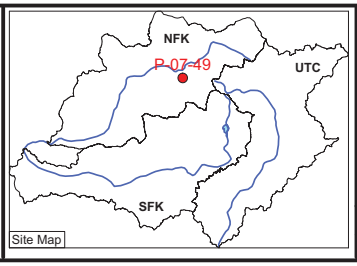
Screens (ft asl):
P-07-49S : 1091.9 - 1096.9
P-07-49D : 1017.4 - 1022.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1114.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-49.grf

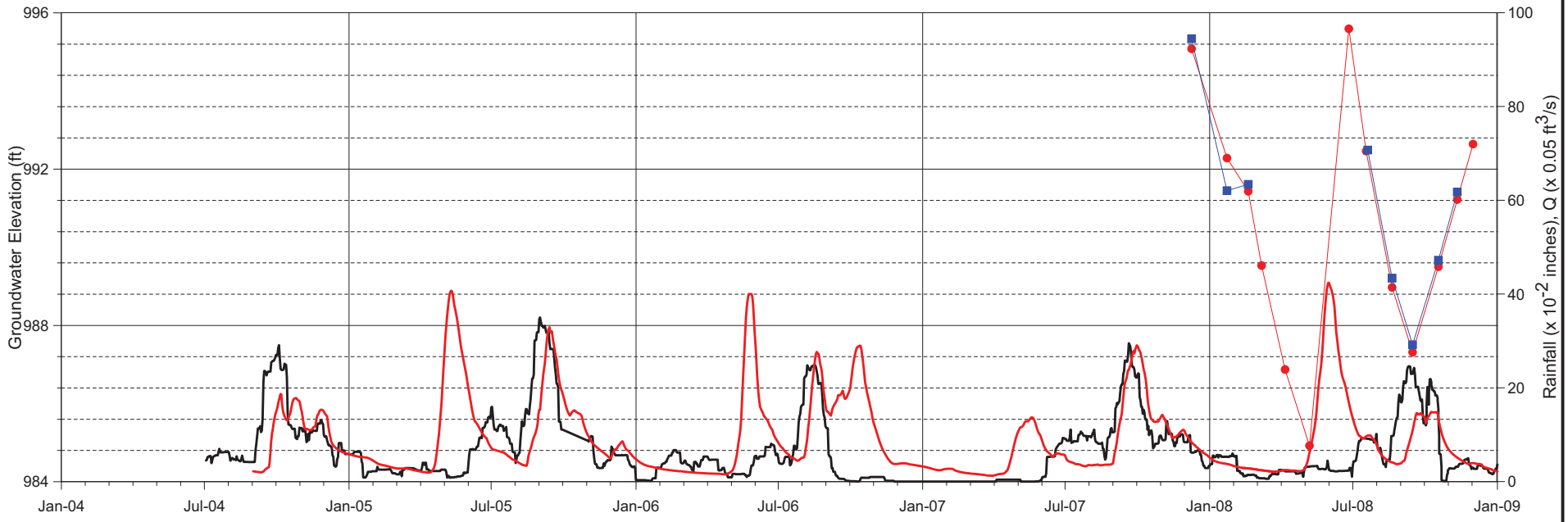


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-50



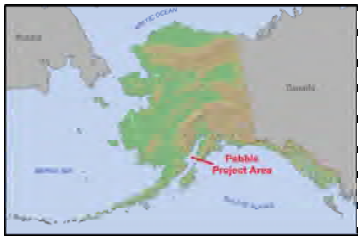
LEGEND:

Groundwater Elevation Plot Legend

- P-07-50S
- P-07-50D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

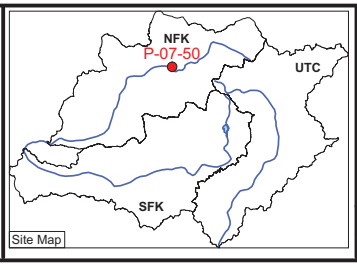
Screens (ft asl):
P-07-50SS : 1023.4 - 1033.4
P-07-50S : 983.3 - 993.3
P-07-50D : 891.5 - 901.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1053.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-50.grf

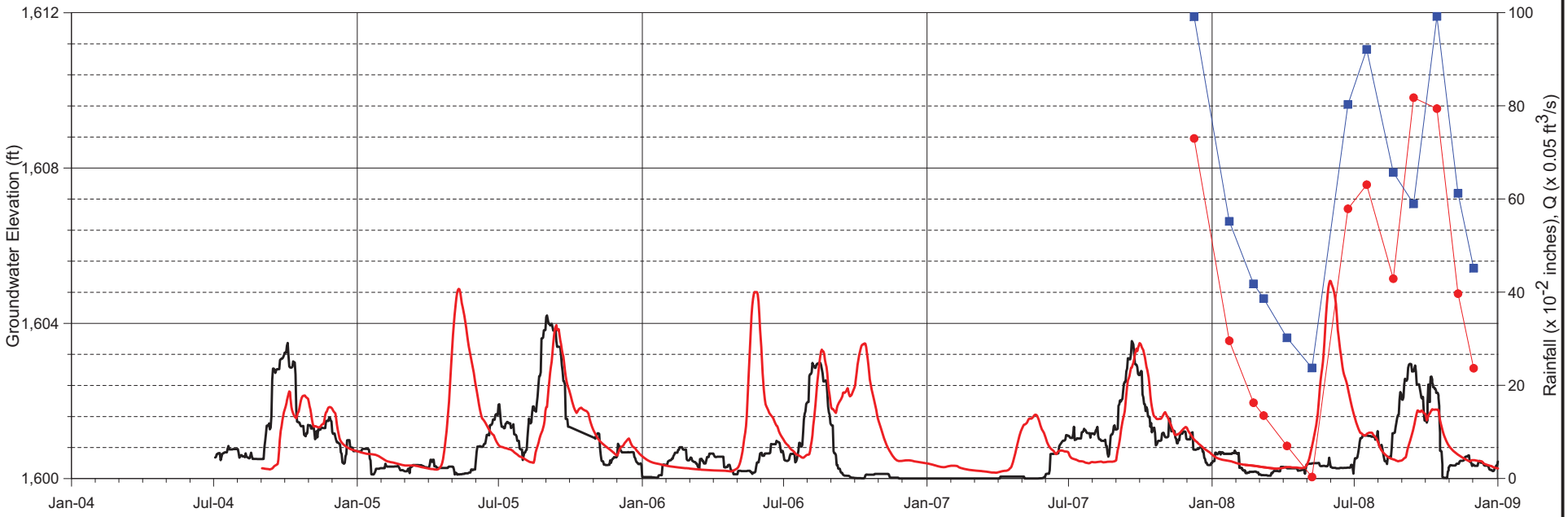


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-51



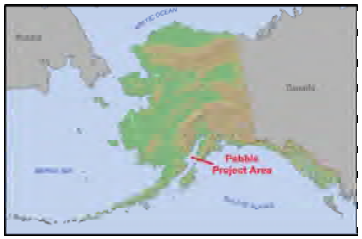
LEGEND:

Groundwater Elevation Plot Legend

- P-07-51S
- P-07-51D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

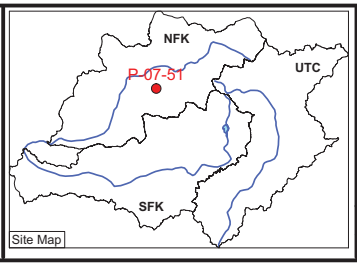
Screens (ft asl):
P-07-51S : 1594.3 - 1604.3
P-07-51D : 1568.0 - 1578.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1614.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-51.grf

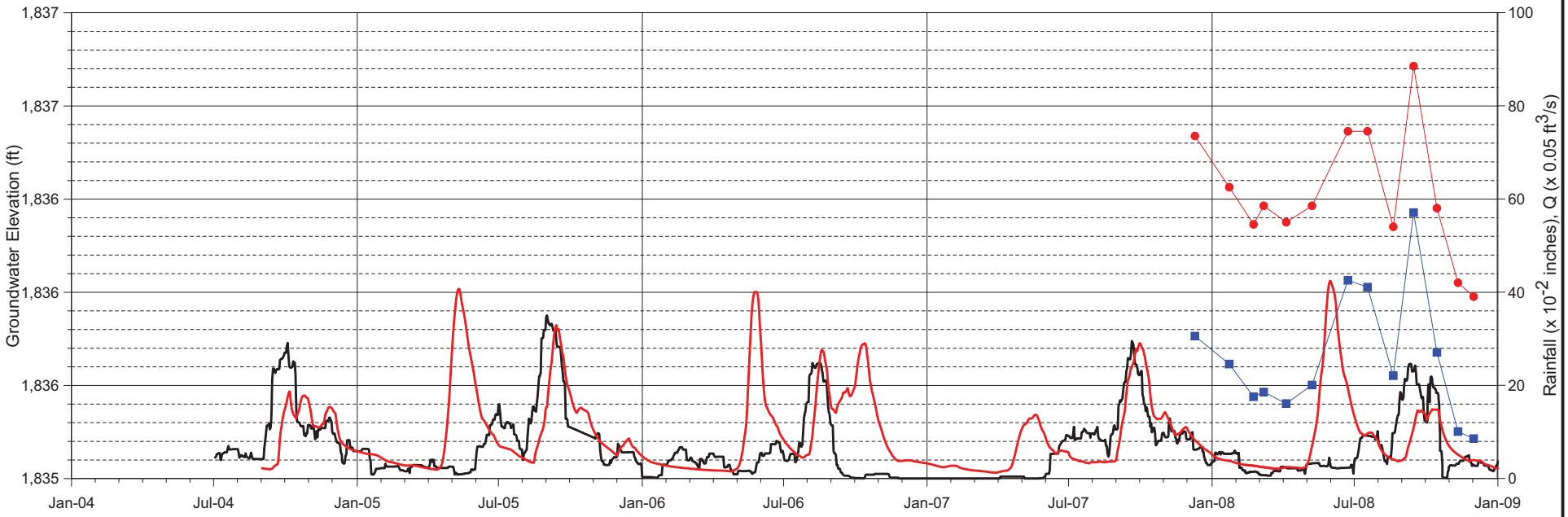


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-52



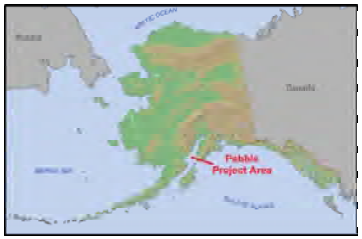
LEGEND:

Groundwater Elevation Plot Legend

- P-07-52S
- P-07-52D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

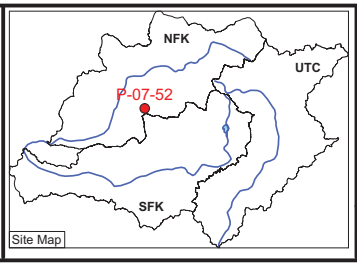
Screens (ft asl):
P-07-52S : 1824.7 - 1834.7
P-07-52D : 1793.4 - 1803.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1852.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-52.grf

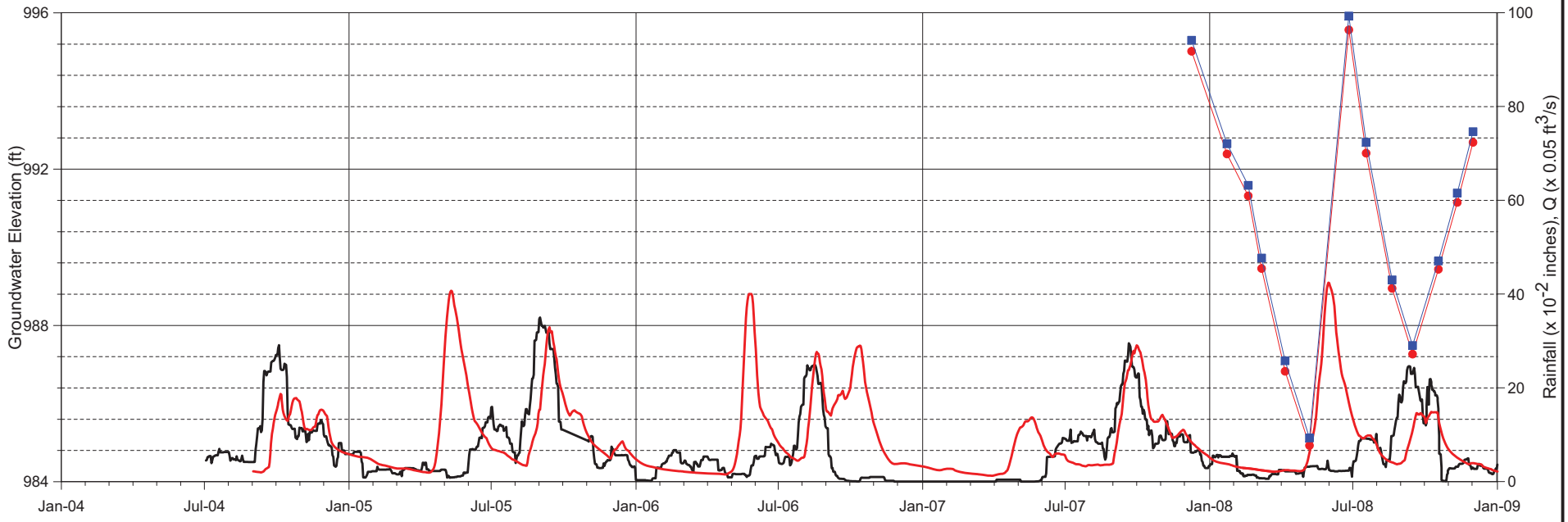


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-07-53



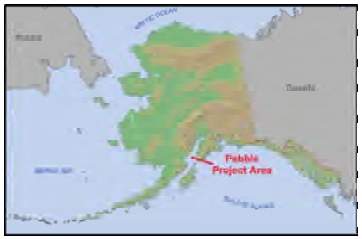
LEGEND:

Groundwater Elevation Plot Legend

- P-07-53S
- P-07-53D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

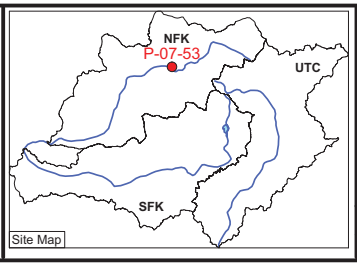
Screens (ft asl):
P-07-53S : 981.0 - 991.0
P-07-53D : 890.6 - 900.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1053.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-07-53.grf

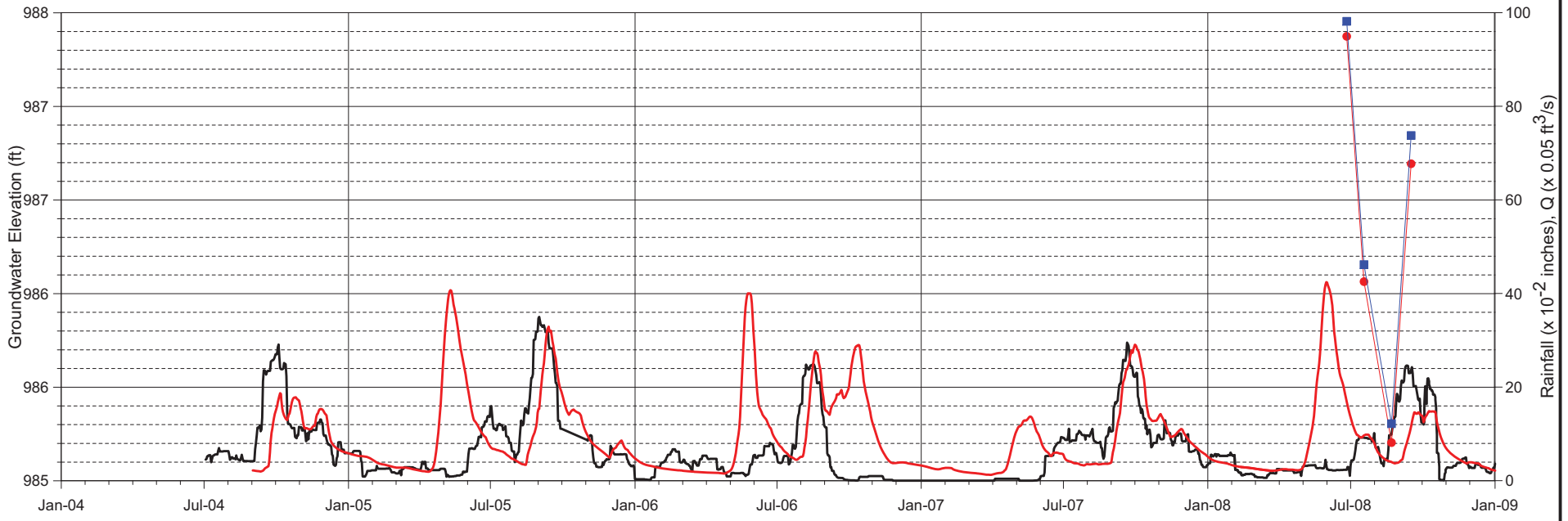


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-55



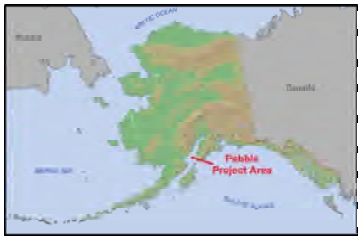
LEGEND:

Groundwater Elevation Plot Legend

- P-08-55S
- P-08-55D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

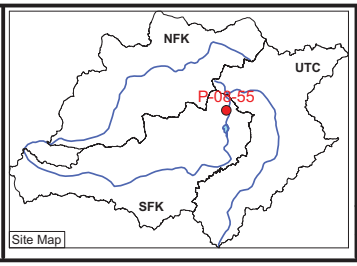
Screens (ft asl):
P-08-55S : 920.7 - 940.4
P-08-55D : 870.6 - 880.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 985.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-55.grf

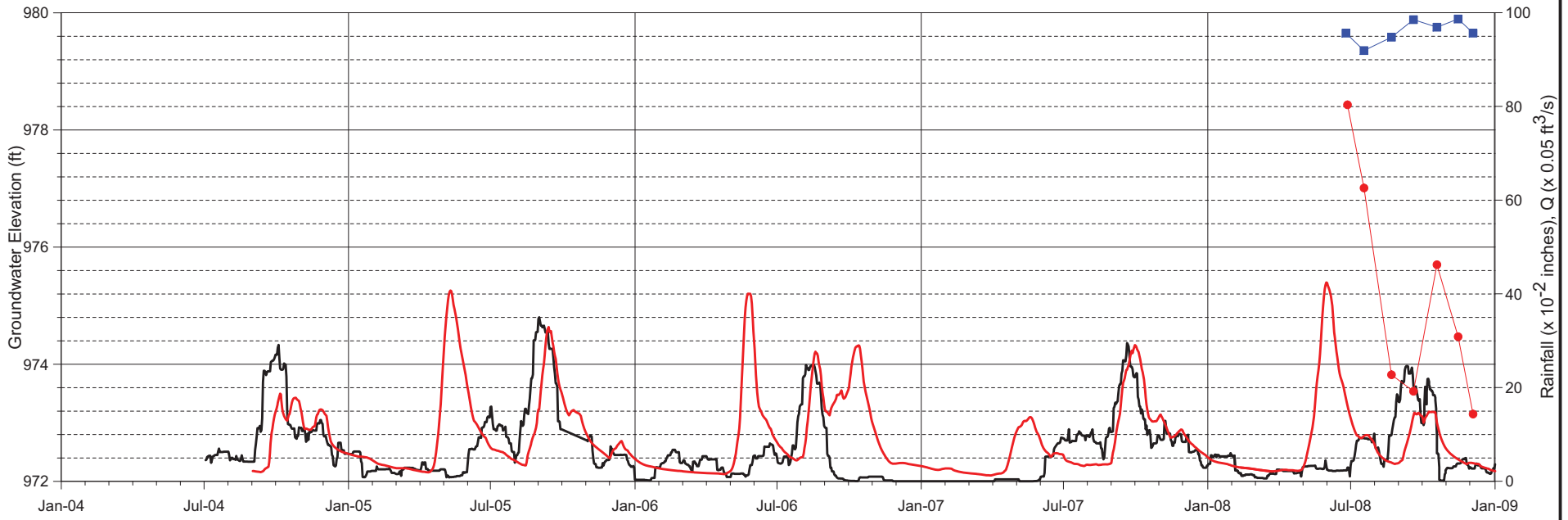


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-56



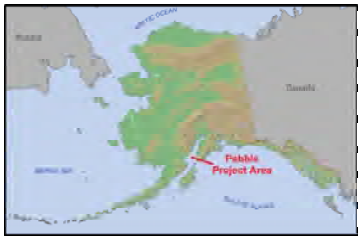
LEGEND:

Groundwater Elevation Plot Legend

- P-08-56S
- P-08-56M
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

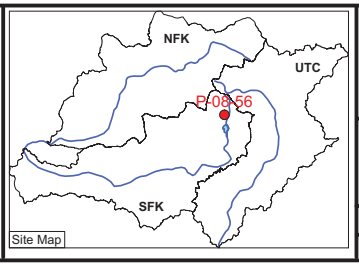
Screens (ft asl):
P-08-56S : 963.3 - 968.3
P-08-56M : 885.7 - 895.7
P-08-56D : 843.4 - 853.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 983.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-56.grf

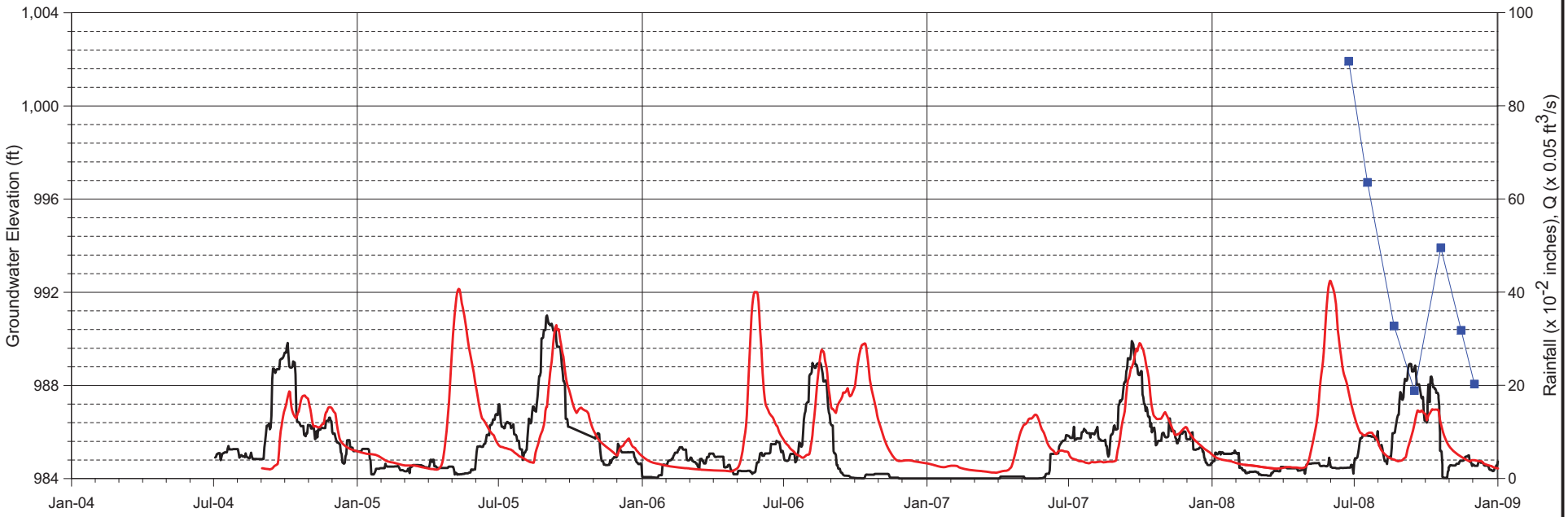


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-57D



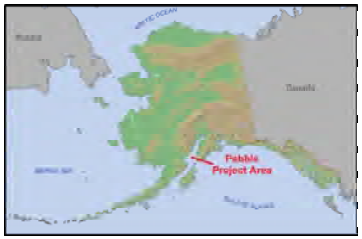
LEGEND:

Groundwater Elevation Plot Legend

- P-08-57D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

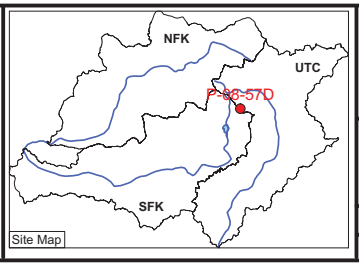
Screens (ft asl):
P-08-57D : 787.5 - 797.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1029.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-57D.grf

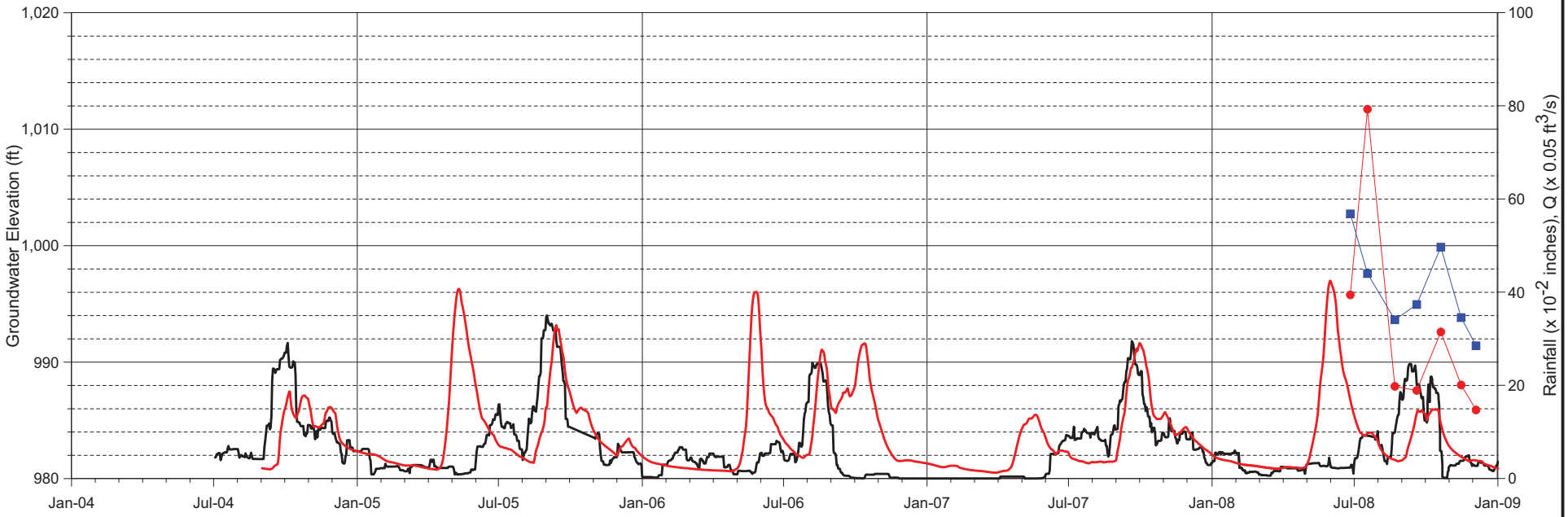


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-58



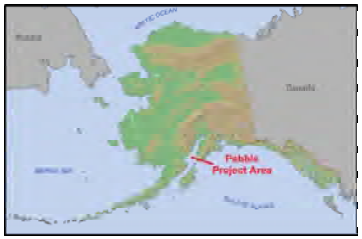
LEGEND:

Groundwater Elevation Plot Legend

- P-08-58M
- P-08-58D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

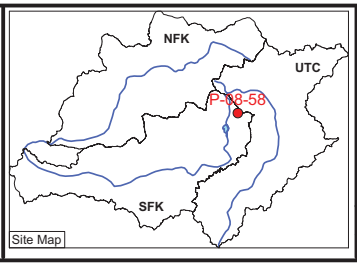
Screens (ft asl):
P-08-58M : 964.2 - 974.0
P-08-58D : 906.4 - 916.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1009.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-58.grf

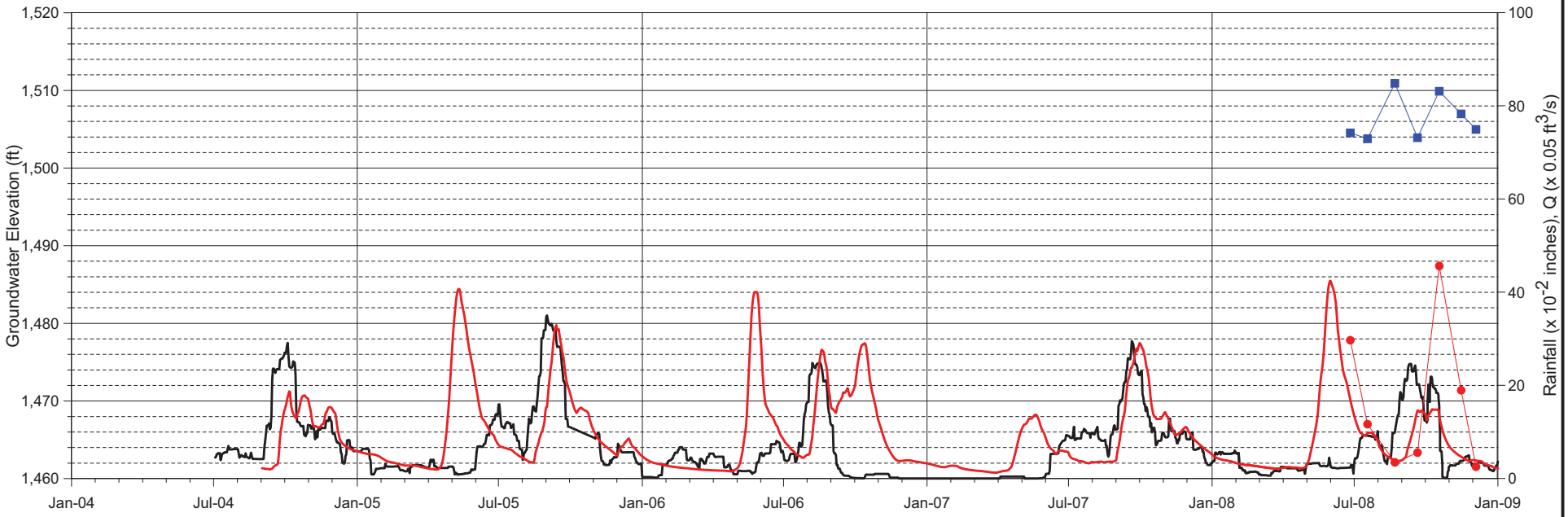


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-59



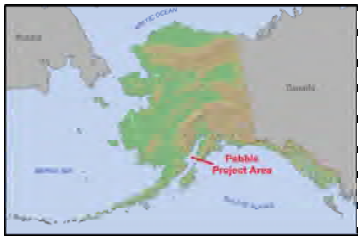
LEGEND:

Groundwater Elevation Plot Legend

- P-08-59S
- P-08-59D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

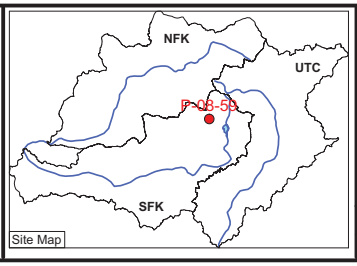
Screens (ft asl):
P-08-59S : 1484.4 - 1488.4
P-08-59D : 1429.4 - 1449.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1529.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-59.grf

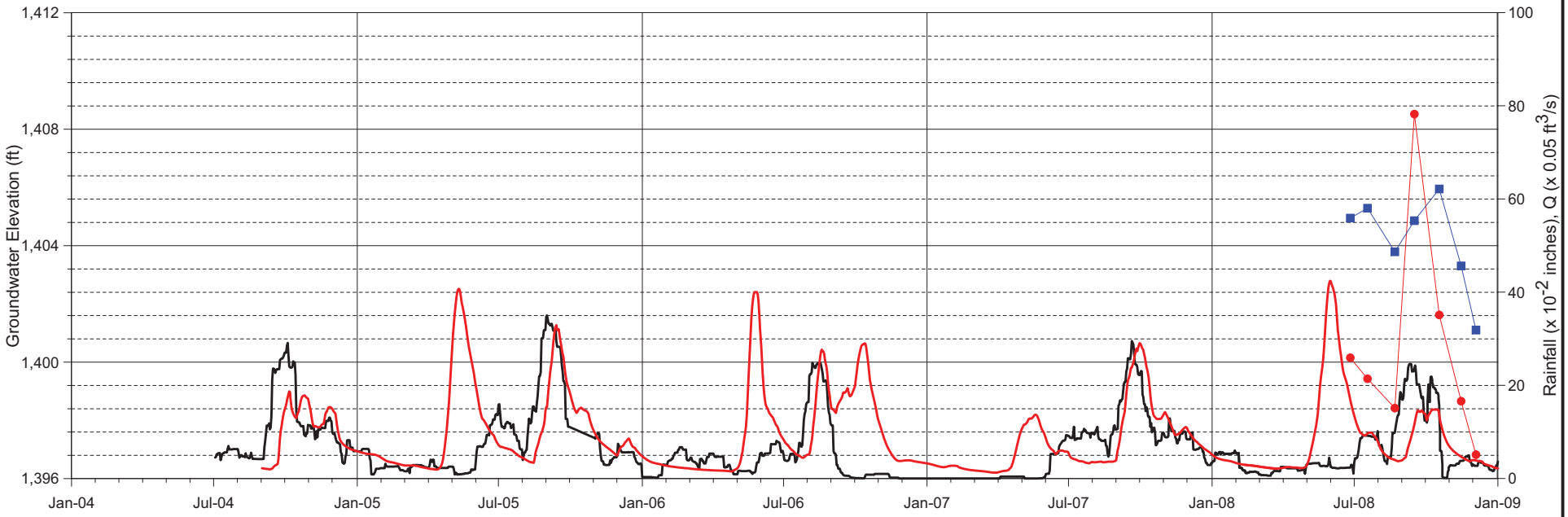


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-60



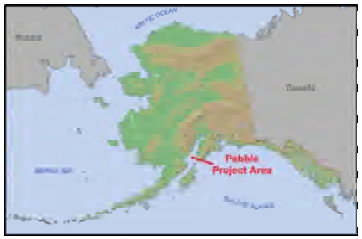
LEGEND:

Groundwater Elevation Plot Legend

- P-08-60S
- P-08-60D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

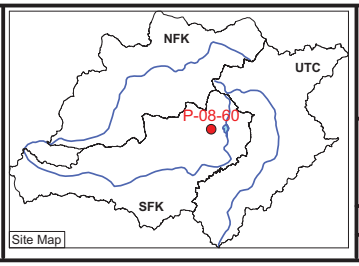
Screens (ft asl):
P-08-60S : 1379.7 - 1385.7
P-08-60D : 1331.1 - 1350.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1409.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-60.grf

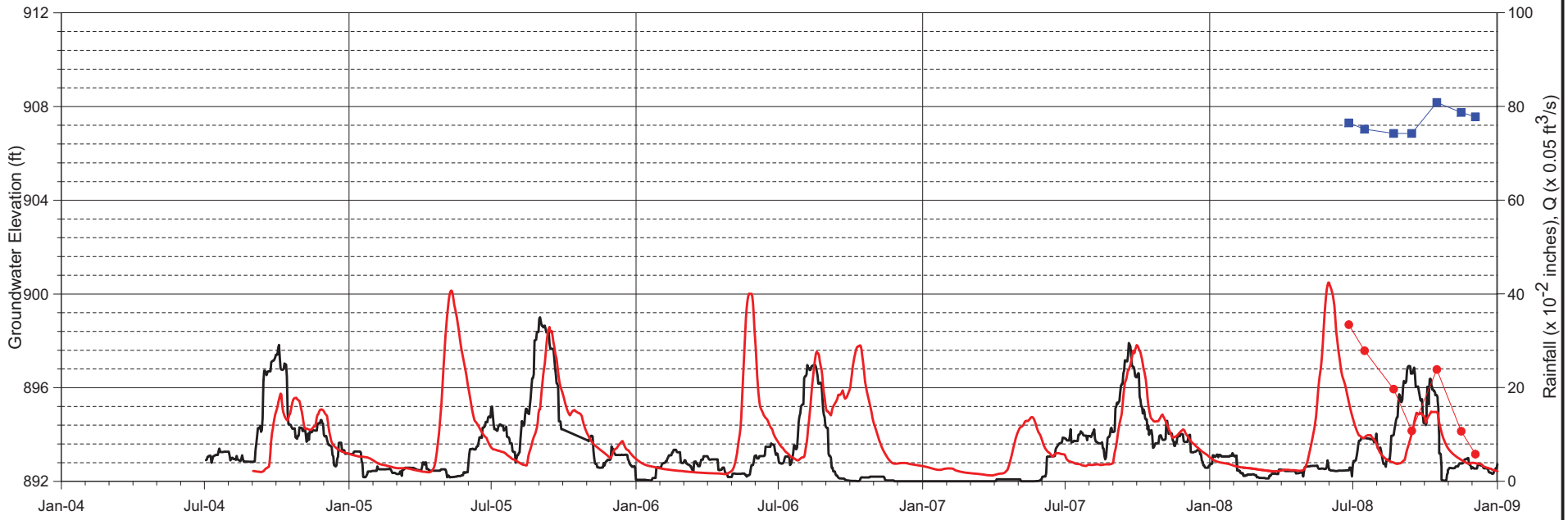


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-61



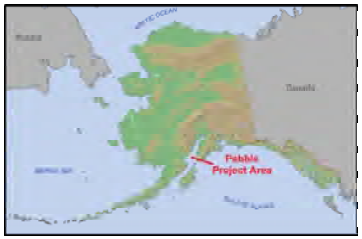
LEGEND:

Groundwater Elevation Plot Legend

- P-08-61S
- P-08-61D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

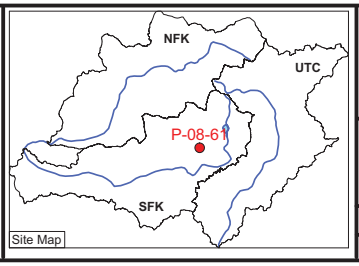
Screens (ft asl):
P-08-61S : 903.2 - 923.2
P-08-61D : 883.8 - 893.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 974.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-61.grf

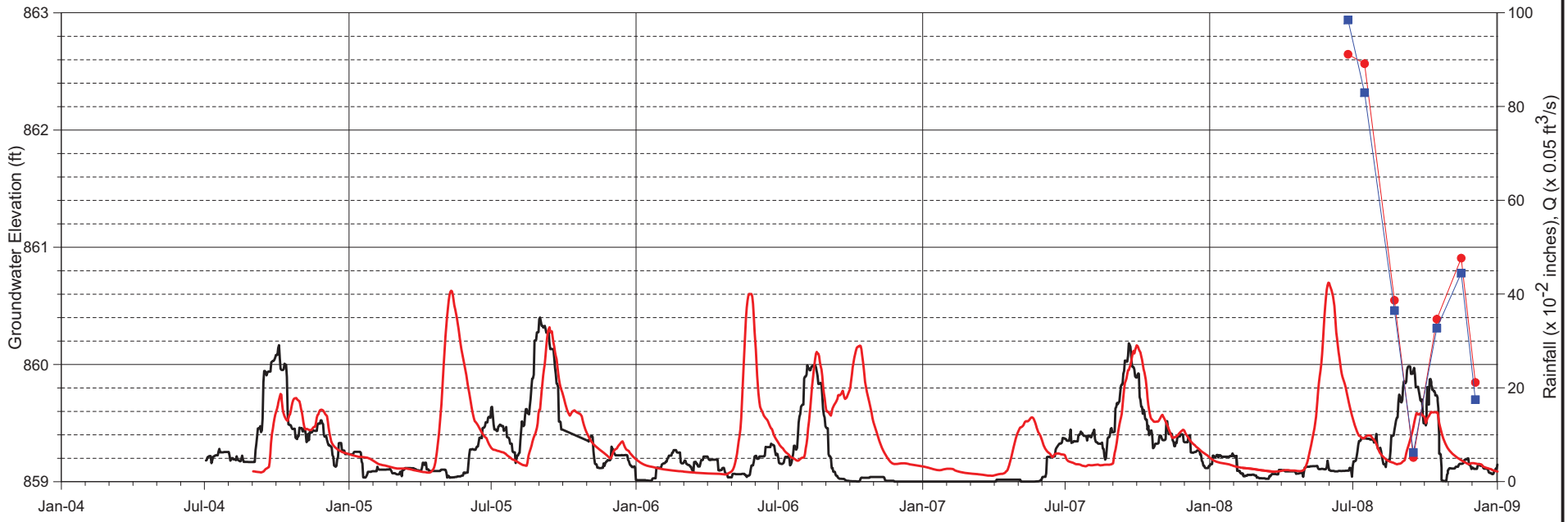


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-62



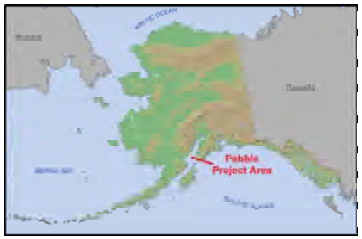
LEGEND:

Groundwater Elevation Plot Legend

- P-08-62M
- P-08-62D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

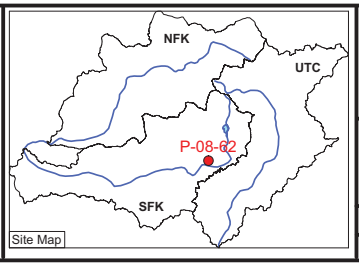
Screens (ft asl):
P-08-62S : 872.4 - 882.2
P-08-62M : 814.7 - 824.5
P-08-62D : 585.3 - 594.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 891.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-62.grf

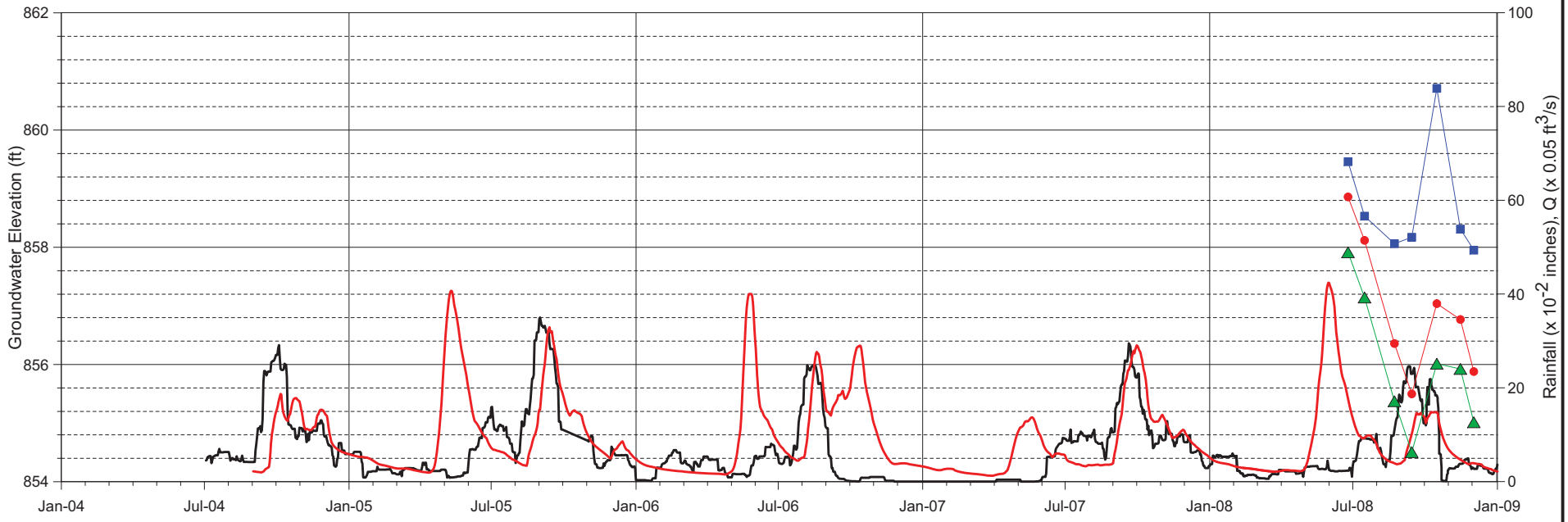


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-63



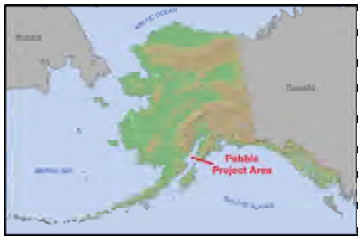
LEGEND:

Groundwater Elevation Plot Legend

- P-08-63S
- P-08-63M
- P-08-63D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

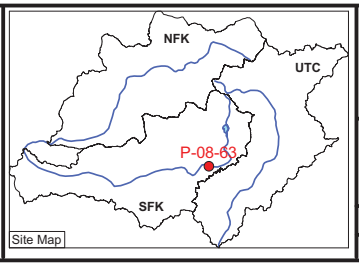
Screens (ft asl):
P-08-63S : 834.9 - 844.8
P-08-63M : 797.9 - 807.7
P-08-63D : 754.5 - 774.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 879.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-63.grf

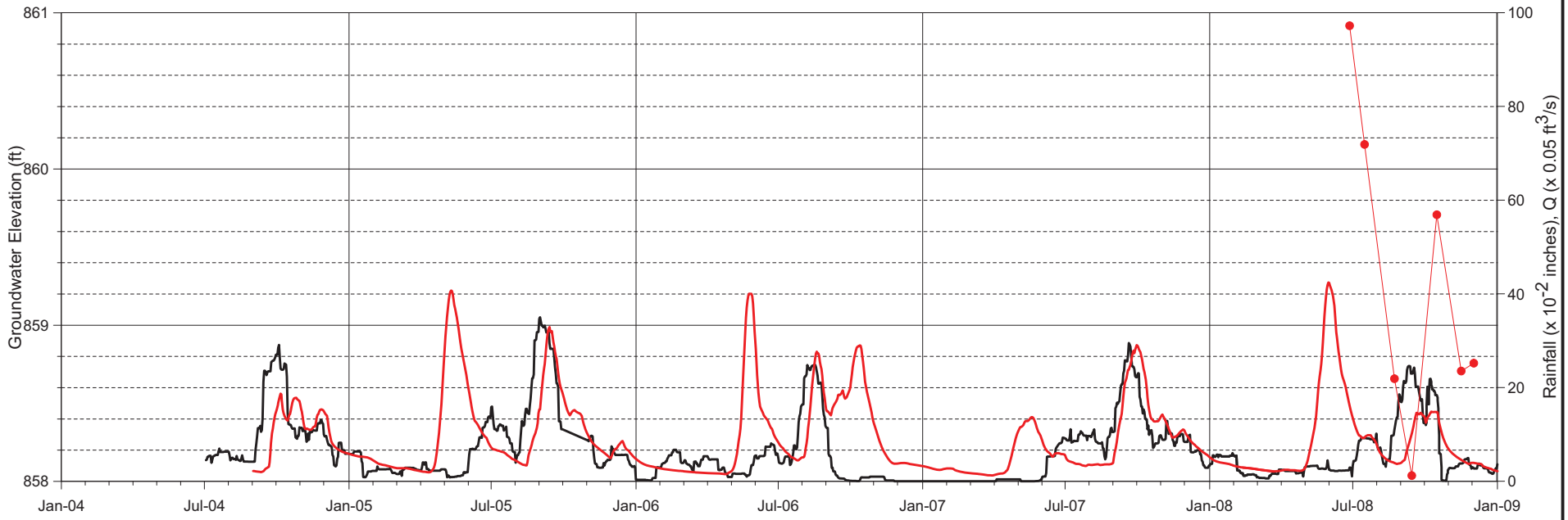


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-64



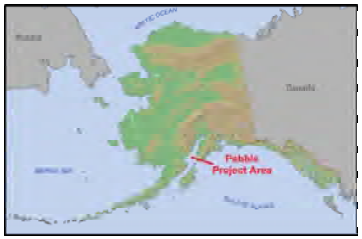
LEGEND:

Groundwater Elevation Plot Legend

- P-08-64S
- P-08-64D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

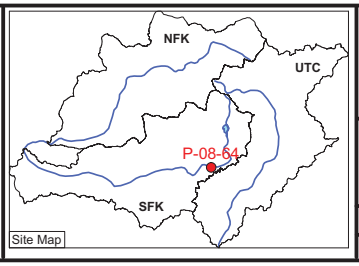
Screens (ft asl):
P-08-64S : 861.0 - 870.8
P-08-64D : 830.3 - 840.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 889 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-64.grf

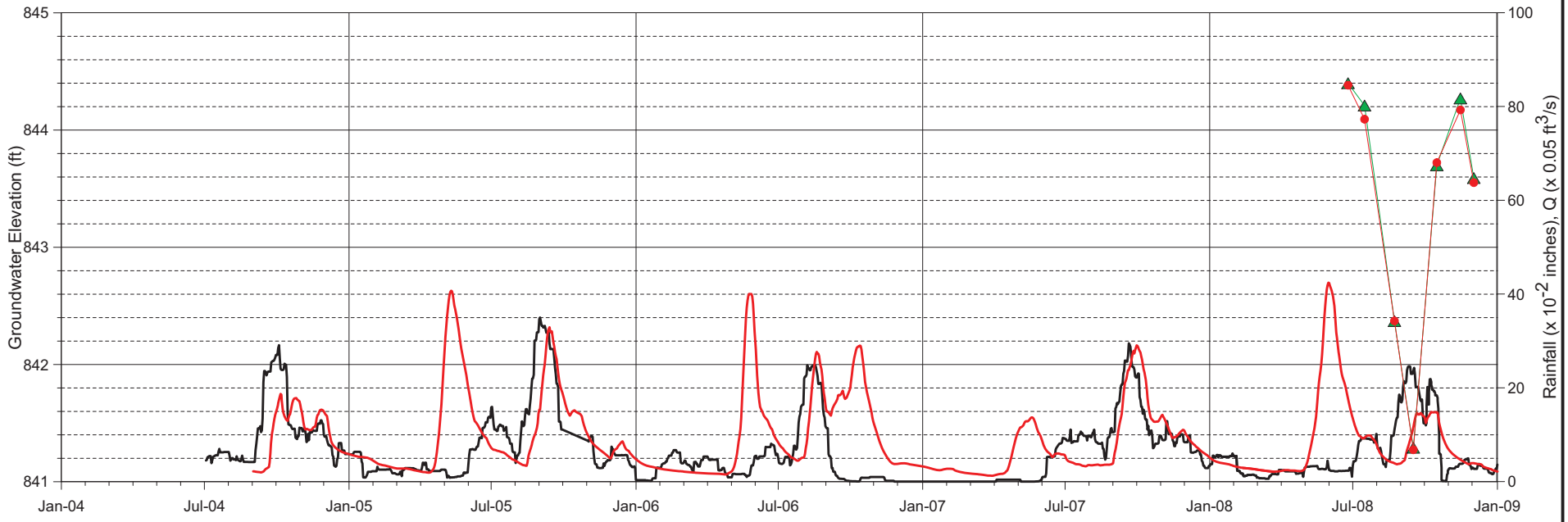


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-65



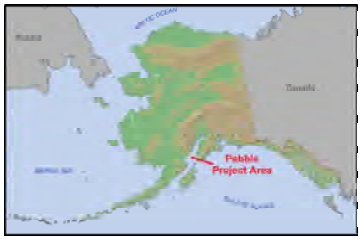
LEGEND:

Groundwater Elevation Plot Legend

- P-08-65S
- P-08-65M
- P-08-65D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

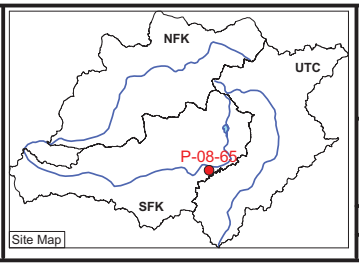
Screens (ft asl):
P-08-65S : 856.4 - 866.2
P-08-65M : 747.2 - 757.2
P-08-65D : 710.3 - 720.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 893.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-65.grf

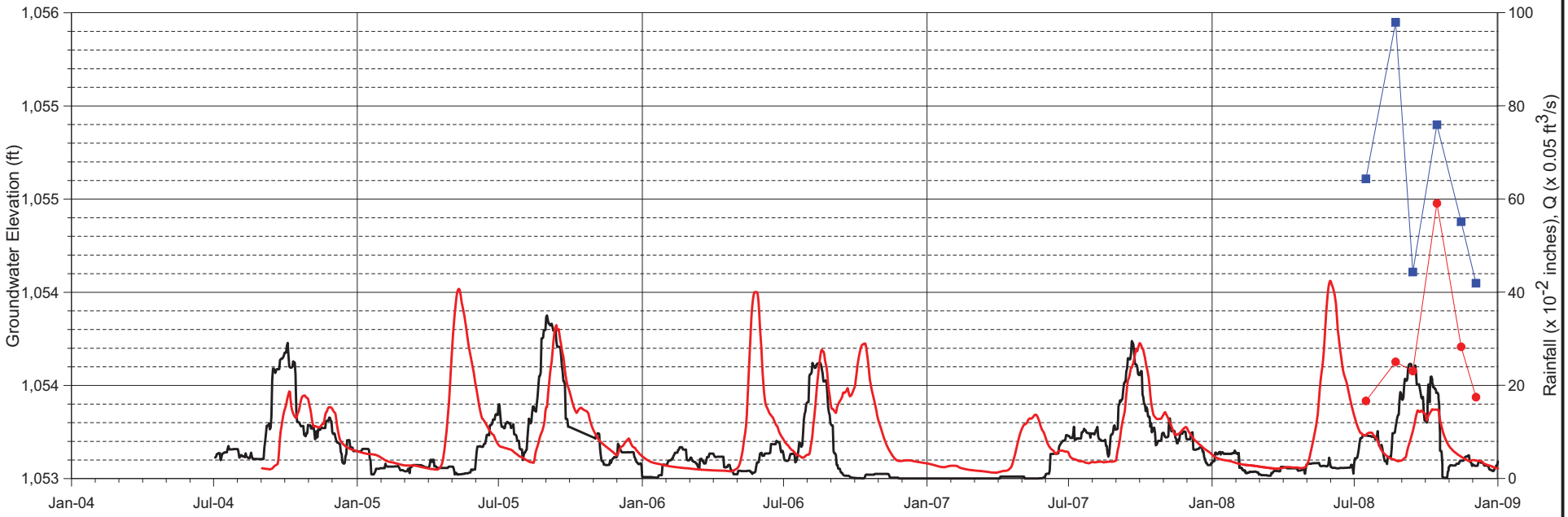


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-66



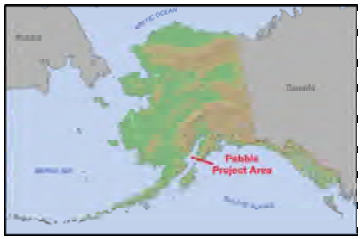
LEGEND:

Groundwater Elevation Plot Legend

- P-08-66S
- P-08-66D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

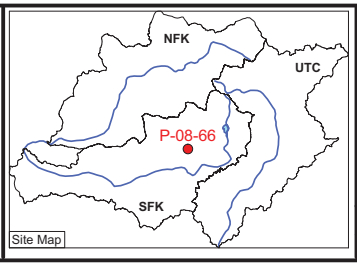
Screens (ft asl):
P-08-66S : 1051.1 - 1056.1
P-08-66D : 1022.4 - 1032.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1079.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-66.grf

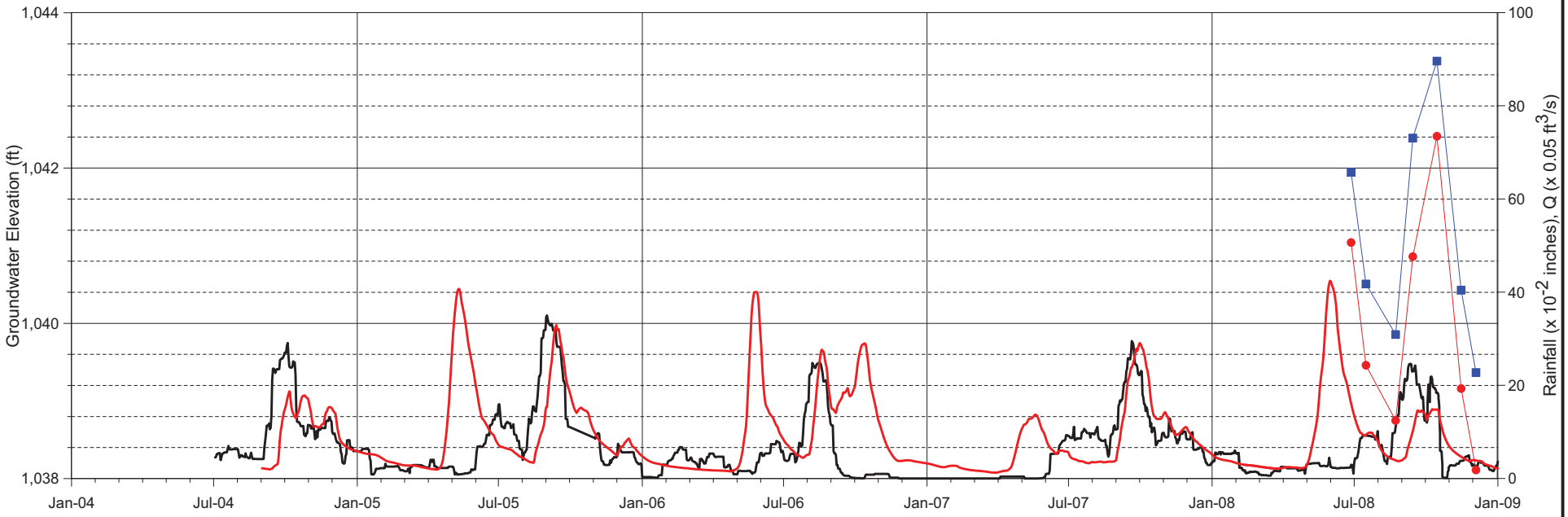


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-67



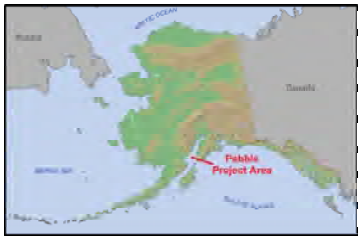
LEGEND:

Groundwater Elevation Plot Legend

- P-08-67S
- P-08-67D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

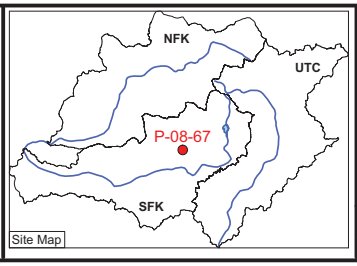
Screens (ft asl):
P-08-67S : 1026.6 - 1036.6
P-08-67D : 997.6 - 1007.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1054 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-67.grf

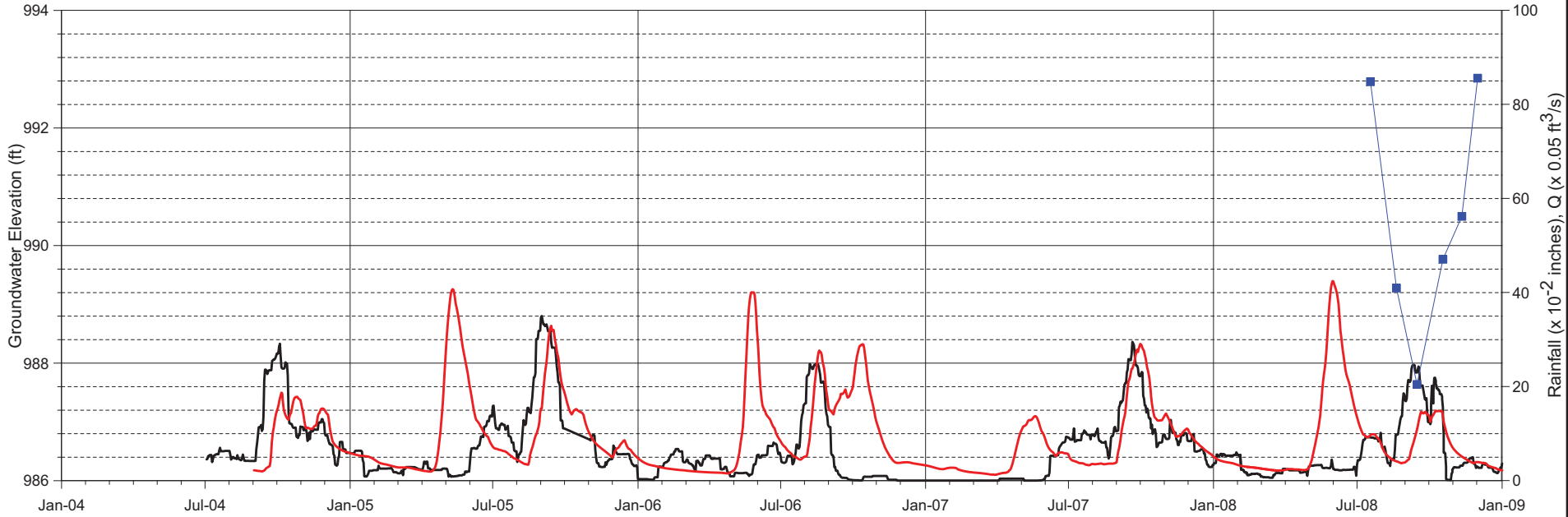


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-68D



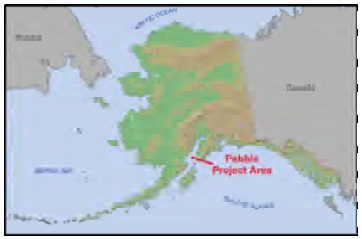
LEGEND:

Groundwater Elevation Plot Legend

- P-08-68D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

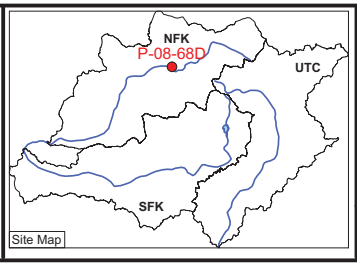
Screens (ft asl):
P-08-68D : 969.5 - 979.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1053.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-68D.grf

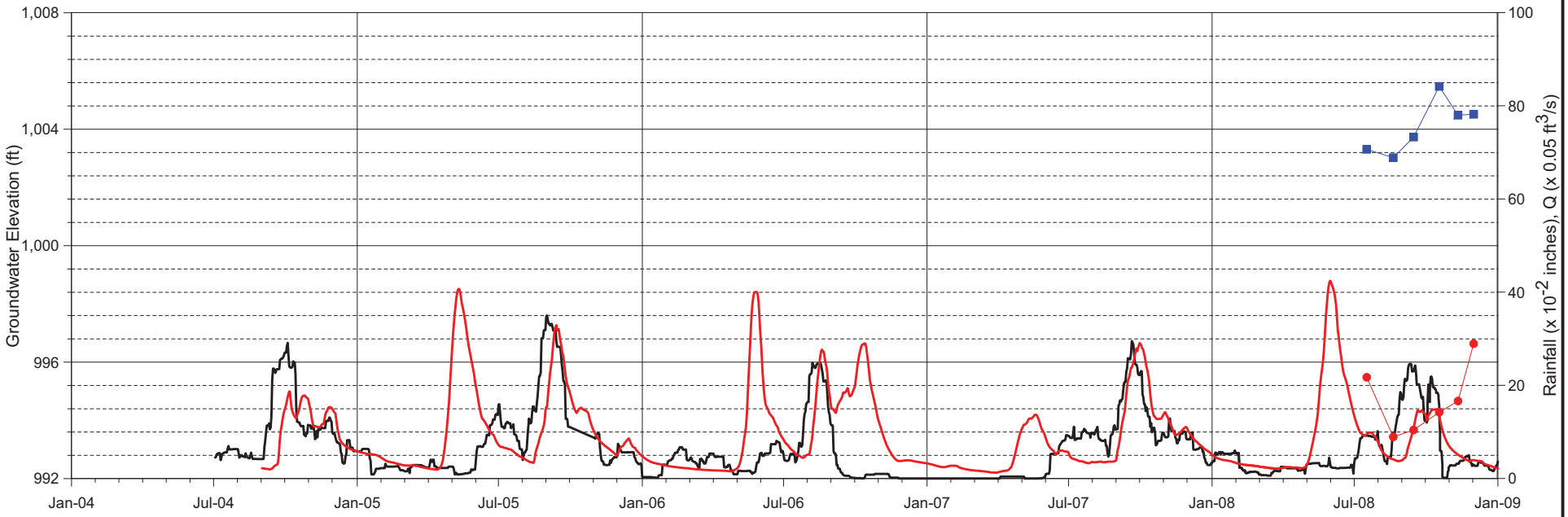


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-69



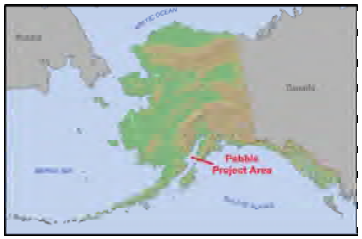
LEGEND:

Groundwater Elevation Plot Legend

- P-08-69S
- P-08-69D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

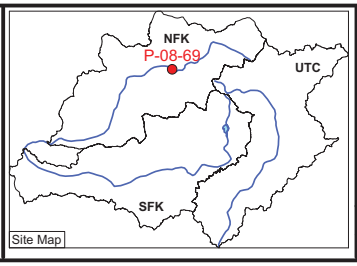
Screens (ft asl):
P-08-69S : 1001.7 - 1005.7
P-08-69D : 965.3 - 975.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1021.5 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-69.grf

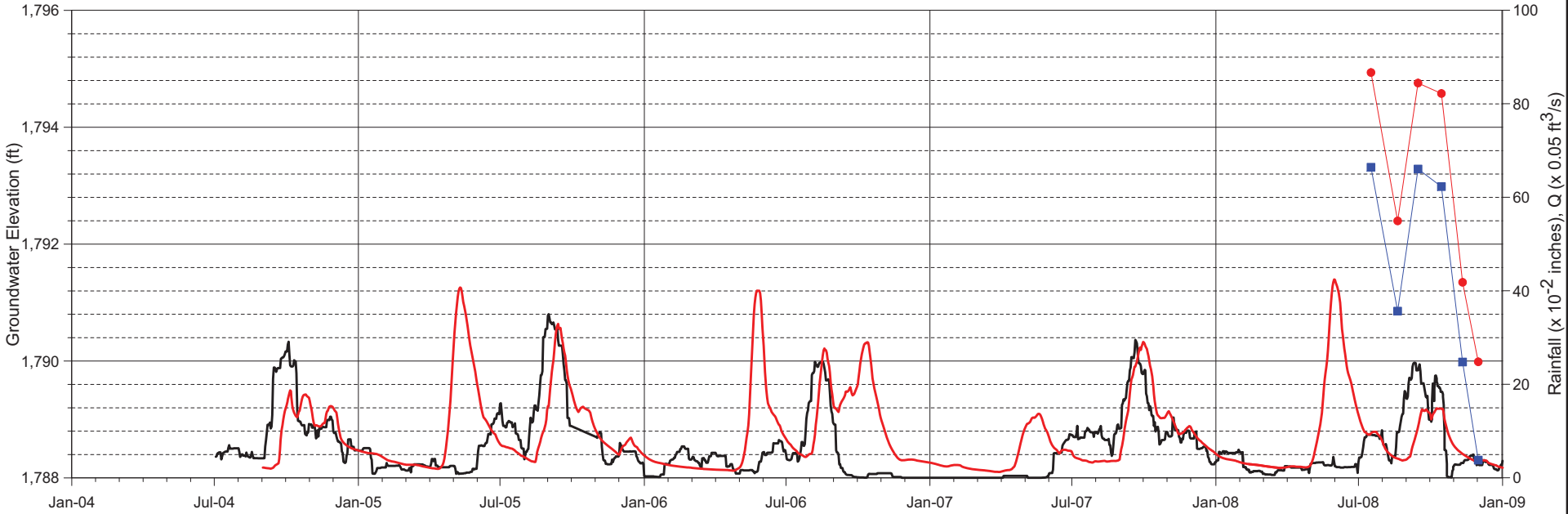


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-70



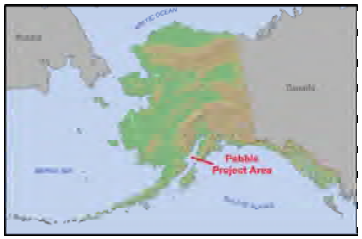
LEGEND:

Groundwater Elevation Plot Legend

- P-08-70S
- P-08-70D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

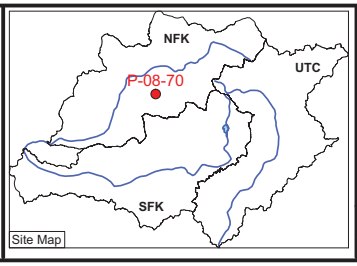
Screens (ft asl):
P-08-70S : 1774.6 - 1779.6
P-08-70D : 1741.9 - 1761.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1794.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-70.grf

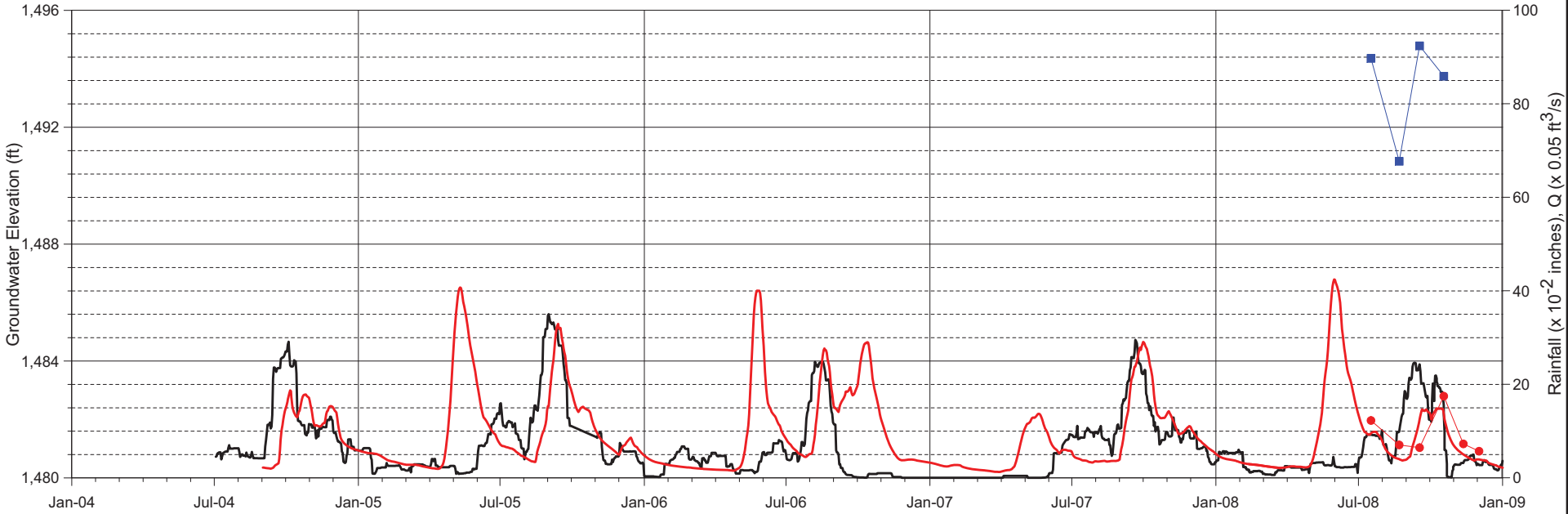


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-71



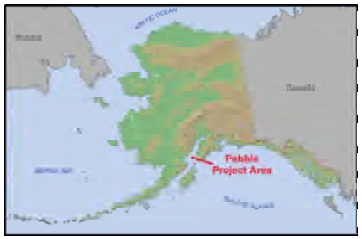
LEGEND:

Groundwater Elevation Plot Legend

- P-08-71S
- P-08-71D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

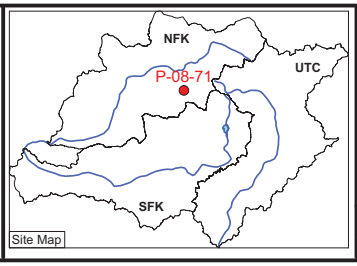
Screens (ft asl):
P-08-71S : 1490.6 - 1493.6
P-08-71D : 1466.1 - 1476.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1500.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-71.grf

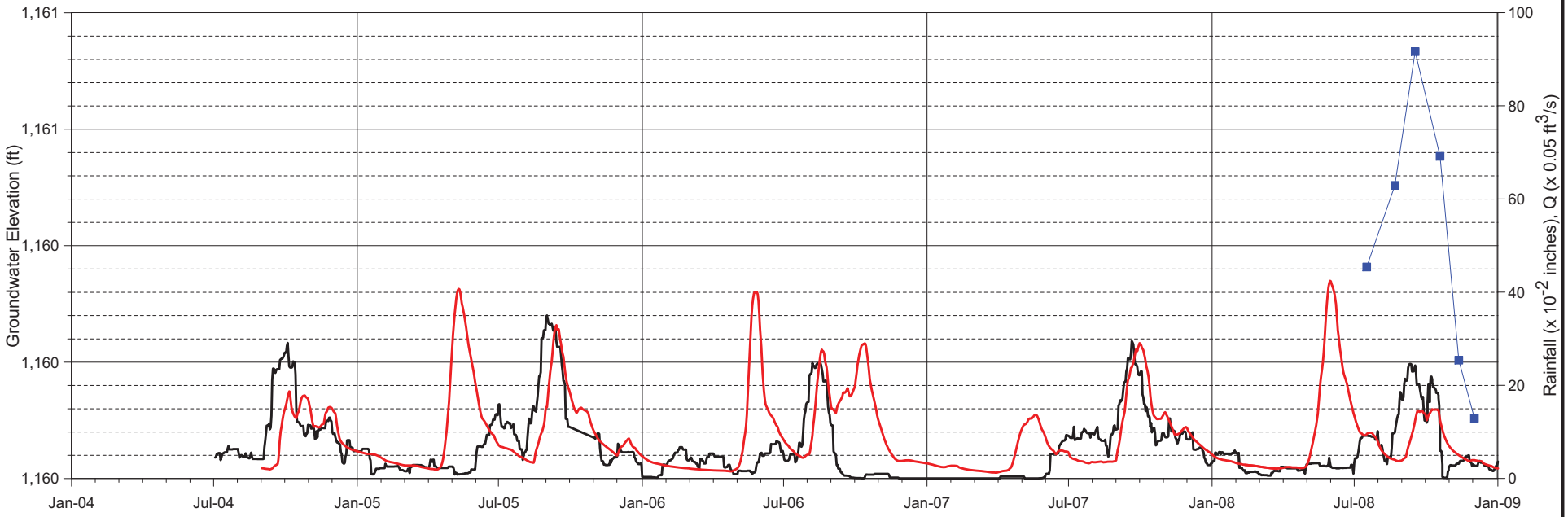


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-72



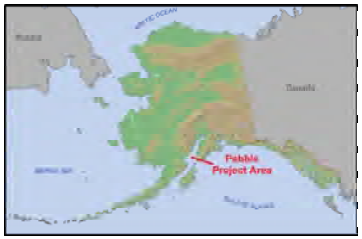
LEGEND:

Groundwater Elevation Plot Legend

- P-08-72D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

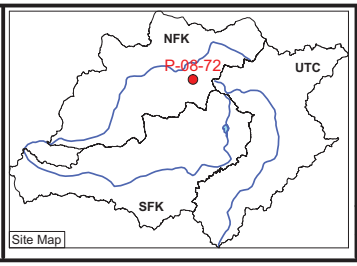
Screens (ft asl):
P-08-72S : 1172.6 - 1176.7
P-08-72D : 1139.6 - 1149.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1187.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-72.grf

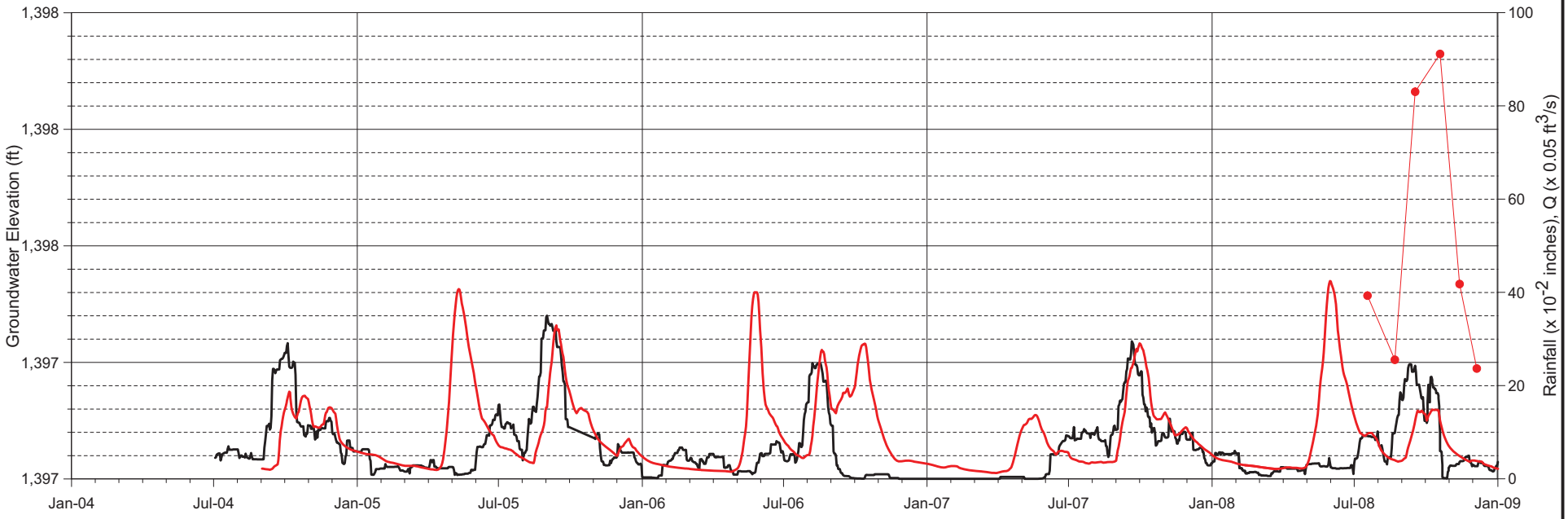


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-73



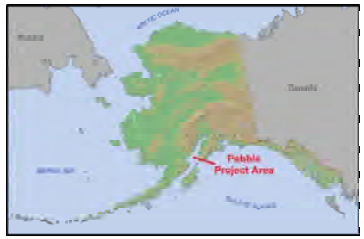
LEGEND:

Groundwater Elevation Plot Legend

- P-08-73S
- P-08-73D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

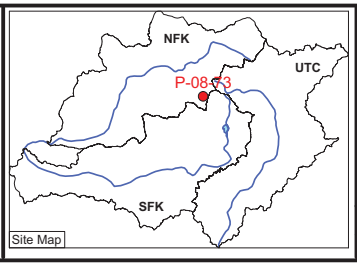
Screens (ft asl):
P-08-73S : 1357.5 - 1367.4
P-08-73D : 1293.1 - 1302.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1397 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-73.grf

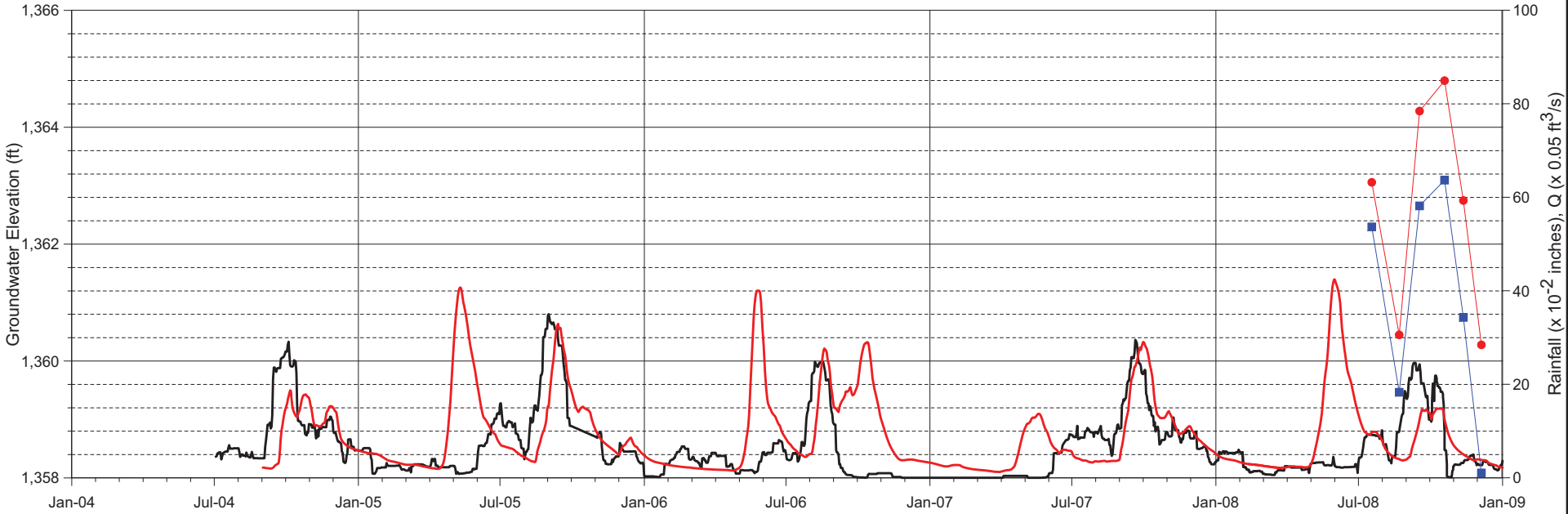


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-74



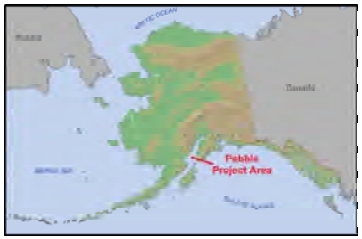
LEGEND:

Groundwater Elevation Plot Legend

- P-08-74S
- P-08-74D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

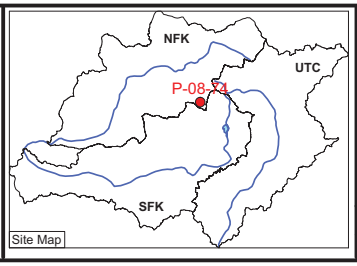
Screens (ft asl):
P-08-74S : 1317.8 - 1328.2
P-08-74D : 1283.4 - 1293.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1369.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-74.grf

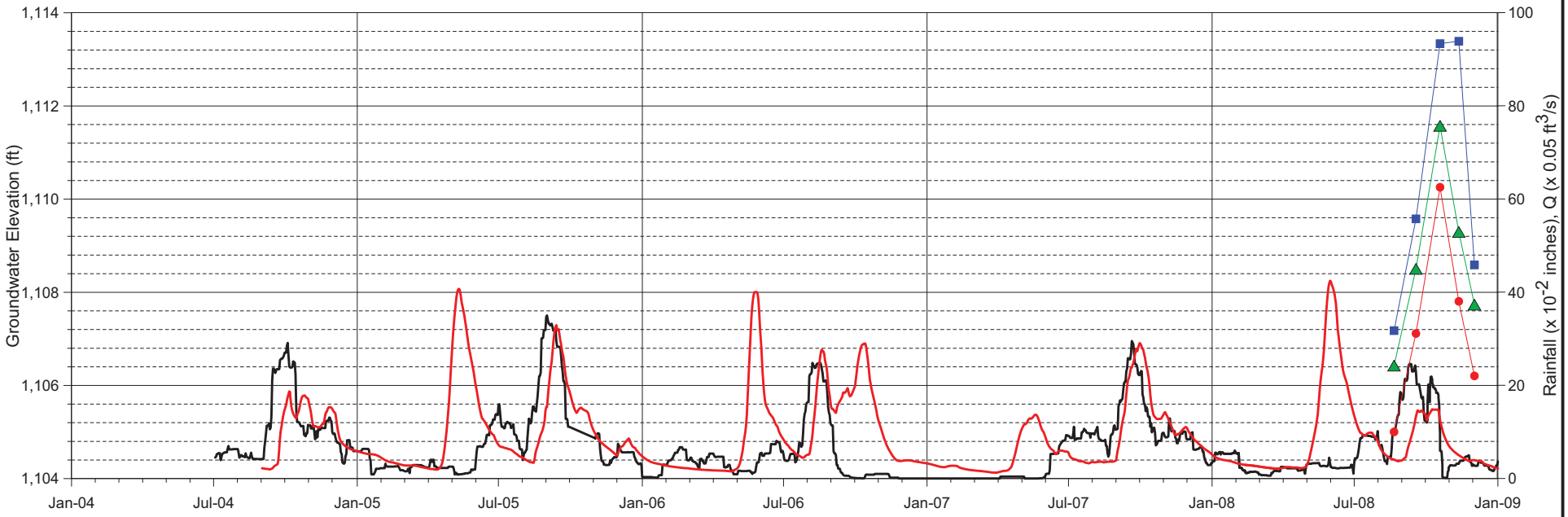


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-75



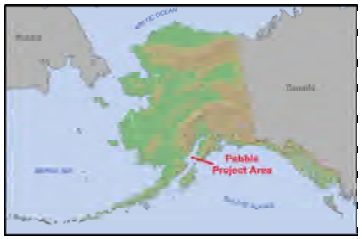
LEGEND:

Groundwater Elevation Plot Legend

- P-08-75S
- P-08-75M
- P-08-75D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

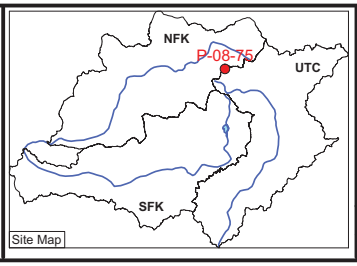
Screens (ft asl):
P-08-75S : 1081.0 - 1091.0
P-08-75M : 992.1 - 1011.7
P-08-75D : 948.9 - 958.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1122.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-75.grf

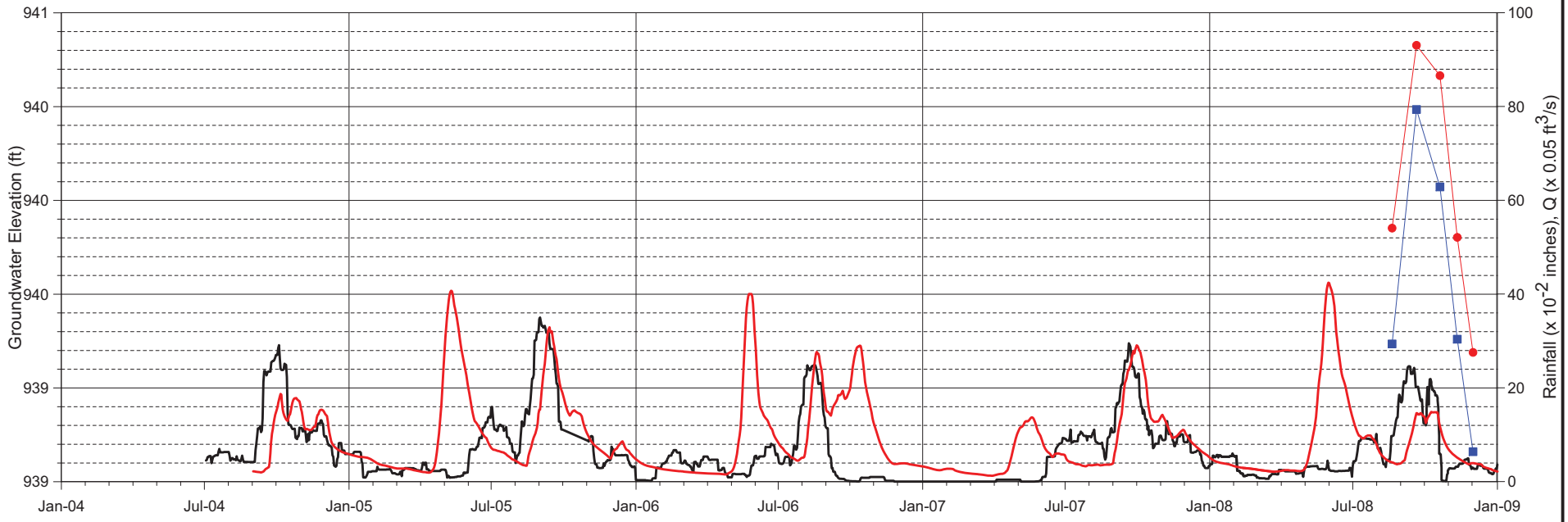


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-76



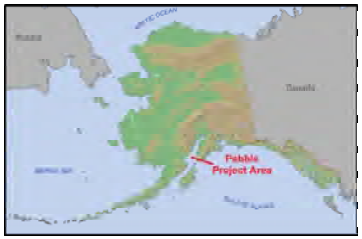
LEGEND:

Groundwater Elevation Plot Legend

- P-08-76S
- P-08-76D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

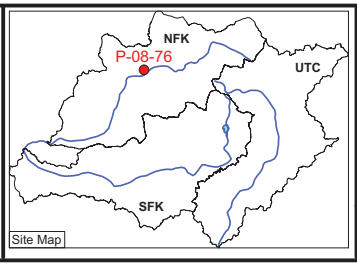
Screens (ft asl):
P-08-76S : 914.8 - 924.8
P-08-76D : 811.6 - 821.6



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 949.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-76.grf

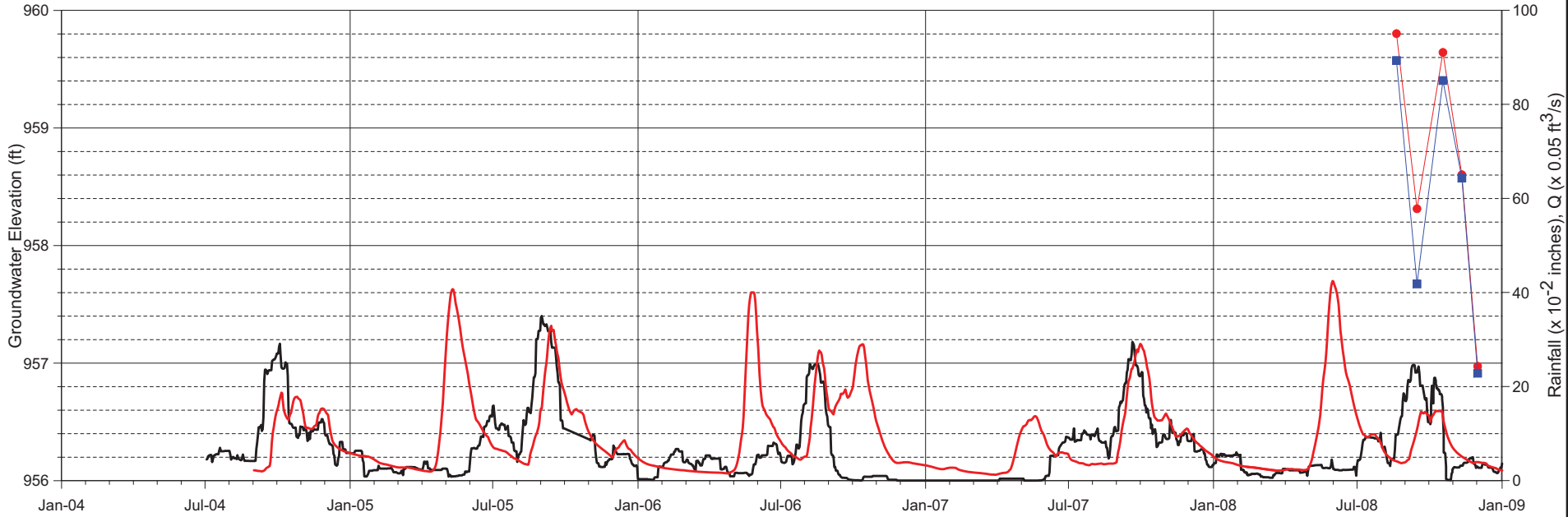


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-77



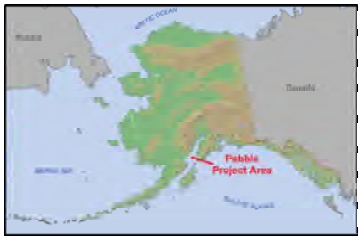
LEGEND:

Groundwater Elevation Plot Legend

- P-08-77S
- P-08-77D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

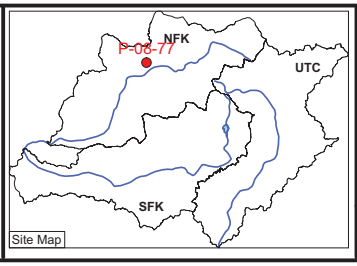
Screens (ft asl):
P-08-77S : 947.7 - 957.5
P-08-77D : 880.9 - 890.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 970.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-77.grf

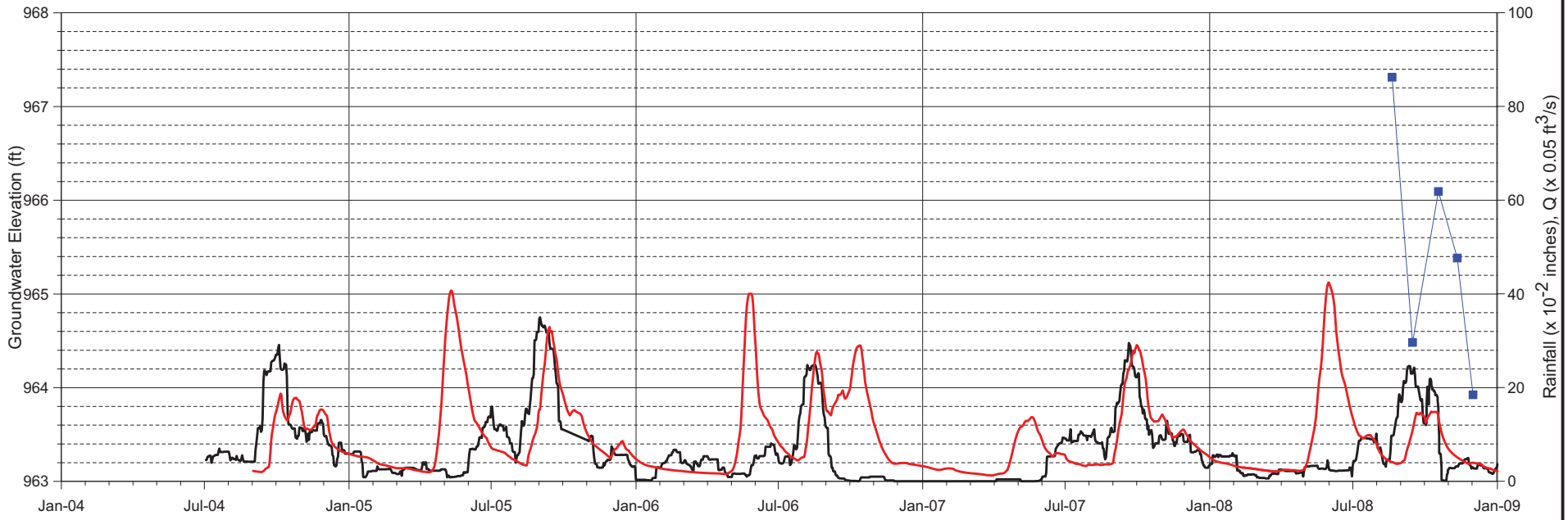


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-78



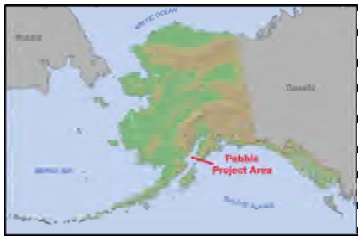
LEGEND:

Groundwater Elevation Plot Legend

- P-08-78D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

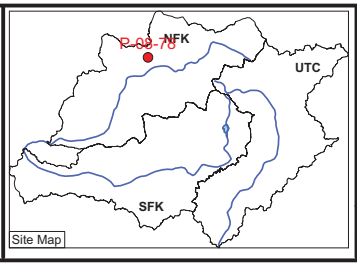
Screens (ft asl):
P-08-78S : 975.2 - 985.2
P-08-78D : 915.7 - 925.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1008.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-78.grf

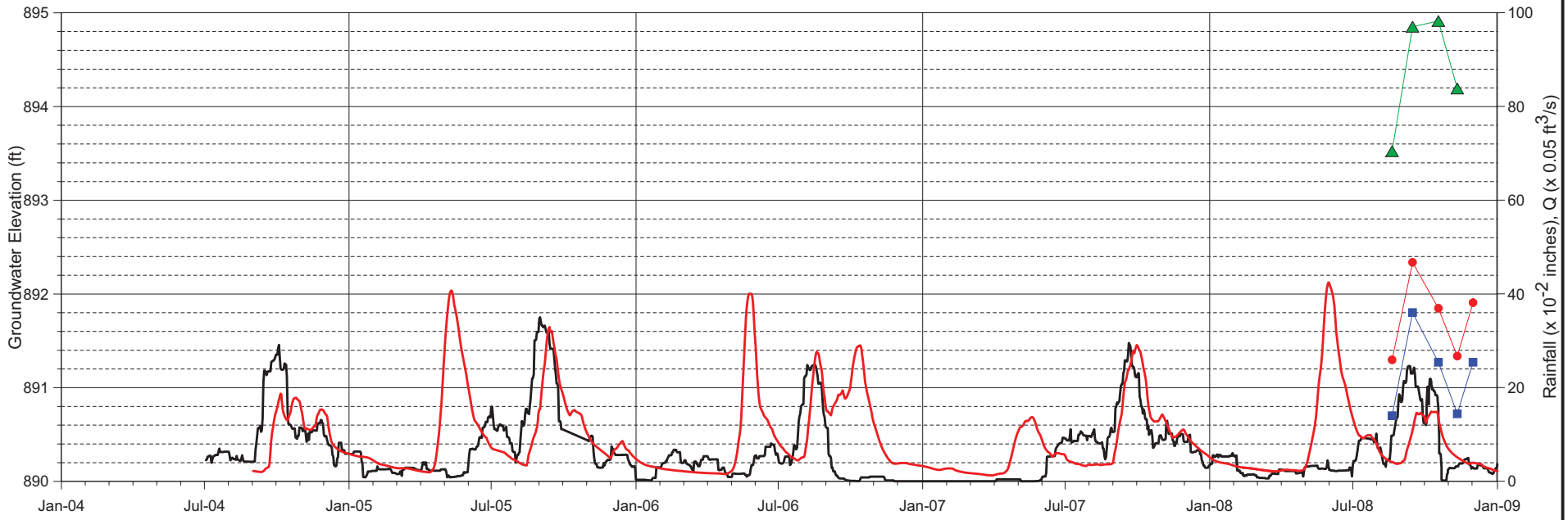


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-79



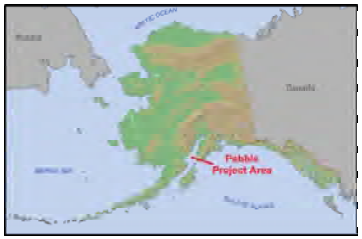
LEGEND:

Groundwater Elevation Plot Legend

- P-08-79S
- P-08-79M
- P-08-79D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

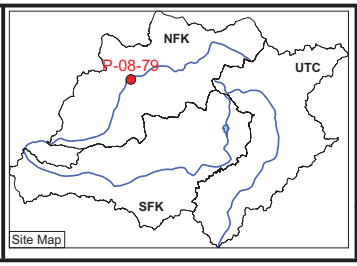
Screens (ft asl):
P-08-79S : 880.0 - 885.0
P-08-79M : 826.3 - 836.1
P-08-79D : 746.0 - 756.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 896 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-79.grf

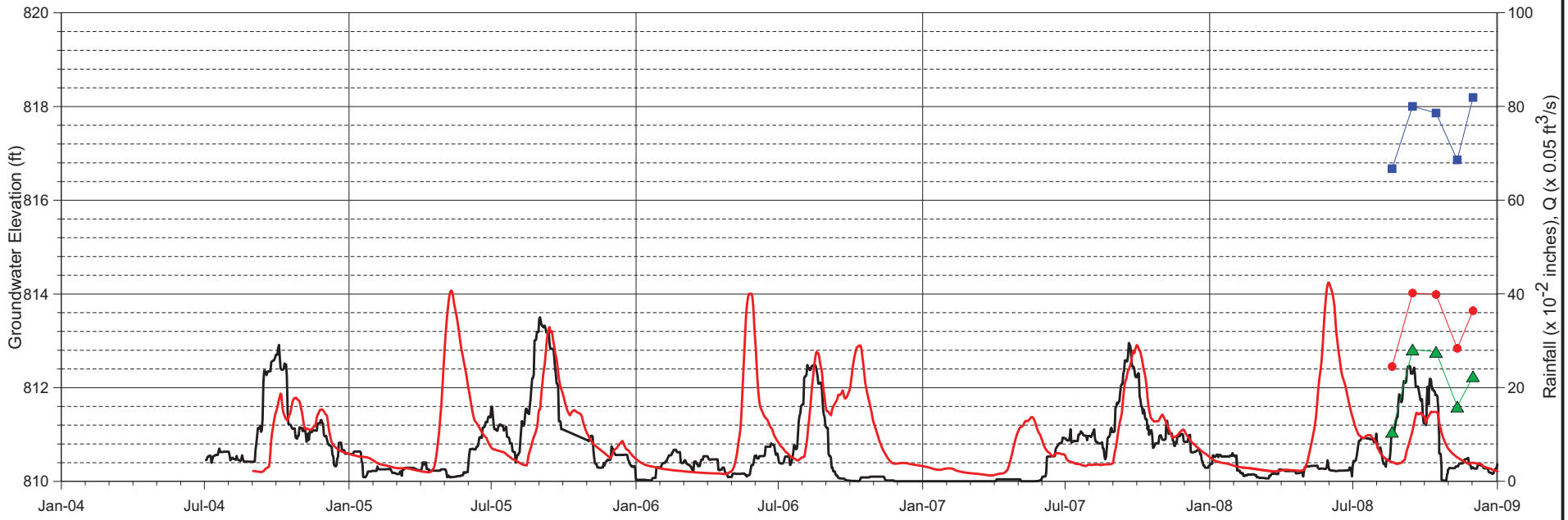


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-80



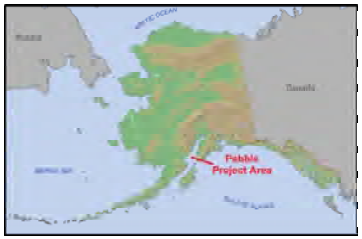
LEGEND:

Groundwater Elevation Plot Legend

- P-08-80S
- P-08-80M
- P-08-80D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

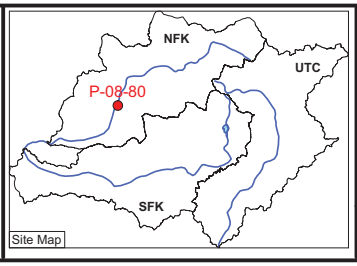
Screens (ft asl):
P-08-80S : 809.8 - 814.1
P-08-80M : 763.5 - 773.3
P-08-80D : 698.8 - 708.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 826.7 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-80.grf

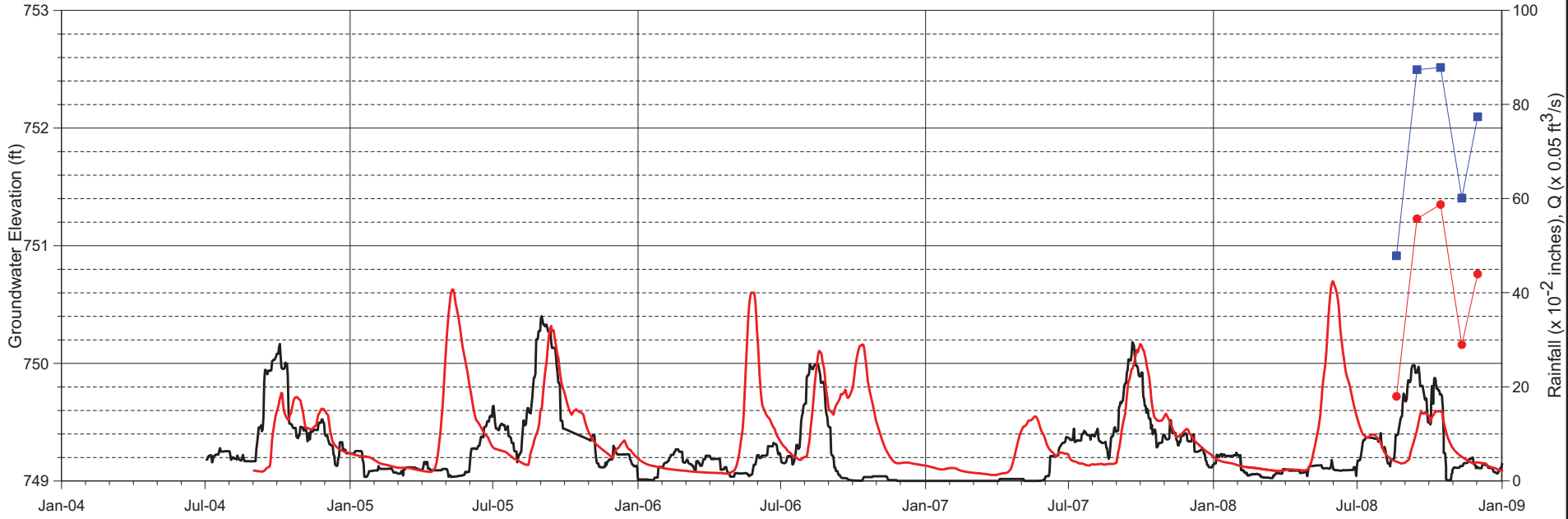


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-81



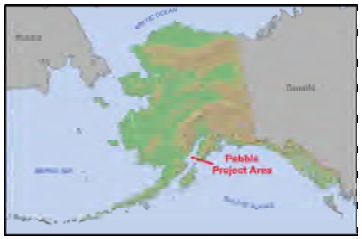
LEGEND:

Groundwater Elevation Plot Legend

- P-08-81S
- P-08-81D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

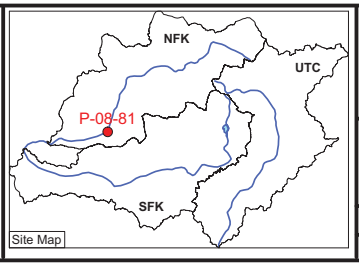
Screens (ft asl):
P-08-81S : 743.3 - 748.3
P-08-81D : 704.5 - 714.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 759.3 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-81.grf

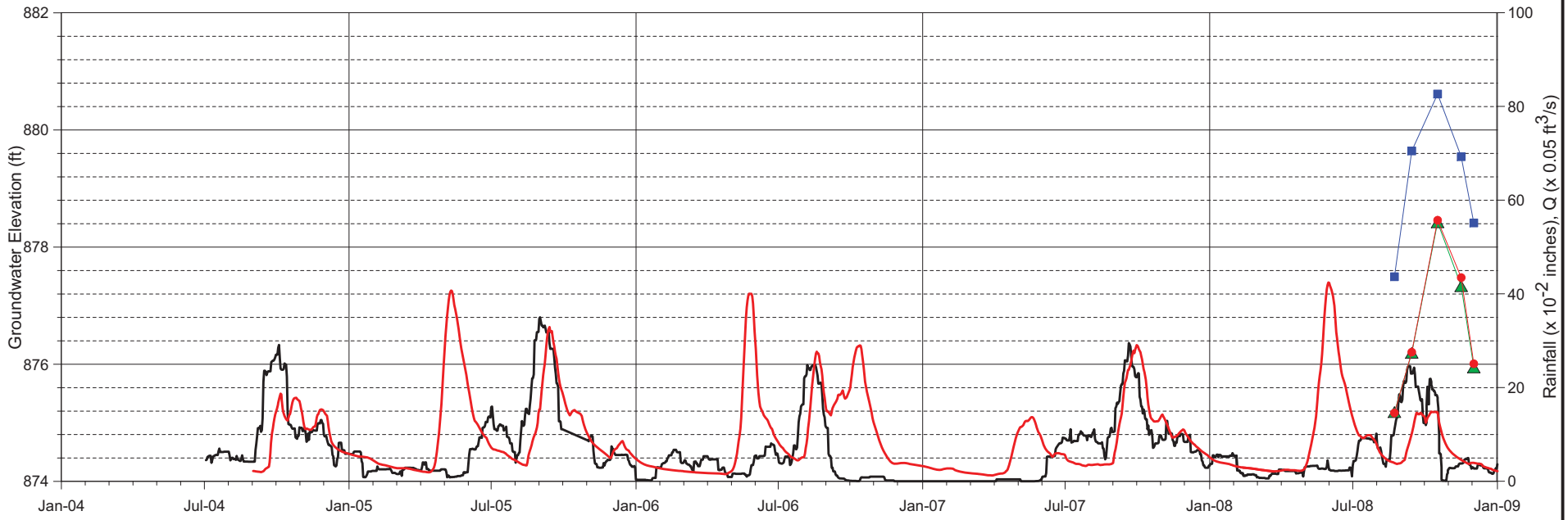


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-82



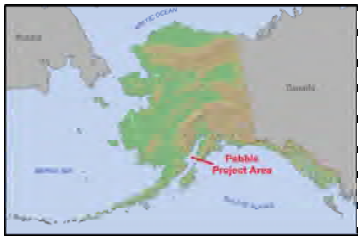
LEGEND:

Groundwater Elevation Plot Legend

- P-08-82S
- P-08-82M
- P-08-82D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

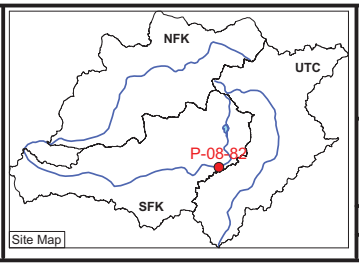
Screens (ft asl):
P-08-82S : 867.2 - 876.4
P-08-82M : 839.0 - 849.0
P-08-82D : 818.2 - 827.4



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 888.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-82.grf

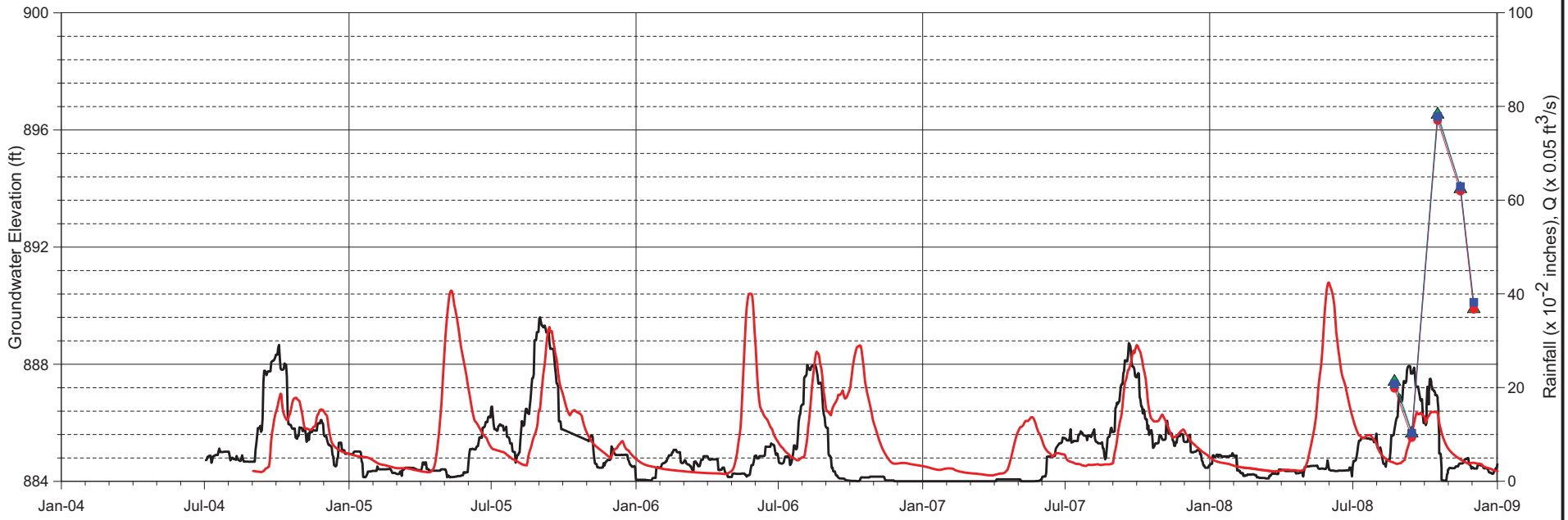


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-83



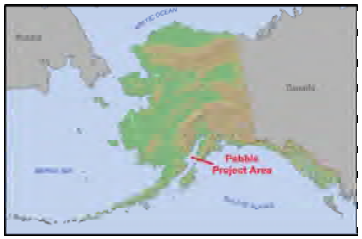
LEGEND:

Groundwater Elevation Plot Legend

- P-08-83S
- P-08-83M
- P-08-83D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

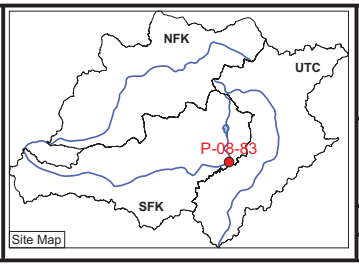
Screens (ft asl):
P-08-83S : 877.1 - 886.7
P-08-83M : 818.5 - 828.3
P-08-83D : 729.5 - 739.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 919.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-83.grf

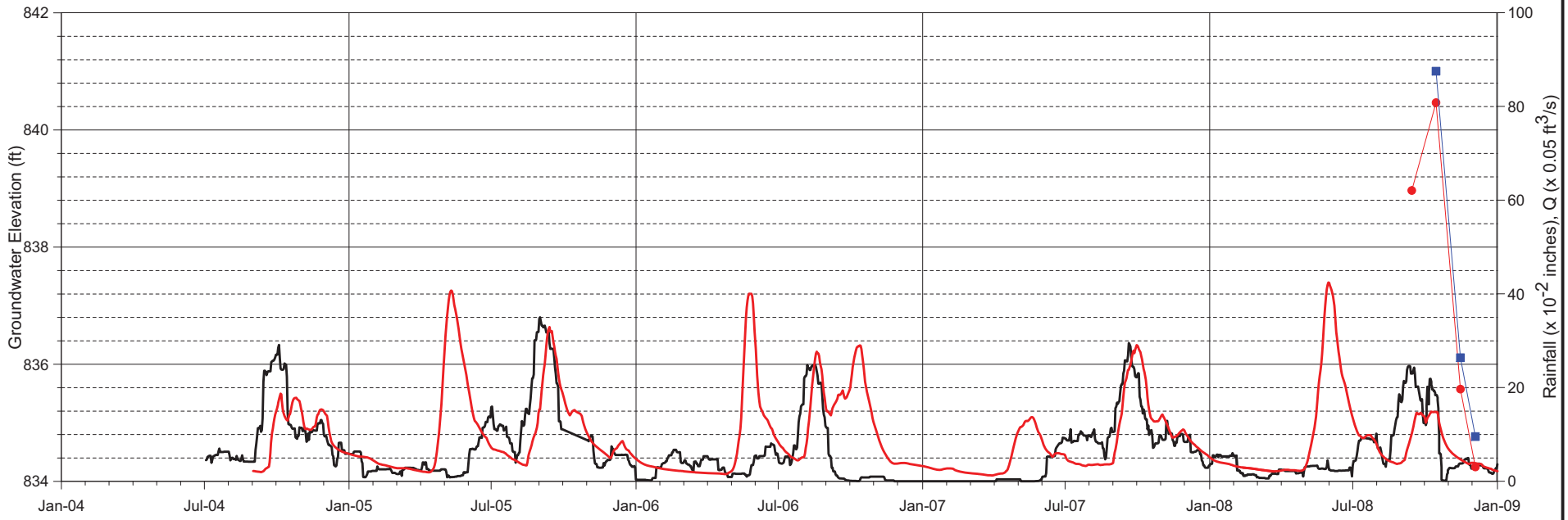


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-84



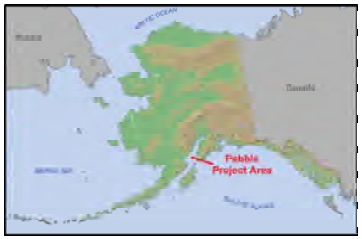
LEGEND:

Groundwater Elevation Plot Legend

- P-08-84S
- P-08-84D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

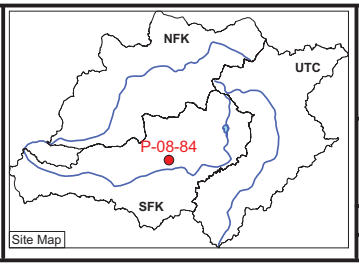
Screens (ft asl):
P-08-84S : 817.3 - 826.9
P-08-84D : 774.1 - 783.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 850.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-84.grf

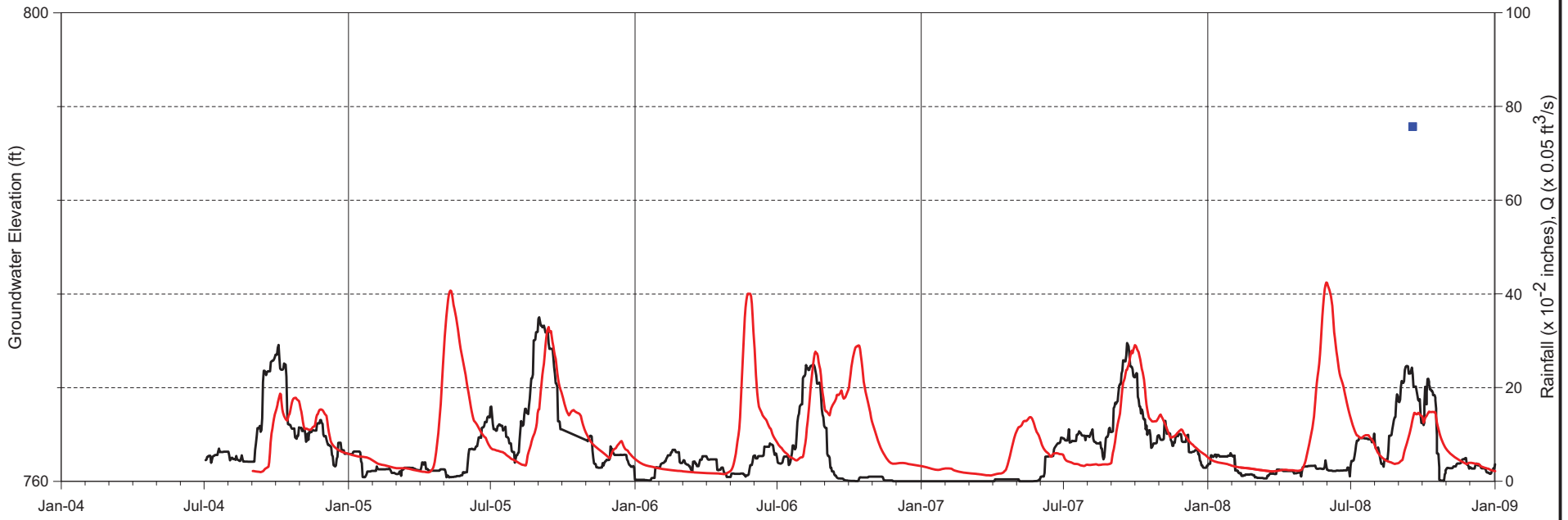


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-85



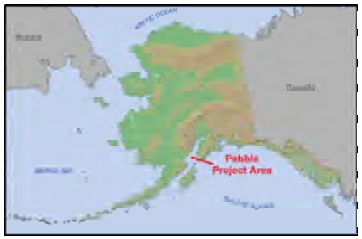
LEGEND:

Groundwater Elevation Plot Legend

- P-08-85S
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
P-08-85S : 758.4 - 768.0
P-08-85D : 654.1 - 663.8

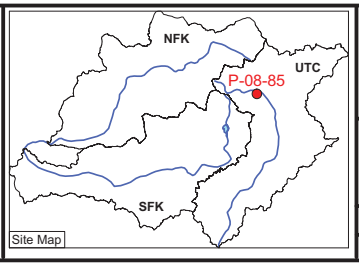


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 790.8 ft asl

P08-85D was flowing, therefore water levels were not recorded.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-85.grf

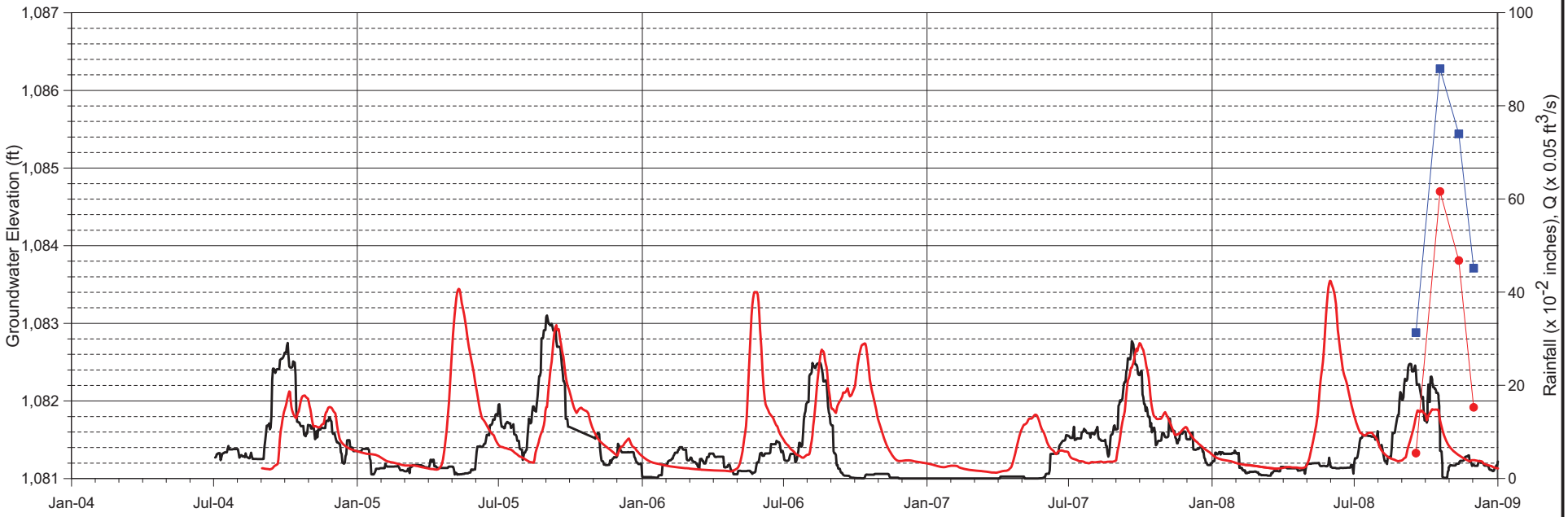


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-86



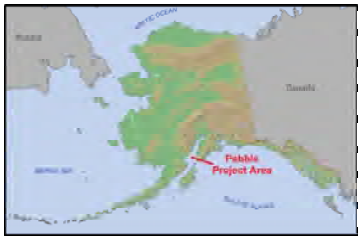
LEGEND:

Groundwater Elevation Plot Legend

- P-08-86S
- P-08-86D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

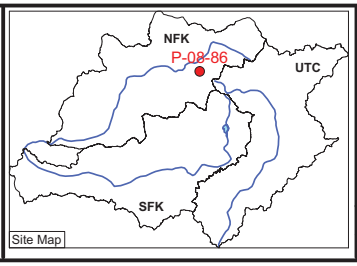
Screens (ft asl):
P-08-86S : 1087.4 - 1097.2
P-08-86D : 1059.5 - 1069.3



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1133.1 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-86.grf

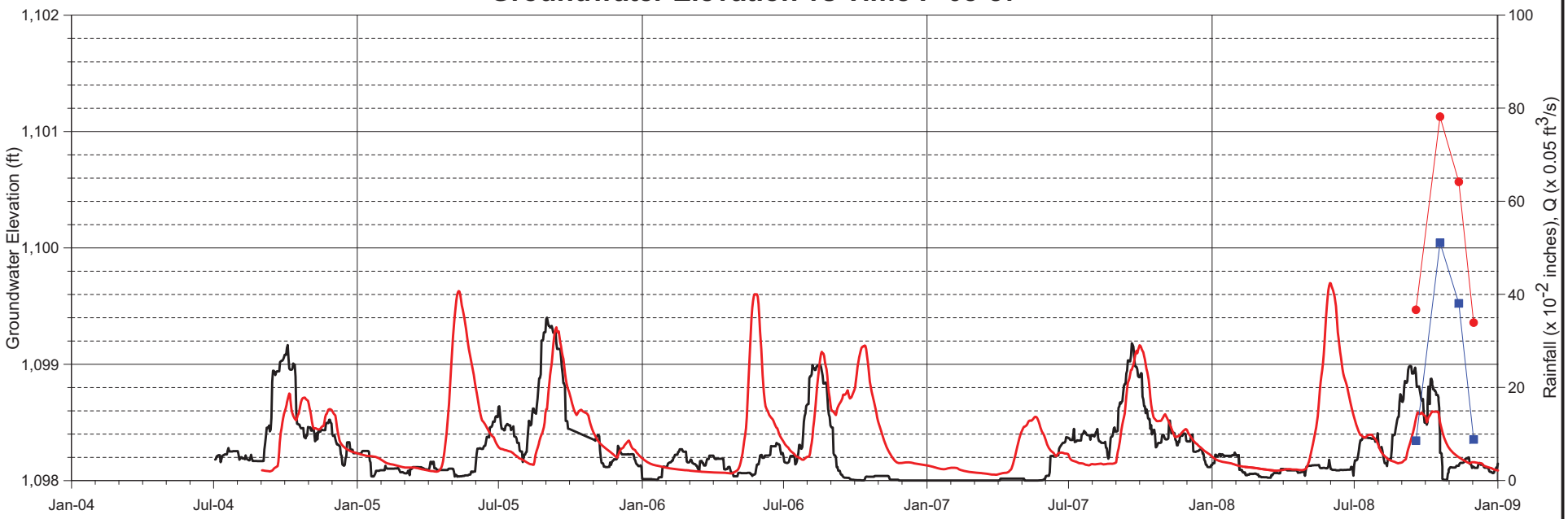


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-87



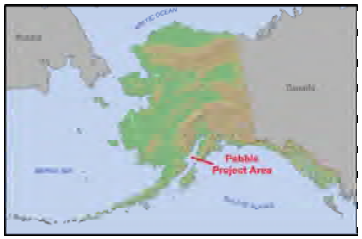
LEGEND:

Groundwater Elevation Plot Legend

- P-08-87S
- P-08-87D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

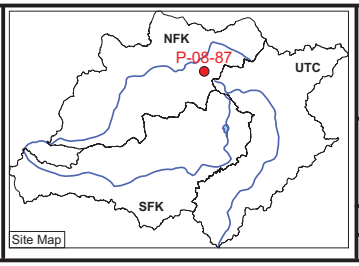
Screens (ft asl):
P-08-87S : 1086.5 - 1096.1
P-08-87D : 1068.5 - 1078.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1138.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-87.grf

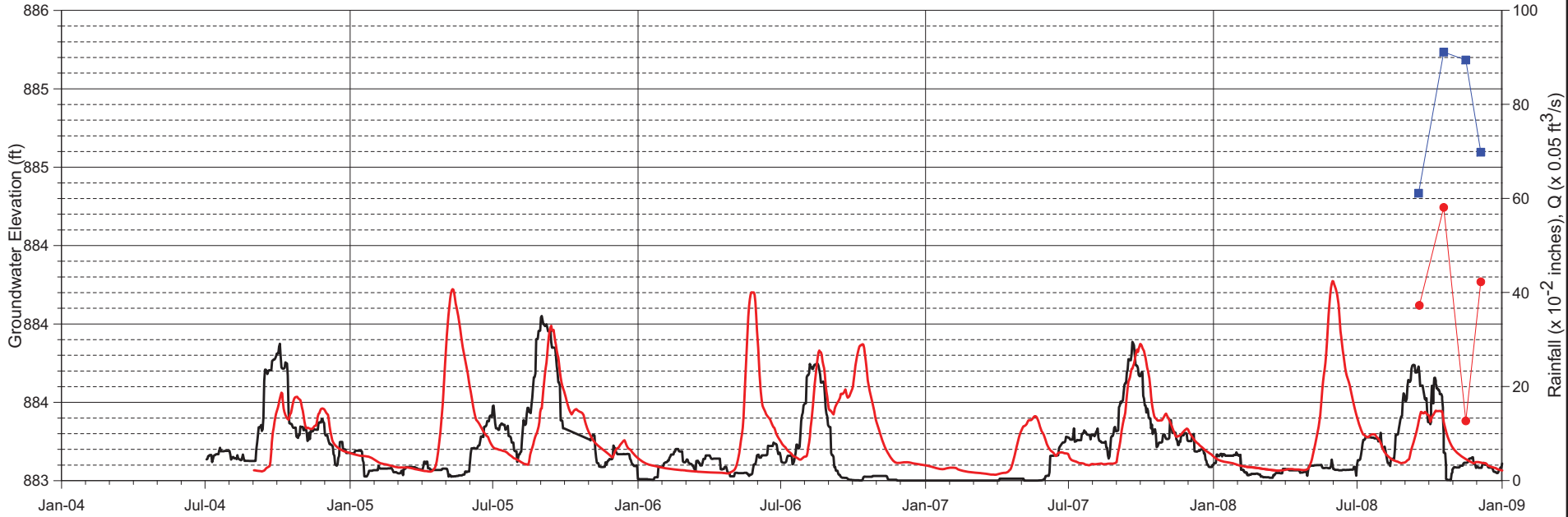


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-88



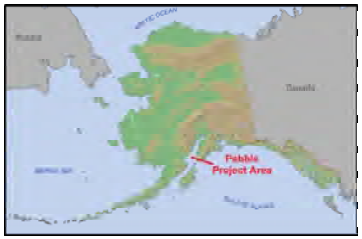
LEGEND:

Groundwater Elevation Plot Legend

- P-08-88S
- P-08-88D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

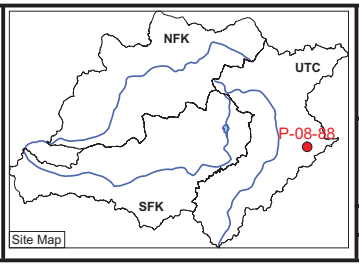
Screens (ft asl):
P-08-88S : 871.9 - 881.8
P-08-88D : 795.8 - 805.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 901.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-88.grf

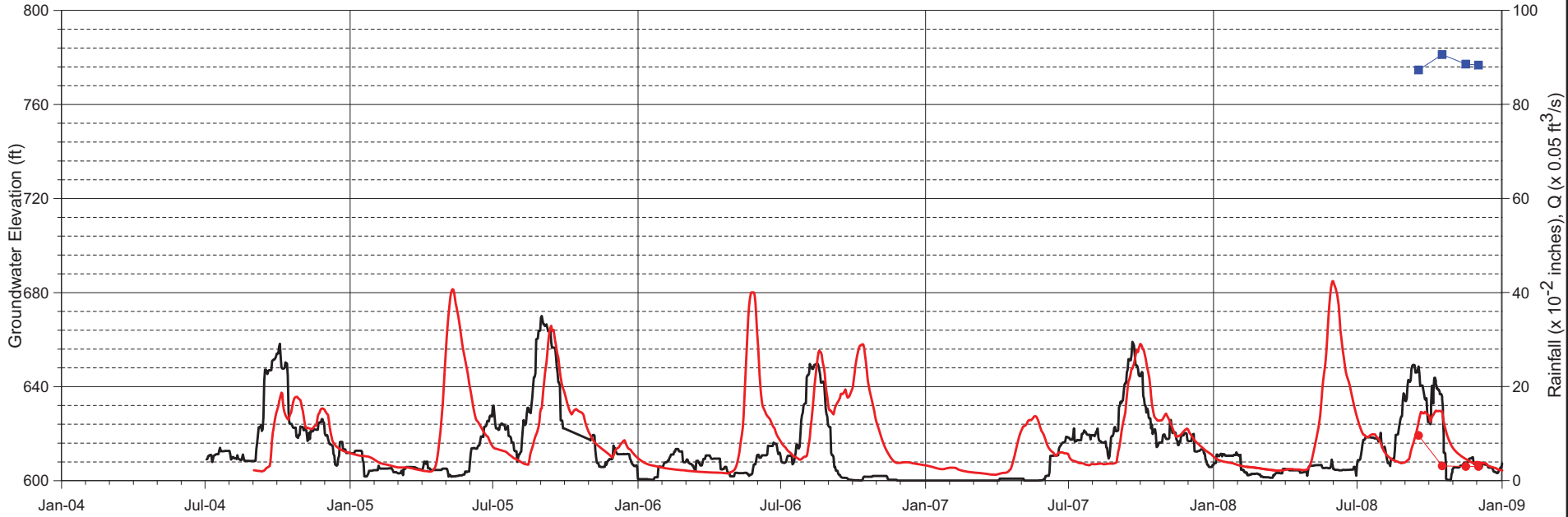


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-08-89



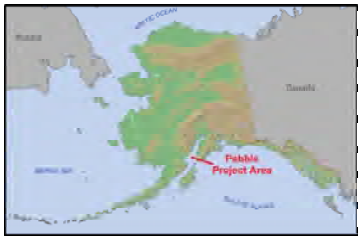
LEGEND:

Groundwater Elevation Plot Legend

- P-08-89S
- P-08-89D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

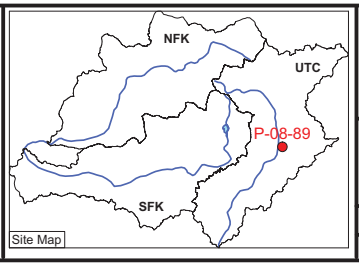
Screens (ft asl):
P-08-89S : 755.2 - 765.2
P-08-89M : 686.7 - 696.6
P-08-89D : 595.3 - 610.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 841.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-08-89.grf

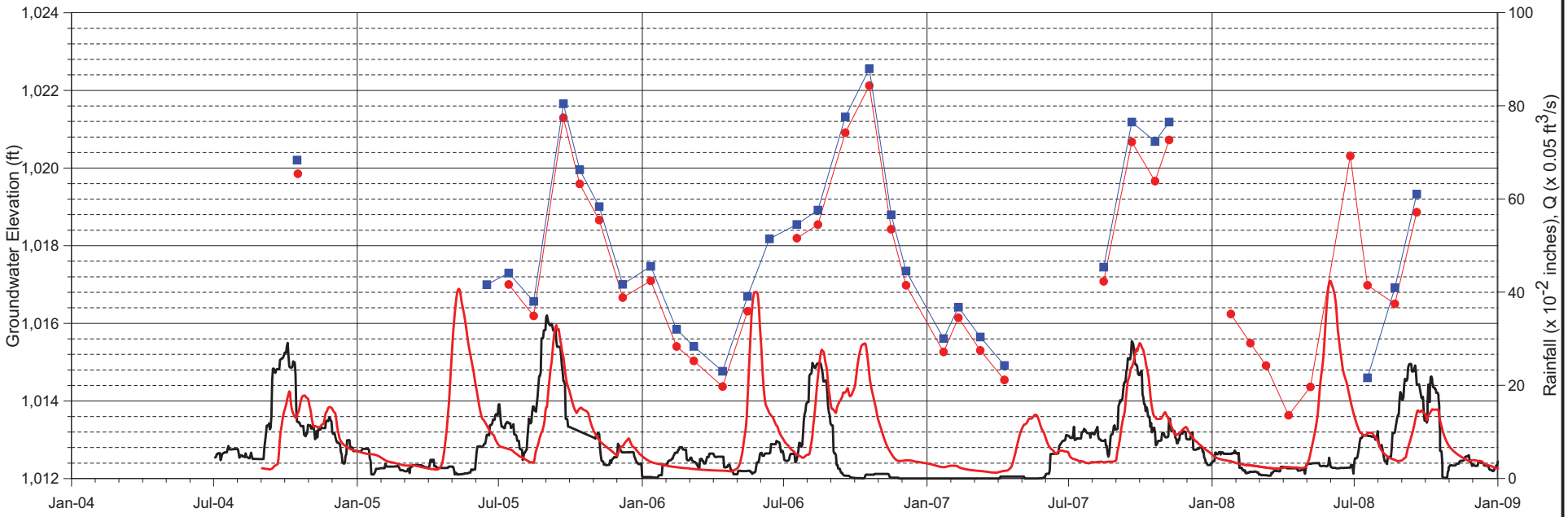


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time P-2



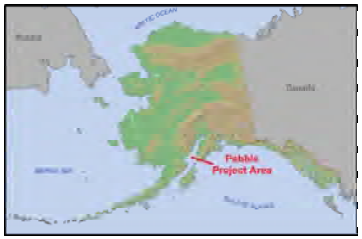
LEGEND:

Groundwater Elevation Plot Legend

- P-2M
- P-2D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

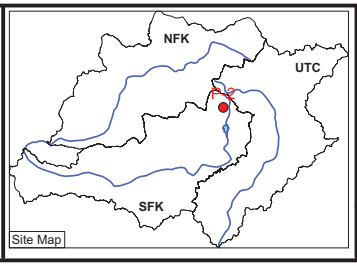
Screens (ft asl):
P-2M : 954.4 - 964.4
P-2D : 935.8 - 945.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1022.4 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-2.grf

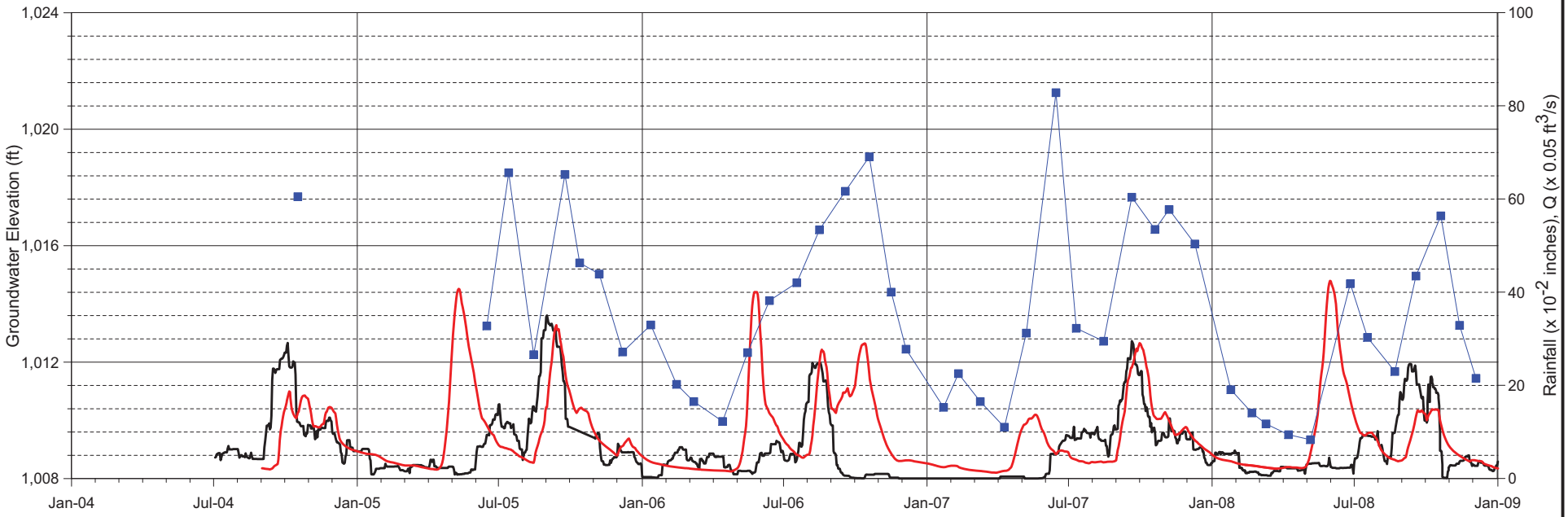


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time P-3



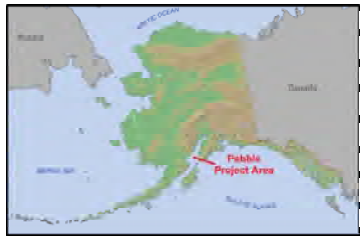
LEGEND:

Groundwater Elevation Plot Legend

- P-3
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

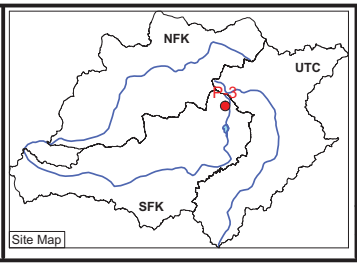
Screens (ft asl):
P-3 : 997.1 - 1007.1



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1019.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-3.grf

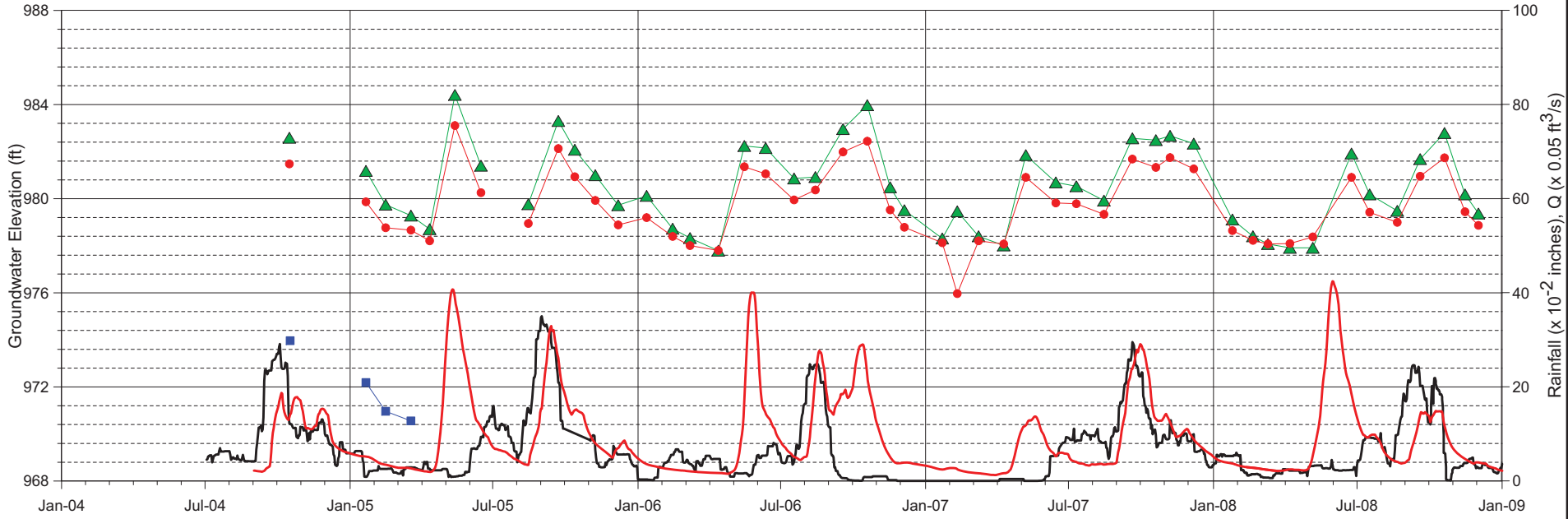


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time P-4



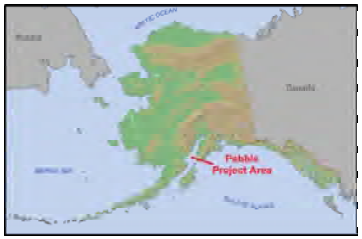
LEGEND:

Groundwater Elevation Plot Legend

- P-4 Mid
- P-4AS
- P-4AD
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

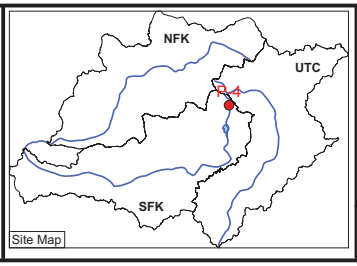
Screens (ft asl):
P-4AS : 947.7 - 957.7
P-4AD : 907.9 - 917.9



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 990.8 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-4.grf

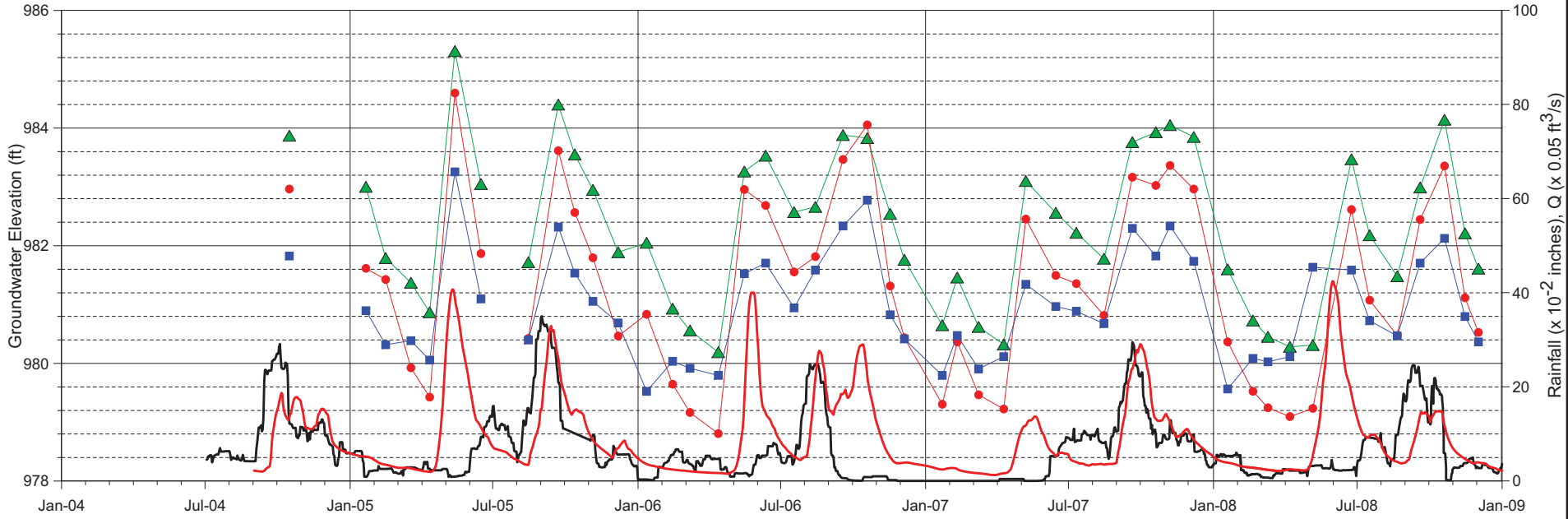


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time P-6



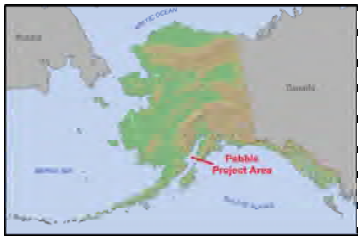
LEGEND:

Groundwater Elevation Plot Legend

- P-6S
- P-6M
- P-6D
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

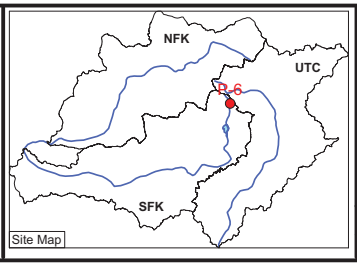
Screens (ft asl):
P-6S : 960.6 - 970.6
P-6M : 909.8 - 914.8
P-6D : 883.5 - 893.5



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 995.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\P-6.grf

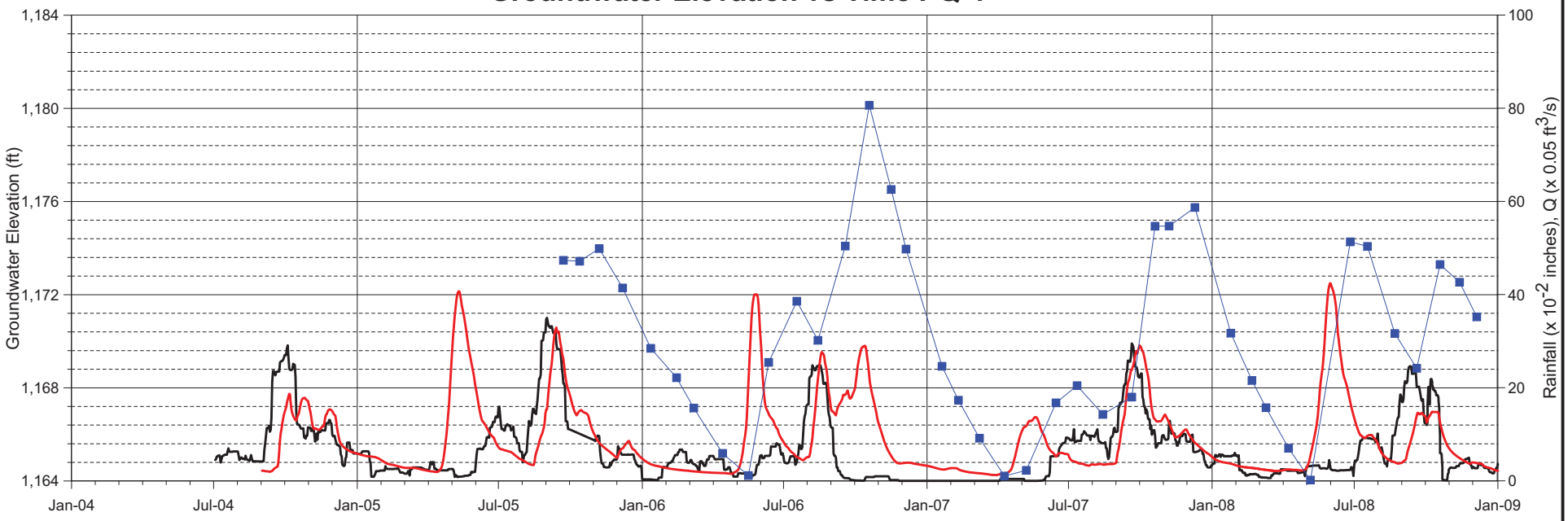


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time PQ-4



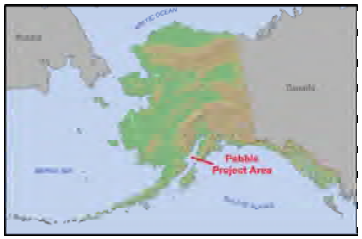
LEGEND:

Groundwater Elevation Plot Legend

- PQ-4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

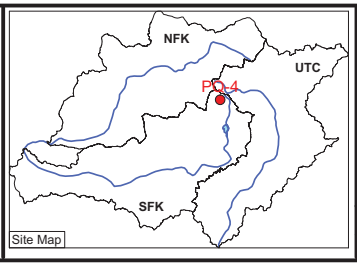
Screens (ft asl):
PQ-4 : 1072.0 - 1082.0



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\PQ-4.grf

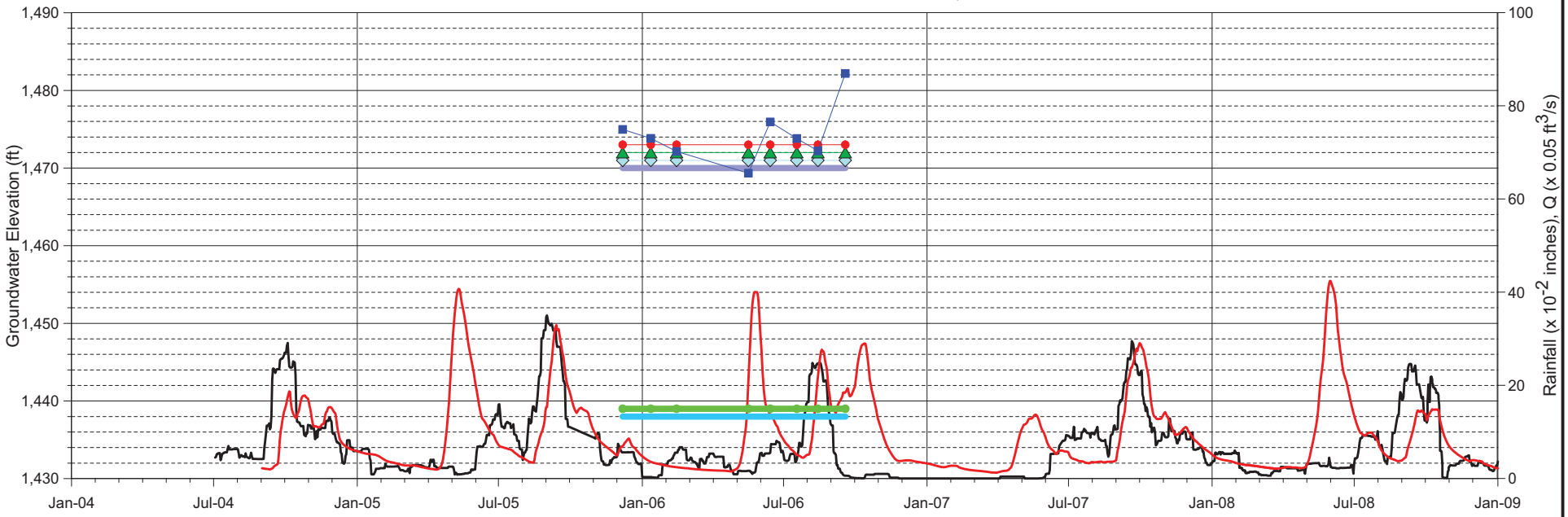


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time PQ-8



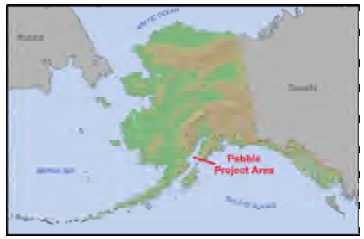
LEGEND:

Groundwater Elevation Plot Legend

- PQ-4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

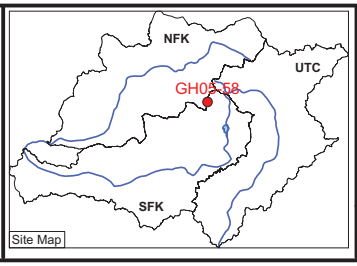
Screens (ft asl):
PQ-8 : 943.7 - 953.7



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.6 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\PQ-8.grf

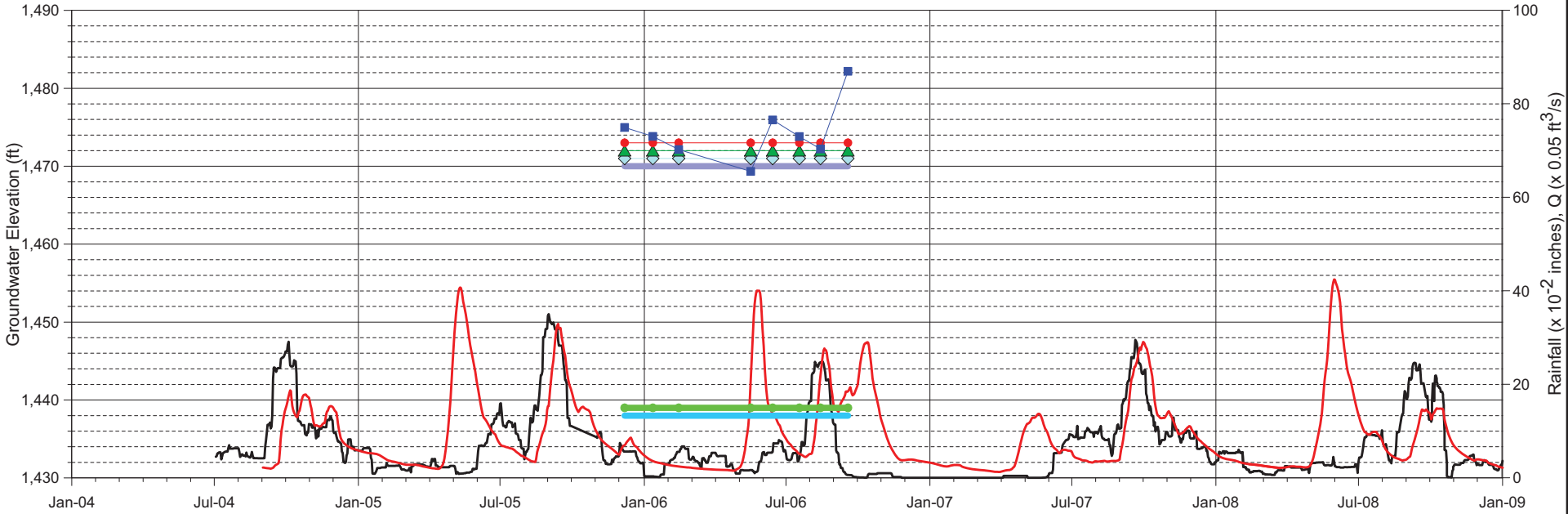


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time PQ-9



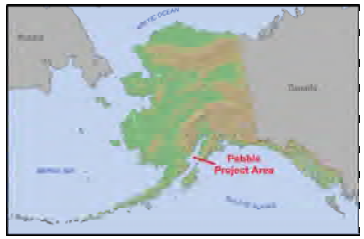
LEGEND:

Groundwater Elevation Plot Legend

- PQ-4
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

Screens (ft asl):
PQ-9 : 1053.2 - 1063.2

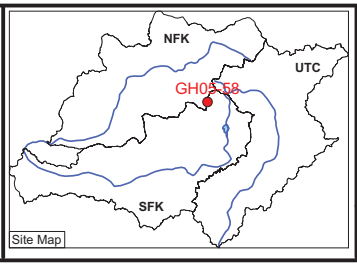


Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1205.6 ft asl

Water levels represent long-term recovery over several years, possibly due to invasion of the monitoring zone by grout. Equilibrium groundwater elevation was not yet reached.

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\PQ-9.grf

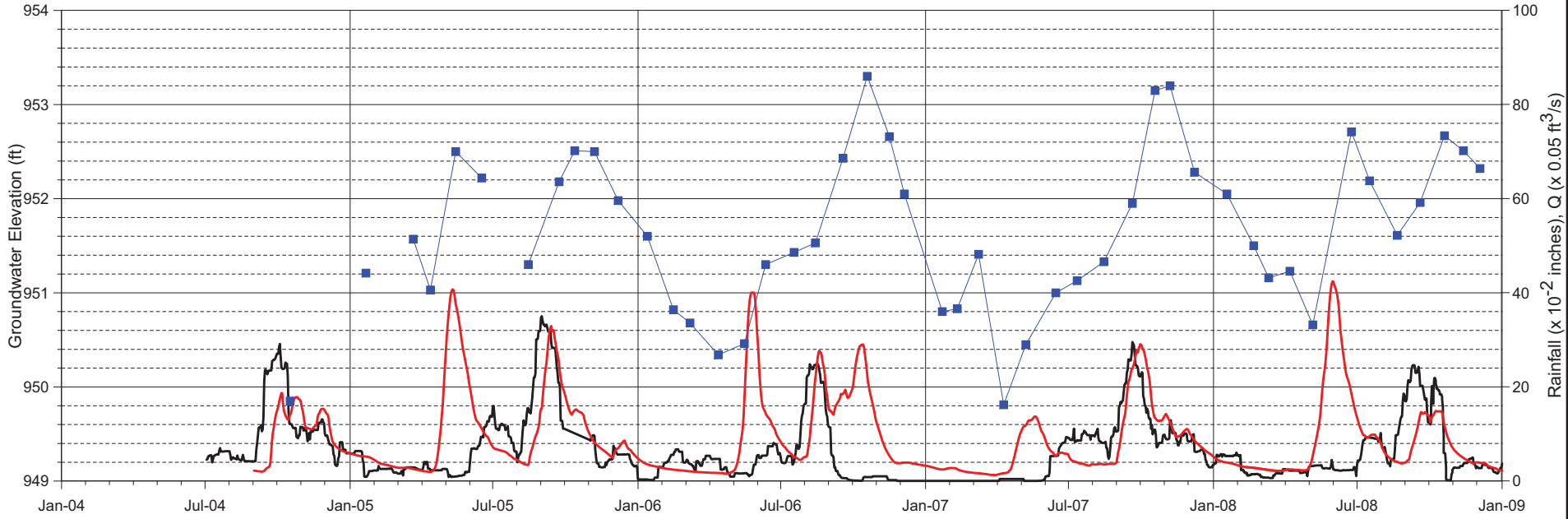


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

Groundwater Elevation vs Time SRK-2 AKA 4251



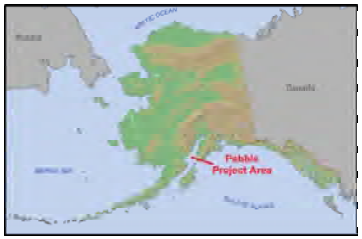
LEGEND:

Groundwater Elevation Plot Legend

- SRK-2 (AKA 4251)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

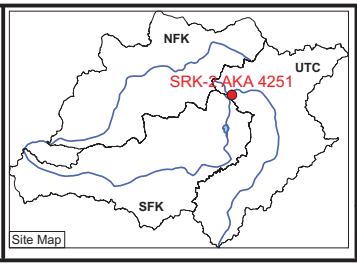
Screens (ft asl):



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 992.9 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\SRK-2 AKA 4251.grf

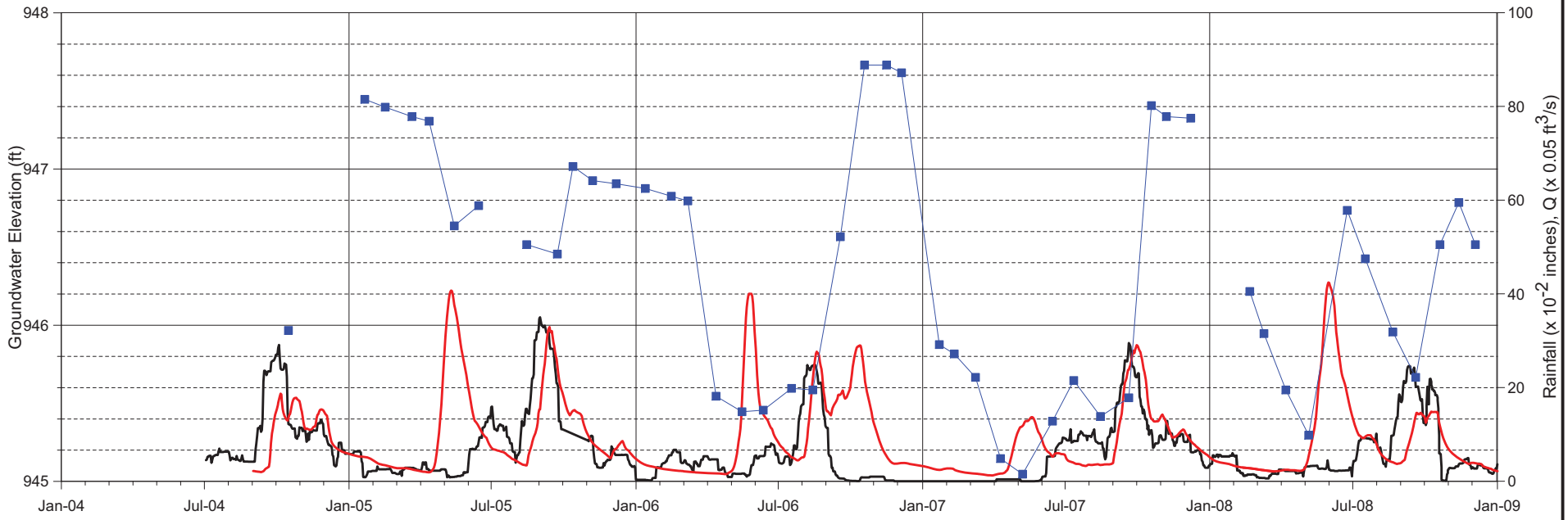


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time SRK-2A



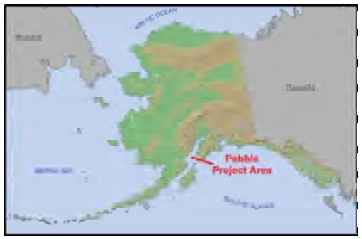
LEGEND:

Groundwater Elevation Plot Legend

- SRK-2A
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

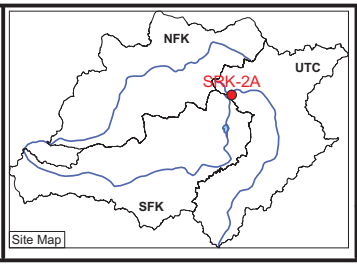
Screens (ft asl):
SRK-2A : 918.2 - 928.2



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 998.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\SRK-2A.grf

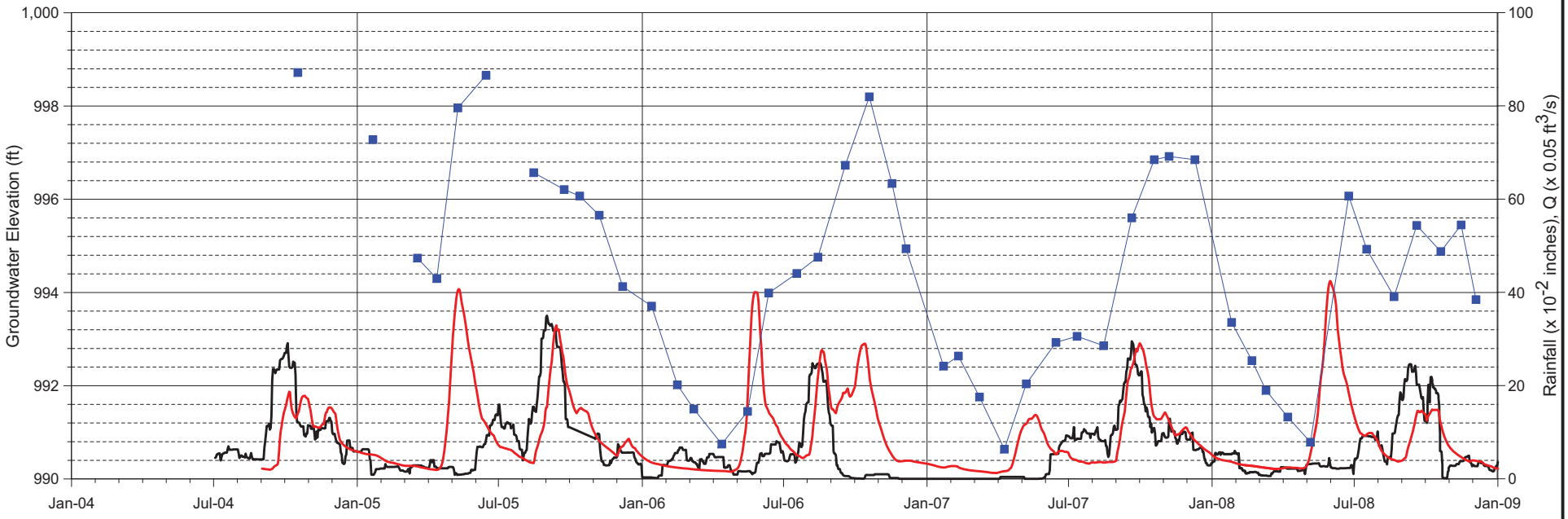


THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 06, 2011

Groundwater Elevation vs Time SRK-3 AKA 4250



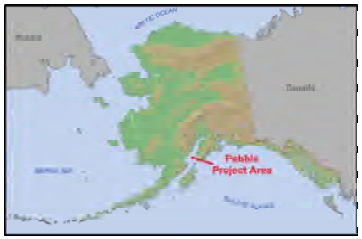
LEGEND:

Groundwater Elevation Plot Legend

- SRK-3 (AKA 4250)
- Streamflow at SK100B: 15 day running average
- Rainfall at Iliamna Airport: 31 day running average

S = Shallow Monitoring Zone
M = Medium Monitoring Zone
D = Deep Monitoring Zone
asl = above sea level

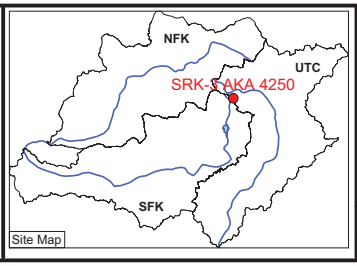
Screens (ft asl):
SRK-3 (AKA 4250) : 950.8 - 960.8



Notes:

1. Discharge data reduced by a factor of 20 for plotting purposes.
2. Rainfall data increased by a factor of 100 for plotting purposes.
3. Ground Surface Elevation: 1024.2 ft asl

File: Z:\Pebble_7126_2010\Data\Hydrographs\Grapher\SRK-3 AKA 4250.grf



THE pebble PARTNERSHIP

Appendix 8.1H:
Time Series of Piezometric Elevations (expanded scale)

Project: 7126	SWS-LC
Version: 3	Apr 05, 2011

APPENDIX 8.1I

Water Balance Model Results

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF TABLES iii
LIST OF FIGURES (following tables) iii
ACRONYMS AND ABBREVIATIONS v
1. INTRODUCTION 1
2. DESCRIPTION OF CALCULATION METHOD 2
2.1 Introduction 2
2.2 Climate Inputs 3
2.2.1 Meteorological Stations 3
2.2.2 Temperature 3
2.2.3 Precipitation 4
2.2.4 Sublimation 5
2.2.5 Snowmelt 5
2.2.6 Evapotranspiration 6
2.2.7 Soil Water Balance 7
2.2.8 Water Available for Runoff and Recharge 7
2.3 Flow Distribution 8
2.3.1 Groundwater Recharge 8
2.3.2 Groundwater Storage and Discharge 8
2.3.3 Groundwater Discharge Off Site and On Site 9
2.3.4 Surface Water Detention and Storage 9
2.3.5 Summary of Flow Calculations 9
2.4 Discretization 9
3. RESULTS 10
3.1 Introduction 10
3.2 South Fork Koktuli Results 10
3.2.1 SK119A 10
3.2.2 SK124A 11
3.2.3 SK100F 11
3.2.4 SK100C 12
3.2.5 SK100B 13
3.2.6 SK100A 14
3.3 North Fork Koktuli Results 15

3.3.1 NK119A 15
3.3.2 NK119B 15
3.3.3 NK100C 15
3.3.4 NK100A 16
3.4 Upper Talarik Creek Results 17
3.4.1 UT100D 17
3.4.2 UT119A 17
3.4.3 UT100B 18
3.4.4 UT100APC1 18
4. SUMMARY OF RESULTS 19
4.1 Climate Inputs 19
4.2 Stream Flows 19
4.3 Groundwater Recharge 20
5. REFERENCES 21

LIST OF TABLES

Table 1, Monthly Temperature Records for Iliamna Airport (^{o}F)

Table 2, Monthly Precipitation Records for Iliamna Airport (inches)

Table 3, Measured Precipitation for 2007 through 2008 at Iliamna and Pebble Site 1

Table 4, Orographic Multipliers of Iliamna Precipitation

Table 5, Comparison of Estimated Snow Packs with Snow Model

Table 6, Areas for Sub-catchments by Elevation

Table 7, Precipitation Multiplier, Annual Net Precipitation, and Recharge by Sub-catchment (1942–2008)

Table 8, Calculated Average Annual Discharges

LIST OF FIGURES (following t les)

Figure 1, Stream Gaging Stations and Watershed Boundaries

Figure 2, Correlation of Iliamna Airport and Pebble Site Meteorological Stations Monthly Temperature

Figure 3, Correlation of Iliamna Airport and Pebble Site 1 Meteorological Station Monthly Precipitation

Figure 4, Correlation of Pebble Site 1A and Regional Snow Pack with Estimated Snow Pack

Figure 5, Measured and Calculated Streamflow at SK119A (Area 1)

Figure 6, Measured and Calculated Streamflow at SK124A (Area 2)

Figure 7, Measured and Calculated Streamflow at SK100F (Area 3)

Figure 8, Comparison of MW-5S Water Levels with Calculated Groundwater Volumes (Area 3)

Figure 9, Measured and Calculated Streamflow at SK100C (Area 5)

Figure 10, Comparison of MW-11M Water Levels with Calculated Groundwater Volumes (Area 5)

Figure 11, Measured and Calculated Streamflow at SK100B (Area 4)

Figure 12, Comparison of MW-1S Water Levels with Calculated Groundwater Volumes (Area 4)

Figure 13, Measured and Calculated Streamflow at SK100A (Area 8)

Figure 14, Measured and Calculated Streamflow at NK119A (Area 14)

Figure 15, Measured and Calculated Streamflow at NK100C (Area 13)

Figure 16, Comparison of MW-8S Water Levels with Calculated Groundwater Volumes (Area 13)

Figure 17, Measured and Calculated Streamflow at NK100A (Area 15)

Figure 18, Measured and Calculated Streamflow at UT100D (Area 9)

Figure 19, Measured and Calculated Streamflow at UT119A (Area 7)

Figure 20, Measured and Calculated Streamflow at UT100B (Area 10)

ACRONYMS AND ABBREVIATIONS

^{o}C	degrees Celsius
cfs	cubic feet per second
EBD	environmental baseline document
ft/ft	feet per foot
km	kilometer
mi^2	square miles
SWE	snow water equivalent
USGS	U.S. Geological Survey

WATER BALANCE MODEL

1. INTRODUCTION

The Pebble Project is located in the headwater areas of the Koktuli River and Upper Talarik Creek. A water balance was developed along with a numerical groundwater model (Appendix 8.1J of Chapter 8 of the environmental baseline document [EBD]) as tools for understanding the groundwater systems as well as the groundwater-surface water interactions. The water balance included both groundwater and surface water components, thereby providing an opportunity to include both groundwater-level data and surface-water-flow data in the assessment of groundwater discharge rates. The groundwater model provides a method to verify that the groundwater components of the water balance meet the physical constraints of the groundwater flow system. A secondary output of this water balance was therefore an understanding of the groundwater-surface water interaction in the study area.

The objective was to calibrate the water balance to measured stream flow data and to verify that the changes in storage calculated by the water balance model were consistent with observed changes in groundwater elevation. By taking this approach, the groundwater recharge estimates generated by the water balance were consistent with the measured stream flows and the overall hydrologic regime of the study area. These recharge estimates were then used as part of the calibration process in the numerical groundwater model. The following components from this water balance were used in the groundwater model:

- Recharge rates from precipitation and streams on a sub-catchment scale.
- Inter sub-catchment groundwater flow rates (henceforth referred to as off-site discharge).
- Rates of groundwater discharge to streams (henceforth referred to as on-site discharge).

The study area was divided into sub-catchments based on the locations of stream-gauging stations (Figure 1). These sub-catchments were linked together in the water balance. The basic input was monthly rainfall and snowmelt. Precipitation was based on Iliamna records (Table 1) and adjusted for orographic, rain shadow, snow catch, and blowing snow effects. Snowmelt was generated from monthly temperature records for Iliamna (Table 2), which were adjusted for altitude. Evapotranspiration, sublimation, infiltration, discharge, and surface detention factors were adjusted to provide a reasonable fit to the streamflow database and to some extent the observed groundwater levels.

Section 2 of this appendix describes the methodology for calculating the water balance, including selection of site climate parameters, the distribution of flows between groundwater and surface water, the method of storage and release of water, and the discretization of the study area. Section 3 of this appendix describes the results of the water balance organized by stream catchments: South Fork Koktuli River; North Fork Koktuli River; and Upper Talarik Creek. Finally, Section 4 summarizes the results and comments on the most important findings of the water balance.

2. DESCRIPTION OF CALCULATION METHOD

2.1 Int o uction

A watershed water balance can be classified as a lumped, distributed, or semi-distributed parameter model. A lumped-parameter model includes a limited number of parameters to characterize the whole basin. A distributed-parameter model is constructed by gridding the basin and applying parameters specific to each grid cell. The distributed model results in a large number of input parameters. A semi-distributed model includes both lumped parameters and distributed parameters within the same calculation. Jakeman and Hornberger (1993) observed that despite the fact that the physics governing the path of a drop of water through a catchment to the stream involves complex relationships, evidence indicates that the information content in a rainfall-runoff record is sufficient to support only very limited complexity. Almost always, one quick flow component and one slow flow component are all that can be identified in a streamflow record. Similarly, Kirchner (2006) concluded that there was a need to develop reduced-form models with very few free parameters. Research at University of British Columbia by Zoran Micovic (2004) into the minimum watershed model structure for representation of runoff processes has shown that very simple models are preferable to more complex models as increased complexity does not improve the results. His research has shown that a model needs only two flow components (surface water and groundwater) and two elevation bands. In this study, 500-foot elevation bands were selected for defining the site climate.

The time step of a hydrologic model depends on the requirements of the study. Time steps can range from portions of a day to monthly. Shorter time steps typically are required for modeling streams that respond quickly to precipitation events and when storm hydrographs are required. As the primary purpose of this study is to establish groundwater recharge rates that feed stream base flows, monthly time steps are appropriate.

The method selected for evaluating groundwater recharge and discharge was a month-to-month water balance approach commonly used for hydrologic evaluations (Alley, 1984; Steenhuis and Van der Molen, 1986). Several methods were available to carry out this task. A spreadsheet method was applied to the Pebble study area. The selected semi-distributed method allowed for adjacent sub-catchments to be chained together. The method included the interaction of surface water and groundwater components of a flow system while respecting climate data, streamflow data, and groundwater level data.

The study area was divided into catchments that corresponded with the catchments of established stream-gaging stations (Figure 1). The overall conceptual approach of the water balance was to consider inputs and outputs, as follows:

- Inputs to each catchment included precipitation within the catchment and inflow from up-gradient catchments.
- Precipitation was distributed amongst runoff, recharge, and evapotranspiration and sublimation.
- Recharge (which is a combination of meteoric recharge and stream leakage) was accumulated in groundwater storage.
- Groundwater was discharged within and from the sub-catchment in proportion to the amount of groundwater in storage.

- A portion of this groundwater was transmitted down-gradient to the next catchment according to Darcy's Law. The remainder of the groundwater was discharged within the sub-catchment to join surface water.
- When the precipitation was snow, it was accumulated until the temperature rose enough to melt the snow and generate runoff, at which time it was distributed into the appropriate components.

The input parameters of the water balance were adjusted until the streamflows calculated by the water balance agreed reasonably with the measured streamflows. The following paragraphs describe the details of the calculations.

2.2 Clim te Inputs

2.2.1 Meteorological Stations

Meteorological data have been collected on site from four stations since 2004 (see Chapter 2 of the EBD). The closest long-term records are for the Iliamna Airport. Meteorological data have been collected at Iliamna Airport from 1942 through 2008 with a few data gaps. To provide a sufficient long-term record of site conditions, the data from Iliamna Airport were used in the water balance calculations. The Iliamna Airport data have been adjusted to site conditions where possible by correlating the Airport data with the available site data.

2.2.2 Temperature

Monthly temperature data have been collected at Iliamna Airport from 1942 through 2008 (Table 1). Temperature data have been collected on site from mid-2004 to present. Correlation of Iliamna Airport and site monthly temperatures (Figure 2) indicated that the Pebble 1 meteorological station monthly temperature was approximately 2.5°C (degrees Celsius) colder than Iliamna Airport, consistent with the expected change in temperature with elevation.

The Pebble 1 meteorological station temperature over the calculation period (1942 to 2008) was estimated by subtracting 2.47°C from the monthly Iliamna Airport temperature. The temperature of each elevation band in the water balance was calculated using the following formula, assuming a temperature gradient of 6.5 ºC per kilometer (km) or 1.981 ºC per 1,000 feet:

$$T = T_s - (1.981)(E-E_s)/1{,}000$$

Where:

T = temperature of middle of elevation band (°C).

T_s = temperature at Site Pebble 1 (°C).

E = elevation of middle of elevation band (feet).

E_s = elevation of Site Pebble 1 (1,550 feet).

2.2.3 Precipitation

The monthly precipitation data from Iliamna Airport (Table 2) were adjusted for location and elevation. The average annual precipitation measured at Iliamna was 26.8 inches. Variations in precipitation are expected as a result of factors such as:

- Orographic effects resulting in more precipitation at higher elevations. This is an important factor for major storms approaching the area but is not a factor for small local storms, more common in summer.
- Rain shadow effects resulting in less precipitation on the northwest side of mountains as most storms are expected to arrive from the southeast.
- Catch efficiency, particularly snow for both Iliamna and site meteorological stations, but particularly Iliamna as it was not fitted with a wind shield.
- Transfer of snow into and out of drainages as a result of blowing snow.

Iliamna precipitation data were not available for some limited periods, notably 1970 through 1975, December 1997 through February 1999, and August 2006 through May 2007. Up to 2006, the missing data were infilled by averaging the 5 years previous and 5 years following the missing month. For August 2006 through May 2007, and September and October 2008, the missing data were infilled with estimates based on precipitation measured on site as discussed below.

Table 3 provides measured monthly precipitation for Iliamna and the Pebble 1 meteorological station. To develop a relationship between the two sites, two correlation factors were applied. The first was a multiplier of the winter precipitation at Iliamna to account for the expected undercatch of snow by the Iliamna precipitation gage. Such losses have been extensively studied (Yang et al., 2000). Second, orographic factors for winter and summer were selected to account for the elevation difference of the two sites.

To account for orographic effects of precipitation, a non-linear relationship was adopted as follows.

$$P = P_i a^{(H/328.1)}$$

Where:

P = the monthly precipitation at the selected elevation (inches).

P_i = the monthly precipitation at Iliamna (inches).

a = the orographic factor.

H = the difference in elevation from Iliamna (feet).

The precipitation estimated from this formula correlated well with observed values (Figure 3). To obtain this correlation, the precipitation from December through April was doubled to account for the undercatch of snow and an orographic factor of 1.1 (10 percent increase per 100 meters or 328.1 feet) was applied to account for orographic effects. In the remaining months, an orographic factor of 1.03 provided an adequate fit to the data. Based on this correlation, missing Iliamna data in 2006 and 2007 were infilled based on Pebble site data.

The precipitation was then calculated for the center of each elevation band based on the 65 years of Iliamna data (1942 through 2008, Table 2). Orographic multipliers for these calculations are presented in Table 4. To account for rain shadow and wind transfer of snow, each sub-catchment was allowed a multiplier of precipitation from 1.0 to 1.5, to allow the precipitation and measured flows to be balanced. These factors are presented under discussion of results (Section 3).

To distribute precipitation between snow and rain, precipitation fell as rain if the average monthly temperature was greater than -2°C and as snow if the average monthly temperature was below -3°C. Between these temperatures, the ratio of precipitation as snow was varied linearly with the temperature.

2.2.4 Sublimation

Sublimation is complex and requires tabulation of a number of variables for a rigorous determination. In this analysis, we have assumed that maximum sublimation is 0.02 inches per day. Sublimation was allowed throughout the year. The snow was assumed to sublimate at the set rate until none remained on the ground.

2.2.5 Snowmelt

Although snowmelt can be estimated, the required meteorological parameters are not available for this site. Instead, the snowmelt was estimated using a temperature index method. The first order estimate of the apparent snowmelt was as follows:

Potential snowmelt (inches per month) = 3(T-1).

Where:

T = the average monthly temperature in °C.

This equation was used to estimate the potential snowmelt for each month. The actual snowmelt was up to the potential after considering the available snow after sublimation. The water available each month was calculated as the sum of snowmelt and rainfall.

The calculated end of winter snow pack (as snow water equivalent, SWE, in inches) based on estimated snowfall, snowmelt, and sublimation is plotted for an elevation of 2,050 feet on Figure 4. Also plotted on Figure 4 is the measured snow water equivalent of snow course station 1A (the snow-pack surveys for Pebble Project are discussed in an appendix to Chapter 7 of the EBD) and the measured snow pack at a regional station, Fishtrap Creek. The plot indicates that the precipitation measured at Iliamna Airport provides an adequate index for defining the snowpack accumulated in the region and in the study area.

Snow pack has been modeled for each sub-catchment with SnowModel (Chapter 7 of the EBD). The estimated end-of-winter snowpack for each catchment was compared with SnowModel results for 2006, 2007, and 2008. SnowModel uses site precipitation directly, while the water balance uses adjusted Iliamna data (except in the 2006/2007 winter when Iliamna data was estimated based on site data). Table 5 includes the SnowModel and water balance end-of-winter snow pack estimates for 2006, 2007, and 2008. Both methods estimated similar snowpacks for 2007 and indicated a low snow pack for 2007. However, the water balance calculated snowpack is lower than the SnowModel snow packs in 2006 and 2008 and indicate much greater variability with elevation (as a result of the orographic effect imposed).

2.2.6 Evapotranspiration

Evapotranspiration was calculated with a methodology following Thornthwaite (1948). First, the potential unadjusted monthly evapotranspiration (PET) was estimated based on the average monthly temperature in degrees Celsius.

$$PET\ (inches) = 0.63(10T/I)^{a}$$

Where:

T = temperature of middle of elevation band (^{o}C).

I = the sum of the i values for the year, where $I = (T/5)^{1.514}$.

a = $6.751x10^{-7}(I^3) - 7.71x10^{-5}(I^2) + 1.792x10^{-2}(I) + 0.49239$.

The unadjusted rate was adjusted for the number of days in the month and the number of hours in the day between sunrise and sunset, which varies with season and latitude. The number-of-days correction was achieved by multiplying by the number of days in the month and dividing by 30.

The equation used for the latitude correction was given by Glarner (2006) as follows:

$$(24\cos^{-1}(-\tan(L)\tan(0.4093\sin(2\Pi\,\mathrm{int}(30.4m-15)/365-1.39))))/12\Pi$$

Where:

L = latitude, and m is month number (1 to 12).

The actual evapotranspiration (AET) was calculated as part of the soil water balance. Typically, the PET represents the evapotranspiration for a full vegetation cover on relatively flat tilled ground with no shortage of water. Although the AET would vary depending on landform, soil type, rainfall distribution, and vegetation type, the value was averaged for the overall study site. To account for the natural distributions by material type and moisture variation over the month, 50 percent of the Thornthwaite PET was allowed for upland sites, whereas 90 percent was allowed for the high evaporation sites.

The AET was limited by the water available each month. For example, if the sum of snowmelt and rainfall in a given month was less than the PET, then the AET was less than the PET. Evapotranspiration was also limited by the soil moisture condition. Below the soil moisture capacity of the soil, the PET was reduced linearly with soil moisture as follows:

$$\text{Adjusted evapotranspiration} = (S_2 + S_1)\, f\, (PET)/(2S_m)$$

Where:

S_m = soil moisture capacity (4 inches for most sites and 14 inches for the high evaporation sites).

S_1 = soil moisture at the beginning of the month.

S_2 = soil moisture at the end of the month.

PET = the calculated full PET.

f = the reduction factor for non-ideal conditions for evapotranspiration (0.5 for most sites and 0.86 for high evaporation sites).

Average pan evaporation for Pebble (meteorological stations Pebble 1 and Pebble 4) for 2006 and 2007 was 10.3 and 13.5 inches. The convention is to assume that PET is 70 percent of pan evaporation, which would be 7.8 and 10.1 inches. This compares with the adopted procedure that resulted in a PET of 8.8 and 8.4 inches.

2.2.7 Soil Water Balance

The monthly soil water balance was calculated assuming the soil profile could retain moisture from month to month. A maximum soil moisture retention of 4 inches was assumed to represent average site conditions. Consideration of sublimation, snowmelt, rainfall, and AET allowed for an estimation of water available for infiltration and runoff. The soil moisture was calculated for the end of each month (S_2) based on the following formula:

$$S_2 = W + S_1 - (S_2 + S_1)\, f\, (PET)/(2S_m)$$

Where:

W = sum of rainfall and snowmelt for the month.

S_m = soil moisture capacity (4 inches for most sites and 14 inches for the high evaporation sites).

S_1 = soil moisture at the beginning of the month.

S_2 = soil moisture at the end of the month.

PET = the calculated full PET.

f = the reduction factor for non-ideal conditions for evapotranspiration (0.5 for most sites and 0.86 for high evaporation sites).

Solving for S_2

$$S_2 = (W + S_1(1 - f\, (PET)/(2S_m)))/(1 + f\, (PET)/(2S_m))$$

Knowing the soil moisture at the beginning and the end of the month provided an estimate of the soil moisture change.

2.2.8 Water Available for Runoff and Recharge

The surplus water or water available for runoff and recharge (V) was then calculated by subtracting the actual evapotranspiration and soil moisture change from the rainfall and snowmelt for the month (W).

$$V = W - f(PET)(S2 + S1)/ (2S_m) - (S2 - S1)$$

Where:

V = recharge.

W = snowmelt for the month.

f = the reduction factor for non-ideal conditions for evapotranspiration (0.5 for most sites and 0.86 for high evaporation sites).

This unit value of surplus water was multiplied by the catchment area for each sub-catchment to provide input to the water balance calculation.

2.3 Flow Distribution

2.3.1 Groundwater Recharge

Groundwater recharge of the water available for runoff and recharge was estimated with an adjustable rate to allow variation in response to effects from surface conditions, soil permeability, and available storage capacity. The infiltration (I) was set equal to available water, up to a volume equal to the product of an infiltration rate and the sub-catchment area (k_1A). For wetter months, a fraction (k_2) of the remaining available water was infiltrated ($k_2(V - k_1A)$). Therefore:

For precipitation less than or equal to k_1A

$$I\ (m^3/month) = V$$

For precipitation greater than A

$$I\ (m^3/month) = k_1A + k_2(V - k_1A)$$

$$= k_2V + k_1A(1 - k_2)$$

This procedure provides an estimate of groundwater recharge that was evident with a monthly water balance. Interflow and groundwater on very short paths is included with surface water with this monthly time increment.

2.3.2 Groundwater Storage and Discharge

A linear reservoir model was used to store and release groundwater. Water was recharged into storage in each sub-catchment. The recharged water accumulated within groundwater storage was released at a rate determined by the product of the average volume of water in storage (Z1/2 + Z2/2) and a discharge factor (j). The factor, j, was adjusted to account for the number of days in the month. Monthly discharge was therefore set equal to:

$$D = j(Z_1/2 + Z_2/2)$$

In this way, month-to-month storage was accounted within each sub-catchment and groundwater discharge increased with increasing storage. The volume of water in storage was, therefore, a sum of the storage in the preceding month (Z_1) plus the volume of water entering the system (I) minus the quantity discharged (D). Therefore:

$$Z_2 = Z_1 + I - D$$

$$= Z_1 + I - j(Z_1/2 + Z_2/2)$$

Solving for Z_2:

$$Z_2 = (I + Z_1(1-jZ_1/2))/(1 + jZ_1/2)$$

Conditions were included to prevent negative storage. Lower discharge factors resulted in larger accumulated storage with the same recharge. The effect of decreasing the factor was to cause a more uniform discharge rate.

2.3.3 Groundwater Discharge Off Site and On Site

Groundwater was discharged from a sub-catchment either as groundwater flow into a downstream sub-catchment or as discharge to surface water within the sub-catchment. The groundwater leaving the sub-catchment as groundwater was calculated with Darcy's Law, taking the product of estimated values for transmissivity (T), width (w), and hydraulic gradient (i):

$$D_{off\text{-}site} = Tiw$$

The remainder was discharged on site to join the surface water:

$$D_{on\text{-}site} = D - D_{off\text{-}site}$$

2.3.4 Surface Water Detention and Storage

The quantity of water reporting to surface water was the difference between water available for runoff and recharge, and the recharge volumes. Some of that water would run off within the month and some would be detained in storage. Surface water storage was included because several sub-catchment areas included ponds and wetlands that were not modeled as distinct water bodies. Within this water balance methodology, these detention features were managed with the same type of detention and linear reservoir model as groundwater storage. However, the discharge factor was typically higher for surface water.

2.3.5 Summary of Flow Calculations

For each sub-catchment, the water available for runoff and recharge was calculated as described above. Recharge was calculated and added to groundwater in storage. Groundwater was stored and released at a rate proportional to the average volume in storage. The groundwater released was passed on to the next sub-catchment downstream as groundwater up to an amount defined by Darcy's Law. The remainder of the released water was discharged within the sub-catchment and was passed on to the next sub-catchment downstream with the surface water. The water that was not recharged was either passed on to the next sub-catchment downstream as immediate runoff or was added to surface water detained in the sub-catchment. In the cases with surface water detention, the water not detained was passed on as immediate runoff. Detained water was released as a proportion of the average volume of water detained.

2.4 Discretization

The study area was divided into sub-catchments as shown on Figure 1. Sub-catchment areas were defined by topographic controls on drainage and the need to calibrate to measured water flow rates and volumes. For example, most of the sub-catchment boundaries were defined by the drainage area reporting to surface water gaging stations.

Each of the sub-catchments was further discretized by elevation. The elevation bands selected were 500-foot intervals, starting at 300 feet. Elevations below 300 feet were included in the lowest band, and elevations above 2,800 feet were included in the highest band. Representative climate conditions (temperature and precipitation) were calculated for the center elevation of each elevation band. Table 6 presents the areas of each of the sub-catchments and each of the elevation bands.

3. RESULTS

3.1 Introduction

This section discusses the results of the site-wide water-balance modeling. The results are summarized in Tables 7 through 11 and on Figures 5 through 20. The results are presented first for the South Fork Koktuli River drainage area, second for the North Fork Koktuli River drainage area, and third for the Upper Talarik Creek drainage area.

The measured and calculated stream flow plots include the following:

- Measured and calculated monthly streamflows in cubic feet per second (cfs) for the period of record. This plot provides a visual indication of the seasonal variation of the stream flow.
- Measured and calculated cumulative streamflows in acre-feet for the period of record. This plot provides a measure of the total volume of water passing the gage.
- Semi-log plot of the distribution of monthly flows in cfs. This plot provides a measure of the ability of the water balance to provide the full range of measured values.
- A plot of measured monthly flows versus calculated monthly flows. This provides a direct indication of the model fit. Based on this fit, a Nash Sutcliff efficiency factor (Nash and Sutcliff, 1970) was calculated.

3.2 South Fork Koktuli Results

3.2.1 SK119A

SK119A is located on tributary SK1.190 about 3,300 feet upstream of its confluence with the South Fork Koktuli River (Figure 1). The catchment area for the gage is approximately 10.7 square miles (mi^2). The average elevation of the sub-catchment is 1,545 feet, the second highest in this study (Table 6). This valley is relatively steep with a narrow valley floor. As such, groundwater recharge, storage, and related stream base flows are expected to be low.

The calculated and measured hydrographs are presented on Figure 5. The flows were matched by adjusting Iliamna precipitation multipliers to 1.3, resulting in an average annual basin precipitation of 54.5 inches and a net precipitation of 47.8 inches (Table 7). Of this, 13.4 inches or 28 percent of the net precipitation was assumed to be recharged to groundwater (Table 7). The full range of flows was adequately characterized, and the Nash Sutcliff factor of 0.67 indicates an adequate fit.

The calculated average annual discharge was 37 cfs or 3.4 cubic feet per second per square mile (cfs/mi^2) (Table 8). The calibration included groundwater flow under the gage of 0.78 cfs. This underflow is consistent with a sand and gravel aquifer with a width of 110 feet and a gradient of 0.01 feet per foot (ft/ft). The calculated average March flows (typically the lowest flow month of the year) was 5 cfs or 0.5 cfs/mi^2.

The measured average annual unit discharge from this catchment is higher than other drainages primarily for the following reasons:

- A greater portion of the catchment is at higher elevations, resulting in higher precipitation and lower evapotranspiration.
- More of the rainfall and snowmelt runs off immediately than in other catchments, as most of the catchment has relatively steep slopes.

In contrast with the average annual flows, measured unit low flows are relatively low due to the relatively low recharge rates and high runoff rates within the drainage.

3.2.2 SK124A

SK124A is located on Tributary SK1.124 about 5,900 feet upstream of the confluence with the South Fork Koktuli River (Figure 1). The sub-catchment area for the gage is approximately 8.5 mi^2. The average elevation of the sub-catchment is 1,462 feet, one of the four highest in this study. The upper reaches of this valley are very steep, similar to SK119A. However, the stream flows out of the valley as much as 2 miles upstream of the gage, flowing over permeable sands and gravels with a depressed water table. Losses from the channel are expected along this lower stretch of the stream, which will decrease the streamflow measured at the gage.

The calculated and measured hydrographs are presented on Figure 6. The flows were matched by adjusting Iliamna precipitation multipliers to 1.25, resulting in an average annual basin precipitation of 51.6 inches and a net precipitation of 43.6 inches (Table 7). Of this, 16.3 inches or 37 percent of the net precipitation was assumed to be recharged to groundwater. The average recharge is higher than SK119A due to the losses from the stream channel as it flows over the permeable sands and gravels. The full range of flows was well represented, and the Nash Sutcliff factor of 0.75 indicates a good fit.

The calculated average annual discharge was 21 cfs or 2.4 cfs/mi^2 (Table 8). The calibration included groundwater flow under the gage of 6.7 cfs. This underflow is consistent with the extensive sand and gravel aquifer underlying the lower reaches of this tributary. The calculated average March flows (typically the lowest flow month of the year) was 1.4 cfs or 0.2 cfs/mi^2.

The measured average annual unit discharge and the average March flows are lower than might be expected in this sub-catchment due to channel losses in the lower reach of the stream.

3.2.3 SK100F

SK100F is located on the South Fork Koktuli River immediately downstream of Frying Pan Lake (Figure 1) with a catchment of about 11.9 mi^2. The average elevation of the sub-catchment is 1,284 feet, a little

above the median in this study (Table 6). The valley walls are moderately steep. Poorly drained moraines are present as are some alluvial fans, fan deltas, and beach deposits. The valley floor, approximately 0.4 to 1 mile wide, is a remnant of the larger glacial Frying Pan Lake. Fine-grained, glacial-lake deposits mantle much of the valley floor, and some deltaic deposits overlie the glacial-lake deposits. The catchment area includes the lake, and considerable pond and wetland areas. The northern boundary of the catchment is a topographic divide south of the headwaters of Upper Talarik Creek. Although there is considerable overburden fill in the valley, most of the drilling indicates that the hydraulic conductivity of the overburden is generally lower than at downstream locations. Groundwater recharge is probably limited by the material types but enhanced by the flat valley floor and extended wet periods. To the south of Frying Pan Lake, the valley floor is not as flat because the surficial materials transition to a glacial moraine. Downstream of the moraine, groundwater levels are depressed below the lake and the adjacent river. This implies that there is relatively low permeability ground immediately downstream of Frying Pan Lake.

The calculated and measured hydrographs are presented on Figure 7. The flows were matched by adjusting Iliamna precipitation multipliers to 1.16, resulting in an average annual basin precipitation of 46.3 inches and a net precipitation of 36.1 inches (Table 7). Of this, 11.8 inches or 33 percent of the net precipitation was assumed to be recharged to groundwater (Table 7). The full range of flows was well represented and the Nash Sutcliff factor of 0.83 indicates a good fit.

The calculated average annual discharge was 28 cfs or 2.4 cfs/mi^2 (Table 8). During March, the low-flow month, flows measured at SK100F are lower than SK100G, further upstream (Figure 1), which indicates that surface flows at SK100G that originated as groundwater are lost to groundwater between SK100G and SK100F. It is also likely that additional groundwater discharge that occurs between SK100G and SK100F is lost. Losses to groundwater in this area are not supported by available piezometric data, because piezometric levels are above Frying Pan Lake. The implication is that losses are occurring from Frying Pan Lake through a regime that is not instrumented. This is likely the narrow southern part of the lake immediately upstream of the gage. Description of the gage site is typical of a site near the bedrock contact, which is expected to be relatively permeable. The calibration included groundwater flow under the gage of 3.6 cfs. The calculated average March flow (typically the lowest flow month of the year) was 6.5 cfs or 0.5 cfs/mi^2.

Also included in the calculation for this catchment was a second linear reservoir to represent water stored in the lakes, ponds, and wetlands. An enhanced evapotranspiration over an area of approximately 1.2 mi^2 was allowed to represent these ponds and wetlands.

The groundwater recharged in this area is illustrated by the calculated stored volume from the water balance and the measured groundwater elevations in piezometer MW-5S (Figure 8). The temporal changes in measured groundwater elevation generally correlated with changes in calculated groundwater storage.

3.2.4 SK100C

Stream gage SK100C is located on the South Fork Koktuli River upstream of the tributary SK1.190 (Figure 1) with a catchment area of approximately 37.5 mi^2. The average elevation of the sub-catchment is 1,146 feet, a little less than the median in the study area (Table 6). A large portion of the catchment area

between SK100C and the upstream gages (SK100F and SK124A) is uplands sands and gravels with almost no runoff, as indicated by the many enclosed, water-filled depressions. In addition, stream flows from SK100F and SK124A flow in channels well above the water table, resulting in large losses from the stream channels. In August 2004, when stream flows at SK100C dried, flows in SK100F averaged 9.5 cfs. Similar documented losses occurred in late winter months. During those low-flow periods, losses have also occurred from the SK124A channel. SK100C is located at a site that goes dry most years. The hydraulic conductivity under the SK100C gage is very high, as indicated by the geologic materials and the results of the pumping test carried at PW-4, which is located just downstream of SK100C.

The calculated and measured hydrographs are presented on Figure 9. The flows were matched by adjusting Iliamna precipitation multipliers to 1.25, resulting in an average annual basin precipitation of 48.6 inches and a net precipitation of 38.5 inches (Table 7). The calculated groundwater recharge of 46.8 inches was 122 percent of the net precipitation (Table 7). The very high recharge is the result of losses from the stream channels (water originating from outside the sub-catchment).

The stream channel losses were estimated by selecting a flow rate from each of the streams that would all be lost and then adding a percentage of the remaining flow. For the SK100F flow, all of the first 20 cfs and 45 percent of the remainder were recharged. For the SK124A flows, the first 3.9 cfs and 45 percent of the remainder were recharged. Although the full range of flows was well represented, several additional low flow months were calculated. A Nash Sutcliff factor of 0.63 indicates an adequate fit to the measured flows.

The calculated average annual discharge was 54 cfs or 1.4 cfs/mi^2 (Table 8). The calibration included groundwater flow of 53 cfs out of the catchment, some of which continued downstream to Area 4 and some of which was diverted to tributary UT119A. This large groundwater flow is indicative of a permeable gravel aquifer. The calculated average March flows (typically the lowest flow month of the year) was 4.4 cfs or 0.1 cfs/mi^2. The channel was dry at SK100C in March for most years. The calculation indicates some warm March months that cause snowmelt, which results in some flow during March at SK100C.

The large volume of water recharged is represented on Figure 10 by the calculated volume in storage and the MW-11M water levels. Both the snowmelt and the fall rains are apparent.

3.2.5 SK100B

Stream gage SK100B, under the care of the U.S. Geological Survey (USGS) and published on the internet, is located on the South Fork Koktuli River (Figure 1) and has a catchment area of approximately 64.96 mi^2. The sub-catchment area for the gage is approximately 21.1 mi^2. The average elevation of the sub-catchment is 1,143 feet, which is close to the average elevation for SK100C and slightly less than the median in this study (Table 6). This gage accepts water flowing past gage SK100C and SK119A as well as from the catchment between these two gages and SK100B. Groundwater discharges downstream of SK100C, which contributes to the base flow. There are outwash sands and gravels, and terrace sands and gravels in the valley adjacent to the river that have high groundwater recharge rates. Discharge from these sands and gravels probably also contributes to the relatively high base flow of this gage. As noted above, channel losses to groundwater occur between gage SK119A and the confluence of tributary SK1.190 and the South Fork Koktuli River. In the water balance, all of the first 4 cfs passing the SK119A gage was

assumed lost from the channel plus 45 percent of the flow over 4 cfs. As the gage is located within a section of alluvial fill that was narrowed by a glacial moraine, this section of SK1.190 may be the most reliable in terms of estimating the total flow.

The calculated and measured hydrographs are presented on Figure 11. The flows were matched by adjusting Iliamna precipitation multipliers to 1.4, resulting in an average annual basin precipitation of 54.5 inches and a net precipitation of 47.8 inches (Table 7). Of this, 19.8 inches or 41 percent of the net precipitation was assumed to be recharged to groundwater. The full range of flows was well represented and the Nash Sutcliff factor of 0.65 indicates an adequate fit.

The calculated average annual discharge was 188 cfs or 2.7 cfs/mi^2 (Table 8). The calibration included groundwater flow under the gage of 14.5 cfs. This underflow is consistent with a sand and gravel aquifer. The calculated average March flows (typically the lowest flow month of the year) was 51 cfs or 0.7 cfs/mi^2.

The seasonal change and the year-to-year trends in groundwater storage calculated by the water balance model correlated reasonably well with measured groundwater levels at MW-1S (Figure 12).

3.2.6 SK100A

Stream gage SK100A is downstream of SK100B (Figure 1), close to the confluence of the South Fork Koktuli River with the North Fork Koktuli River. The catchment area is approximately 102.6 mi^2. The sub-catchment area for the gage is approximately 37.6 mi^2. The average elevation of the sub-catchment is 768 feet, the lowest in this study. This gage accepts water flowing past SK100B as well as from the catchment between SK100B and SK100A. A significant portion of the catchment added between these two stations is relatively flat land, perhaps on the surface of overburden fill within a paleo valley. The southern boundary of the catchment is the top of a gentle slope into the Kaskanak Creek catchment. The lack of a strong topographic divide and the probable presence of a deep overburden fill would seem to provide an opportunity for a transfer of groundwater from the South Fork Koktuli basin into the Kaskanak basin. However, many small ponds were mapped throughout the Kaskanak basin and over the divide into the South Fork Koktuli basin, indicating probable high groundwater levels in this area. The topography and presence of the ponds is consistent with the presence of low-permeability materials, which would limit seepage losses across the divide. Low-flow measurements (see Chapter 7 of the EBD) indicate that baseflow decreases downstream from SK100B to SK100LF10 (about 7.8 miles downstream) and then recovers at SK100A (about 13.9 miles downstream). The losses are probably related to the extensive sand and gravel aquifer materials downstream of UT100B and the parallel tributary on the same alluvial plane that almost certainly captures some of the SK flows. The recovery of baseflow at SK100A and low flows measured at Kaskanak Creek (KC100A; see Chapter 7 of the EBD) indicate that if there are any cross-catchment seepage losses from this section of the South Fork Koktuli River, they are relatively small.

The measured and calculated hydrographs for SK100A are presented on Figure 13. The flows were matched by adjusting Iliamna precipitation multipliers to 1.1, resulting in an average basin precipitation of 40.1 inches and a net precipitation of 28.8 inches (Table 7). Of this, 21.2 inches or 74 percent of the net precipitation was assumed to recharge groundwater. The full range of flows was well represented, and the Nash Sutcliff factor of 0.7 indicates an adequate fit.

The calculated average annual discharge was 263 cfs or 2.5 cfs/mi^2 (Table 8). The calibration included flow under the gage of 19.9 cfs. The calculated average March flows (typically the month of the year with lowest flow) was 88 cfs or 0.8 cfs/mi^2.

3.3 No t Fo Ko tuli Results

3.3.1 NK119A

NK119A (Area G) is on a tributary (NK1.190) about 1 mile upstream of its confluence with the North Fork Koktuli River (Figure 1). The catchment area is approximately 7.8 mi^2. The average elevation of the catchment is 1,654 feet, the highest in this study. Drill holes within this catchment all indicated thin overburden. In addition, the basin is relatively steep; therefore, recharge is relatively low and groundwater storage limited.

The calculated and measured hydrographs are presented on Figure 14. The flows were matched by adjusting Iliamna precipitation multipliers to 1.23, resulting in an average basin precipitation of 52.5 inches and a net precipitation of 45.7 inches (Table 7). Of this, 10.2 inches or 22 percent of the net precipitation was assumed to recharge groundwater (Table 7). The full range of flows was well represented and the Nash Sutcliff factor of 0.67 indicates an adequate fit.

The calculated average annual discharge was 25 cfs or 3.2 cfs/mi^2 (Table 8). The calibration included flow under the gage of 0.94 cfs. The calculated average March flow (typically the lowest flow month of the year) was 5 cfs or 0.6 cfs/mi^2.

3.3.2 NK119B

Stream gage NK119B is on a tributary to NK1.190 (1.190.10) (Figure 1). The catchment area is approximately 3.9 mi^2. The average elevation of the catchment is 1,482 feet, the third highest in the study area. This tributary originates in the valley immediately west of the Pebble Deposit, flows north, then swings west through extensive glacial deposits. There is a potential for losses from the channel. During low flow measurements, no flow was detected at this gage.

Hydrographs were not prepared for NK119B, as there was insufficient data to develop an adequate calibration. The flows were estimated by adjusting Iliamna precipitation multipliers to 1.12, resulting in an average basin precipitation of 46.3 inches and a net precipitation of 36.9 inches (Table 7). Of this, 4.7 inches or 13 percent of the net precipitation was assumed to recharge groundwater (Table 7).

The calculated average annual discharge was 10 cfs or 2.6 cfs/mi^2 (Table 8). The estimation included flow past the gage of 1.1 cfs. The calculated average March flows (typically the lowest flow month of the year) was 1.1 cfs or 0.3 cfs/mi^2.

3.3.3 NK100C

Stream gage NK100C is near the headwaters of the North Fork Koktuli River (Figure 1). The catchment area is approximately 24.4 mi^2. The average elevation of the catchment is 1,323 feet, well above the median for this study area. Monitoring well MW-8 was drilled within this catchment through 95 feet of

overburden. Ice-contact deposits and pothole lakes are common throughout the lower elevations of the catchment. Drillhole GH04-01 encountered 147 feet of overburden, about 50 feet of which was primarily sand and gravel. NK100C is located within a channel cut through a terminal moraine.

The calculated and measured hydrographs are presented on Figure 15. Enhanced evapotranspiration over an area of approximately 3 mi^2 was allowed to represent the ponds and wetlands. The flows were matched by adjusting Iliamna precipitation multipliers to 1.07, resulting in an average basin precipitation of 43.1 inches and a net precipitation of 32.3 inches (Table 7). Of this, 13.0 inches or 40 percent of the net precipitation was assumed to recharge groundwater (Table 7). Although the full range of flows was represented, the calculated flows are somewhat deficient in the mid-flow range. This deficiency is also apparent in the Nash Sutcliff factor of 0.51, indicating a marginally acceptable fit.

The calculated average annual discharge was 54 cfs or 2.2 cfs/mi^2 (Table 8). The estimation included flow under the gage of 5.5 cfs. The calculated average March flows (typically the lowest flow month of the year) was 18 cfs or 0.7 cfs/mi^2.

Figure 16 illustrates the relationship between the calculated volume of water in groundwater storage in the drainage area with groundwater levels measured in MW-8S. The increases and decreases in calculated storage generally correlated with increases and decreases in the groundwater levels.

3.3.4 NK100A

Stream gage NK100A, under the care of the USGS, is published on line. The catchment area is approximately 105.8 mi^2. The sub-catchment area is approximately 69.8 mi^2. The average elevation of the sub-catchment is 1,185 feet, near the median for this study. This gage receives flow passing NK119A, NK119B, and NK100C. Downstream of these three gages is a large glacial outwash deposit. Low-flow measurements indicate that losses to groundwater within the glacial outwash occur downstream of NK100C. NK100LF3 (Chapter 7) is located near the downstream end of the mapped outwash sand and gravel. The relatively constant low flow along this section of the river (the norm is for flows to increase in a downstream direction) is probably due to high groundwater flow rates in the outwash sand and gravel. At the next low-flow station downstream, NKLF4, the low-flow rate increases as does the unit low-flow rate. At NKLF4 and NK100A, the unit low-flow rates are fairly similar.

The calculated and measured hydrographs are presented on Figure 17. The flows were matched by adjusting Iliamna precipitation multipliers to 1.12, resulting in an average basin precipitation of 43.9 inches and a net precipitation of 34.1 inches (Table 7). Of this, 10.8 inches or 32 percent of the net precipitation was assumed to recharge groundwater (Table 7). The range of flows was well represented except for a small deficiency in the mid-flow range. The Nash Sutcliff factor of 0.67 indicates an adequate fit.

The calculated average annual discharge was 266 cfs or 2.5 cfs/mi^2 (Table 8). The estimation included flow under the gage of 2.6 cfs. The calculated average March flows (typically the lowest flow month of the year) was 70 cfs or 0.7 cfs/mi^2.

3.4 Upper Talarik Creek Results

3.4.1 UT100D

Stream gage UT100D (Figure 1) measures the flow from the headwaters of Upper Talarik Creek immediately north of the headwaters of the South Fork Koktuli River and east of the headwaters of the North Fork Koktuli River. The catchment area is approximately 12.0 mi^2. The average elevation of the catchment is 1,147 feet, near the median for this study. UT100E is within the catchment for UT100D. Base flows dominate the hydrograph for UT100E, consistent with the many springs mapped immediately upstream of this gage. Although the base flow increases from UT100E to UT100D, the unit flow decreases. This decrease is consistent with the mapped springs upstream of UT100E and with the geology change from outwash sands and gravels upstream of UT100E to glacial lake deposits downstream of UT100E.

Figure 18 presents the measured and calculated flows for UT100D. The flows were matched by adjusting the Iliamna precipitation multiplier to 1.12, resulting in an average basin precipitation of 43.6 inches and a net precipitation of 32.9 inches (Table 7). Of this, 12.2 inches or 37 percent of the net precipitation was assumed to be recharged to groundwater (Table 7). The full range of flows was well represented and the Nash Sutcliff factor of 0.71 indicates an adequate fit.

The calculated average annual discharge was 30 cfs or 2.5 cfs/mi^2 (Table 8). The estimation included flow under the gage of 0.26 cfs. The calculated average March flows (typically the lowest flow month of the year) was 13 cfs or 1.1 cfs/mi^2.

3.4.2 UT119A

Stream gage UT119A (Figure 1) measures discharge from tributary UT1.190 immediately upstream of the confluence. The measured flows are predominantly groundwater discharge. About 20 cfs is derived from the South Fork Koktuli catchment (both from the river and from recharge within the surface water catchment boundaries). The remainder of the groundwater discharge originates as recharge within the UT119A catchment area (about 6 cfs). There is very little surface runoff.

Figure 19 presents the measured and calculated monthly and cumulative flows. The flows were matched by adjusting the Iliamna precipitation multiplier to 1.24, resulting in an average basin precipitation of 46.3 inches and a net precipitation of 36.7 inches (Table 7). Of this, 25 inches or 68 percent of the net precipitation was assumed to be recharged to groundwater (Table 7). As the flows in this groundwater-dominated regime are quite consistent throughout the year, the full range is represented. The uniform flow rate resulted in a negative Nash Sutcliff factor, which implies that the average flow rate may be a better estimate of the flows.

The calculated average annual discharge was 28 cfs or 6.9 cfs/mi^2 (Table 8). The estimation included flow under the gage of 0.68 cfs. The calculated average March flows (typically the lowest flow month of the year) was 24 cfs or 6 cfs/mi^2.

The unit flows at UT119A are much higher than at other gages (6 compared to 2.5) because of the cross boundary flow from the South Fork Koktuli catchment into this catchment.

3.4.3 UT100B

Stream gage UT100B (Figure 1) is under the care of the USGS, and the gage is published on the internet. The catchment area is approximately 86.2 mi^2. Stream gage UT100B receives flow passing UT100D and UT119A as well as flow generated from within the sub-catchment (downstream of UT100D and UT119A and upstream of UT100B). The sub-catchment area is approximately 70.2 mi^2, and the average elevation is 1,070 feet, the fourth lowest in the study area. Although the lower elevations of this sub-catchment are covered with glacial lake deposits that inhibit groundwater recharge, there is a very large area of permeable glacial outwash and ice contact deposits east of Upper Talarik Creek, which has very little to no runoff and correspondingly high recharge. Groundwater discharge is evident as springs upstream of UT100B, which probably originated from that large groundwater recharge area.

Figure 20 presents the measured and calculated monthly and cumulative flows. The flows were matched by adjusting the Iliamna precipitation multiplier to 1.17, resulting in an average basin precipitation of 45 inches and a net precipitation of 34.7 inches (Table 7). Of this, 17.7 inches or 51 percent of the net precipitation was assumed to be recharged to groundwater. The full range of flows was well represented, and the Nash Sutcliff factor of 0.63 indicates an adequate fit.

The calculated average annual discharge was 231 cfs or 2.7 cfs/mi^2 (Table 8). The estimation included flow under the gage of 7.8 cfs. The calculated average March flows (typically the lowest flow month of the year) was 120 cfs or 1.4 cfs/mi^2.

The high unit base flow results in part from discharge from UT119A, which is almost completely groundwater, and high groundwater discharge from other areas along the creek, notably from the east bank of the creek, between UT100LF5 and UT100B (Figure 1). Of the total calculated March flows of approximately 120 cfs, 13 cfs originates from upstream of UT100D and 24 cfs originates from upstream of UT119A, leaving 83 cfs or 70 percent of the March flow originating within the UT100B sub-catchment. This is a unit base flow of 1.18 cfs/mi^2, still much larger than the average in the South Fork Koktuli or North Fork Koktuli catchments.

3.4.4 UT100APC1

Stream gage UT100APC1 is downstream of UT100B, with most of the channel within a deep valley. The catchment area for the gage is 101.4 mi^2. Stream gage UT100APC1 measures flow passing UT100B as well as flow generated from within the sub-catchment (downstream of UT100B and upstream of UT100APC1). The sub-catchment area is approximately 15.2 mi^2 and the average elevation is 780 feet, the second lowest in the study area.

Flows were not calibrated for this gage because the measured period was much shorter than other gages in this study area. The flows were estimated by adjusting the Iliamna precipitation multiplier to 1.2, resulting in an average basin precipitation of 43.8 inches and a net precipitation of 33.5 inches (Table 7). Of this, 10.8 inches or 32 percent of the net precipitation was assumed to be recharged to groundwater.

The calculated average annual discharge was 276 cfs or 2.7 cfs/mi^2 (Table 8). The estimation included flow under the gage of 0.16 cfs. The calculated average March flows (typically the lowest flow month of the year) was 139 cfs or 1.4 cfs/mi^2.

4. SUMMARY OF RESULTS

4.1 Clim te Inputs

The water balance was based on climate data from Iliamna Airport, which had a period of record from 1942 through 2008. The site precipitation data were calibrated to measured site precipitation through the following adjustments:

- Doubling the Iliamna winter precipitation (December through April) to account for the expected undercatch of snow at Iliamna.
- Applying an orographic factor of 10 percent per 100 meters (328 feet) for winter months and 3 percent for summer months to account for the expected increase of precipitation with elevation and to match measured flows at meteorological station Pebble 1.
- Applying a precipitation multiplier to each catchment to account for potential undercatch of snow on site, the potential for rain shadow effects, and the potential for distribution variations due to blowing snow.

A comparison between the measured snow pack on site, regional snow pack, and calculated snow pack from the water balance implied that the general pattern of snowfall was good but that the estimated snowpack in the spring of 2008, although higher than 2007, was less than measured snowpacks on site.

The average annual precipitation measured at Iliamna Airport (1942 through 2008) was 26.8 inches. Including the adjustments listed above, the average estimated annual precipitation for sub-catchments within the study area ranged from 40 to 55 inches (1.5 to 2 times measured Iliamna precipitation).

4.2 St e m Flows

Average annual unit flows measured in the streams were generally consistent with the rainfall applied when the differences in elevation and gage underflows were considered. Following are general observations with respect to average annual flows.

- Nine of the 14 catchments in the water balance had estimated annual unit flows that ranged from 2.4 to 2.7 cfs/mi^2. These nine catchments were distributed across the three major drainages. The minor variation within this range resulted from differing elevations.
- The highest average annual unit flow was at gage UT119A (6.9 cfs/mi^2), which was more than double the next highest unit flow of 3.4 cfs/mi^2. This high unit flow was the result of groundwater flow from the South Fork Koktuli drainage to this tributary and ongoing recharge from enclosed, water-filled depressions within the catchment of UT119A.
- The second and third highest average annual unit flow was estimated for the SK119A gage (3.4 cfs/mi^2) and NK119A (3.2 cfs/mi^2). These high flows were simulated by recognizing the high elevations and hence higher precipitation.
- NK100C had the second lowest estimated average annual unit flow of 2.7 cfs/mi^2. This low flow was obtained with a combination of increased evaporation from ponds within Big Wiggly Basin and the lowest multiplier of Iliamna precipitation within the study area (1.07).

- SK100C had the lowest average annual unit flow (1.4 cfs/mi^2). This was due to the high groundwater recharge component, which depleted the streamflow. Part of the groundwater recharge flowed towards UT119A and the rest flowed downstream past SK100C.

Low flows are the most important consideration for assessment of surface water/groundwater interaction. Several areas are clearly important for groundwater surface water interaction within the study area. Following are some observations.

- A large sand and gravel aquifer downstream of Frying Pan Lake accepts considerable leakage from the main stream channel of the South Fork Koktuli River. This loss from the channel results in a dry stream bed over a considerable distance, and includes gage SK100C. Additional losses from the SK1.240 stream channel also contribute to this aquifer, together with recharge from precipitation. Groundwater flow from this area is both downstream along the South Fork Koktuli River and towards tributary UT1.190.
- The highest unit base flows were measured within the Upper Talarik Creek drainage. These high base flows are the result of aquifer storage with sufficient volume to make a difference to the base flows. These aquifers are as follows:
  - An outwash sand and gravel immediately upslope of UT100E. This sand and gravel aquifer results in base flow being an important component of the average annual flow at UT100E.
  - A large sand and gravel aquifer within the South Fork Koktuli River drainage that discharges partly to tributary UT1.190. Most of the flow from this tributary is groundwater.
  - A large aquifer east of Upper Talarik Creek that provides groundwater discharge to the creek year round.
- Extensive sand and gravel deposits downstream of SK100B and a parallel tributary on the same sand and gravel that probably captures South Fork Koktuli flows results in a base flow reduction. This base flow is recovered upstream of SK100A.
- In the North Fork Koktuli River valley, stream baseflow decreases downstream of NK100B. From NK100B downstream to NK100LF4, a glacial outwash sand and gravel has been mapped (Hamilton, 2008). Base flow increases near NK100LF4, which is located at the downstream end of the outwash deposit.

4.3 G oun w te Rec ge

Groundwater recharge rates were assigned to each of the sub-catchments adequate to simulate the measured discharge to streams. These groundwater recharge rates have been assigned to a numerical groundwater model to verify that the recharge rates and groundwater flow pathways meet the physics of groundwater flow, and are consistent with groundwater levels that have been taken through the basin. The groundwater flow modeling is described in Appendix 8.1J of Chapter 8 of the EBD.

The average groundwater recharge rates for each basin are presented in Table 8. Following are some comments:

- The highest estimated average annual recharge rate was within the subcatchment for SK100C (46.8 inches), which is greater than the estimated net precipitation for that area. This discrepancy

is due to water that flows into the catchment as surface water and then leaks into the groundwater system from the surface-water channel.

- Several catchments have high groundwater recharge rates, primarily due to the large permeable outwash, ice contact, and terrace deposits. These include UT119A (25 inches), SK100A (21.2 inches), SK100B (19.8 inches), and UT100B (17.7 inches).
- Eight of the remaining nine catchments have recharge rates that range from 10.2 to 16.3 inches.
- The lowest recharge rate is for the NK119B catchment (4.7 inches).

5. REFERENCES

Alley, William M. 1984. On the Treatment of Evapotranspiration, Soil Moisture Accounting, and Aquifer Recharge in Monthly Water Balance Models. Water Resources Research, Vol. 20, 1137- 1149.

Glarner, Herbert. 2006. Length of day – Formulae. Retrieved 2006, from http://herbert.wikispaces.com

Hamilton, Thomas D. 2008. Surficial Geologic Map of the Pebble Limited Partnership's Pebble Project. A study prepared for the Pebble Limited Partnership.

Jakeman, A.J. and G.M. Hornberger. 1993. How much complexity is warranted in a rainfall-runoff model? Water Resources Research, Vol. 29, 2637-2649.

Kirchner, James W. 2006. Getting the right answers for the right reasons: Linking measurements, analyses and models to advance the science of hydrology. Water Resources Research, Vol. 42, WO3SO4.

Micovic, Zoran, 2004. Minimum watershed model structure for representation of runoff processes. Ph.D. thesis, University of British Columbia.

Nash, J.E. and J.V. Sutcliff. 1970. River flow forecasting through conceptual models part 1 – A discussion of principles. Journal of Hydrology, Vol. 10 (3), 282-290.

Steenhuis T.S. and W.H. Van der Molen. 1986. The Thornthwaite – Mather Procedure as a Simple Engineering Method to Predict Recharge. Journal of Hydrology, Vol. 84, 221-229.

Thornthwaite C.W. 1948. An Approach to a Rational Classification of Climate. American Geophysical Review, Vol. 38.

Yang, D., B. Goodison, J. Metcalfe, P. Louie, E. Elomaa, C. Hanson, V. Golubev, T. Gunther, J. Milkovic, and M. Lapin. 2001. Compatibility evaluation of national precipitation gage measurements. Journal of Geophysical Research, Vol. 106, 1481–1491, doi:10.1029/2000JD900612.

TABLES

TABLE 1

Monthly Temperature Records for Illiamna Airport (°F)

	Average	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Jan	16	33	5	17	34	19	-7	16	15	15	8	7	10	5	23	1	19	17	11	23	24	10	24
Feb	18	34	20	31	24	14	20	15	7	2	18	18	14	0	13	10	16	24	25	23	7	23	19
Mar	22	23	23	19	20	9	19	20	28	30	9	18	14	18	21	16	28	28	7	20	10	19	22
Apr	32	36	32	31	28	31	33	31	25	32	33	27	35	29	24	28	35	37	32	24	30	32	26
May	43	46	43	43	39	40	41	43	39	41	42	36	42	42	39	39	46	43	44	43	44	40	43
June	51	51	53	52	50	50	49	50	47	48	49	48	56	51	47	48	56	50	54	51	51	51	47
July	55	55	54	55	55	54	54	53	54	54	56	53	58	53	53	55	57	54	52	55	53	57	55
Aug	54	56	53	54	54	52	55	51	53	57	54	54	55	52	52	55	58	54	54	52	52	54	53
Sept	48	52	45	46	46	48	46	44	49	48	47	47	47	47	46	45	47	46	47	46	48	45	50
Oct	35	35	37	37	33	38	34	35	36	35	34	39	32	39	30	28	42	33	37	36	29	36	34
Nov	25	17	31	25	12	19	31	16	29	18	26	33	27	29	17	13	35	20	31	24	22	27	10
Dec	16	-7	20	24	17	6	21	11	10	12	14	12	24	2	8	5	4	22	9	31	6	15	29
Annual	35	36	35	36	34	32	33	32	33	33	33	32	35	31	31	29	37	36	34	36	31	34	34

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Jan	18	13	18	8	9	5	1	0	10	16	16	16	18	37	30	30	6	32	16	15	20	35	22
Feb	13	10	17	14	16	15	27	22	16	17	16	16	11	33	25	4	23	21	13	20	1	10	24
Mar	14	34	8	25	28	27	31	0	22	22	22	22	15	22	27	30	27	35	24	33	34	22	19
Apr	26	34	30	33	30	34	30	26	31	31	31	31	31	27	37	37	37	36	27	36	30	20	27
May	36	39	39	45	44	42	44	35	42	42	42	42	41	41	45	46	43	48	41	45	43	39	42
June	51	48	52	51	53	51	52	45	51	51	51	51	49	52	51	52	51	53	49	53	54	48	49
July	55	55	55	57	57	56	52	54	55	55	55	55	56	57	54	58	56	56	53	57	55	55	54
Aug	54	53	53	57	57	52	51	53	54	52	54	55	55	57	59	56	52	54	54	55	55	52	52
Sept	49	50	49	49	46	49	42	47	47	47	47	49	47	48	49	51	48	46	47	46	50	47	48
Oct	35	29	30	34	32	40	29	35	35	35	35	35	34	34	37	41	37	35	28	32	35	29	38
Nov	23	24	21	31	27	21	30	26	30	21	25	17	30	16	31	33	28	25	27	33	26	24	28
Dec	4	9	12	12	3	27	5	9	17	17	17	12	17	10	27	7	6	18	28	29	25	36	29
Annual	31	33	32	35	33	35	33	29	34	34	34	33	34	36	39	37	34	38	34	38	36	35	36

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	23	26	-3	15	17	21	14	23	19	14	12	16	16	4	28	25	31	12	23	5	12.5	7.5
Feb	25	25	25	2	13	7	22	16	21	14	31	16	16	30	28	21	36	29	23	22	22.7	16.8
Mar	28	25	20	26	23	21	29	20	17	31	21	22	14	30	27	24	23	19	29	18	6.2	22.7
Apr	33	29	35	38	36	33	40	36	37	34	36	31	29	35	35	32	38	35	34	29	35.3	27.8
May	42	44	43	45	45	42	48	45	47	47	47	42	40	44	41	45	45	48	47	45	43.3	42.6
June	50	53	52	52	50	52	54	52	52	53	55	51	51	51	54	53	52	54	55	51	51.6	49.1
July	59	58	56	57	55	56	59	55	57	55	59	55	55	55	56	56	58	60	58	55	56.4	53.9
Aug	56	55	56	56	53	54	57	56	55	53	57	54	54	54	56	56	57	59	57	53	56.3	54.0
Sept	46	47	51	48	51	47	48	49	52	44	50	47	48	46	49	49	48	45	49	49	50.1	47.8
Oct	38	34	36	33	38	34	40	32	38	30	30	35	30	35	28	43	40	40	35	40	33.1	29.0
Nov	20	21	21	17	25	25	27	19	20	25	30	25	20	33	23	37	26	31	15	14	33.2	18.3
Dec	14	21	24	20	18	19	29	15	26	10	17	17	5	34	12	25	17	24	29	17	17.2	22.9
Annual	36	37	35	34	35	34	39	35	37	34	37	34	31	38	36	39	39	38	38	33	35	33

missing data replaced with average values.

TABLE 2
Mont l P ecipit tion Reco s fo lli mn Ai po t (inc es)

	Average	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Jan	1.3	0.9	0.1	1.3	1.2	1.7	1.6	0.9	2.9	0.5	0.7	1.3	1.9	0.6	2.0	0.9	4.1	1.9	0.5	2.7	1.7	1.2	1.8
Feb	1.3	1.2	1.2	1.4	1.2	1.2	0.9	0.5	1.1	0.1	1.7	1.4	3.8	1.2	3.5	1.8	0.8	0.7	1.6	0.6	1.0	1.1	0.7
Mar	1.2	1.4	0.8	1.2	1.0	3.2	2.1	1.0	3.1	0.1	1.2	1.4	1.1	2.2	1.7	0.5	0.7	1.3	0.0	0.1	0.4	0.6	4.5
Apr	1.1	2.9	1.1	0.1	0.5	1.8	0.3	0.7	0.4	1.6	0.5	1.7	0.2	0.9	1.6	1.3	0.6	0.7	1.3	1.2	1.6	0.6	2.7
May	1.2	2.0	0.4	2.8	1.7	2.4	1.6	0.4	0.6	0.3	0.1	1.4	0.5	0.4	0.6	1.2	0.3	1.5	0.9	2.2	0.4	2.5	1.0
June	1.6	1.3	1.7	1.0	0.6	2.4	0.9	1.3	1.0	3.9	2.3	1.1	1.1	0.3	2.4	0.9	0.2	2.0	0.3	1.7	2.3	2.7	2.0
July	2.6	3.1	2.3	3.5	2.4	3.2	4.0	4.9	1.4	2.0	0.8	3.7	0.9	5.0	2.8	2.6	0.6	2.8	2.3	5.0	5.7	1.2	1.2
Aug	4.6	5.1	6.4	7.5	6.2	6.8	2.1	4.9	6.4	6.4	4.2	3.5	7.5	6.8	4.5	2.8	2.7	4.4	7.1	6.5	6.3	2.8	5.0
Sept	4.6	2.8	4.3	4.7	6.2	3.9	5.2	4.2	2.7	4.1	5.6	2.7	5.4	3.6	3.3	4.4	3.8	3.5	1.0	6.4	11.2	2.4	2.5
Oct	3.1	1.8	4.7	2.6	5.1	7.2	1.1	1.8	2.8	2.4	2.4	4.2	1.8	2.9	3.1	3.6	2.3	3.6	1.3	2.3	4.0	1.9	1.3
Nov	2.1	1.4	2.9	1.7	1.0	1.1	1.5	0.8	2.1	0.2	2.7	2.5	2.3	2.6	0.9	1.3	2.9	1.5	1.2	1.0	3.3	0.6	0.2
Dec	1.7	0.4	5.5	1.7	0.4	3.0	2.4	2.8	0.6	0.5	2.3	1.3	0.9	0.7	2.7	0.4	1.8	1.0	1.7	1.0	2.5	1.4	2.4
Annual	26.5	24.3	31.5	29.6	27.5	37.7	23.6	24.3	25.0	22.1	24.3	26.1	27.5	27.0	29.1	21.7	20.7	24.8	19.1	30.7	40.2	19.1	25.4
	1964	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
Jan	1.2	0.7	0.5	1.3	1.0	1.0	0.3	1.0	1.0	1.0	1.0	1.0	0.8	1.5	0.5	1.2	1.4	2.4	0.6	0.4	2.3	2.5	2.4
Feb	2.4	1.0	1.3	0.6	1.1	1.5	2.0	1.2	1.2	0.7	1.2	1.1	0.4	1.7	1.7	0.5	1.8	2.0	0.3	1.5	2.2	1.4	0.5
Mar	1.3	2.4	1.3	2.3	0.1	1.2	2.7	1.3	1.3	1.3	1.3	1.3	1.8	0.9	0.4	1.5	1.0	1.8	1.0	0.0	0.3	1.8	0.0
Apr	2.0	1.8	0.3	2.6	1.1	0.5	1.7	1.5	1.5	1.5	1.5	1.5	1.7	2.5	0.8	2.0	1.4	0.5	0.9	2.5	0.6	0.4	0.5
May	2.1	2.0	2.6	0.0	2.6	0.9	0.3	1.3	1.3	1.3	1.3	1.3	0.9	1.9	1.7	0.9	1.2	1.3	0.6	1.3	0.8	4.1	2.0
June	1.6	1.3	0.7	4.1	0.5	2.5	2.0	1.4	2.7	2.5	2.5	2.4	1.1	2.6	3.0	2.6	4.4	2.0	2.5	0.8	0.4	4.3	0.4
July	1.4	3.3	3.3	5.5	0.3	4.6	3.4	2.9	2.9	2.9	2.9	1.7	2.1	1.1	3.2	3.6	6.6	3.7	3.8	1.0	0.6	2.6	3.7
Aug	5.2	4.8	8.2	8.7	2.1	4.6	4.5	4.5	4.5	5.3	5.0	2.1	2.5	3.6	3.0	3.7	8.1	4.3	2.6	3.7	5.2	10.5	6.2
Sept	3.5	8.1	3.3	4.8	2.0	2.4	4.8	4.8	4.8	5.1	3.8	9.2	3.7	6.1	3.0	2.5	5.4	1.7	9.3	3.0	1.6	6.1	6.6
Oct	4.3	0.2	2.7	0.8	3.4	5.3	2.8	2.8	2.8	5.1	3.4	2.4	1.0	3.5	4.1	3.4	4.8	2.3	3.0	5.4	1.4	4.5	3.2
Nov	0.8	1.8	2.6	4.9	0.5	1.9	2.2	2.2	2.2	2.6	2.9	0.2	4.0	0.2	3.2	7.9	1.5	2.1	1.8	4.9	1.9	1.7	4.0
Dec	0.7	1.7	0.8	3.0	1.0	1.3	1.7	1.7	1.7	1.7	1.7	1.4	2.1	0.6	3.7	1.5	0.1	1.5	0.9	0.5	3.1	1.3	2.8
Annual	26.5	29.1	27.7	38.9	15.7	27.7	28.3	26.5	27.7	31.0	28.5	25.5	22.1	26.1	28.3	31.6	37.5	25.6	27.2	25.0	20.3	41.2	32.3
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	
Jan	2.8	2.2	1.1	1.9	0.5	1.3	1.7	2.4	0.6	0.5	0.7	1.2	1.2	1.6	2.3	1.7	0.0	0.4	1.9	0.1	0.5	1.6	
Feb	0.4	1.3	2.0	2.2	0.7	0.7	0.9	0.4	0.3	1.5	1.5	1.4	1.4	1.3	2.5	1.9	2.4	1.3	0.8	1.7	0.1	0.4	
Mar	0.9	2.6	0.3	1.1	1.8	2.2	0.7	0.5	0.4	1.1	0.2	0.6	0.8	1.1	0.9	0.0	0.2	1.0	0.9	1.3	0.4	0.2	
Apr	0.3	2.0	1.1	0.8	0.7	0.2	0.2	1.1	1.6	0.5	0.4	1.0	1.7	0.4	1.3	1.2	1.6	1.5	0.7	0.8	0.6	0.7	
May	1.5	0.8	1.7	1.4	0.5	0.2	0.5	1.5	0.0	0.8	1.6	0.9	0.6	0.2	1.1	1.3	1.5	1.4	0.3	0.5	0.5	1.0	
June	1.1	1.3	0.6	0.7	0.4	1.4	0.4	1.7	0.4	1.8	0.5	1.2	2.2	1.0	0.9	0.6	2.0	1.5	2.5	2.3	1.7	0.7	
July	2.5	0.5	1.9	2.2	2.1	1.9	1.1	3.1	1.7	2.2	0.2	2.4	3.0	3.4	4.5	1.9	3.1	1.7	3.6	1.1	2.7	2.9	
Aug	2.9	5.0	4.6	2.4	1.8	5.3	2.6	2.2	3.3	7.2	3.7	4.0	5.4	4.1	2.7	3.8	5.1	1.3	4.5	5.9	2.6	1.4	
Sept	5.0	2.6	7.5	4.4	2.5	4.4	5.6	2.0	7.1	3.4	3.4	4.3	4.6	6.0	2.6	6.2	1.7	7.3	8.2	3.6	7.8	7.3	
Oct	4.5	3.5	8.0	3.1	3.1	1.7	2.4	2.2	1.3	1.0	0.3	2.8	2.7	3.8	3.8	5.8	4.9	4.0	2.9	4.7	3.1	3.4	
Nov	2.0	1.7	2.2	2.9	1.1	1.5	4.7	5.9	0.7	0.6	1.6	2.7	0.4	3.4	0.4	3.8	6.1	3.8	0.9	0.8	1.6	1.2	
Dec	1.3	2.2	0.3	3.3	1.8	2.2	1.9	2.7	0.7	0.7	1.57	1.6	1.6	2.0	2.5	0.9	0.6	2.0	1.7	0.9	1.5	1.0	
Annual	25.3	25.6	31.2	26.5	16.9	22.9	22.7	25.8	18.1	21.3	15.5	24.1	25.5	28.3	25.4	29.1	29.1	27.2	29.0	23.7	23.2	21.8	

Notes:
estimated as average of "valid" data from 5 years before and 5 years following.
estimated based on precipitation measured on site.

TABLE 3

Me su e P ecipit tion fo 2007 t oug 2008
t lli mn n Pe le Site 1

Year	Month	Iliamna	Site 1
2006	Jan	0.07	0.36
	Feb	1.72	5.33
	Mar	1.29	2.75
	Apr	0.75	2.02
	May	0.51	0.86
	Jun	2.28	3.20
	Jul	1.07	0.78
	Aug	7.72	8.41
	Sep		5.21
	Oct		6.95
	Nov		1.20
	Dec		2.65
2007	Jan		1.52
	Feb		0.38
	Mar		1.10
	Apr		1.81
	May		0.80
	Jun	1.65	2.22
	Jul	2.66	2.38
	Aug	2.52	1.57
	Sep	7.98	10.10
	Oct	3.07	4.39
	Nov	2.64	5.61
	Dec	2.06	2.74
2008	Jan	1.64	3.82
	Feb	0.36	1.77
	Mar	0.19	1.65
	Apr	0.68	1.57
	May	1.03	2.20
	Jun	0.7	0.91
	Jul	2.85	2.64
	Aug	1.44	2.36
	Sep	7.13	7.09
	Oct	3.41	2.64
	Nov	1.18	1.50
	Dec		3.03

TABLE 4

O og p ic Multiplie s of lli mn P ecipit tion

Elevation bands (ft)			Multipliers	
lower	upper	center	winter	remainder
	800	550	1.14	1.04
800	1,300	1,050	1.38	1.09
1,300	1,800	1,550	1.66	1.14
1,800	2,300	2,050	2.00	1.20
2,300		2,550	2.40	1.26

TABLE 5
Comp ison of Estim te Snow P c s wit SnowMo el

	Mean Snow Water Equivalent (Inches)						
	4/19/2006		9/4/2007		6/4/2008		4/6/2008
Basin	SnowModel	Water Balance	SnowModel	Water Balance	SnowModel	Water Balance	Lidar
NK100A	21.5	12.68	6.1	5.12	23.8	10.83	
NK100C	22.6	12.86	6.3	4.85	26.3	11.15	
NK119A	23.8	17.72	7.5	7.63	24.8	15.15	29.4
NK119B	22.3	14.42	0	5.77	25.1	11.74	24.8
SK100A	19.5	8.63	4.5	4.06	19.3	9.32	
SK100B	21.3	17.54	5.7	8.09	21.7	13.58	
SK100C	21.2	15.18	5.5	6.43	22.2	11.81	
SK100F	21.8	14.26	6.3	5.79	23.7	11.64	23.7
SK119A	23.3	18.63	6.9	8.23	22.6	16.11	30.9
SK124A	22.3	17.00	6.5	7.34	22.7	14.20	32
UT100B	19.2	12.48	4.4	5.42	19.6	11.11	
UT100D	20.5	12.74	5.8	5.01	22.6	10.46	15.2
UT119A	18.1	12.80	2	5.74	17.2	10.77	

TABLE 6
A e s fo Su -c tc ments Ele tion

			Area (ft^2)							
		lower bound elevation		800	1,300	1,800	2,300			
		upper bound elevation	800	1,300	1,800	2,300				
		average elevation	550	1,050	1,550	2,050	2,550			
Area #	Gage	Ppt multiplier						Total	Average Elevation (ft)	Contributing Area ft^2	Contributing Area mi^2
Area 1	SK119A	1.3	0	96,792,640	119,224,632	72,286,065	10,874,703	299,178,040	1,545	299,178,040	10.7
Area 2	SK124A	1.25	0	87,495,294	106,612,592	41,143,274	2,359,332	237,610,491	1,462	237,610,491	8.5
Area 3	SK100F	1.16	0	166,711,165	110,268,968	22,705,708	0	332,162,241	1,284	332,162,241	11.9
				32,476,400							
Area 4	SK100B	1.4	47,207,937	411,392,482	102,421,348	26,622,175	413,099	588,057,043	1,143	1,932,589,191	69.3
Area 5	SK100C	1.25	0	227,722,372	71,392,852	10,208,435	0	475,581,377	1,146	1,045,354,109	37.5
				166,091,000							
Area 7	UT119A	1.24	30,715,763	81,932,391	241,376	0	0	112,889,531	915	112,889,531	4.0
Area 8	SK100A	1.1	738,901,889	215,925,756	51,867,752	28,139,397	13,074,248	1,047,909,041	768	2,980,498,233	106.9
Area 9	UT100D	1.12	11,567,296	250,148,843	66,965,000	4,700,230	0	333,381,369	1,147	333,381,369	12.0
Area 10	UT100B	1.17	467,891,232	912,556,354	352,526,971	105,875,389	24,696,713	1,957,442,358	1,070	2,403,713,258	86.2
			93,895,700								
Area 11	UT100APC1	1.2	247,534,512	158,041,590	18,539,276	0	0	424,115,378	780	2,827,828,636	101.4
Area 12	NK119B	1.12	0	20,344,713	85,063,750	5,260,551	0	110,669,015	1,482	110,669,015	4.0
Area 13	NK100C	1.07	0	342,479,833	159,272,725	73,569,566	21,479,499	678,761,824	1,323	678,761,824	24.3
				81,960,200							
Area 14	NK119A	1.23	0	14,689,317	148,147,245	47,412,817	6,110,914	216,360,293	1,654	216,360,293	7.8
Area 15	NK100A	1.12	232,016,642	1,073,216,830	531,269,049	101,214,990	7,337,421	1,945,054,933	1,185	2,950,846,064	105.8

Note:
Areas where additional evaporation is allowed to account for wet conditions.

TABLE 7

P ecipit tion Multiplie Annu l Net P ecipit tion n Rec ge Su -c tc ment (1942 - 2008)

		Ppt	Contributing Area		Precipitation	Net Precipitation		Recharge [a]		
Area #	Gage	multiplier	ft^2	mi^2	inches	ft^3	inches	ft^3	inches	percent
Area 1	SK119A	1.3	299,178,040	10.7	54.5	1,191,993,265	47.8	334,532,779	13.4	28
Area 2	SK124A	1.25	237,610,491	8.5	51.6	864,237,512	43.6	322,355,662	16.3	37
Area 3	SK100F	1.16	332,162,241	11.9	46.3	999,692,013	36.1	327,913,040	11.8	33
Area 4	SK100B	1.4	1,932,589,191	69.3	54.5	2,344,151,364	47.8	970,852,636	19.8	41
Area 5	SK100C	1.25	1,045,354,109	37.5	48.6	1,524,235,563	38.5	1,855,903,928	46.8	122
Area 7	UT119A	1.24	112,889,531	4.0	46.3	345,572,328	36.7	235,373,492	25.0	68
Area 8	SK100A	1.1	2,980,498,233	106.9	40.1	2,512,332,141	28.8	1,854,031,001	21.2	74
Area 9	UT100D	1.12	333,381,369	12.0	43.6	912,891,661	32.9	338,857,665	12.2	37
Area 10	UT100B	1.17	2,403,713,258	86.2	45.0	5,668,003,496	34.7	2,894,584,029	17.7	51
Area 11	UT100APC1	1.2	2,827,828,636	101.4	43.8	1,183,941,341	33.5	382,493,729	10.8	32
Area 12	NK119B	1.12	110,669,015	4.0	46.3	339,849,664	36.9	43,252,070	4.7	13
Area 13	NK100C	1.07	678,761,824	24.3	43.1	1,827,609,470	32.3	736,475,117	13.0	40
Area 14	NK119A	1.23	216,360,293	7.8	52.5	824,787,447	45.7	184,227,553	10.2	22
Area 15	NK100A	1.12	2,950,846,064	105.8	43.9	5,527,541,531	34.1	1,750,809,416	10.8	32

Note:

a. Includes loss from stream channel where defined seperately.

TABLE 8
C lcul te A e ge Annu l Disc ges

Area #	Gage	Ppt multiplier	Annual Discharge (cfs)	Annual Discharge (cfs/mi^2)	March Flow (cfs)	March Flow (cfs/mi^2)	March Flow % of annual	Underflow (cfs)
Area 1	SK119A	1.3	37	3.4	5	0.5	14	0.78
Area 2	SK124A	1.25	21	2.4	1.4	0.2	7	6.7
Area 3	SK100F	1.16	28	2.4	6.5	0.5	23	3.6
Area 4	SK100B	1.4	188	2.7	51	0.7	27	14.5
Area 5	SK100C	1.25	54	1.4	4.4	0.1	8	53
Area 7	UT119A	1.24	28	6.9	24	6.0	88	0.68
Area 8	SK100A	1.1	263	2.5	88	0.8	34	19.9
Area 9	UT100D	1.12	30	2.5	13	1.1	43	0.26
Area 10	UT100B	1.17	231	2.7	120	1.4	52	7.8
Area 11	UT100APC1	1.2	276	2.7	139	1.4	50	0.16
Area 12	NK119B	1.12	10	2.6	1.1	0.3	10	1.1
Area 13	NK100C	1.07	54	2.2	18	0.7	33	5.5
Area 14	NK119A	1.23	25	3.2	5	0.6	18	0.94
Area 15	NK100A	1.12	266	2.5	70	0.7	26	2.6

FIGURES

1,350,000 1,400,000 1,450,000

2,200,000 2,150,000 2,100,000

N

Pebble Snow Course 1 & 1A (ss1)

Pebble Snow Course 2 (ss2)

13 15 14 12 9 10 3 2 1 8 5 4 7 11

NK100LF1 NK100B NK100C NK100LF3 NK119B NK119A NK100LF4 NK100LF5 NK1.190 SK1.240 SK1.190 SK1.210 SK1.310 UT1.190

Pebble 1 Pebble 3 Pebble 4

UT100E UT146A UT100LF1 UT138A UT141A UT100D SK136B SK136A SK134A SK100G SK133A SK131A SK100F UT135A UT100LF3A UT 100LF4 UT100LF5A SK124A SK100LF2 SK100LF4 SK100D SK100LF5A SK119A SK100LF6 SK100C SK100LF8 SK100LF7 SK100LF9 SK100B UT10LF6 UT119B UT122LF1 UT119A UT100B UT10LF7 UT10LF8

NK100A SK100A SK100LF10 KC100A UT100APC1

Z:\Pebble_7126_2010\GIS\MXDs\T4008\Figure 8-1-14 Stream Gaging Stations and Watershed Boundaries.mxd

THE pebble PARTNERSHIP

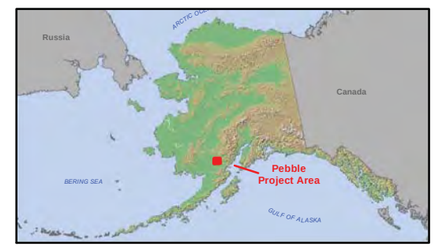
Figure 1
Stream Gaging Stations and Watershed Boundaries

Water Balance Model Study Area

Legend

- Snow Course Station
- Meteorological Station
- Stream Gaging Station
- Low Flow Stream Gaging Station
- General Deposit Location
- Lakes
- Rivers
- Sub-catchment

Note - numbers inside sub-catchments denote the sub-catchment number



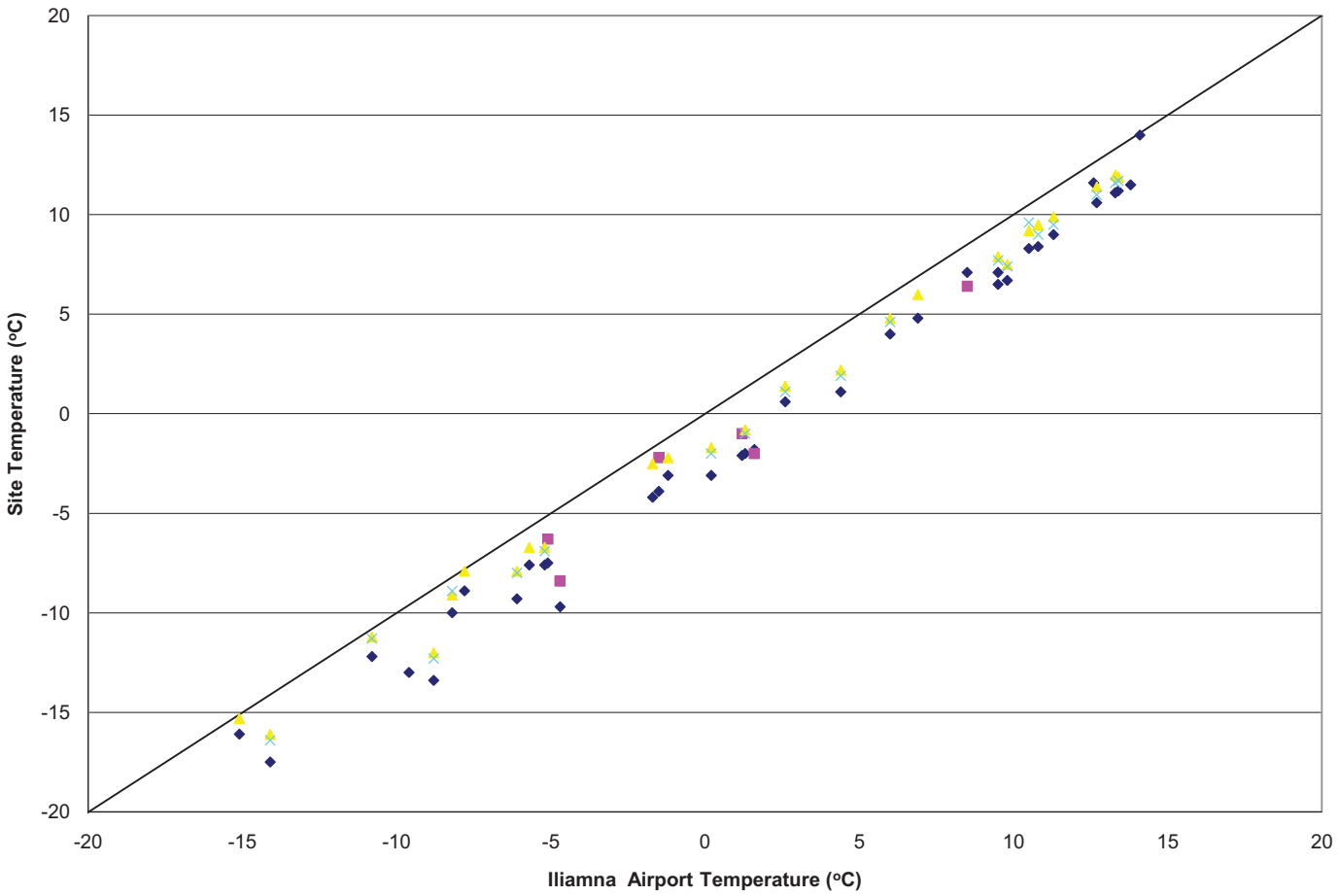
Feet
0 6,100 12,200 18,300 24,400 30,500

Meters
0 2,000 4,000 6,000 8,000 10,000

Scale 1:155,600

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL



THE pebble PARTNERSHIP

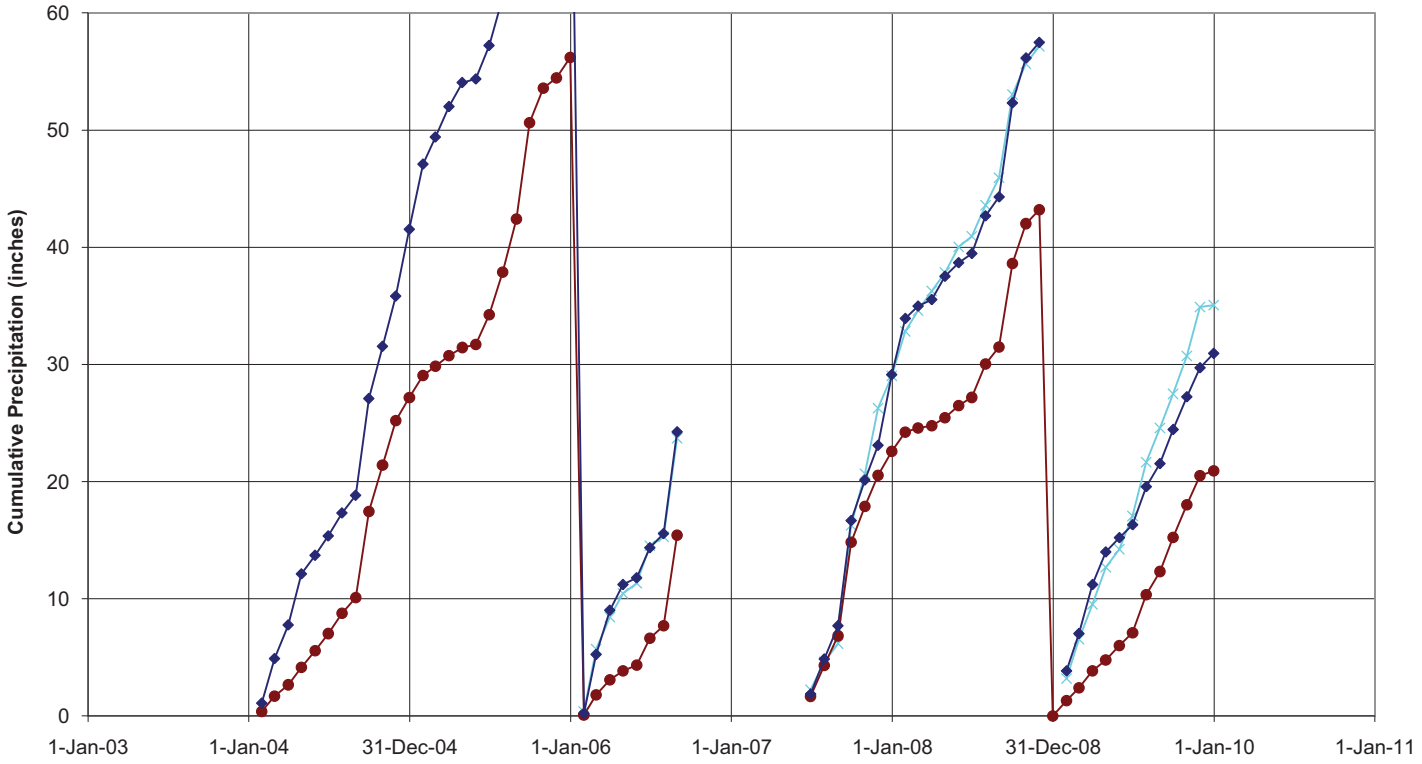
Figure 2
Correlation of Iliamna Airport and Pebble Site Meteorological Stations Monthly Temperatures

Appendix 8.1I
Water Balance Model

- Pebble Site 1
- Pebble Site 2
- Pebble Site 3
- Pebble Site 4
- 1 to 1 Line



Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011



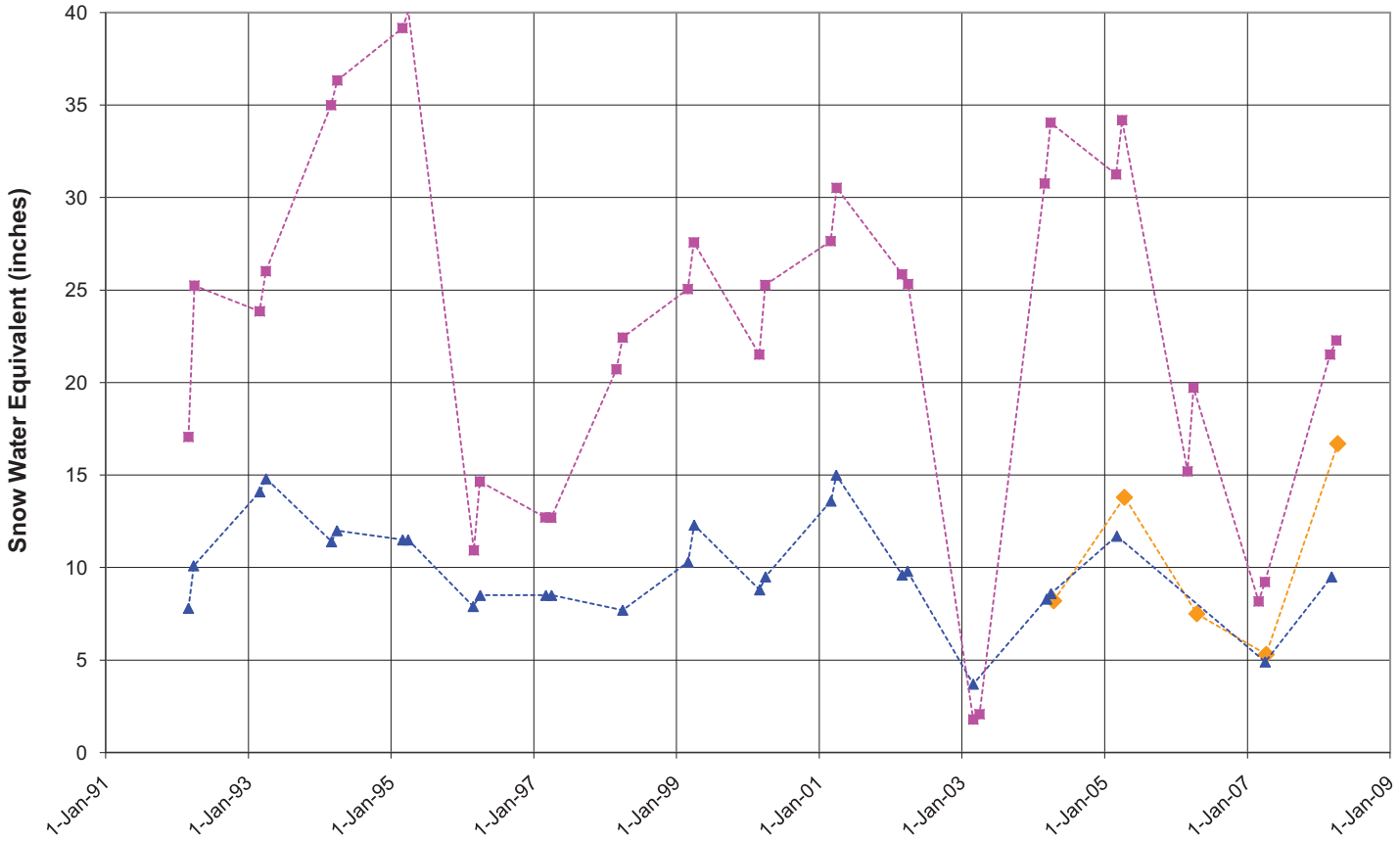
THE pebble PARTNERSHIP

Figure 3
Correlation of Iliamna Airport and Pebble Site 1 Meteorological Stations Monthly Precipitation

Appendix 8.1I
Water Balance Model



Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

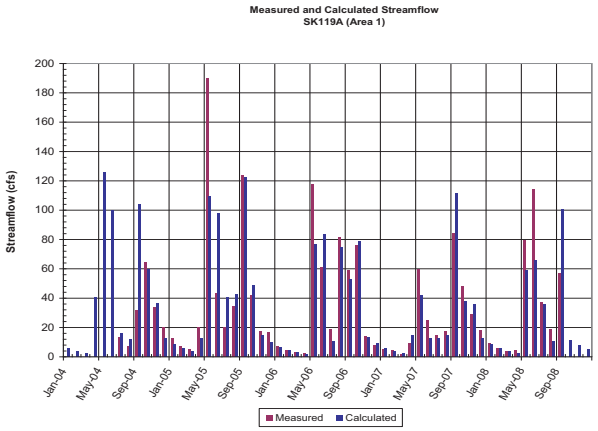
Figure 4
Comparison of Pebble Site 1A and Regional Snow Pack with Estimated Snow Pack

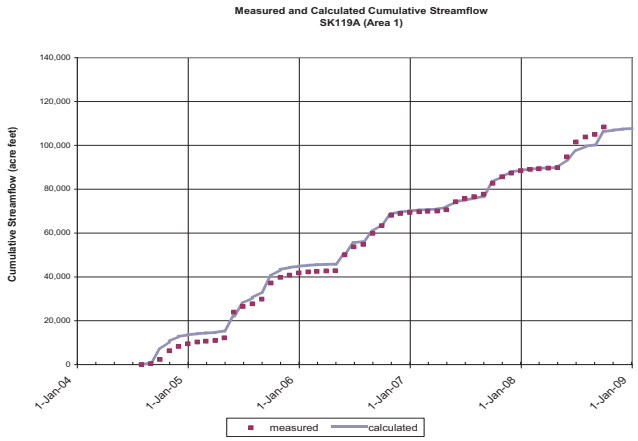
Appendix 8.1I
Water Balance Model

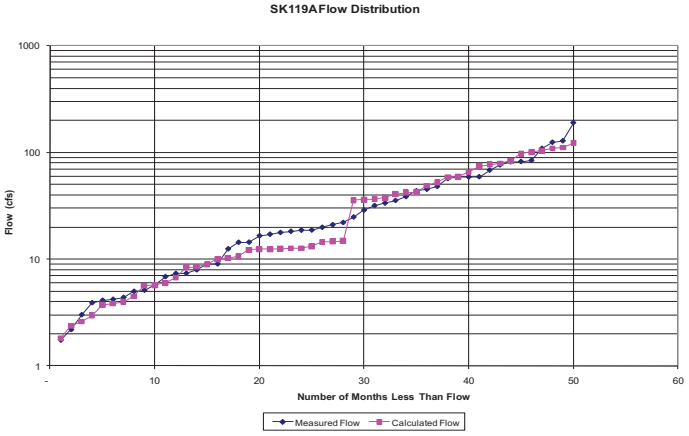
Pebble Snow Course 1A (2000 ft
Fishtrap Creek (1800 ft)
Calculated for Elevation 2050 ft

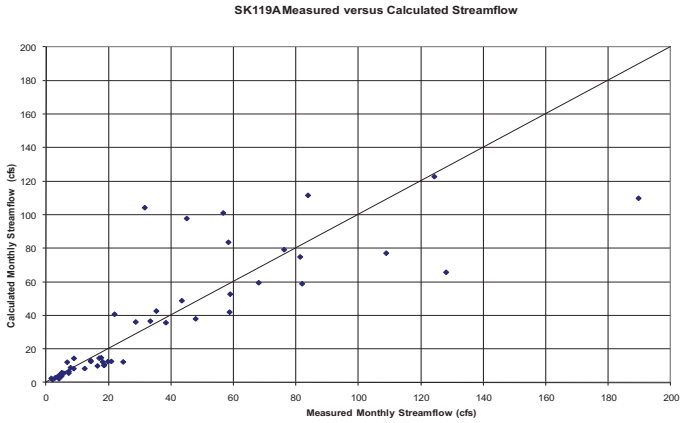


Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011







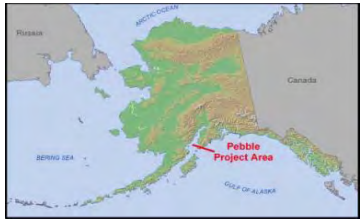


THE pebble PARTNERSHIP

Figure 5
Measured and Calculated Streamflow at SK119A (Area 1)

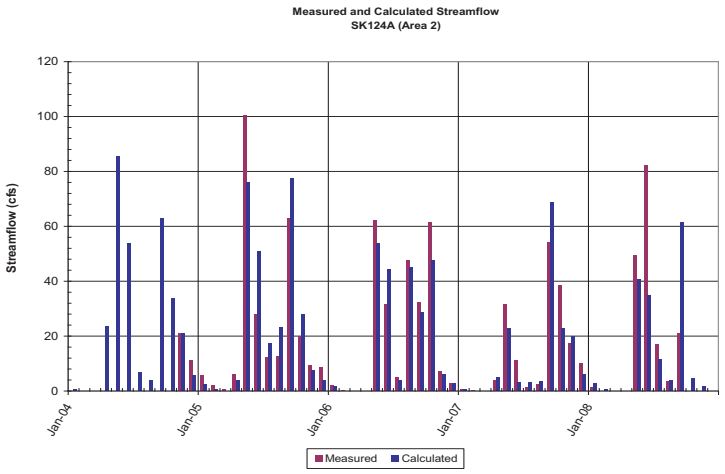
Appendix 8.1I
Water Balance Model

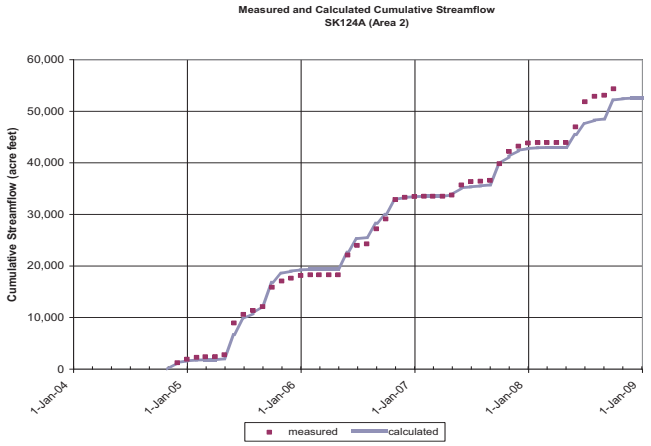
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.67

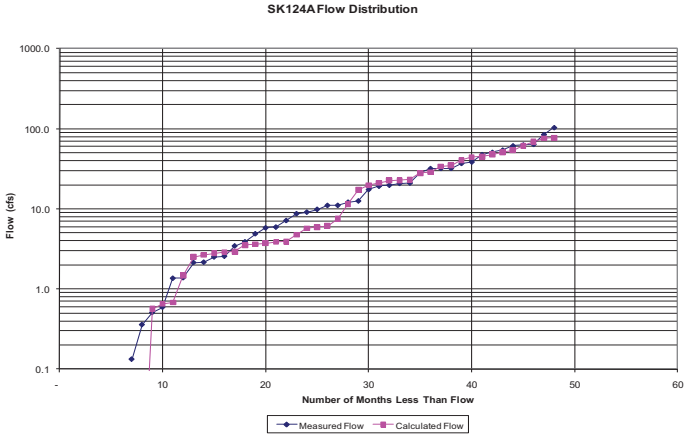


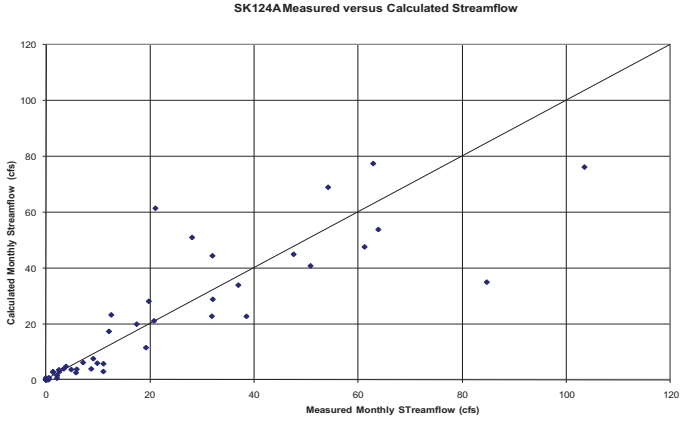
Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

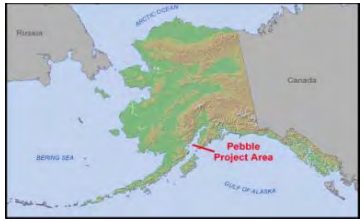
Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures











THE pebble PARTNERSHIP

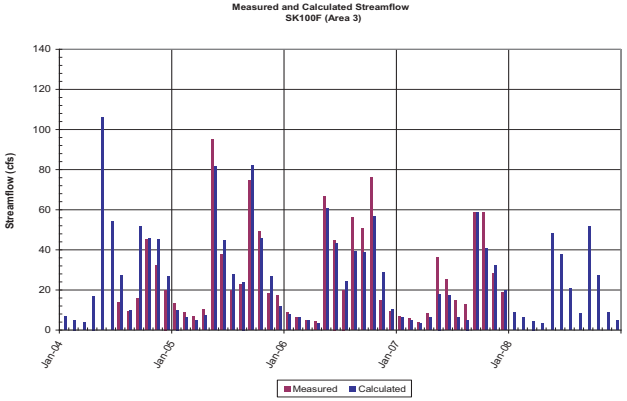
Figure 6
Measured and Calculated Streamflow at SK124A (Area 2)

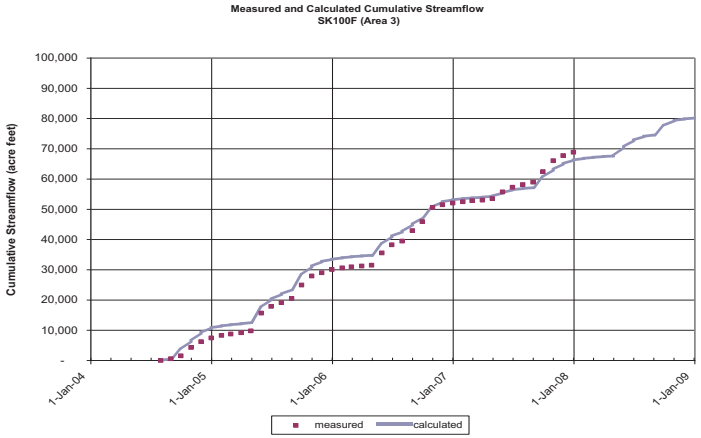
Appendix 8.1I
Water Balance Model

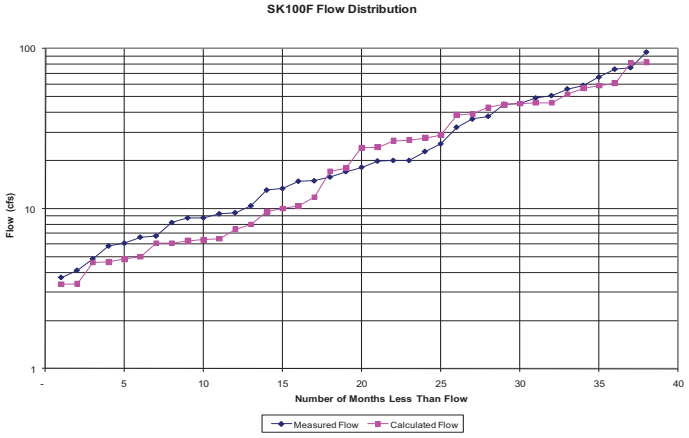
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.75

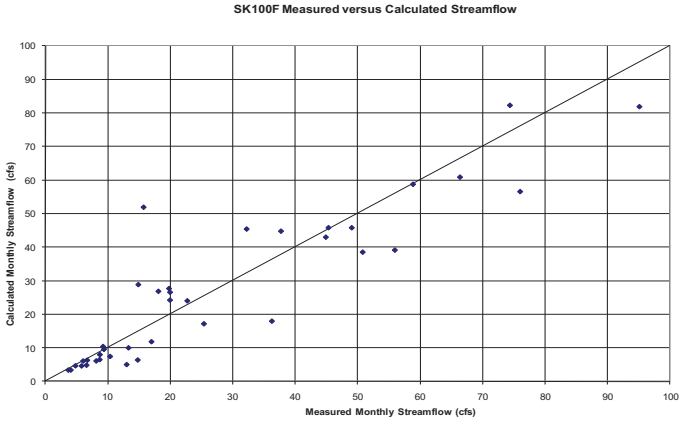
Project No: 7126	Author: SWS -RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures







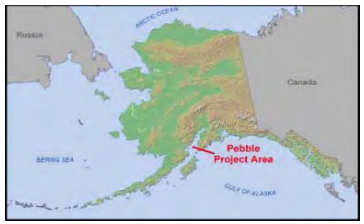


THE pebble PARTNERSHIP

Figure 7
Measured and Calculated Streamflow at SK100F (Area 3)

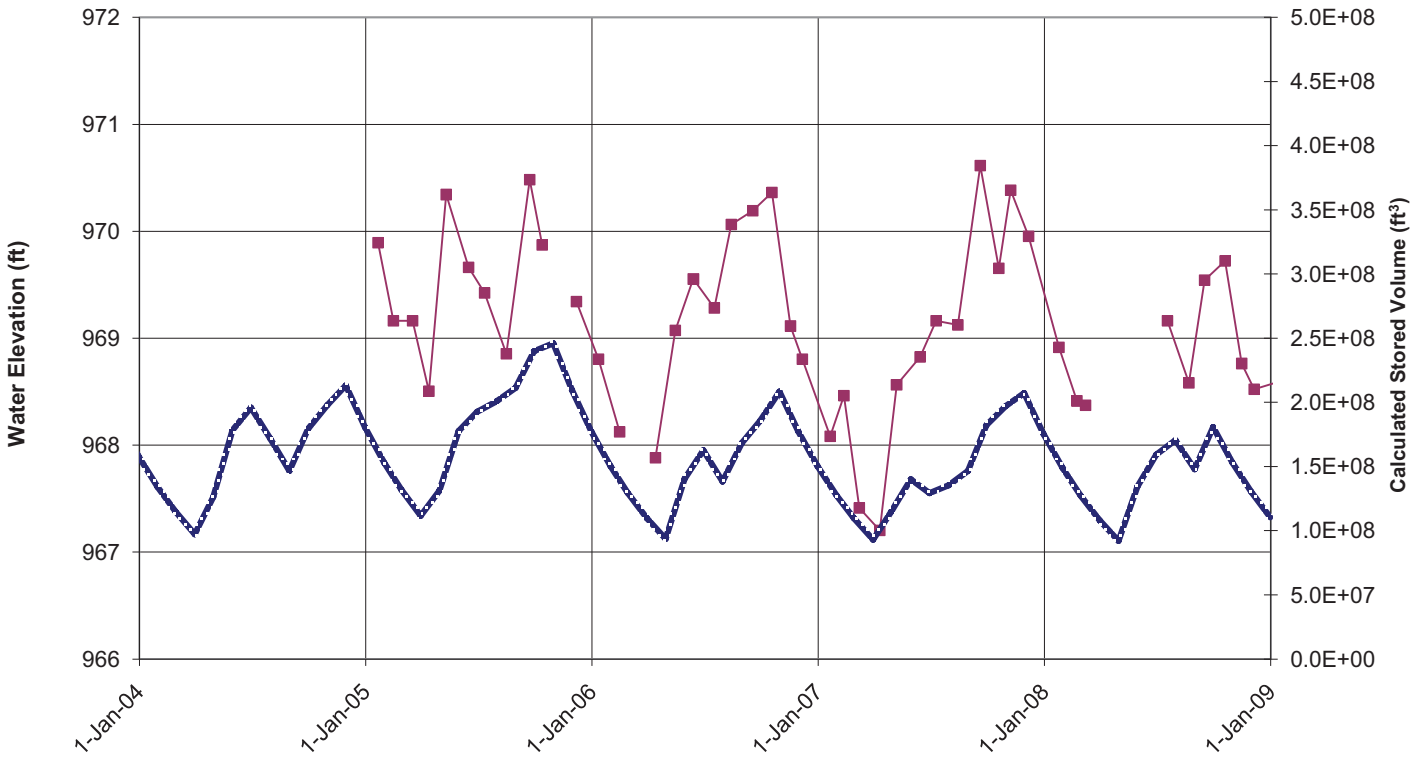
Appendix 8.1I
Water Balance Model

Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.83



Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures



THE pebble PARTNERSHIP

Figure 8
Comparison of MW-5S Water Levels with Calculated Groundwater Volumes (Area 3)

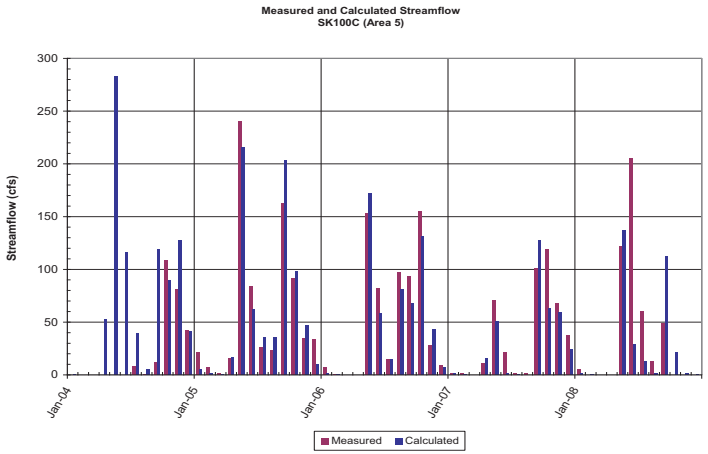
Appendix 8.1I
Water Balance Model

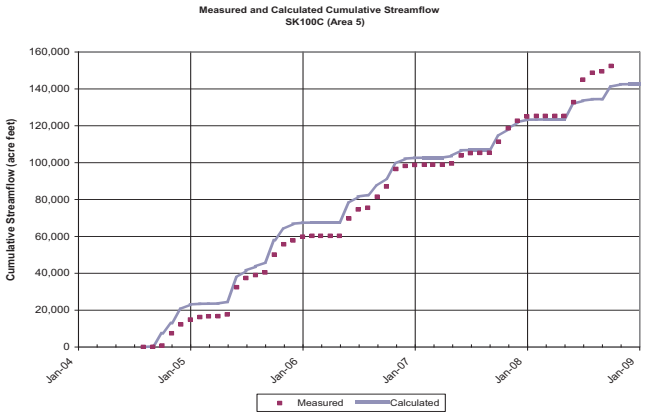
MW5-S Piezometer Elevation

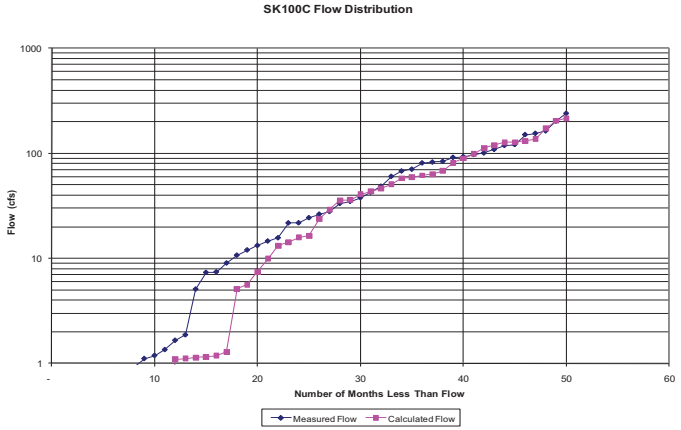
Calculated Area 3 Groundwater Volume

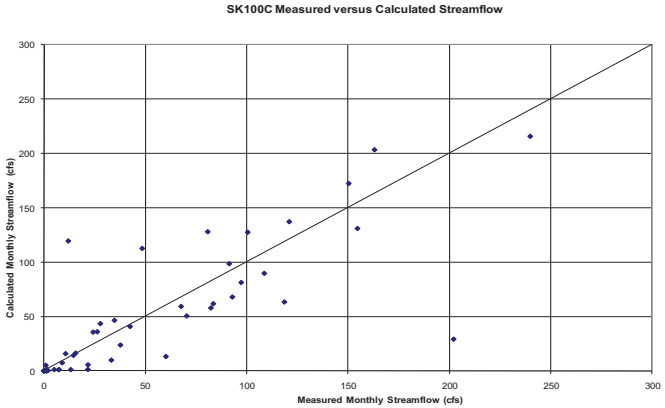


Project No: 7126	Author: SWS-PP
Version: 1	Date: April, 2011







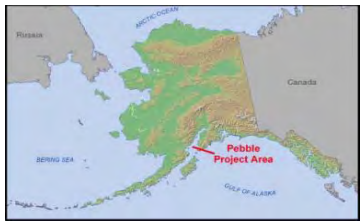


THE pebble PARTNERSHIP

Figure 9
Measured and Calculated Streamflow at SK100C (Area 5)

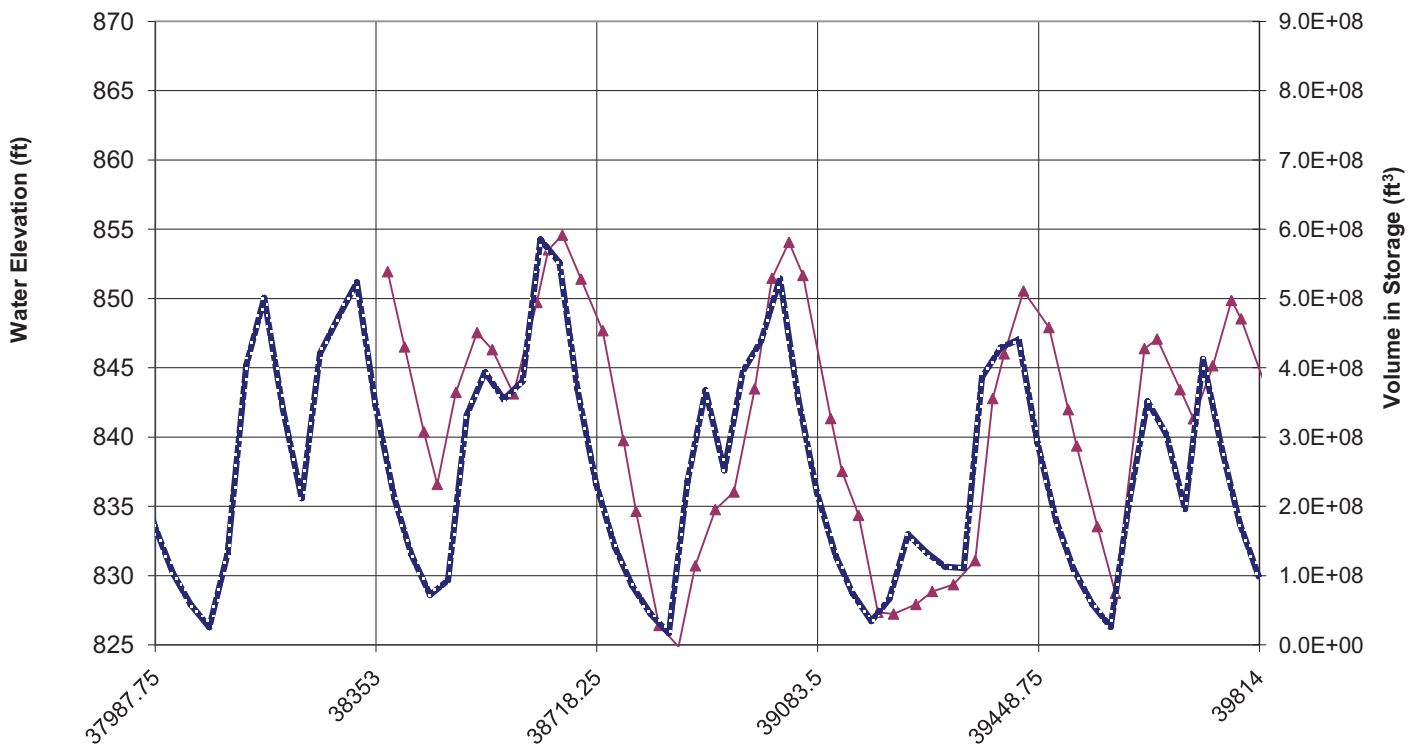
Appendix 8.1I
Water Balance Model

Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.63



Project No: 7126	Author: SWS -RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures



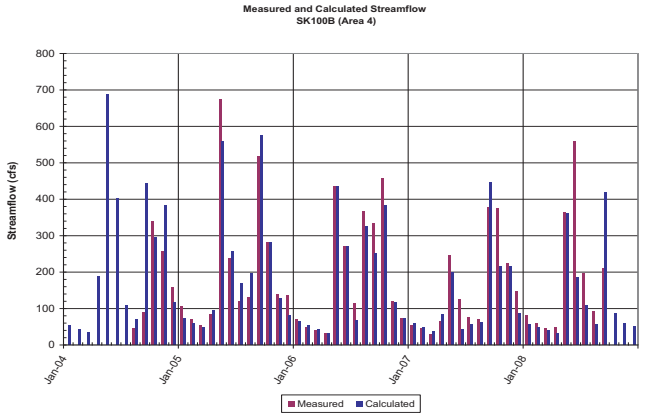
THE pebble PARTNERSHIP

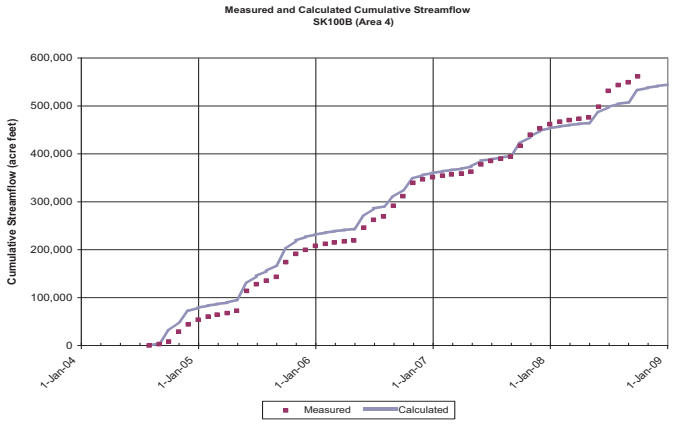
Figure 10
Comparison of MW-11M Water Levels with Calculated Groundwater Volumes (Area 5)

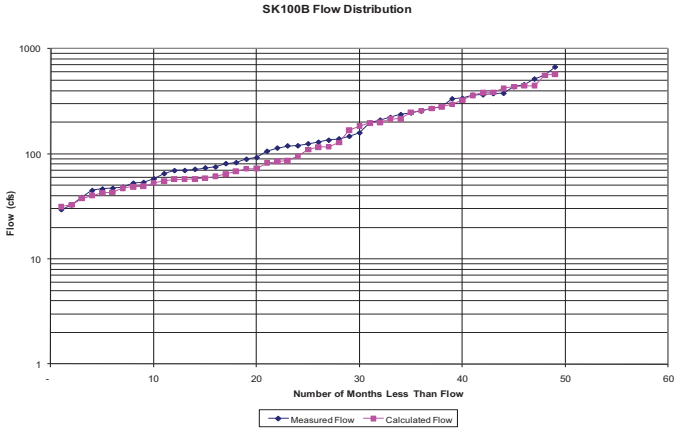
Appendix 8.1I
Water Balance Model

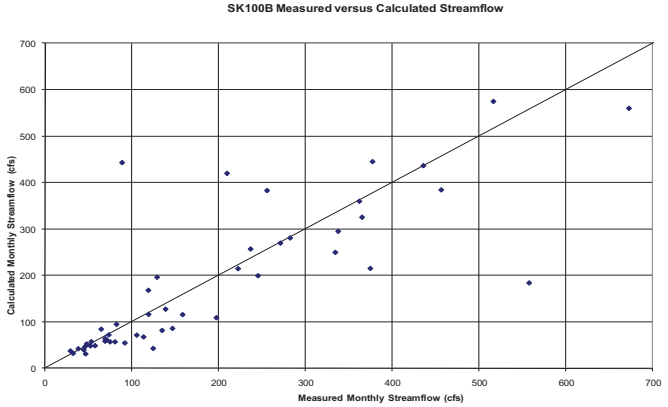


Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011







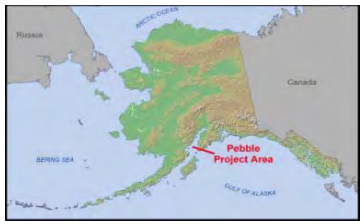


THE pebble PARTNERSHIP

Figure 11
Measured and Calculated Streamflow at SK100B (Area 4)

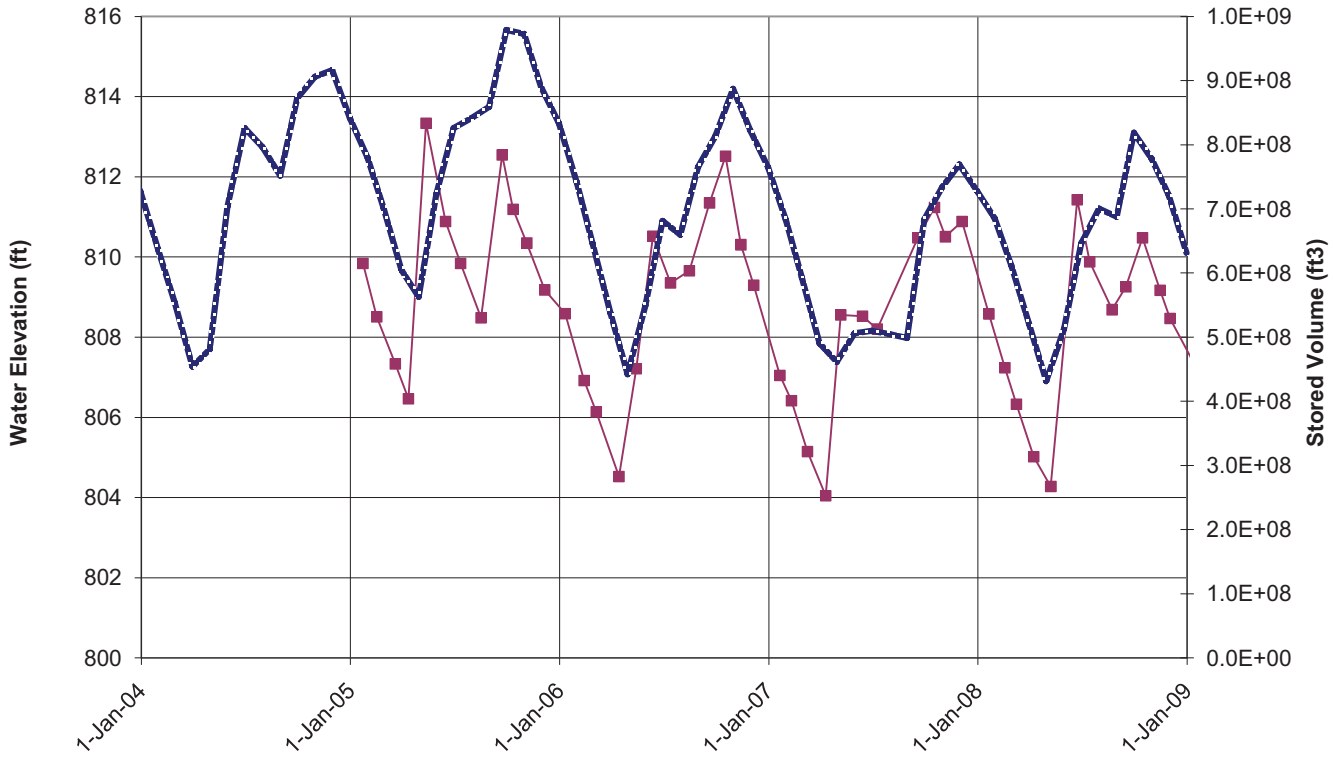
Appendix 8.1I
Water Balance Model

Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.65



Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures



THE pebble PARTNERSHIP

Figure 12
Comparison of MW-1M Water Levels with Calculated Groundwater Volumes (Area 4)

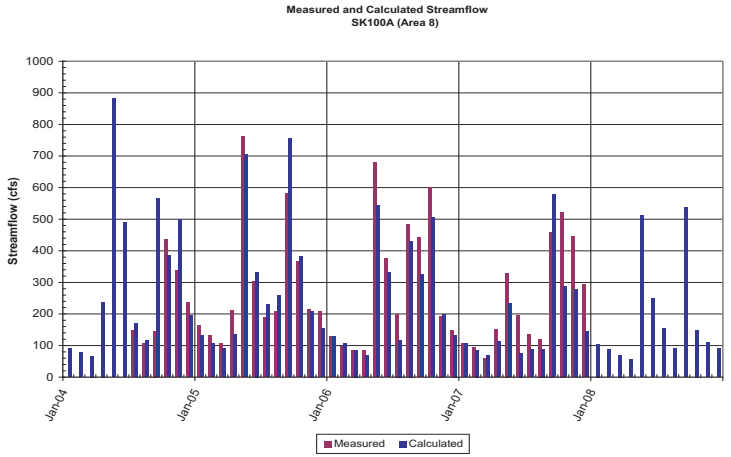
Appendix 8.1I
Water Balance Model

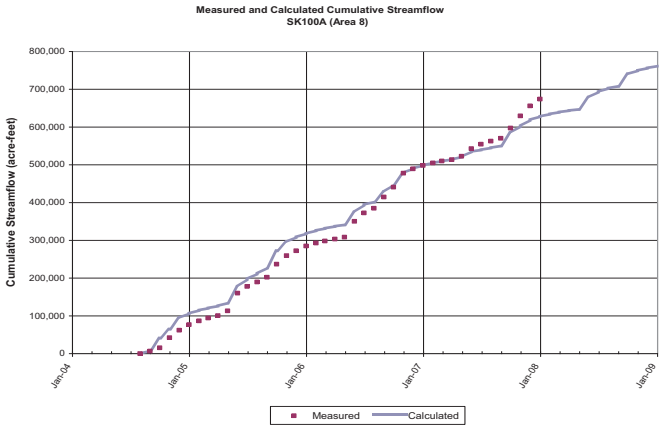
Calculated Area 4 Groundwater Volume

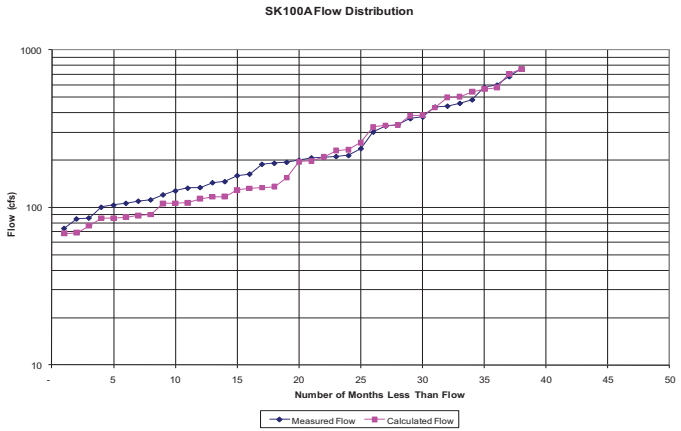
MW1-S Piezometer Elevation

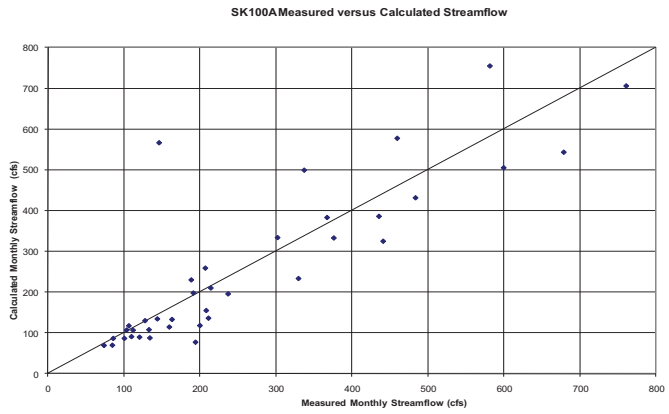


Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011







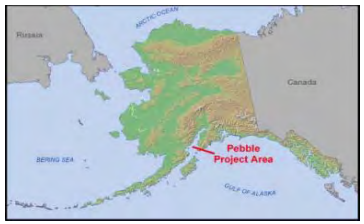


THE pebble PARTNERSHIP

Figure 13
Measured and Calculated Streamflow at SK100A (Area 8)

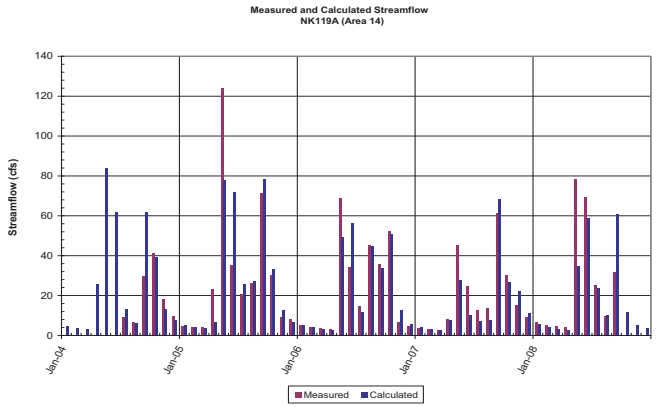
Appendix 8.1I
Water Balance Model

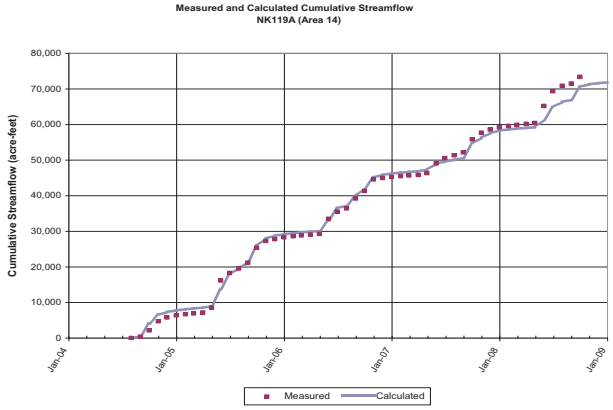
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.75

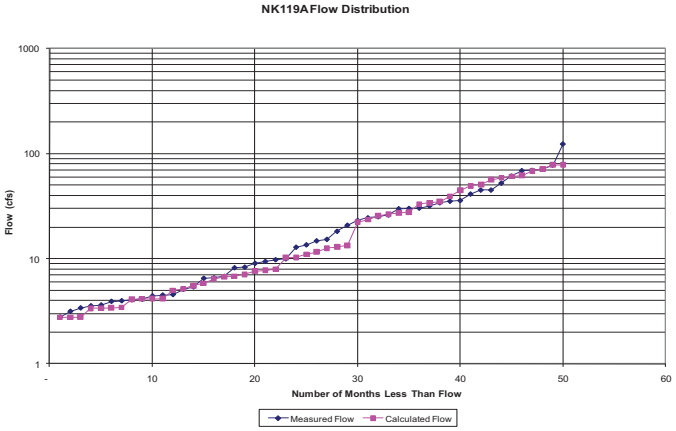


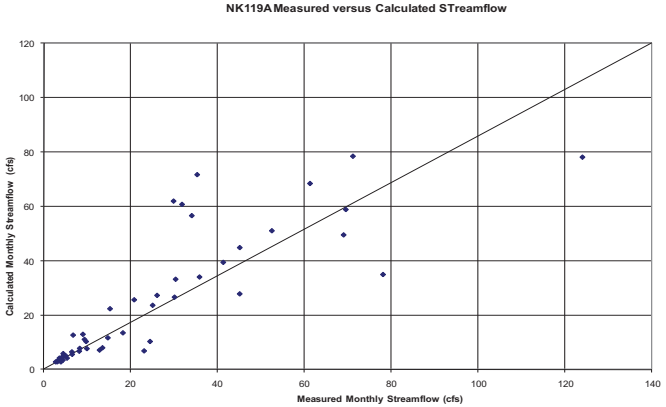
Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures







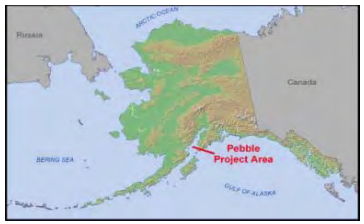


THE pebble PARTNERSHIP

Figure 14
Measured and Calculated Streamflow at NK119A (Area 14)

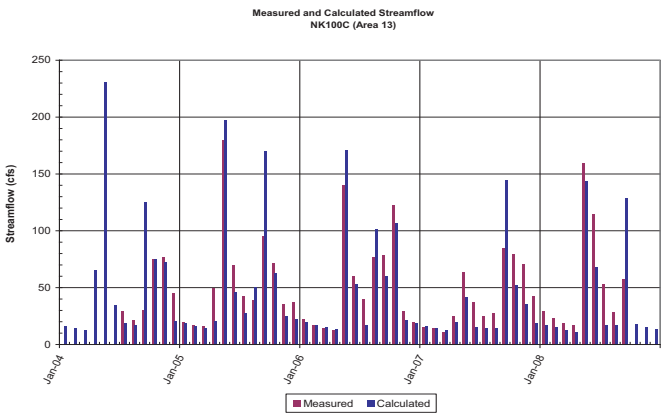
Appendix 8.1I
Water Balance Model

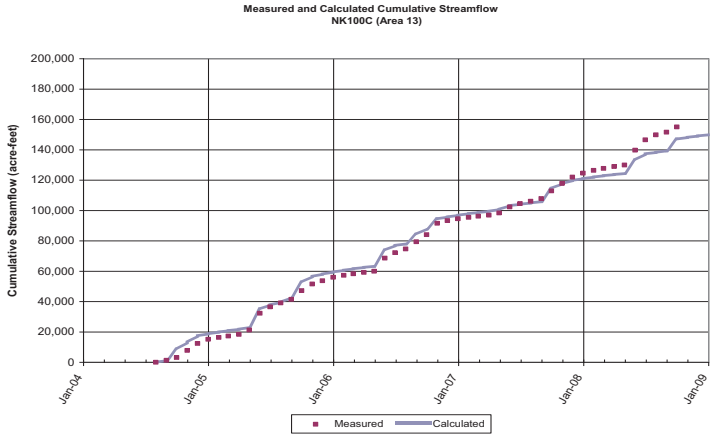
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.67

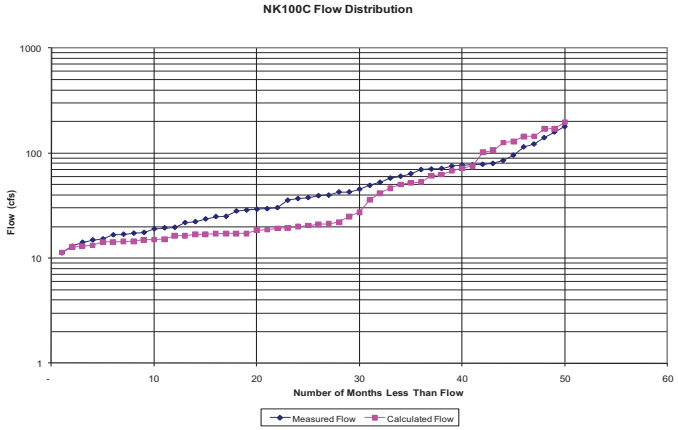


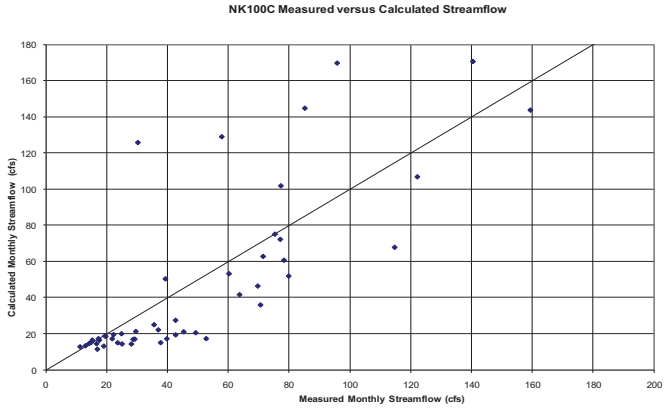
Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures







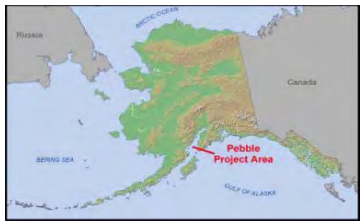


THE pebble PARTNERSHIP

Figure 15
Measured and Calculated Streamflow at NK100C (Area 13)

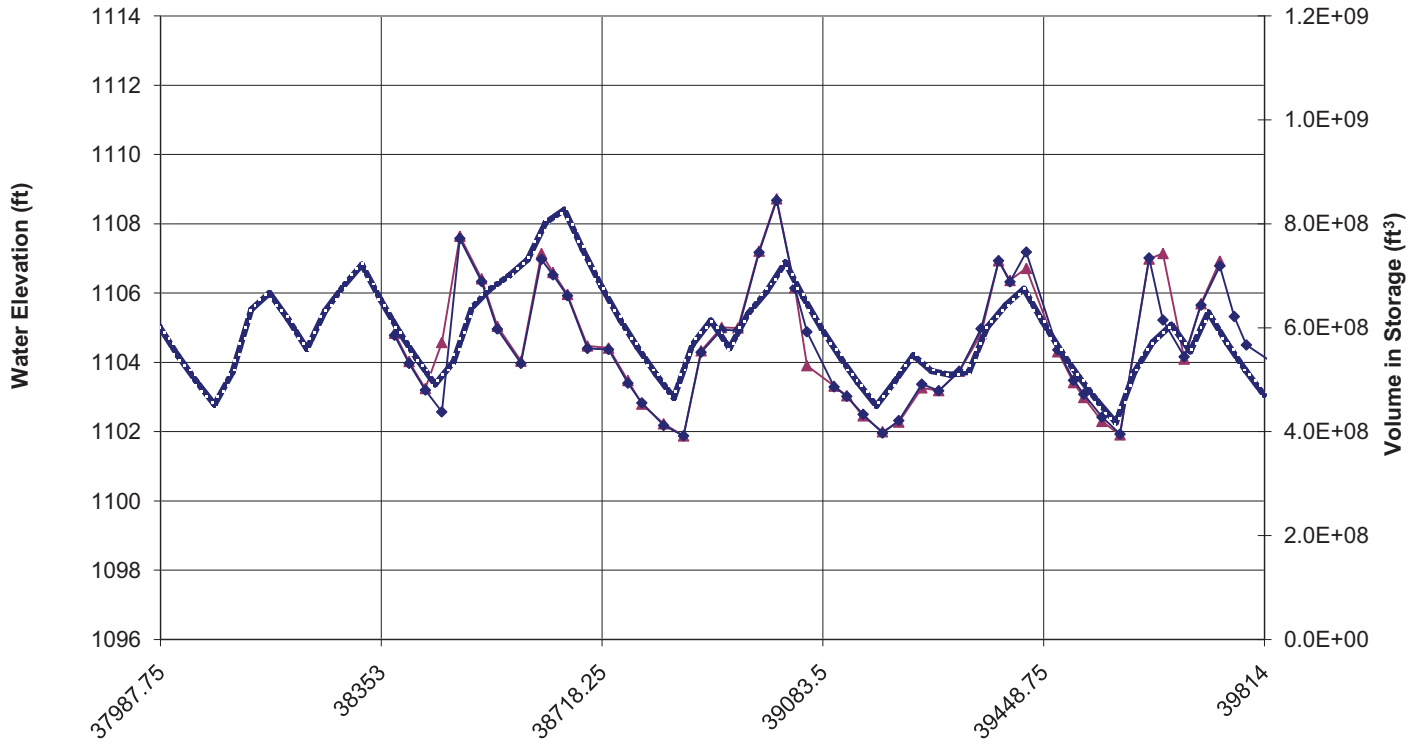
Appendix 8.1I
Water Balance Model

Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.51



Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures



THE pebble PARTNERSHIP

Figure 16
Comparison of MW-8S Water Levels with Calculated Groundwater Volumes (Area 13)

Appendix 8.1I
Water Balance Model

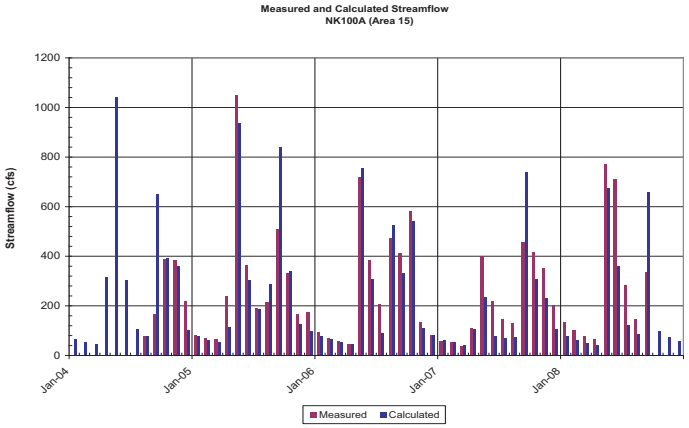
MW8-S Piezometer Elevation

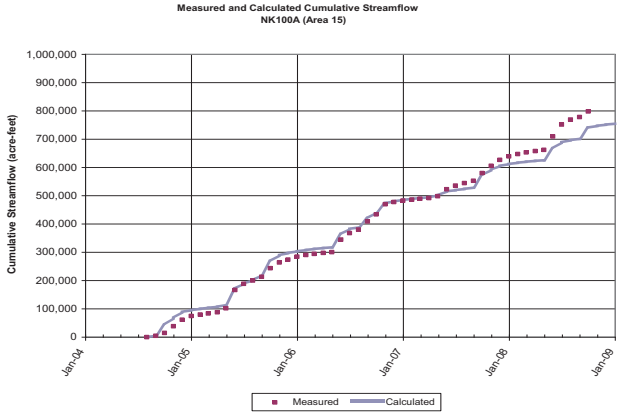
MW8-M Piezometer Elevation

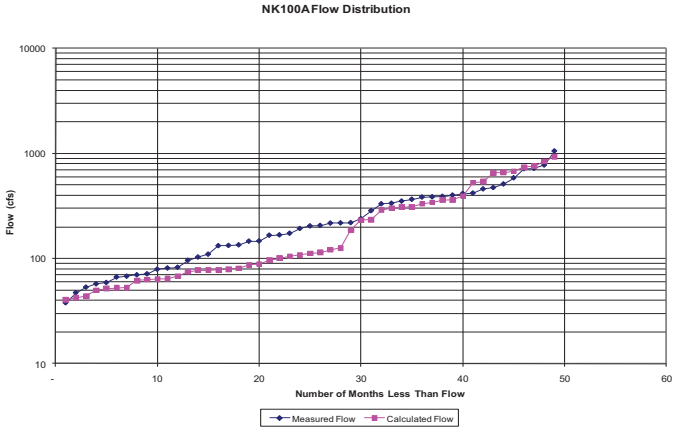
Calculated Area 13 Groundwater Volume

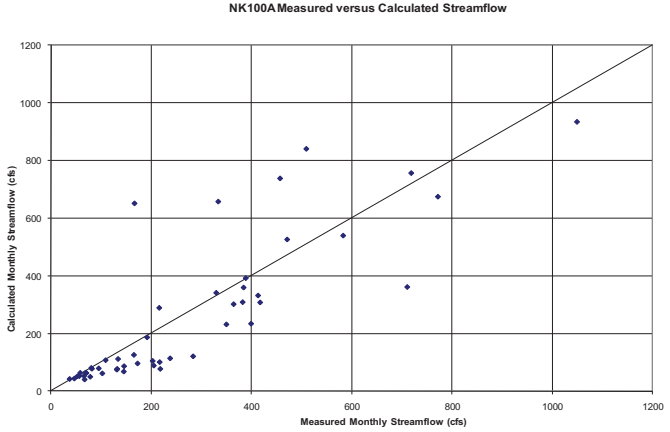


Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011







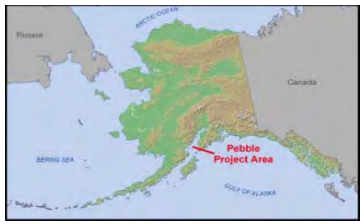


THE pebble PARTNERSHIP

Figure 17
Measured and Calculated Streamflow at NK100A (Area 15)

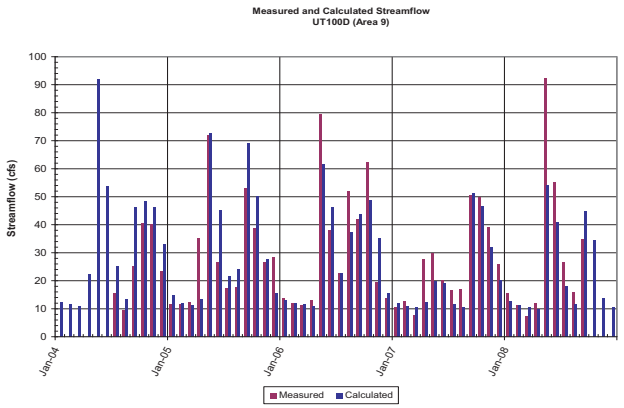
Appendix 8.1I
Water Balance Model

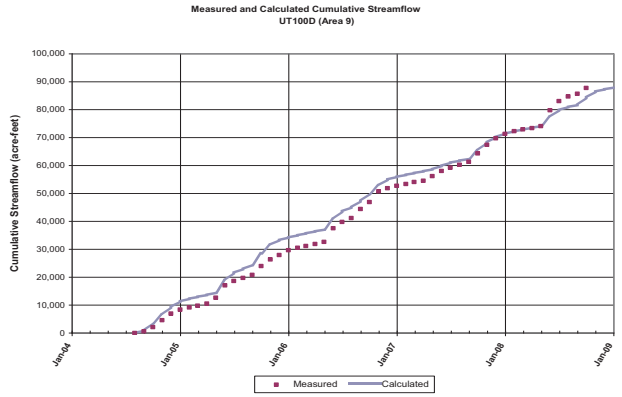
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.67

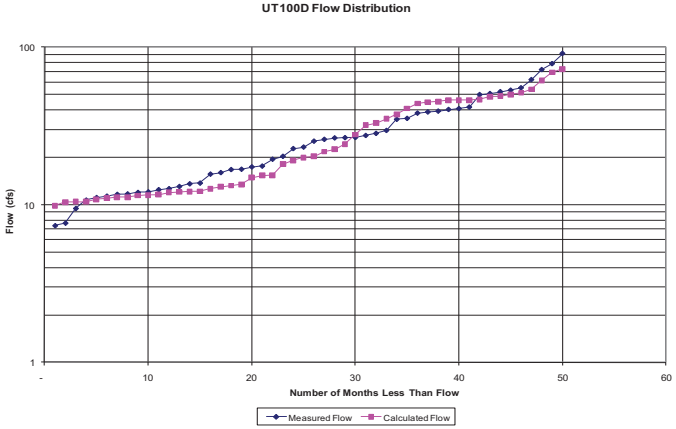


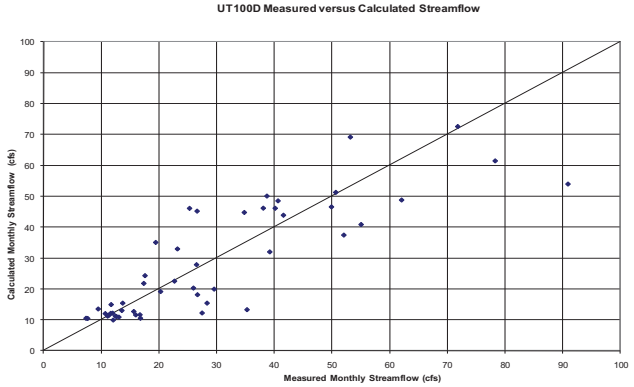
Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures







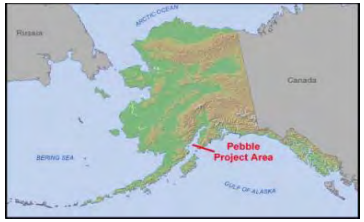


THE pebble PARTNERSHIP

Figure 18
Measured and Calculated Streamflow at UT100D (Area 9)

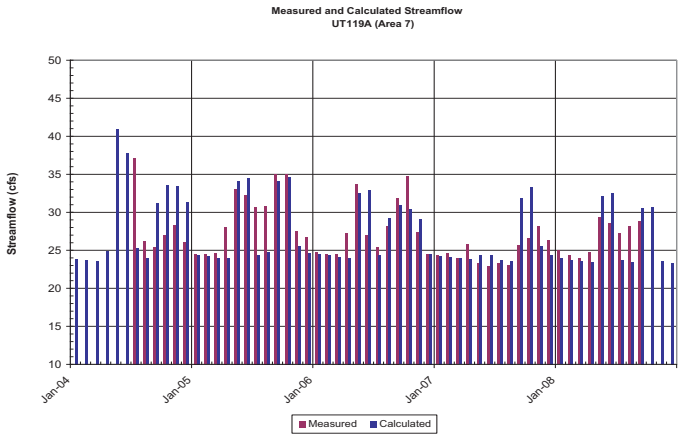
Appendix 8.1I
Water Balance Model

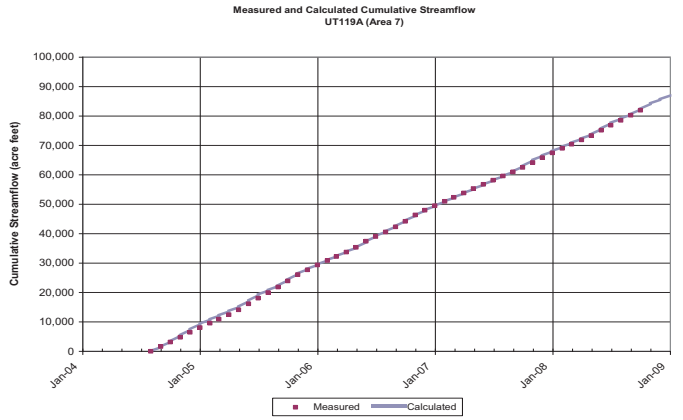
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.71

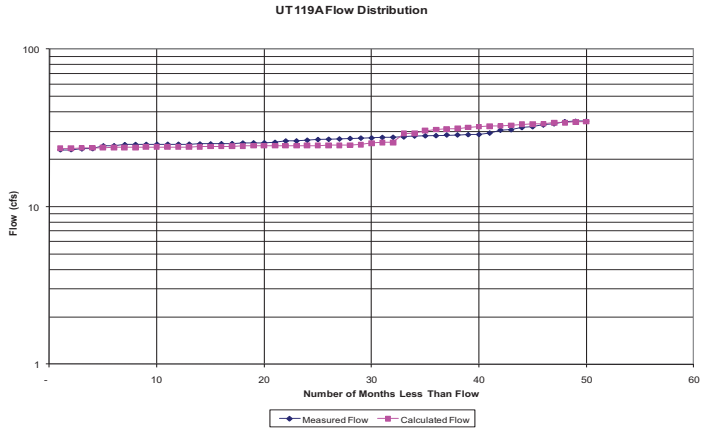


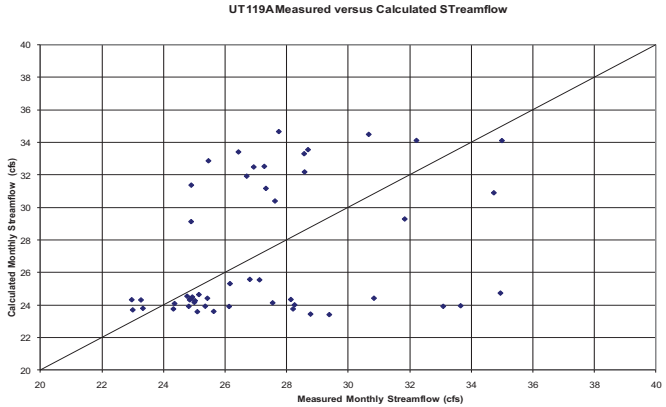
Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures







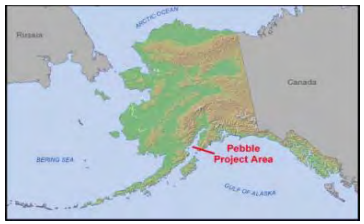


THE pebble PARTNERSHIP

Figure 19
Measured and Calculated Streamflow at UT119A (Area 7)

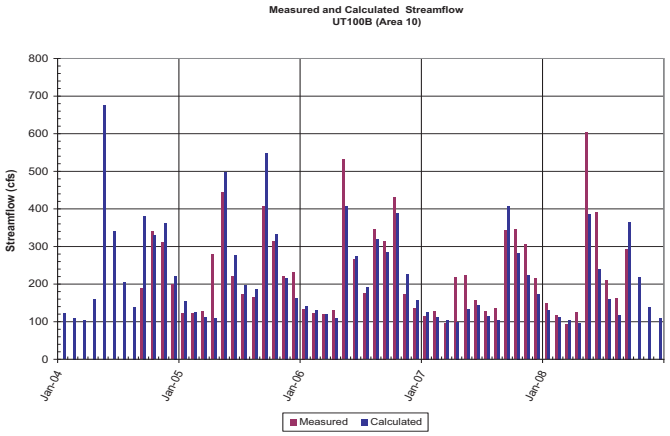
Appendix 8.1I
Water Balance Model

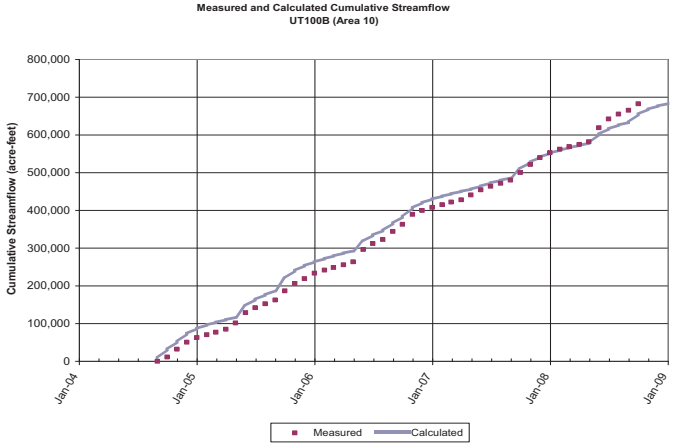
Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = -0.8

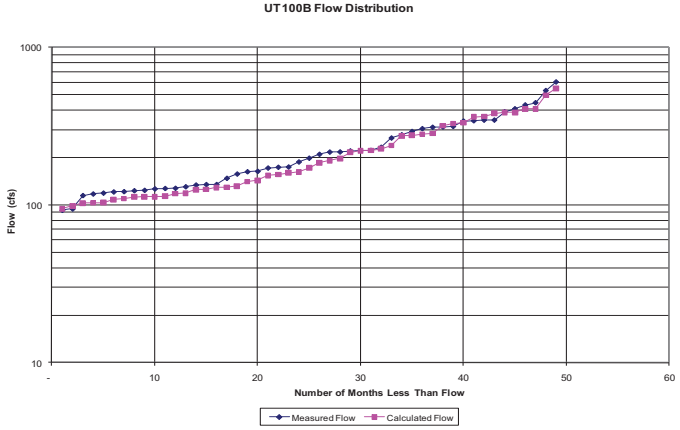


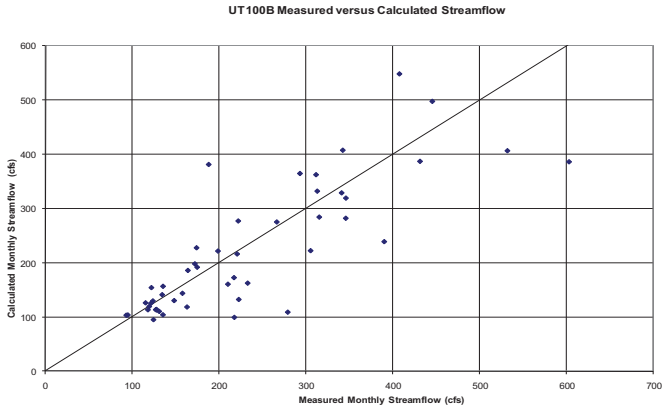
Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures







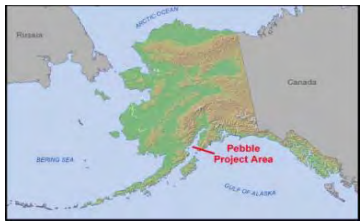


THE pebble PARTNERSHIP

Figure 20
Measured and Calculated Streamflow at UT100B (Area 10)

Appendix 8.1I
Water Balance Model

Note:
Nash Sutcliff (1970) Model Efficiency Coefficient = 0.63



Project No: 7126	Author: SWS-RR
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T4009\Appendix 8.1I Figures

APPENDIX 8.1J

Groundwater Model Results

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF TABLES iii
LIST OF FIGURES iii
ILLUSTRATION vii
ACRONYMS AND ABBREVIATIONS viii
1. INTRODUCTION 1
1.1 General Approach 1
1.2 Modeling Objectives 1
1.3 Organization 2
2. CONCEPTUAL MODEL 2
2.1 Regional Setting 2
2.2 Hydrology 3
2.2.1 Water Balance Model 3
2.3 Conceptual Hydrogeologic Model 3
2.3.1 South Fork Koktuli River 4
3. CODE SELECTION 5
4. MODEL DEVELOPMENT 5
4.1 Model Domain and Discretization 5
4.1.1 Grid Discretization 6
4.1.2 Layer Discretization 6
4.1.3 Temporal Discretization 7
4.2 Boundary Conditions 7
4.2.1 Rivers, Streams, and Lakes 7
4.2.1.1 Transient Representation of River Leakage and Discharge 10
4.2.2 Seeps 11
4.2.3 Constant-Head Discharge Boundaries 12
4.2.4 Meteoric Recharge 12
4.3 Aquifer Properties 13
4.3.1 Hydraulic Conductivity 13
4.4 Pumping Test Calibration 14
4.4.1 Specific Yield – Layer 1 16
4.4.2 Specific Storage 16
4.5 Other Model Inputs 16
4.5.1 Initial Heads 16

4.5.2 Convergence Criterion and Other Solver Parameters 16
5. MODEL CALIBRATION 17
5.1 Methodology 17
5.1.1.1 Calibration Goals 17
5.1.1.2 Calibration Targets 18
5.2 Model Calibration Analysis 19
5.2.1 Hydraulic Conductivity 19
5.2.2 Groundwater Elevations 19
5.2.2.1 Snapshots of Groundwater Elevations 19
5.2.2.2 Head Calibration Statistics 20
5.2.2.3 Hydrographs 21
5.2.2.4 Vertical Head Differences 22
5.2.3 Recharge and Discharge Rates 23
5.2.3.1 South Fork Koktuli 23
5.2.3.2 Upper Talarik Creek and North Fork Koktuli River 25
5.2.4 Low-Flow Streamflow Comparison 25
6. SUMMARY 26
6.1.1 Model Calibration Achievements 28
7. REFERENCES 29

LIST OF TABLES

Table 4.1, Recharge Ratios

Table 4.2, Hydraulic Conductivity Zone Input Data and Field-Calculated Statistics

Table 4.3, Pumping Test Model Results

Table 5.1, Head Calibration Statistics

Table 5.2, Root Mean Square Error Relative to Range in Observed Heads

LIST OF FIGURES

Figure 2.1, Model Domain and Mine Study Area

Figure 2.2, Stream Gaging Locations

Figure 4.1, Model Domain

Figure 4.2, Model Grid

Figure 4.3, Conceptual Model Layer Discretization

Figure 4.4, Topographic Surface – Model Domain

Figure 4.5, Topographic Surface – Local Study Area

Figure 4.6, Bedrock Surface – Local Study Area

Figure 4.7, Layer 1 Thickness – Local Study Area

Figure 4.8, Layer 2 Thickness – Local Study Area

Figure 4.9, Layer 3 Thickness – Local Study Area

Figure 4.10, Cross-Section Location Map

Figure 4.11, Cross-Section A-A' (North-South)

Figure 4.12, Cross-Section B-B' (West-East)

Figure 4.13, Simulated River and Lake Stage Elevations

Figure 4.14, Simulated River and Lake Conductance – March 2005

Figure 4.15, Simulated River and Lake Conductance – September 2005

Figure 4.16, Drain Elevations

Figure 4.17, Drain Conductance

Figure 4.18, Constant-Head Boundary Conditions Layers 1-4

Figure 4.19, Topographic Slope

Figure 4.20, Geology-Based Recharge Zones

Figure 4.21, Relative Meteoric Infiltration Zones in Local Study Area

Figure 4.22a, Transient Recharge – South Fork Koktuli

Figure 4.22b, Transient Recharge – North Fork Koktuli

Figure 4.22c, Transient Recharge – Upper Talarik

Figure 4.23, Annual Recharge by Watershed: 2005 to 2007

Figure 4.24, Hydraulic Conductivity Zones in Model Domain – Layer 1

Figure 4.25, Hydraulic Conductivity Zones in Model Domain – Layer 2

Figure 4.26, Hydraulic Conductivity Zones in Model Domain – Layer 3

Figure 4.27, Hydraulic Conductivity Zones in Model Domain – Layer 4

Figure 4.28, Hydraulic Conductivity Zones in Local Study Area – Layer 1

Figure 4.29, Hydraulic Conductivity Zones in Local Study Area – Layer 2

Figure 4.30, Hydraulic Conductivity Zones in Local Study Area – Layer 3

Figure 4.31, Pumping Test Model Domain Locations

Figure 4.32, PW5 TMR Model Domain Discretization

Figure 4.33a, PW5 Pumping Test Observed and Simulated Drawdown: MW-05-14D (Layer 4)

Figure 4.33b, PW5 Pumping Test Observed and Simulated Drawdown: P-06-25D (Layer 4)

Figure 4.33c, PW5 Pumping Test Observed and Simulated Drawdown: MW-05-14S (Layer 3)

Figure 4.34a, PW6 Pumping Test Observed and Simulated Drawdown: MW-05-14S (Layer 3)

Figure 4.34b, PW6 Pumping Test Observed and Simulated Drawdown: PW5 (Layer 4)

Figure 4.34c, PW6 Pumping Test Observed and Simulated Drawdown: P-05-25D (Layer 4)

Figure 4.34d, PW6 Pumping Test Observed and Simulated Drawdown: MW-05-14D (Layer 4)

Figure 4.35a, PW3 Pumping Test Observed and Simulated Drawdown: MW-11M (Layer 3)

Figure 4.35b, PW3 Pumping Test Observed and Simulated Drawdown: MW-11D (Layer 3)

Figure 4.36, PW4 Pumping Test Observed and Simulated Drawdown: MW-1M (Layer 2)

Figure 4.37a, PW8 Pumping Test Observed and Simulated Drawdown: P-05-29D (Layer 4)

Figure 4.37b, PW8 Pumping Test Observed and Simulated Drawdown: P-05-29D2 (Layer 4)

Figure 5.1, Flow Calibration Zones

Figure 5.2, Head Calibration Target Locations – Layer 1

Figure 5.3, Head Calibration Target Locations – Layer 2

Figure 5.4, Head Calibration Target Locations – Layer 3

Figure 5.5, Head Calibration Target Locations – Layer 4

Figure 5.6, Hydraulic Conductivity Frequency Plots (Layers 1 to 3) Overburden

Figure 5.7, Hydraulic Conductivity Frequency Plots (Layer 4) Bedrock

Figure 5.8a, Simulated Groundwater Elevations, March 2007 (Layer 1)

Figure 5.8b, Simulated Groundwater Elevations Main Study Area, March 2007 (Layer 1)

Figure 5.8c, Simulated Groundwater Elevations, September 2007 (Layer 1)

Figure 5.8d, Simulated Groundwater Elevations Main Study Area, September 2007 (Layer 1)

Figure 5.9a, Heads Residuals vs. Observed Scatter Plot - All Layers, All Times

Figure 5.9b, Modeled vs. Observed Head Scatter Plot – Layers 1 to 4

Figure 5.10a, Head Residual vs. Time – Upper South Fork Koktuli (MW-5D, MW-5M, P-05-07D, SRK-5M)

Figure 5.10b, Head Residual vs. Time – Upper South Fork Koktuli (MW-3)

Figure 5.10c, Head Residual vs. Time – Lower South Fork Koktuli (MW-11D, GH04-30, GH04-33, MW-2D)

Figure 5.10d, Head Residual vs. Time – Lower South Fork Koktuli (MW-1D, MW-1S, GH04-17)

Figure 5.10e, Head Residual vs. Time – North Fork Koktuli (MW-8D, MW-8M, MW-7S, MW-7D, MW-10)

Figure 5.11a, Head Residual Bubble Plot – Layer 1, October, 2005

Figure 5.11b, Head Residual Bubble Plot – Layer 2, October, 2005

Figure 5.11c, Head Residual Bubble Plot – Layer 3, October, 2005

Figure 5.11d, Head Residual Bubble Plot – Layer 4, October, 2005

Figure 5.12, Observed and Simulated Hydrographs: P-4AS, P-4, P-4AD, MW-5S, MW-5M and MW-5D

Figure 5.13, Observed and Simulated Hydrographs: MW-1S, MW-1M, MW-1D, GH04-05, MW-05-13S, MW-05-13D

Figure 5.14, Observed and Simulated Hydrographs: MW-11, MW-11D, GH04-17, MW-05-14S, MW-05-14D, GH04-18

Figure 5.15, Observed and Simulated Hydrographs: P-05-27S, P-05-27D, MW-05-2M and MW-2D

Figure 5.16, Observed and Simulated Hydrographs: SRK-2A, SRK-2, P-05-09S, P-05-09D, P-05-31S and P-05-31D

Figure 5.17, Observed and Simulated Hydrographs: MW-8S, MW-8M and MW-8D

Figure 5.18, Observed and Simulated Vertical Head Difference Between Nested Wells - Area 3

Figure 5.19, Observed and Simulated Vertical Head Difference Between Nested Wells - Areas 4/ 5

Figure 5.20, Observed and Simulated Vertical Head Difference Between Nested Wells - Area 7

Figure 5.21, Observed and Simulated Vertical Head Difference Between Nested Wells - Area 9

Figure 5.22, Observed and Simulated Vertical Head Difference Between Nested Wells - Area 13

Figure 5.23, Cumulative Annual Flow: Modflow Model vs. Water Balance Model (2005)

Figure 5.24, Cumulative Annual Flow: Modflow Model vs. Water Balance Model (2006)

Figure 5.25, Cumulative Annual Flow: Modflow Model vs. Water Balance Model (2007)

Figure 5.26, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli: Areas 1, 2 and 8 (2005)

Figure 5.27, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Main Channel: Areas 3, 5, 4 (2005)

Figure 5.28, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, flow from SFK - Area 7 (2005)

Figure 5.29, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, Main Channel Areas 9,10,11 (2005)

Figure 5.30, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli: Areas 13 and 14 (2005)

Figure 5.31, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli: Areas 12, 15 (2005)

Figure 5.32, Model vs. Calculated Flow from Area 5 to Areas 4 and 7 (2005)

Figure 5.33, 2005 Discharge On Site (Area 5) and Observed MW-11S Piezometric Heads

Figure 5.34, 2005 Discharge On Site (Area 5) and Measured Streamflow at SK100C on s/b cap

Figure 5.35, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Tributaries Areas 1,2, 8 (2006)

Figure 5.36, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Main Channel : Area 3,4, 5 (2006)

Figure 5.37, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, flow from SFK : Area 7 (2006)

Figure 5.38, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, Main Channel : Area 9,10, 11 (2006)

Figure 5.39, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli - Areas 13 and 14 (2006)

Figure 5.40, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli - Areas 12 and 15 (2006)

Figure 5.41, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Tributaries : Areas 1, 2, 8 (2007)

Figure 5.42, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – South Fork Koktuli Main Channel : Areas 3,4, 5 (2007)

Figure 5.43, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, flow from SFK : Area 7 (2007)

Figure 5.44, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – Upper Talarik, Main Channel: Areas 9,10, 11 (2007)

Figure 5.45, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli - Areas 13 and 14 (2007)

Figure 5.46, Comparison of Recharge and Discharge from Groundwater and Water Balance Models – North Fork Koktuli - Areas 12 and 15 (2007)

Figure 5.47, Observed vs. Simulated Low-flow Streamflow Scatterplot (March 2005, April 2006, March 2007)

Figure 5.48, Streamflow vs. Distance Upstream (SFK)

Figure 5.49, Streamflow vs. Distance Upstream (NFK)

Figure 5.50, Streamflow vs. Distance Upstream (UT)

ILLUSTRATION

Illustration 2.1, Schematic Representation of River Boundary

ACRONYMS AND ABBREVIATIONS

EBD	environmental baseline document
AMSL	above mean sea level
TMR	Telescopic Mesh Refinement
MFST	MODFLOW-SURFACT
RMSE	Root Mean Square Error

GROUNDWATER MODEL RESULTS

1. INTRODUCTION

The Pebble Deposit is located in the headwater areas of the Koktuli River and Upper Talarik Creek. A three-dimensional, finite-difference, groundwater-flow model (Groundwater Model) was developed as a tool to characterize groundwater flow rates and directions in the mine study area. This document presents a summary of the Phase III Model Calibration Study (Phase III Study).

The objectives of the groundwater flow model are discussed in Section 1.1, and the general approach used during construction and initial calibration of the groundwater flow model is presented in Section 1.2. Section 1.3 outlines the organization of this document.

1.1 Gene l App o c

The general approach to modeling the groundwater system at this site included a numerical groundwater model and a site-wide water balance model (Water Balance Model). The Water Balance Model (Section 8.1.6.5 and Appendix 8.1I of Chapter 8 of the environmental baseline document [EBD]) was used to estimate the following components of the water balance, which are needed in the Groundwater Model:

- Watershed-scale recharge to groundwater from precipitation and streams.
- Inter-watershed groundwater flow rates (henceforth referred to as *off-site discharge*).
- Rates of groundwater discharge to streams (henceforth referred to as *on-site discharge*).

As described in Section 8.1.6.5 and Appendix 8.1I of Chapter 8 of the EBD, a number of hydrologic parameters were used as input to the Water Balance Model, the values of which were adjusted until the Water Balance Model reasonably matched transient streamflows at streamflow gaging stations in the South Fork Koktuli River, North Fork Koktuli River, and the Upper Talarik Creek.

The Groundwater Model was developed and calibrated based on a variety of hydrogeologic field measurements (e.g., sub-surface geology, groundwater elevations, aquifer hydraulic tests, observed flow characteristics, etc.). This Phase III Study involved a simplified representation of the complex flow and sub-surface geology in the Pebble study area. The flow rates calculated by the calibrated Groundwater Model were then compared to the corresponding flow rates calculated with the Water Balance Model. The purpose of this phase of the calibration was to validate that the flows estimated by the Water Balance Model were hydrogeologically feasible, and to gain insights about potential refinements that may be appropriate for the Water Balance Model.

This model calibration study assessed the most recent revision of the Water Balance Model, which included the latest revision of the measured streamflows.

1.2 Mo eling O ecti es

The objectives of this phase of modeling were as follows:

- Subdivide the overburden into three model layers rather than the single model layer that was used in Phase I.
- Expand the model domain to make it more appropriate for the expanded Pebble Deposit that had been identified.
- Incorporate the latest data that were collected up to the end of 2007.
- Improve the calibration over the Phase II model.

The calibration is assessed by comparing the model outputs to the recharge, on-site discharge and off-site discharge estimated by the Water Balance Model, and to the piezometric elevations that have been measured in the study area. As such, the groundwater model is being used partly to verify whether a hydrogeologic system can be envisaged that would allow the groundwater flows being modeled in the Water Balance Model. That is, if the Groundwater Model can reasonably match the groundwater flows calculated by the Water Balance Model and simultaneously match the piezometric elevations observed in the field, the validity of each model is strengthened.

This version of the Groundwater Model is also being used to interpret groundwater flow directions and groundwater-surface water interaction.

1.3 Organization

The remainder of this document is organized as follows:

- Section 2: *Conceptual Model* – discussion of the hydrologic and hydrogeologic characteristics that form the basis used for development and calibration of the Groundwater Model.
- Section 3: *Code Selection* – description of the various codes used as part of this modeling study.
- Section 4: *Model Development* – presentation of the input parameters used in the Groundwater Model.
- Section 5: *Model Calibration* – review of calibration metrics, comparison of the Water Balance and Groundwater Models, and description of insights gained during the Groundwater Model calibration process.
- Section 6: *Summary*– outline of the insights gained from Phase III of the model calibration.
- Section 7: *References.*

2. CONCEPTUAL MODEL

2.1 Regional Setting

The Pebble Project is located in southwestern Alaska, approximately 18 miles northwest of the town of Iliamna. The mine study area, including the Pebble Deposit, is drained by the North Fork Koktuli River, South Fork Koktuli River, and Upper Talarik Creek. The main stems of the creek and rivers flow primarily within floodplain channels eroded into widespread glacial deposits. The valley glacial infill is bounded by bedrock mantled with glacial deposits.

This study refers to 23 sub-catchments located within the model domain. These sub-catchments are identified as Area 1 through Area 23. The mine study area includes Areas 1 through 15, which is within

the model domain (Figure 2.1). Each of these areas is the catchment of a stream-gaging station (Figure 2.2).

2.2 H olog

The long-term mean annual precipitation in the mine study area is estimated to be 34.1 inches per year, of which approximately 30 percent falls as snow.

Numerous streams drain the mine study area, including smaller streams in the uplands regions and large rivers in valley regions. Continuous stream-gaging stations have been installed to monitor transient streamflows and additional stations were established to collect spot measurements of low-flow streamflows (Figure 2.2). Numerous seeps have been mapped in the study area, including some seeps with discharge rates of up to 250 gallons per minute.

2.2.1 Water Balance Model

The Water Balance Model (Section 8.1.5 and Appendix 8.1I of Chapter 8 of the EBD) was developed to estimate the watershed-scale groundwater recharge and discharge in the mine study area. The source of groundwater recharge to this basin is rain and snowmelt, which provide runoff to the streams in the area and recharge the aquifer. Some of the groundwater recharge is from direct infiltration through the exposed ground and the balance is from stream leakage.

The Water Balance Model is a spreadsheet analytical model and is based on an average monthly water balance approach commonly used for hydrologic evaluations. This method provides a simple technique for evaluating the interaction between surface water and groundwater components of a flow system. Basic input parameters include rainfall, snowmelt, and temperature records, as well as streamflow and groundwater level data that are used to characterize the flow system.

The Pebble mine study area was discretized into 15 sub-catchments (Figure 2.2). Sub-catchment areas were defined by the locations of streamflow gaging stations and the corresponding topographic controls on drainage. Groundwater recharge and discharge characteristics were simulated for each of the sub-catchment areas using the Water Balance Model.

The sub-catchment areas associated with each of the major water bodies are grouped as follows:

- South Fork Koktuli River: Areas 1, 2, 3, 4, 5, and 8.
- North Fork Koktuli River: Areas 12, 13, 14, and 15.
- Upper Talarik Creek: Areas 7, 9, 10, and 11.

In the modeling analysis presented later in this study, Area 7 tends to be associated with the discussion of the South Fork Koktuli River because some of the groundwater from Area 5 flows into Area 7.

2.3 Conceptu l H ogeologic Mo el

The complex overburden geology of this area has been simplified into a conceptual hydrogeologic model, as follows:

- Surficial aquifer

- Shallow aquitard
- Intermediate aquifer
- Deep aquitard
- Deep aquifer

These overburden units are discontinuous throughout the mine study area. For example, only a single aquifer occurs in the area of MW-13 in the area of groundwater discharge along the South Fork Koktuli River. In contrast, all five units occur near MW-2D in the headwaters of the Tributary UT1.190. Within the overburden, zones have been assigned to represent the changes in hydraulic conductivity of the overburden deposits. These zones have generally been developed according to the boundaries of bedrock-valley-fill deposits.

The hydraulic conductivity varies over several orders of magnitude in overburden aquifers and aquitards across the study area. The highest value of hydraulic conductivity in the mine study area was measured during the pumping test at PW-4 (approximately 2,500 feet per day), which is located at the east end of Area 4. The hydraulic conductivities of aquitards were not measured, but the lowest vertical hydraulic conductivity used in the model to represent overburden layers was 0.001 foot per day.

The bedrock is characterized as two distinct hydrostratigraphic units: relatively thin and permeable upper bedrock, and relatively thick and lower-permeability deep bedrock. The thickness of the shallow permeable zone in the weathered bedrock is believed to be limited based on observations during drilling and hydraulic tests. The permeability of the shallow bedrock is probably due to more and/or wider fractures than in the deeper bedrock. No data are available to indicate a distinct difference in hydrogeologic properties among the various rock types in the mine study area. Based on packer tests that have been conducted in the mine study area, the bedrock hydraulic conductivity appears to decrease with depth.

No anthropogenic sources of significant recharge or discharge are currently known in the mine study area.

The South Fork Koktuli River was the main focus during the Phase III calibration of the Groundwater Model. Further characterization of the South Fork Koktuli River leakage basin is presented below.

2.3.1 South Fork Koktuli River

This study sub-area extends about 7 miles downstream from the Pebble Deposit area along the South Fork Koktuli River. The catchment for the river ranges from an elevation of 830 feet to approximately 2,700 feet above mean sea level (feet AMSL). The upper slopes are dominated by bedrock outcrops. A substantial thickness of overburden is present along the river through this area. A paleo-channel probably drained across the present alignment of the South Fork Koktuli River towards Upper Talarik Creek.

The overburden material in the basin ranges from clay to clean gravel. Every hole drilled in this sub-catchment was found to have permeable material. Substantial thicknesses were encountered at MW-3, GH04-30, GH03-03, and MW-11. Smaller but still substantial thicknesses were perforated in MW-2 and GH04-10.

Groundwater originates on site as recharge of rainfall and snowmelt, both directly and as run-on and groundwater from the nearby slopes. The numerous enclosed depressions on the site may naturally

enhance the recharge. Although some recharge travels downstream as groundwater, this quantity is limited by the relatively low permeability material surrounding the lake and the relatively high bedrock elevation downstream of the lake.

The river probably recharges the groundwater system almost immediately downstream of Frying Pan Lake. This interpretation is based on piezometric levels in MW-3, which are considerably lower than the adjacent river level. Streamflow loss probably continues for several miles downstream. The loss is visually obvious in the vicinity of GH04-35, where the channel often dries during low-flow periods. Piezometric measurements indicate the groundwater levels are also noticeably below the channel bottom in this area.

Groundwater leaves this area by two routes, which is unusual for a river valley. Most of the groundwater continues down the South Fork Koktuli River valley (i.e., from Area 5 to Area 4). The remainder crosses the surface water divide and discharges to the Upper Talarik Creek watershed (i.e., from Area 5 to Area 7). The Water Balance Model estimated that about 66 percent of the groundwater migrates into Area 4 and about 34 percent migrates into Area 7.

3. CODE SELECTION

The finite difference code MODFLOW-SURFACT version 3.0 (Hydrogeologic, 1996) was used to implement the conceptual hydrogeologic model. MODFLOW-SURFACT (MFST) was used rather than the standard U.S. Geological Survey MODFLOW 1996 or 2000 because MFST uses a mathematical formulation called pseudo-soil functions that minimizes convergence problems associated with cell wetting and drying. This problem is usually observed in models like this, where steep slopes and steep groundwater gradients are expected.

Version 5 of the Groundwater Vistas graphical user interface (Environmental Simulations, 2004) was used to develop the input files for MFST and to post-process the model results.

Due to the number of input parameters, model-specific processors were developed to facilitate efficient pre- and post-processing of some of the model data. Software used for this purpose includes:

- ArcGIS
- Surfer
- Fortran programs
- Various database programs

4. MODEL DEVELOPMENT

4.1 Mo el Dom in n Disc eti tion

The model domain was enlarged over Phase I to accommodate the increased size of the Pebble Deposit and was large enough to minimize bias in the results but small enough to keep the model manageable (Figure 4.1). The model includes the 15 sub-catchment areas that were used in the Water Balance Model and an additional eight sub-catchments to accommodate the additional area that was not included in the Water Balance Model.

4.1.1 Grid Discretization

A uniform finite difference grid consisting of rectangular grid cells of 1,000 feet by 1,000 feet was overlain on the regional model domain (Figure 4.2). The model grid consists of 223 rows and 272 columns. The active portion of the model domain encompasses a total area of about 1,414 square miles.

4.1.2 Layer Discretization

The Groundwater Model consisted of five layers to represent the hydrostratigraphic units listed below:

- Layers 1 to 3 – Overburden
- Layer 4 – Permeable Weathered Bedrock
- Layer 5 – Competent Bedrock

Figure 4.3 presents a conceptual illustration of the model layer discretization. The five hydrogeologic layers that defined the overburden in the conceptual geological model are represented by three layers in the numerical model (Layers 1 to 3). The geological model was simplified in this way to increase the efficiency of model development and calibration. In the current model, Layers 1 through 5 were defined as having "variable transmissivity," which means that transmissivity is calculated as a function of the simulated groundwater elevation in each layer when the simulated level is below the top of the layer. This approach for calculating transmissivity increases the validity and applicability of the model.

The top of Layer 1 was defined based on a Digital Elevation Model (DEM) developed on a 150-foot grid across the model domain, and a more detailed 100-foot grid within the inner portion of the mine study area. Therefore, each 1,000-by-1,000-foot grid cell in the Groundwater Model covered an area represented by about 35 to 100 points in the DEM, depending on whether it was located within the 100-ft DEM or the 150-ft DEM. A Fortran program was developed to assign an elevation to the top of each Layer 1 grid cell in the Groundwater Model equal to the average elevation in the DEM over the corresponding area. Figure 4.4 illustrates the top of Layer 1 in the regional model domain, and Figure 4.5 shows the top of Layer 1 in the mine study area.

The bottom of Layer 3 (top of weathered bedrock) was defined by manually contouring the bedrock elevations from drill holes and seismic surveys where available across the mine study area, digitizing the resulting contours, and finally interpolating the resulting points to a 1,000-foot grid. This surface was then imported into the model. To prevent mathematical instability that can arise in a numerical model when simulating steeply sloping layers, the bottom of Layer 3 along the bedrock ridges (i.e., in areas where overburden does not overlie bedrock) was truncated to provide a more gradual transition in layer elevations. Values of hydraulic conductivity in these uplands regions (see Section 4.3) were then specified to be low to correspond to competent bedrock that is represented by this layer. Figure 4.6 presents contours for the bottom of Layer 3 (i.e., top of bedrock in areas of overburden cover but not in areas where overburden is absent) in the mine study area.

The bottoms of Layers 1 and 2 were based on geologic interpretation in areas where data were available and were assigned in areas where data were not available, as follows:

- Geologic cross-sections in a portion of the mine study area (Appendix 8.1B of Chapter 8); or

- Outside this area, the bottom of Layer 2 was defined to be five feet above the bottom of Layer 3, and the bottom of Layer 1 was defined to be five feet above the bottom of Layer 2. This approach maximized the thickness in Layer 1 where stratigraphic information was not available, and thus minimized potential numerical issues with the model with no loss in model applicability.

Thickness contours for Layers 1, 2, and 3 are presented in Figures 4.7 through 4.9, respectively. Uniform thicknesses of 50 feet and 500 feet were defined for Layers 4 and 5, respectively (i.e., weathered and competent bedrock) across the model domain.

Figure 4.10 shows a cross-section location map, and Figures 4.11 and 4.12 present north-south and east-west cross sections, respectively, through the mine study area of the Groundwater Model.

4.1.3 Temporal Discretization

The modeling was conducted in stages. The initial stage involved the development of a steady-state model to obtain a first approximation of the input parameters. A steady-state model was used initially because the execution times are much shorter than a transient model. The first approximation of parameters from the steady-state model was then used in the transient model to further refine the calibration.

The next stage in model calibration involved transient simulations with monthly stress periods for the period between December 2004 and March 2006. Upon refinement of the model input parameters, the transient Groundwater Model was extended to include 37 monthly stress periods that represented the period from December 2004 to December 2008. The choice of monthly stress periods is consistent with the Water Balance Model. The duration of each stress period is equal to the number of days in the respective month. For example, the duration of the December 2004 stress period was 31 days. Three time steps were simulated for each stress period. A sensitivity analysis demonstrated that three time steps were sufficient for simulating transient flow in the Groundwater Model.

4.2 Boun Con itions

Boundary conditions are used to specify groundwater inflows and outflows in the model domain. The types of boundary conditions defined in the Groundwater Model include the following:

- Rivers, streams, and lakes were represented using the RIVER package.
- Seeps were represented using the DRAIN package.
- Meteoric recharge was represented using the RECHARGE package.
- Inflow and outflow around the outer edge of the model domain were represented with Constant-Head boundaries.

The following paragraphs discuss each of these sets of boundaries in more detail.

4.2.1 Rivers, Streams, and Lakes

Rivers, streams, and lakes were simulated using the RIVER package, which simulates flow between a surface-water body and an aquifer. The conceptualization of this package includes a sediment layer at the bottom of the surface-water body that would limit flow between the aquifer and the surface-water body. This sediment layer conceptualized in the river package can also be used to represent horizons of low

hydraulic conductivity within the aquifer if they are not already represented in a model layer. Flow between the surface-water body and the aquifer is calculated using Darcy's Law, which is written in the following form:

$$FLOW = C(STAGE - GWE) \quad \text{(Equation 1)}$$

Where *FLOW* is simulated flow rate in or out of the domain through an intervening layer (cubic feet per day).

C is conductance of the sediments at the bottom of the river, which is a function of the river width, and the thickness and hydraulic conductivity of these sediments (square feet per day) = $K_v A/b$.

K_v is hydraulic conductivity of sediment layer (feet per day).

A is cross-sectional area of vertical flow (square feet) = Lw.

L is length of river reach crossing a finite-difference cell

w is width or river reach in a finite-difference cell.

b is thickness of sediment layer (feet).

STAGE is stage elevation of the surface-water body (creek, river or lake) defined as a model input at each grid cell (feet AMSL).

GWE is simulated groundwater elevation (feet AMSL).

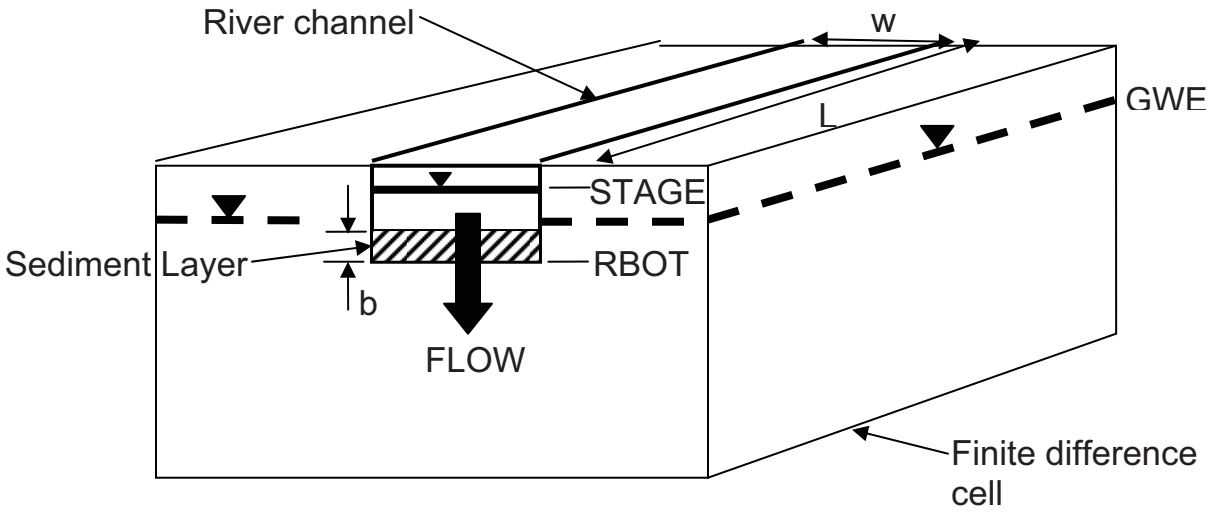


Illustration 1. Schematic Representation of River Boundary

When the simulated groundwater elevation is higher than the river stage elevation, the model will simulate discharge from the aquifer into the surface-water body. When the simulated groundwater elevation is lower than the surface water stage elevation, the model will simulate leakage from the river into the aquifer. Leakage into the aquifer will be calculated using Equation 1 when the simulated groundwater elevation is above the bottom of the sediment layer (i.e., greater than RBOT as shown in

Illustration 1). When the simulated groundwater elevation is less than RBOT, leakage into the aquifer will be calculated using Equation 2.

$$FLOW = C(STAGE - RBOT) \qquad \text{(Equation 2)}$$

Where RBOT is the bottom of the sediment layer as shown in Illustration 1.

In Equation 2, the flow rate is proportional to the difference between the surface water stage and the bed bottom elevation. This conditional formulation of leakage into an aquifer limits the flow rate when the aquifer becomes unsaturated under the bed and may underestimate the actual surface water leakage that will occur under this condition.

For this study, ArcGIS was used to develop a shape file that defined the model grid cells that coincided with a stream, lake, or river. Figure 4.13 illustrates the locations of modeled rivers, streams, and lakes in the Groundwater Model. For simplicity, these features will be referred to as RIVER boundaries in the remainder of this report.

ArcGIS was also used to intersect the model grid with the rivers to calculate the length of river that crossed each grid cell and the area of each lake that intersected each grid cell. A Fortran program was developed to define the RIVER boundaries as follows:

- Read the river lengths and lake areas exported from ArcGIS.
- Assigned appropriate stage elevations for each of these model grid cells based on the minimum topographic DEM survey data within each grid cell.
- Calculated the conductance of rivers based on the vertical hydraulic conductivity and thickness of the riverbed, and the length and width of the channel.
- Calculated the conductance of lakes based on the assigned vertical hydraulic conductivity and thickness of the riverbed, and the area of the channel within the grid cell.
- Assigned the transient stage based on the DEM elevation and the assigned depth of water.

Figure 4.13 illustrates the stages assigned to all model cells with rivers, streams, or lakes.

Reach numbers were assigned to river segments and lakes in each sub-catchment facilitating the calculation of streamflow at streamflow gaging stations during baseflow periods (Figure 2.2). This approach allowed the flows calculated by the Groundwater Model to be compared with the low-flow streamflows measured in March 2005, because these flows are likely due entirely to groundwater discharge.

River conductance (C in Equations 1 and 2) was defined on a reach-specific basis. That is, each river reach in the model domain was defined to have a specific conductance. The main river branches in the plains were assigned relatively high conductance values. The highest conductance values were based on the following parameter values (see Equation 1):

K_v = 10 feet per day.

L = 1,000 feet.

w = 50 feet (fall stress periods).

b = 1 foot.

These parameter values resulted in a maximum conductance of 500,000 square feet per day, which represent the wider channels and more permeable bedding materials present in the plains.

River reaches that represented smaller tributaries that originated in the highlands were assigned relatively low conductance values. The minimum river conductance assigned to a tributary was based on the following parameters values:

K_v = 0.001 foot per day.

L = 1,000 feet.

w = 1 foot.

b = 1 foot.

These parameter values resulted in conductance values of 1 square foot per day. Therefore, conductance values throughout the model domain ranged from 1 to 500,000 square feet per day.

Figure 4.14 depicts the distribution of conductance for average conditions, and Figure 4.15 shows the distribution of conductance during peak flow stress periods in the September months.

4.2.1.1 Transient Representation of River Leakage and Discharge

As discussed in Section 5.2.2, the properties affecting river leakage and discharge were entered as transient inputs to represent the changing width of the lakes and rivers, and the changing depths of rivers. Specifically, the streams are wider during periods of high flow, particularly during spring runoff, and narrower during periods of low flow. Also, the height of water in river channels will be highest during peak spring and fall months and lowest during winter months.

To represent temporal variations in river channel width and height of water, the river channels were segregated into three main classes:

- Class 1 – largest tributaries that occur in the valley areas.
- Class 2 – medium-sized tributaries.
- Class 3 – smallest tributaries that occur mainly in the uplands areas.

The average widths of the river channels were generally assigned to be 50, 3, and 1 foot for Classes 1 to 3, respectively. The river channel widths were increased for the May and September months of each year as follows: Class 1 width increased to 60 feet, Class 2 width increased to 6 feet, and Class 3 width increased to 2 feet. These increases in river channel width effectively resulted in higher conductances for these tributaries during the peak runoff months.

The height of water in each river channel was assumed to be 2 feet on average for most of the watersheds. The average height of water in Class 1 river channels in Areas 4 and 5 were estimated to be 5 feet based on measured river stage and channel dimensions. Based on the stream-stage records, the increase in river water height was estimated to be approximately 0.6 foot in May and September for all sub-catchment areas except Areas 4 and 5. For these areas, the increase in water height was assumed to be 1.5 feet to represent the relatively high head fluctuations in these areas.

The definition of river channel width, water height, riverbed hydraulic conductivity, and thickness contribute to the calculated conductance of each river reach. During model calibration, the riverbed hydraulic conductivity was adjusted in each sub-catchment.

Per Equation 2, the leakage rate from the RIVER boundary to the aquifer is proportional to the difference between river stage and RBOT when the groundwater elevation is below RBOT. Therefore, transient values of RBOT were assigned to several river reaches in Areas 4 and 5 to account for transient recharge conditions without influencing the conductance for on-site discharge in these reaches. The RBOT parameter was adjusted in these reaches, which are known to be predominantly recharging the aquifer during non-peak months. RBOT was adjusted in a manner so that the simulated recharge was relatively low between stream gage stations SK100LF2 and SK100LF6 to represent the negligible streamflow that occurs in these reaches during non-peak periods.

4.2.2 Seeps

As discussed in Section 2, a large number of seeps were mapped within the mine study area and many of these seeps have relatively large flows. These seeps represent groundwater discharge, and this water drains into nearby streams, rivers, and lakes.

Seeps were represented in the Groundwater Model as DRAIN cells. That is, a groundwater discharge flow was calculated in the model when the simulated groundwater elevation was higher than the drain elevation, which was defined as the top elevation of the Layer 1 grid cell. The flow rate was calculated using an equation analogous to Equation 1. Unlike the RIVER package, the DRAIN package does not simulate leakage into the aquifer when the simulated groundwater elevation is lower than the top of Layer 1 at a DRAIN cell.

Figure 4.16 presents the DRAIN cell locations and corresponding elevations imported into Layer 1 of the model. The elevation assigned to each DRAIN cell is based on the average of topographic survey data points within each respective cell boundary. The criteria used to define the locations of DRAIN cells in the active portion of the model domain are as follows:

- A DRAIN cell was not assigned to a grid cell where another boundary condition was already assigned (e.g., Constant-Head or RIVER cells).
- In the high-permeability floodplains along the South Fork Koktuli River, DRAIN cells were not simulated because seeps are limited in this portion of the model domain.
- In areas within the seep inventory areas, DRAIN cells were defined to occur in grid cells that coincided with mapped seep locations.
- In areas outside the seep inventory areas (i.e., areas where seep mapping was conducted in the field), a DRAIN cell was defined in all Layer 1 grid cells.

For this phase of modeling, a relatively low conductance of 1 square foot per day was assumed for DRAIN cells (Figure 4.17). Given the relatively large grid cell size in the regional model, and that the discharge of groundwater to DRAIN cells in a sub-catchment is generally balanced by the discharge of groundwater to RIVER cells in the same sub-catchment, the DRAIN conductance was not calibrated in Phase III of the modeling study.

4.2.3 Constant-Head Discharge Boundaries

Constant-Head boundaries were assigned at the edge of the model domain to provide outlets for groundwater flow where surface water bodies occur. The location and elevations assigned to the Constant-Head boundaries for Layers 1 through 4 are shown on Figure 4.18. The elevations assigned to the Constant-Head boundaries correspond to topographic elevations in these areas.

4.2.4 Meteoric Recharge

The Water Balance Model was developed to estimate how the water budget is distributed between runoff, evapotranspiration, sublimation, storage, and groundwater recharge within each of the 15 sub-catchments. The groundwater recharge from the Water Balance Model included both meteoric recharge and stream leakage. In contrast, the Groundwater Model deals with meteoric recharge and stream leakage separately. Therefore, a proportion of the Water Balance recharge was assigned as meteoric recharge in the Groundwater Model and the total recharge was checked against the Water Balance Model after each Groundwater Model simulation was complete.

In contrast with the Water Balance Model, which provided a lumped recharge rate for a complete sub-catchment, the meteoric recharge rate for the Groundwater Model can vary from grid cell to grid cell. Therefore, the following general criteria were used to distribute the recharge within each sub-catchment of the Groundwater Model:

- Average topographic slope at each cell location (relatively low recharge assigned to steep slopes and relatively high recharge assigned to flat areas).
- Surficial geology where available (Section 8.1.7.2) (relatively low recharge assigned to low-permeability materials and relatively high recharge assigned to high-permeability materials).
- Enhanced recharge along ridge crests to account for the highly fractured rock that occurs along many ridge crests.

A Fortran program was used to calculate the average topographic slope at each model grid cell based on the topographic DEM. Figure 4.19 shows the distribution of topographic slope in the model domain. A relative infiltration multiplier was assigned to each cell based on the following intervals (a slope of 100 percent is equivalent to an angle of 45 degrees):

- Slope of 0 to 5 percent: Multiplier of 1.0.
- Slope of 5 to 8 percent: Multiplier of 0.8.
- Slope of 8 to 12 percent: Multiplier of 0.6.
- Slope of 12 to 16 percent: Multiplier of 0.4.
- Slope > 16 percent: Multiplier of 0.1.

This method provides a simple approach for distributing meteoric recharge so that higher recharge is assigned where the topography is flatter, and lower rates are assigned where topography is steeper. The multipliers were adjusted during the calibration process to determine which multipliers resulted in an improved calibration.

The surficial geology map was used to define zones of relative infiltration. The geologic conditions for overburden were divided into four categories, from the most permeable to the least permeable. The fifth and sixth surficial geology categories represent bedrock outcrops: the fifth category represents general bedrock, and the sixth category represents highly fractured bedrock ridges where high recharge is believed to occur (Figure 4.20). The relative infiltration multipliers used for this study were as follows:

- Zone 1 overburden (most permeable): Multiplier of 2.0.
- Zone 2 overburden: Multiplier of 1.6.
- Zone 3 overburden: Multiplier of 1.2.
- Zone 4 overburden (least permeable): Multiplier of 0.1.
- Zone 5 (general bedrock): Multiplier of 0.1.
- Zone 6 (highly fractured bedrock ridges): Multiplier of 0.5.

The meteoric recharge rates input to the Groundwater Model were defined to be equal to 50 percent to 100 percent of the sub-catchment recharge rates estimated with the Water Balance Model and were distributed based on the relative infiltration multipliers defined for each grid cell using the above criteria. Figure 4.21 shows the distribution of relative infiltration multipliers in the mine study area.

A Fortran program was used to combine the distribution of surficial geology zone and topographic slope multipliers to calculate an overall infiltration multiplier for each model grid cell in each sub-catchment. The values of recharge calculated with the Water Balance Model for each sub-catchment and each month were then used by the program to calculate recharge rates for each grid cell for each monthly stress period during the Groundwater Model simulation. The Fortran program included the option of specifying a ratio for each sub-catchment of total meteoric infiltration as a function of the recharge predicted by the Water Balance Model. For example, the meteoric infiltration simulated using MFST could be 100 percent of the sub-catchment recharge predicted by the Water Balance Model each month, or it could be specified to be less than or greater than 100 percent of the Water Balance Model.

Table 4.1 lists the ratio of Groundwater Model meteoric recharge relative to the recharge explicitly predicted using the Water Balance Model. The ratios ranged from a minimum of 70 percent (Areas 5 and 11) to a maximum of 120 percent (Area 4). Figures 4.22a through 4.22c illustrate transient recharge distribution for sub-catchments in the South Fork Koktuli, North Fork Koktuli, and Upper Talarik watersheds, respectively. Figure 4.23 presents a comparison of sub-catchment annual recharge volume for 2005, 2006, and 2007 as simulated with the Water Balance Model. Figure 4.23 indicates that recharge was calculated to decrease noticeably after 2005 in a number of sub-catchments.

4.3 A uife P ope ties

4.3.1 Hydraulic Conductivity

The hydrogeologic units at this site have been represented with 278 hydraulic-conductivity zones. Each sub-catchment was divided into two types of zones: upland areas and valley-fill areas. These areas were then assigned default values of hydraulic conductivity for Layers 1 through 4 based on the geologic materials represented by each zone. Layer 5 was assigned a uniform horizontal (Kx) and vertical (Kz) hydraulic conductivity value of 0.001 foot per day, although the model has the capability of representing watershed-specific values of hydraulic conductivity in Layer 5.

The geologic cross sections (Appendix 8.1B of Chapter 8 of the EBD) were used to define zones of similar aquifer materials in each layer. These zones were then defined as hydraulic conductivity zones within the mine study area where cross sections were available. Sixty three, 58, and 87 hydraulic conductivity zones were used to distinguish between different overburden material types in Layers 1, 2, and 3, respectively.

Figures 4.24 through 4.27 present the hydraulic conductivity zones in the model domainfor Layers 1 through 4, respectively. Figures 4.28 through 4.30 present the hydraulic conductivity zones in the mine study area where cross-sections were used to define aquifer material zones for Layers 1 through 3, respectively. Table 4.2 presents the horizontal and vertical hydraulic conductivity used for each distinct zone in the Groundwater Model.

The vertical anisotropy ratio for overburden was initially assumed to be a factor of two (horizontal to vertical) based on the model simulations of pumping tests discussed below. This anisotropy was revised for select hydraulic conductivity zones in the model during calibration. In some cases, a much higher anisotropy ratio (e.g., 1,000 or higher) was required to provide a reasonable match with observed piezometric heads in the vicinity of these zones. A vertical anisotropy ratio of 1,000 or more is justified in many areas, because one layer in the numerical model often represents a combined aquifer-aquitard series of units. Aquitards often have a hydraulic conductivity more than 1,000 times smaller than sands and gravels.

The hydraulic conductivity values specified in the Groundwater Model are presented in Table 4.2.

4.4 Pumping Test C li tion

Several local-scale models were developed and calibrated to the observed drawdown of a series of pumping tests in the local study area. Telescopic Mesh Refinement (TMR) was used to extract the local-scale models from the regional groundwater model. This process of model development assigns boundary conditions to the local model based on the boundary conditions of the regional model while providing additional refinement of the local model.

The TMR function in the Groundwater Vistas software was used to create individual local-scale models for each pumping test simulation. The TMR process involved the application of Constant-Head boundaries on the outer perimeter of each local model domain, with heads consistent with those simulated in the regional groundwater model.

The purpose of these local-scale pumping test models was to refine the general range of hydraulic conductivity and storage in overburden and weathered bedrock calculated using pumping test data. The pumping test calibration was done with an earlier version of the regional Groundwater Model.

TMR models were calibrated to pumping tests at PW3, PW4, PW5, PW6, and PW8. The domains of these models measured 3,000 feet by 3,000 feet in plain view (Figure 4.31).

Prior to developing the local-scale model, the regional model grid was refined to have a spacing of 100 feet by 100 feet within the local model domain. The grid was refined in this fashion to simulate heads around the boundary of the local model with a higher resolution than the 1,000 feet by 1,000 feet regional model cells. Grid spacings were also adjusted outside of the local-model domain so that the transition between the 1,000-feet spacing and 100-feet spacing was always within a factor of 1.5 of neighboring cell dimensions.

The grid spacing in the local models was 2 feet by 2 feet in the vicinity of the pumping wells, and increased to 100 feet by 100 feet at the boundary of the model. The grids were refined in a manner that maintained a maximum factor of 1.5 between dimensions of neighboring grid cells. Figure 4.32 presents an example of the grid discretization for the PW5 pumping test model.

The models were calibrated using a two-step process:

- Steady-state simulation without pumping to create the initial head distribution for the transient pumping test model.
- Transient simulation of the pumping test drawdown (pumping tests were conducted over a period of 1 day or less).

The local-scale model input parameters for hydraulic conductivity and storage were adjusted in an iterative fashion. The simulated drawdown calculated by the model was compared to the observed drawdown at nearby monitoring wells, and hydraulic conductivity and storage were adjusted until the best match was obtained.

Statistics were evaluated during each pumping test model calibration to provide a quantitative measure of the degree of fit for each simulation. Statistics of log residual (i.e., log of the observed drawdown minus the log of the simulated drawdown) were calculated because of the order of magnitude changes in drawdown in the early portion of each test. In cases where drawdown stabilized during the pumping tests (e.g., as a result of vertical recharge), then statistics for the early portion of the test where drawdown was increasing were evaluated separately. The ratio of average observed and simulated drawdown in the last hour of a pumping test was also evaluated as part of the statistical analysis.

Figures 4.33a through 4.33c present curves comparing observed and simulated drawdown at monitoring wells near the pumped well. The PW5 pumped well is in weathered bedrock (Layer 4). Two of the monitoring wells were also in weathered bedrock (MW-05-14D and P-05-25D); one monitoring well was in Layer 3 of the overburden aquifer (MW-05-14S). In this example, the horizontal and vertical hydraulic conductivity, and the specific storage in the weathered bedrock and overburden were adjusted during model calibration.

Table 4.3 presents the calibrated hydraulic conductivity and specific storage parameters for all pumping tests. In general, the ratio of horizontal to vertical hydraulic conductivity in the vicinity of the pumping wells was calibrated to range from 2 to 20 in overburden, and ranged from 2 to 100 in weathered bedrock. This result indicates that anisotropy varies widely across the mine study area. Specific storage was generally about $3x10^{-5}$ $feet^{-1}$, although it was as high as $6x10^{-4}$ $feet^{-1}$ at MW-11M. These values were used to constrain the regional model hydraulic conductivity and specific storage parameters calibrated in the vicinity of these pumping test areas, and to provide a general guide for the order of magnitude expected for hydraulic conductivity and storage parameters in similar aquifer materials throughout the model domain.

Figures comparing the observed and simulated drawdown at monitoring wells for other pumping tests include the following:

- PW6: Figures 4.34a through 4.34d.
- PW3: Figures 4.35a and 4.35b.

- PW4: Figure 4.36.
- PW8: Figures 4.37a and 4.37b.

4.4.1 Specific Yield – Layer 1

Specific yield is used to represent storage in the transient Groundwater Model when a layer is unconfined (i.e., the groundwater elevation is below the top of the layer). A value for specific yield of 0.1 was established during calibration and was applied throughout all layers in the model domain.

4.4.2 Specific Storage

Values of specific storage were $1x10^{-3}$ $feet^{-1}$ for Layers 1 to 4, and $1x10^{-6}$ $feet^{-1}$ for Layer 5

4.5 Ot e Mo el Inputs

4.5.1 Initial Heads

The initial heads for the transient simulation were calculated by running the steady-state model. Steady-state simulations used recharge rates calculated from the Water Balance Model for October 2005. This period was used during the initial steady-state simulations to evaluate how model input parameters affected the model calibration to groundwater elevations measured in October 2005 across the mine study area. The steady-state Groundwater Model was also used to compare its estimates of recharge and discharge to those calculated by the Water Balance.

Analysis of the steady-state and transient model results indicates that the steady-state simulation of the October 2005 stress period was relatively comparable to the transient model simulation of October 2005 (i.e., with respect to the overall water balance for key sub-catchments such as Area 5).

After making a series of adjustments to the transient model during the calibration process, a new steady-state model would be generated from the transient model input parameters, using the October 2005 infiltration rates to conduct the steady-state simulation. The groundwater elevations simulated using the steady-state model were then used as initial conditions for subsequent transient model simulations.

The transient model calibration results presented in Section 5 are based on initial heads that were derived using the October 2005 infiltration rates in a steady-state model.

4.5.2 Convergence Criterion and Other Solver Parameters

The PCG5 solver was used with the MFST code. A sensitivity analysis revealed that a convergence criterion of 0.01 foot was reasonable for the transient model. Other solver parameters used with the PCG5 package included the following:

- Number of outer iterations: 1,000.
- Number of inner iterations: 10.
- Maximum orthogonalizations: 10.
- Backtracking factor: 0.9.

- Residual reduction factor: 1.0.

5. MODEL CALIBRATION

5.1 Met o olog

As discussed in Section 4, a steady-state model was initially developed to start the calibration process, based on recharge conditions that correspond to the October 2005 stress period. This period was most appropriate for a steady-state analysis because it did not involve a high or low-flow condition.

Once the steady-state model was providing reasonable simulations, a transient groundwater flow model was developed to simulate the seasonal fluctuations in regional groundwater recharge and discharge, and piezometric heads between December 1, 2004, and December 31, 2007. Comparison of the transient simulation of the October 2005 stress period to the steady-state model with the same recharge rate distribution indicates that the steady-state model provides a reasonable representation of regional flow and piezometric head conditions for this time period.

By using the transient model to simulate seasonal fluctuations, the overall uniqueness of the numerical Groundwater Model is improved because it allows for validation of model input parameters under high and low recharge conditions. For example, ASTM (1999) states: "[b]y matching different hydrologic conditions [e.g., high and low recharge], the uniqueness problem is addressed, because one set of heads can be matched with the proper ratio of ground-water flow rates to hydraulic conductivities; whereas, when the flow rates are changed, representing a different condition, the range of acceptable hydraulic conductivities becomes much more limited."

The calibration focused on the South Fork Koktuli River recharge and discharge areas, particularly catchment Areas 3, 4, and 5. This focus included discharge from Area 5 to Area 7 (which is in the Upper Talarik watershed), so Area 7 was also included as a priority area during the calibration. Area 9, located in the headwaters of Upper Talarik Creek, was included as a priority area because of its proximity to the Pebble Deposit.

Although the Groundwater Model is a relatively simple representation of the regional groundwater flow system, the calibration process was still relatively complicated because of the key calibration targets, which include:

- 220 piezometers with up to 35 measurements per piezometer for a total of 3,936 groundwater elevation calibration points.
- 14 watersheds, each with 37 monthly estimates of recharge, off-site discharge, and on-site discharge for a total of 117 flow estimates.

Revision of the input parameters in one sub-catchment area to improve the calibration in that area would typically have a "ripple" effect on the calibration performance in other sub-catchment areas. This type of integrated system behavior increased the level of parameter uniqueness in the model but increased the complexity of the calibration.

5.1.1.1 Calibration Goals

The following goals were considered as indicators of model calibration (in no particular order):

- Groundwater elevations at monitoring wells and piezometers (e.g., calibration statistics and visual analysis using hydrographs of observed and simulated groundwater elevations).
- Horizontal hydraulic gradients between key wells on a coinciding flow path (e.g., between monitoring wells south of SK100F, and monitoring wells south of SK100C).
- Graphical and quantitative assessment of the direction and rate of groundwater flow in key areas (e.g., where Area 5 groundwater flow is divided between Areas 4 and 7).
- Qualitative assessment of vertical head differences between model layers at nested monitoring wells.
- Graphical assessment of the magnitude of seasonal fluctuations in groundwater elevations, particularly between periods of low and high recharge.
- Quantitative assessment of sub-catchment discharge rates on site and off site (comparison between the Water Balance Model and the Groundwater Model).
- Quantitative comparison of the combined meteoric and river leakage for each sub-catchment from the Groundwater Model to the corresponding estimates from the Water Balance Model.
- Qualitative comparison of hydraulic conductivity used in the Groundwater Model with values derived from aquifer hydraulic tests performed in the field.
- Graphical comparison of measured streamflows during three low-flow events (March 2005, April 2006, and March 2007) with simulated streamflows derived with the Groundwater Model.
- Qualitative comparison of transient gaining/losing conditions in the Groundwater Model relative to conditions observed in the field (particularly in the main branch of the South Fork Koktuli River).

The calibration to measured hydraulic heads verifies the credibility of the model as hydrogeologically feasible, and the calibration to estimated flow rates verifies the credibility of the model as describing the flows of water in the system.

5.1.1.2 Calibration Targets

The calibration targets in the area of focus for this stage of the calibration (i.e., plains areas in sub-catchments 3, 4, 5, 7, and 9) were developed as follows:

- A list of all monitoring wells was reviewed.
- Wells or individual water level measurements were filtered from this list if they:
  - appeared to be dry (i.e., the depth to water level is less than 2 feet above the depth to the bottom of the well);
  - the water level in the well or piezometer appeared to be perched (e.g., MW-05-2SR, P-05-16SS, and P-05-26S); or
  - individual water levels appeared to be anomalous relative to water levels measured at other times at the same location.

Table 5.1 lists the wells and piezometers that were used as calibration targets. Of the 220 calibration target wells, 128 are completed in overburden (Layers 1 to 3), and 92 are completed in weathered bedrock (Layer 4). During calibration of the Groundwater Model, greater emphasis was placed on matching

targets situated in valley areas, because a higher proportion of groundwater flow occurs in these areas relative to the uplands areas where soil materials generally have a lower permeability. Table 5.1 identifies calibration targets situated in valley areas within the mine study area.

Figure 5.1 illustrates the 14 sub-catchments where simulated recharge, off-site discharge, and on-site discharge were compared between the Groundwater and Water Balance Models. Figures 5.2 through 5.5 show the calibration target locations in Layers 1 to 4, respectively. Head calibration target locations were used for evaluating calibration scatter plots, residual bubble plots, and quantitative metrics evaluation.

5.2 Model Calibration Analysis

5.2.1 Hydraulic Conductivity

Figures 5.6 and 5.7 compare the range of field-calculated values of hydraulic conductivity to the range of hydraulic conductivity used in the overburden and bedrock layers of the Groundwater Model, respectively. These figures illustrate that the range of hydraulic conductivity values in the overburden and bedrock layers of the Groundwater Model are consistent with the range of values calculated in the field.

5.2.2 Groundwater Elevations

5.2.2.1 Snapshots of Groundwater Elevations

Figure 5.8a presents groundwater elevation contours for Layer 1 corresponding to a low recharge stress period (March 2007). Similarly, Figure 5.8b presents simulated groundwater elevations for Layer 1 corresponding to the high recharge stress period (September 2007). Both groundwater contour maps illustrate the following:

- Simulated groundwater elevations generally mirror topographic elevations, which is consistent with the conceptual model discussed in Section 2.
- The groundwater flow directions and gradients are generally consistent between low and high recharge events on a regional scale, although there are local scale differences.

Figure 5.9a shows a scatter plot of modeled versus observed groundwater elevations, which is a common qualitative analysis tool for calibrating groundwater flow models. The ideal plot for a model calibration will show all points congregating around a straight line that extends from left to right at a 45-degree angle (i.e., when the observed and simulated groundwater elevations are in close agreement). The scatter plot, which shows data points representing all transient data for the calibration targets, shows that the simulated results agree reasonably with the observed heads relative to the regional range in observed groundwater elevations.

The simulated heads tend to be lower than the observed heads in the uplands (i.e., areas with higher observed heads). The focus during calibration was on matching heads in the valleys where the greatest recharge and discharge was occurring at rivers and lakes (i.e., where the greatest accuracy in simulated heads was needed to better represent flows).

Figure 5.9b shows a scatter plot of simulated versus observed groundwater elevations for each layer. These scatter plots illustrate the following:

- Residuals are lowest in Layers 1 and 2 of the Groundwater Model, possibly because the piezometric heads in these layers are more strongly influenced by RIVER boundary conditions and are thus easier to match during calibration than heads in target wells screened in Layers 3 and 4.
- Residuals in Layer 3 tend to increase with increasing altitudes.
- The greatest residuals tend to occur in Layer 4 in the uplands regions (i.e., where observed groundwater elevations are highest). These figures illustrate that the model tends to underestimate heads in Layers 3 and 4 in the uplands regions, although these areas are outside the area of focus for this phase of the calibration.

5.2.2.2 Head Calibration Statistics

A residual is defined as the difference (in feet) between the simulated and observed groundwater elevations at target locations. A positive residual indicates that the simulated groundwater elevation is too low, and a negative residual indicates that the simulated groundwater elevation is too high. The absolute residual is the absolute value of a residual, and the Mean Absolute Residual (MAR) is defined as the mean of a group of absolute residuals.

Table 5.1 presents a summary of calibration statistics for all 3,936 temporal data at the target wells, including the number of temporal observation points, the average residual and MAR, and a comparison of the observed and simulated range in piezometric heads at each target location. (The range in piezometric heads is defined as the difference between the minimum and maximum piezometric heads observed at a target location.)

Based on the statistics for valley-region targets presented in Table 5.1, the average residual for these locations is -12 feet, the overall MAR is 16 feet, and the average difference between simulated and observed range in heads is -2 feet (i.e., the model predicted a range in heads at targets that was on average 2 feet higher than the observed range in heads).When considered in the context of large range in observed heads at valley-region targets in the model (e.g., RMSE statistics discussed below), these statistics indicate that the Groundwater Model is in good agreement with heads in the mine study area.

The change in residual over time at various calibration targets is illustrated in Figures 5.10a through 5.10e. Notwithstanding seasonal fluctuations, calibration target locations in the valley areas have generally consistent residuals over time in the South Fork Koktuli watershed (e.g., monitoring wells MW-5M and MW-5D shown in Figure 5.10a). In contrast, calibration target locations near or within the uplands areas tend to exhibit residuals that become increasingly positive over time, indicating that the simulated heads at these locations increasingly underestimate the observed heads over time (e.g., P-05-07D and SRK-5M in Figure 5.10a). The increase in residuals over time for key monitoring wells in the North Fork Koktuli watershed (Figure 5.10e) is consistent with trends observed at uplands wells in the South Fork Koktuli watershed. Analysis of the model during calibration indicated that this increasing residual trend in the uplands and in the North Fork Koktuli watershed was related to the temporal decline in recharge as predicted using the Water Balance Model (Figure 4.23).

The spatial distribution of the average head residuals for Layers 1 through 4 is shown using bubble plots on Figures 5.11a through 5.11d, respectively. The color of the target symbols on these figures indicates whether the residual is positive (i.e., the simulated head is lower than the observed head) or negative (i.e., the simulated head is higher than the observed head). The symbols are sized proportionally to the square

root of the residual, so that a small symbol implies a low residual value and a larger symbol implies a larger residual value. The distribution of residuals indicate that there is a reasonably good match between piezometric heads predicted by the Groundwater Model in the valley areas. Examination of the residuals distribution in Figures 5.11a to 5.11d indicates that the lowest residuals are observed at targets in the valley regions and the highest residuals are observed at targets in the upland regions (where groundwater hydraulic gradients are steeper).

Summary statistics for the Root Mean Square Error (RMSE) as a percentage of the observed range in target heads are presented in Table 5.2 for the priority sub-catchments (i.e., Areas 3, 4, 5, 7, and 9) and for all targets. A model is often accepted as reasonably well calibrated if the RMSE is less than 10 percent of the observed range in groundwater elevations for the corresponding target area. The overall RMSE is 3 percent of the observed range in heads at all targets in the regional model domain, indicating that the model provides a reasonable representation of regional piezometric heads.

In four of the five key sub-catchments, the overall RMSE is less than or equal to 10 percent, which indicates that the head calibration is generally very good at the sub-regional level. The overall RMSE in Area 4 is 12 percent. The RMSE statistics for Area 9 are also relatively high (18 percent) in Layer 2. Similarly, the RMSE in Area 5 for Layers 2 is13 percent and for Layer 4 is13 percent.

5.2.2.3 Hydrographs

Figures 5.12 through 5.17 present hydrographs of observed and simulated groundwater elevations for monitoring wells situated in the valley regions of Areas 3, 4, 5, 7, 9, and 13, respectively.

A number of calibration target hydrographs shown in these figures indicate that there is good agreement between simulated and observed heads. The head targets that provide the best match are those situated in the center of the valley regions near major surface water tributaries. For example, a relatively good match was obtained at most of the hydrographs shown in Figures 5.12 through 5.17. The good agreement between simulated and observed heads near major rivers is an important aspect of representing groundwater-surface water interactions in the mine study area.

There are some targets where the match is not as good, either because the general heads level is too low or too high in the Groundwater Model, or because the simulated amplitude in fluctuations is different from the observed data. Targets that don't match as well are sometimes situated in areas where river leakage is recharging the aquifer (e.g., east portion of Area 5) or closer to the uplands region. At some locations it was difficult to improve the match between simulated and observed heads without compromising the match for other targets such as recharge or discharge flow rates. While this provided some constraints in the ability to match heads at all target locations, it also increases the validity of the Groundwater Model because the calibration effort involved matching a number of features in the study area, not just piezometric heads.

There are several nested well locations in the mine study area where the Groundwater Model provides a good match to the amplitude of fluctuations observed in overburden, and the simulated amplitude in the weather bedrock unit underestimates the observed fluctuation (e.g., see hydrographs for MW-5S, MW-5M, and MW-5D in Figure 5.12). The higher amplitude of seasonable fluctuations in the bedrock well (MW-5D) may reflect the influence of high recharge in up-gradient bedrock ridge zones.

The amplitude of the simulated piezometric time series in the eastern region of Area 4 (e.g., MW-1S) and the western region of Area 5 (e.g., GH04-17, MW-11M) is highly sensitive to river leakage to the aquifer

(Figures 5.13 and 5.14). If the rate of river leakage was simulated to be relatively high, then the amplitude in seasonal fluctuations was relatively small. As the rate of river leakage was decreased, the amplitude in seasonal head fluctuations increased.

Figure 5.16 shows hydrographs for several wells that represent a good match between the Groundwater Model and observed heads (SRK-2 and SRK-2A). The Groundwater Model provides a reasonably good match to simulated heads at the boundary region between Areas 3 and 9, as well as in the west and east regions of Area 9.

The simulated heads at deep monitoring wells in the central region of Area 9 (e.g., P-05-09 and P-05-31) do not match the observed heads well. The field data indicate a strong downward gradient at these two locations (e.g., the observed vertical head differential is approximately 50 feet at these two well nests). During model calibration, the downward gradient could be better represented by increasing the river conductance and, therefore, the on-site discharge for the eastern portion of the main river channel in Area 9. However, this approach resulted in simulated on-site discharge that was higher than the Water Balance Model and also resulted in simulated low-flow streamflow that was higher than observed. There are probably local-scale features not represented in the regional Groundwater Model that are affecting piezometric heads at these deeper monitoring wells in Area 9.

5.2.2.4 Vertical Head Differences

Some nested piezometers indicated large vertical hydraulic gradients between hydrogeologic layers. The shallow piezometer in three of the nests appeared to be monitoring a perched water table. For example, the water level in P-05-26S was about 100 feet higher than P-05-26D. Similar conditions were noted at P-05-16 and MW-05-02. Because the model is not currently intended to simulate these local conditions, the shallow wells were not used as targets at these locations. Besides these three special cases, the vertically nested wells generally fell in different model layers based on the screen elevation, which allowed the vertical head differences to be simulated by the model. In a few cases, two nested wells fell within a single model layer, and both targets were considered during model calibration.

Figures 5.18 to 5.22 compare simulated and observed vertical head differences at well nests in Area 3, Areas 4 and 5, Area 7, Area 9, and Area 13, respectively. These charts illustrate that the simulated direction of flow between shallow and deeper model layers is matching reasonably well with observed flow conditions.

General observations from these figures include:

- Figure 5.18 shows that the groundwater flow at the MW-5 nest location in Area 3 fluctuates between upward and downward flow. During dry periods, the flow tends to be downward, and during wet periods the flow tends to be upward. This supports the possibility discussed above that high recharge in the bedrock ridge areas may be causing the higher amplitude in seasonal fluctuations in bedrock on this region.
- Figure 5.19 indicates that observed flow in Area 5 is typically downwards at the MW-11 location, yet the model simulates fluctuating flow direction from upward to downward.

5.2.3 Recharge and Discharge Rates

As discussed, the flow rates calculated by the Groundwater Model were compared with the flow rates calculated by the Water Balance Model. Figures 5.23 to 5.25 compare the total cumulative annual recharge, off-site discharge, and on-site discharge estimated by the Water Balance and Groundwater Models for each sub-catchment for the 2005, 2006, and 2007 periods, respectively. Figures 5.23 to 5.25 show that the recharge and discharge estimated by the Groundwater and Water Balance Models match reasonably overall.

Figures 5.26 to 5.31 compare the 2005 monthly cumulative recharge, on-site discharge, and off-site discharge for the 14 sub-catchments simulated with the Water Balance Model. An assessment of this flow calibration for 2005 is presented in detail in the following paragraphs. The comparison of flows simulated with the Water Balance Model and the Groundwater Model for 2006 and 2007 is similar to the discussion presented below for 2005, and thus is not repeated here.

5.2.3.1 South Fork Koktuli

Figure 5.26 compares the monthly cumulative recharge, on-site discharge, and off-site discharge for sub-catchment Areas 1, 2, and 8, as simulated by the Water Balance Model and the Groundwater Model. Areas 1 and 2 are tributaries to the lower South Fork Koktuli River within the domain of the Groundwater Model (Figure 2.2). The recharge and off-site discharge for Area 1 agree reasonably between these two models. For Area 2, the simulated recharge in the Groundwater Model has a more consistent rate of recharge than the Water Balance Model, which simulated large changes in river leakage over time in Area 2. The on-site discharge has a similar characteristic, where the Groundwater Model predicted a relatively consistent rate of discharge and the Water Balance Model predicted a slower rate early in time and a faster rate in the latter half of 2005.

Area 8 on-site discharge predicted by the Groundwater Model is higher than the Water Balance Model. A relatively low effort was expended in calibrating conditions in Area 8 because there were no monitoring wells in Area 8 that could be used as calibration targets. However, the simulation of baseflow during the low-flow streamflow monitoring events is reasonably good for South Fork Koktuli stations in Area 8, which indicates that simulated river leakage for this sub-catchment is matching reasonably well with field conditions.

Figure 5.27 compares recharge and discharge for the Water Balance Model and Groundwater Model for Areas 3, 4, and 5, which are the three sub-catchments along the main stem of the South Fork Koktuli River (Figure 2.2). The off-site discharge for Area 3 agrees well between the two models, but the Groundwater Model is predicting higher recharge and on-site discharge than the Water Balance Model. The Groundwater Model is providing a reasonable representation of baseflow during the low-flow streamflow monitoring events (see Section 5.2.4), and the Water Balance Model under-predicts streamflow during the winter of 2005. For these reasons, there is some justification for predicting higher overall on-site discharge, although it appears that the on-site discharge rate for the latter half of 2005 in the Groundwater Model may be too high. In general, the Water Balance Model tends to predict noticeably different rates of on-site discharge for winter versus the summer and fall months (i.e., as shown by the low rate of discharge in Area 3 in winter and significantly higher rate of on-site discharge in the latter portion of 2005). This seasonal trend is difficult to match with the Groundwater Model, which tends to predict a more consistent rate of on-site discharge.

Additional analysis of temporal fluctuations in the on-site discharge simulated with the Water Balance Model are hydrogeologically feasible. For example, the Water Balance Model simulated an initial period in Winter 2005 where the on-site discharge was consistently low, followed by a significant increase in the simulated rate of on-site discharge in Area 3 in the remainder of the year

Figure 5.27 shows that the two models predict similar rates of combined off-site discharge from Area 5 to Areas 4 and 7. The Water Balance Model calculated that about 55 percent of the off-site discharge from Area 5 was transmitted to Area 4 and about 45 percent to Area 7. The results from the Groundwater Model were similar, with an average of approximately 60 percent of the off-site discharge from Area 5 being transmitted to Area 4 and 40 percent to Area 7. Thus the routing of flows downstream of Area 5 in the Groundwater Model agrees closely with the Water Balance Model. This aspect of the calibration reinforces the success of the calibration in this important area of the model because the absolute value and routing of off-site discharge for Area 5 agreed very closely between the Water Balance Model and the Groundwater Model (Figure 5.32).

Figure 5.27 shows that the Area 5 total recharge (and mainly the river leakage) and on-site discharge predicted by the Groundwater Model are noticeably lower than the Water Balance Model predictions.

Figure 5.33 compares the 2005 on-site discharge rates predicted by the two models and the observed heads at monitoring well MW-11S. Both models predicted a similar trend in the overall on-site discharge rates, although the absolute discharge rates simulated with the Water Balance Model (peak of approximately 95 cubic feet per second) are higher than the discharge rates simulated with the Groundwater Model (peak of approximately 25 cubic feet per second). The similarity in trends shown in Figure 5.33 illustrate that both models are simulating a correlation between on-site discharge and piezometric heads at MW-11S as expected.

To investigate which of the two sets of discharge rates may be more hydrogeologically feasible, the simulated on-site discharge rates were compared to the measured streamflow at gaging station SK100C (Figure 5.34). Streamflow at this station is attributed to baseflow and runoff, whereas the on-site discharge simulated by the two models is equivalent to the total simulated baseflow component to the South Fork Koktuli River in Area 5. Comparison of the simulated discharge rates with the measured streamflow at SK100C (Figure 5.34) indicates that the Water Balance Model is predicting an on-site discharge rate that is higher than the measured streamflow at SK100C for some months. This is possible considering that some of this baseflow simulated in Area 5 may leak back to the aquifer in losing portions of the South Fork Koktuli River.

During calibration of the Groundwater Model, river conductance for the main river tributaries in Area 5 was adjusted higher in an attempt to better match the high flows predicted by the Water Balance Model. However, simulation of a higher river conductance in the Groundwater Model resulted in dampening of the simulated head fluctuations observed at monitoring wells such as MW-11S. Thus the Groundwater Model was constrained in its ability to match the flows simulated by the Water Balance Model because of the requirement to match seasonal head fluctuations at a variety of calibration targets in the sub-catchment.

Figure 5.27 shows that on-site and off-site discharge in Area 4 match reasonably well with the Water Balance Model. The recharge predicted by the Groundwater Model is lower in the latter portion of 2005 than was simulated with the Water Balance Model. Similar to the discussion above, attempts to adjust input parameters in the Groundwater Model to match the higher recharge rate simulated with the Water

Balance Model resulted in a compromise to the match in piezometric heads at target locations, such as monitoring well MW-1S (i.e., resulted in a smaller amplitude in heads fluctuations than was observed in the field).

Figure 5.28 shows the cumulative recharge and discharge for the Groundwater Model and the Water Balance Model for Area 7, which is the sub-catchment for Tributary UT1.190 of Upper Talarik Creek. The Groundwater Model simulated a large component of off-site discharge between Area 7 and Area 11. In contrast, the Water Balance Model considered groundwater flow only from Area 7 to Area 10. The Groundwater Model also simulated a higher overall rate of off-site discharge than the Water Balance Model. However, the recharge and on-site discharge agree closely.

5.2.3.2 Upper Talarik Creek and North Fork Koktuli River

Figure 5.29 compares the simulated recharge and discharge for the Groundwater and Water Balance Models for sub-catchments on the main channel of Upper Talarik Creek (i.e., Areas 9, 10, and 11). The on-site discharge for Area 9 is higher than predicted by the Water Balance Model in the early portion of 2005. However, the rate of on-site discharge matches well between the two models after June 2005. Similar to other watersheds, the Groundwater Model predicts a more consistent on-site discharge rate than the Water Balance Model (which predicts at first a very low rate and then a higher rate in the latter half of 2005). As discussed above, the higher on-site discharge rate simulated with the Groundwater Model is related to the simulation of a relatively large downward vertical flow component in the vicinity of monitoring well nests P-05-09 and P-05-31 as observed in the field. If the Groundwater Model was adjusted to simulate a lower on-site discharge, then it would result in an even larger difference between the observed and simulated piezometric heads in the central portion of Area 9.

Figure 5.29 shows that flow rates simulated by the two models match reasonably well for Area 10. There is some difference between off-site discharge for Area 11, possibly because of the high discharge occurring from Area 7 to Area 11 in the Groundwater Model, which is not represented in the Water Balance Model.

Figures 5.30 and 5.31 compare recharge and discharge for the North Fork Koktuli River sub-catchments (i.e., Areas 12 to 15). The two models agree reasonably for these sub-catchments.

Figure 5.35 to 5.40 show recharge and discharge flow comparisons between the Water Balance and Groundwater Models for 2006 stress periods. Similarly, Figures 5.41 to 5.46 compare flows for the 2007 stress periods. The 2006 and 2007 flows exhibit similar trends to those discussed above.

5.2.4 Low-Flow Streamflow Comparison

Streamflows calculated by the Groundwater Model at specific gaging stations were compared with streamflows measured in the field during a period of zero runoff. This comparison was possible because the streamflows were measured at times when groundwater was the only contributor to flow. As discussed in Section 4.2.1, river reach numbers were used to facilitate tracking of the total flow that would occur upstream from each gaging station in the model.

The streamflow calculated by the Groundwater Model was determined for each gaging station by adding the net discharge from groundwater to all river reaches up-gradient of a surface water gaging station. Figure 5.47 compares the simulated and observed low-flow streamflow for stations where measurements

were collected during the March 2005, April 2006, and March 2007 monitoring events. This figure indicates that the simulated and measured low-flow rates agree reasonably well at a number of monitoring stations.

Regions where low-flow streamflow does not match well between the Groundwater Model and field measurements include the downstream reaches of the Upper Talarik Creek in March 2005, as well as one of the South Fork Koktuli stations measured in 2006 and 2007. The best agreement is demonstrated in the South Fork Koktuli River basin, which is the area where most of the calibration effort was spent.

The Groundwater Model replicates the variations in streamflow along the South Fork Koktuli River channel very well, including the part of the channel that seasonally goes dry between SK100C and SK100D. In other words, the model is simulating interactions between groundwater and surface water reasonably well for the South Fork Koktuli River (Figure 5.48). This match to low-flow streamflow measurements, combined with a good match in piezometric heads at a number of monitoring wells near the South Fork Koktuli River, validates the input parameters used to represent regional groundwater-surface water interactions for the major river tributary in this watershed.

Although there are local-scale differences between simulated and observed low-flow streamflows in the North Fork Koktuli watershed (Figure 5.49), the general trends predicted for the North Fork Koktuli are in reasonable agreement (e.g., declining low-flow baseflow between 2005 and 2007, and general rate of increase in low-flow streamflow between NK100B and NK100LF4).

The Groundwater Model also replicates variations in flow along the Upper Talarik Creek channel fairly well in 2006 and 2007 (Figure 5.50). Some of the downstream stations measured in 2005 do not match well with the Groundwater Model, although it is possible measurements at these stations do not reflect baseflow conditions.

6. SUMMARY

A three-dimensional Groundwater Model was developed to represent the regional groundwater flow system. The Groundwater Model included three layers to represent flow in the overburden, one layer for weathered bedrock, and one for deeper competent bedrock units. The simulation period of the model started on December 1, 2004, and ended on December 31, 2007. Transient recharge estimates from the Water Balance Model for each catchment area were used as input for the transient recharge defined in the Groundwater Model.

The objectives of this Phase III Model Calibration Study included the following:

- Subdivide the overburden into three model layers, rather than the single model layer that was used in Phase I.
- Expand the model domain to make it more appropriate for the expanded Pebble Deposit that had been identified.
- Incorporate the latest data that were collected up to the end of 2007.
- Improve the calibration over the Phase I and II models.

The calibration focused on the following areas:

- South Fork Koktuli River recharge and discharge areas (particularly sub-catchment areas 3, 4, and 5).
- Area 7 (tributary of Upper Talarik Creek just above stream-gaging station UT100B) because it receives groundwater flow from Area 5.
- Area 9 (headwaters of Upper Talarik Creek).

A number of qualitative and quantitative calibration goals were used to maximize the uniqueness of the parameter combination used in the Groundwater Model. Qualitative calibration analyses (e.g., graphical output) evaluated how well the model matched observed conditions with respect to the following:

- Comparison of hydraulic conductivity calculated using simple analytical models and response, or pumping test collected from the field with calibrated hydraulic conductivity values in the Groundwater Model.
- Comparison of heads calculated by the model with heads observed in the field.
- Amplitude and timing of transient fluctuations in piezometric elevations observed in monitoring wells throughout the mine study area.
- Transient monthly and total annual recharge, on-site discharge and off-site discharge estimated by the Groundwater Model and the Water Balance Model for each catchment area for 2005, 2006, and 2007.
- Low-flow streamflows measured along the South Fork Koktuli River, North Fork Koktuli River, and Upper Talarik Creek in March 2005, April 2006, and March 2007.
- Difference in vertical heads at discrete locations where monitoring wells are installed in multiple layers.

Quantitative calibration goals included the attainment of a reasonable RMSE for the mine study area (e.g., less than 10 percent of the observed range in piezometric elevations).

A total of 220 calibration target wells were defined in the mine study area, with a sub-set of 139 key target locations in the valley-fill portions of the mine study area because these areas were within the main area of interest.

The calibration analysis presented in Section 5 of this document indicates that the heads in the main areas of interest in the Groundwater Model (i.e., South Fork Koktuli River catchment and Upper Talarik Creek headwater and UT1.190 areas) are in reasonable agreement with observed conditions. Recharge and discharge rates calibrated with the Groundwater Model generally agree with values estimated by the Water Balance Model. The level of calibration achieved in the South Fork Koktuli catchment area is best because it received a larger proportion of the calibration effort. More attention has been paid recently to the importance of the North Fork Koktuli watershed and the Upper Talarik Creek headwaters. A number of monitoring wells were installed in these regions in late 2006 or 2007.

A number of refinements have been made to the Groundwater Model in this Phase III Study, such as the addition of more layers to represent overburden; expansion of the model domain to include additional sub-catchments; calibration of flows in additional sub-catchments such as Area 8, 12, and 15; addition of new monitoring wells as calibration targets; expansion of the simulation time period from approximately

1 year to 3 years; and additional low-flow streamflow events that were used as part of the flow calibration. The model was also refined with respect to the representation of layer elevations and hydraulic conductivity zones based on a series of geologic cross sections that were prepared as part of this study (Chapter 8 of the EBD). These refinements have improved the representation of regional hydrogeology in the model, and have also increased the number of piezometric head and flow targets available for calibration of the Groundwater Model.

The Groundwater Model is providing a better representation of regional groundwater flow in the mine study area. The Groundwater Model has also been helpful as an interpretive tool to confirm the conceptual model for regional groundwater flow, and for evaluating the hydrogeologic feasibility of Water Balance Model simulations of transient recharge and discharge on a sub-catchment basis.

A summary of the Groundwater Model calibration achievements discussed in Section 5 is provided below.

6.1.1 Model Calibration Achievements

Comparison of simulated and observed piezometric heads was conducted using scatter plots, bubble plots, statistical analyses, and graphs. Results of these analyses are as follows:

- Simulated heads in Layers 1 and 2, particularly in the valley regions, provided the best match to observed heads, possibly because heads in these layers are more directly influenced by surface water boundary conditions in the model.
- Simulated heads at target locations in Layers 3 (deep overburden) and 4 (fractured bedrock) tend to underestimate observed heads in the uplands regions, although this area is not as important for estimating flows as the valley regions.
- The overall RMSE is approximately 3 percent of the range in observed heads for all calibration targets, which is less than the 10 percent threshold that serves as the rule of thumb for defining a good calibration. There are some sub-catchments where RMSE statistics in individual layers are higher than 10 percent, although most of the key sub-catchments have overall RMSE values less than 10 percent of the range in observed heads in those areas.
- At head calibration target locations, the average difference between the simulated and observed range in temporal piezometric heads was less than 2 feet, which is quite good. The average difference in Layer 1 (6 feet) was larger than the average differences in the deeper layers (less than 1 foot), possibly because temporal trends in piezometric heads at shallow wells are more susceptible to local scale heterogeneities.
- The differences between simulated and observed heads (i.e., residuals) tend to increase in time at some uplands locations and for targets in the North Fork Koktuli watershed, which is likely due to the estimate of initial heads. Residuals in valley regions in the South Fork Koktuli watershed are relatively consistent over time, notwithstanding some seasonal fluctuations.
- Hydrographs illustrated that although some of the targets did not have a good match to average heads or the amplitude in seasonal fluctuations, many of calibration targets had matched to both the average heads and seasonal fluctuations.
- There were some areas identified for further evaluation in the heads calibration such as the central portion of Area 9 and the uplands portion of Area 3, as well as the degree of seasonal fluctuation

observed in several bedrock wells that may be due to high recharge in bedrock ridge zones in the uplands areas.

- Comparison of recharge and discharge simulated with the Groundwater Model and the Water Balance Model indicated that trends observed in 2005 are similar to trends observed for flow in 2006 and 2007.
- There are some sub-catchments where the match between recharge and discharge for the Groundwater Model and the Water Balance Model can be improved. In some cases, however, attempts to improve the match in flows resulted in a compromise to the heads calibration. In these cases, maintaining the heads calibration was assumed to take priority over matching the flows. The recharge and discharge flows matched reasonably well for a number of the sub-catchments that were simulated with the Water Balance Model.
- The low-flow streamflow comparison demonstrated that there was a good match between the Groundwater Model simulations and field data collected at most of the South Fork Koktuli stations. General trends in the simulated and field curves match fairly well for portions of the major tributary in each of these watersheds.

7. REFERENCES

American Society for Testing and Materials (ASTM). 1999. D 5490-93 Standard Guide for Comparing Ground-Water Flow Model Simulations to Site-Specific Information, in ASTM Standards on Determining Subsurface Hydraulic Properties and Groundwater Modeling, American Society for Testing and Materials, West Conshohocken, PA.

Environmental Simulations, 2004. Groundwater Vistas User Manual.

Hydrogeologic, 1996. MODFLOW SURFACT User Manual.

TABLES

TABLE 4.1
Rec ge R tios

Area	Recharge Ratio
1	80%
2	100%
3	100%
4	120%
5	70%
6	100%
7	100%
8	50%
9	80%
10	100%
11	70%
12	100%
13	80%
14	100%
15	100%

TABLE 4.2
H ulic Con ucti it one Input D t n Fiel -C lcul te St tistics

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
1	0.5	0.5	1	1	1234	1	0.4	0.4	0.4
2	10	5	2	2	1234	--	--	--	--
3	1	1	1	3	1234	7	0.005	4	0.4
4	0.5	0.5	1	4	1234	--	--	--	--
5	0.1	0.01	10	5	1234	--	--	--	--
6	0.5	0.5	1	4	1234	--	--	--	--
7	0.5	0.05	10	7	1234	--	--	--	--
8	0.5	0.5	1	8	1234	--	--	--	--
9	0.5	0.5	1	9	1234	1	0.2	0.2	0.2
10	0.5	0.5	1	10	1234	--	--	--	--
11	0.5	0.5	1	11	1234	--	--	--	--
12	100	50	2	12	1234	2	0.002	0.006	0.0
13	0.5	0.5	1	13	1234	--	--	--	--
14	15	7.5	2	14	1234	4	0.3	227	26.5
15	0.5	0.5	1	15	1234	--	--	--	--
16	0.5	0.5	1	16	1234	--	--	--	--
17	0.5	0.5	1	17	1234	--	--	--	--
18	0.5	0.5	1	18	1234	--	--	--	--
19	0.5	0.5	1	19	1234	--	--	--	--
20	0.5	0.5	1	20	1234	--	--	--	--
21	0.5	0.5	1	21	1234	--	--	--	--
22	0.5	0.5	1	22	1234	--	--	--	--
23	0.5	0.5	1	23	1234	--	--	--	--
24	10	5	2	9	1234	--	--	--	--
31	300	150	2	1	123	--	--	--	--
32	900	450	2	2	123	--	--	--	--
33	20	2	10	3	123	--	--	--	--
34	2499.9	1249.95	2	4	123	1	255.0	255.0	255.0
35	100	1.05	95	5	123	--	--	--	--
36	300	150	2	4	123	--	--	--	--
37	30	15	2	7	1	--	--	--	--
38	300	150	2	8	123	--	--	--	--
39	99	10.5	9	9	123	--	--	--	--
40	50	25	2	10	123	--	--	--	--
41	50	25	2	11	123	--	--	--	--
42	300	150	2	12	123	--	--	--	--
43	99	49.5	2	13	123	1	91.0	91.0	91.0

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
44	300	150	2	14	123	--	--	--	--
45	300	150	2	15	123	--	--	--	--
46	300	150	2	16	123	--	--	--	--
47	300	150	2	17	123	--	--	--	--
48	300	150	2	18	123	--	--	--	--
49	300	150	2	19	123	--	--	--	--
50	300	150	2	20	123	--	--	--	--
51	300	150	2	21	123	--	--	--	--
52	300	150	2	22	123	--	--	--	--
53	300	150	2	23	123	--	--	--	--
54	725.0666	9.800375	74	7	2	--	--	--	--
55	176.73	8.852266	20	7	3	--	--	--	--
56	0.99	0.105	9	9	123	--	--	--	--
61	50	25	2	1	4	--	--	--	--
62	50	25	2	2	4	--	--	--	--
63	4	0.04	100	3	4	7	0.2	79	3.1
64	50	25	2	4	4	2	4	74	17.2
65	20	1	20	5	4	3	2	227	21.9
66	50	25	2	4	4	--	--	--	--
67	29.50669	4.903703	6	7	4	--	--	--	--
68	50	25	2	8	4	--	--	--	--
69	200	0.04	5000	9	4	7	0.2	57	2.9
70	46.08792	4.98078	9	10	4	--	--	--	--
71	327.1107	5.014236	65	11	4	--	--	--	--
72	50	25	2	12	4	--	--	--	--
73	50	25	2	13	4	--	--	--	--
74	50	25	2	14	4	--	--	--	--
75	50	25	2	15	4	--	--	--	--
76	50	25	2	16	4	--	--	--	--
77	50	25	2	17	4	--	--	--	--
78	50	25	2	18	4	--	--	--	--
79	50	25	2	19	4	--	--	--	--
80	50	25	2	20	4	--	--	--	--
81	50	25	2	21	4	--	--	--	--
82	50	25	2	22	4	--	--	--	--
83	50	25	2	23	4	--	--	--	--
84	0.04	0.04	1	9	4	--	--	--	--
85	0.04	0.04	1	9	4	--	--	--	--
100	2500	1250	2	1	1	--	--	--	--
101	2500	1250	2	4	1	1	170.0	170.0	170.0

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
102	2500	1250	2	4	1	--	--	--	--
103	2500	125	20	5	1	--	--	--	--
104	1	0.01	100	7	1	--	--	--	--
105	500	10	50	4	1	--	--	--	--
106	500	1	500	5	1	--	--	--	--
107	5	0.001	5000	7	1	--	--	--	--
111	100	1	100	5	1	--	--	--	--
112	500	10	50	10	1	--	--	--	--
113	500	1	500	5	1	--	--	--	--
114	100	1	100	5	1	1	35.0	35.0	35.0
115	5	0.01	500	7	1	4	1	255	21.2
116	500	10	50	2	1	--	--	--	--
117	500	1	500	5	1	1	283.0	283.0	283.0
118	25	0.0125	2000	5	1	2	4	9	6.0
119	20	0.1	200	5	1	--	--	--	--
120	2500	125	20	5	1	1	28.0	28.0	28.0
121	2500	125	20	5	1	1	247.0	247.0	247.0
122	2	0.001	2000	7	1	--	--	--	--
123	20	0.1	200	5	1	--	--	--	--
124	500	10	50	4	1	--	--	--	--
125	100	50	2	4	1	--	--	--	--
126	100	50	2	4	1	--	--	--	--
127	1	1	1	3	1	--	--	--	--
129	2500	1250	2	3	1	--	--	--	--
130	2500	1250	2	3	1	--	--	--	--
132	2500	1250	2	3	1	1	0.8	0.8	0.8
133	500	10	50	3	1	1	10.0	10.0	10.0
135	100	50	2	3	1	--	--	--	--
136	500	10	50	3	1	--	--	--	--
137	20	1	20	3	1	--	--	--	--
138	100	1	100	3	1	--	--	--	--
139	20	1	20	3	1	--	--	--	--
141	20	1	20	3	1	--	--	--	--
144	1	0.1	10	9	1	--	--	--	--
145	1	0.1	10	9	1	--	--	--	--
147	1	0.1	10	9	1	--	--	--	--
148	100	1	100	3	1	--	--	--	--
149	1	0.1	10	9	1	--	--	--	--
152	500	10	50	9	1	--	--	--	--
154	20	0.001	20000	9	1	2	0.04	2	0.3

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
160	1	1	1	9	1	--	--	--	--
162	100	50	2	9	1	--	--	--	--
164	20	2	10	3	1	6	1	85	14.7
165	10	5	2	9	1	1	354.0	354.0	354.0
166	1	1	1	3	1	--	--	--	--
168	1	1	1	9	1	--	--	--	--
169	1	1	1	10	1	--	--	--	--
170	2500	1250	2	9	1	--	--	--	--
171	100	1	100	13	1	--	--	--	--
172	100	1	100	9	1	--	--	--	--
173	100	50	2	9	1	--	--	--	--
174	500	10	50	13	1	--	--	--	--
175	100	50	2	15	1	--	--	--	--
177	20	1	20	12	1	--	--	--	--
180	100	50	2	12	1	--	--	--	--
181	2500	1250	2	13	1	--	--	--	--
182	2500	1250	2	15	1	--	--	--	--
183	2500	1250	2	15	1	--	--	--	--
184	2500	1250	2	14	1	--	--	--	--
185	100	50	2	14	1	--	--	--	--
186	1000	500	2	3	1	--	--	--	--
187	250	1.25	200	5	1	--	--	--	--
190	1	0.1	10	3	1	--	--	--	--
191	1	0.1	10	3	1	--	--	--	--
192	1	0.1	10	3	1	--	--	--	--
193	20	2	10	3	1	--	--	--	--
194	20	2	10	3	1	--	--	--	--
195	1	0.1	10	3	1	--	--	--	--
196	20	2	10	3	1	--	--	--	--
197	1	0.1	10	3	1	--	--	--	--
198	1	0.1	10	3	1	--	--	--	--
199	1	0.1	10	3	1	--	--	--	--
200	1	0.1	10	3	2	--	--	--	--
201	1	0.1	10	3	2	--	--	--	--
202	1	0.1	10	3	2	--	--	--	--
203	20	2	10	3	2	--	--	--	--
204	20	2	10	3	2	--	--	--	--
205	20	2	10	3	2	--	--	--	--
206	1	0.1	10	3	2	--	--	--	--
207	20	2	10	3	2	--	--	--	--

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
208	1	0.1	10	3	2	--	--	--	--
209	1	0.1	10	3	2	--	--	--	--
210	1	0.1	10	3	2	--	--	--	--
211	1	0.1	10	3	3	--	--	--	--
212	1	0.1	10	3	3	--	--	--	--
213	20	2	10	3	3	--	--	--	--
214	1	0.1	10	3	3	--	--	--	--
215	1	0.1	10	3	3	--	--	--	--
216	1	0.1	10	3	3	--	--	--	--
217	1	0.1	10	3	3	--	--	--	--
218	1	0.1	10	3	4	--	--	--	--
219	1	0.1	10	3	4	--	--	--	--
220	1	0.1	10	3	4	--	--	--	--
221	1	0.1	10	3	4	--	--	--	--
222	1	0.1	10	3	4	--	--	--	--
223	1	0.1	10	3	4	--	--	--	--
300	100	50	2	4	2	1	2.0	2.0	2.0
301	100	0.1	1000	5	2	--	--	--	--
303	100	5	20	5	2	--	--	--	--
304	20	0.1	200	5	2	1	156.0	156.0	156.0
306	79.44157	9.916889	8	7	2	--	--	--	--
307	19.54159	1.999972	10	7	2	--	--	--	--
308	20	0.1	200	5	2	--	--	--	--
309	20	0.1	200	5	2	--	--	--	--
311	500	1	500	5	2	2	181	1700	554.7
314	500	1	500	5	2	--	--	--	--
315	100	5	20	5	2	--	--	--	--
316	500	1	500	5	2	2	85	213	134.6
317	5.8	0.58	10	7	2	3	3	312	44.5
318	1000	500	2	3	2	--	--	--	--
319	2500	1250	2	1	2	--	--	--	--
320	2500	1250	2	4	2	1	2069.0	2069.0	2069.0
321	2500	1250	2	4	2	--	--	--	--
322	250	1.25	200	5	2	4	85	1675	237.3
323	1041.825	248.7579	4	7	2	--	--	--	--
324	2500	1250	2	10	2	--	--	--	--
325	500	1	500	5	2	1	99.0	99.0	99.0
326	2500	1.25	2000	5	2	--	--	--	--
327	25	1.25	20	5	2	--	--	--	--
328	2500	125	20	5	2	--	--	--	--

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
329	100	10	10	7	2	--	--	--	--
330	100	10	10	7	2	--	--	--	--
331	100	10	10	7	2	--	--	--	--
332	100	1	100	3	2	--	--	--	--
339	100	1	100	3	2	1	57.0	57.0	57
340	1	1	1	3	2	--	--	--	--
341	2500	0.00125	2000000	9	2	1	266.0	266.0	266.0
343	20	1	20	9	2	--	--	--	--
345	100	1	100	3	2	1	6.0	6.0	6.0
348	1	1	1	3	2	1	6.0	6.0	6.0
349	1	1	1	9	2	--	--	--	--
351	2500	1250	2	9	2	--	--	--	--
353	20	1	20	3	2	--	--	--	--
354	20	1	20	3	2	--	--	--	--
357	1	1	1	3	2	--	--	--	--
358	1	1	1	3	2	--	--	--	--
359	1	0.5	2	9	2	--	--	--	--
360	20	1	20	9	2	--	--	--	--
361	1	1	1	9	2	--	--	--	--
362	1	1	1	9	2	--	--	--	--
364	2500	1250	2	9	2	--	--	--	--
365	20	1	20	9	2	--	--	--	--
367	2500	1250	2	9	2	--	--	--	--
368	1.01	1.01	1	0	2	2	1	96	9.8
369	10	5	2	9	2	1	1.0	1.0	1.0
370	1	1	1	9	2	--	--	--	--
371	1	1	1	10	2	--	--	--	--
372	100	50	2	13	2	--	--	--	--
373	100	50	2	9	2	--	--	--	--
374	500	10	50	13	2	1	213.0	213.0	213.0
375	500	10	50	9	2	--	--	--	--
377	500	10	50	13	2	--	--	--	--
378	100	50	2	15	2	--	--	--	--
379	2500	1250	2	13	2	--	--	--	--
380	2500	1250	2	15	2	--	--	--	--
381	2500	1250	2	15	2	--	--	--	--
382	100	50	2	14	2	--	--	--	--
383	100	50	2	15	2	--	--	--	--
386	100	50	2	14	2	--	--	--	--
387	100	50	2	14	2	--	--	--	--

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
500	100	50	2	4	3	--	--	--	--
501	100	50	2	4	3	--	--	--	--
502	100	5	20	5	3	--	--	--	--
504	19.59053	2	10	7	3	--	--	--	--
505	0.992395	0.1002817	10	7	3	--	--	--	--
507	20	0.1	200	5	3	--	--	--	--
509	100	0.1	1000	5	3	--	--	--	--
510	24.46363	9.278668	3	7	3	--	--	--	--
512	20	0.1	200	5	3	--	--	--	--
513	19.72848	1.731591	11	7	3	--	--	--	--
514	100	0.1	1000	5	3	--	--	--	--
516	20	0.1	200	5	3	--	--	--	--
517	20	2	10	3	3	1	0.5	0.5	0.5
518	100	5	20	5	3	--	--	--	--
519	20	0.1	200	5	3	--	--	--	--
521	500	1	500	5	3	--	--	--	--
522	100	50	2	4	3	--	--	--	--
523	1	1	1	1	3	--	--	--	--
524	1	1	1	4	3	--	--	--	--
525	20	1	20	4	3	--	--	--	--
526	20	0.1	200	5	3	--	--	--	--
527	500	1	500	5	3	--	--	--	--
528	500	1	500	5	3	--	--	--	--
530	500	10	50	4	3	--	--	--	--
531	500	10	50	4	3	--	--	--	--
532	500	1	500	5	3	1	85.0	85.0	85.0
533	2500	1250	2	4	3	--	--	--	--
534	2500	125	20	5	3	--	--	--	--
535	2421.587	250	10	7	3	--	--	--	--
537	1000	50	20	5	3	--	--	--	--
539	250	1.25	200	5	3	2	0.03	255	2.8
540	2500	1250	2	10	3	--	--	--	--
541	100	1	100	5	3	1	567.0	567.0	567.0
542	6.599338	0.66	10	7	3	--	--	--	--
543	2500	1250	2	2	3	--	--	--	--
544	2500	1250	2	4	3	--	--	--	--
546	2500	125	20	5	3	1	113.0	113.0	113.0
547	100	5	20	5	3	1	198.0	198.0	198.0
548	500	1	500	5	3	--	--	--	--
549	2500	125	20	5	3	--	--	--	--

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
550	100	1	100	3	3	1	43.0	43.0	43.0
551	1	1	1	3	3	--	--	--	--
552	100	50	2	3	3	--	--	--	--
555	500	10	50	3	3	1	0.0005	0.0005	0.0005
556	100	1	100	3	3	--	--	--	--
558	500	10	50	3	3	--	--	--	--
560	0.1	0.1	1	9	3	1	0.0003	0.0003	0.0003
561	0.1	0.1	1	9	3	1	170.0	170.0	170.0
562	20	1	20	3	3	--	--	--	--
563	100	1	100	9	3	--	--	--	--
564	20	1	20	3	3	--	--	--	--
565	2500	1250	2	3	3	--	--	--	--
567	1	1	1	3	3	--	--	--	--
568	1	1	1	9	3	--	--	--	--
572	100	1	100	3	3	--	--	--	--
573	20	1	20	3	3	--	--	--	--
574	100	1	100	3	3	3	0.2	57	6.4
575	100	1	100	9	3	2	1	43	6.6
577	20	1	20	3	3	--	--	--	--
580	20	1	20	3	3	--	--	--	--
581	20	1	20	9	3	2	0.004	3	0.1
582	100	50	2	9	3	--	--	--	--
583	50	25	2	9	3	--	--	--	--
584	20	1	20	9	3	--	--	--	--
586	1	1	1	9	3	--	--	--	--
587	10	5	2	9	3	1	20.0	20.0	20.0
588	100	50	2	9	3	--	--	--	--
589	2500	1250	2	9	3	--	--	--	--
591	100	1	100	9	3	--	--	--	--
592	2500	1250	2	9	3	--	--	--	--
593	1	1	1	9	3	--	--	--	--
594	1	1	1	3	3	--	--	--	--
595	20	2	10	3	3	--	--	--	--
596	10	5	2	9	3	1	6.0	6.0	6.0
598	100	1	100	10	3	--	--	--	--
599	1	1	1	9	3	--	--	--	--
600	1	1	1	10	3	--	--	--	--
601	100	1	100	13	3	--	--	--	--
602	100	1	100	9	3	--	--	--	--
603	1	1	1	13	3	--	--	--	--

Hydraulic Conductivity Zone ID	Groundwater Model					Field-Calculated K Statistics			
	Kx (feet/day)	Kz (feet/day)	Kx:Kz	Area	Layer [a]	No. Values	Kmin [b]	Kmax [c]	Kgm [d]
606	100	50	2	14	3	--	--	--	--
607	100	50	2	15	3	--	--	--	--
608	2500	1250	2	13	3	--	--	--	--
609	2500	1250	2	15	3	1	156.0	156.0	156.0
610	2500	1250	2	15	3	--	--	--	--
613	100	50	2	14	3	--	--	--	--
614	100	50	2	14	3	--	--	--	--
615	2500	1250	2	9	3	--	--	--	--
621	0.001	0.001	1	1	5	--	--	--	--
622	0.001	0.001	1	2	5	--	--	--	--
623	0.001	0.001	1	3	5	--	--	--	--
624	0.001	0.001	1	4	5	--	--	--	--
625	0.001	0.0001	10	5	5	--	--	--	--
626	0.001	0.001	1	4	5	--	--	--	--
627	0.001001204	9.99927E-05	10	7	5	--	--	--	--
628	0.001	0.001	1	8	5	--	--	--	--
629	0.001	0.001	1	9	5	--	--	--	--
630	0.001001417	0.00010002	10	10	5	--	--	--	--
631	0.001002364	0.000100028	10	11	5	--	--	--	--
632	0.001	0.001	1	12	5	--	--	--	--
633	0.001	0.001	1	13	5	--	--	--	--
634	0.001	0.001	1	14	5	--	--	--	--
635	0.001	0.001	1	15	5	--	--	--	--
636	0.001	0.001	1	16	5	--	--	--	--
637	0.001	0.001	1	17	5	--	--	--	--
638	0.001	0.001	1	18	5	--	--	--	--
639	0.001	0.001	1	19	5	--	--	--	--
640	0.001	0.001	1	20	5	--	--	--	--
641	0.001	0.001	1	21	5	--	--	--	--
642	0.001	0.001	1	22	5	--	--	--	--
643	0.001	0.001	1	23	5	--	--	--	--
644	0.001	0.001	1	9	5	--	--	--	--

Notes:

a. Layer defined as "1234" or "123" means the hydraulic zone extends over multiple layers (e.g., Layers 1 to 4 or Layers 1 to 3, respectively).

b. Kmin = Minimum field-calculated hydraulic conductivity for targets within model hydraulic conductivity zone.

c. Kmax = Maximum field-calculated hydraulic conductivity for targets within model hydraulic conductivity zone.

d. Kgm = Geometric mean of field-calculated hydraulic conductivity values for targets within model hydraulic conductivity zone.

-- not applicable.

TABLE 4.3
Pumping Test Mo eling Results

Pumped Well	Pumped Well Layer	Monitoring Well	Monitoring Well Layer	Aquifer	Calibrated Run ID	MODFLOW Calibrated Parameters Kx (feet/day)	Kz (feet/day)	Ss (per foot)	K from Analytical Model (feet/day)
PW3	2	MW-11M	2	Overburden	TMR-308	500	250	6.E-04	140
		MW-11D [a]	3	Overburden		500	25	3.E-05	n/a
PW4	2	MW-1M	2	Overburden	TMR-404	2,500	1,250	3.E-05	2,070
PW5	4	MW-14D	4	Bedrock	TMR-510	70	35	3.E-05	190
		MW-14S	3	Overburden		400	200	3.E-05	n/a
		P-05-25	4	Bedrock		70	35	3.E-05	n/a
PW6	3	PW5	4	Bedrock	TMR-604	70	35	3.E-05	n/a
		MW-14S	3	Overburden		400	200	3.E-05	440
		MW-14D	4	Bedrock		70	35	3.E-05	n/a
		P-05-25	4	Bedrock		70	35	3.E-05	n/a
PW8	4	P-05-29D	4	Bedrock	TMR-808	4	0.04	3.E-05	n/a
		P-05-29D2	4	Bedrock		4	0.04	3.E-05	4.5

Note:

a. Geologic cross-section shows a silt/clay layer between MW-11M and MW-11D.

Key:

n/a = not applicable.

TABLE 5.1
He C li tion St tistics

Model Area	Model Layer	Location	No. Of Observation Points	Average Residual [a] (feet)	Mean Absolute Residual (feet)	Range in Heads (feet) [b] Observed	Simulated	Difference [c]
1	3	GH04-19	33	31	31	1	11	-10
1	4	GH04-20	7	-144	144	2	2	0
1	4	GH06-65	5	-60	60	4	1	3
1	4	GH07-92D	1	-26	26	--	--	--
1	4	GH07-93	1	-35	35	--	--	--
1	4	GH07-94	1	-77	77	--	--	--
2	3	GH04-22	17	-74	74	10	2	8
2	4	GH05-55	9	-174	174	17	3	14
3	1	GH04-06	14	-2	2	4	3	1
3	1	GH04-47	34	-2	2	3	4	-1
3	1	GH06-80	5	0	1	2	0	2
3	1	KP-P3S	34	-25	25	9	13	-4
3	1	MW-05-12S	30	-40	40	16	9	7
3	1	MW-5S	34	-3	3	3	3	0
3	1	P-05-20S	25	-3	3	4	3	1
3	1	P-05-21S	12	-2	2	3	3	0
3	1	P-05-29M	26	2	2	2	6	-4
3	1	P-05-36S	26	-16	16	4	14	-10
3	1	P-3	30	-20	20	11	14	-3
3	1	P-4AS	34	-3	4	7	13	-6
3	1	P-6S	34	-4	5	4	12	-8
3	2	GH04-48	33	-38	38	15	20	-5
3	2	KP-P4	31	-2	4	8	13	-5
3	2	MW-5M	33	-2	2	3	3	0
3	2	P-05-07S	28	-21	21	9	13	-4
3	2	P-4	3	2	2	2	2	0
3	2	P-6M	34	-4	5	6	12	-6
3	2	PQ-9	28	7	7	5	12	-7
3	3	GH04-45A	15	-55	55	6	10	-4
3	3	GH05-61	19	-5	5	9	3	6
3	3	GH06-74	5	-40	40	3	2	1
3	3	KP-P3M	35	-21	21	10	13	-3
3	3	P-05-20D	1	-8	8	--	--	--
3	3	P-05-21D	1	1	1	--	--	--
3	3	P-05-21M	1	0	0	--	--	--
3	3	P-05-22D	28	-4	4	13	4	9

Area	Model Layer	Location	No. Of Observation Points	Average Residual [a] (feet)	Mean Absolute Residual (feet)	Range in Heads (feet) [b]		
						Observed	Simulated	Difference [c]
3	3	P-05-36M	27	-17	17	4	14	-10
3	3	P-4AD	34	-4	4	7	13	-6
3	3	P-6D	34	-5	6	5	12	-7
3	4	GH04-27	10	-113	113	9	12	-3
3	4	GH04-46	32	-30	30	35	11	24
3	4	GH05-53	15	-212	212	28	64	-36
3	4	GH05-54	1	-328	328	--	--	--
3	4	GH05-56	5	-134	134	17	10	7
3	4	GH05-59	26	-9	9	8	10	-2
3	4	GH05-63	14	-38	38	11	8	3
3	4	GH06-70S	2	-69	69	0	0	0
3	4	I-125	20	-3	6	21	12	9
3	4	I-172	34	-13	13	10	27	-17
3	4	KP-P3D	8	-32	32	3	4	-1
3	4	M-110	34	-19	19	36	21	15
3	4	M-12	33	-24	24	22	12	10
3	4	M-21	31	-28	28	19	10	9
3	4	M-62	24	17	20	62	17	45
3	4	MW-05-12D	30	-25	25	20	10	10
3	4	MW-5D	34	-2	3	11	3	8
3	4	P-05-07D	27	-33	33	16	15	1
3	4	P-05-08	28	-22	22	25	20	5
3	4	P-05-29D	26	1	2	6	6	0
3	4	P-05-29D2	26	1	2	6	6	0
3	4	P-05-36D	27	-17	17	4	13	-9
3	4	P-2D	24	-15	15	8	12	-4
3	4	P-2M	26	-15	15	8	13	-5
3	4	PQ-4	27	-120	120	16	8	8
3	4	PQ-8	19	-8	8	8	16	-8
4	1	GH04-05	23	0	1	5	2	3
4	1	MW-1S	33	0	1	9	7	2
4	2	GH04-16	12	-1	3	10	6	4
4	2	GH04-38	29	-53	53	32	10	22
4	2	MW-05-13S	27	-3	3	6	4	2
4	2	MW-1M	34	-1	1	9	7	2
4	3	GH04-14	24	-19	19	15	6	9
4	3	GH04-37	29	12	13	28	11	17
4	4	MW-05-13D	24	-3	3	5	4	1
4	4	MW-1D	34	-1	1	9	7	2

Area	Model Layer	Location	No. Of Observation Points	Average Residual [a] (feet)	Mean Absolute Residual (feet)	Range in Heads (feet) [b]		
						Observed	Simulated	Difference [c]
5	1	GH04-17	34	-2	3	15	10	5
5	1	MW-05-11SS	20	-17	17	5	27	-22
5	1	P-05-10S	26	0	3	17	11	6
5	1	P-05-11S	26	-3	4	15	14	1
5	1	P-05-14S	28	-16	16	14	14	0
5	1	P-05-15S	27	-9	9	11	16	-5
5	1	P-05-17S	13	-20	20	2	17	-15
5	1	P-05-24S	27	-21	21	22	43	-21
5	2	GH04-30	28	-24	24	18	16	2
5	2	GH04-33	32	-33	33	14	21	-7
5	2	GH04-35	23	-10	10	18	21	-3
5	2	GH05-52	2	-26	26	1	2	-1
5	2	GH06-75	4	1	6	14	1	13
5	2	MW-11M	35	-4	6	30	27	3
5	2	MW-11S	32	-2	5	28	25	3
5	2	MW-3D	32	2	5	23	15	8
5	2	P-05-11M	27	1	3	16	14	2
5	2	P-05-12	26	-1	3	18	13	5
5	2	P-05-13	27	-11	11	18	14	4
5	2	P-05-14D	28	-19	19	17	17	0
5	2	P-05-15D	19	-16	16	17	14	3
5	2	P-05-17D	26	19	19	19	21	-2
5	2	P-05-26D	24	-6	7	23	14	9
5	3	GH04-18	34	-1	3	15	10	5
5	3	GH04-31	6	17	17	3	24	-21
5	3	GH06-76	4	9	9	14	1	13
5	3	MW-05-14S	25	7	7	25	19	6
5	3	MW-11D	35	-4	5	29	26	3
5	3	P-05-10D	27	0	3	17	12	5
5	3	P-05-11D	28	2	3	17	13	4
5	3	P-05-24D	27	-29	29	23	32	-9
5	4	GH04-12A	31	-13	13	31	17	14
5	4	GH04-28	33	-53	53	11	20	-9
5	4	GH04-43	32	-54	54	2	1	1
5	4	MW-05-14D	27	7	8	29	20	9
5	4	P-05-23	27	-46	46	9	20	-11
5	4	P-05-25	28	7	8	29	20	9
7	1	MW-05-02M	16	-9	9	8	20	-12
7	1	MW-2S	32	-1	5	8	24	-16

Area	Model Layer	Location	No. Of Observation Points	Average Residual [a] (feet)	Mean Absolute Residual (feet)	Range in Heads (feet) [b]		
						Observed	Simulated	Difference [c]
7	1	P-05-16S	26	1	3	12	12	0
7	1	P-05-18	21	-19	19	8	32	-24
7	1	P-05-19M	26	-9	10	10	23	-13
7	1	P-05-19S	10	-8	8	4	17	-13
7	1	P-05-27M	20	-10	14	12	40	-28
7	1	P-05-27S	23	-15	17	10	40	-30
7	2	MW-2D	33	-8	8	5	13	-8
7	2	P-05-16D	26	4	4	15	19	-4
7	2	P-05-16M	27	0	3	15	19	-4
7	2	P-05-27D	23	-7	7	19	23	-4
9	1	GH04-02	33	-14	14	10	12	-2
9	1	P-05-09S	28	-27	27	12	20	-8
9	1	P-05-28S	25	-13	14	22	27	-5
9	1	P-05-30S	25	-5	7	10	23	-13
9	1	P-05-31S	17	-3	3	2	10	-8
9	1	P-06-40S	8	14	14	18	6	12
9	2	P-05-09D	29	6	7	3	16	-13
9	2	P-06-37S	16	-52	52	10	7	3
9	2	P-06-39S	17	-3	5	15	4	11
9	2	SRK-2A	33	-2	5	3	16	-13
9	3	GH05-64	26	10	12	28	31	-3
9	3	I-201	34	-19	19	6	13	-7
9	3	KP-P1	34	2	4	4	15	-11
9	3	P-05-28D	26	-16	16	27	26	1
9	3	P-05-33D	26	2	3	9	7	2
9	3	P-05-35	25	-20	20	5	2	3
9	3	P-06-41S	10	-8	8	2	2	0
9	3	SRK-2	32	-4	5	3	15	-12
9	4	GH07-104	1	-25	25	--	--	--
9	4	MW-4S	4	-46	46	0	10	-10
9	4	P-05-30D	25	-38	38	7	12	-5
9	4	P-05-31D	24	23	23	16	10	6
9	4	P-05-32D	26	12	12	15	11	4
9	4	P-05-34D	2	16	16	3	0	3
9	4	P-06-37D	15	-62	62	9	5	4
9	4	P-06-37M	15	-62	62	8	5	3
9	4	P-06-38D	1	-31	31	--	--	--
9	4	P-06-38M	16	3	4	9	7	2
9	4	P-06-39D	16	15	15	11	6	5

Area	Model Layer	Location	No. Of Observation Points	Average Residual [a] (feet)	Mean Absolute Residual (feet)	Range in Heads (feet) [b]		
						Observed	Simulated	Difference [c]
9	4	P-06-41D	6	13	13	2	3	-1
9	4	P-06-41M	7	10	10	2	3	-1
9	4	P-07-44D	1	-19	19	--	--	--
9	4	P-07-46D	1	-64	64	--	--	--
9	4	SRK-3	32	-33	33	8	10	-2
10	4	P-07-45D	1	11	11	--	--	--
10	4	P-07-47D	1	-61	61	--	--	--
12	3	GH05-58	22	-115	115	22	21	1
12	3	MW-6D	35	-4	8	18	20	-2
12	3	P-07-49S	1	-36	36	--	--	--
12	4	GH05-57	25	-52	52	6	21	-15
12	4	P-07-49D	1	-37	37	--	--	--
13	1	GH04-01	4	22	22	3	1	2
13	1	MW-8S	34	-3	4	7	12	-5
13	1	P-07-42S	1	-26	26	--	--	--
13	1	P-07-43S	1	-49	49	--	--	--
13	2	MW-8M	34	-3	4	7	12	-5
13	2	P-07-43M	1	-35	35	--	--	--
13	3	GH07-101	1	-54	54	--	--	--
13	3	GH07-102S	1	-74	74	--	--	--
13	3	MW-8D	33	-8	8	5	12	-7
13	3	P-07-42D	1	-20	20	--	--	--
13	4	GH07-102D	1	-73	73	--	--	--
13	4	P-07-43D	1	-35	35	--	--	--
14	1	MW-7S	29	-18	19	12	47	-35
14	2	GH04-08	6	-25	25	3	34	-31
14	2	GH04-23	32	-83	83	15	19	-4
14	3	GH07-96S	1	-43	43	--	--	--
14	3	GH07-98S	1	-160	160	--	--	--
14	3	MW-9D	14	-8	11	14	43	-29
14	4	GH04-25	35	-24	24	9	34	-25
14	4	GH06-66	5	-55	55	2	1	1
14	4	GH06-67	5	-103	103	17	2	15
14	4	GH06-68	5	45	45	1	5	-4
14	4	GH06-69	5	-96	96	6	0	6
14	4	GH07-100	1	-299	299	--	--	--
14	4	GH07-82D	1	-77	77	--	--	--
14	4	GH07-82S	1	-72	72	--	--	--
14	4	GH07-85	1	-156	156	--	--	--

Area	Model Layer	Location	No. Of Observation Points	Average Residual [a] (feet)	Mean Absolute Residual (feet)	Range in Heads (feet) [b]		
						Observed	Simulated	Difference [c]
14	4	GH07-87D	1	-64	64	--	--	--
14	4	GH07-87S	1	-67	67	--	--	--
14	4	GH07-95	1	-5	5	--	--	--
14	4	GH07-96D	1	-39	39	--	--	--
14	4	GH07-97D	1	-51	51	--	--	--
14	4	GH07-97S	1	-51	51	--	--	--
14	4	GH07-98D	1	-160	160	--	--	--
14	4	MW-7D	35	-16	17	17	47	-30
15	2	P-07-50S	1	34	34	--	--	--
15	2	P-07-53S	1	34	34	--	--	--
15	3	GH07-103S	1	-93	93	--	--	--
15	3	P-07-48S	1	9	9	--	--	--
15	4	GH07-103D	1	-89	89	--	--	--
15	4	GH07-84	1	-25	25	--	--	--
15	4	GH07-88	1	-5	5	--	--	--
15	4	GH07-89D	1	66	66	--	--	--
15	4	GH07-89S	1	65	65	--	--	--
15	4	MW-10	34	29	29	7	19	-12
15	4	P-07-48D	1	15	15	--	--	--
15	4	P-07-50D	1	34	34	--	--	--
15	4	P-07-51D	1	7	7	--	--	--
15	4	P-07-51S	1	4	4	--	--	--
15	4	P-07-52D	1	119	119	--	--	--
15	4	P-07-52S	1	120	120	--	--	--
15	4	P-07-53D	1	34	34	--	--	--
			Average	-23	32			-2

Notes:

a. Residual = Observed Head - Simulated Head.

b. Range in heads = Maximum Head - Minimum Head.

c. 2 Difference in head range = Observed Range - Simulated Range.

Key:

-- = not applicable.

TABLE 5.2
Root Me n S u e E o Rel ti e to R nge in O se e He s

	RMSE Relative to Range in Observed Heads					
	WS-03	**WS-04**	**WS-05**	**WS-07**	**WS-09**	**ALL [a]**
Layer 1	6%	3%	16%	14%	5%	2%
Layer 2	6%	25%	13%	8%	18%	3%
Layer 3	10%	43%	9%	--	6%	3%
Layer 4	5%	29%	13%	--	5%	4%
All Layers	4%	12%	7%	10%	4%	3%

Notes:

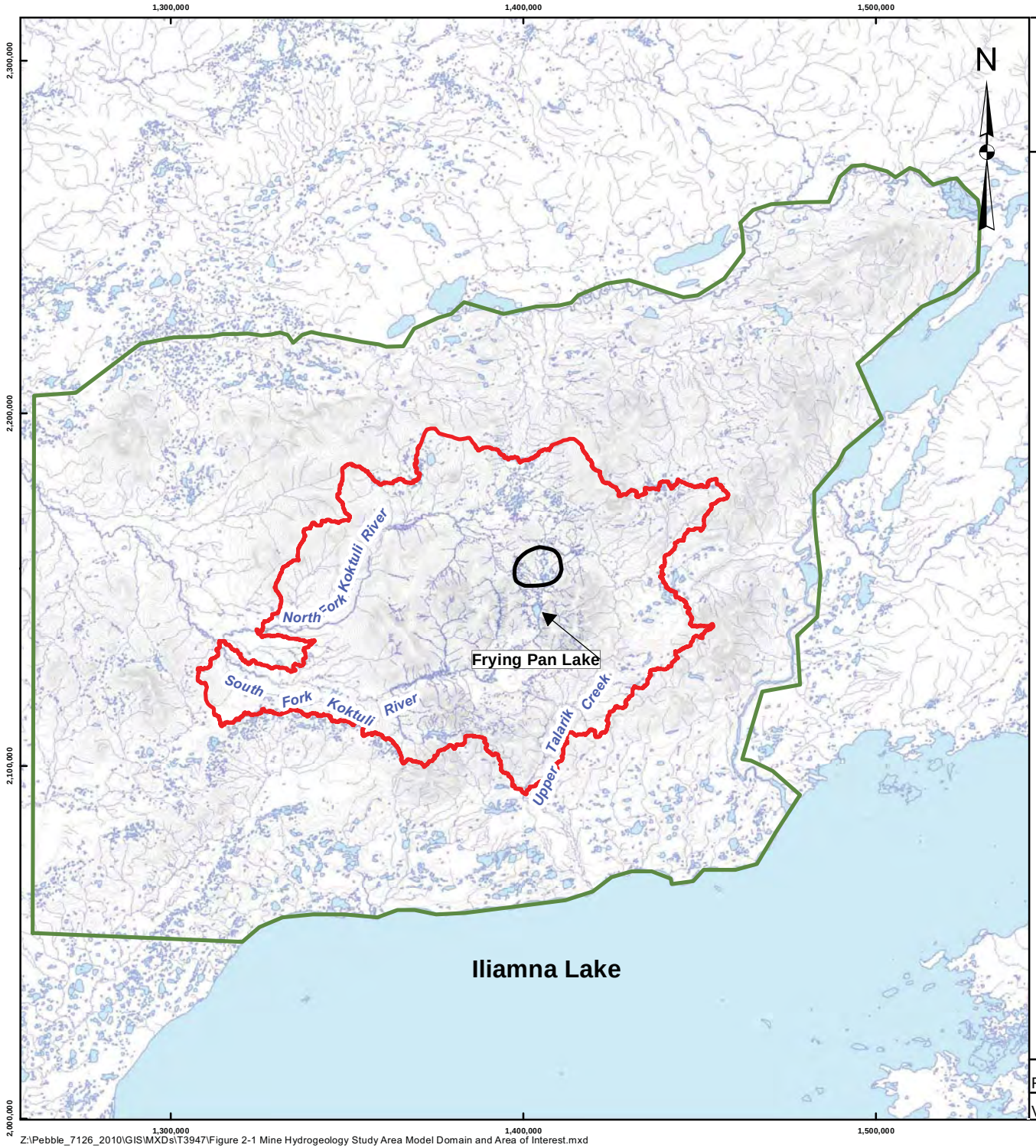
a. Statistics for all watersheds based on targets in Areas 1 through 15.

Key:

RMSE = Root Mean Squared Error.

-- = not applicable

FIGURES



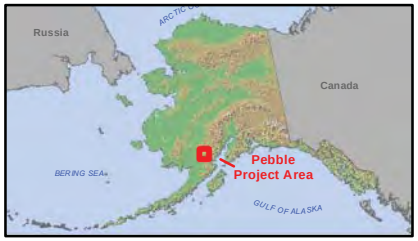
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 2.1
Mine Hydrology Study Area,
Model Domain and Mine Study Area

Legend

- Mine Study Area
- Model Domain
- General Deposit Location
- Lakes
- Rivers
- 50 ft Contour Interval



Feet
0 20,000 40,000 60,000 80,000

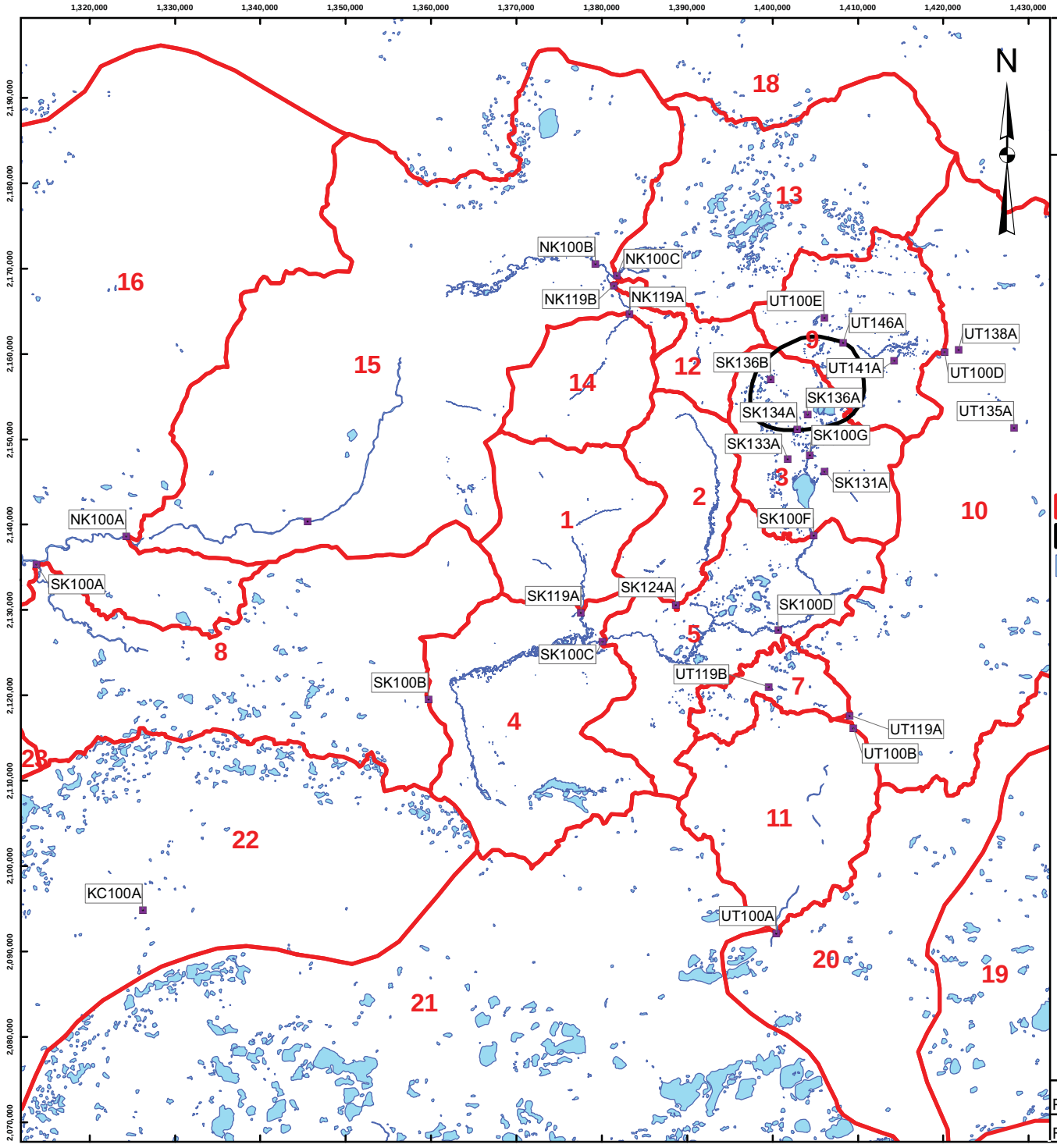
Meters
0 5,200 10,400 15,600 20,800 26,000

Scale 1:500,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-BL
Version: 1	Date: April, 2011

Z:\Pebble_7126_2010\GIS\MXDs\T3947\Figure 2-1 Mine Hydrogeology Study Area Model Domain and Area of Interest.mxd



Z:\Pebble_7126_2010\GIS\MXDs\T3927\Figure 2-2 - Stream Gaging Locations (landscape).mxd

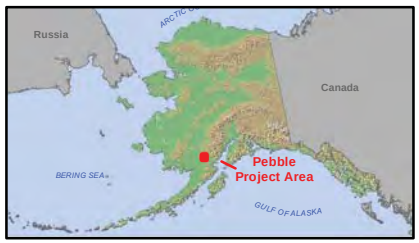
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 2.2
Stream Gaging Locations

Legend

- Stream Gaging Station
- Sub-catchment Boundary *(10 = ID Number)*
- General Deposit Location
- Lakes



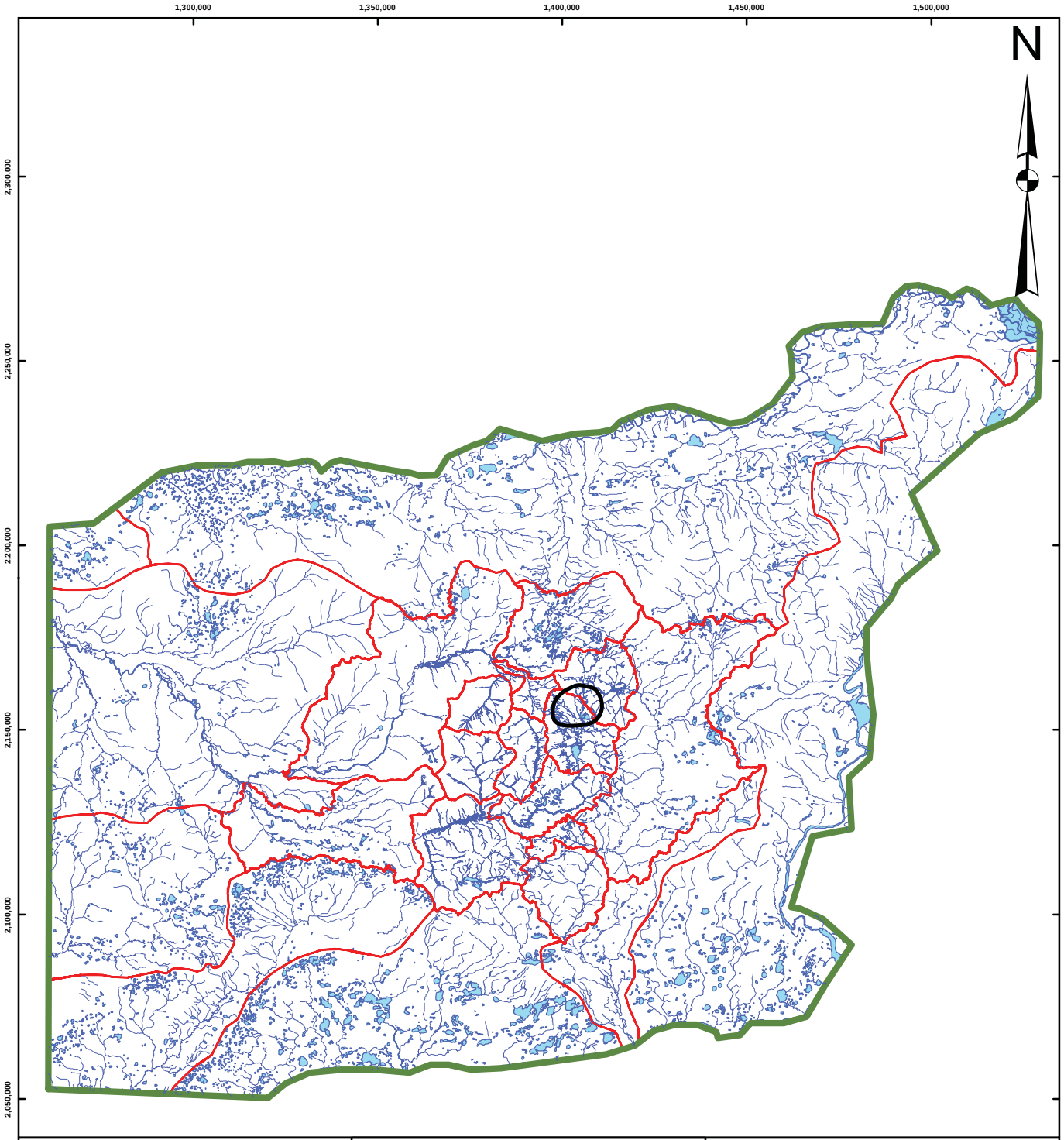
Feet
0 10,000 20,000 30,000 40,000

Meters
0 2,500 5,000 7,500 10,000

Scale 1:210,681

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F2.2 Version: 1	Author: SWS-BL





Legend

- Rivers
- Watershed Boundary
- General Deposit Location
- Expanded Groundwater Model Domain
- Lakes

0 20,000 40,000 60,000 80,000 Feet

0 5,300 10,600 15,900 21,200 Meters

Scale 1:483,524

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

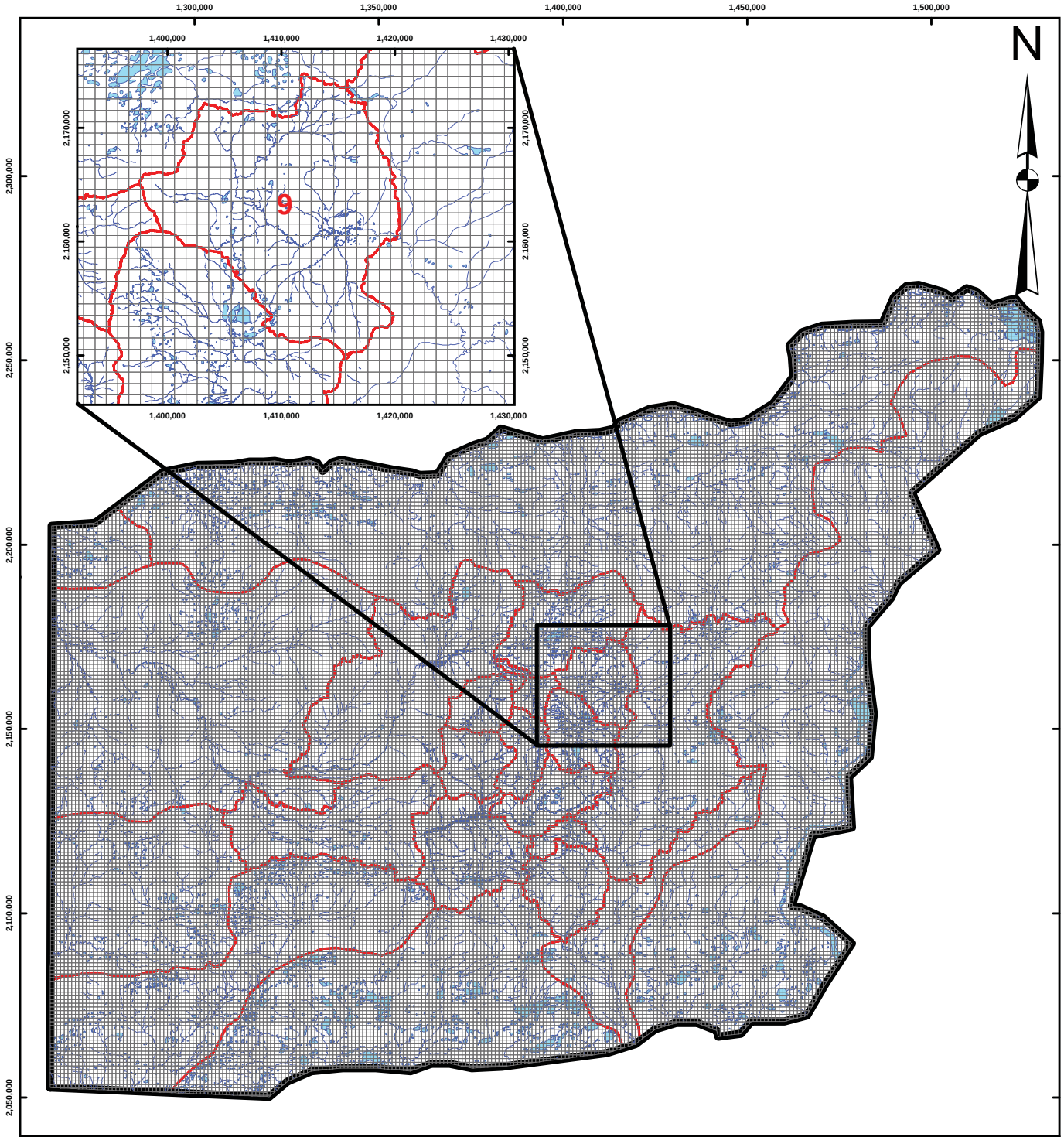
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.1
Model Domain

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3928\Figure F4.1 - Model Domain.mxd





Legend

- Grid
- Expanded Groundwater Model Domain
- Watershed Boundary
- Lakes
- Rivers

Feet: 0 — 20,000 — 40,000 — 60,000 — 80,000

Meters: 0 — 5,000 — 10,000 — 15,000 — 20,000

Scale 1:483,524

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.2
Model Grid

Project No: 7126	Date: September 2, 2008
Fig. F4.2 Version: 2	Author: WMC-LC

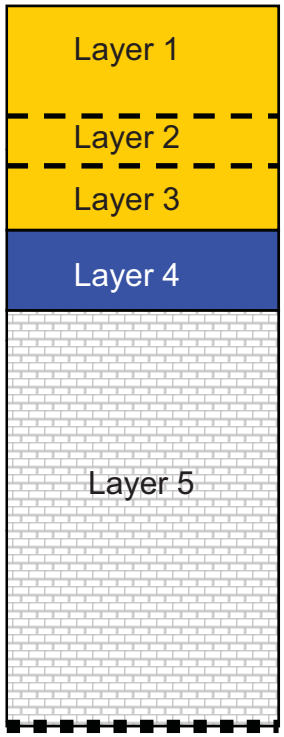
\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.2 - Model Grid.mxd

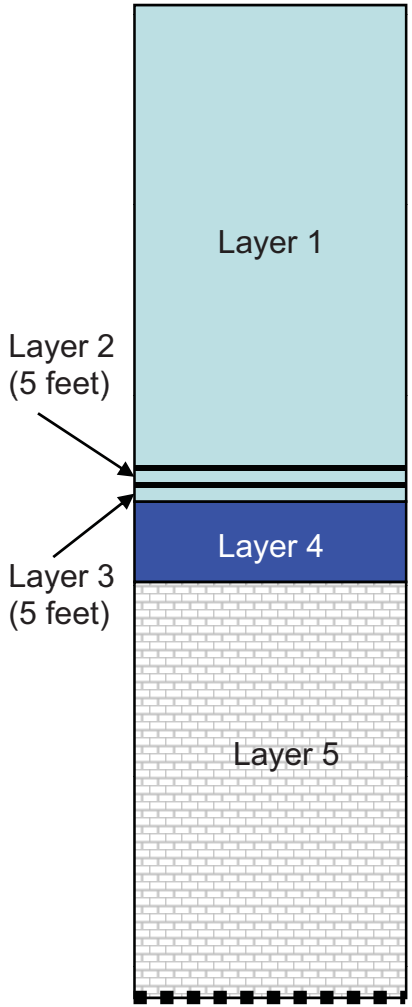
Conceptual Model Layers

Layers 1 to 3: Overburden (variable thickness)

Layer 4: Weathered bedrock (50 feet)

Layer 5: Competent bedrock (5000 feet)





Layers 1 to 3: Overburden + Weathered and Competent bedrock

Layer 4: Competent bedrock (50 feet)

Layer 5: Competent bedrock (5000 feet)

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.3
Conceptual Model Layer Discretization



Project: 7126	Date: June 16, 2008
Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4-3 - Conceptual Model Layer Discretization.xls

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

THE pebble PARTNERSHIP

Figure 4.4
Topographic Surface Model Domain

Appendix 8.1J
Groundwater Model Results

Legend

Elevation

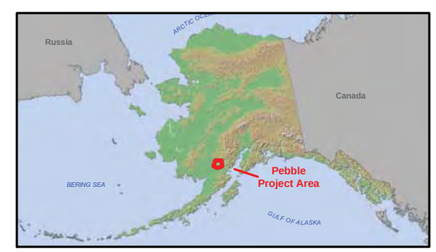
High : 254

Low : 0

Expanded Groundwater Model Domain

Watershed Boundary

Lakes



Feet
0 12,000 24,000 36,000 48,000 60,000

Meters
0 3,000 6,000 9,000 12,000 15,000

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.25 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.25 - Topographic Surface - Model Domain.mxd

1,350,000 1,400,000 1,450,000

2,200,000

2,150,000

2,100,000

N

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.5
Topographic Surface
Mine Study Area

Legend

Elevation

Value

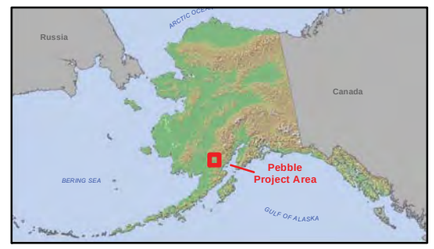
High : 3536

Low : 46

Mine Study Area

Sub-catchments

Lakes



Feet
0 10,000 20,000 30,000 40,000

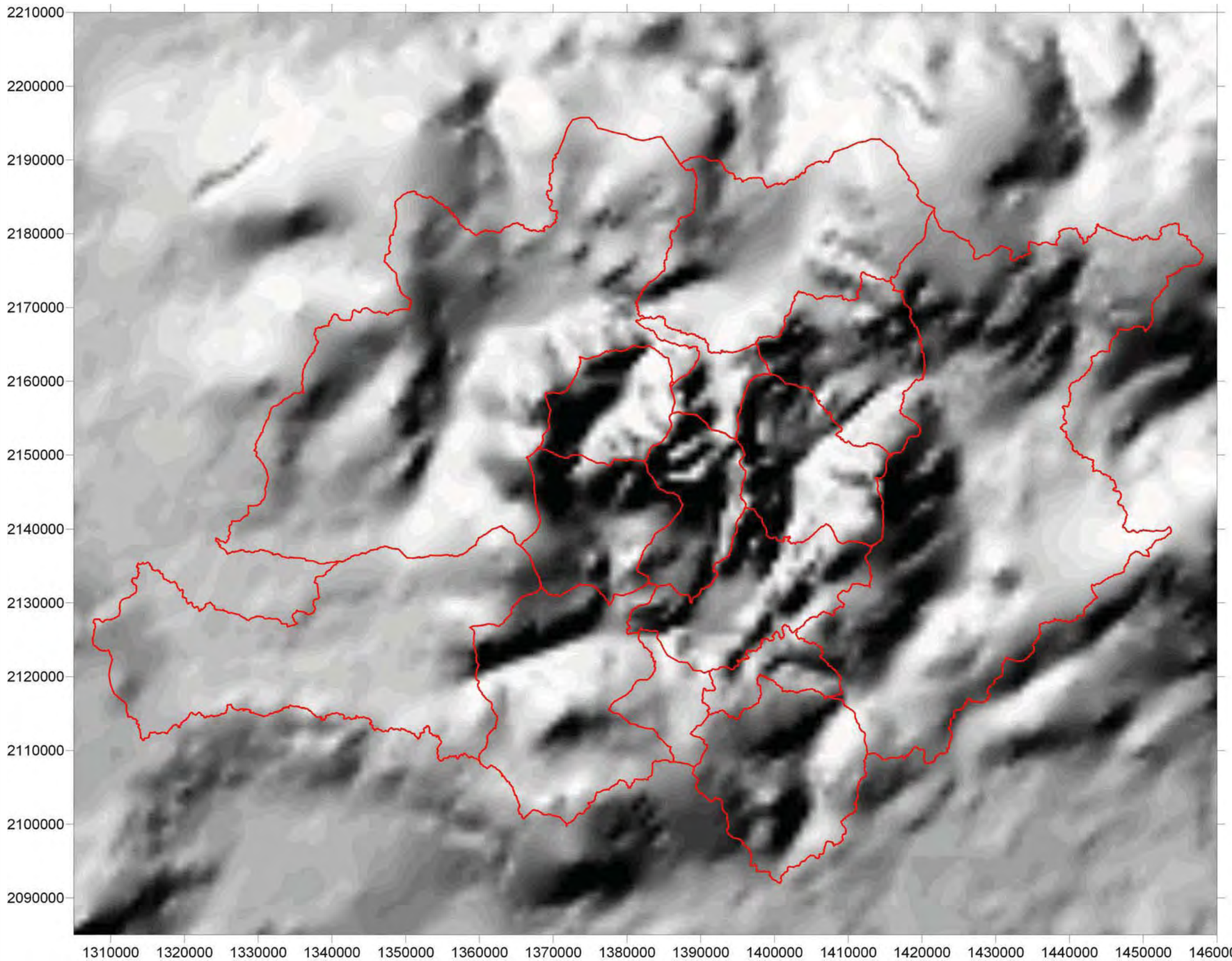
Meters
0 2,500 5,000 7,500 10,000

Scale 1:156,435

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F4.26 Version: 1	Author: SWS-BL

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.26 - Topographic Surface - Local Study Area.mxd



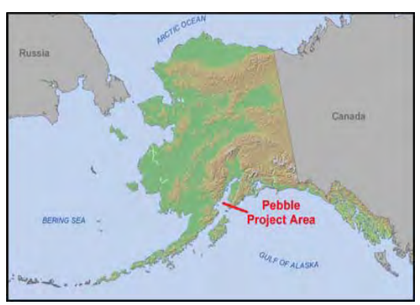
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.6
Bedrock Surface
Local Study Area

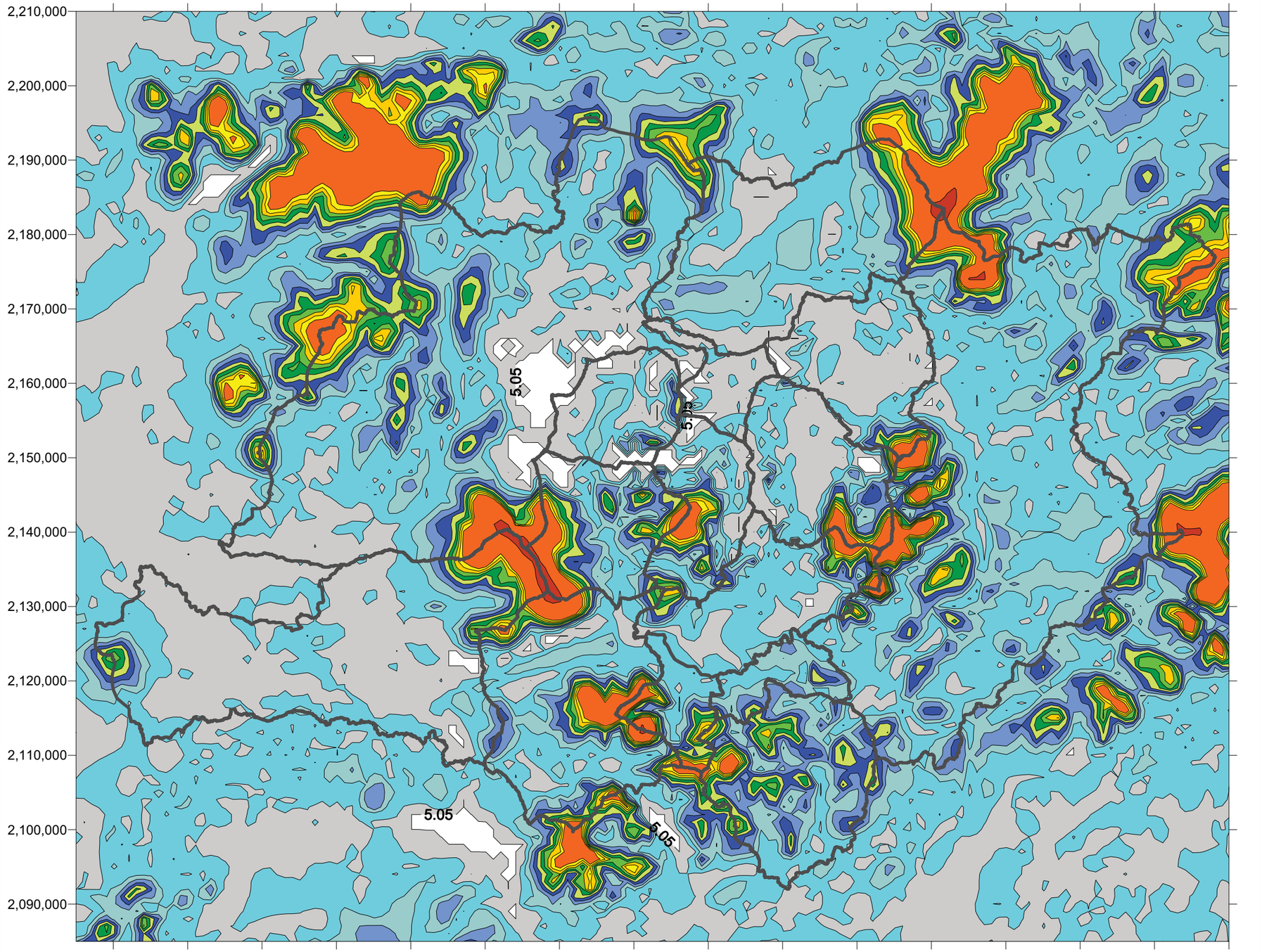
Legend

Watershed Boundary



Project: 7126	Date: June 16, 2008
Fig F4.27 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4-27 - Bedrock Surface - V2.xls



THE pebble PARTNERSHIP

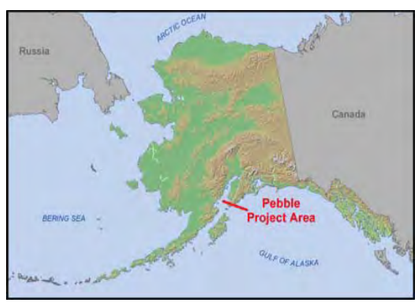
Appendix 8.1J
Groundwater Model Results

Figure 4.7
Layer 1 Thickness
Local Study Area

Legend

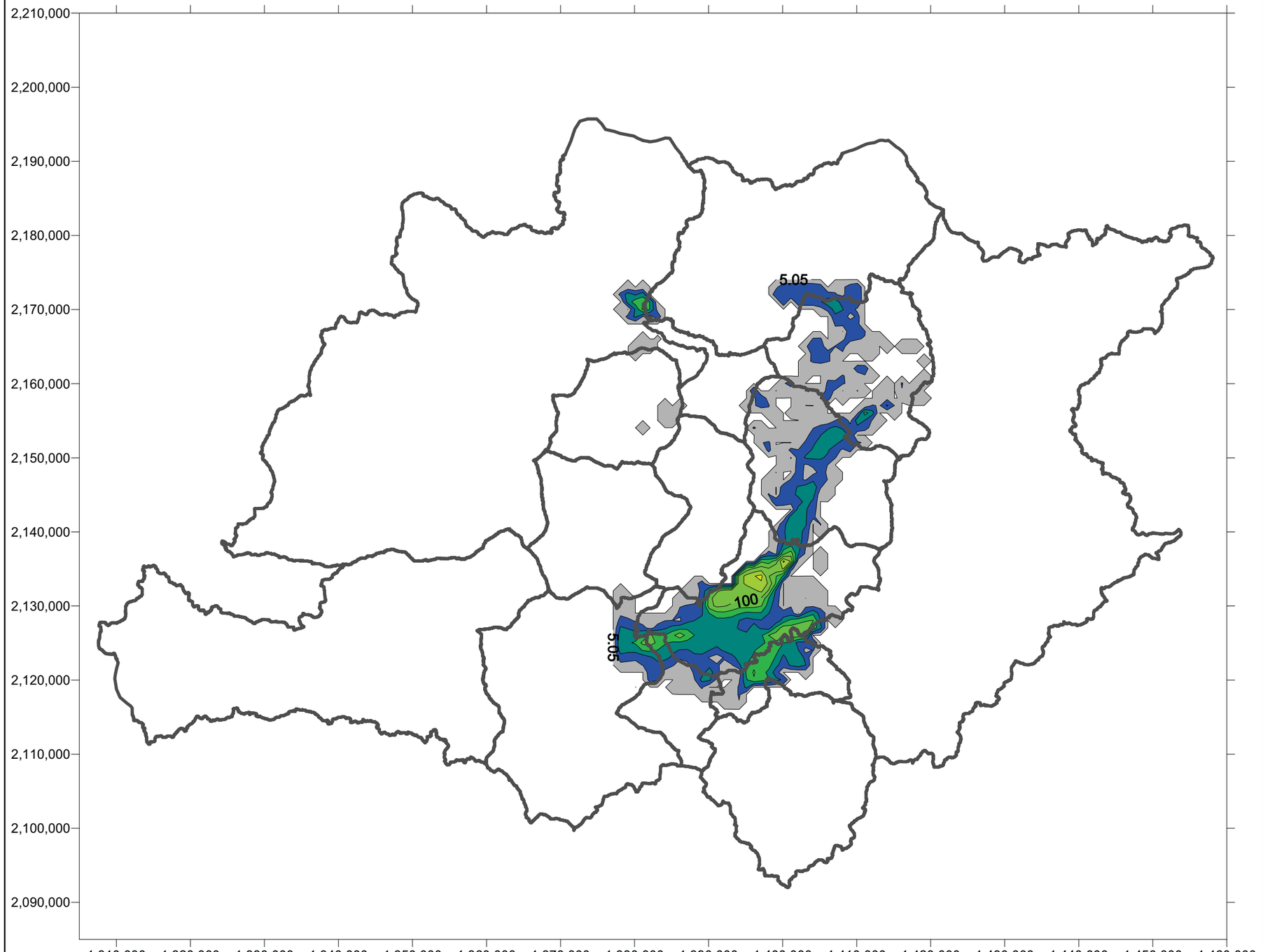
Layer 1 Thickness (ft)

- 3000
- 2500
- 2000
- 1000
- 500
- 450
- 400
- 350
- 300
- 250
- 200
- 150
- 100
- 50
- 5.05
- 0



Project: 7126	Date: June 16, 2008
Fig F4.28 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4-28 - Layer1 Thickness.xls



THE pebble PARTNERSHIP

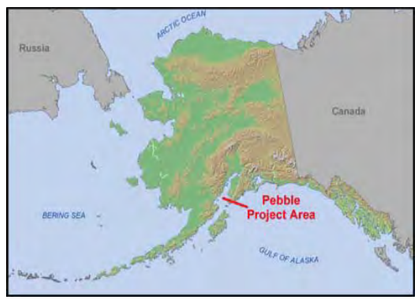
Appendix 8.1J
Groundwater Model Results

Figure 4.8
Layer 2 Thickness
Local Study Area

Legend

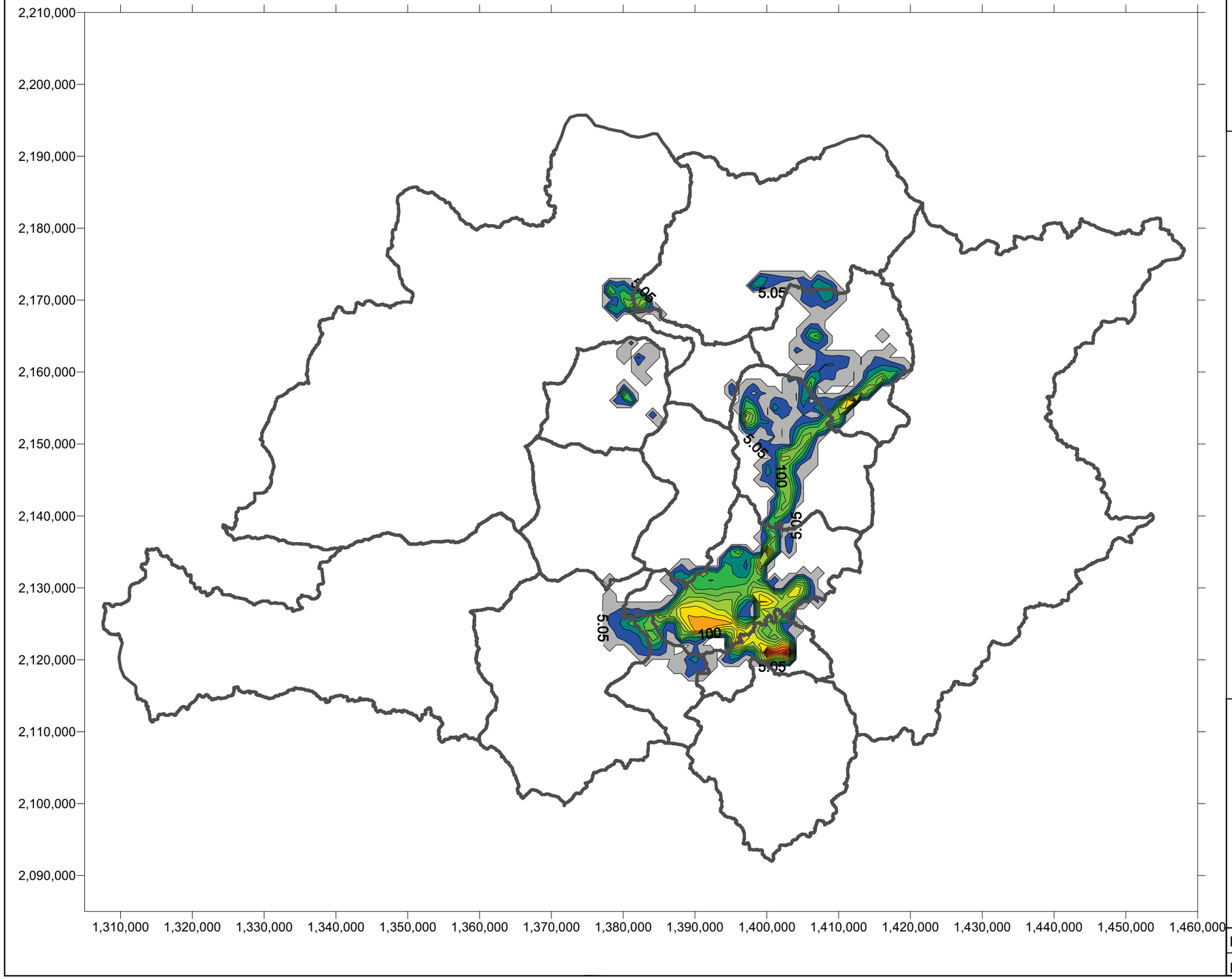
Layer 2 Thickness (ft)

300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
5.05
0



Project: 7126	Date: June 16, 2008
Fig F4.29 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4-29 - Layer 2 Thickness.xls



THE pebble PARTNERSHIP

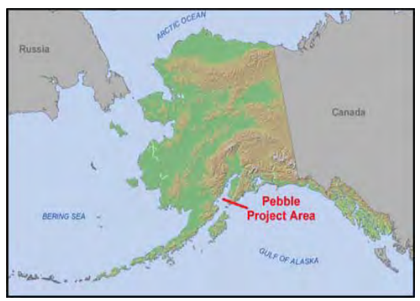
Appendix 8.1J
Groundwater Model Results

Figure 4.9
Layer 3 Thickness
Local Study Area

Legend

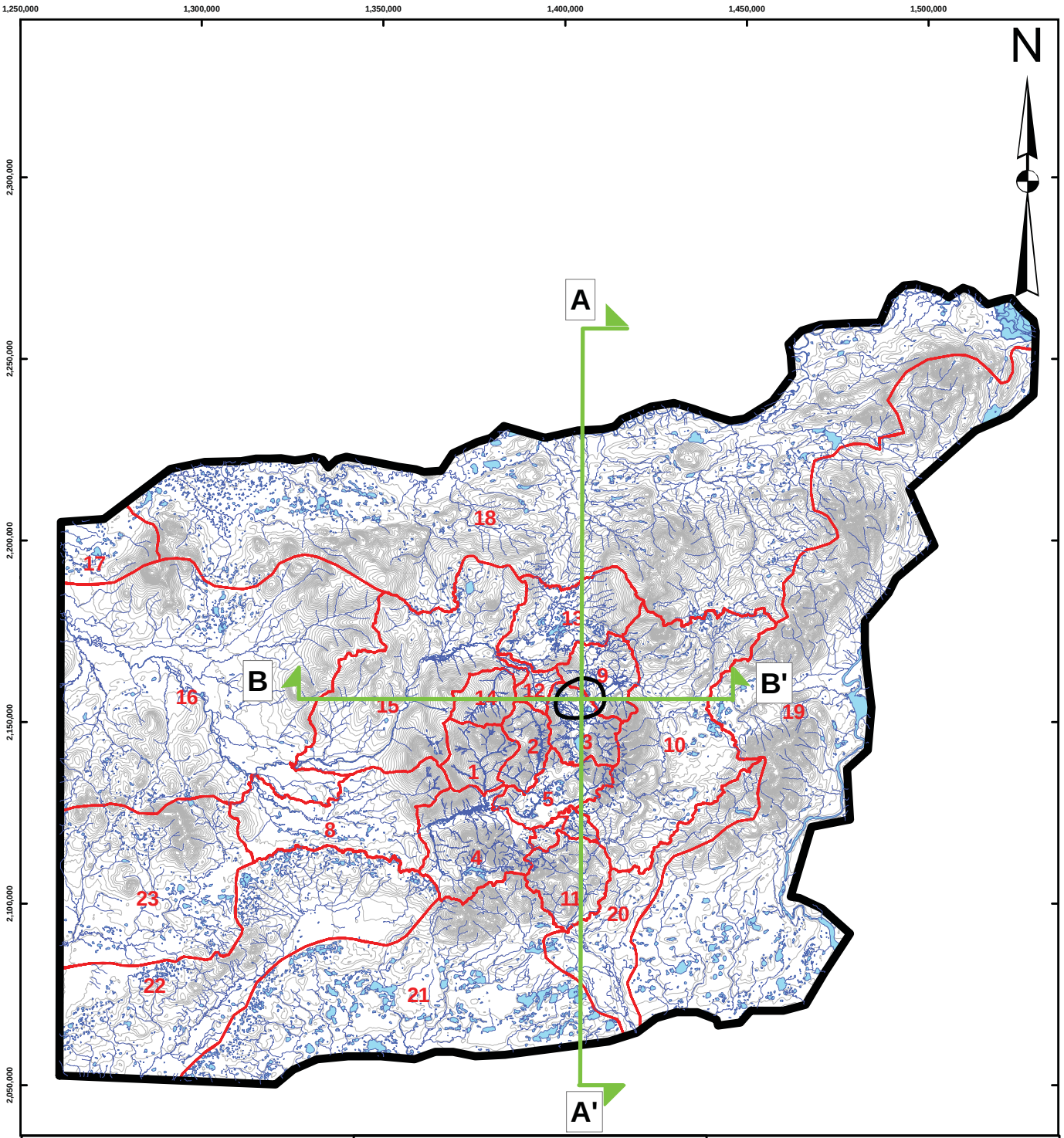
Layer 3 Thickness (ft)

300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
5.05
0



Project: 7126	Date: June 16, 2008
Fig F4.30 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4-30 - Layer 3 Thickness.xls





Legend

- General Pit Outline
- Expanded Groundwater Model Domain
- Watershed Boundary
- Lakes
- Rivers
- 50-ft Contour Interval

Feet: 0 — 20,000 — 40,000 — 60,000 — 80,000

Meters: 0 — 5,000 — 10,000 — 15,000 — 20,000

Scale 1:489,668

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

THE pebble PARTNERSHIP

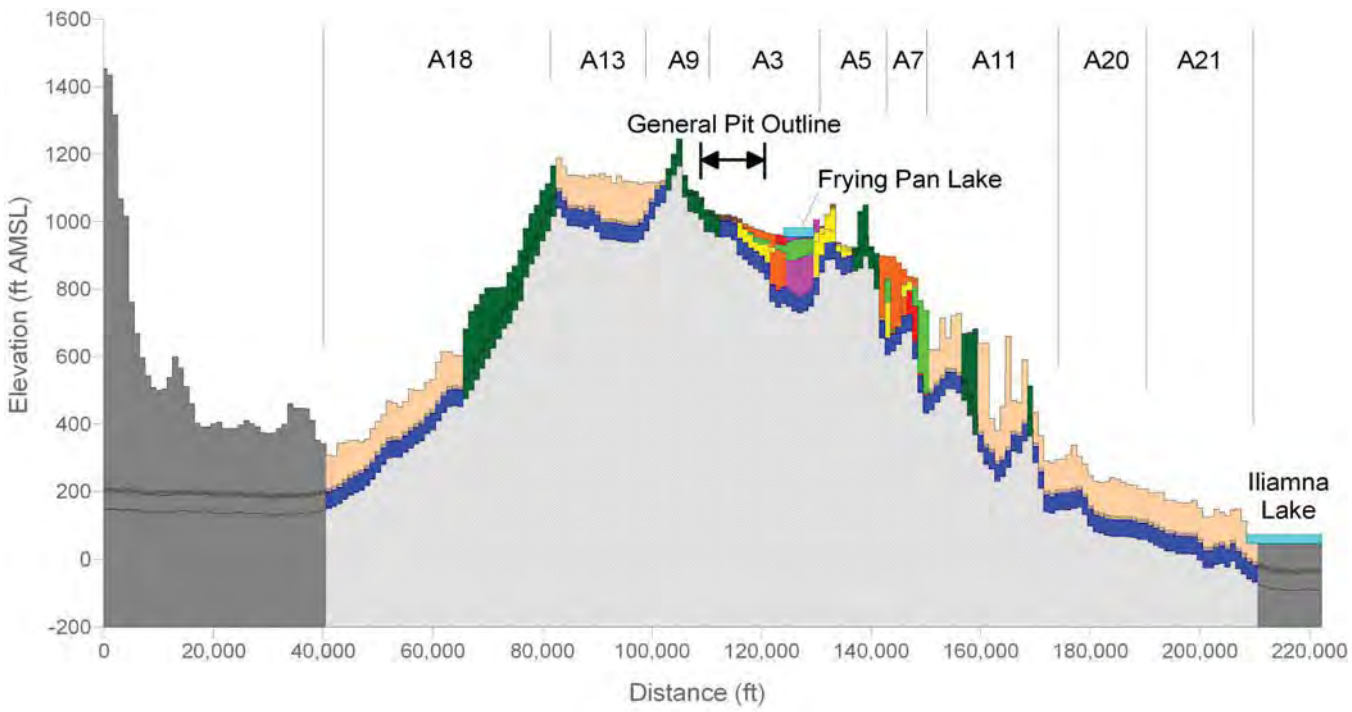
Appendix 8.1J
Groundwater Model Results

Figure 4.10
Cross-Section Location Map

Project No: 7126	Date: May 13, 2008
Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.4 - Model Domain Cross-Section Location Map.mxd

A (NORTH) LOOKING EAST A' (SOUTH)



Legend

- gravel, gravelly sand
- gravel, gravelly sand with sand, silty sand
- gravel, gravelly sand with clay/silt aquitards
- sand, silty sand
- sand, silty sand with clay/silt lenses
- clay, silty clay
- General bedrock
- General overburden
- weathered bedrock
- non-weathered bedrock
- inactive

A7 = Area 7

THE pebble PARTNERSHIP

Groundwater Model Results

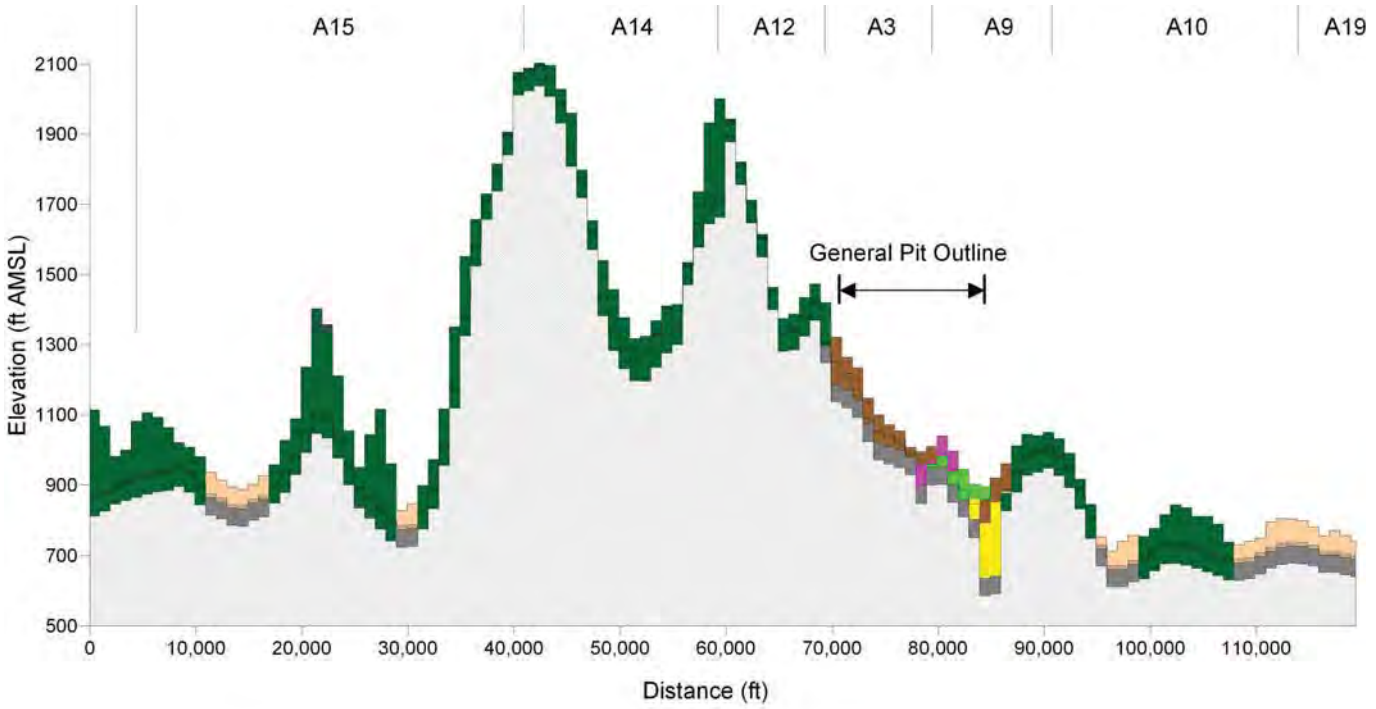
Figure 4.11
Cross-Section A-A'
(North-South)



Project: 7126	Date: Dec 31, 2010
Fig: F4.5 Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\Tickets\T3769_Figure_4_1_1\Output\Figure 4-11 Appendix 8.1J - Groundwater Model.pdf

B (WEST) LOOKING NORTH B' (EAST)



Legend

- gravel, gravelly sand
- gravel, gravelly sand with sand, silty sand
- gravel, gravelly sand with clay/silt aquitards
- sand, silty sand
- sand, silty sand with clay/silt lenses
- clay, silty clay
- General bedrock
- General overburden
- weathered bedrock
- non-weathered bedrock
- miscellaneous
- A3 = Area 3

THE pebble PARTNERSHIP

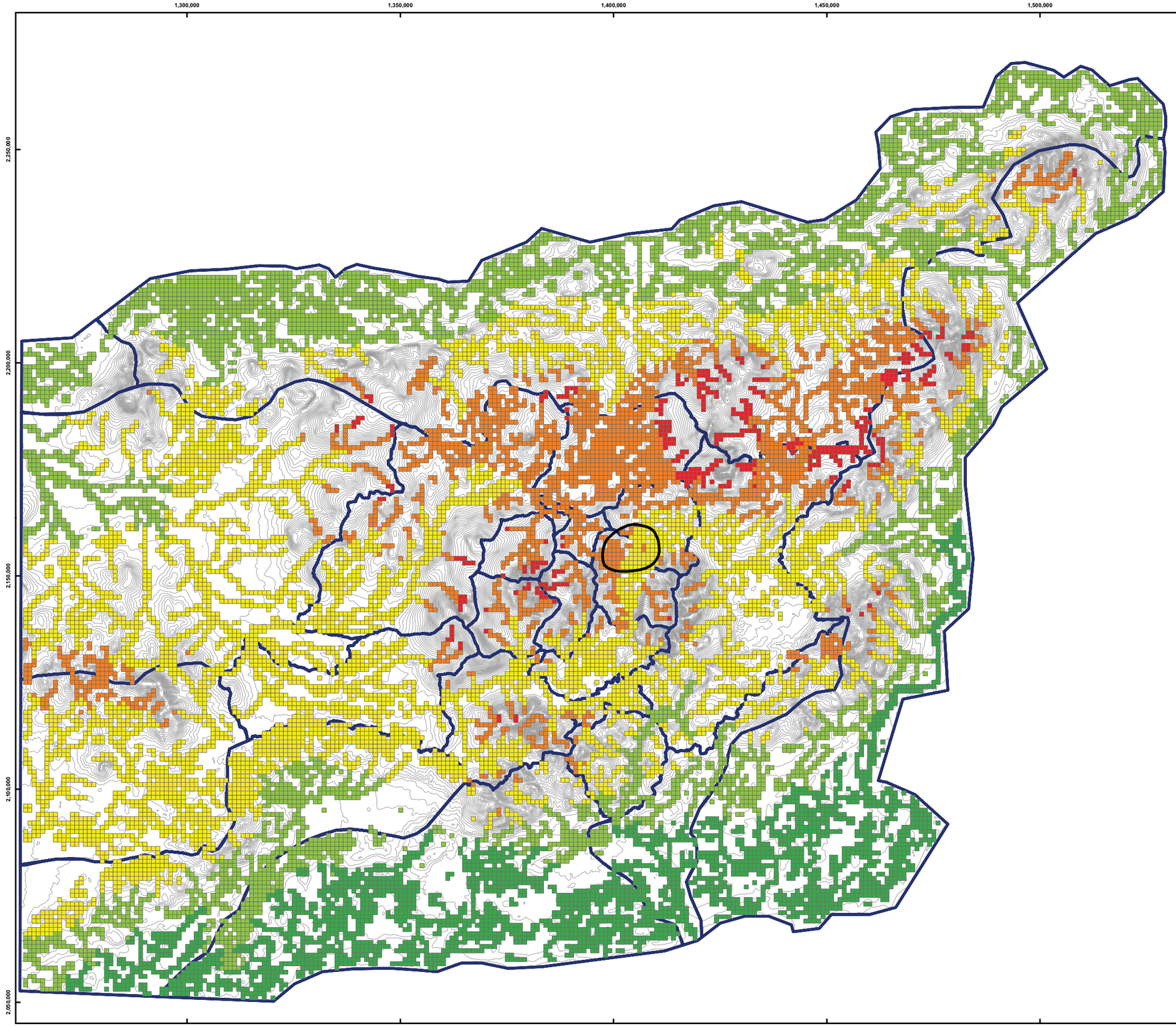
Appendix 8.1J
Groundwater Model Results

Figure 4.12
Cross-Section B-B'
(West-East)



Project: 7126	Date: Sept 26, 2008
Fig: F4.6 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4-6 - Cross-Section B-B'.xls



THE pebble PARTNERSHIP

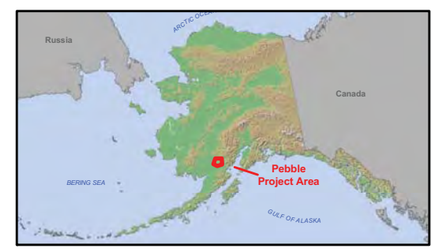
Appendix 8.1J
Groundwater Model Results

Figure 4.13
Simulated River and Lake
Stage Elevations

Legend

Stage Elevation (ft)

- 0-250.
- 251-500
- 501-1000
- 1001-1500
- 15001-2300
- General Deposit Location
- Watershed Boundary
- 50-ft Contour Interval



0 15,000 30,000 45,000 60,000 Feet

0 3,000 6,000 9,000 12,000 15,000 Meters

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: August 25, 2008
Fig. F4.08 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.08 - Simulated River and Lake Stage Elevations.mxd

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

THE pebble PARTNERSHIP

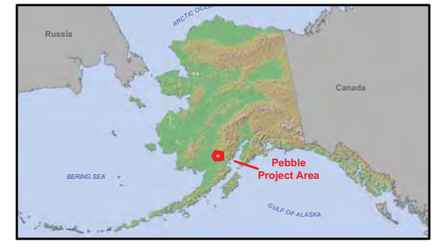
Appendix 8.1J
Groundwater Model Results

Figure 4.14
Simulated River and Lake
Conductance - March 2005

Legend

Conductance (ft^2/day)

- 0-5000
- 5001-20000
- 20001-40000
- 40001-50000
- 50001-63000
- General Deposit Location
- Watershed Boundary
- 50-ft Contour Interval



0 15,000 30,000 45,000 60,000 Feet

0 5,100 10,200 15,300 20,400 Meters

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: August 25, 2008
Fig. F4.09 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.09 - Simulated River and Lake Stage Conductance.mxd

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

THE pebble PARTNERSHIP

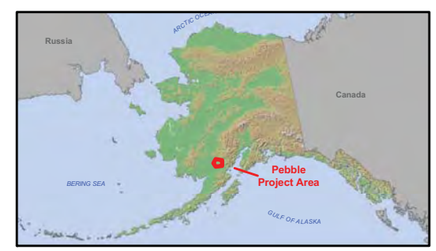
Appendix 8.1J
Groundwater Model Results

Figure 4.15
Simulated River and Lake
Conductance - September 2005

Legend

Conductance (ft^2/day)

- 0-5000
- 5001-20000
- 20001-40000
- 40001-60000
- 60001-87000
- General Deposit Location
- Watershed Boundary
- 50-ft Contour Interval



0 15,000 30,000 45,000 60,000 Feet

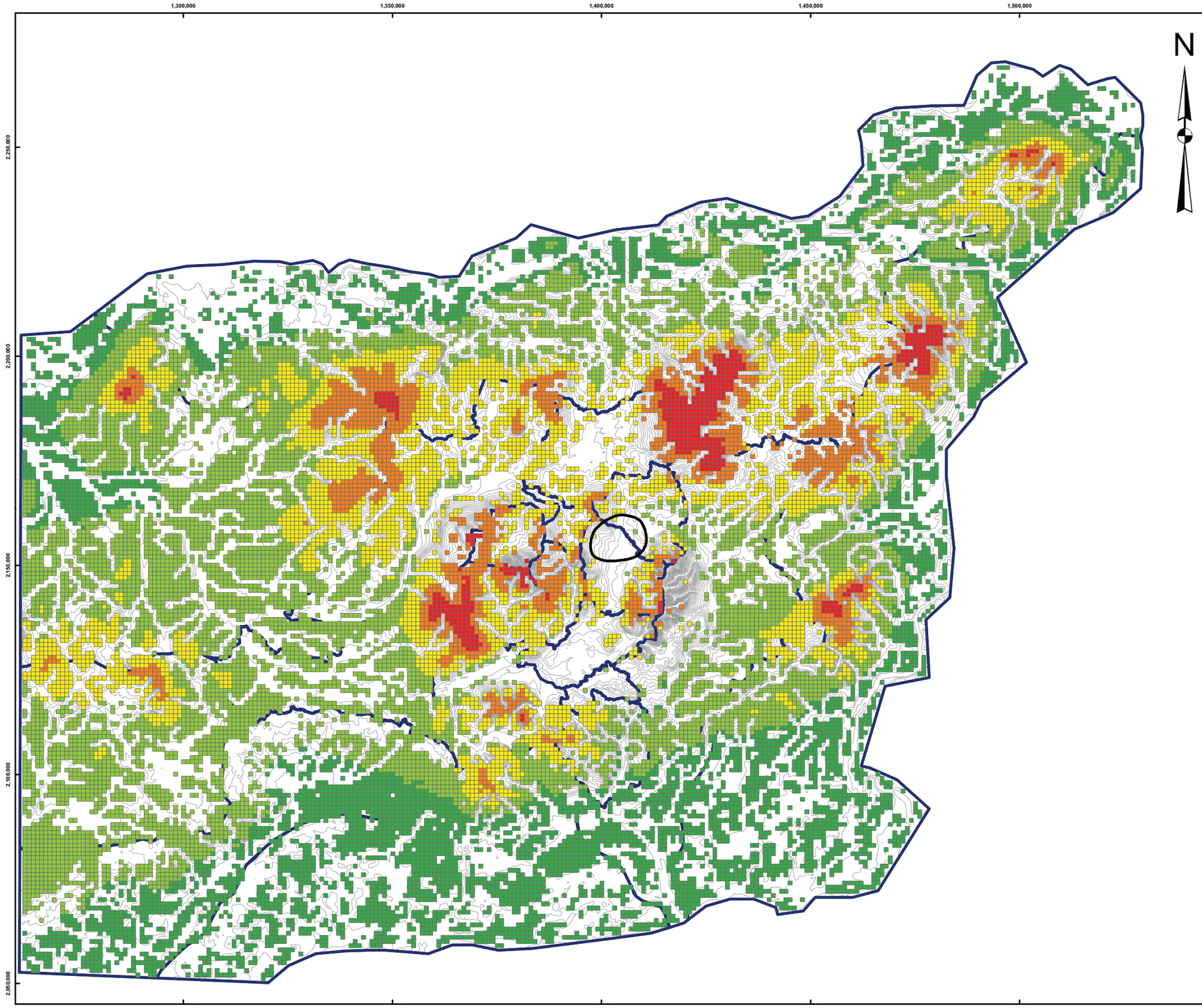
0 5,100 10,200 15,300 20,400 Meters

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: August 25, 2008
Fig. F4.09a Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.09 - Simulated River and Lake Stage Conductance - September 2005.mxd



THE pebble PARTNERSHIP

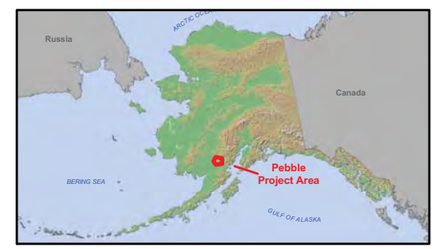
Appendix 8.1J
Groundwater Model Results

Figure 4.16
Drain Elevations

Legend

Stage Elevation (ft)

- 0-500
- 501-1000
- 1001-1500
- 1501-2000
- 2001-3000
- General Deposit Location
- Watershed Boundary
- 50-ft Contour Interval



Feet
0 15,000 30,000 45,000 60,000

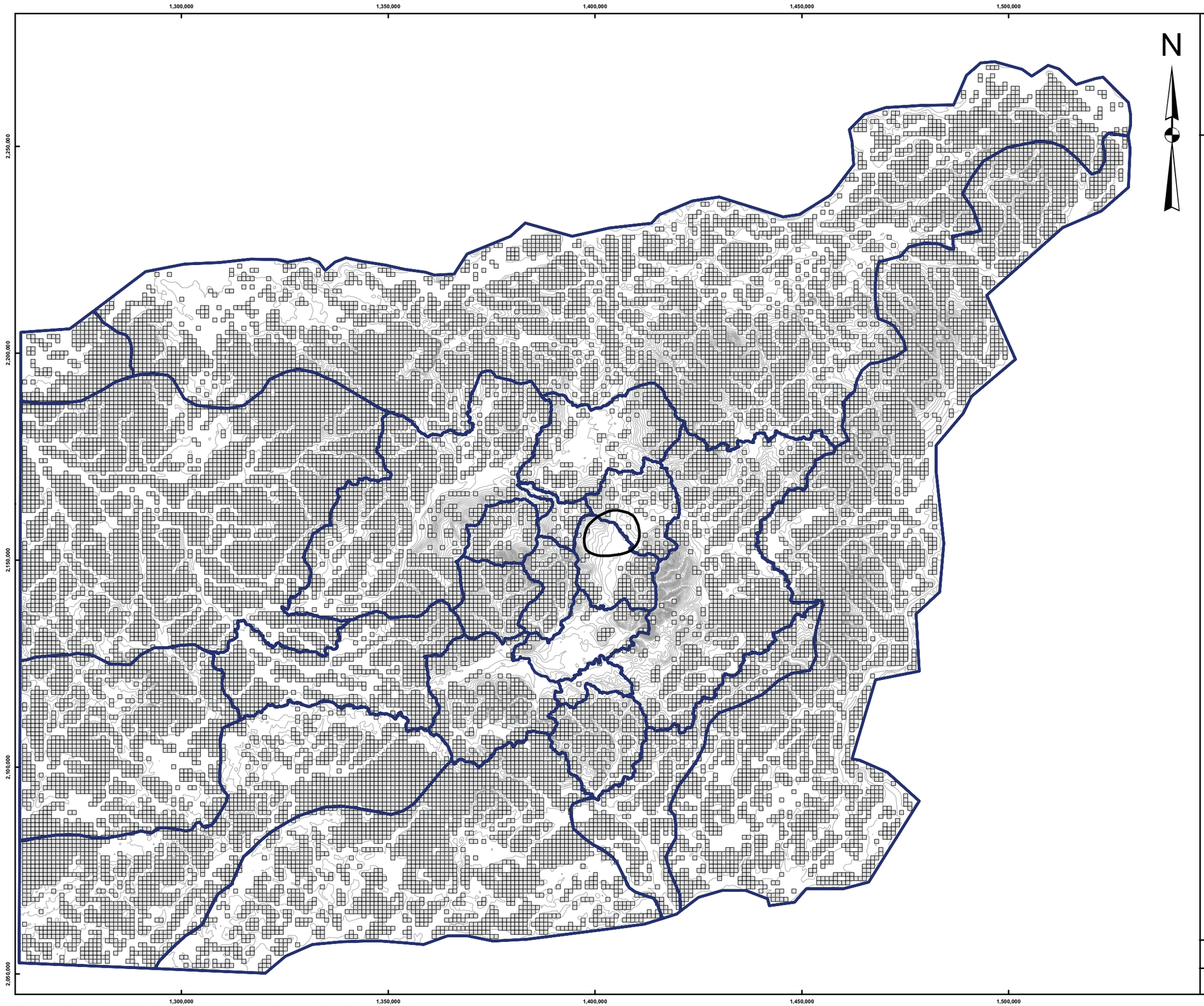
Meters
0 5,000 10,000 15,000 20,000

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.13 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.13 - Simulated Drain Elevations.mxd



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

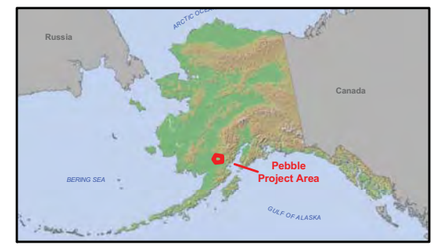
Figure 4.17
Drain Conductance

Legend

DRAIN

Conductance (ft^2/day)

- 1
- General Deposit Location
- Watershed Boundary
- 50-ft Contour Interval



Feet
0 15,000 30,000 45,000 60,000

Meters
0 5,000 10,000 15,000 20,000

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.14 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.14 - Simulated Drain Conductance.mxd

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

THE pebble PARTNERSHIP

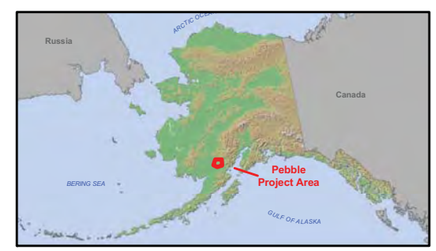
Appendix 8.1J
Groundwater Model Results

Figure 4.18
Constant-Head
Boundary Conditions
Layers 1-4

Legend

CH Elevation (ft)

- 46-100
- 101-200
- 201-300
- 301-400
- 401-727
- Lakes
- Rivers
- 50-ft Contour Interval



Feet
0 15,000 30,000 45,000 60,000

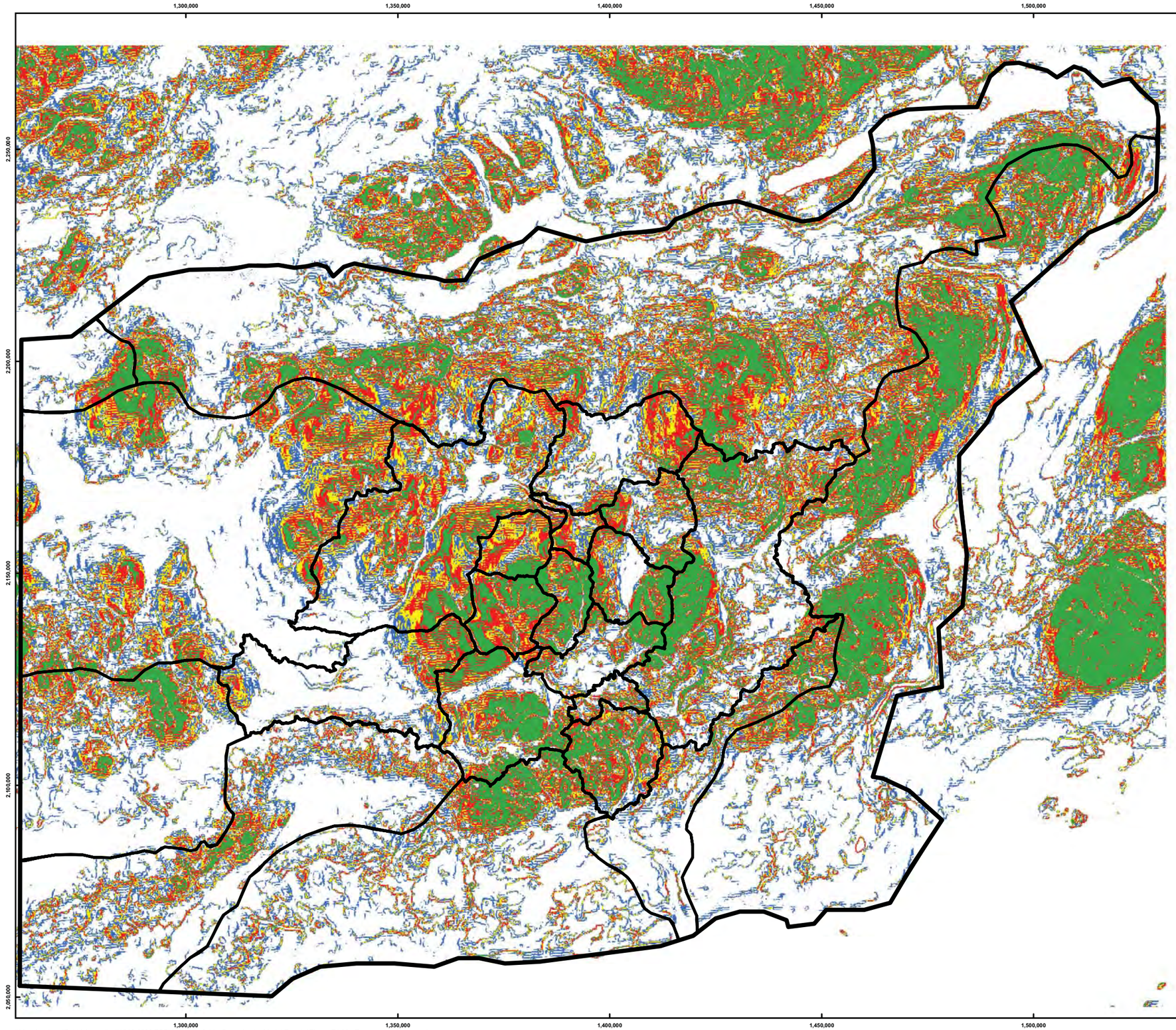
Meters
0 3,750 7,500 11,250 15,000

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.15 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.15 - Constant-Head Boundary Conditions - Layers 1-4.mxd



THE pebble PARTNERSHIP

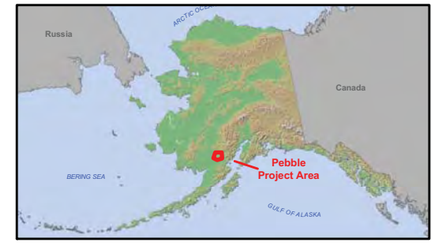
Appendix 8.1J
Groundwater Model Results

Figure 4.19
Topographic Slope

Legend

Slope (degrees)

- 0-2
- 2-4
- 4-6
- 6-10
- 10-53
- Watershed Boundary



0 15,000 30,000 45,000 60,000 Feet

0 5,000 10,000 15,000 20,000 Meters

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.23 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.23 - Topographic Slope.mxd

1,360,000 1,370,000 1,380,000 1,390,000 1,400,000 1,410,000 1,420,000 1,430,000 1,440,000 1,450,000

2,190,000 2,180,000 2,170,000 2,160,000 2,150,000 2,140,000 2,130,000 2,120,000 2,110,000

N

THE pebble PARTNERSHIP

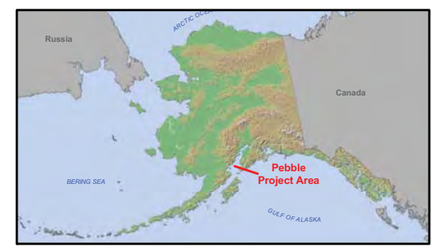
Appendix 8.1J
Groundwater Model Results

Figure 4.20
Geology-Based Recharge Zones

Legend

Recharge Zones

- 1 - High Recharge
- 2 - Med High Recharge
- 3 - Med Low Recharge
- 4 - Low Recharge
- 5 - Bedrock
- 6 - Bedrock Ridge
- Watershed Boundary
- General Deposit Location
- Frying Pan Lake
- Rivers



Feet
0 5,000 10,000 15,000 20,000

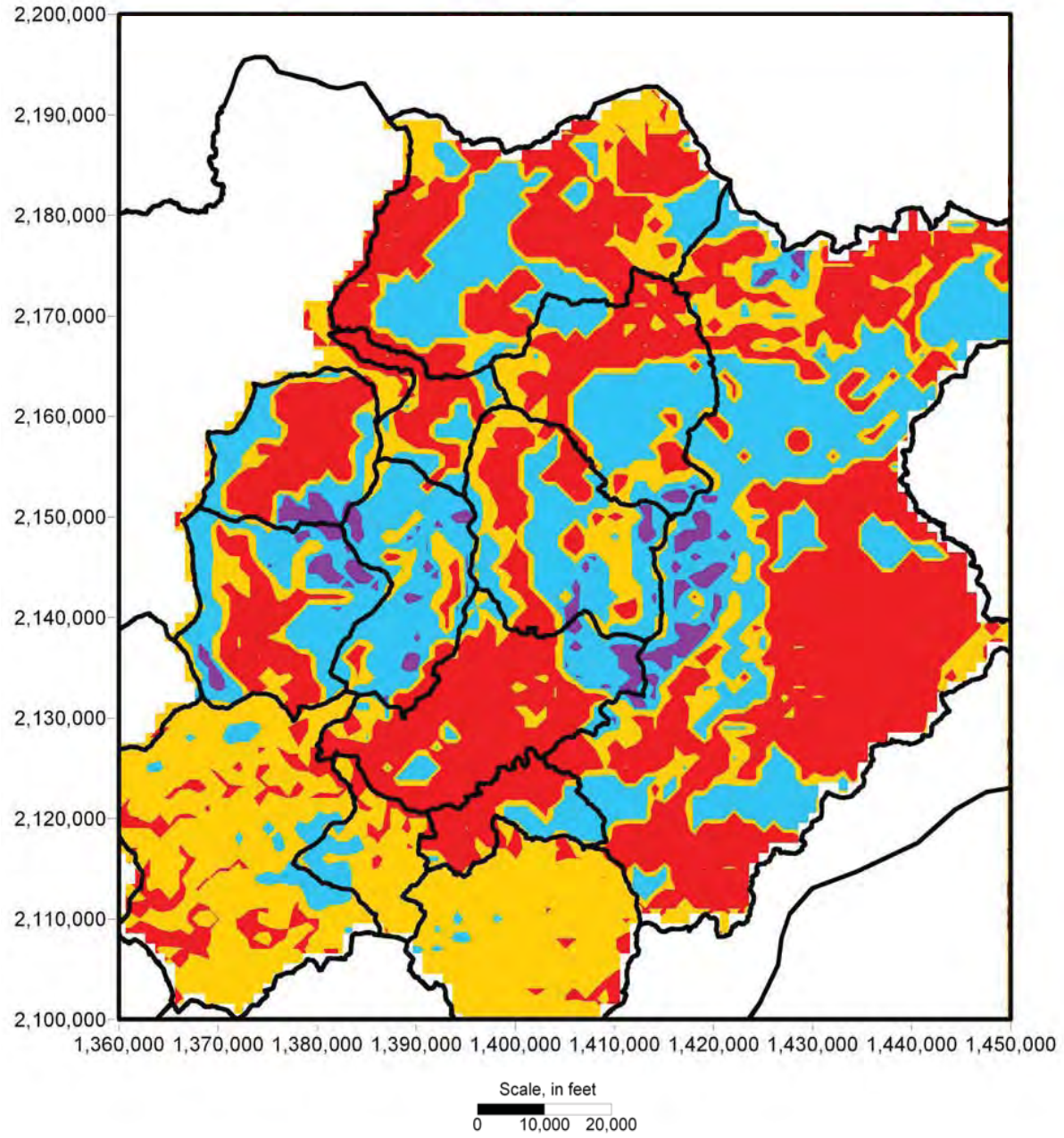
Meters
0 1,750 3,500 5,250 7,000

Scale 1:98,566

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: August 25, 2008
Fig. F4.22 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.22 - Geology-Based Infiltration Zones.mxd

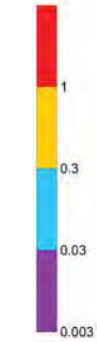


THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.21
Relative Meteoric Infiltration Zones in Local Study Area

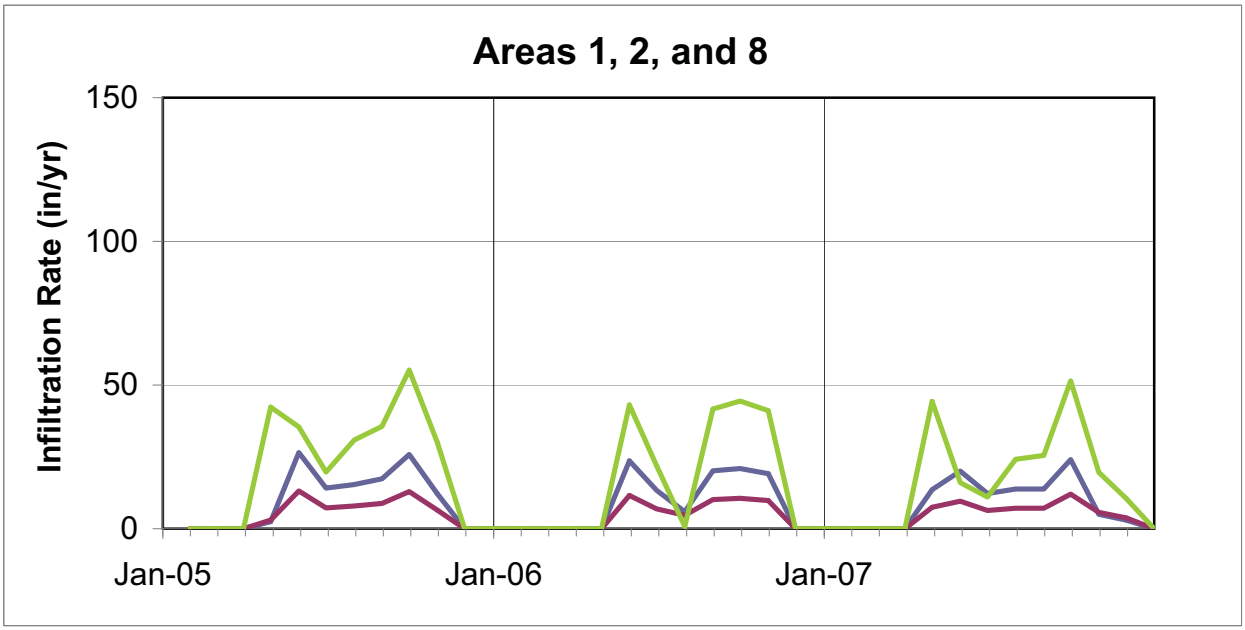
Legend

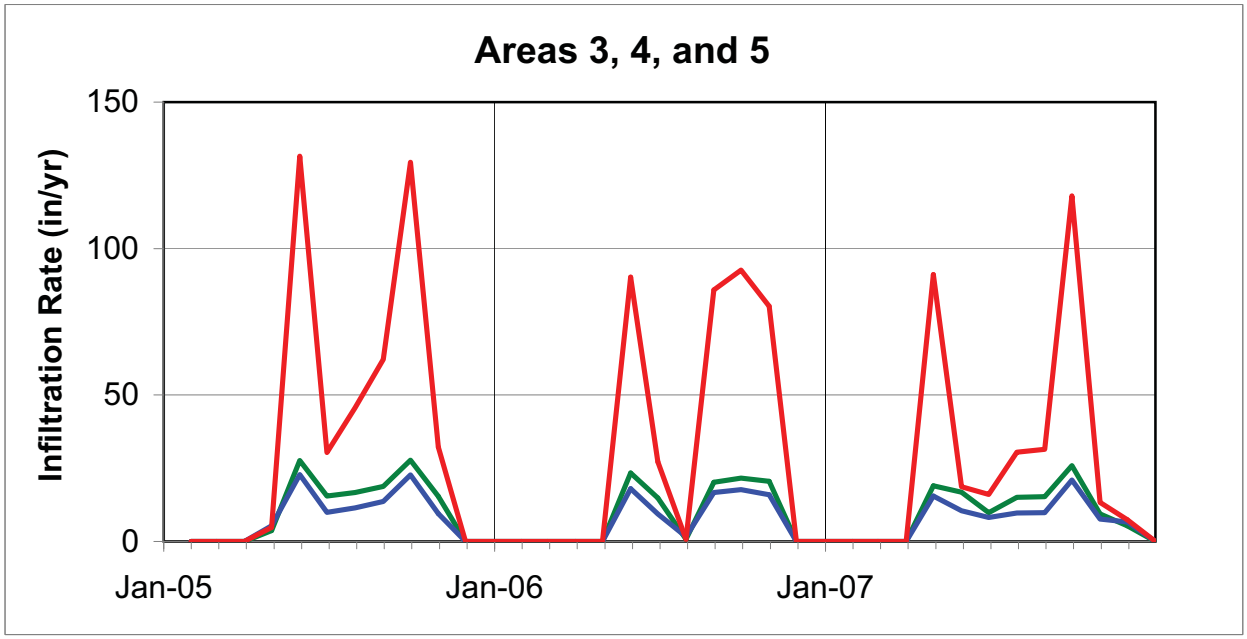




Project: 7126	Date: Aug 26, 2008
Fig. F4.24 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.24 - Relative Meteoric Infiltration Zones in Local Study Area.xls







Legend

- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Area 8

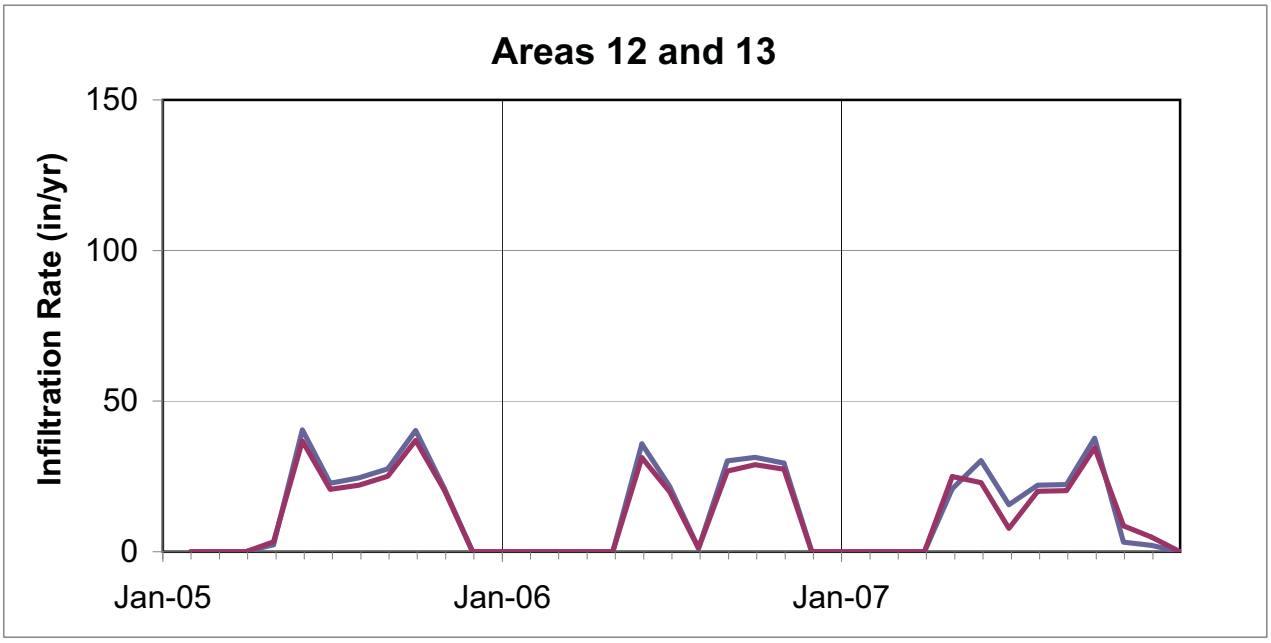
THE pebble PARTNERSHIP

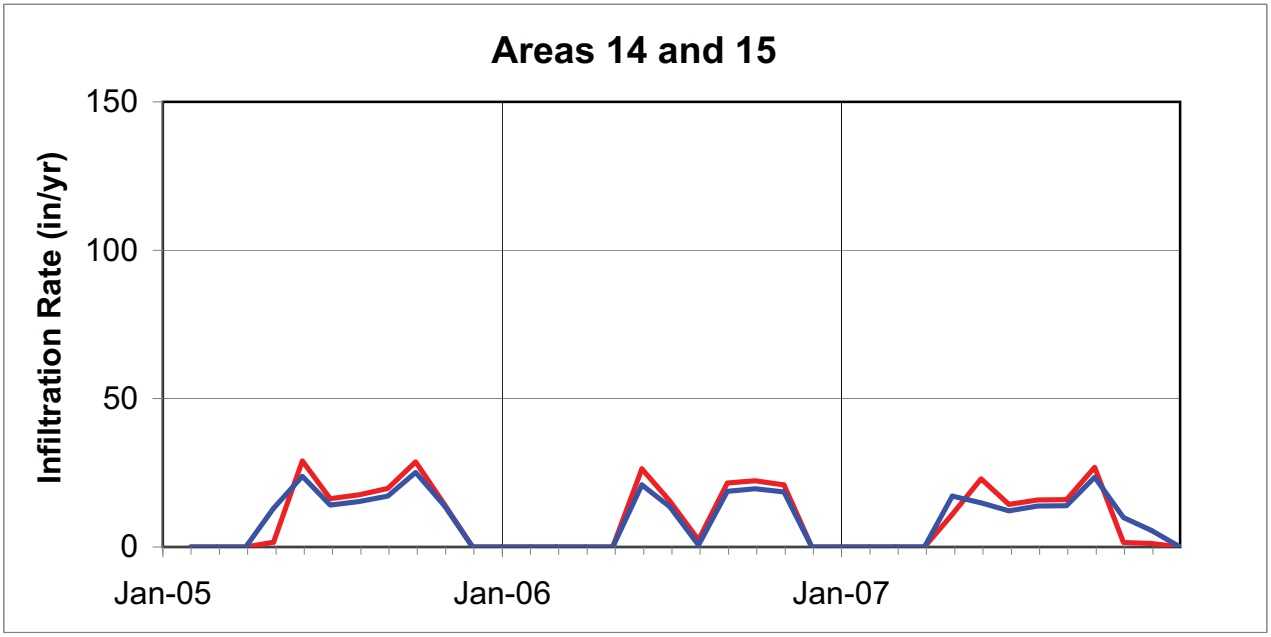
Appendix 8.1J
Groundwater Model Results

Figure 4.22a:
Transient Recharge
South Fork Koktuli

Project: 7126	Date: Aug 25, 2008
Fig F4.12a Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4-12a - Transient Recharge.xls







Legend

- Area 12
- Area 13
- Area 14
- Area 15

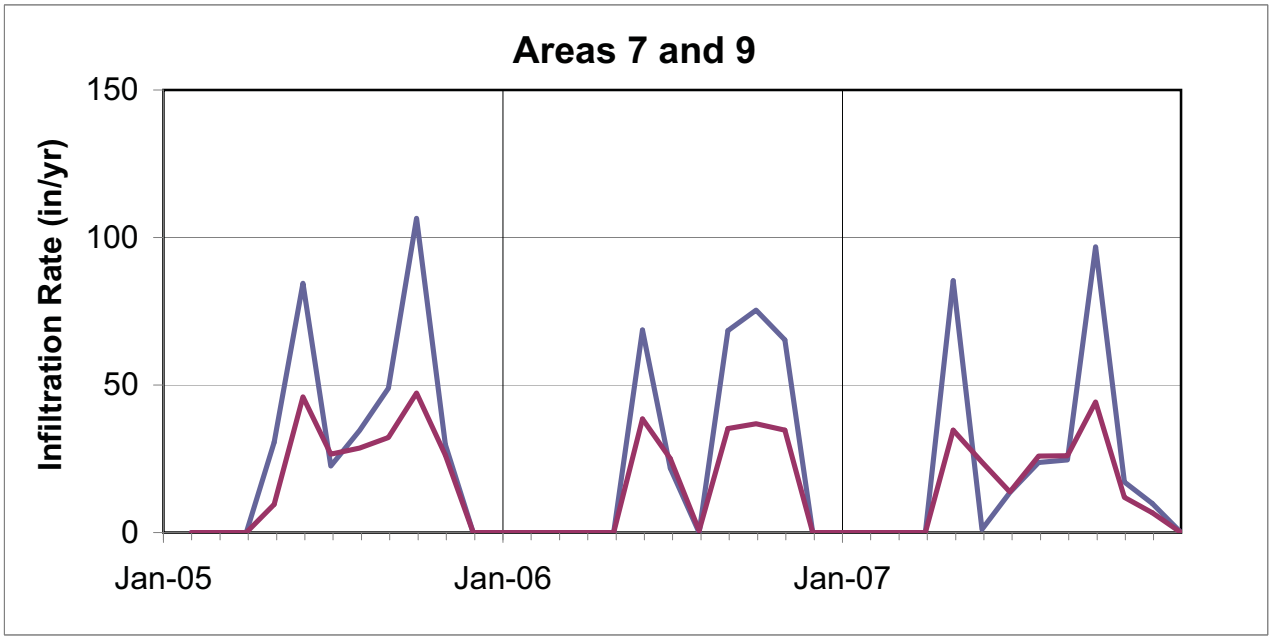
THE pebble PARTNERSHIP

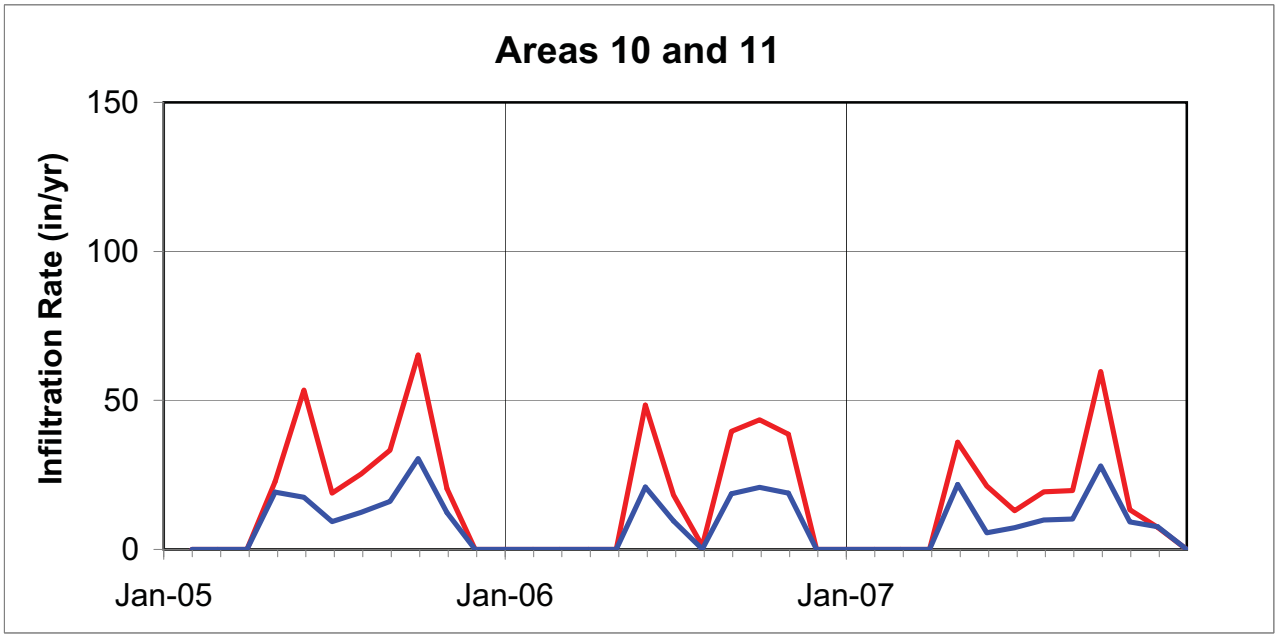
Appendix 8.1J
Groundwater Model Results

Figure 4.22b:
Transient Recharge - North Fork Koktuli

Project: 7126	Date: Aug 25, 2008
Fig F4.12b Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4-12b- Transient Recharge.xls







Legend

- Area 7
- Area 9
- Area 10
- Area 11

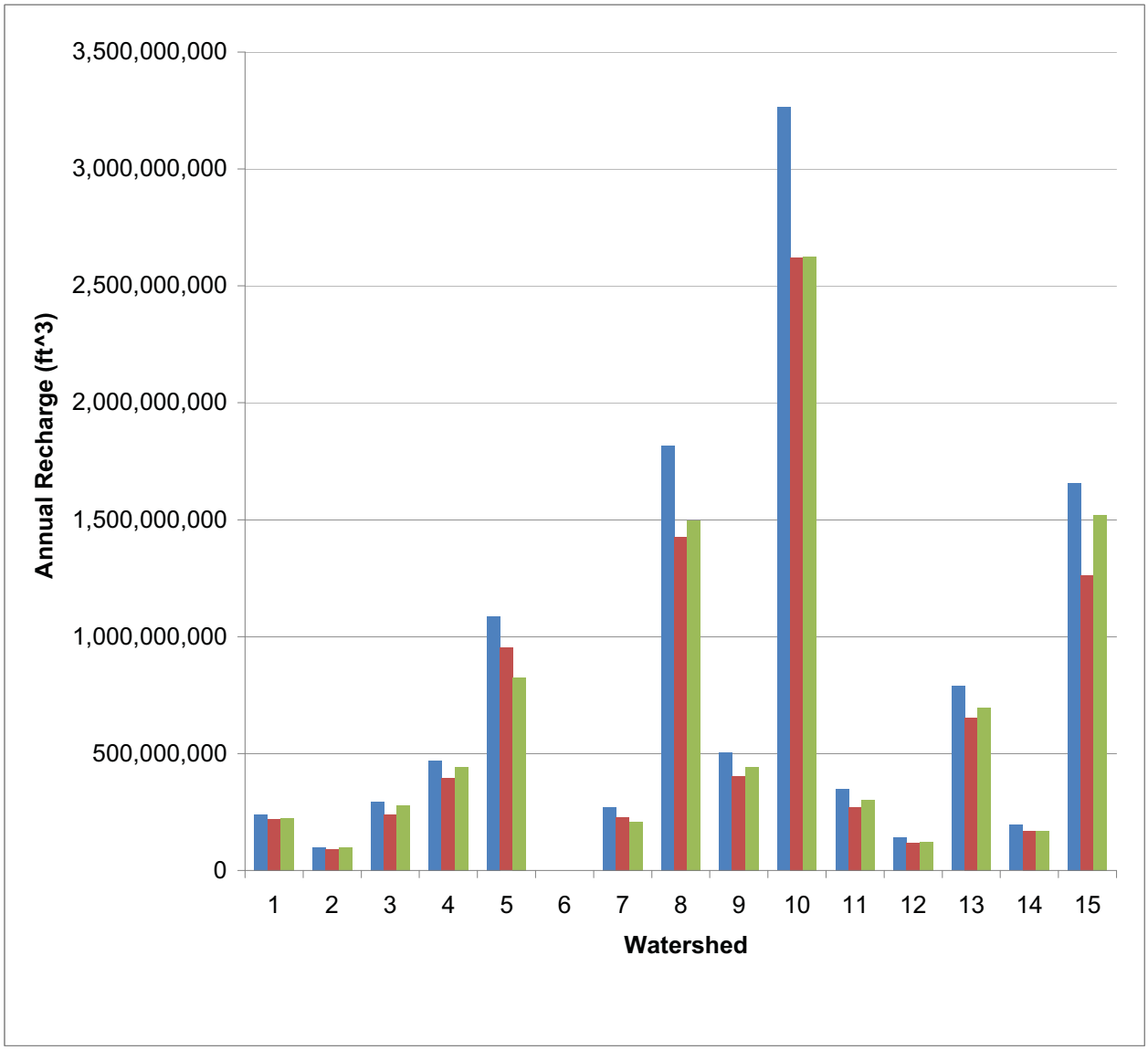
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.22c:
Transient Recharge - Upper Talarik

Project: 7126	Date: Aug 25, 2008
Fig F4.12c Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4-12c- Transient Recharge.xls





Legend

2005
2006
2007

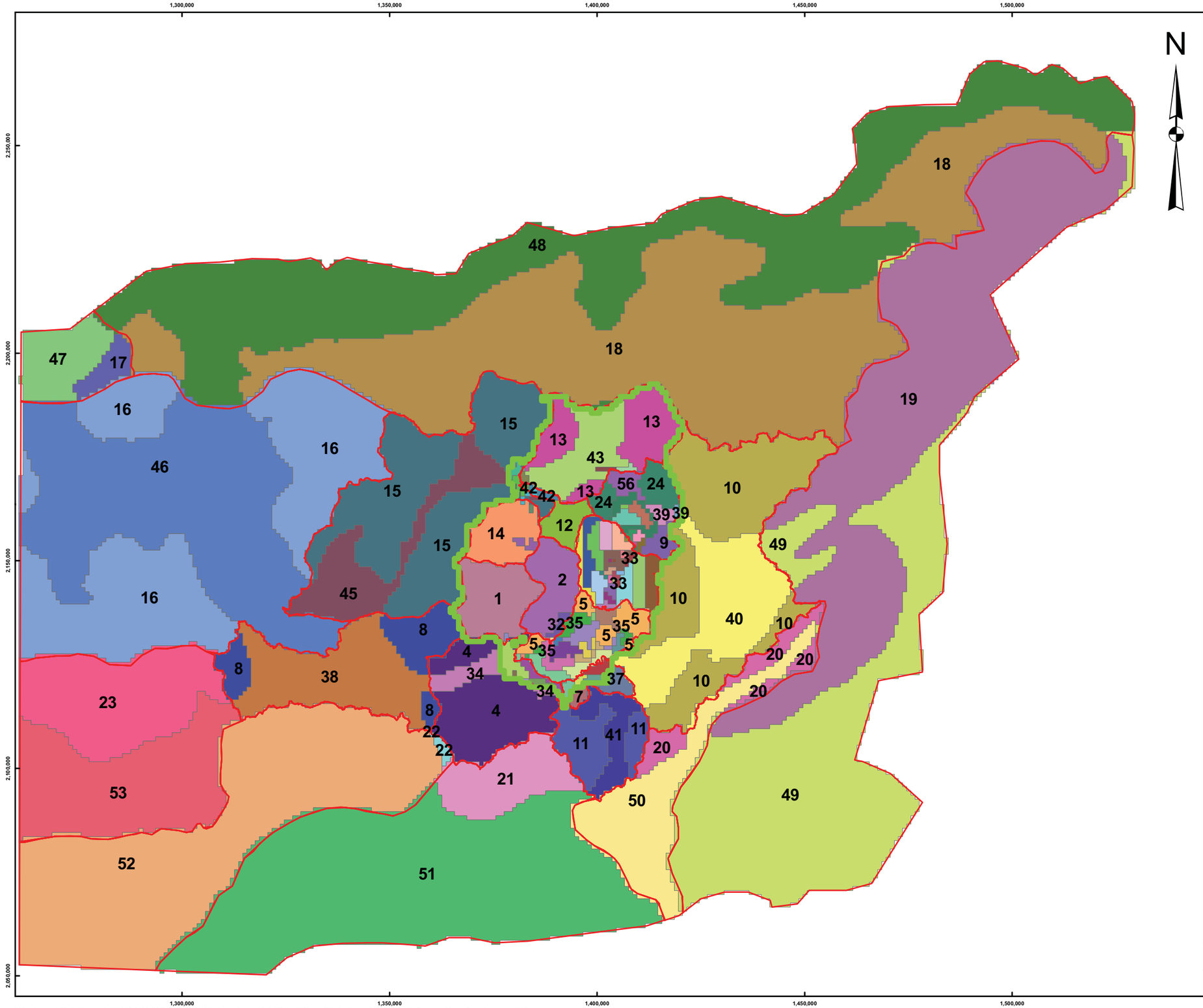
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.23 Annual Recharge by Watershed: 2005 to 2007

Project: 7126	Date: Aug 26, 2008
Fig F4.31 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4-31 Annual Recharge by Watershed 2005 to 2007.xls



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.24
Hydraulic Conductivity Zones
in Model Domain - Layer 1

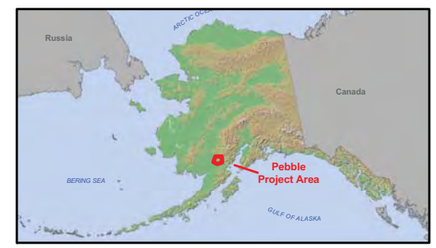
Legend

K Zones (1-99) - Layer 1

1	16	38
2	17	39
3	18	40
4	19	49
5	20	50
6	21	51
7	22	52
8	23	53
9	24	56
10	32	
11	33	
12	34	
13	35	
14	36	
15	37	

Watershed Boundary

Local Hydraulic Conductivity Zones (see Fig F4.19)



Feet
0 15,000 30,000 45,000 60,000

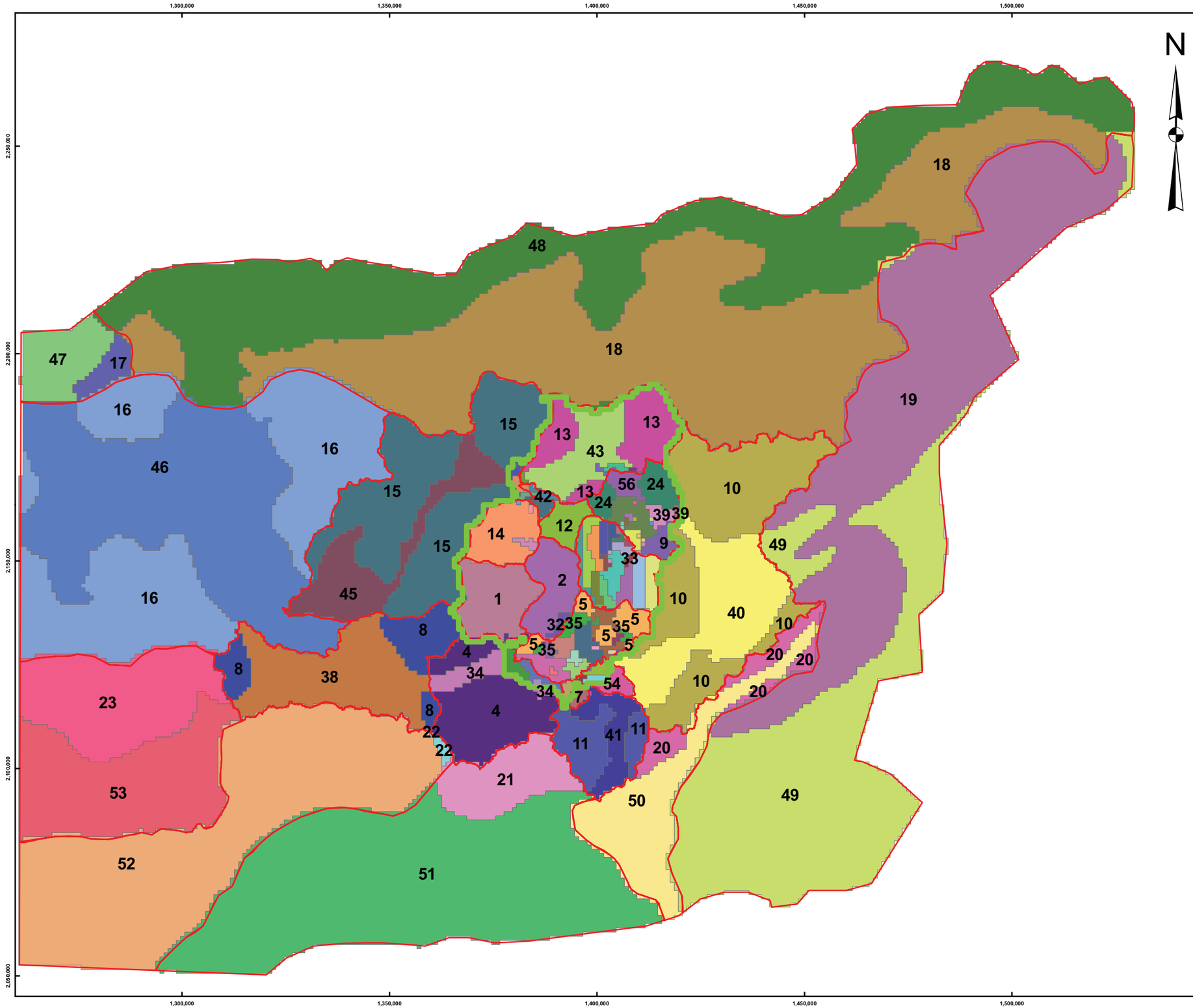
Meters
0 5,000 10,000 15,000 20,000

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: August 25, 2008
Fig. F4.16 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.16 - Hydraulic Conductivity Zones in Model Domain - Layer 1 V2.mxd



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.25
Hydraulic Conductivity Zones
in Model Domain - Layer 2

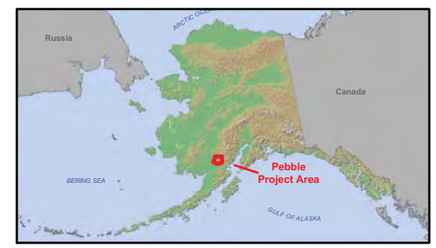
Legend

K Zones (1-99) - Layer 2

1	18	42
2	19	43
3	20	45
4	21	46
5	22	47
6	23	48
7	24	49
8	32	50
9	33	51
10	34	52
11	35	53
12	36	54
13	37	56
14	38	
15	39	
16	40	
17	41	

Watershed Boundary

Local Hydraulic Conductivity Zones (see Fig F4.20)



0 15,000 30,000 45,000 60,000 Feet

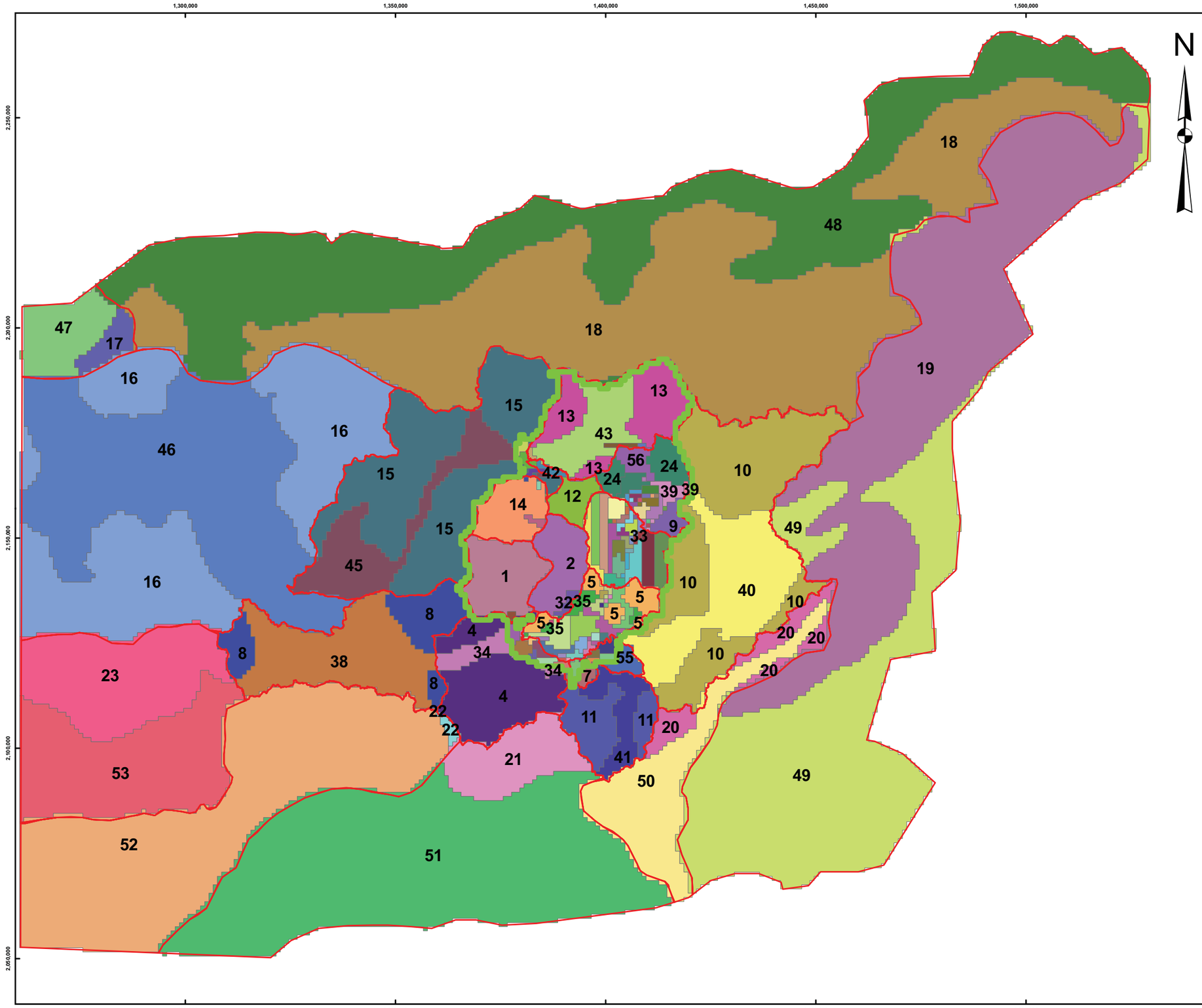
0 5,000 10,000 15,000 20,000 Meters

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: August 25, 2008
Fig. F4.17 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.17 - Hydraulic Conductivity Zones in Model Domain - Layer 2 V2.mxd



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.26
Hydraulic Conductivity Zones in Model Domain - Layer 3

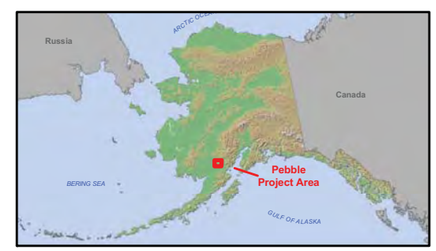
Legend

K Zones (1-99) - Layer 3

1	17	40
2	18	41
3	19	42
4	20	43
5	21	45
6	22	46
7	23	47
8	24	48
9	32	49
10	33	50
11	34	51
12	35	52
13	36	53
14	37	55
15	38	56
16	39	

Watershed Boundary

Local Hydraulic Conductivity Zones (see Fig F4.21)



Feet
0 15,000 30,000 45,000 60,000

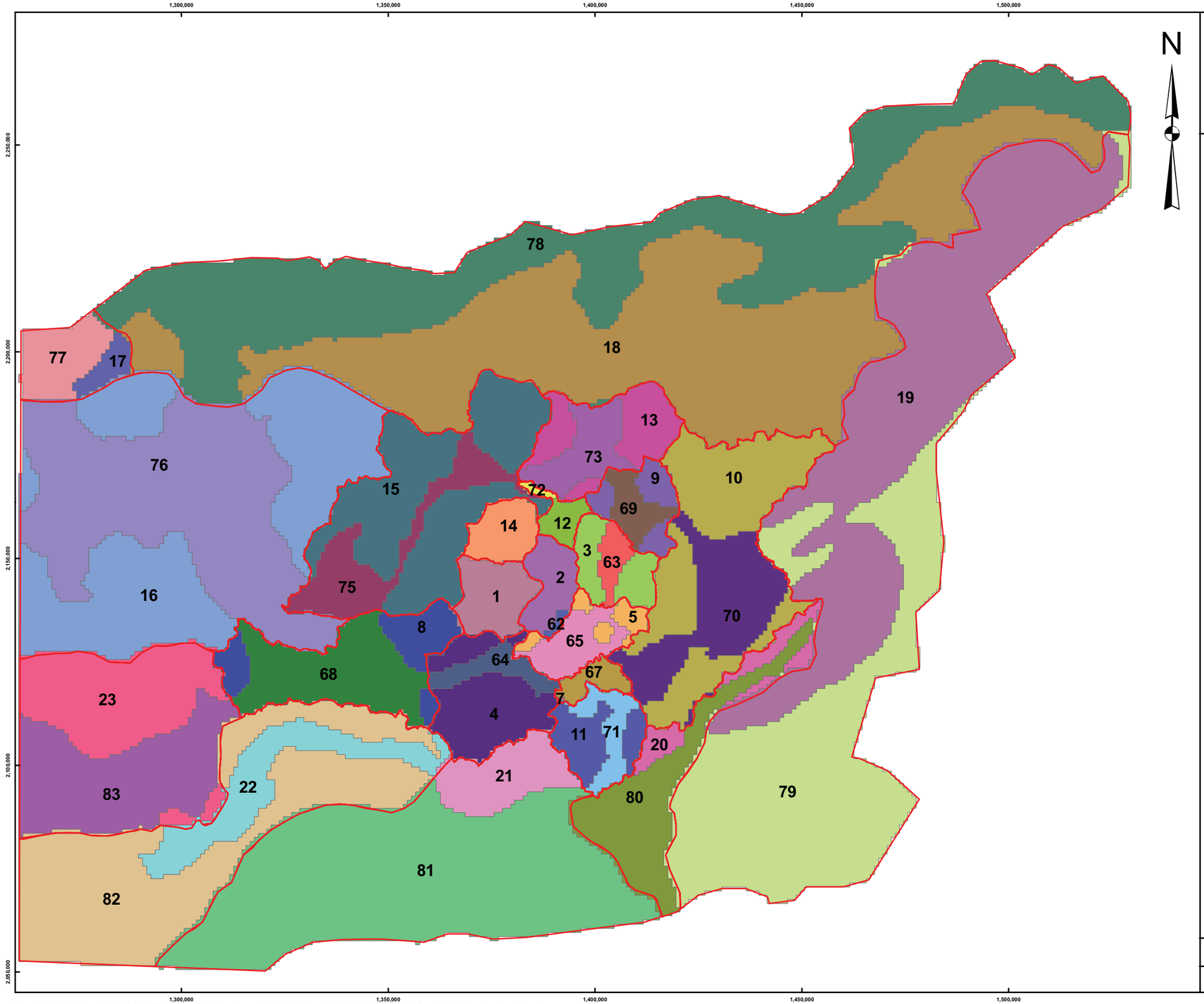
Meters
0 5,100 10,200 15,300 20,400

Scale 1:283,282

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.18 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.18 - Hydraulic Conductivity Zones in Model Domain - Layer 3 V2.mxd



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.27
Hydraulic Conductivity Zones
in Model Domain - Layer 4

Legend

K Zones (1-99) - Layer 4

1	16	70	Watershed Boundary
2	17	71	
3	18	72	
4	19	73	
5	20	75	
6	21	76	
7	22	77	
8	23	78	
9	62	79	
10	63	80	
11	64	81	
12	65	82	
13	67	83	
14	68		
15	69		



Feet
0 15,000 30,000 45,000 60,000

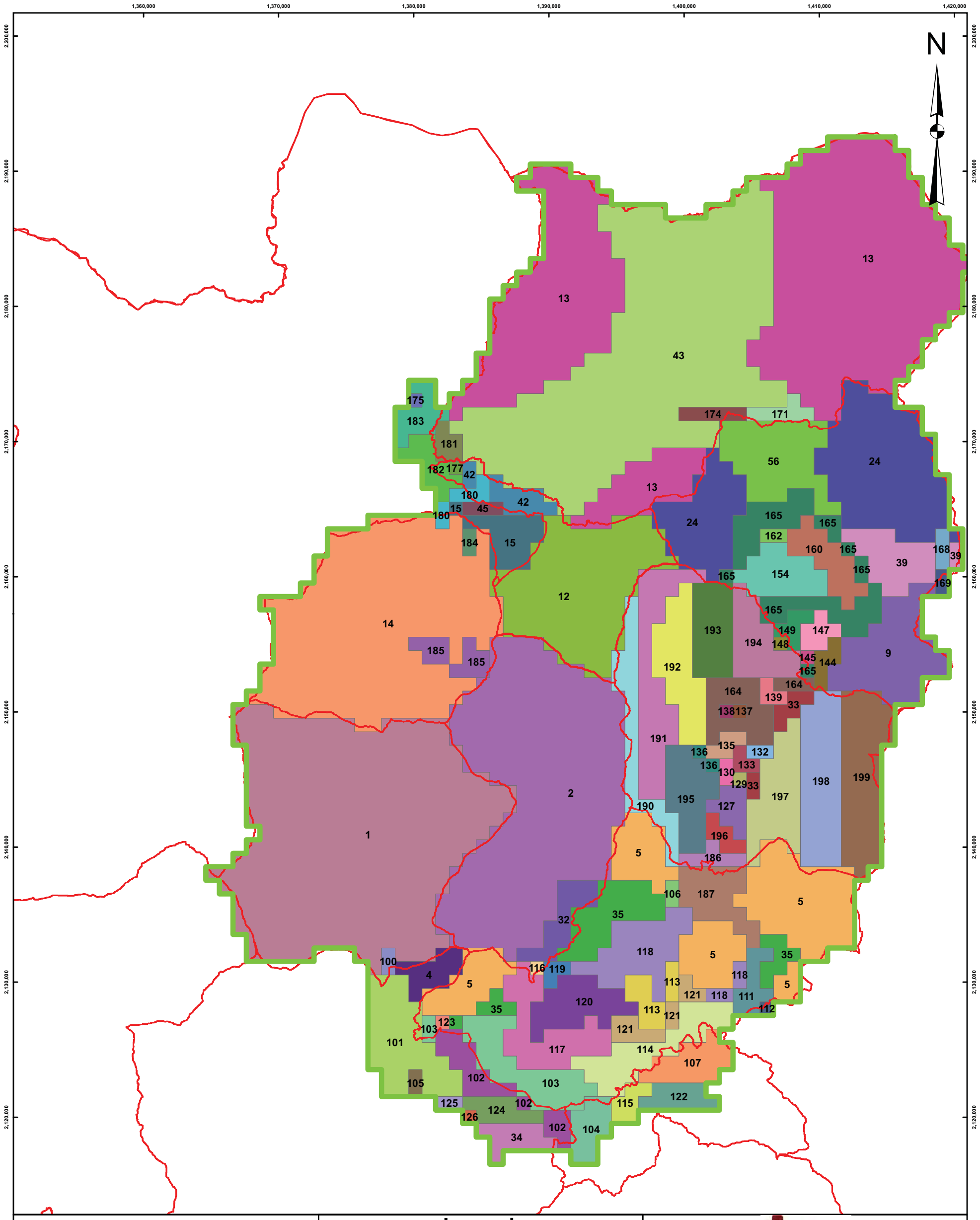
Meters
0 5,000 10,000 15,000 20,000

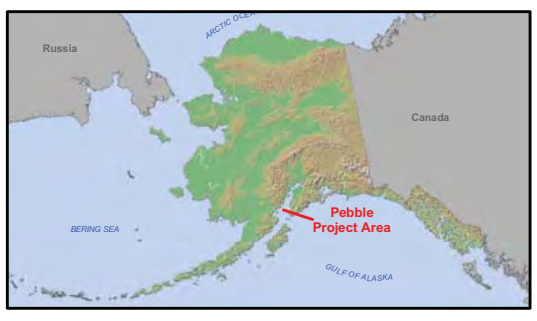
Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: June 30, 2008
Fig. F4.16 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure XX.XX - Hydraulic Conductivity Zones in Model Domain - Layer 4 V2.mxd





0 5,000 10,000 15,000 20,000 Feet

0 1,250 2,500 3,750 5,000 Meters

Scale 1:84,673

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Legend

K Zones - Layer 1

1	35	111	125	145	171	190	
2	39	112	126	147	172	191	
3	42	113	127	148	173	192	
4	43	114	129	149	174	193	
5	45	115	130	152	175	194	
9	56	116	132	154	177	195	
12	100	117	133	160	180	196	
13	101	118	135	162	181	197	
14	102	119	136	164	182	198	
15	103	120	137	165	183	199	
24	104	121	138	166	184		
32	105	122	139	168	185		
33	106	123	141	169	186		
34	107	124	144	170	187		

Local Hydraulic Conductivity Zones Watershed Boundary

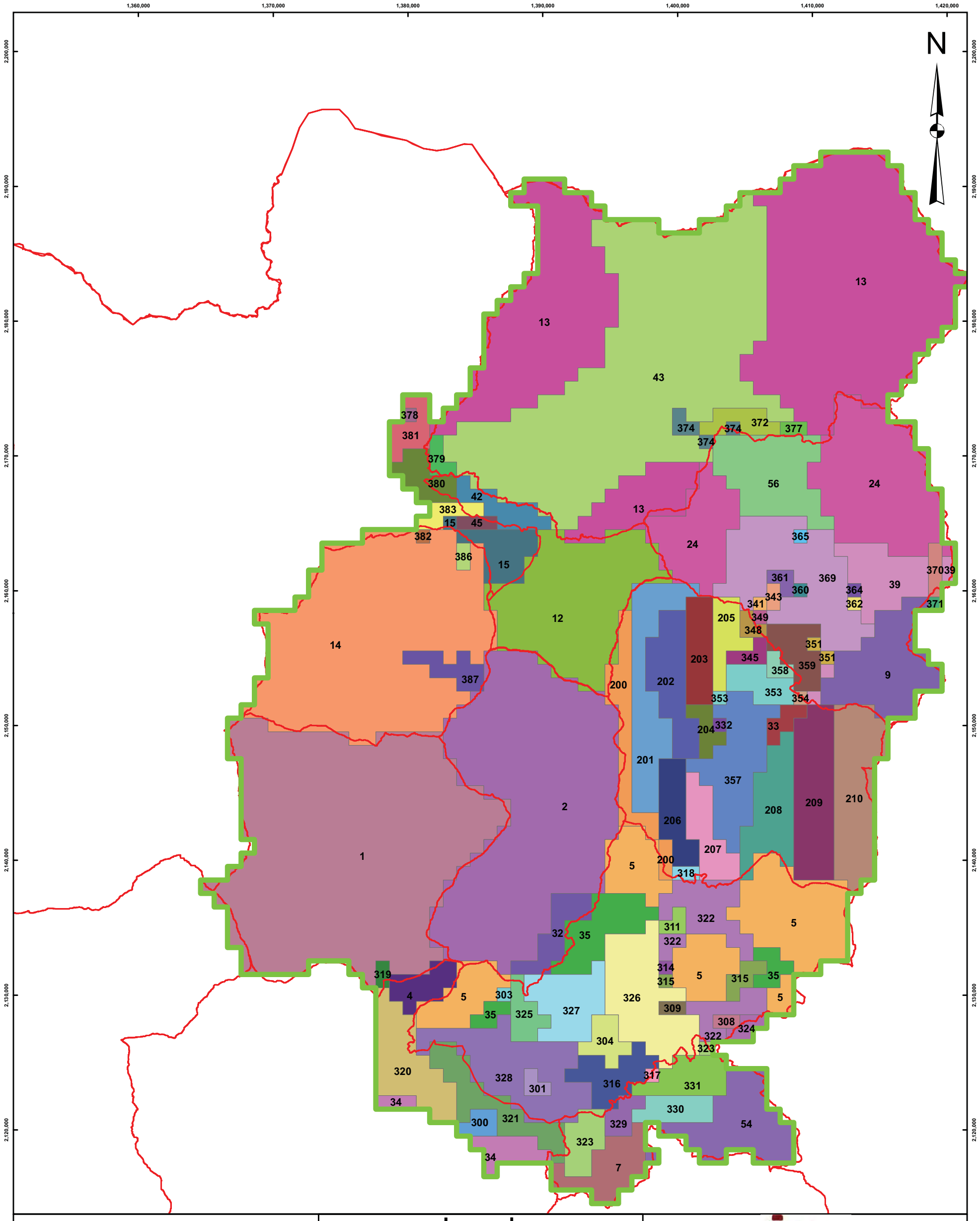
THE pebble PARTNERSHIP

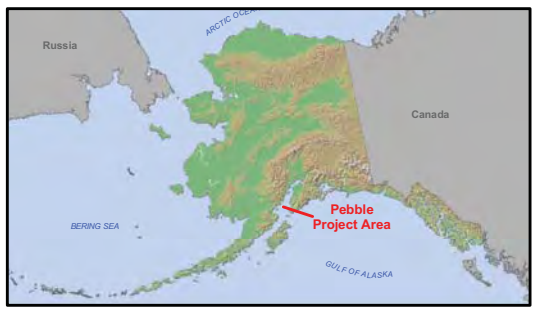
Appendix 8.1J
Groundwater Model Results

Figure 4.28
Hydraulic Conductivity Zones in Local Study Area - Layer 1

Project No: 7126	Date: August 25, 2008
Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.19 - Hydraulic Conductivity Zones in Local Study Area - Layer 1 V2.mxd





Feet
0 5,000 10,000 15,000 20,000

Meters
0 1,000 2,000 3,000 4,000 5,000

Scale 1:84,907

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Legend

K Zones - Layer 2

1	33	204	308	324	345	365	380	
2	34	205	309	325	348	367	381	
3	35	206	311	326	349	368	382	
4	39	207	314	327	351	369	383	
5	42	208	315	328	353	370	386	
7	43	209	316	329	354	371	387	
9	45	210	317	330	357	372		
12	54	300	318	331	358	373		
13	56	301	319	332	359	374		
14	200	303	320	339	360	375		
15	201	304	321	340	361	377		
24	202	306	322	341	362	378		
32	203	307	323	343	364	379		

Local Hydraulic Conductivity Zones
Watershed Boundary

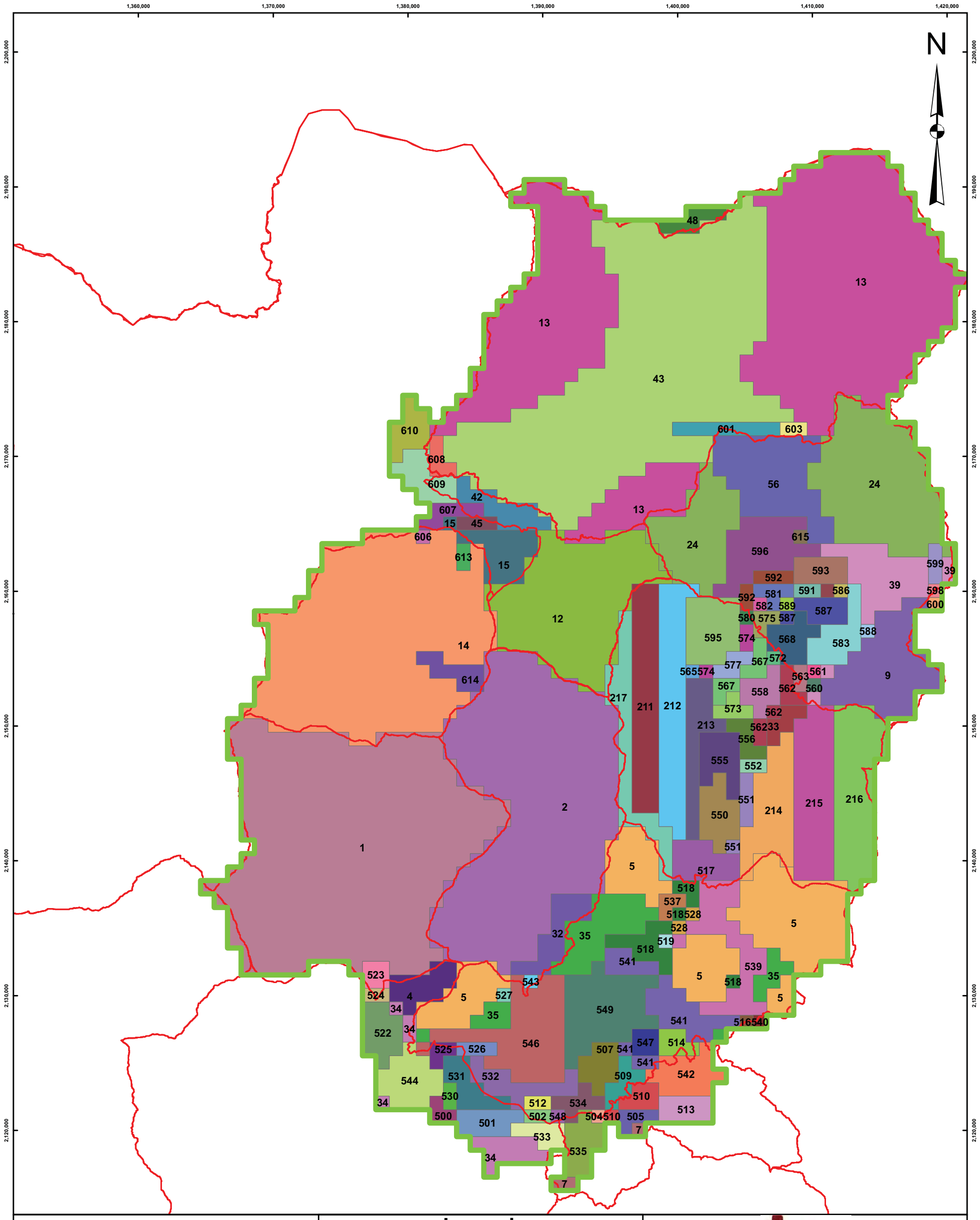
THE pebble PARTNERSHIP

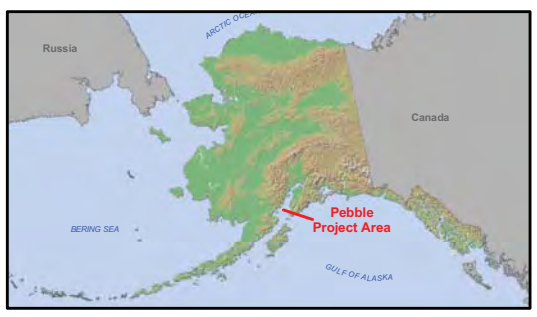
Appendix 8.1J
Groundwater Model Results

Figure 4.29
Hydraulic Conductivity Zones in Local Study Area - Layer 2

Project No: 7126	Date: August 25, 2008
Fig F4.20 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.20 - Hydraulic Conductivity Zones in Local Study Area - Layer 2 V2.mxd





Feet
0 5,000 10,000 15,000 20,000
Meters
0 1,000 2,000 3,000 4,000 5,000

Scale 1:84,907

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Legend

K Zones - Layer 3

1	42	507	528	549	574	596	
2	43	509	530	550	575	598	
3	45	510	531	551	577	599	
4	48	512	532	552	580	600	
5	56	513	533	555	581	601	
7	211	514	534	556	582	602	
9	212	516	535	558	583	603	
12	213	517	537	560	584	606	
13	214	518	539	561	586	607	
14	215	519	540	562	587	608	
15	216	521	541	563	588	609	
24	217	522	542	564	589	610	
32	500	523	543	565	591	613	
33	501	524	544	567	592	614	
34	502	525	546	568	593	615	
35	504	526	547	572	594		
39	505	527	548	573	595		

Local Hydraulic Conductivity Zones Watershed Boundary

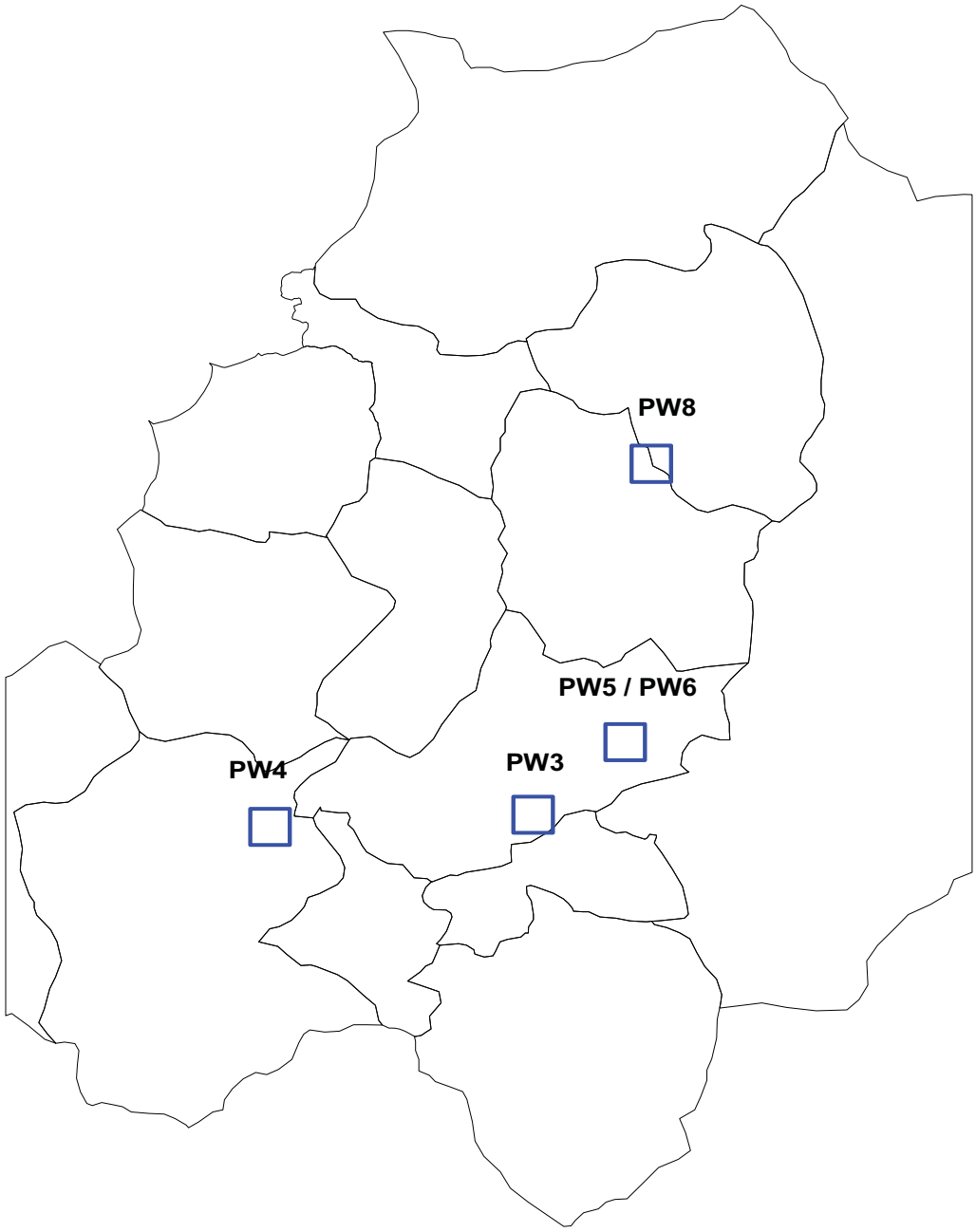
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 4.30
Hydraulic Conductivity Zones in Local Study Area - Layer 3

Project No: 7126	Date: August 25, 2008
Fig F4.21 Version: 2	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.21 - Hydraulic Conductivity Zones in Local Study Area - Layer 3 V2.mxd





Legend

Domain extent for TMR Model

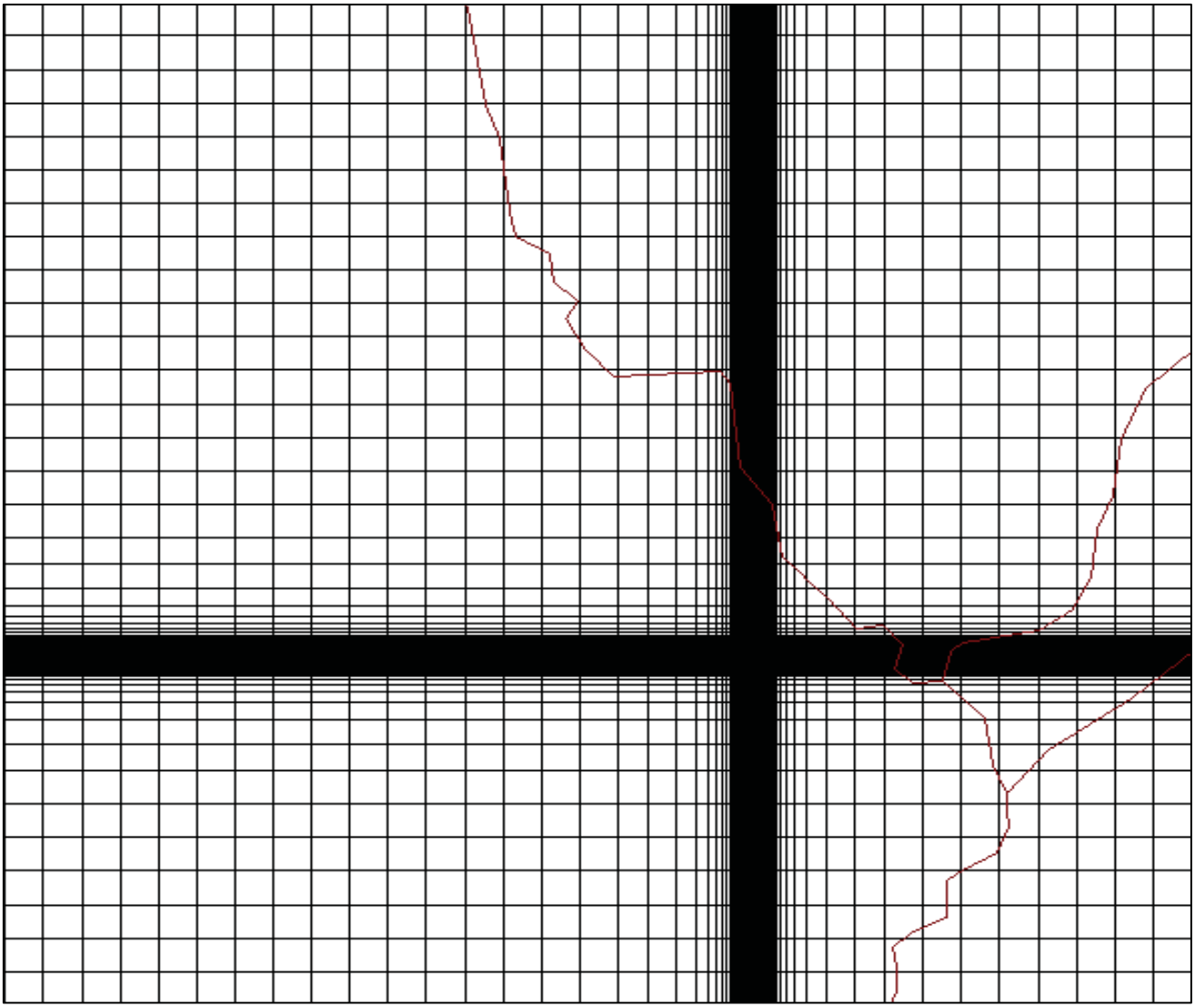
THE pebble PARTNERSHIP

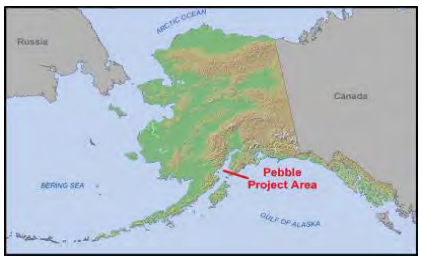
Appendix 8.1J
Groundwater Model Results

Figure 4.31
Pumping Test Model Domain Locations

Project: 7126	Date: Aug 26, 2008
Fig F4.33 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4.33 Pumping Test Model Dopmain Locations.xls





Legend

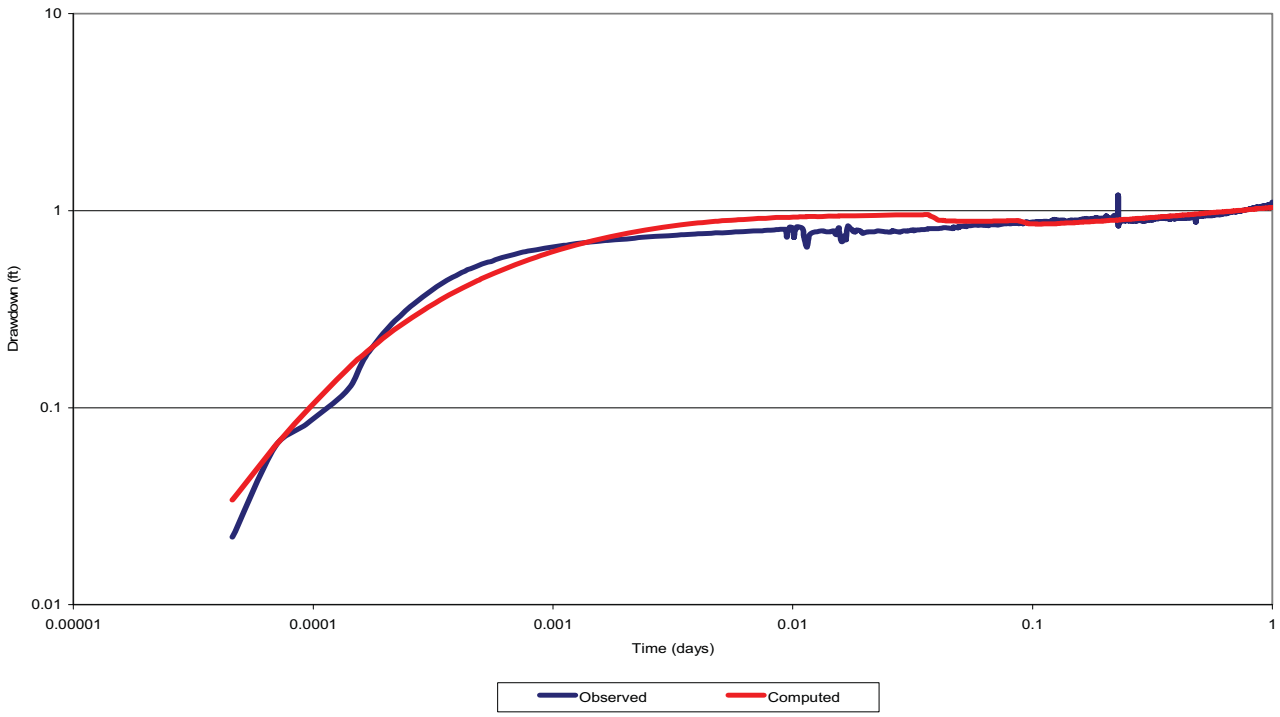
THE pebble PARTNERSHIP

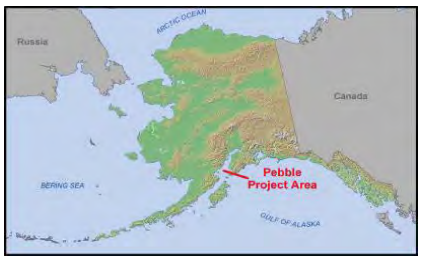
Appendix 8.1J
Groundwater Model Results

Figure 4.32
PW5 TMR Model Domain
Discretization

Project: 7126	Date: Aug 26, 2008
Fig F4.34 Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4.34 PW5 TWR Model Domain Discretization.xls





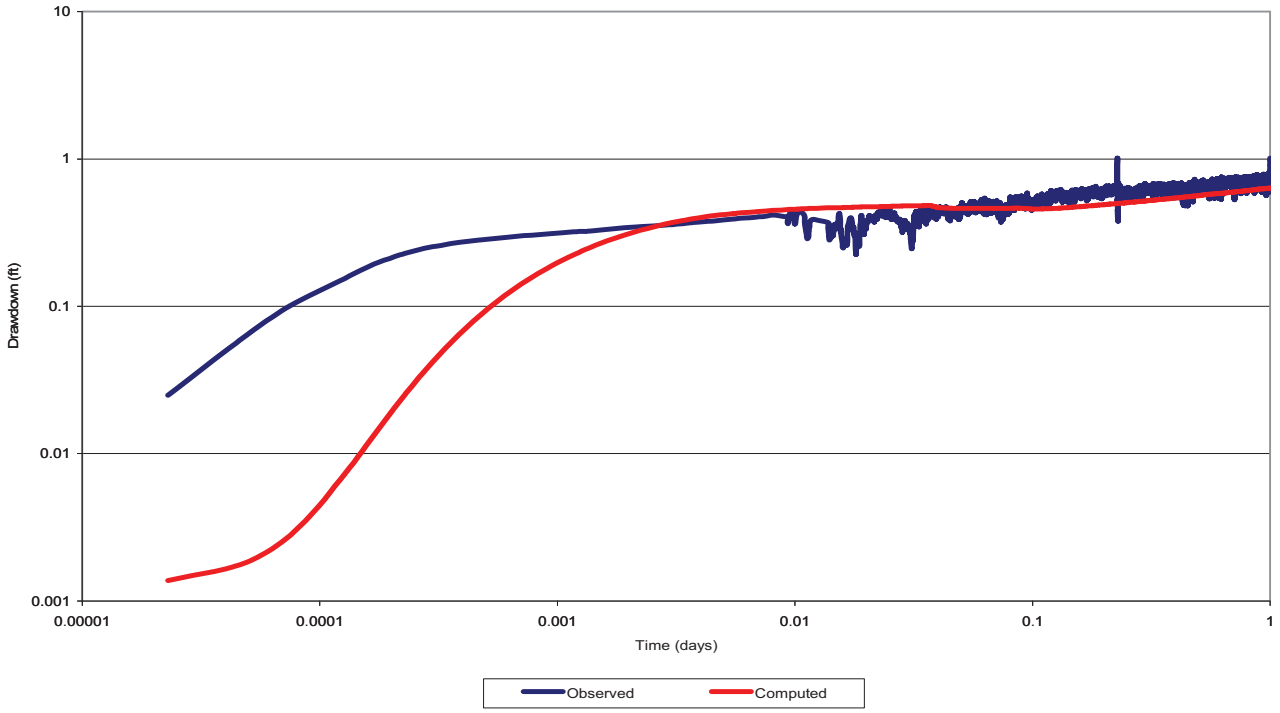
THE pebble PARTNERSHIP

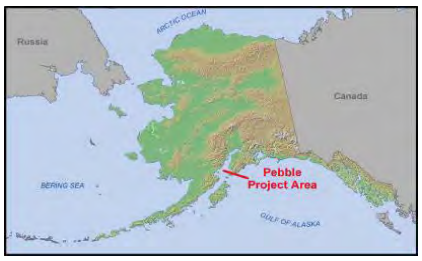
Appendix 8.1J
Groundwater Model Results

Figure 4.33a
PW5 Pumping Test Observed and Simulated Drawdown: MW-05-14D (Layer 4)

Project: 7126	Date: Aug 26, 2008
Fig F4.36a Version: 1	Author: WMC-LC

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F4.36a PW5 Pumping Test Observed and Siumulated Drawdown MW-15-14D (Layer 4).xls





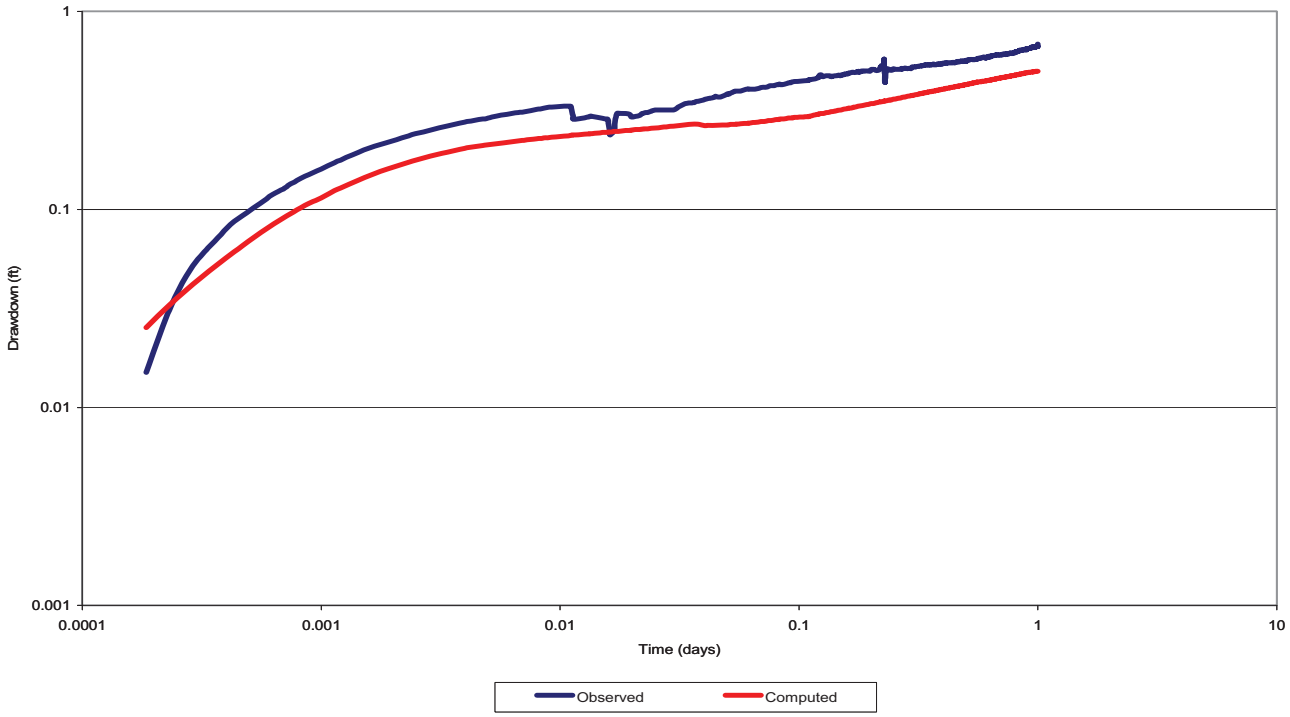
THE pebble PARTNERSHIP

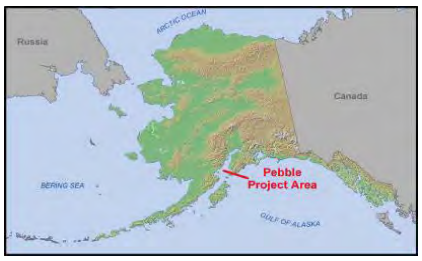
Groundwater Model Results

Figure 4.33b
PW5 Pumping Test Observed and Simulated Drawdown: P-06-25D (Layer 4)

Project: 7126	Date: Dec 31, 2010
Fig F4.33b Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.33b PW5 Pumping Test Observed and Simulated Drawdown P-05-25D (Layer 4).xls



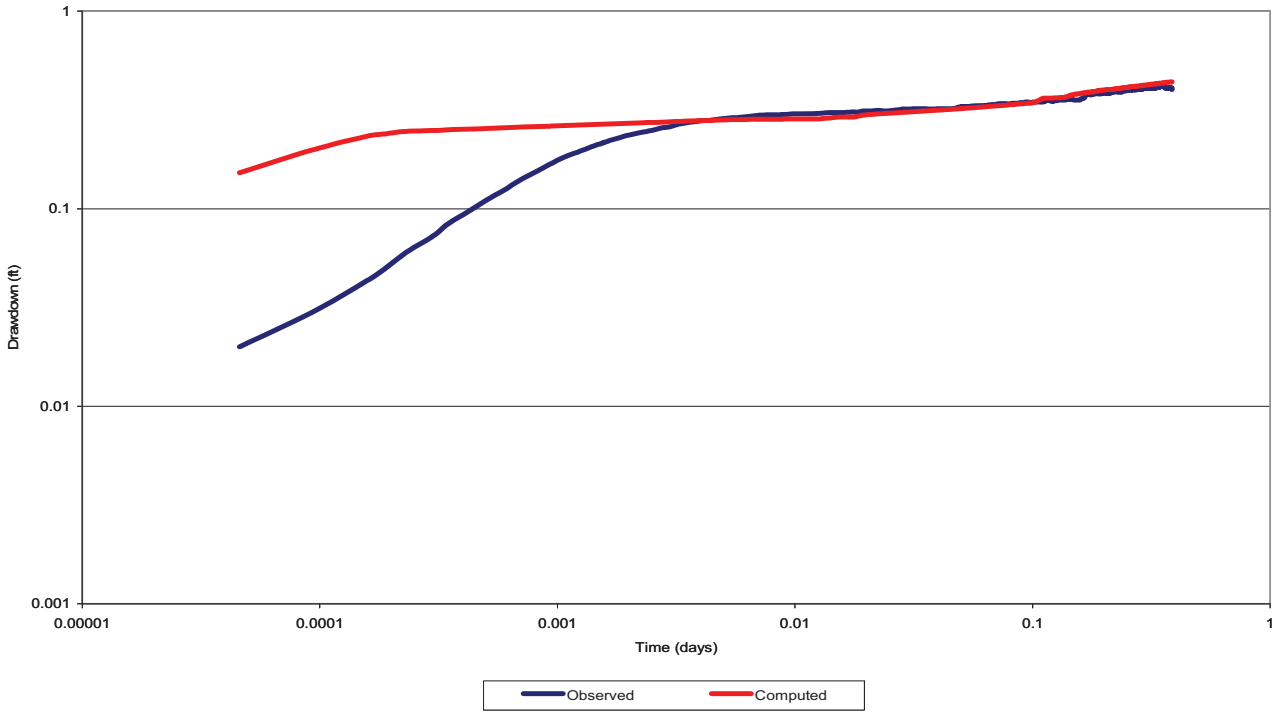


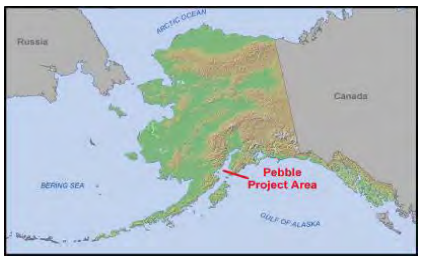
THE pebble PARTNERSHIP

Groundwater Model Results

Figure 4.33c
PW5 Pumping Test Observed and Simulated Drawdown: MW-05-14S (Layer 3)

Project: 7126	Date: Dec 31, 2010
Fig F4.33c Version: 1	Author: SWS-BL





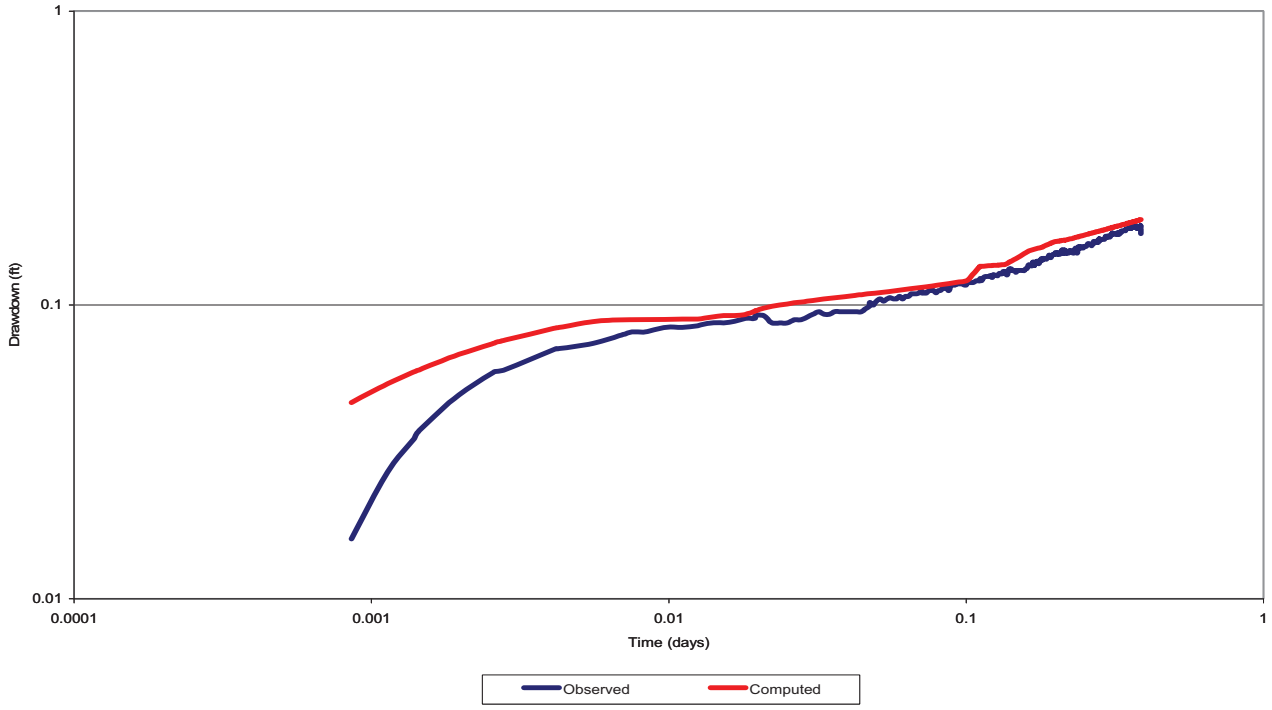
THE pebble PARTNERSHIP

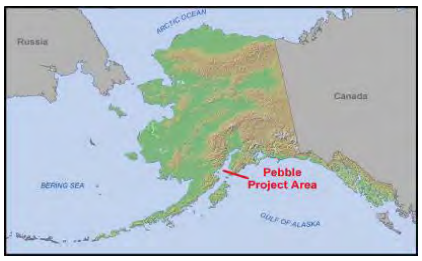
Groundwater Model Results

Figure 4.34a
PW6 Pumping Test Observed and Simulated Drawdown: MW-05-14S (Layer 3)

Project: 7126	Date: Dec 31, 2010
Fig F4.34a Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.34a - PW6 Pumping Test Observed and Simulated Drawdown MW-05-14S (Layer 3).xls



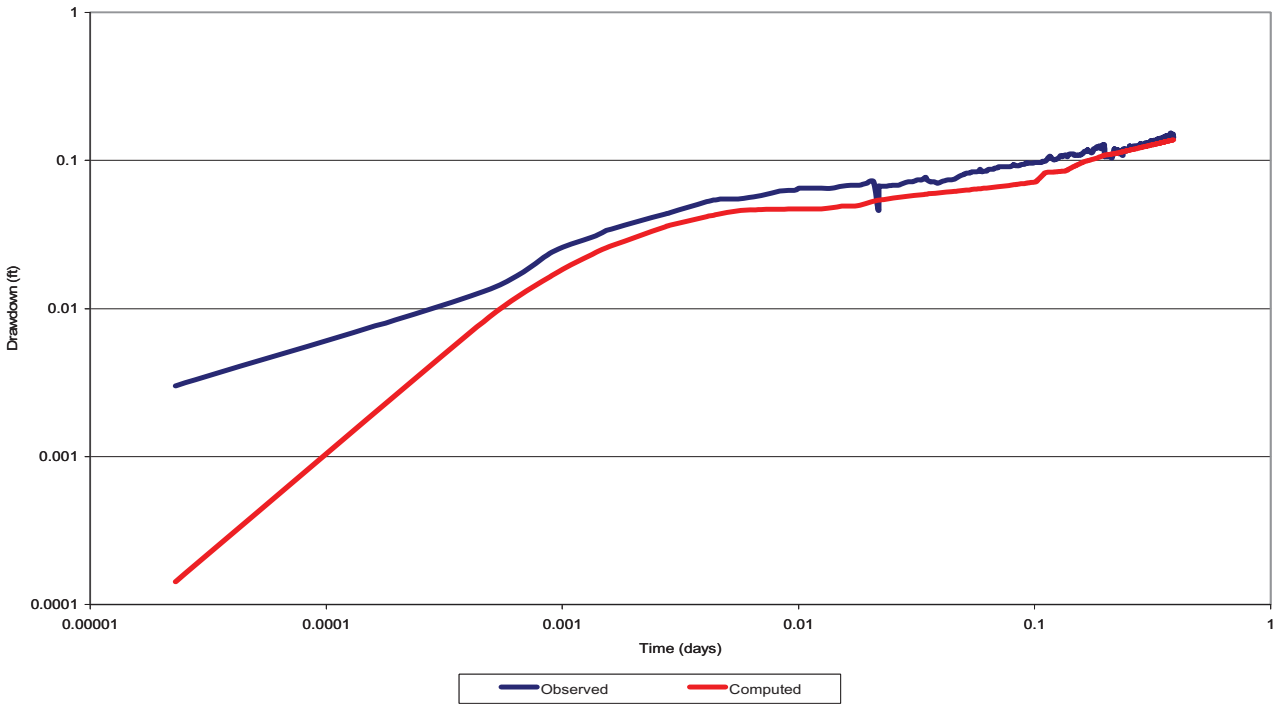


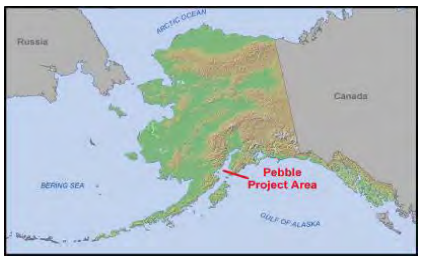
THE pebble PARTNERSHIP

Groundwater Model Results

Figure 4.34b
PW6 Pumping Test Observed and Simulated Drawdown: PW5 (Layer 4)

Project: 7126	Date: Dec 31, 2010
Fig F4.34b Version: 1	Author: SWS-BL





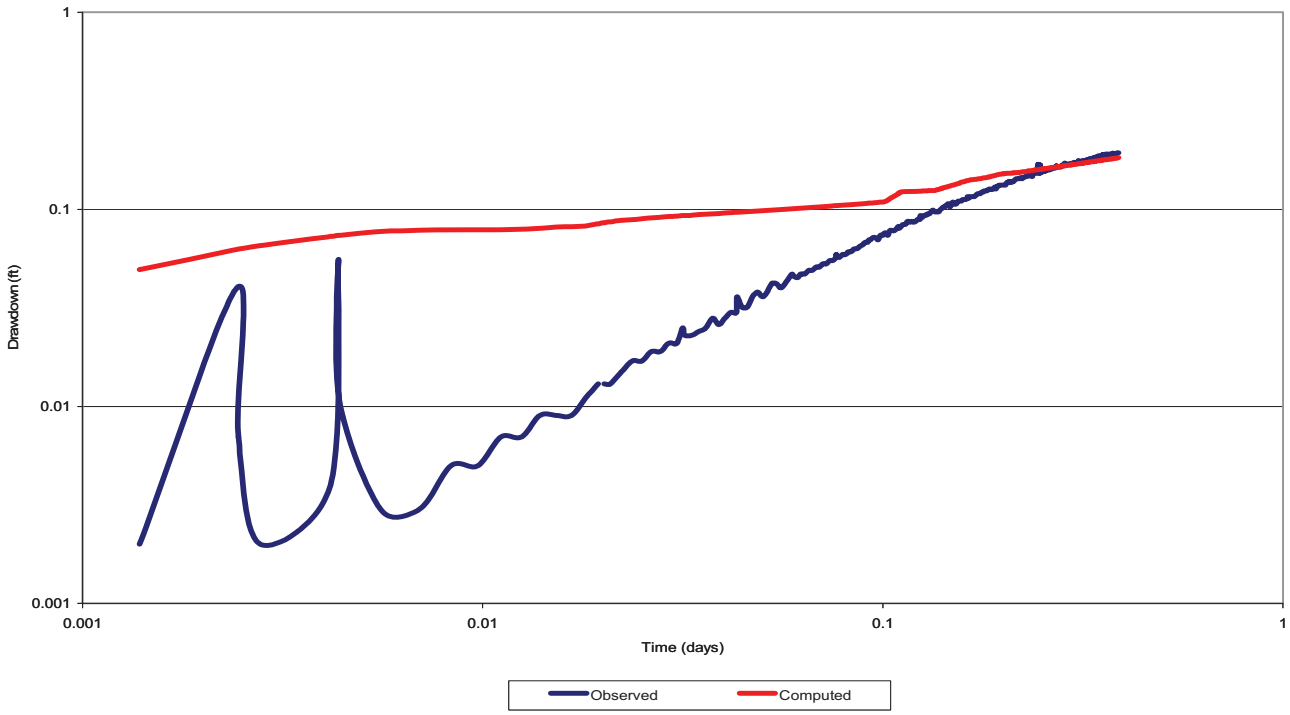
THE pebble PARTNERSHIP

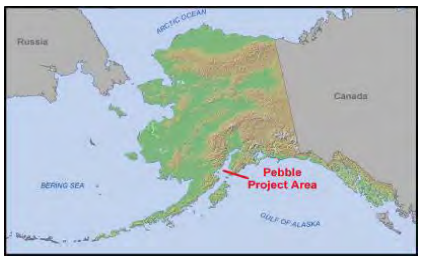
Groundwater Model Results

Figure 4.34c
PW6 Pumping Test Observed and Simulated Drawdown: P-05-25D (Layer 4)

Project: 7126	Date: Dec 31, 2010
Fig F4.34c Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.34c PW6 Pumping Test Observed and Simulated Drawdown P-05-25D (Layer 4).xls





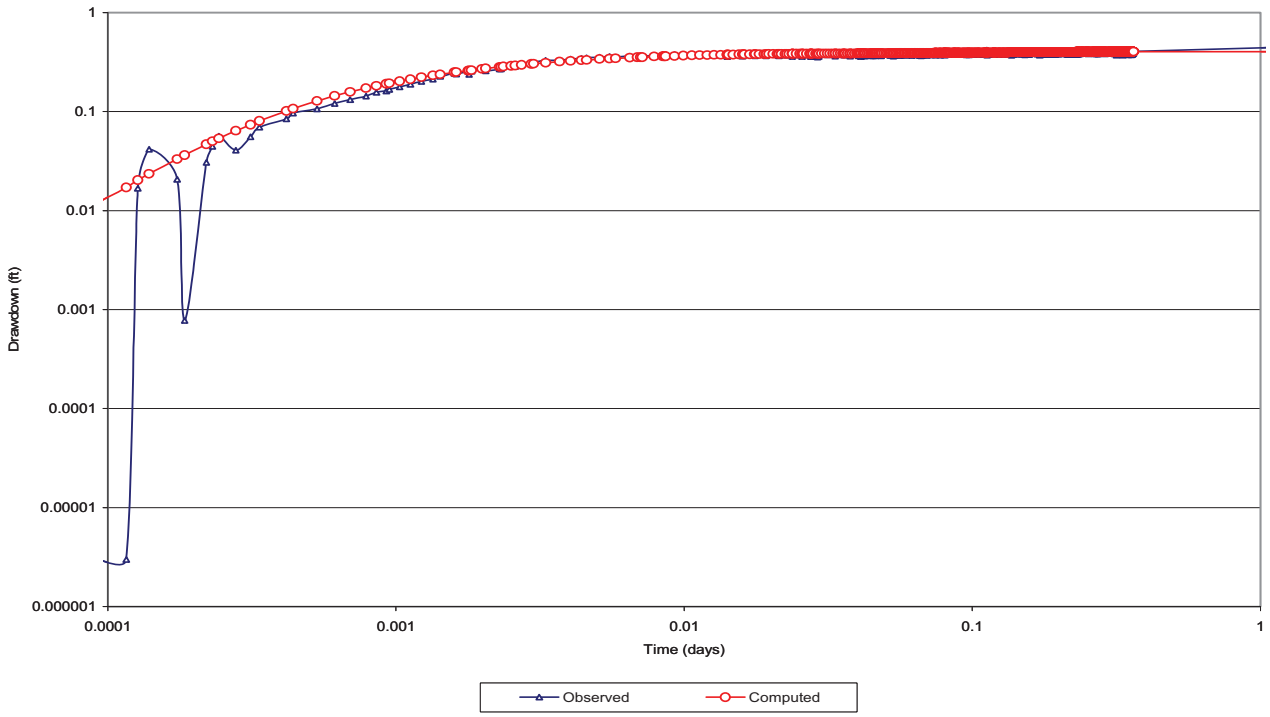
THE pebble PARTNERSHIP

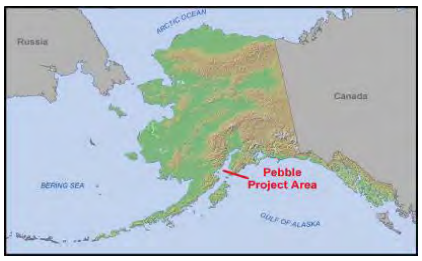
Groundwater Model Results

Figure 4.34d
PW6 Pumping Test Observed and Simulated Drawdown: MW-05-14D (Layer 4)

Project: 7126	Date: Dec 31, 2010
Fig F4.34d Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.34d PW6 Pumping Test Observed and Simulated Drawdown Mw-05-14D (Layer 4).xls





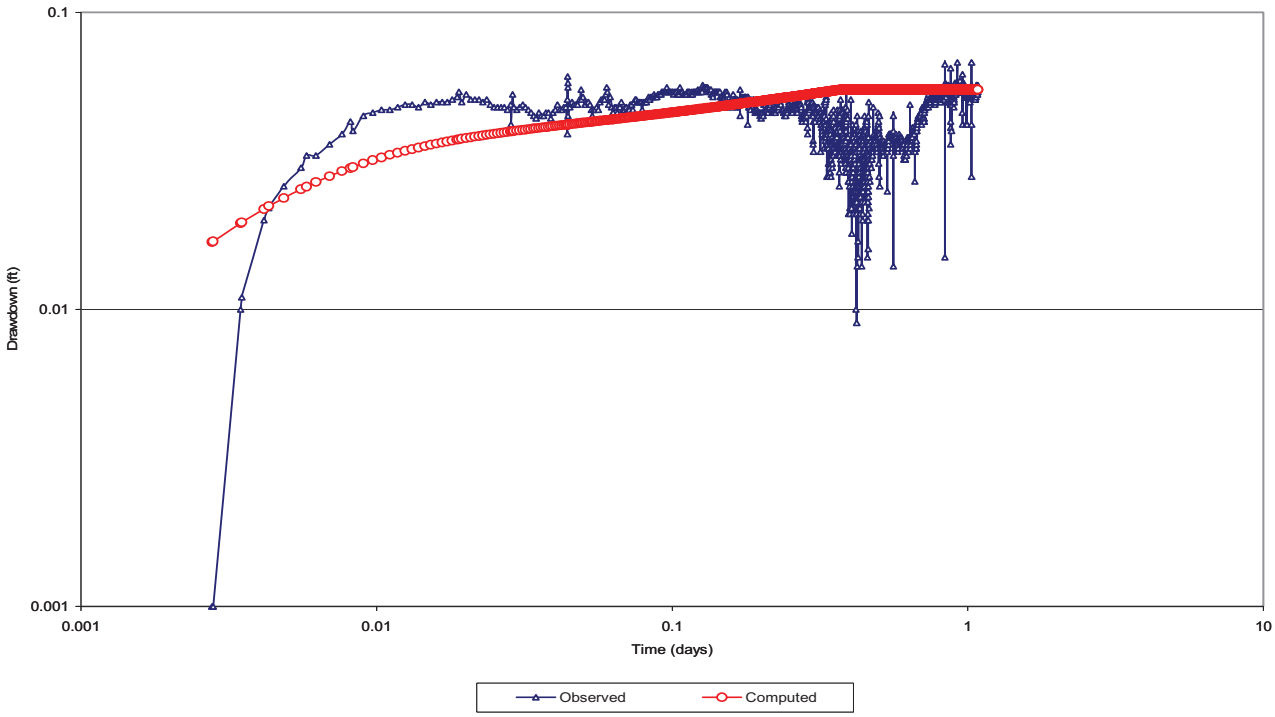
THE pebble PARTNERSHIP

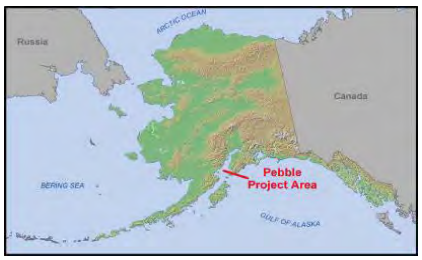
Groundwater Model Results

Figure 4.35a
PW3 Pumping Test Observed and Simulated Drawdown: MW-11M (Layer 3)

Project: 7126	Date: Dec 31, 2010
Fig F4.35a Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.35a PW3 Pumping Test Observed and Simulated Drawdown MW-11M (Layer 3).xls





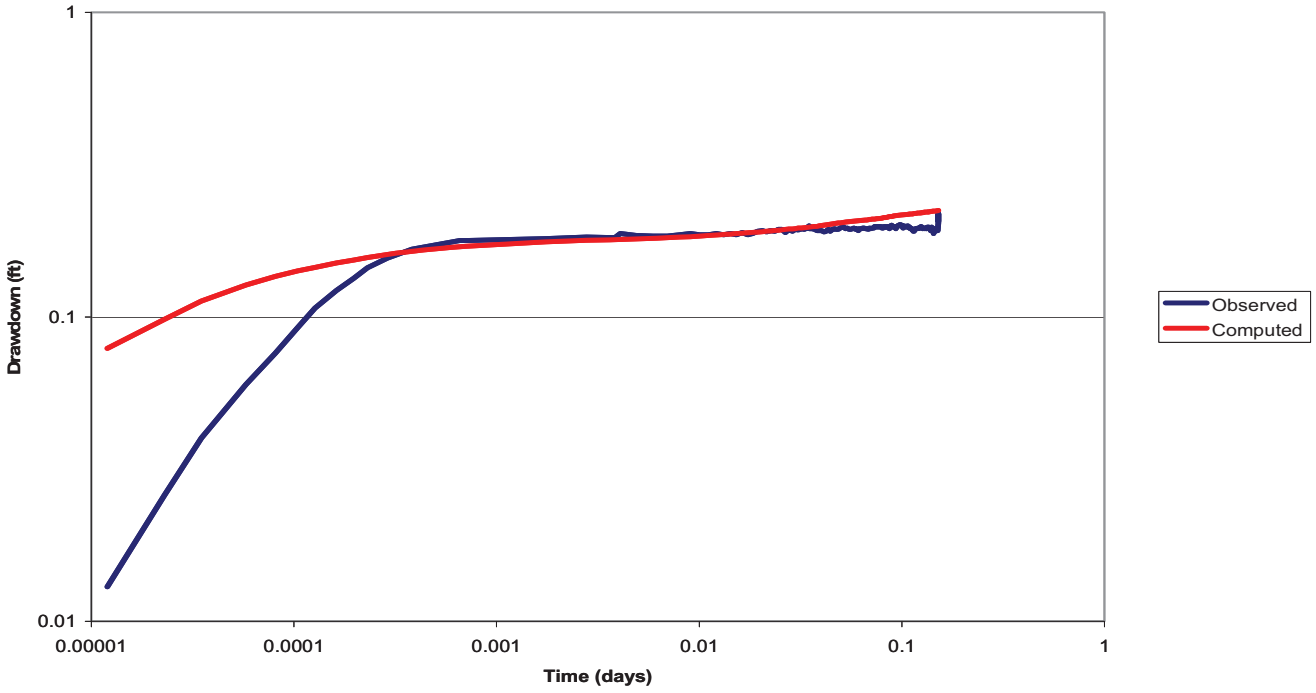
THE pebble PARTNERSHIP

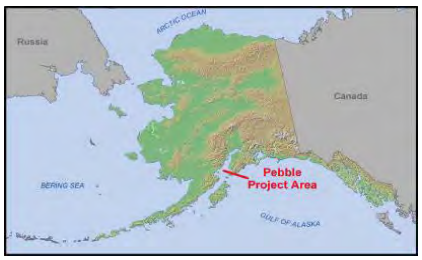
Groundwater Model Results

Figure 4.35b
PW3 Pumping Test Observed and Simulated Drawdown: MW-11D (Layer 3)

Project: 7126	Date: Dec 31, 2010
Fig F4.35b Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.35b PW3 Pumping Test Observed and Simulated Drawdown MW-11D (Layer 3).xls





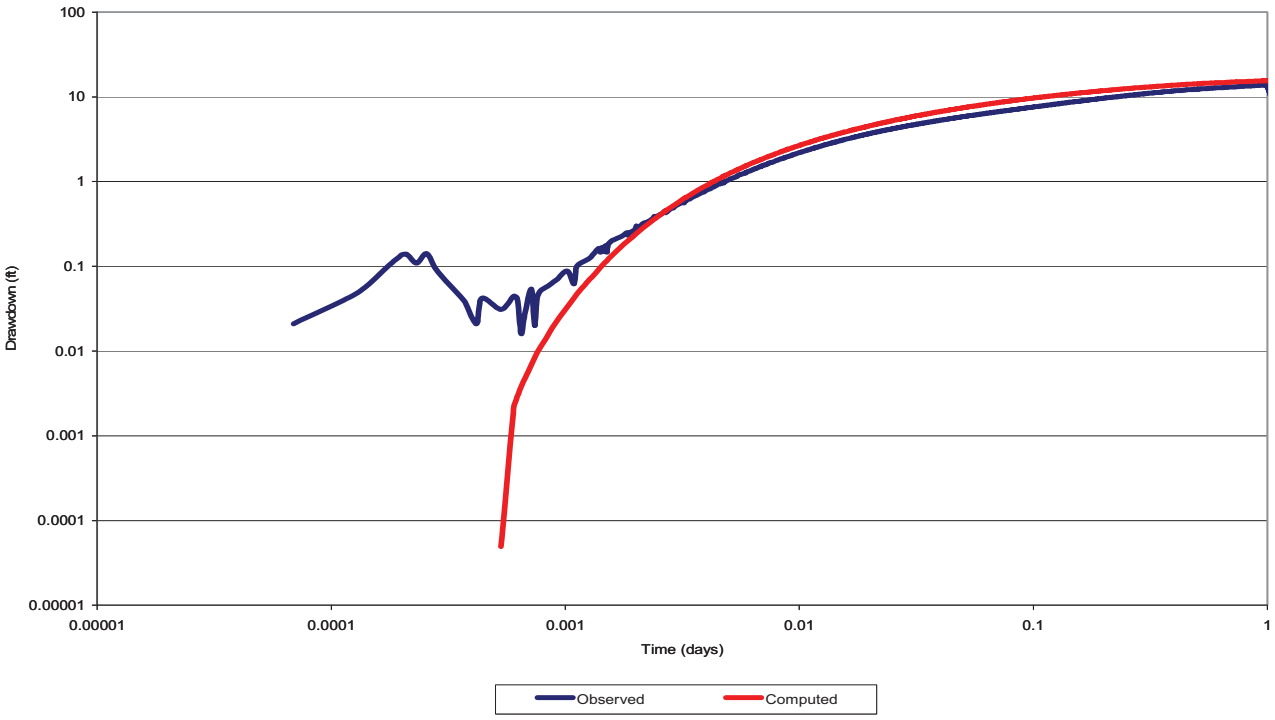
THE pebble PARTNERSHIP

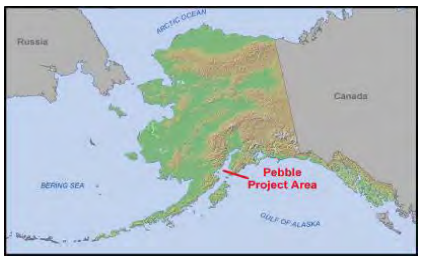
Groundwater Model Results

Figure 4.36
PW4 Pumping Test Observed and Simulated Drawdown: MW-1M (Layer 2)

Project: 7126	Date: Dec 31, 2010
Fig F4.36 Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.36 PW4 Pumping Test Observed and Simulated Drawdown MW-1M (Layer 2).xls





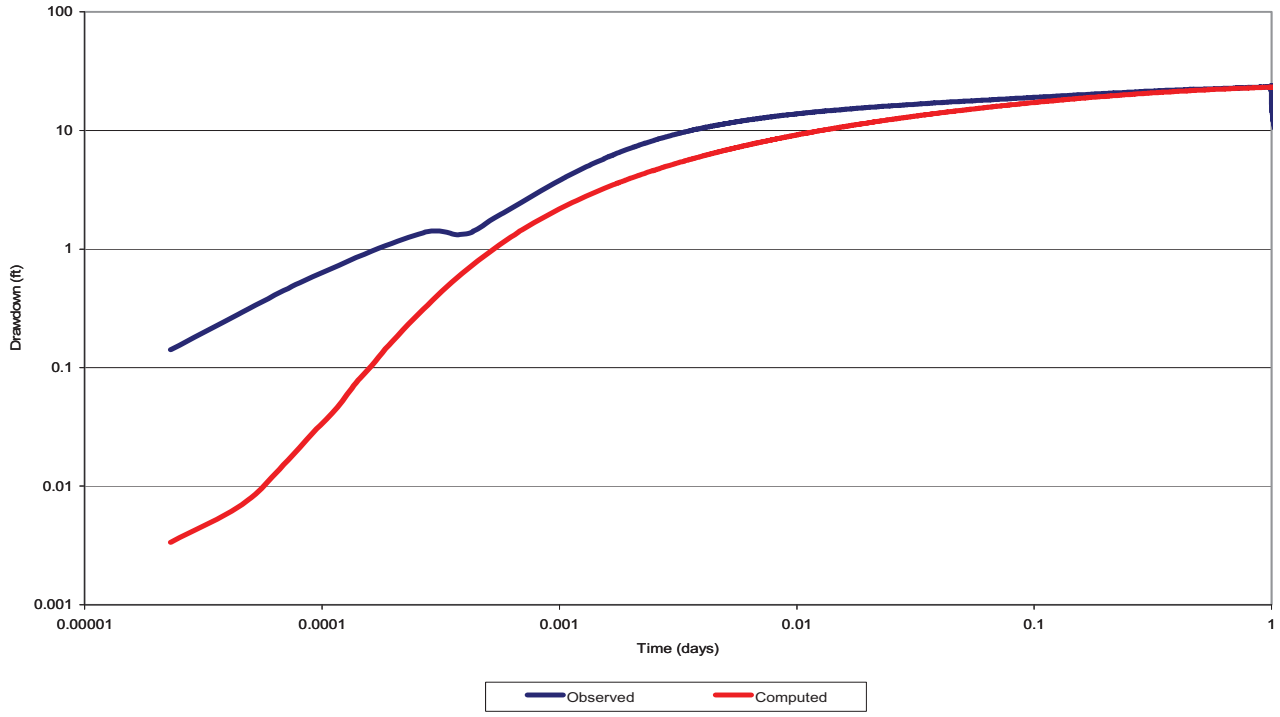
THE pebble PARTNERSHIP

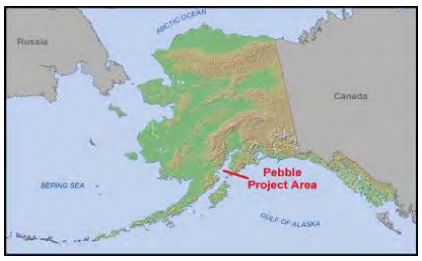
Groundwater Model Results

Figure 4.37a
PW8 Pumping Test Observed and Simulated Drawdown: P-05-29D (Layer 4)

Project: 7126	Date: Dec 31, 2010
Fig F4.37a Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.37a PW8 Pumping Test Observed and Simulated Drawdown P-05-29D (Layer 4).xls





THE pebble PARTNERSHIP

Groundwater Model Results

Figure 4.37b
PW8 Pumping Test Observed and Simulated Drawdown: P-05-29D2 (Layer 4)

Project: 7126	Date: Dec 31, 2010
Fig F4.37b Version: 1	Author: SWS-BL

Z:\Pebble_7-075\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F4.37b PW8 Pumping Test Observed and Simulated Drawdown P-05-29D2 (Layer 4).xls

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

16 17 18 19 20 21 22 23

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Lake Iliamna

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

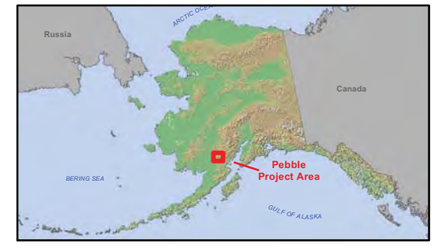
Figure 5.1
Flow Calibration Zones

Legend

- Sub-catchements *(10 = ID number)*
- Expanded Groundwater Model Domain
- General Deposit Location
- Lakes

Watershed

- South Fork Koktuli
- North Fork Koktuli
- Upper Talarik



Feet
0 15,000 30,000 45,000 60,000

Meters
0 5,000 10,000 15,000 20,000

Scale 1:284,886

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.1 Version: 1	Author: WMC-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3949\Figure F5.1 - Flow Caliobration Zones.mxd

1,350,000 1,400,000 1,450,000

2,200,000

2,150,000

2,100,000

N

18 13 9 16 15 14 12 10 3 2 1 5 8 7 4 23 22 21 11 20 19

GH04-01 MW-8S GH04-02 P-05-09S P-05-30S P-05-31S P-05-36S P-06-40S MW-05-12S P-3 P-6S P-05-29S P-05-29M MW-7S KP-P3S P-4AS MW-5S P-05-28S GH04-06 GH04-47 P-05-21S P-05-20S P-05-26S P-05-14S MW-05-11SS GH04-17 P-05-15S P-05-24S P-05-27S P-05-10S P-05-27M MW-05-13S P-05-18 P-05-11S P-05-19S MW-1S P-05-19M P-05-17S GH04-05 P-05-16SS MW-05-2SR P-05-16S MW-2S MW-05-02M

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

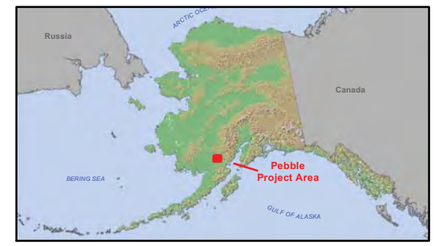
Figure 5.2
Head Calibration Target Locations - Layer 1

Legend

- Layer 1 Target
- Sub-catchments *(10 = ID Number)*
- General Deposit Location
- Lakes

Watershed

- South Fork Koktuli
- North Fork Koktuli
- Upper Talarik



Feet
0 6,300 12,600 18,900 25,200 31,500

Meters
0 2,000 4,000 6,000 8,000 10,000

Scale 1:154,613

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.2 Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3950\Figure F5.2 - Flow Calibration Target Locations - Layer 1.mxd

1,350,000 1,400,000 1,450,000

2,200,000 2,150,000 2,100,000

N

18 13 16 15 14 12 9 1 2 3 5 8 4 7 10 11 20 19 23 22 21

MW-8M
GH04-23
P-05-09D
P-06-37S
P-06-39S
SRK-2A
PQ-9
P-4
KP-P4
P-05-07S
P-6M
GH04-08
MW-5M
GH04-48
MW-3D
P-05-26D
GH04-30
P-05-14D
P-05-13
GH04-33
P-05-12
P-05-15D
MW-11M
GH04-16
GH04-35
MW-11S
MW-1M
P-05-11M
P-05-27D
MW-2D
GH04-38
P-05-16D
P-05-16M
P-05-17D

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

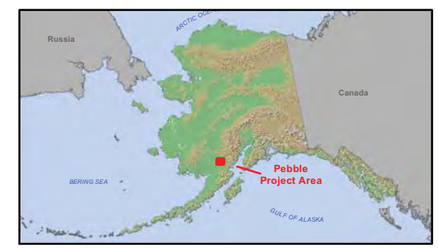
Figure 5.3
Head Calibration Target Locations - Layer 2

Legend

- Layer 2 Target
- Sub-catchments *(10 = ID Number)*
- General Deposit Location
- Lakes

Watershed

- South Fork Koktuli
- North Fork Koktul
- Upper Talarik



Feet
0 5,250 10,500 15,750 21,000 26,250 31,500

Meters
0 2,000 4,000 6,000 8,000 10,000

Scale 1:154,613

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.3 Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3951\Figure F5-3 - Flow Calibration Target Locations - Layer 2.mxd

1,350,000 1,400,000 1,450,000

2,200,000 2,150,000 2,100,000

N

18 13 16 15 14 12 9 10 3 2 1 5 8 7 4 23 22 21 11 20 19

MW-8D
MW-6D
SRK-2
P-05-35
P-06-41S
P-05-33D
KP-P1
I-201
GH05-58
P-4AD
P-6D
P-05-36M
P-05-28D
GH05-64
KP-P3M
MW-9D
GH05-61
P-05-21D
P-05-21M
P-05-20D
P-05-22D
GH04-45A
GH04-22
GH04-19
GH04-31
MW-05-14S
P-05-24D
GH04-18
MW-11D
P-05-10D
P-05-11D
GH04-14
GH04-37

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

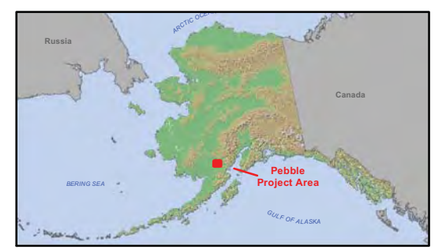
Figure 5.4
Head Calibration Target Locations - Layer 3

Legend

- Layer 3 Target
- Sub-catchments *(10 = ID Number)*
- General Deposit Location
- Lakes

Watershed

- South Fork Koktuli
- North Fork Koktuli
- Upper Talarik



Feet
0 5,500 11,000 16,500 22,000 27,500 33,000

Meters
0 2,000 4,000 6,000 8,000 10,000

Scale 1:154,613

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.4 Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3952\Figure F5-4 - Flow Calibration Target Locations - Layer 3.mxd

1,350,000 1,400,000 1,450,000

2,200,000 2,150,000 2,100,000

N

18 13 16 15 14 9 2 1 3 10 2 5 8 4 7 23 22 11 20 19 21

P-06-38M
P-05-30D
PQ-4
M-62
P-06-37M
M-21
M-110
P-05-31D
MW-10
M-12
PQ-8
P-05-34D
MW-05-12D
I-172
P-06-39D
P-06-41M
GH04-25
GH05-57
P-05-32D
P-05-08
SRK-3
GH04-27
I-125
P-05-36D
P-05-07D
P-2M
P-05-29D
MW-7D
GH05-59
KP-P3D
P-05-29D2
MW-5D
P-2D
GH05-63
GH05-53
GH04-46
GH04-43
GH04-28
GH04-20
MW-05-14D
P-05-25
P-05-23
MW-05-13D
MW-1D
GH04-12A

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

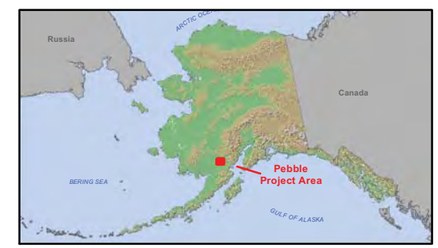
Figure 5.5
Head Calibration Target Locations - Layer 4

Legend

- Layer 4 Target
- Sub-catchments *(10 = ID Number)*
- General Deposit Location
- Lakes

Watershed

- South Fork Koktuli
- North Fork Koktul
- Upper Talarik



Feet
0 7,800 15,600 23,400 31,200 39,000

Meters
0 2,000 4,000 6,000 8,000 10,000

Scale 1:154,613

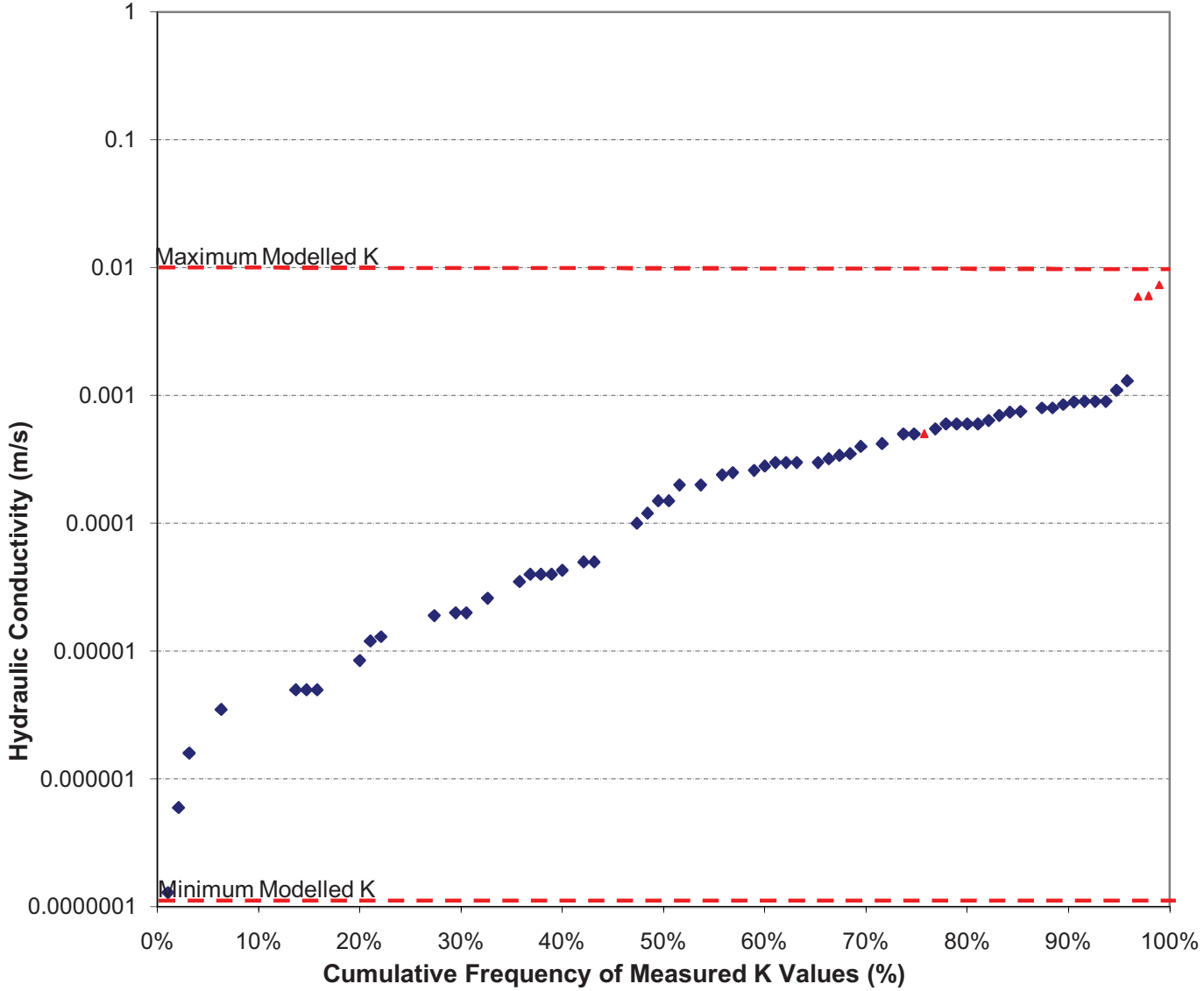
Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.5 Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3953\Figure F5-5 - Flow Calibration Target Locations - Layer 4.mxd

Cumulative Frequency of Hydraulic Conductivity (K)

Pebble Project Pumping and Response Test Results 2004-2007



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.6
Hydraulic Conductivity Frequency Plots
(Layers 1 through 3)
Overburden

Legend

◆ Overburden - Response

▲ Overburden - Pumping

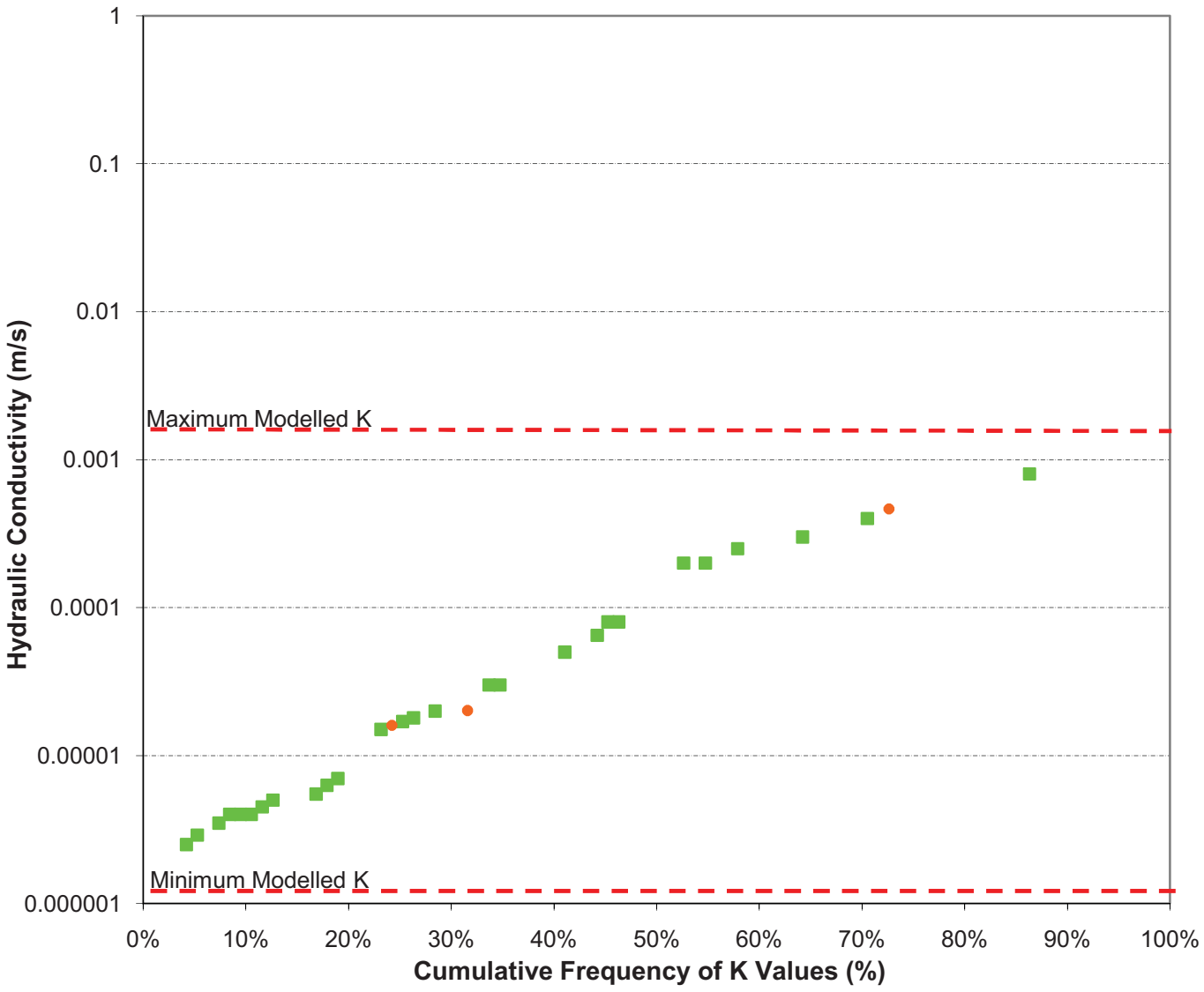


Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\13954\Figure F5.10a Cumulative Frequency of Calculated Hydraulic Conductivity - Overburden.xls

Cumulative Frequency of Hydraulic Conductivity

Pebble Project Pumping and Response Test Results 2004-2007



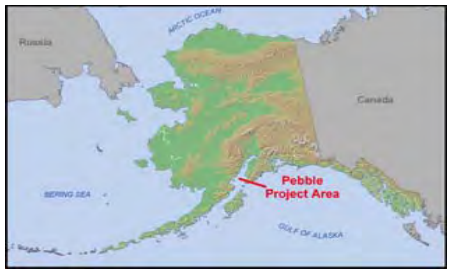
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.7
Hydraulic Conductivity Frequency Plots (Layer 4)
Bedrock

Legend

- Bedrock - Response
- Bedrock - Pumping



Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\13955\Figure F5.10b Cumulative Frequency of Calculated Hydraulic Conductivity - Bedrock.xls

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

N

Lake Iliamna

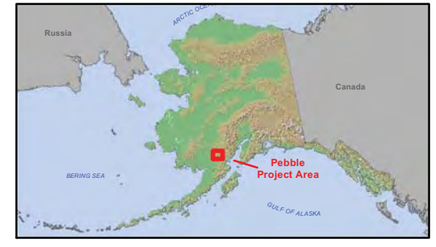
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.8a
Simulated Groundwater Elevations
March, 2007 (Layer 1)

Legend

- Simulated Watertable Elevation - 25 ft Contour Interval
- General Deposit Location
- Expanded Groundwater Model Domain
- Lakes
- Rivers



0 15,000 30,000 45,000 60,000 Feet

0 5,250 10,500 15,750 21,000 Meters

Scale 1:285,796

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.11a Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3957\Figure F5-8a - Simulated Groundwater Elevations, March 2007 (Layer 1).mxd

1,350,000 1,400,000 1,450,000

2,200,000 2,150,000 2,100,000

N

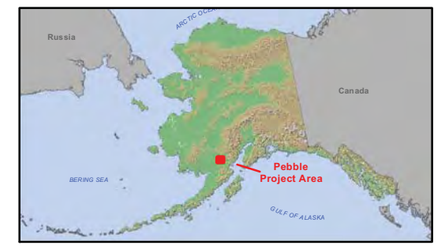
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.8b
Simulated Groundwater Elevations
Mine Study Area
March, 2007 (Layer 1)

Legend

- Simulated Watertable Elevation - 25 ft Contour Interval
- Mine Study Area
- Expanded Groundwater Model Domain
- Lakes
- Rivers
- 50-ft Contour Interval



0 7,900 15,800 23,700 31,600 Feet

0 1,600 3,200 4,800 6,400 8,000 Meters

Scale 1:164,754

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.11b Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3958\Figure F5-8b - Simulated Groundwater Elevations, March 2007 (Layer 1 - Study Area).mxd

1,300,000 1,350,000 1,400,000 1,450,000 1,500,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000

Lake Iliamna

N

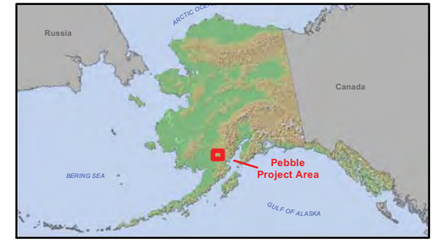
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.8c
Simulated Groundwater Elevations
September, 2007 (Layer 1)

Legend

- Simulated Watertable Elevation - 25 ft Contour Interval
- General Deposit Location
- Expanded Groundwater Model Domain
- Lakes
- Rivers



0 15,000 30,000 45,000 60,000 Feet

0 5,250 10,500 15,750 21,000 Meters

Scale 1:285,796

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.11 Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T3959\Figure F5.8c - Simulated Groundwater Elevations, September 2007 (Layer 1).mxd

1,350,000 1,400,000 1,450,000

2,200,000 2,150,000 2,100,000

N

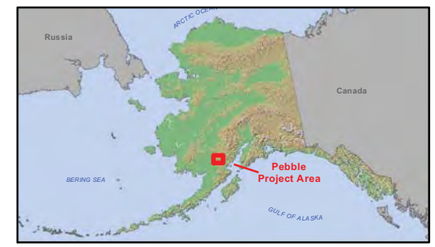
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.8d
Simulated Groundwater Elevations
Mine Study Area
September, 2007 (Layer 1)

Legend

- Simulated Watertable Elevation - 25 ft Contour Interval
- Mine Study Area
- Expanded Groundwater Model Domain
- Lakes
- Rivers
- 50-ft Contour Interval



0 7,900 15,800 23,700 31,600 Feet

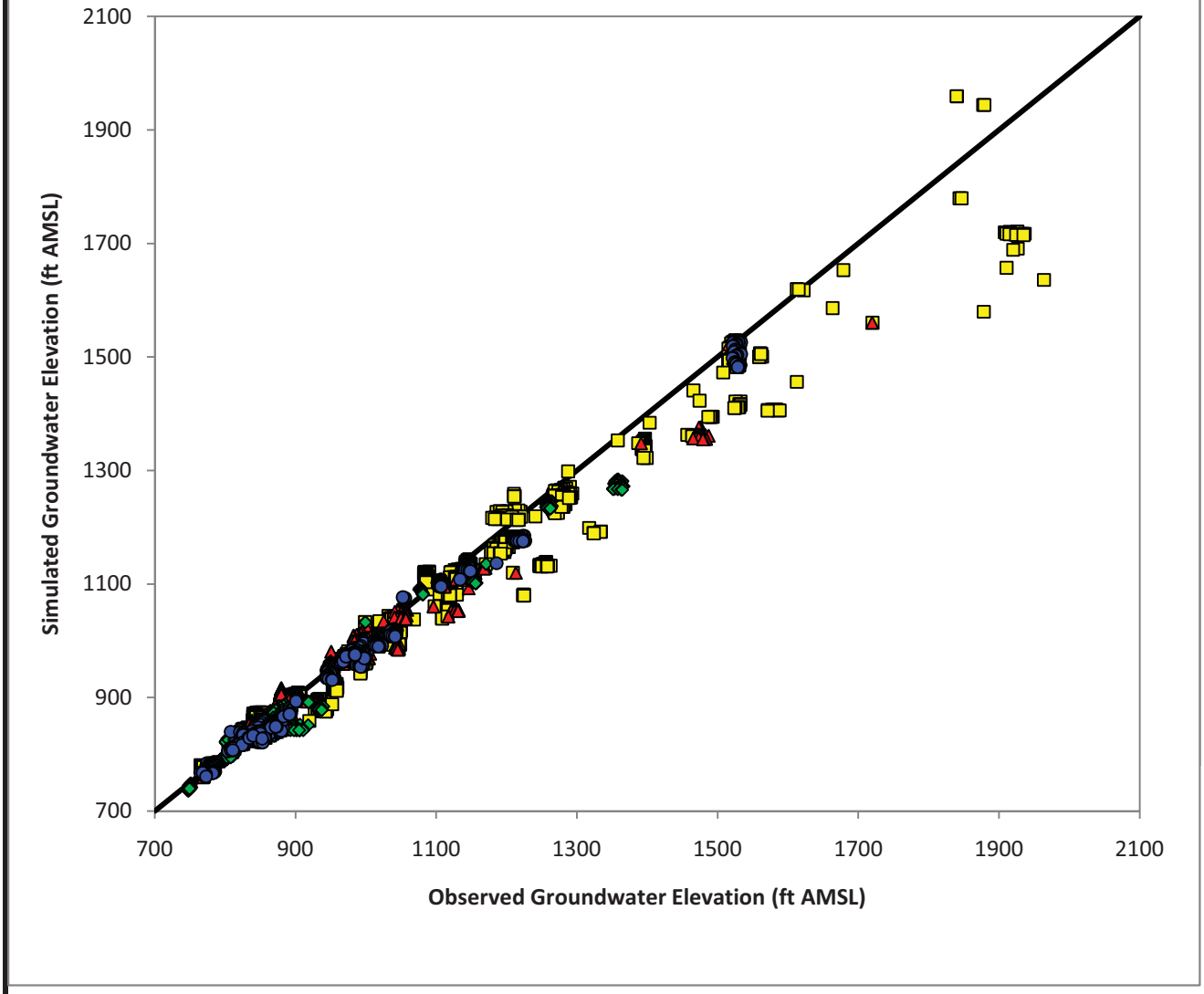
0 1,600 3,200 4,800 6,400 8,000 Meters

Scale 1:164,754

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Fig. F5.11c Version: 1	Author: SWS-BL

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F5.11c Simulated Groundwater Elevations, September, 2007 (Layer 1 - Study Area).mxd





Legend

- Simulated = Observed
- Layer 4
- Layer 3
- Layer 2
- Layer 1

AMSL = Above Mean Sea Level

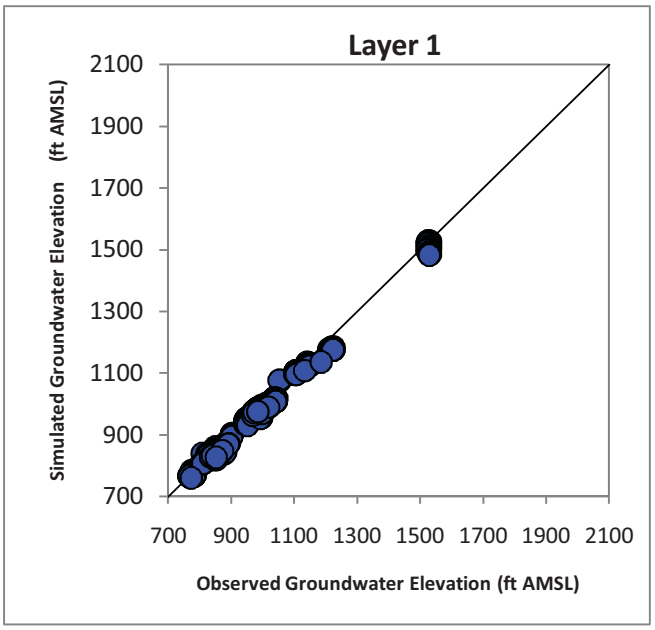
THE pebble PARTNERSHIP

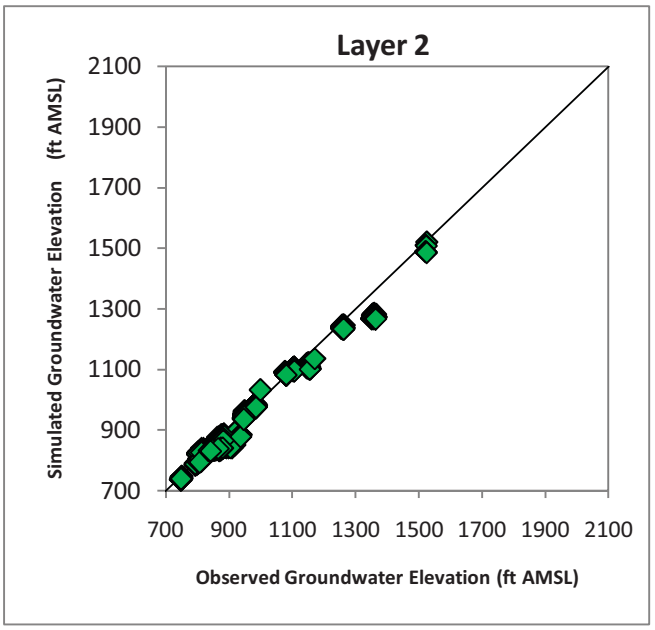
Appendix 8.1J
Groundwater Model Results

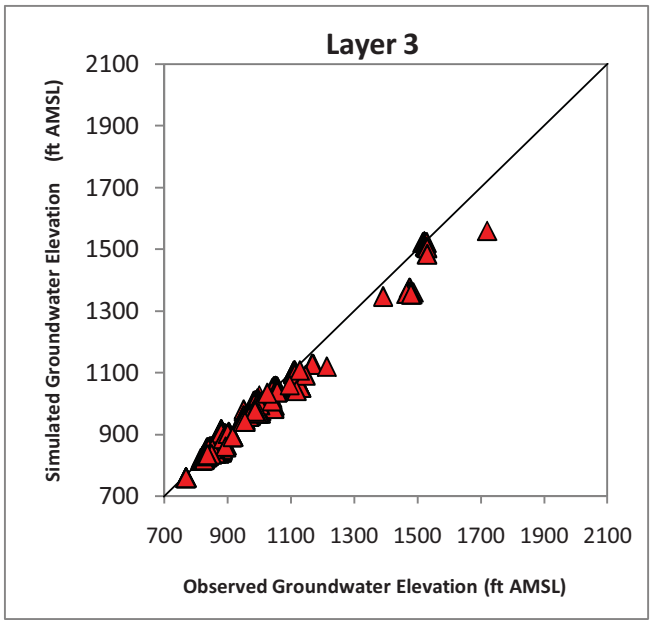
Figure 5.9a
Head Residuals vs. Observed Scatter Plot - All Layers, All Times

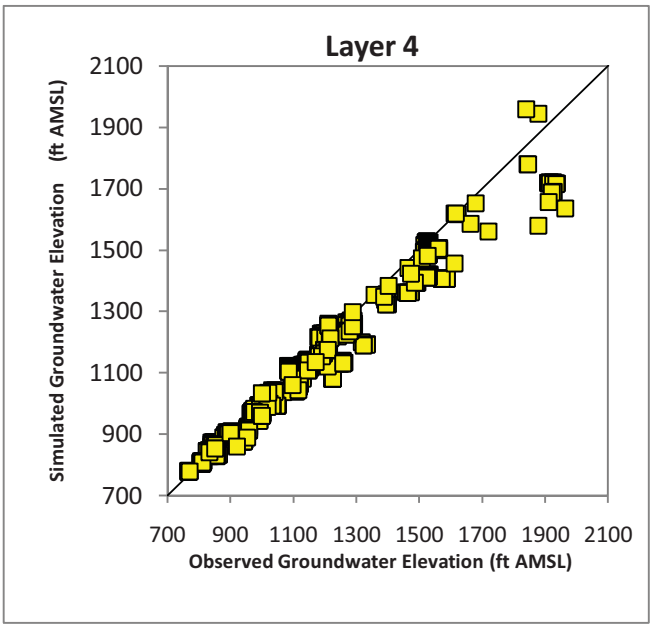
Project: 7126	Date: April 2011
Fig F5.17 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3961\Figure F5-17 Heads Residuals vs Observed Scatter Plot - All .xls











Legend

- Simulated = Observed
- Layer 4
- Layer 3
- Layer 2
- Layer 1

AMSL = Above Mean Sea Level

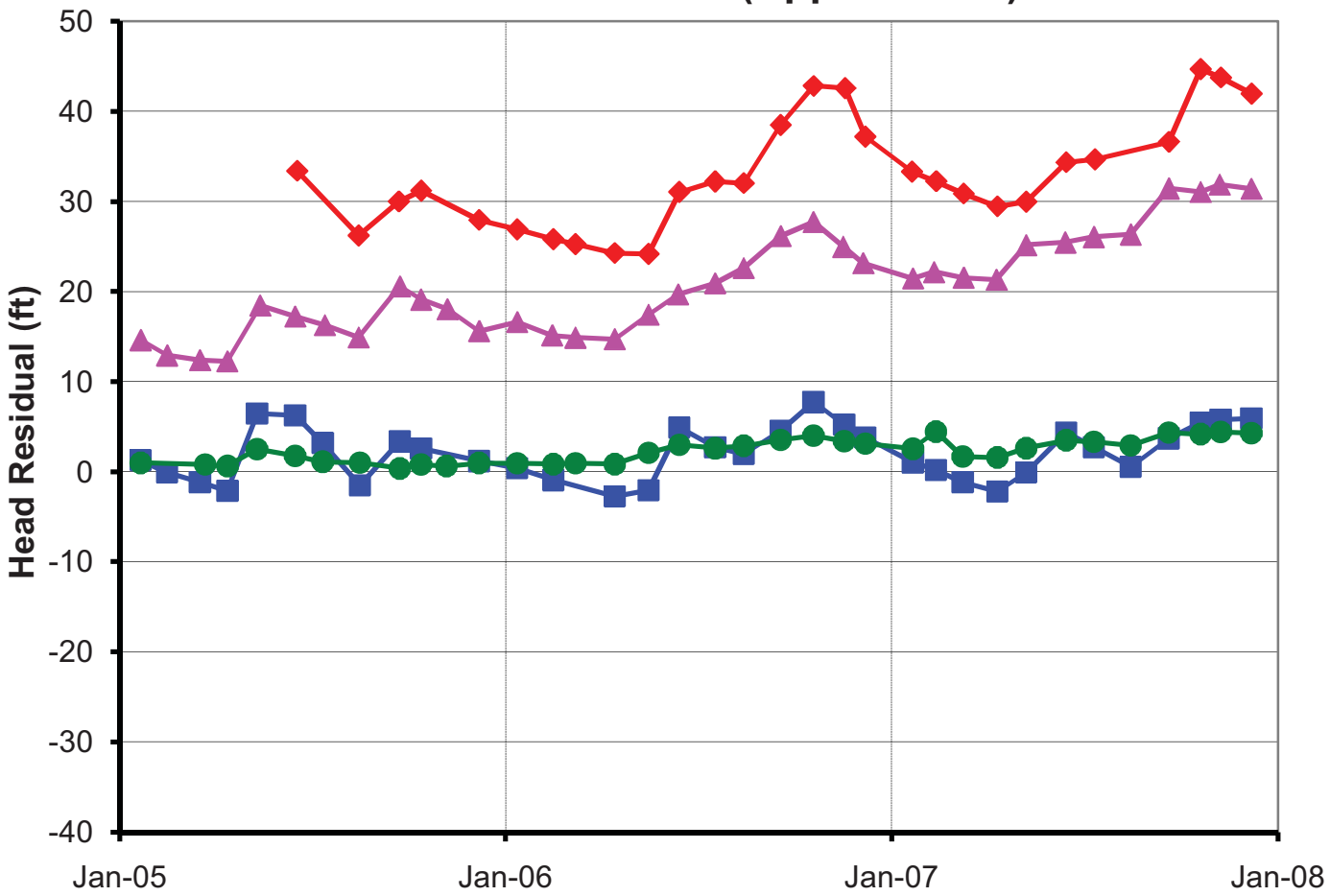
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.9b
Modeled vs. Observed Head
Scatter Plot - Layers 1-4

Project: 7126	Date: April, 2011
Fig F5.18 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3962\Figure F5-18 Heads Residuals vs Observed Scatter Plot - Laye.xls



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.10a
Head Residuals vs. Time - Upper South Fork Koktuli (MW-5D, MW-5M, P-05-07D, SRK-5M)

Legend

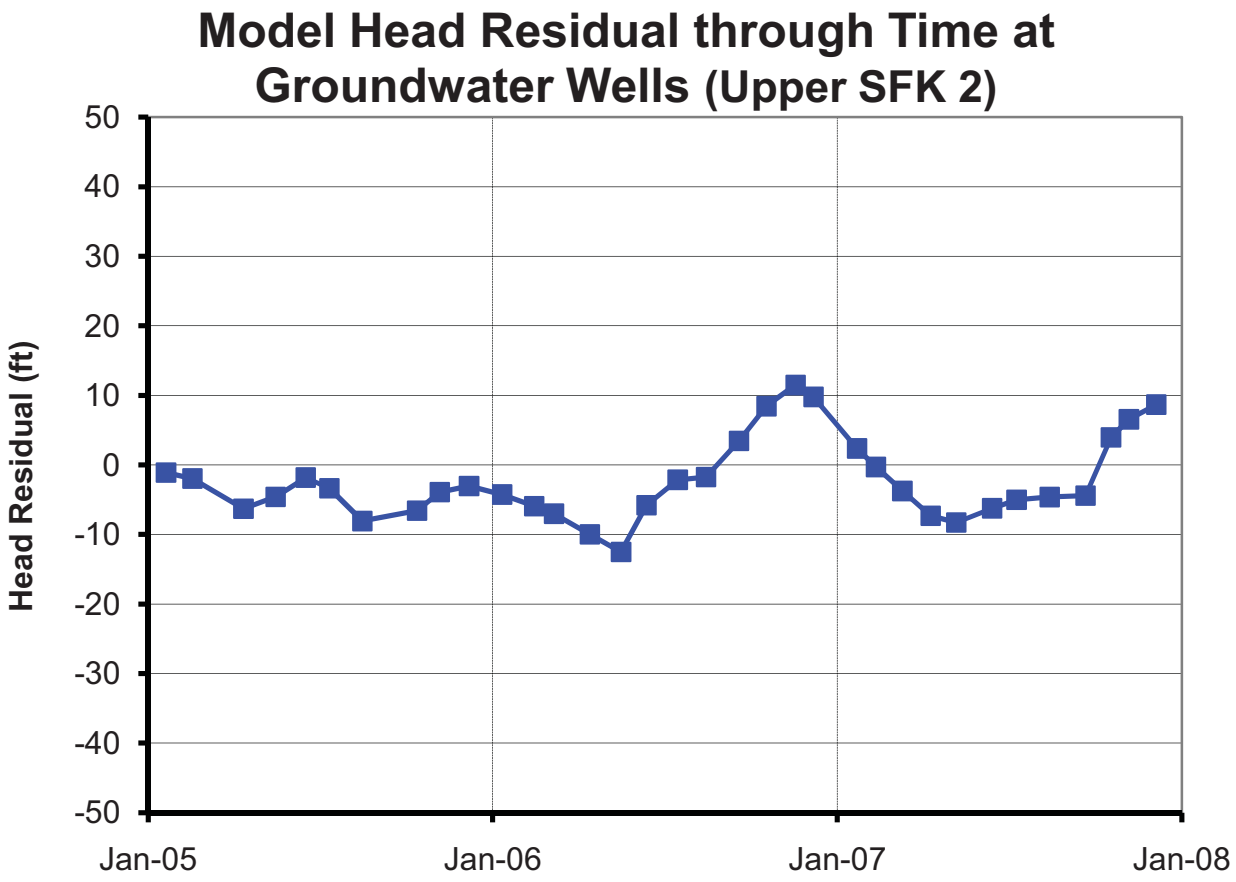
Monitoring Well or Piezometer

- MW-5D
- MW-5M
- P-05-07D
- SRK-5M



Project No: 7126	Date: April 2011
Fig F5.62a Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3963\Figure F5.62a - Head Residual vs Time - Upper SFK1.xls



THE pebble PARTNERSHIP

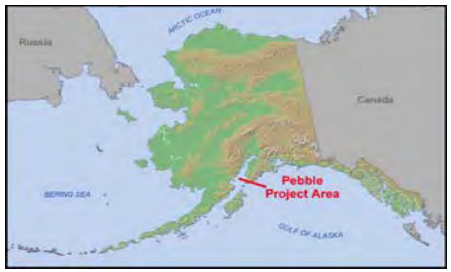
Appendix 8.1J
Groundwater Model Results

Figure 5.10b
Head Residuals vs. Time -
Upper South Fork Koktuli
(MW-3)

Legend

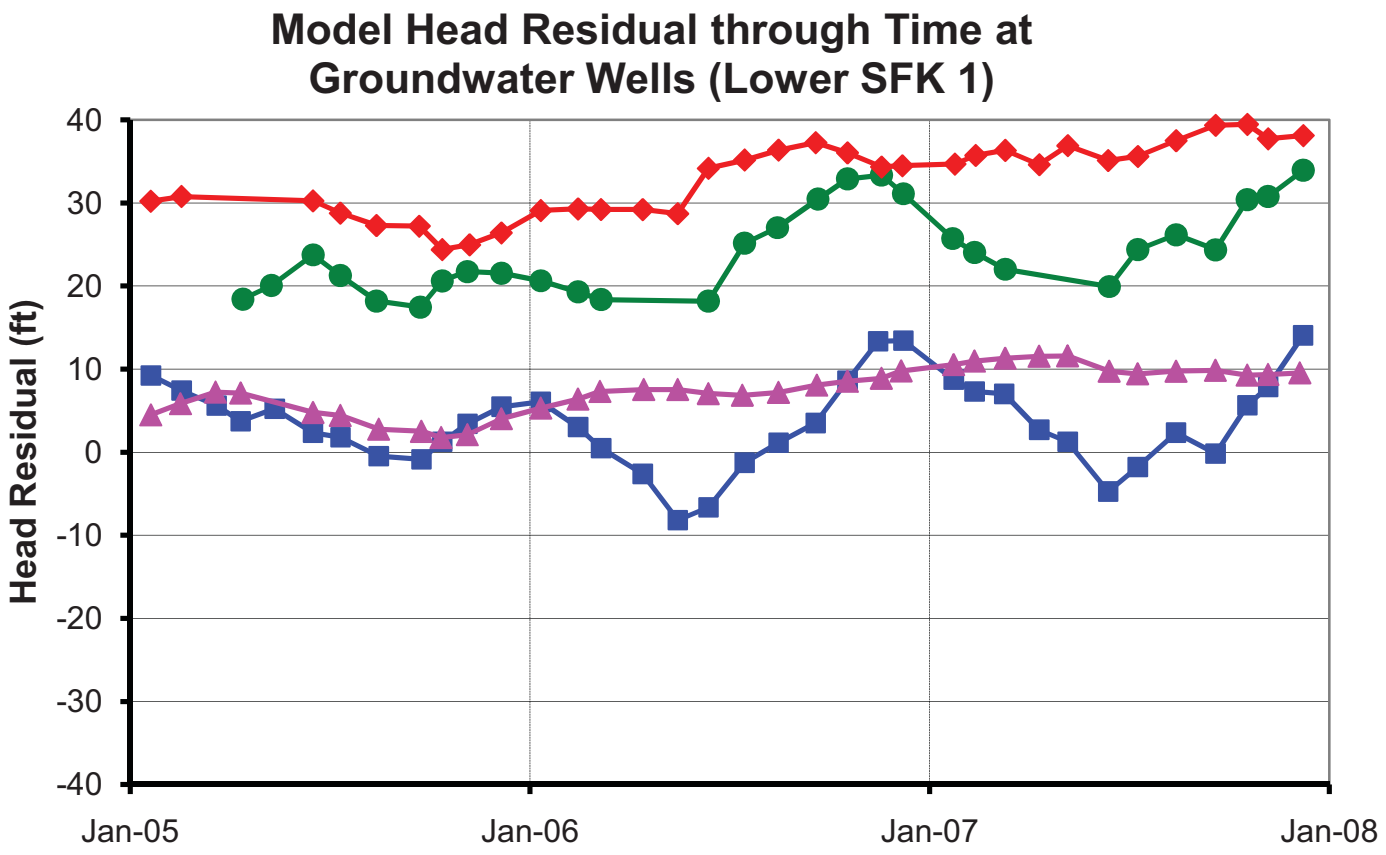
Monitoring Well or Piezometer

MW-3



Project No: 7126	Date: April 2011
Fig F5.62b Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3964\Figure F5.62b - Head Residual vs Time - Upper SFK2.xls



THE pebble PARTNERSHIP

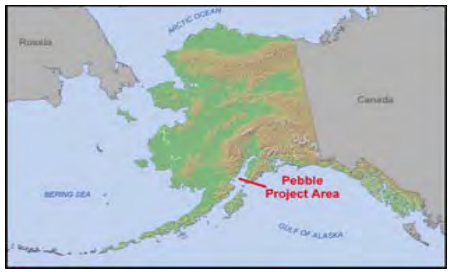
Appendix 8.1J
Groundwater Model Results

Figure 5.10c
Head Residuals vs. Time - Lower South Fork Koktuli (MW-11D, GH04-30, GH04-33, MW-2D)

Legend

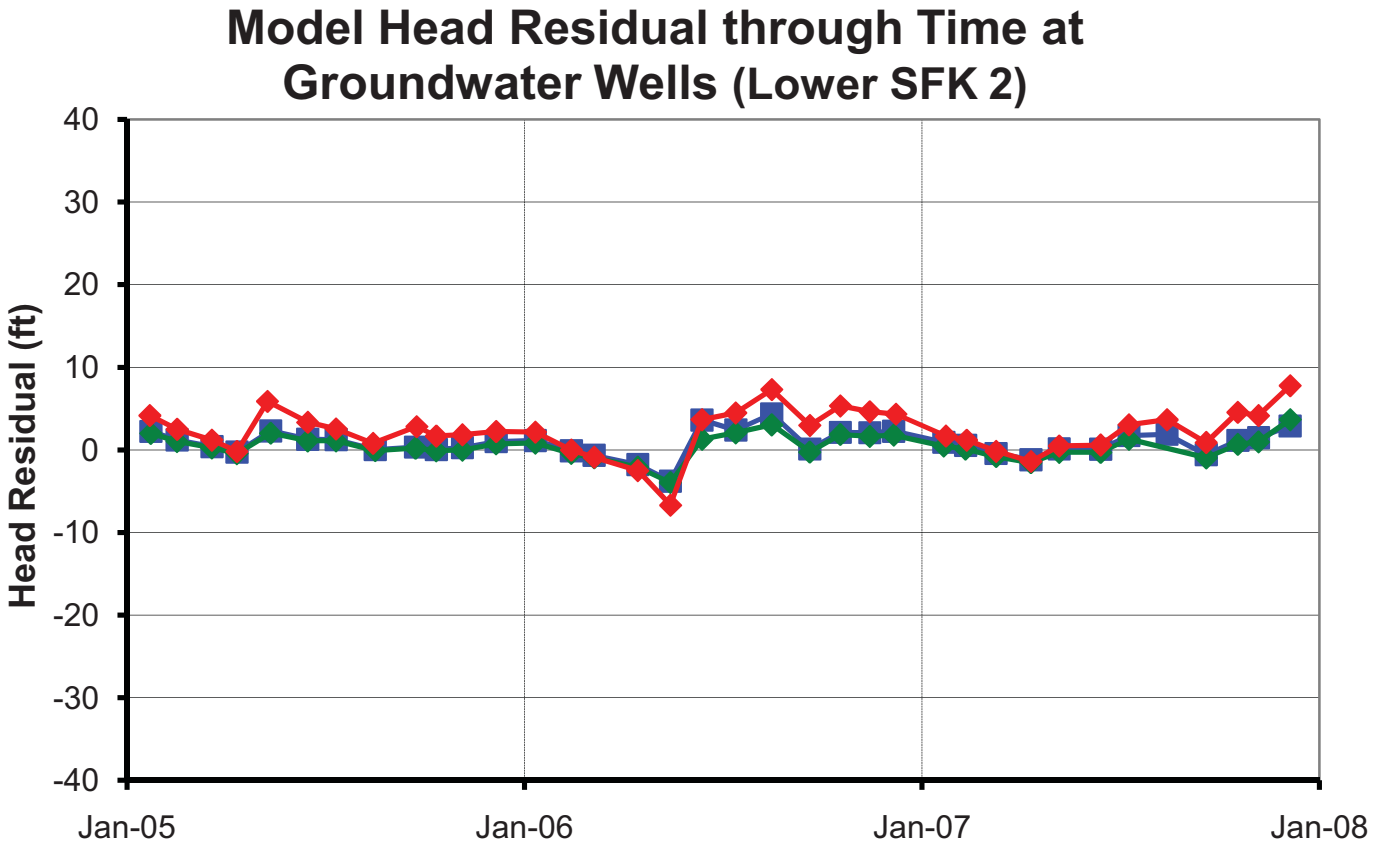
Monitoring Well or Piezometer

- MW-11D
- GH04-30
- GH04-33
- MW-2D



Project No: 7126	Date: April 2011
Fig F5.62c Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\13965\Figure F5.62c - Head Residual vs Time - Lower SFK1.xls



THE pebble PARTNERSHIP

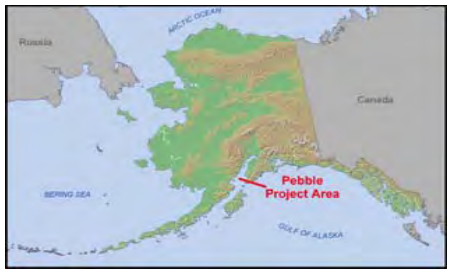
Appendix 8.1J
Groundwater Model Results

Figure 5.10d
Head Residuals vs. Time -
Lower South Fork Koktuli
(MW-1D, MW-1S, GH04-17)

Legend

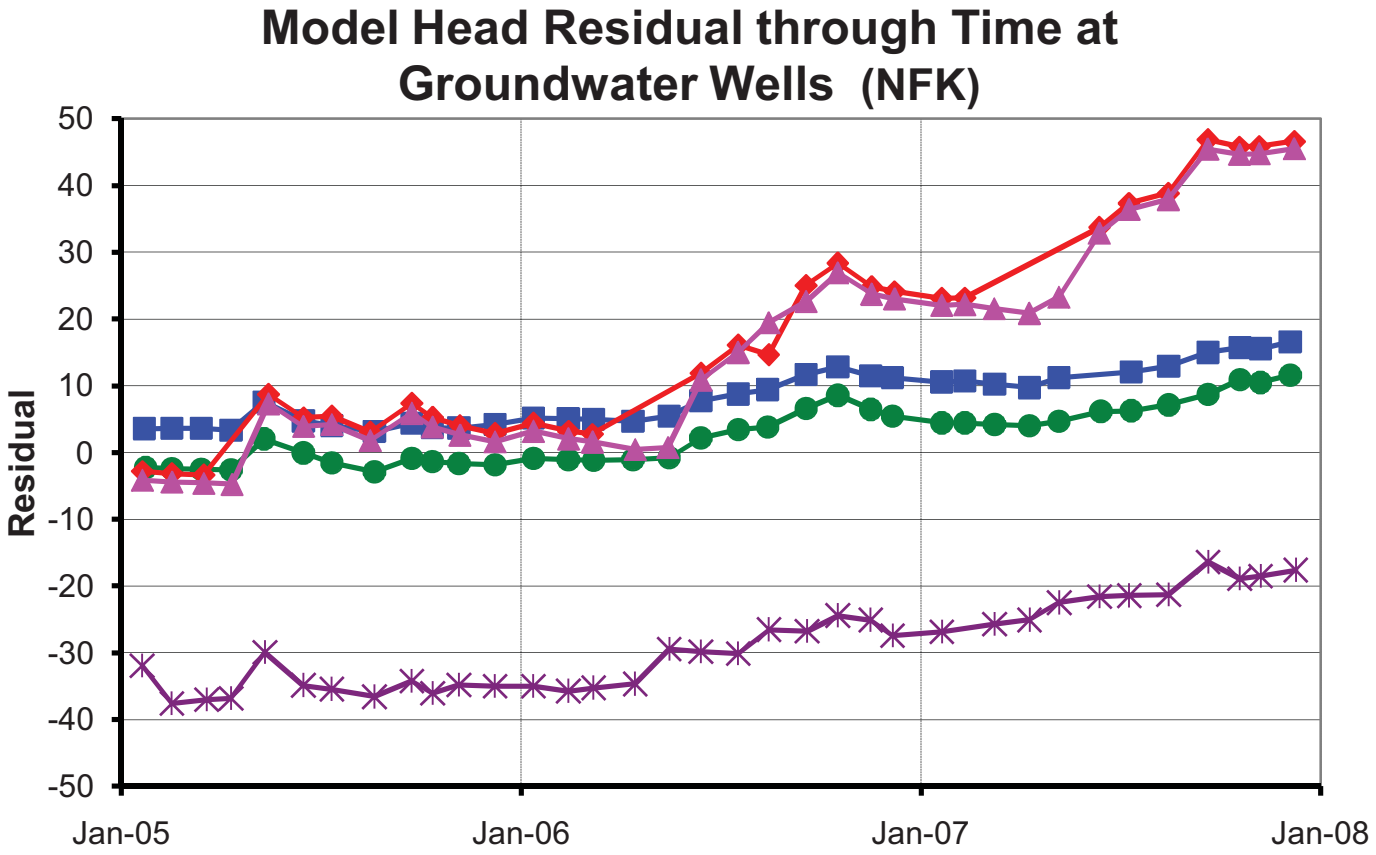
Monitoring Well or Piezometer

- MW-1D
- MW-1S
- GH04-17



Project No: 7126	Date: April 2011
Fig F5.62c Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\13966\Figure F5.62d - Head Residual vs Time - Lower SFK2.xls



THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.10e
Head Residual vs. Time -
North Fork Koktuli
(MW-8D, MW-8M, MW-7S,
MW-7D, MW-10)

Legend

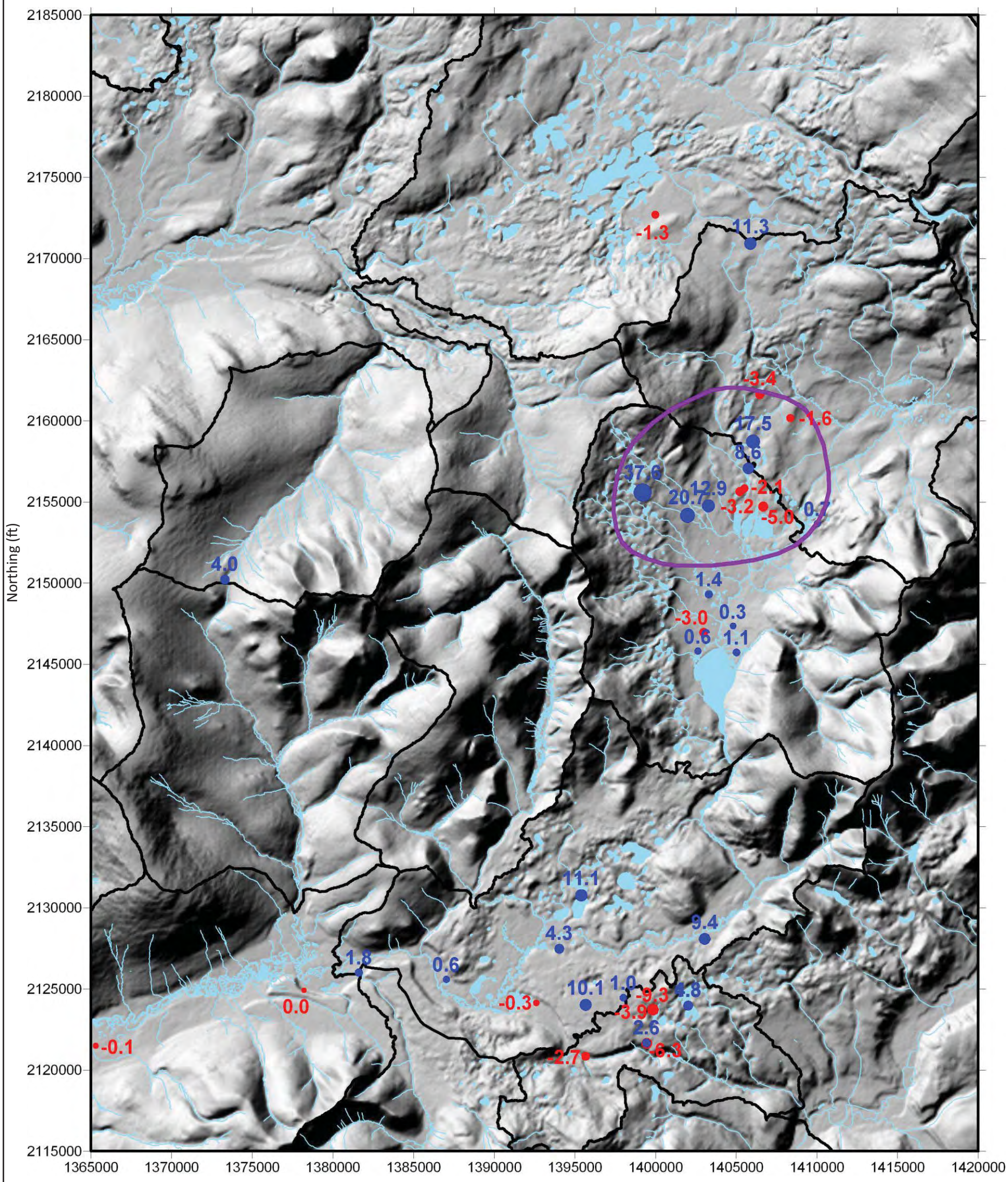
Monitoring Well or Piezometer

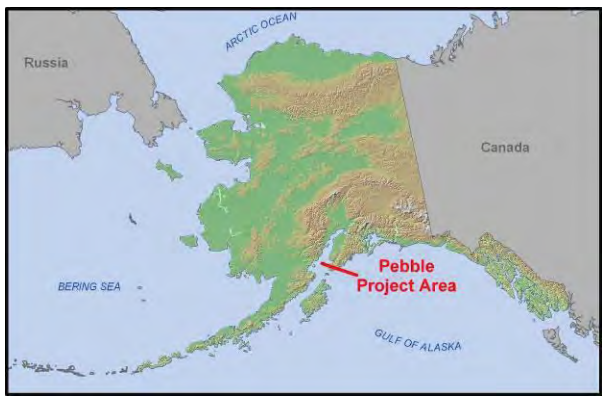
- MW-8D
- MW-8M
- MW-7S
- MW-7D
- MW-10



Project No: 7126	Date: April 2011
Fig F5.62c Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3967\Figure F5.62e - Head Residual vs Time - NFK.xls





Legend

- Modeled Head > Observed Head
- Modeled Head < Observed Head
- Sub-catchment Boundary
- General Deposit Area

Note:
1. Circle diameter proportional to residual
2. Residual unit = ft.

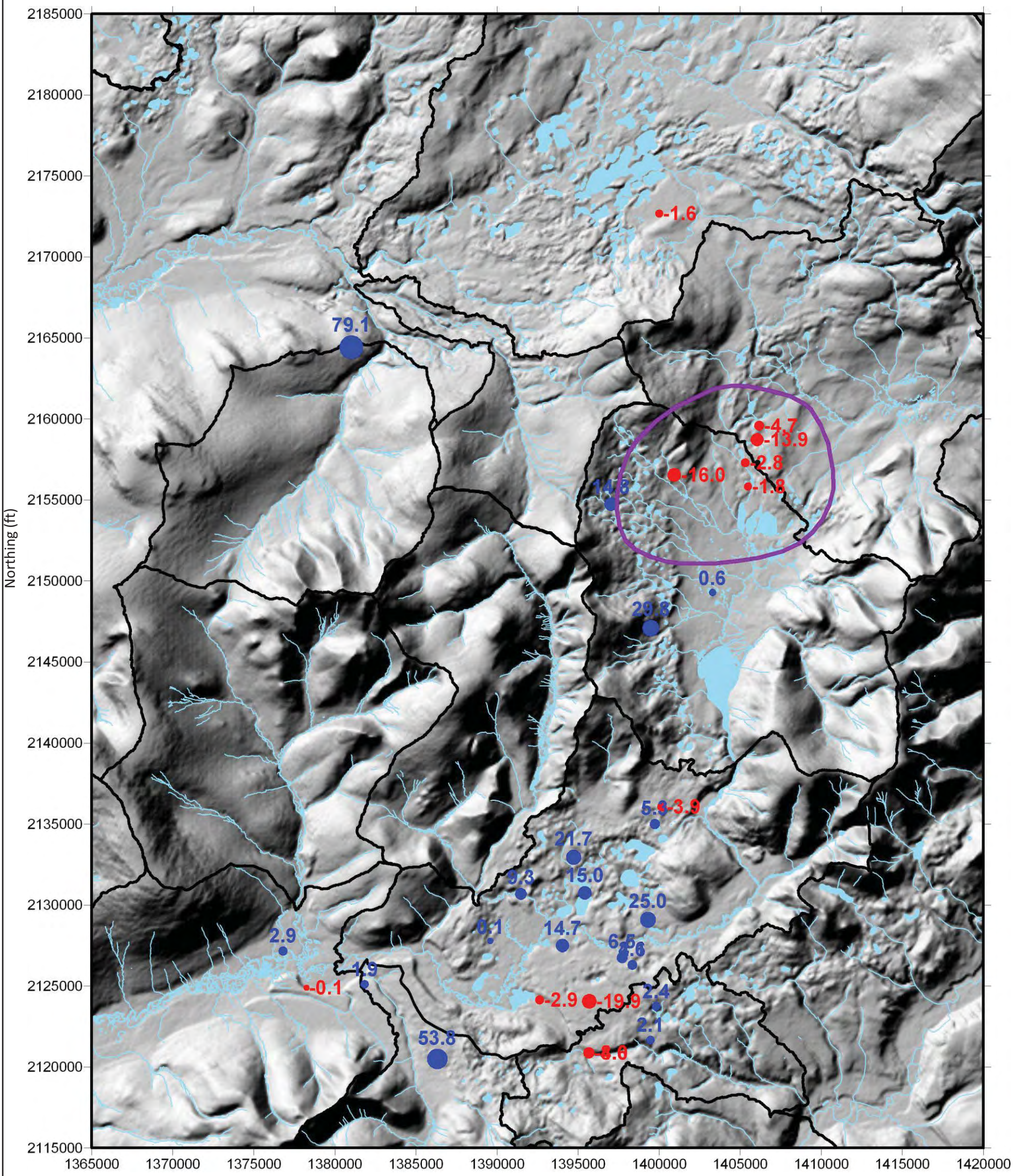
THE pebble PARTNERSHIP

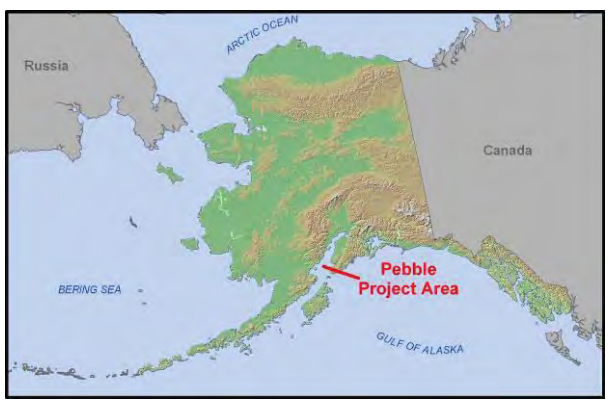
Appendix 8.1J
Groundwater Model Results

Figure 5.11a
Head Residual Bubble Plot - Layer 1
October, 2005

Project: 7126	Date: April, 2011
Fig F5.13 Version: 1	Author: SWS-BL

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F5.13 - Head Residual Bubble Plot - Layer1.xls





Legend

- Modeled Head > Observed Head
- Modeled Head < Observed Head
- Sub-catchment Boundary
- Gerenal Deposit Area

Note:
1. Circle diameter proportional to residual
2. Residual unit = ft.

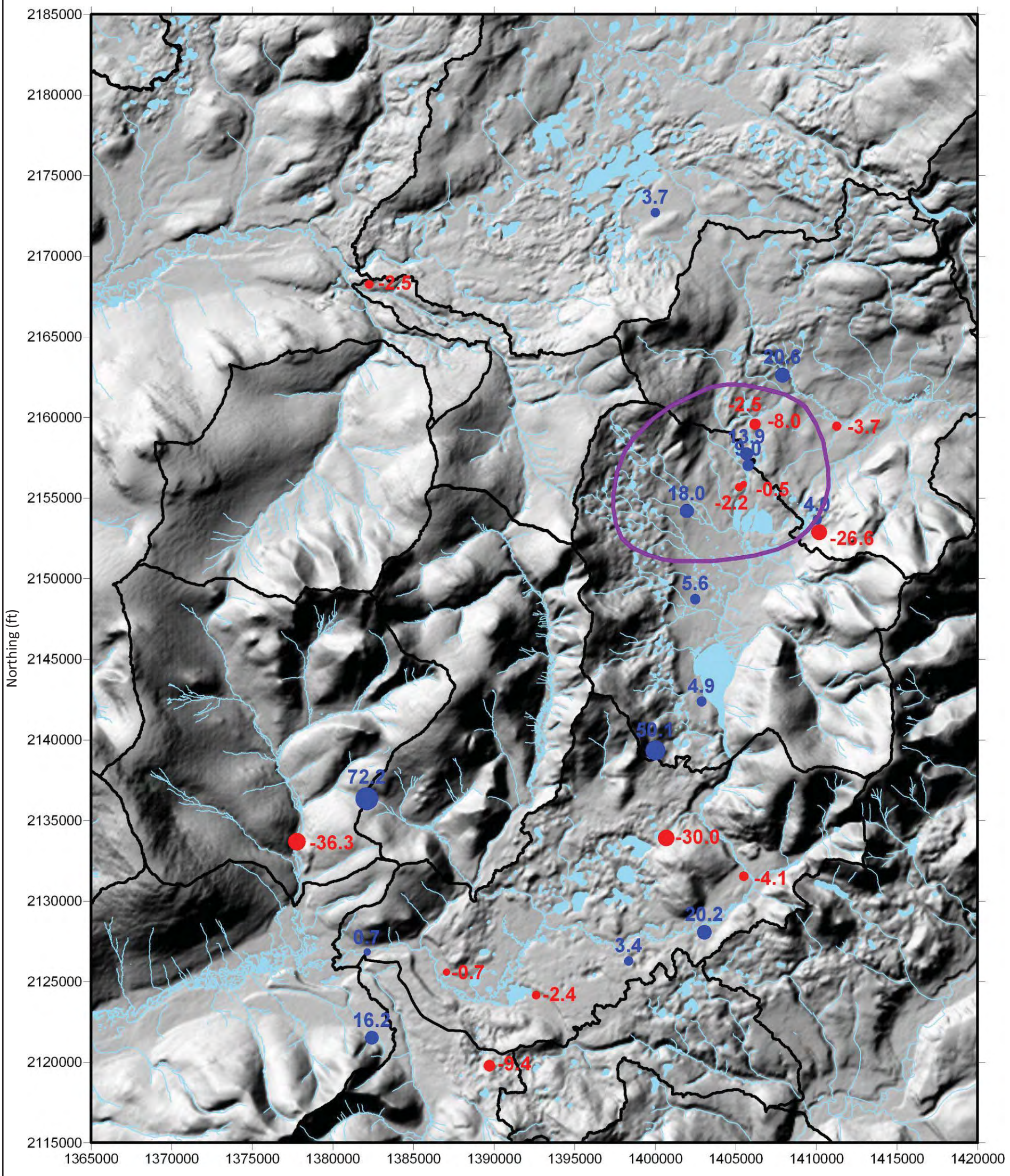
THE pebble PARTNERSHIP

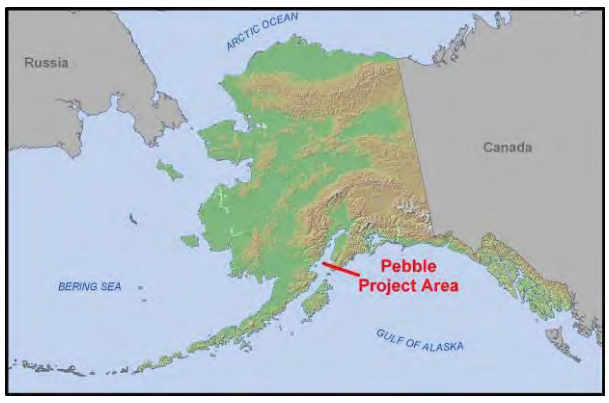
Appendix 8.1J
Groundwater Model Results

Figure 5.11b
Head Residual Bubble Plot - Layer 2
October, 2005

Project: 7126	Date: April, 2011
Fig F5.14 Version: 1	Author: SWS-BL

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F5.14 - Head Residual Bubble Plot - Layer2.xls





Legend

- Modeled Head > Observed Head
- Modeled Head< Observed Head
- Sub-catchment Boundary
- General Deposit Area

Note:
1. Circle diameter proportional to residual
2. Residual unit = ft.

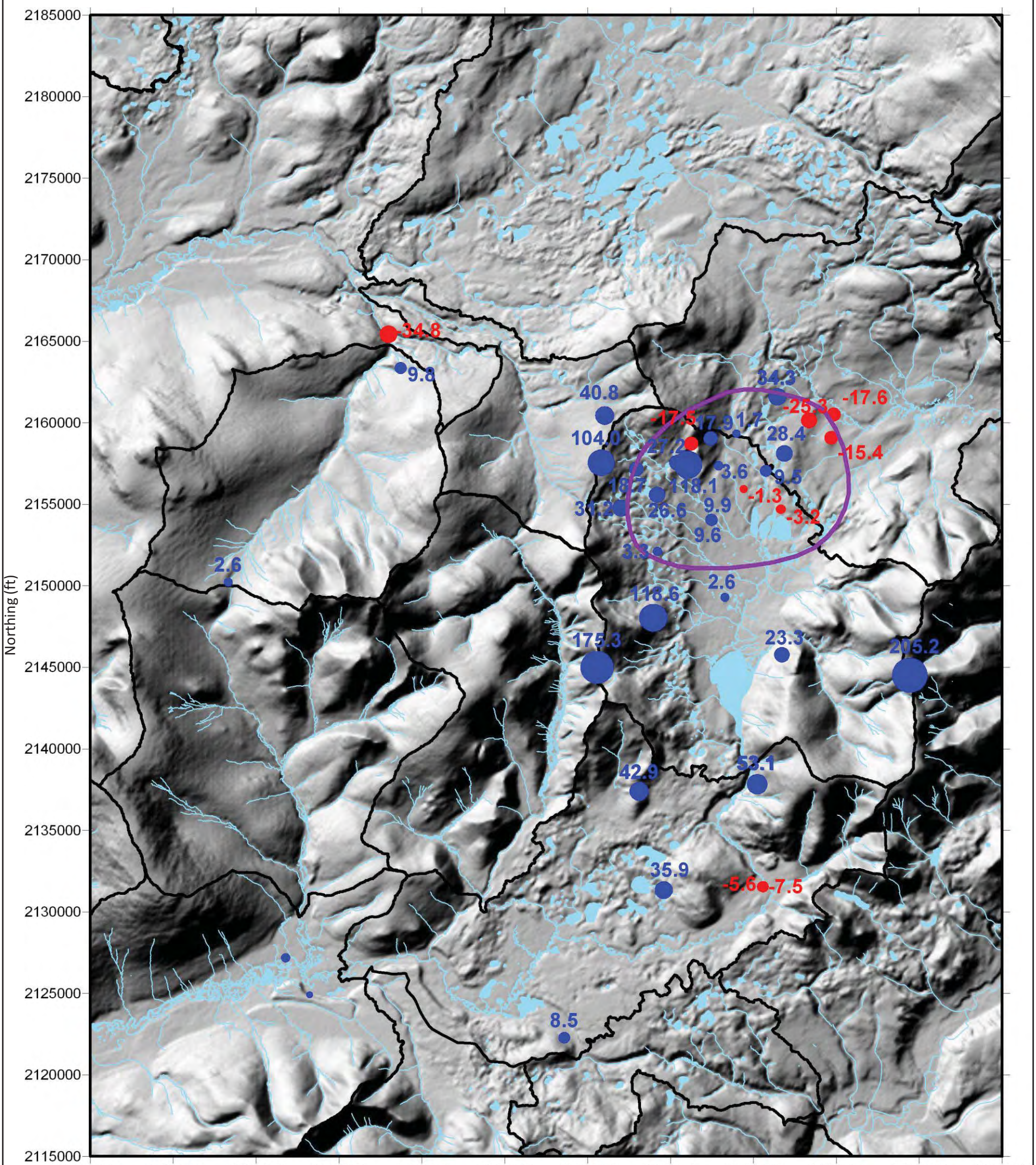
THE pebble PARTNERSHIP

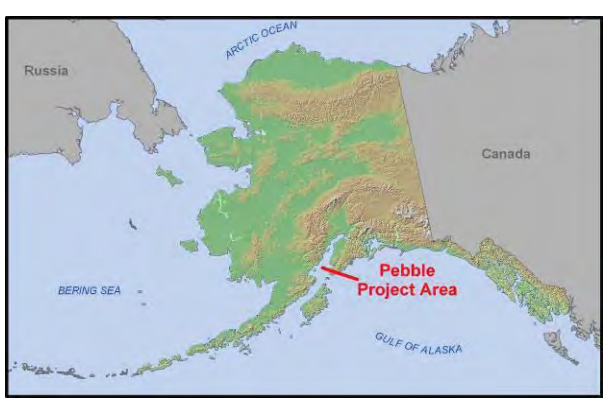
Appendix 8.1J
Groundwater Model Results

Figure 5.11c
Head Residual Bubble Plot - Layer 3
October, 2005

Project: 7126	Date: April, 2011
Fig F5.15 Version: 1	Author: SWS-BL

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F5.15 - Head Residual Bubble Plot - Layer3.xls





Legend

- Modeled Head > Observed Head
- Modeled Head < Observed Head
- Sub-catchment Boundary
- General Deposit Area

Note:
1. Circle diameter proportional to residual
2. Residual units = ft.

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

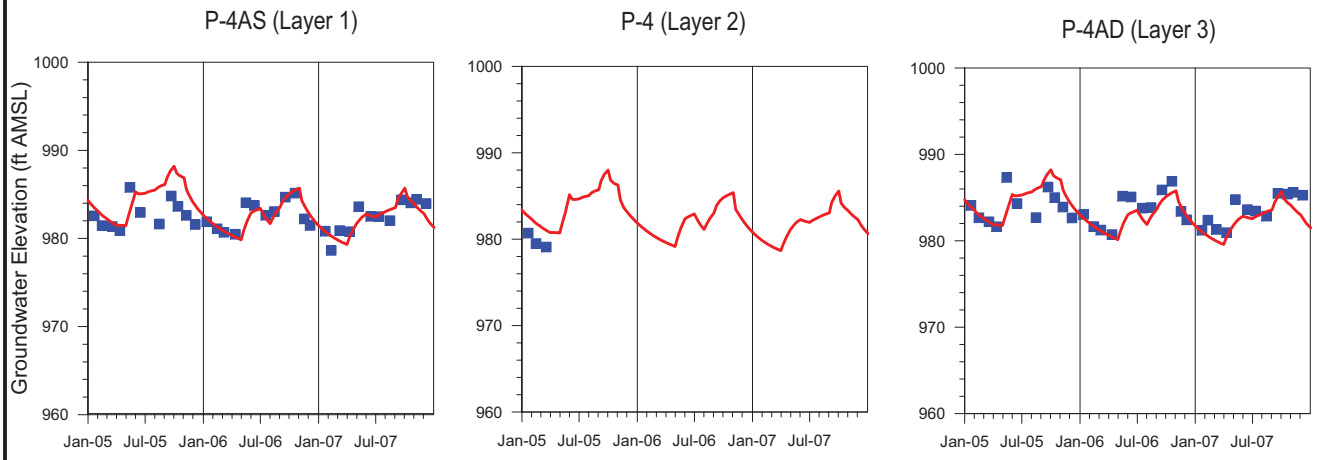
Figure 5.11d
Head Residual Bubble Plot - Layer 4
October, 2005

Project: 7126	Date: April, 2011
Fig F5.16 Version: 1	Author: SWS-BL

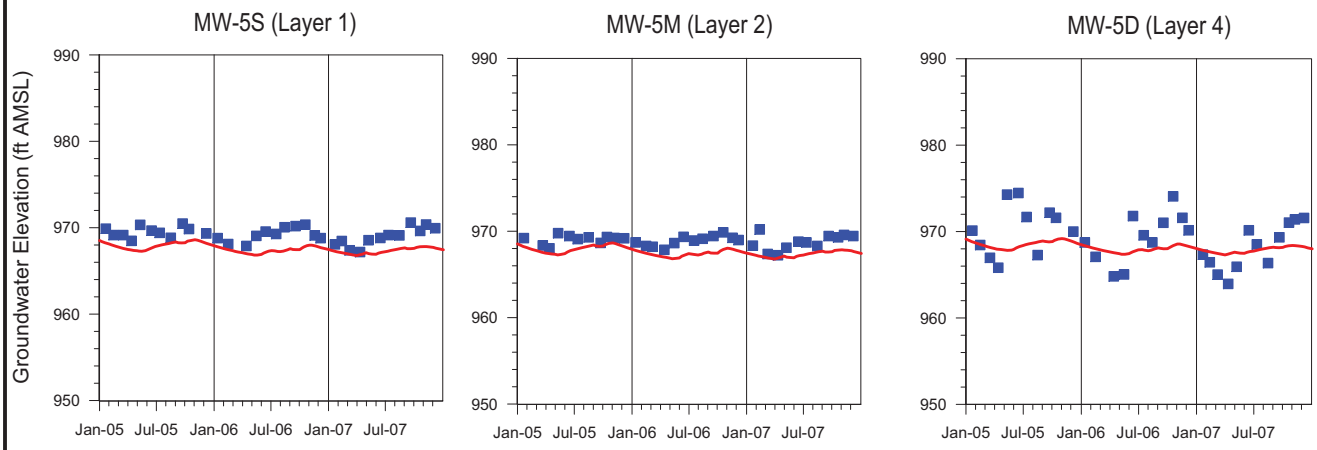
\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F5.16 - Head Residual Bubble Plot - Layer4.xls

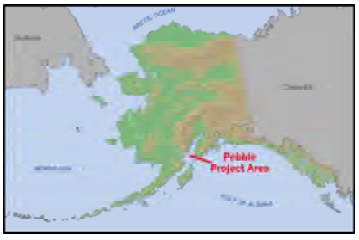
Simulation TR-753

Proposed Open Pit Area - Area 3



Frying Pan Lake - Area 3





Legend

Head in Monitoring Wells and Piezometers

Observed — Model

Note: AMSL: above mean sea level

THE pebble PARTNERSHIP

Appendix 8.1J - Groundwater Model Results

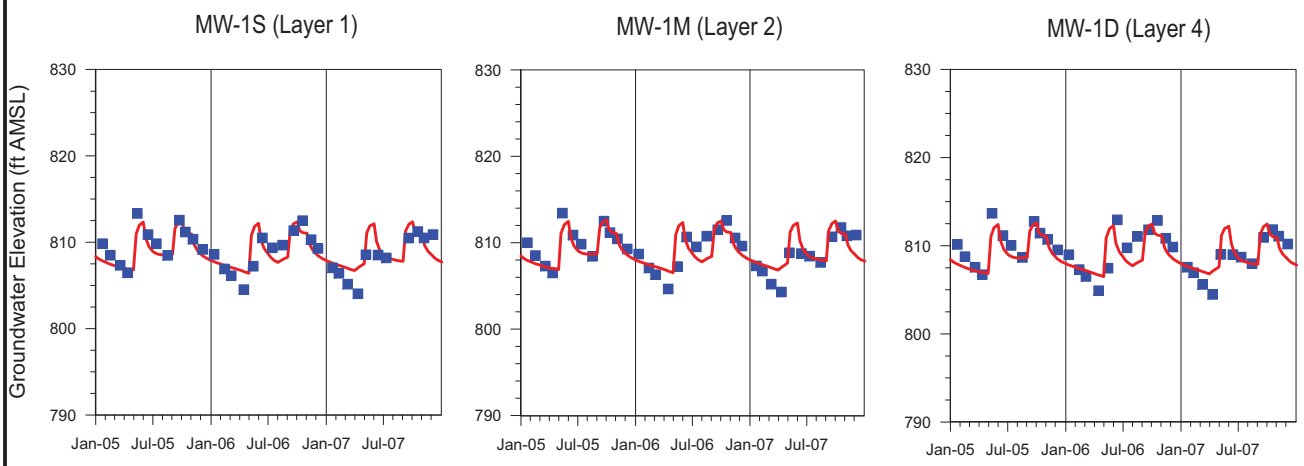
Figure 5.12:
Observed and Simulated Hydrographs:
P-4AS, P-4, P-4AD, MW-5S,
MW-5M and MW-5D

Project: 7126	Date: April-2011
Fig. 5.19a Version: 4	Author: SWS-RR

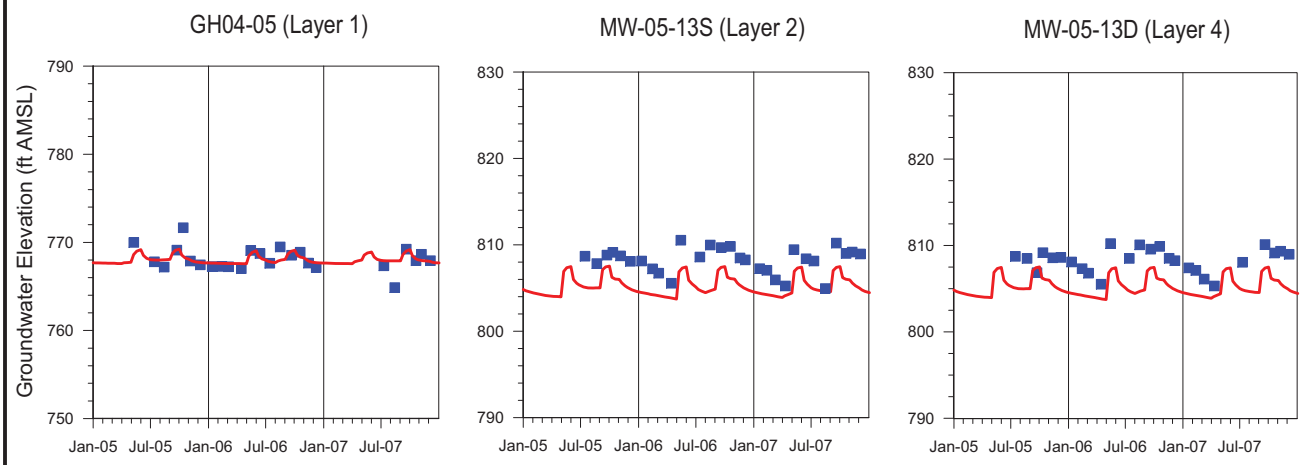
Z:\Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F5.19a - P-05-29D to MW-5 (Area 3).grf

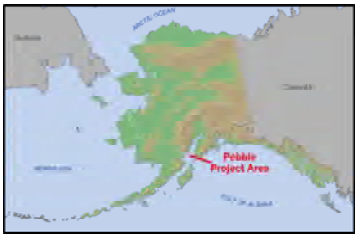
Simulation TR-753

Lower South Fork Koktuli - Area 4



Lower South Fork Koktuli - Area 4





Legend

Head in Monitoring Wells and Piezometers

Observed — Model

Note: AMSL = above mean sea level

THE pebble PARTNERSHIP

Appendix 8.1J - Groundwater Model Results

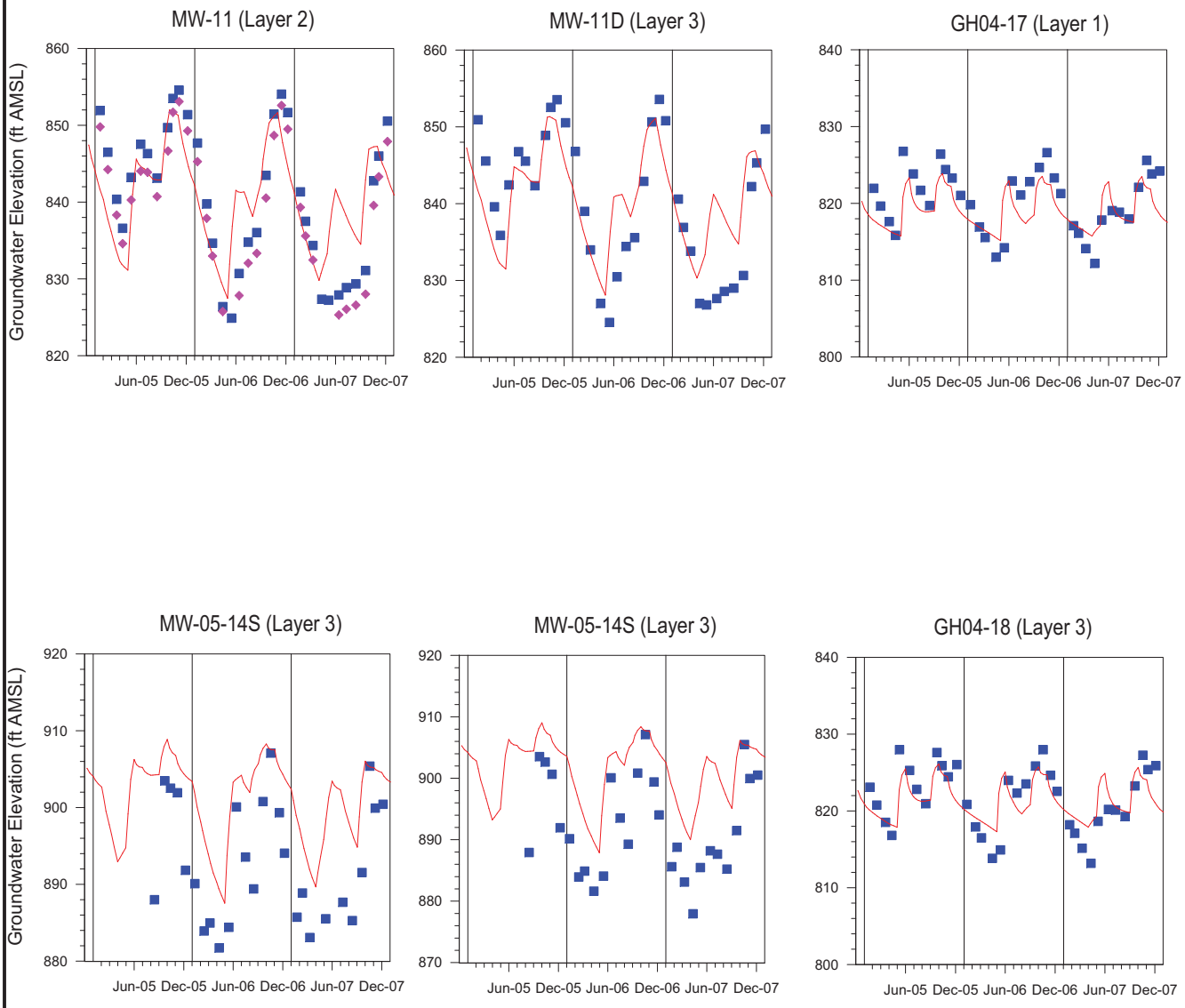
Figure 5.13:
Observed and Simulated Hydrographs:
MW-1S, MW-1M, MW-1D, GH04-05,
MW-05-13S and MW-05-13D

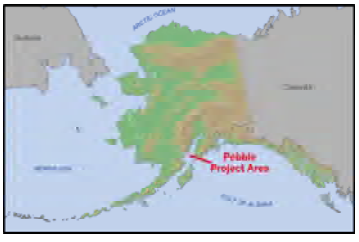
Project: 7126	Date: April-2011
Fig. 5.19b Version: 4	Author: SWS-RR

Z:\Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F5.19b -GH04-05 to MW-13 (Area 4).grf

Simulation TR-753

South Fork Koktuli - Area 5





Legend

Head in Monitoring Wells and Piezometers

Observed — Model

MW-11M ◆ MW-11S — Model

Note: AMSL = above mean sea level

Appendix 8.1J - Groundwater Model Results

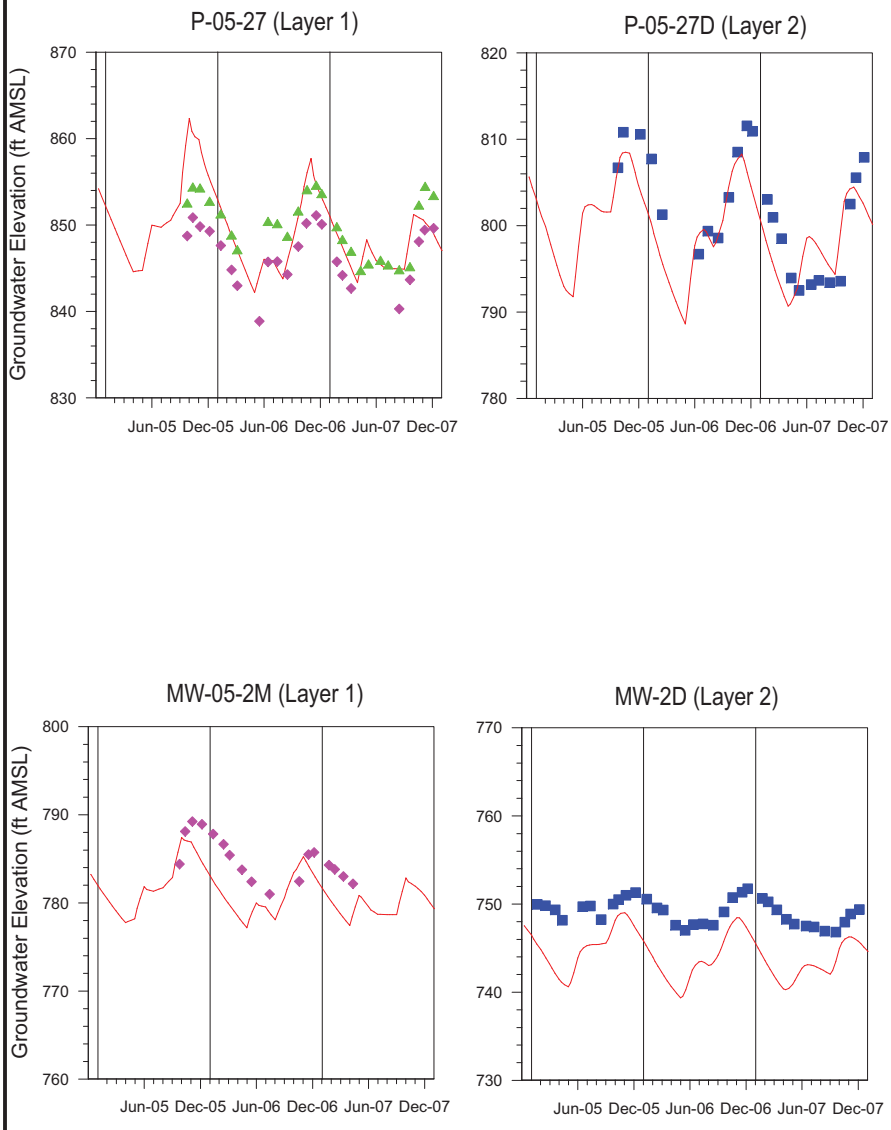
Figure 5.14:
Observed and Simulated Hydrographs:
MW-11, MW-11D, GH04-17,
MW-05-14S, MW-05-14D and GH04-18

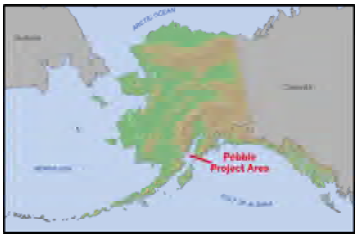
Project: 7126	Date: April-2011
Fig. 5.19c Version: 1	Author: SWS-RR

Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F5.19c - GH04-16 to MW-05-14S (Area53).grf

Simulation TR-753

Upper Talarik - Area 7





Legend

Head in Monitoring Wells and Piezometers

Observed — Model

P-05-27M P-05-27S — Model

Note: MASL = above mean sea level

Appendix 8.1J - Groundwater Model Results

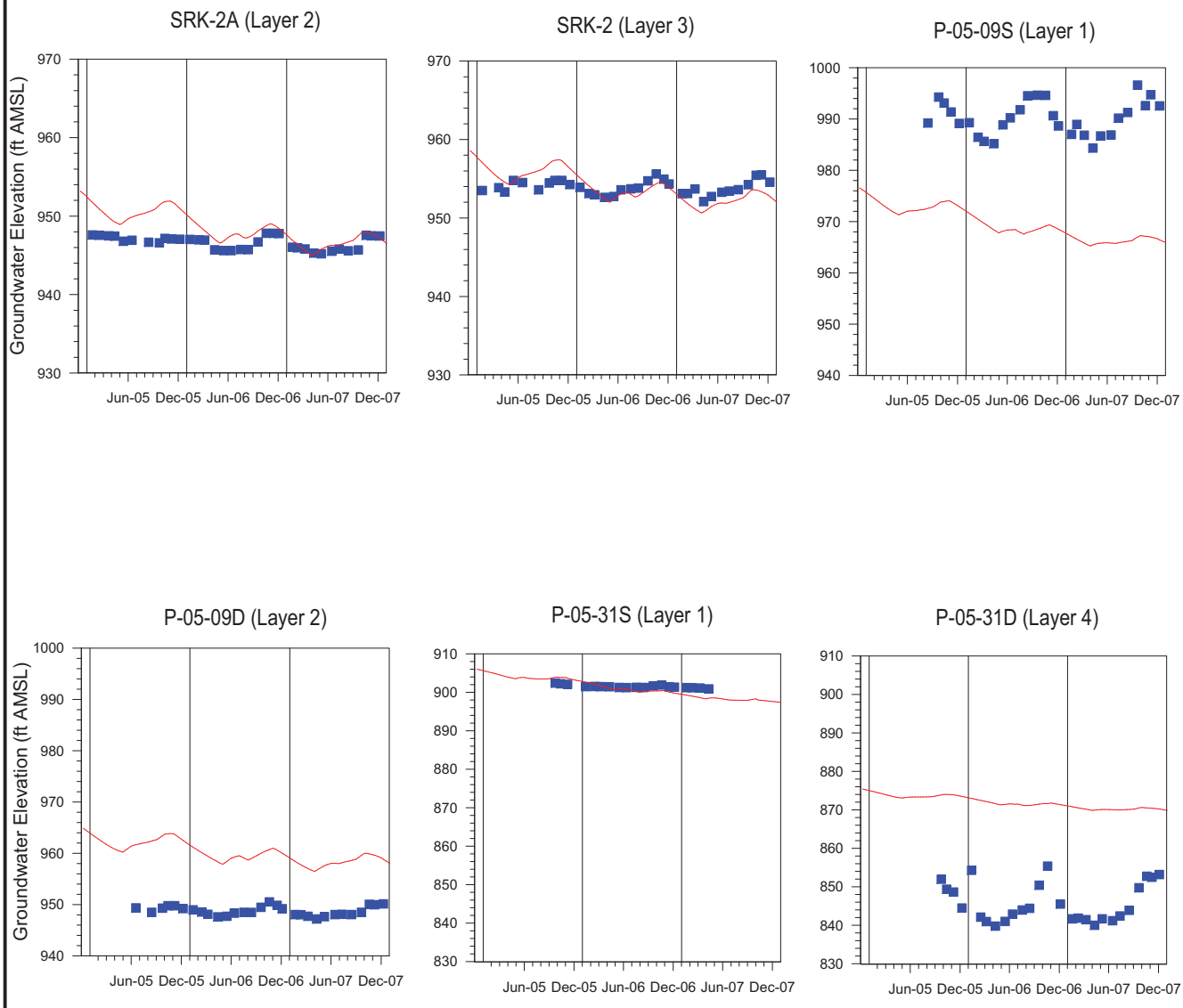
Figure 5.15:
Observed and Simulated Hydrographs:
P-05-27S, P-05-27D, MW-05-2M and MW-2D

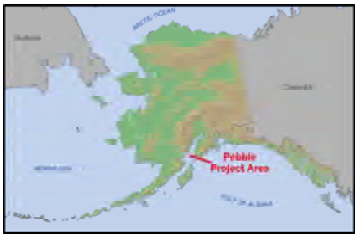
Project: 7126	Date: April-2011
Fig. 5.19d Version: 1	Author: SWS-RR

Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F5.19d -P-05-27 to MW-2 (Area 7).grf

Simulation TR-753

Upper Talarik - Area 9





Legend

Head in Monitoring Wells and Piezometers

Observed — Model

Note: MASL = above mean sea level

THE pebble PARTNERSHIP

Appendix 8.1J - Groundwater Model Results

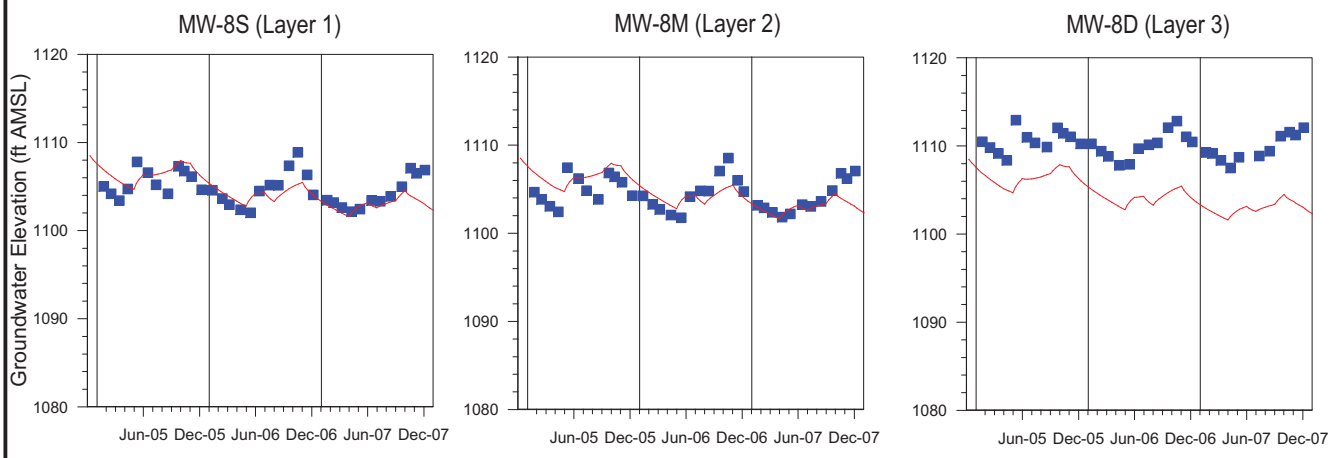
Figure 5.16:
Observed and Simulated Hydrographs: SRK-2A, SRK-2, P-05-09S, P-05-09D, P-05-31S and P-05-31D

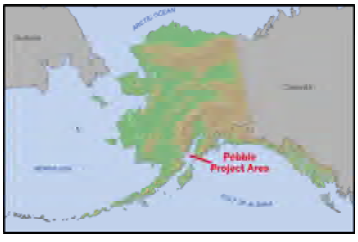
Project: 7126	Date: April-2011
Fig. 5.19e Version: 1	Author: SWS-RR

Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F5.19e -SRK-2 to P-05-31 (Area 9).grf

Simulation TR-753

North Fork Koktuli - Area 13





Legend

Head in Monitoring Wells and Piezometers

Observed — Model

Note: AMSL = above mean sea level

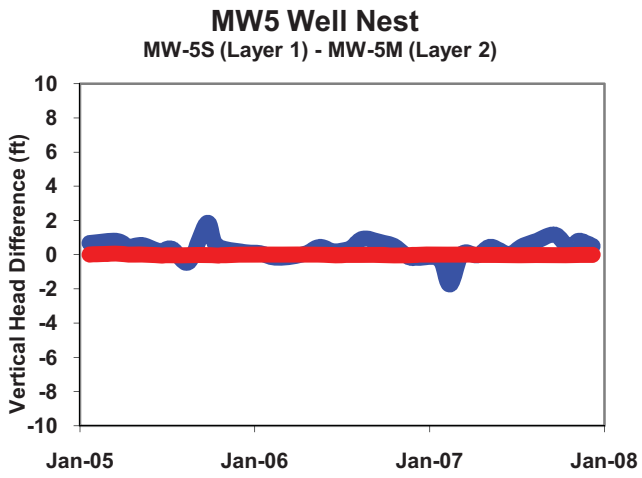
THE pebble PARTNERSHIP

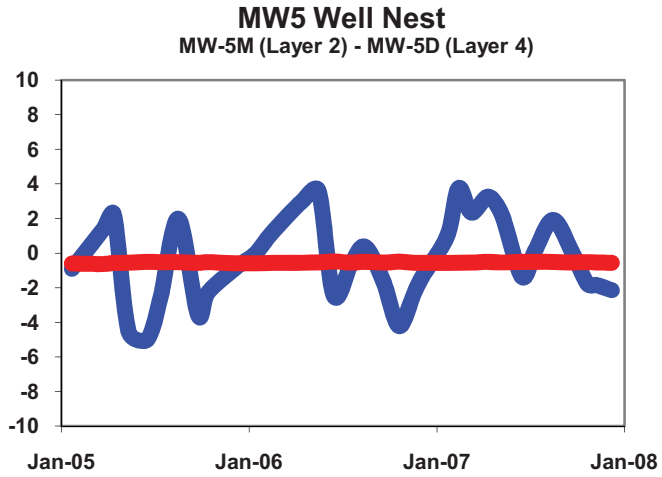
Appendix 8.1J - Groundwater Model Results

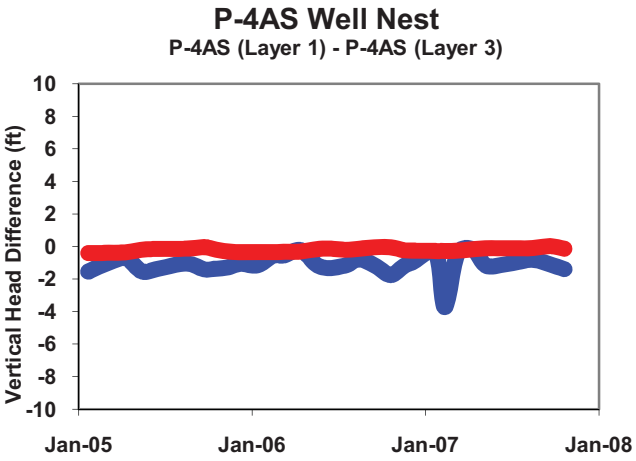
Figure 5.17:
Observed and Simulated Hydrographs:
MW-8S, MW-8M and MW-8D

Project: 7126	Date: April-2011
Fig. 5.19f Version: 1	Author: SWS-RR

Pebble_7-075\groundwater_model\2007 GW Model\Regional Model\Calibration\target files TR-753\Figure F5.19f -MW-8 (Area 13).grf









Legend

Observed Vertical Head Difference

Model Simulated Vertical Head Difference

Notes:

- Head Difference = SHALLOW Groundwater Elevation - DEEP Groundwater Elevation
- Positive head difference represents downward flow
- Negative head difference represents upward flow

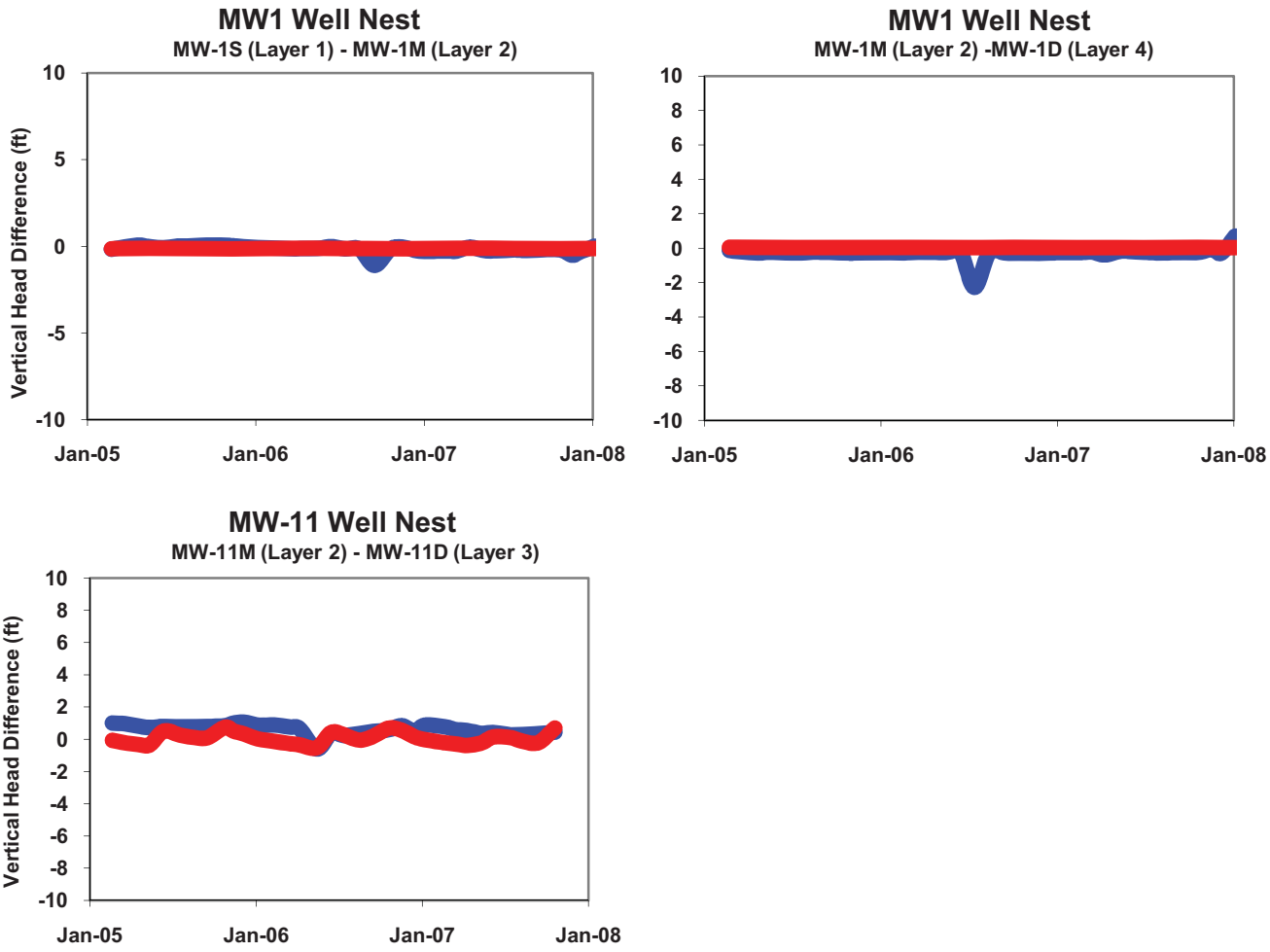
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.18
Observed and Simulated Vertical Head Difference Between Nested Wells - Area 3

Project: 7126	Date: April 2011
Fig F5.20Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3979\Figure F5-20a Observed and Simulated Vertical Head Difference bt Nested Wells - Area 3.xls





Legend

Observed Vertical Head Difference

Model Simulated Vertical Head Difference

Notes:

- Head Difference = SHALLOW Groundwater Elevation - DEEP Groundwater Elevation
- Positive head difference represents downward flow
- Negative head difference represents upward flow

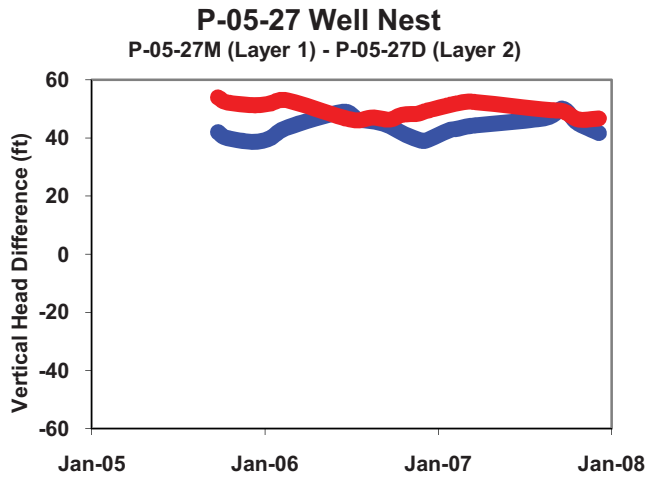
THE pebble PARTNERSHIP

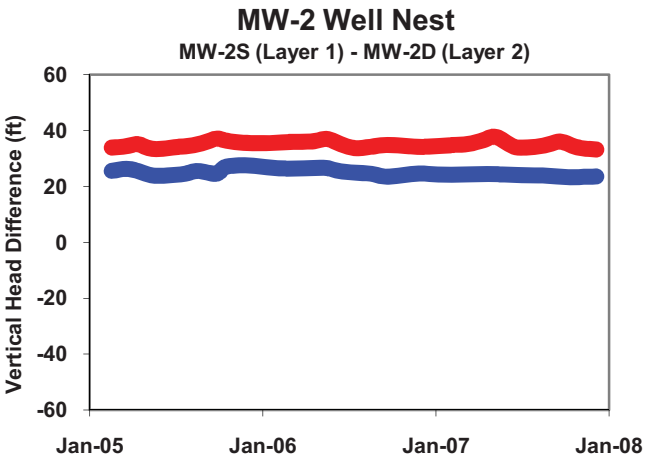
Appendix 8.1J
Groundwater Model Results

Figure 5.19
Observed and Simulated Vertical Head Difference Between Nested Wells - Areas 4 & 5

Project: 7126	Date: April 2011
Fig F5.20Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3980\Figure F5-20b Observed and Simulated Vertical Head Difference bt Nested Wells - Area 4 and 5.xls







Legend

Observed Vertical Head Difference

Model Simulated Vertical Head Difference

Notes:

- Head Difference = SHALLOW Groundwater Elevation - DEEP Groundwater Elevation
- Positive head difference represents downward flow
- Negative head difference represents upward flow

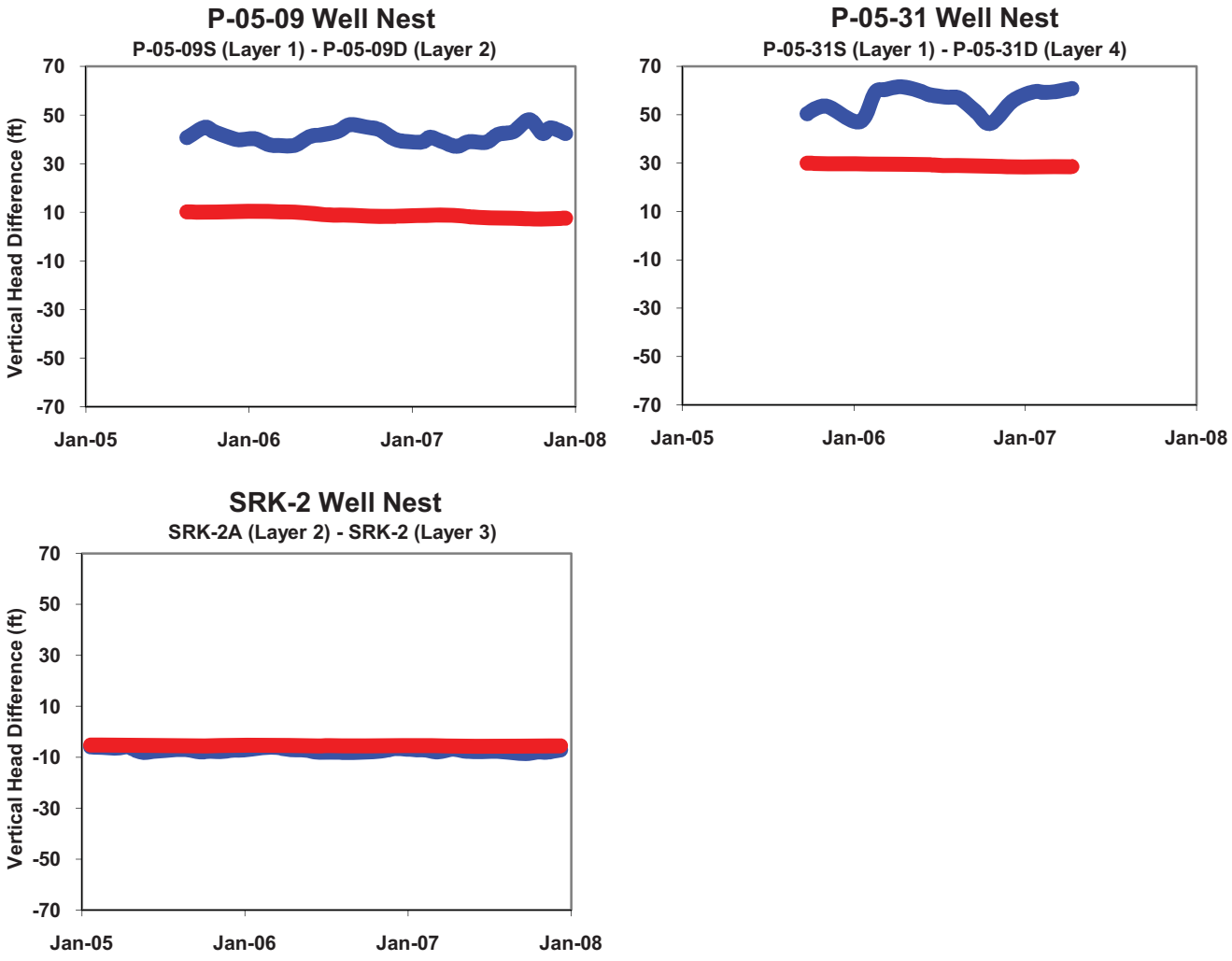
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.20
Observed and Simulated Vertical Head Difference Between Nested Wells - Area 7

Project: 7126	Date: April 2011
Fig F5.20Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3981\Figure F5-20c Observed and Simulated Vertical Head Difference bt Nested Wells - Area 7.xls





Legend

Observed Vertical Head Difference

Model Simulated Vertical Head Difference

Notes:

- Head Difference = SHALLOW Groundwater Elevation - DEEP Groundwater Elevation
- Positive head difference represents downward flow
- Negative head difference represents upward flow

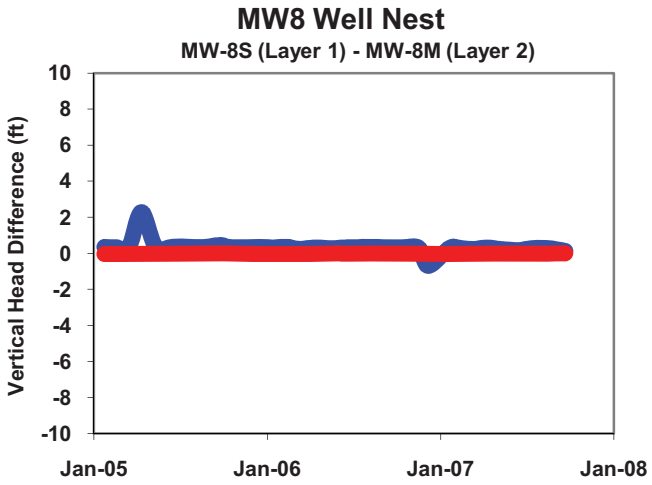
THE pebble PARTNERSHIP

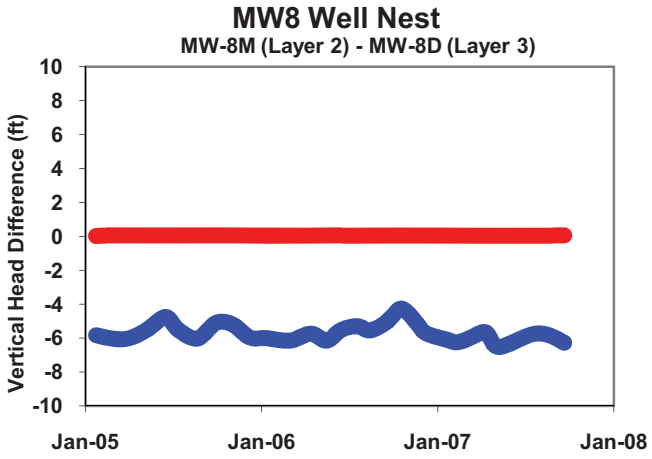
Appendix 8.1J
Groundwater Model Results

Figure 5.21
Observed and Simulated Vertical Head Difference Between Nested Wells - Area 9

Project: 7126	Date: April 2011
Fig F5.20Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3982\Figure F5-20d Observed and Simulated Vertical Head Difference bt Nested Wells - Area 9.xls







Legend

Observed Vertical Head Difference

Model Simulated Vertical Head Difference

Notes:

- Head Difference = SHALLOW Groundwater Elevation - DEEP Groundwater Elevation
- Positive head difference represents downward flow
- Negative head difference represents upward flow

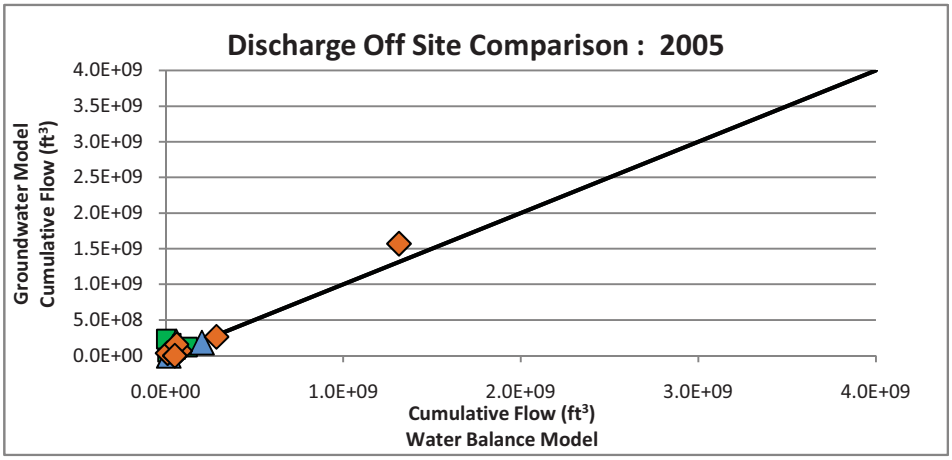
THE pebble PARTNERSHIP

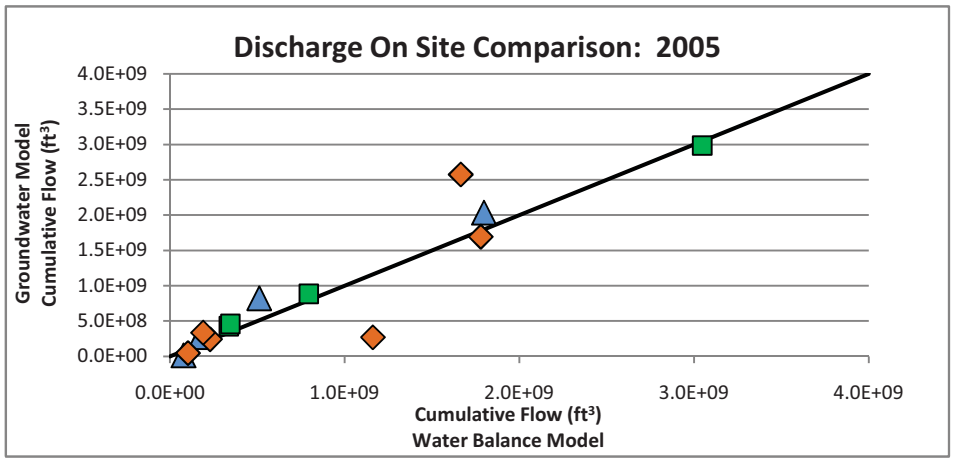
Appendix 8.1J
Groundwater Model Results

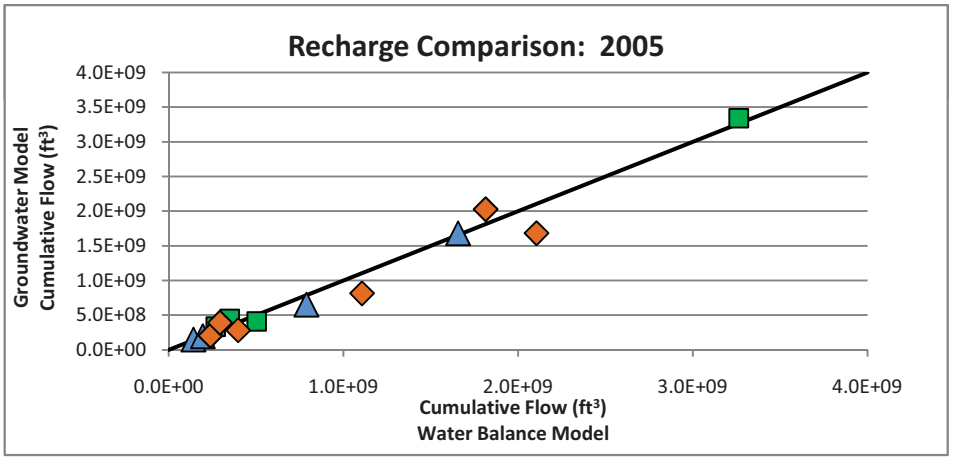
Figure 5.22
Observed and Simulated Vertical Head Difference Between Nested Wells - Area 13

Project: 7126	Date: April 2011
Fig F5.20Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3983\Figure F5-20e Observed and Simulated Vertical Head Difference bt Nested Wells - Area 13.xls









Legend

- GW Model = WB Model
- Upper Talarik Watershed
- North Fork Koktuli River Watershed
- South Fork Koktuli River Watershed

GW = Groundwater
WB = Water Balance

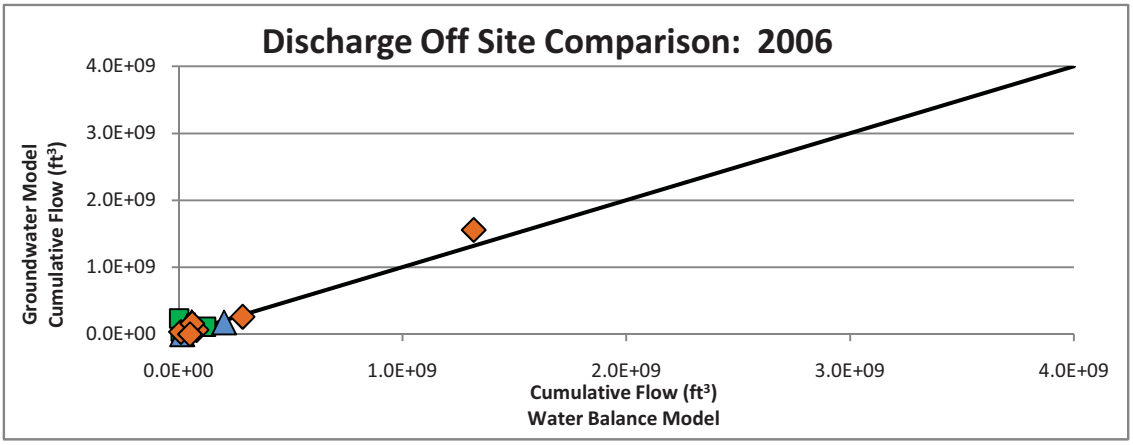
THE pebble PARTNERSHIP

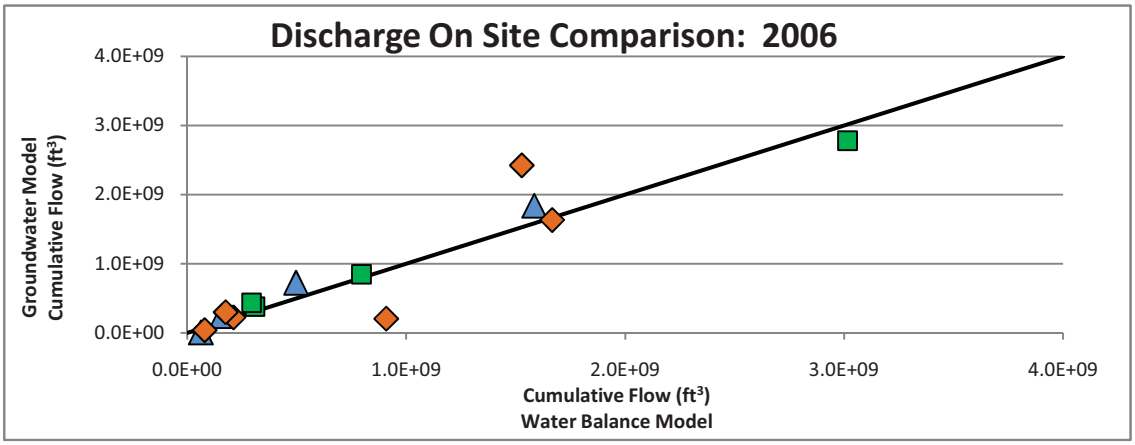
Appendix 8.1J
Groundwater Model Results

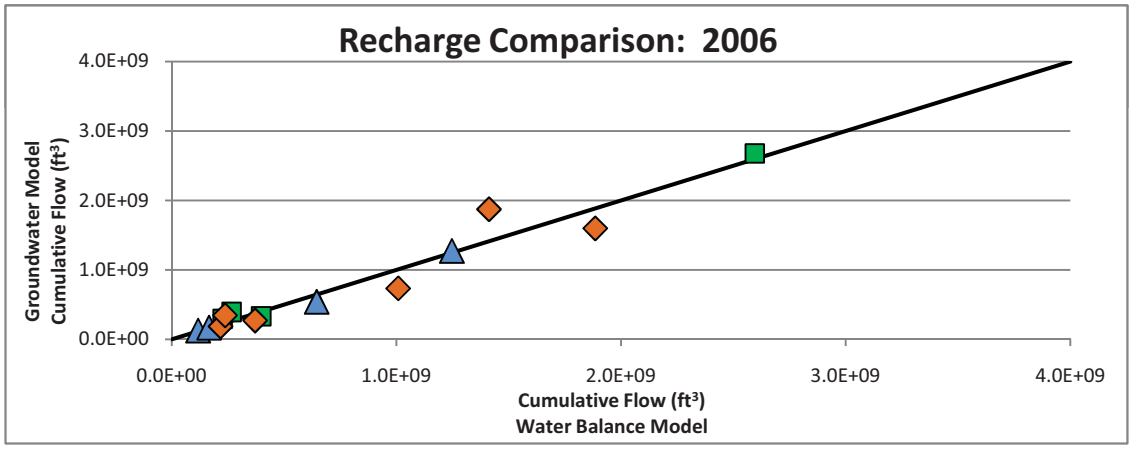
Figure 5.23
Cumulative Annual Flow:
Groundwater Model vs. Water Balance Model (2005)

Project: 7126	Date: April 2011
Fig F5.21 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3984\Figure F5-21 Cumulative Annual Flow Modeflow model vs Water .xls









Legend

- GW Model = WB Model
- Upper Talarik Watershed
- North Fork Koktuli River Watershed
- South Fork Koktuli River Watershed

GW = Groundwater
WB = Water Balance

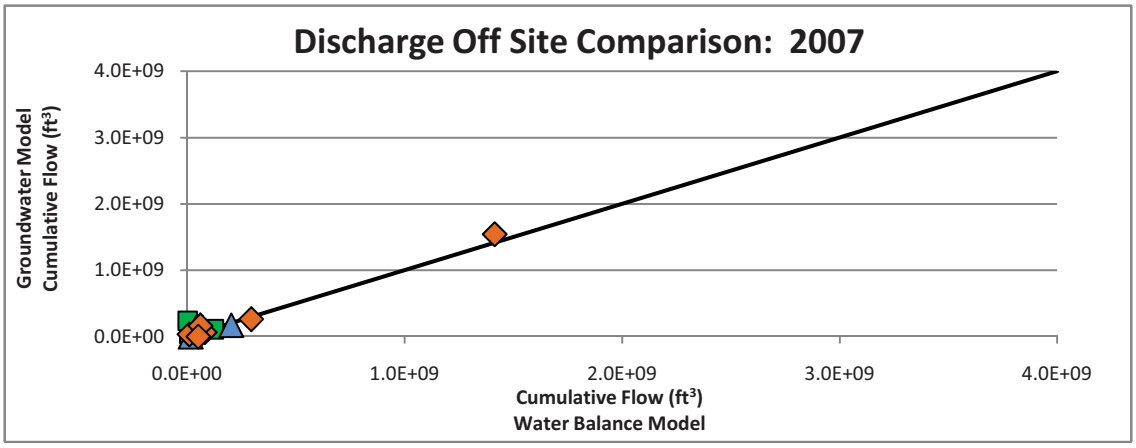
THE pebble PARTNERSHIP

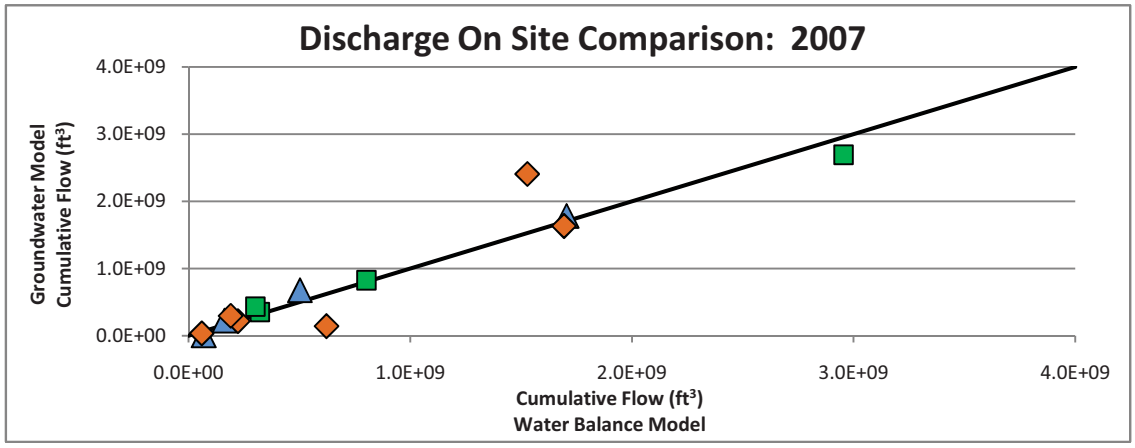
Appendix 8.1J
Groundwater Model Results

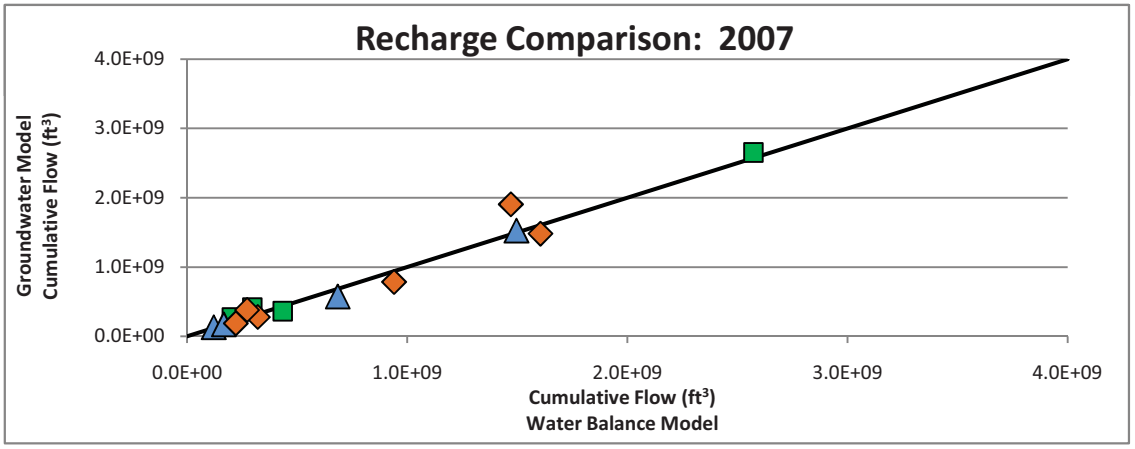
Figure 5.24
Cumulative Annual Flow: Groundwater Model vs. Water Balance Model (2006)

Project: 7126	Date: April 2011
Fig F5.22 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3985\Figure F5-22 Cumulative Annual Flow Modeflow model vs Water .xls









Legend

- GW Model = WB Model
- Upper Talarik Watershed
- North Fork Koktuli River Watershed
- South Fork Koktuli River Watershed

GW = Groundwater
WB = Water Balance

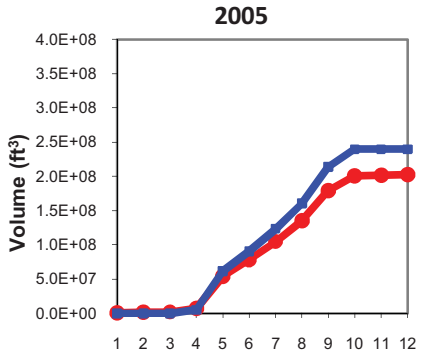
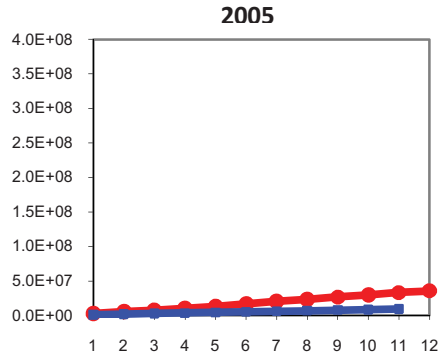
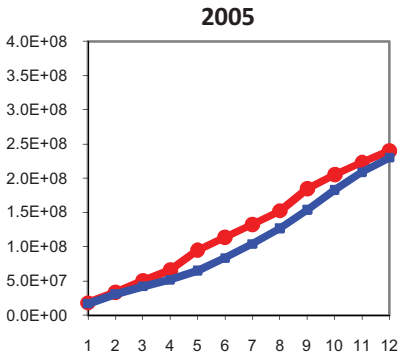
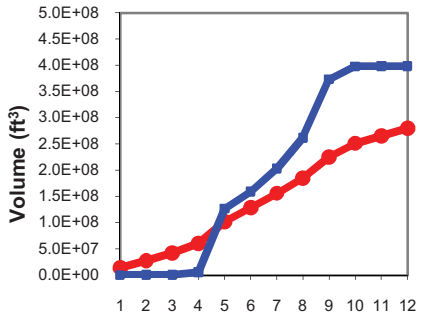
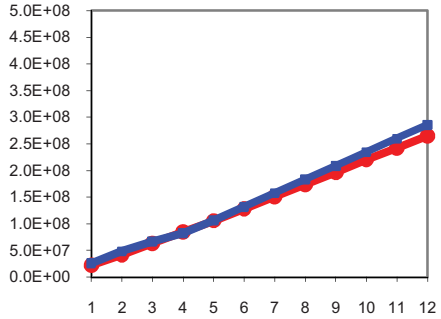
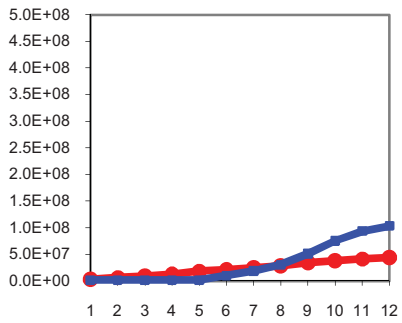
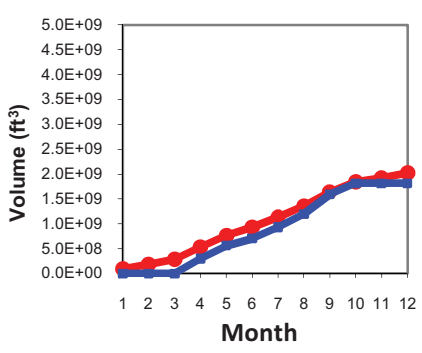
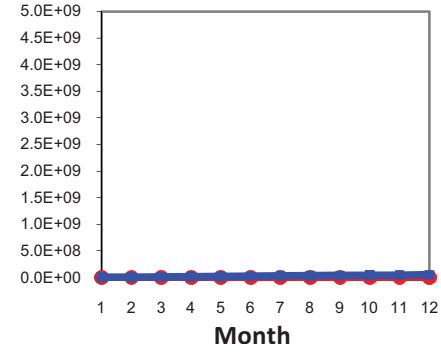
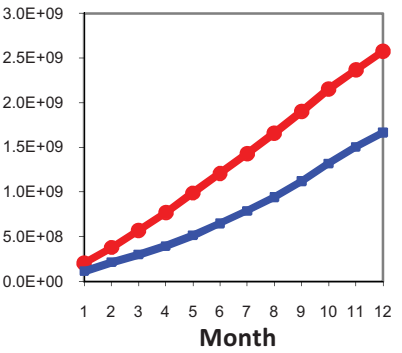
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.25
Cumulative Annual Flow: Groundwater Model vs. Water Balance Model (2007)

Project: 7126	Date: April 2011
Fig F5.23 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3986\Figure F5-23 Cumulative Annual Flow Modeflow model vs Water .xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 1 (SK119A)		
		
SUB-CATCHMENT AREA 2 (SK124A)		
		
SUB-CATCHMENT AREA 8 (SK100A)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

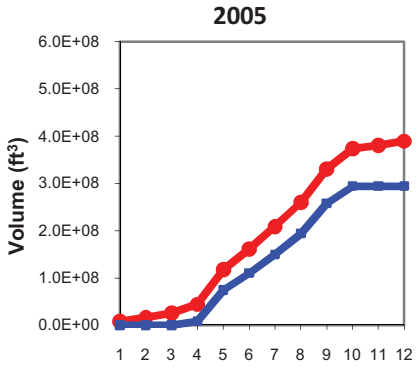
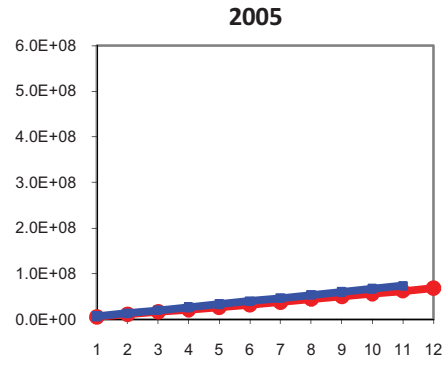
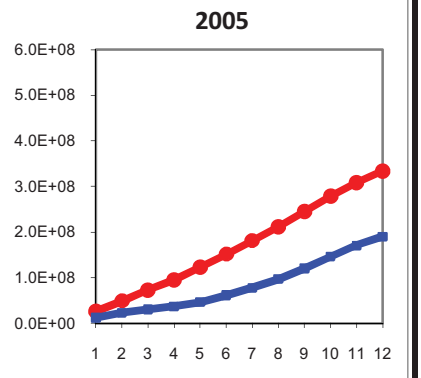
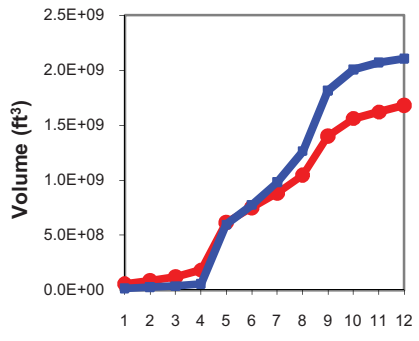
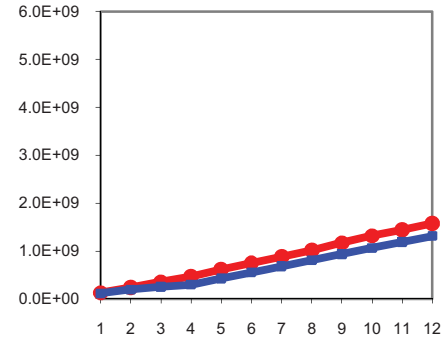
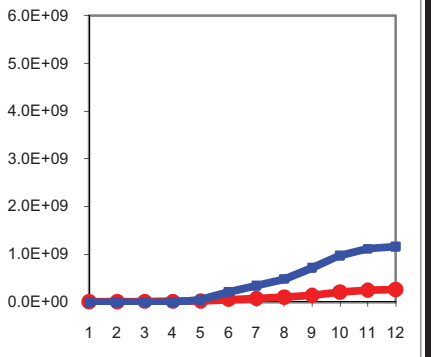
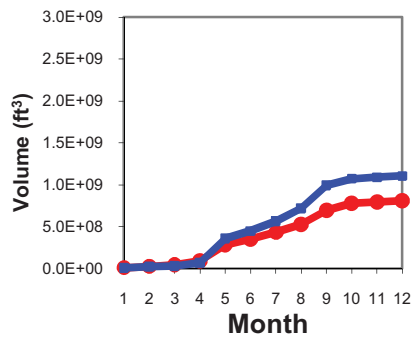
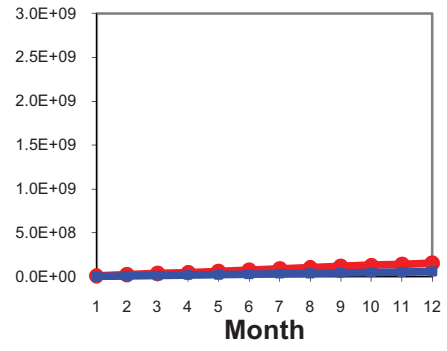
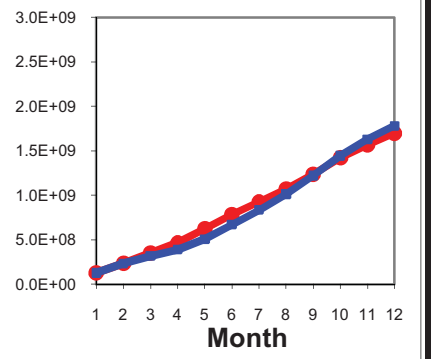
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.26
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli: Area 1, 2, 8 (2005)

Project: 7126	Date: April 2011
Fig F5.40 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.40 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK 1, 2, 8.xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 3 (SK100F)		
		
SUB-CATCHMENT AREA 5 (SK100C)		
		
SUB-CATCHMENT AREA 4 (SK100B)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

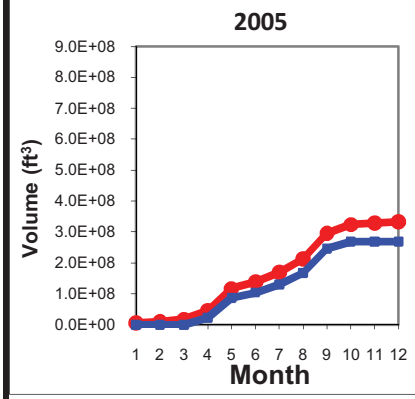
Appendix 8.1J
Groundwater Model Results

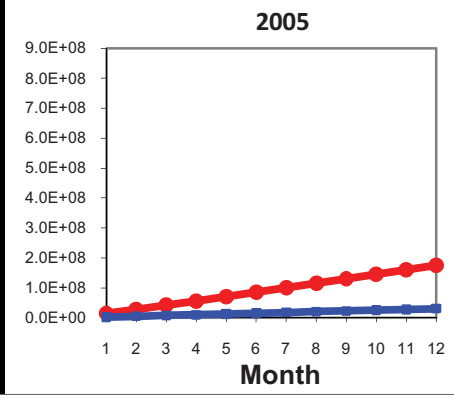
Figure 5.27
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli Main Channel: Area 3, 5, 4 (2005)

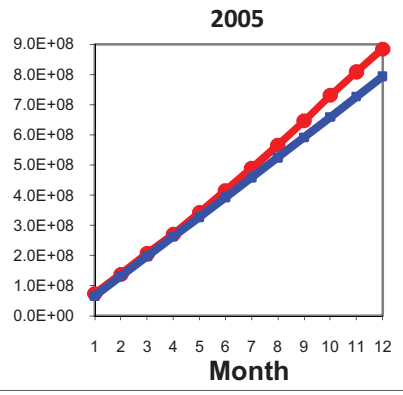
Project: 7126	Date: April 2011
Fig F5.41 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.41 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK 3,5, 4.xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	SUB-CATCHMENT AREA 7 (UT119A)	









Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

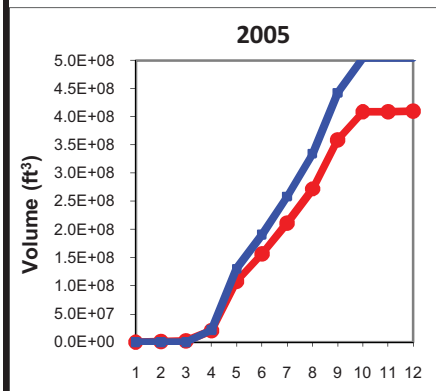
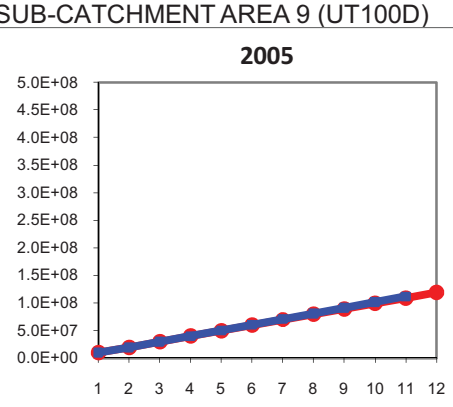
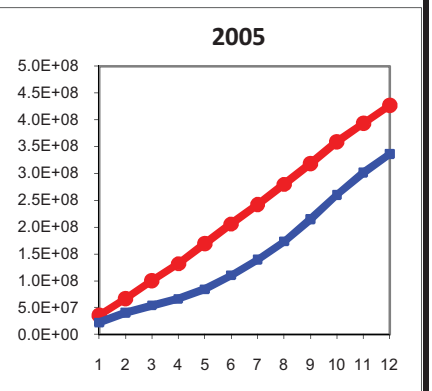
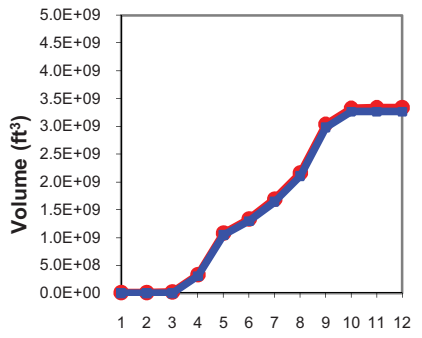
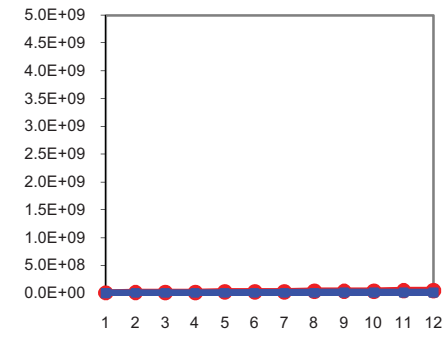
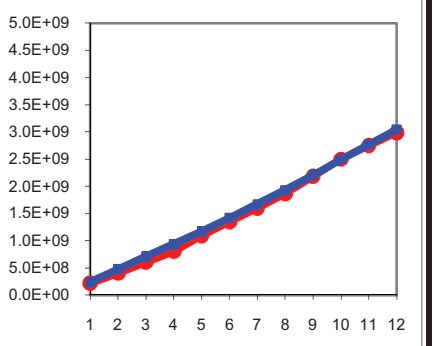
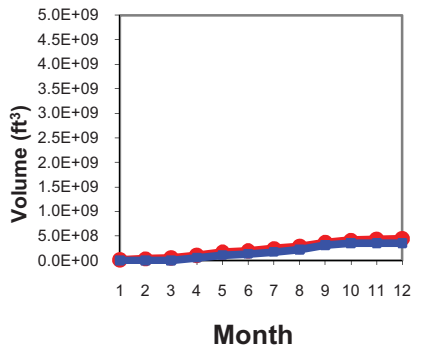
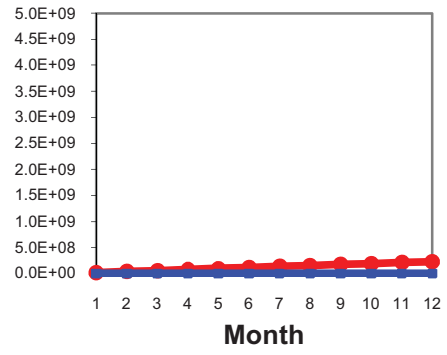
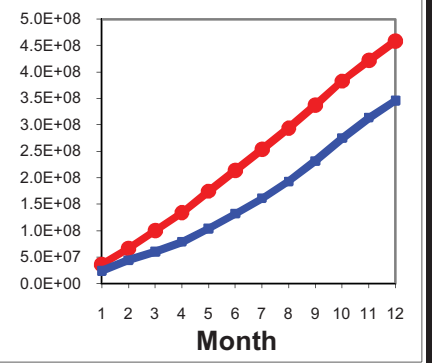
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.28
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik, flow from SFK: Area 7
(2005)

Project: 7126	Date: April 2011
Fig F5.42 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.42 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models -UT 7.xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 9 (UT100D)		
		
SUB-CATCHMENT AREA10 (UT100B)		
		
SUB-CATCHMENT AREA 11 (UT100A)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

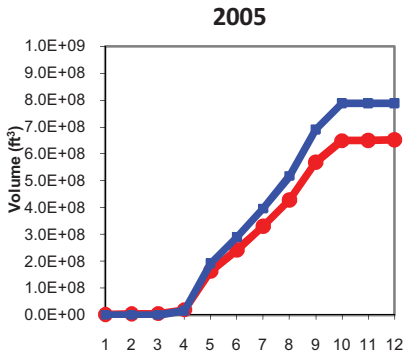
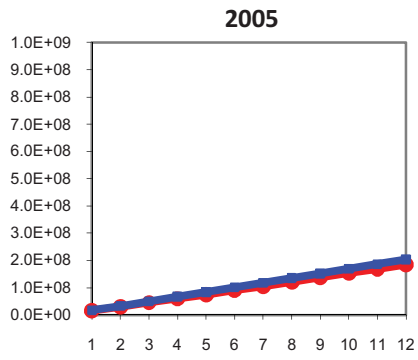
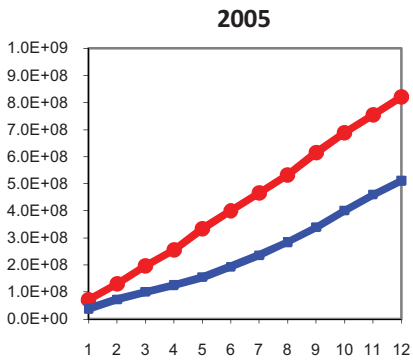
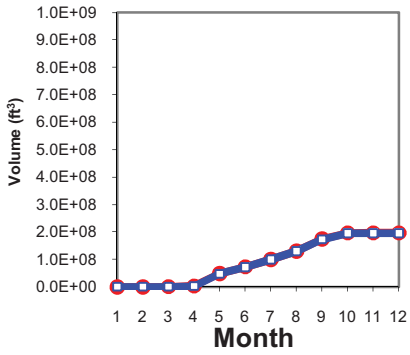
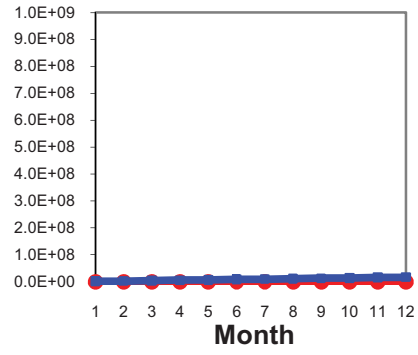
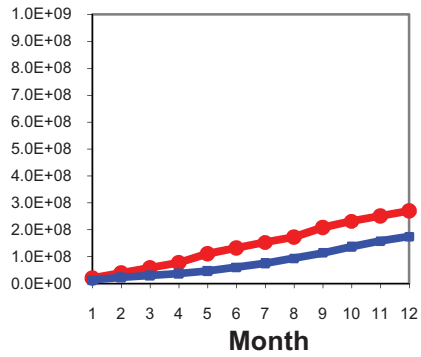
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.29
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik: Area 9, 10, 11
(2005)

Project: 7126	Date: April 2011
Fig F5.43 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.43 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models -UT 9, 10, 11.xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	SUB-CATCHMENT AREA 13 (NK100C)	
		
	SUB-CATCHMENT AREA 14 (NK119A)	
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

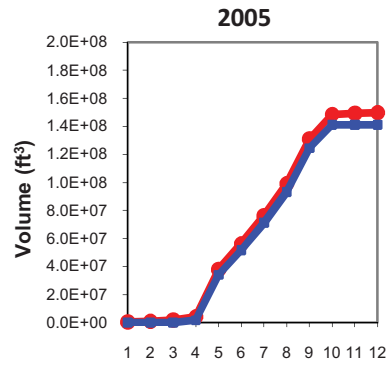
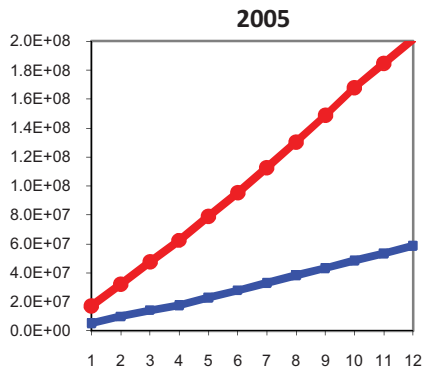
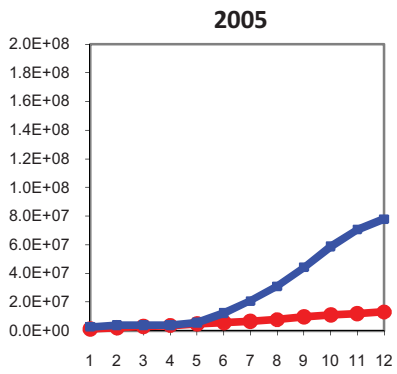
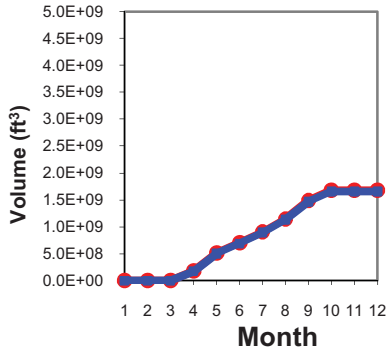
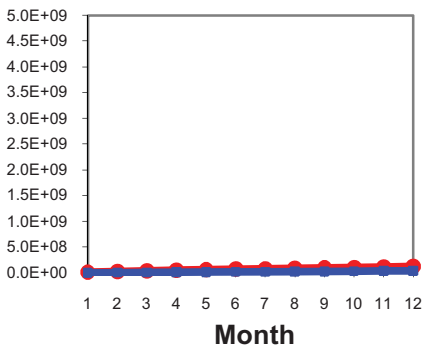
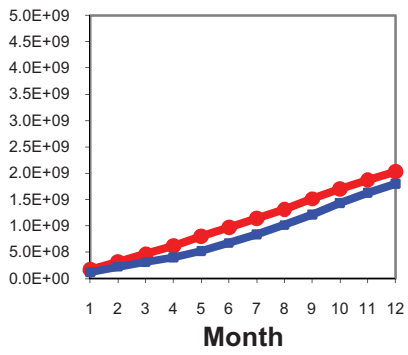
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.30
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli: Area 13, 14
(2005)

Project: 7126	Date: April 2011
Fig F5.44 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.44 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - NFK 13 and 14.xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	SUB-CATCHMENT AREA 12 (NK119B)	
		
	SUB-CATCHMENT AREA 15 (NK100A)	
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

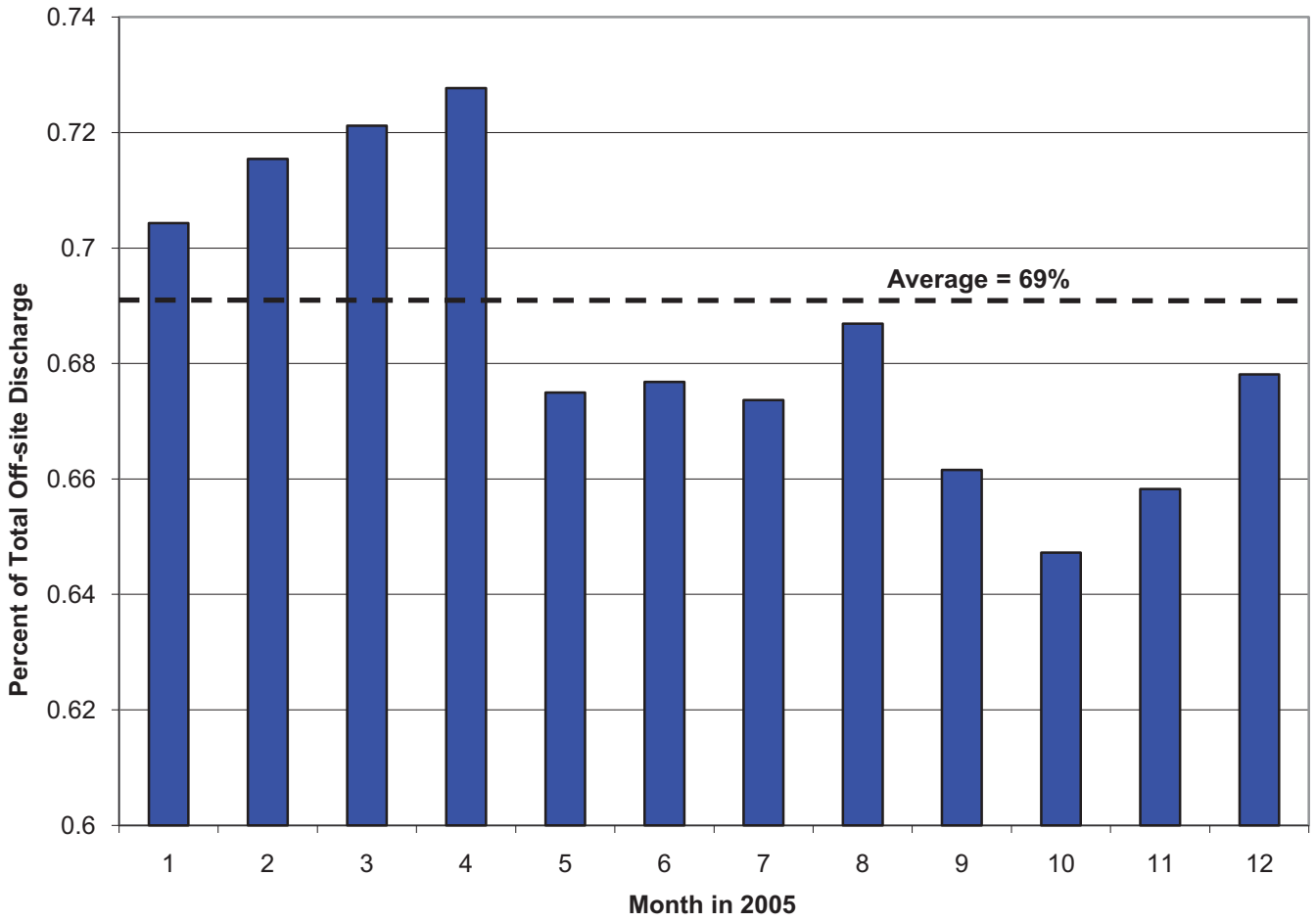
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.31
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli: Area 12, 15
(2005)

Project: 7126	Date: April 2011
Fig F5.45 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.45 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - NFK 12, 15.xls

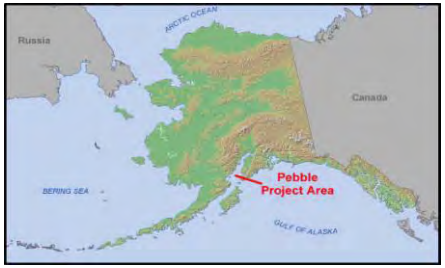


THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

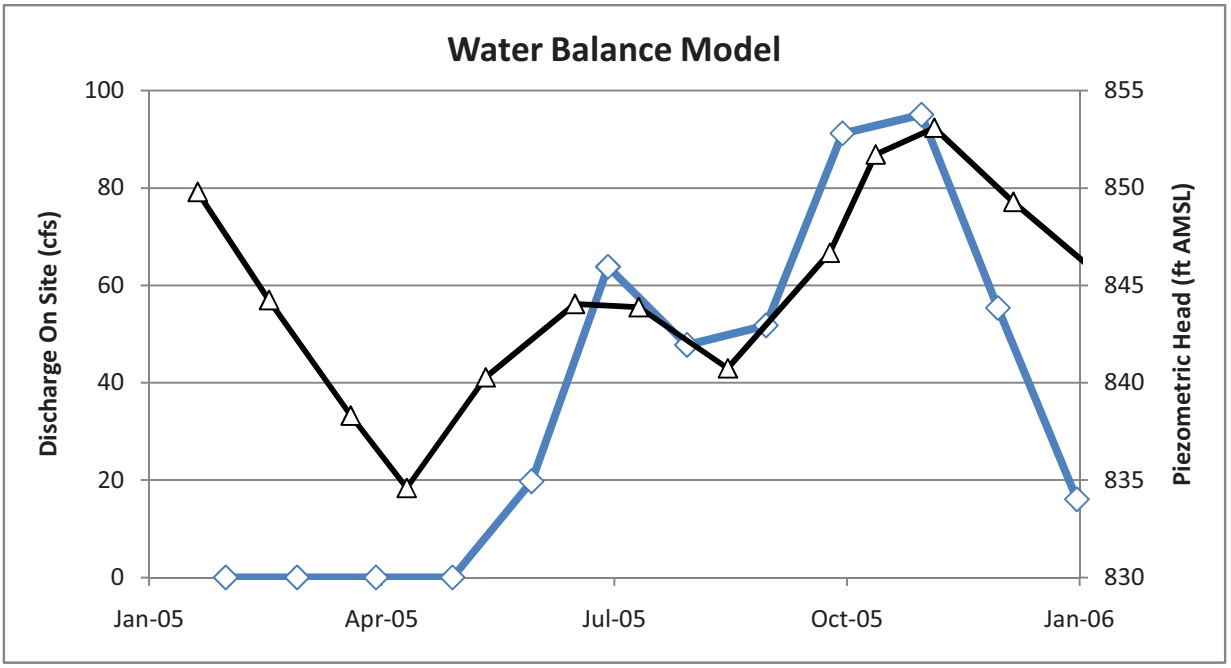
Figure 5.32
Model vs Calculated Flow from
Area 5 to Areas 4 and 7 (2005)

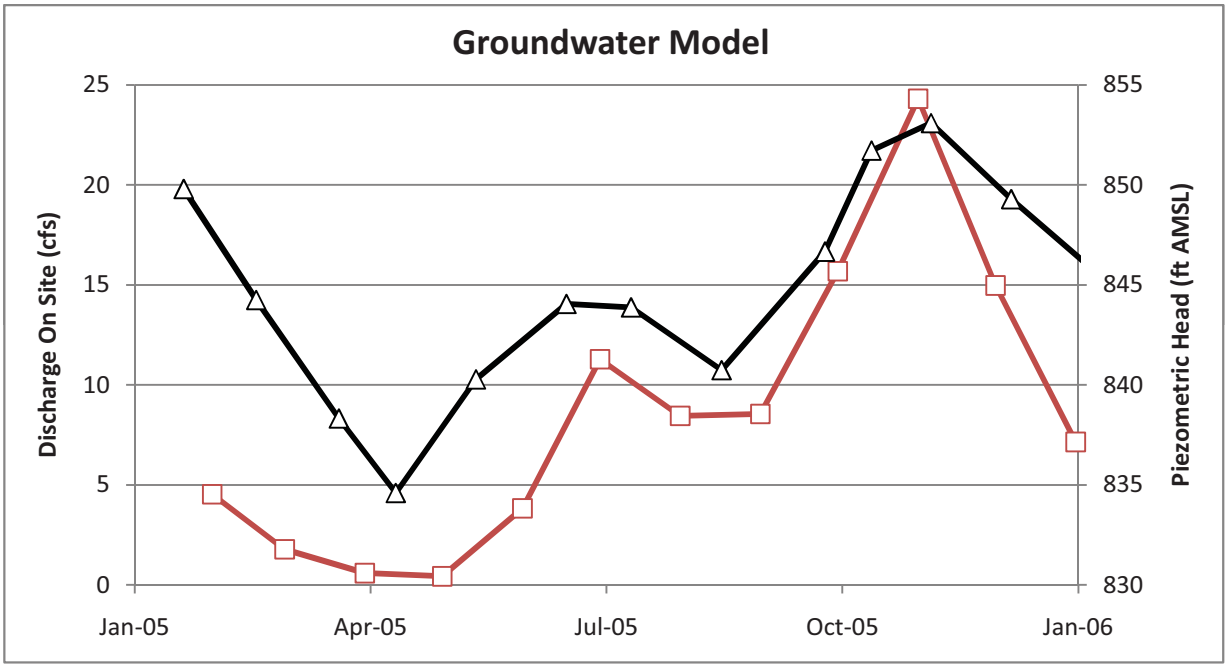
Note :
1. Area numbers refer
to watershed numbers



Project No: 7126	Date: Aprill, 2011
Fig F5.29 Version: 1	Author: SWS-RR

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix 8.1J - Groundwater Model Results\Figure F5.29 - Model vs Calculated Flow from Area 5 to Areas 4 and 7 (2005).xls







Legend

- Discharge On Site
- Discharge On Site
- Observed Head at MW-11S

Note:
1. MW-11S refers to a monitoring well location

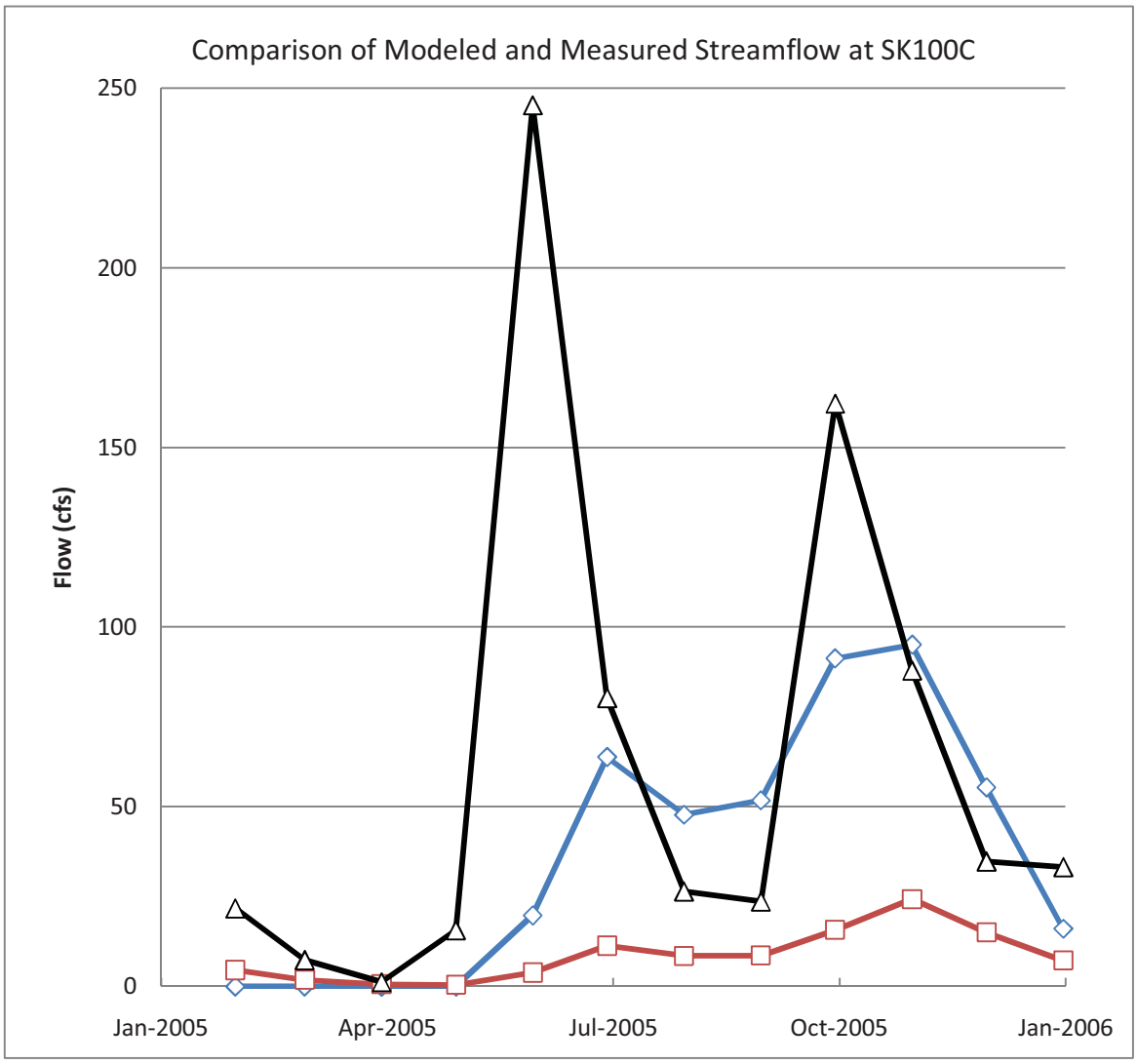
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.33
2005 Discharge on Site (Area 5) and Observed MW-11S Piezometric Heads

Project: 7126	Date: Aprill, 2011
Fig F5.58 Version: 1	Author: SWS-RR

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F5-58 - 2005 Discharge on Site (Area 5) and Observed MW-11S Piezometric Heads.xls





Legend

- On-site Discharge, Water Balance Model
- On-site Discharge, Groundwater Model
- Measured Streamflow SK100C

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

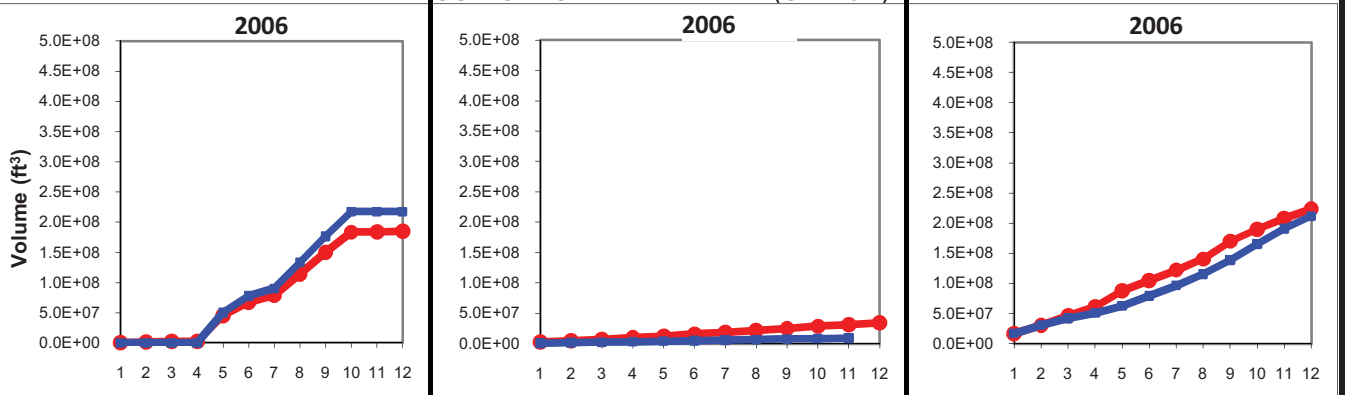
Figure 5.34
2005 Discharge on Site (Area 5) and Measured Streamflow at SK100C

Project: 7126	Date: Aprill, 2011
Fig F5.59 Version: 1	Author: SWS-RR

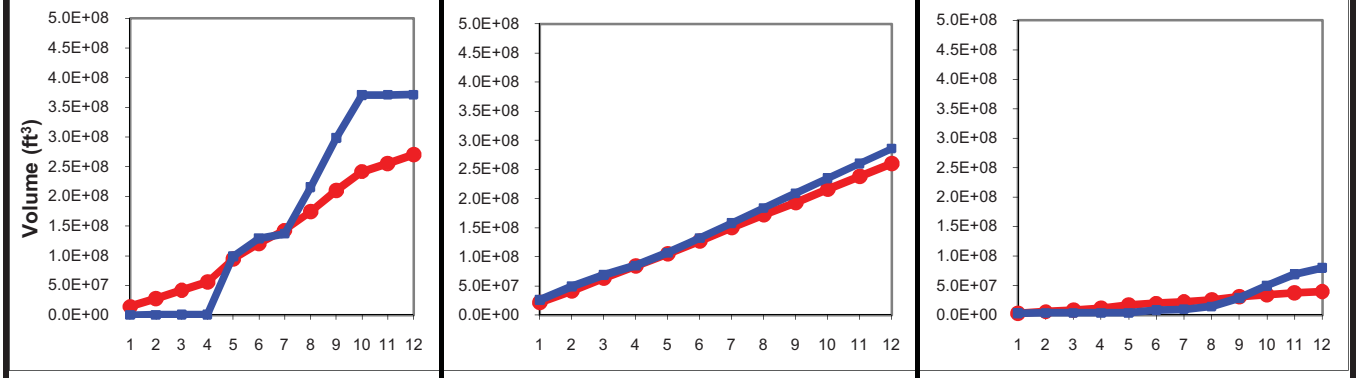
Z:\Pebble_7126_2010\GIS\MXDs\T3989\Figure F5-59 - 2005 Discharge on Site (Area 5) and Measured.xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

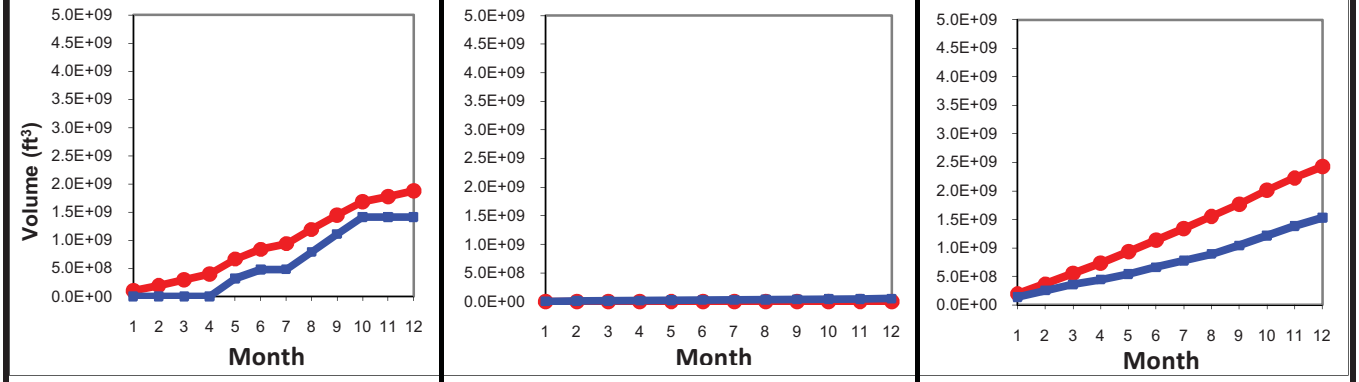
SUB-CATCHMENT AREA 1 (SK119A)



SUB-CATCHMENT AREA 2 (SK124A)



SUB-CATCHMENT AREA 8 (SK100A)





Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

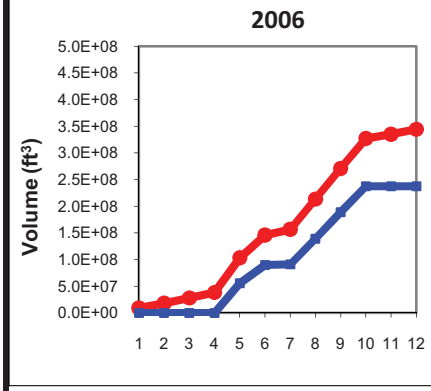
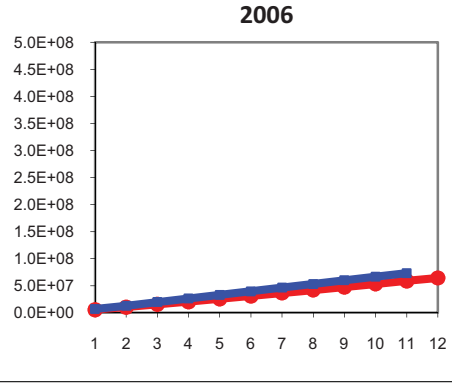
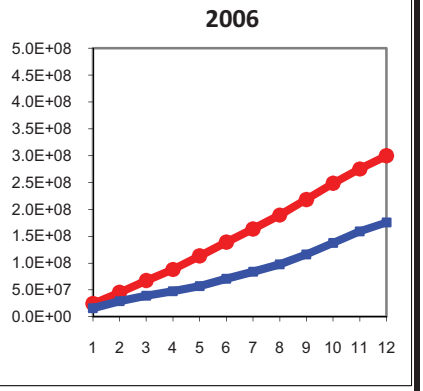
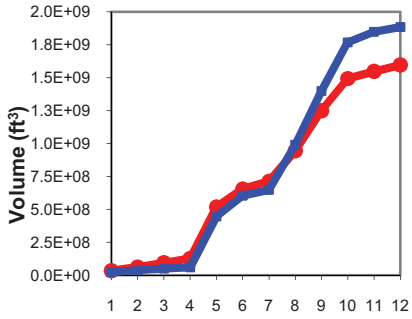
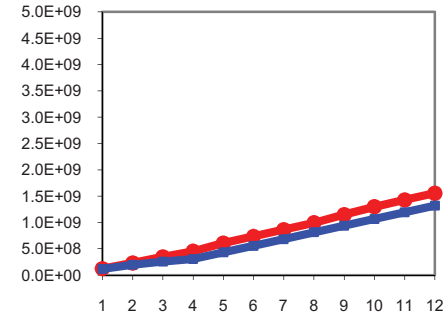
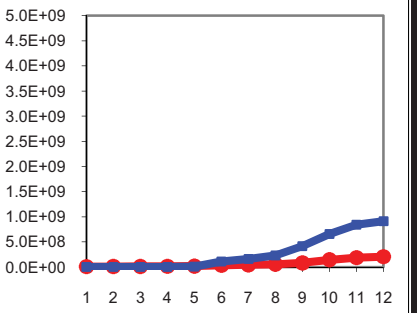
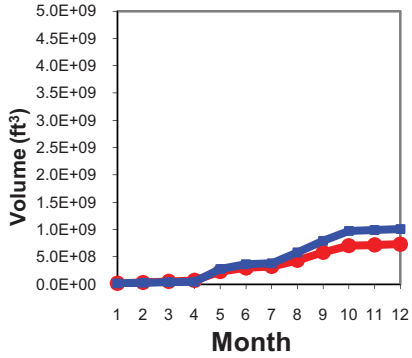
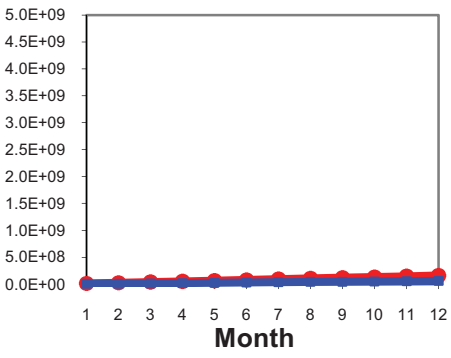
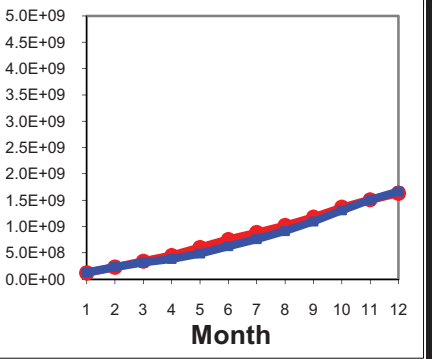
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.35
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli Tributaries: Area 1, 2, 8 (2006)

Project: 7126	Date: April 2011
Fig F5.46 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.46 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK (2006).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 3 (SK100F)		
		
SUB-CATCHMENT AREA 5 (SK100C)		
		
SUB-CATCHMENT AREA 4 (SK100B)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

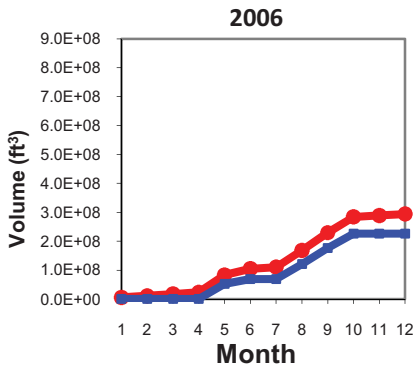
Appendix 8.1J
Groundwater Model Results

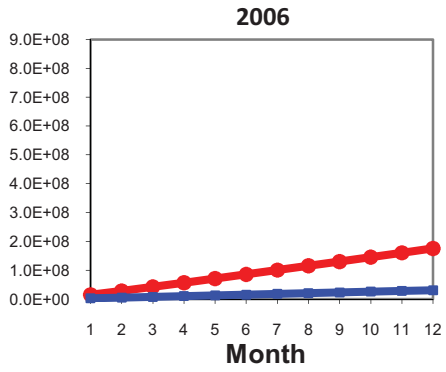
Figure 5.36
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli Main Channel: Area 3, 4, 5 (2006)

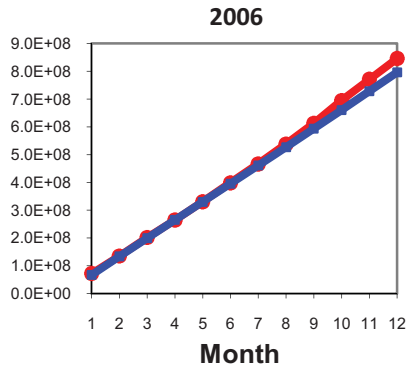
Project: 7126	Date: April 2011
Fig F5.47 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.47 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK Main Channel (2006).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	SUB-CATCHMENT AREA 7 (UT119A)	









Legend

Groundwater Model

Water Balance Model

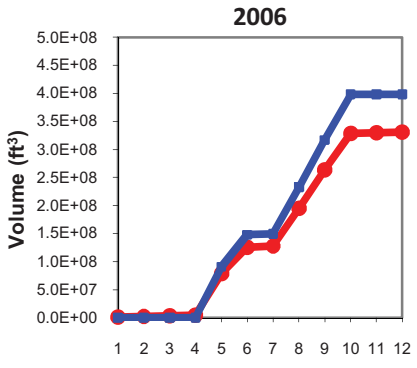
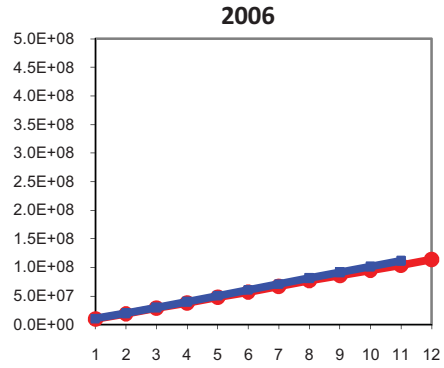
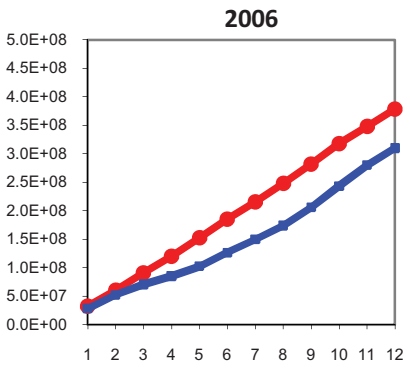
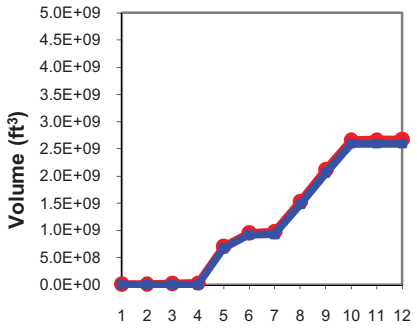
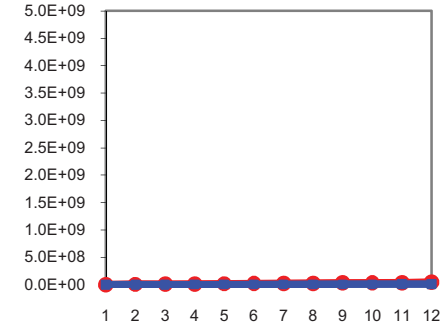
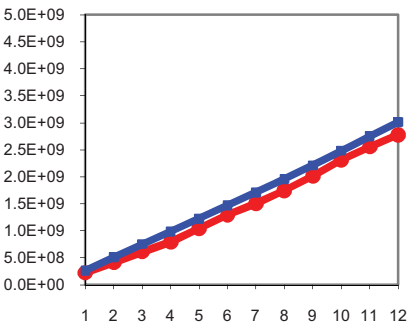
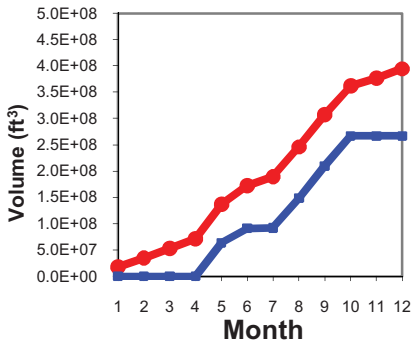
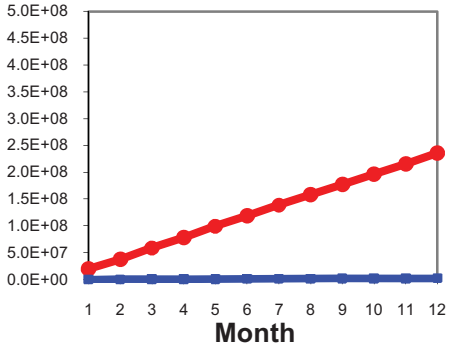
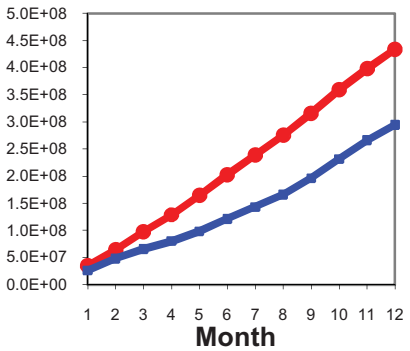
Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.37
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik, flow from SFK: Area 7 (2006)

Project: 7126	Date: April 2011
Fig F5.48 Version: 1	Author: SWS-KB

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 9 (UT100D)		
		
SUB-CATCHMENT AREA 10 (UT100B)		
		
SUB-CATCHMENT AREA 11 (UT100A)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

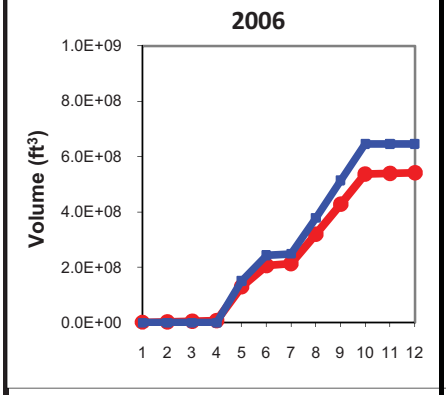
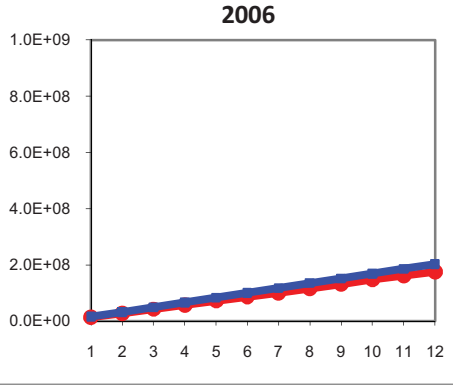
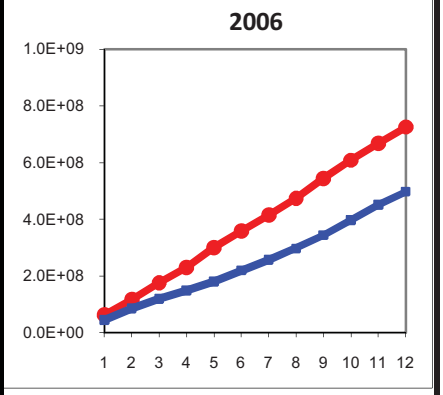
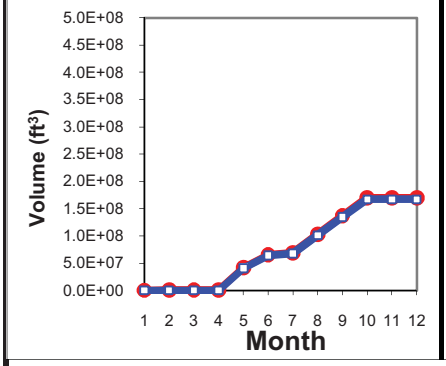
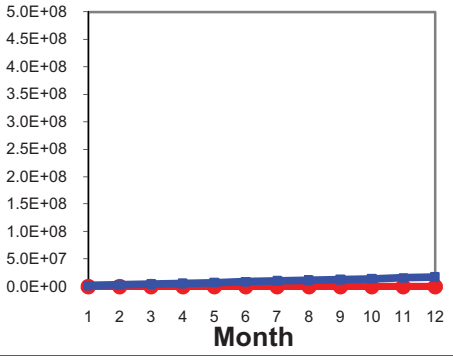
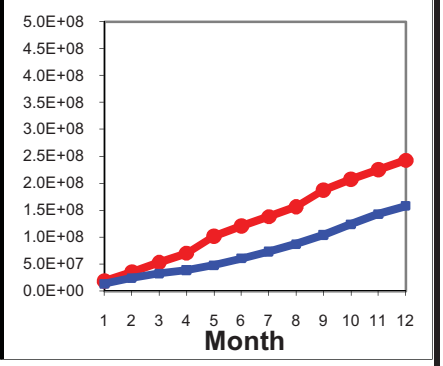
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.38
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik, Main Channel: Area 9, 10, 11 (2006)

Project: 7126	Date: April 2011
Fig F5.49 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.49 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - UT Main Channel (2006).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	SUB-CATCHMENT AREA 13 (NK100B)	
		
	SUB-CATCHMENT AREA 14 (NK119A)	
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

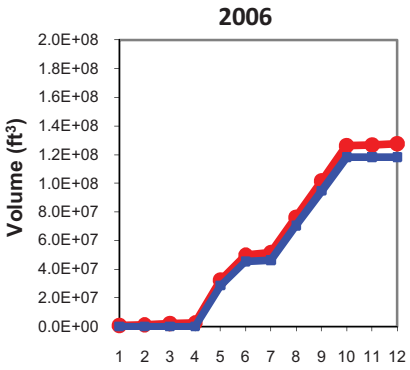
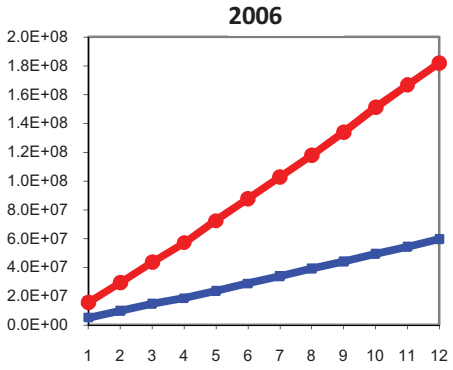
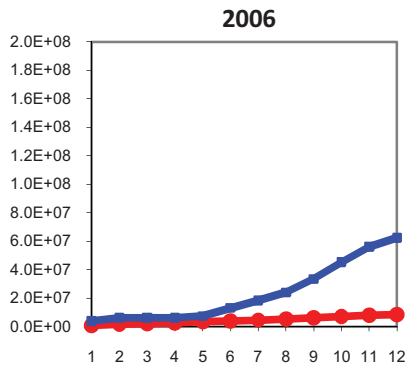
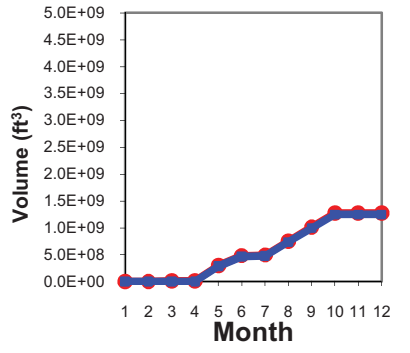
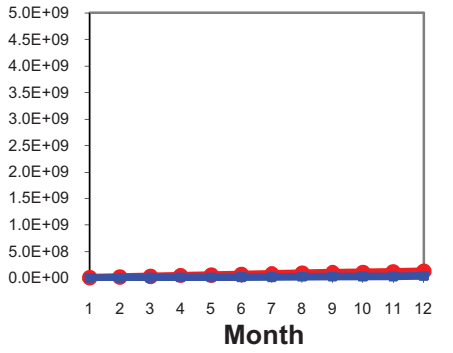
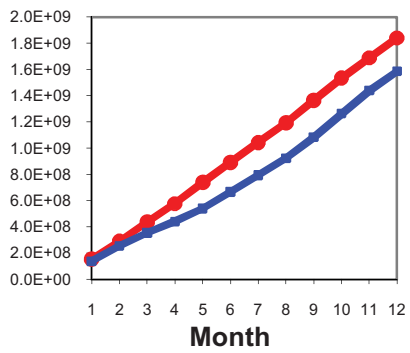
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.39
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli - Area 13, 14
(2006)

Project: 7126	Date: April 2011
Fig F5.50 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.50 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - NFK 13, 14 (2006).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
	SUB-CATCHMENT AREA 12 (NK119B)	
		
	SUB-CATCHMENT AREA 15 (NK100A)	
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

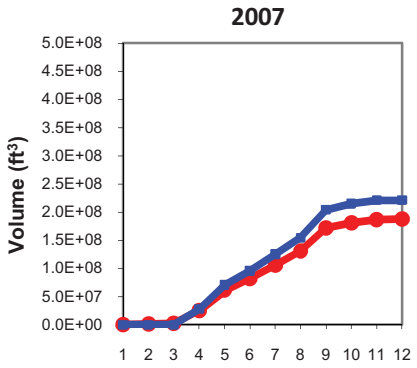
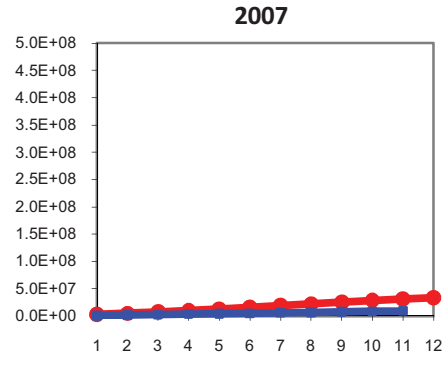
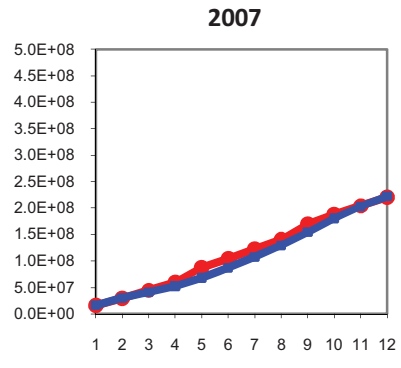
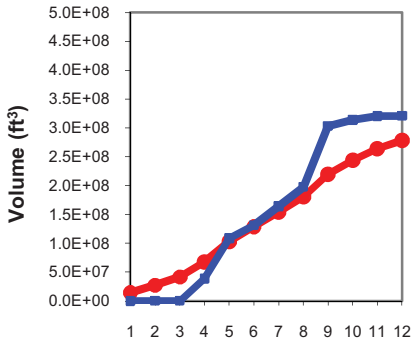
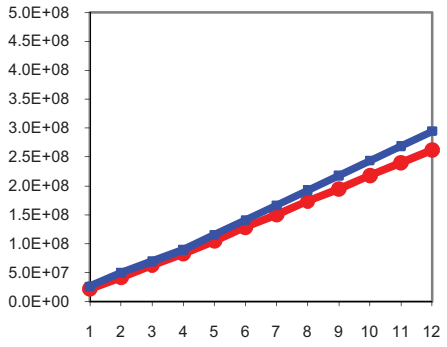
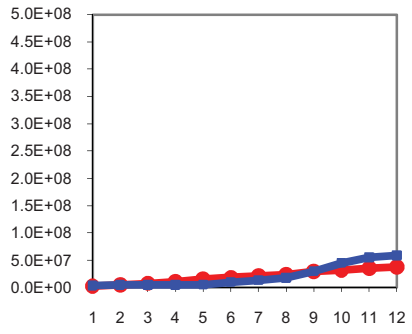
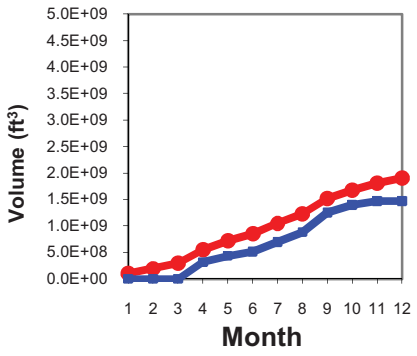
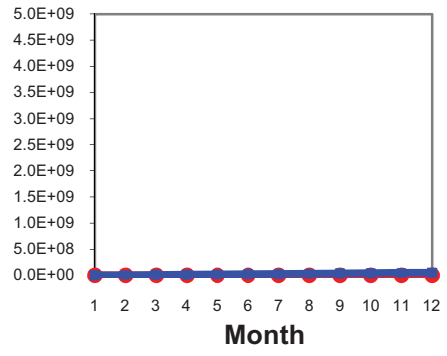
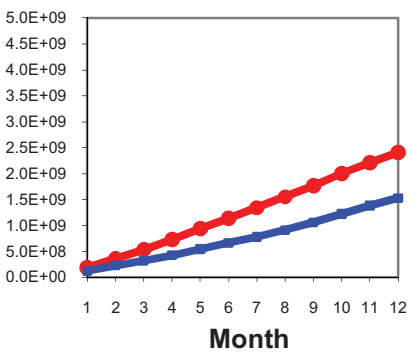
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.40
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli: Area 12, 15
(2006)

Project: 7126	Date: April 2011
Fig F5.51 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.51 - Comparison of Recharge and Discharge from Grou.ndwater and Water Balance Models - NFK 12, 15 (2006).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 1 (SK119A)		
		
SUB-CATCHMENT AREA 2 (SK124A)		
		
SUB-CATCHMENT AREA 8 (SK100A)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

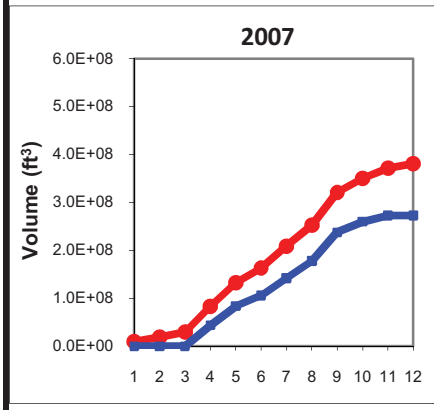
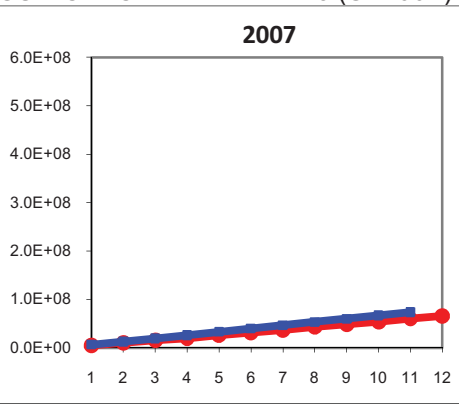
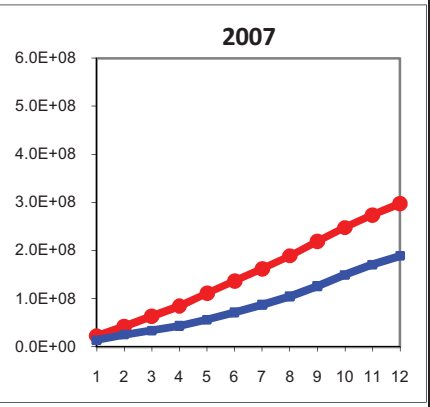
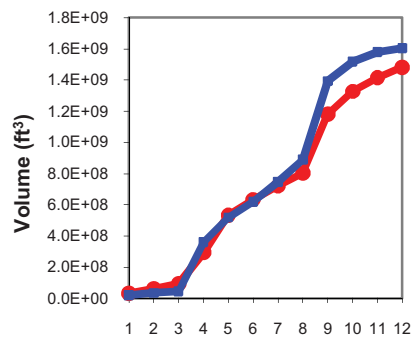
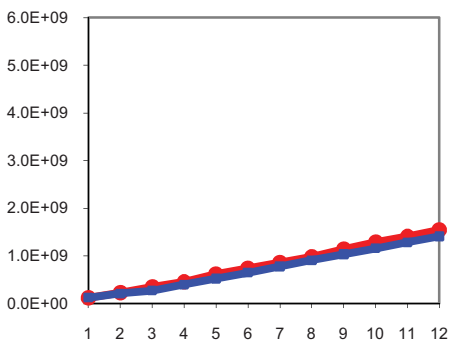
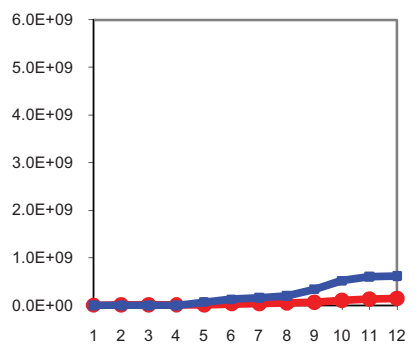
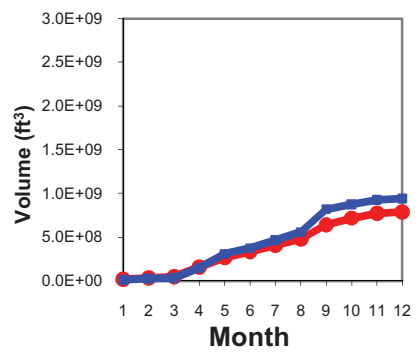
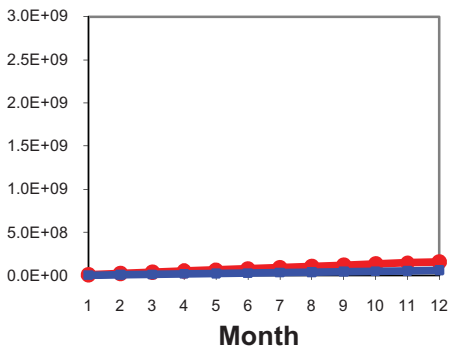
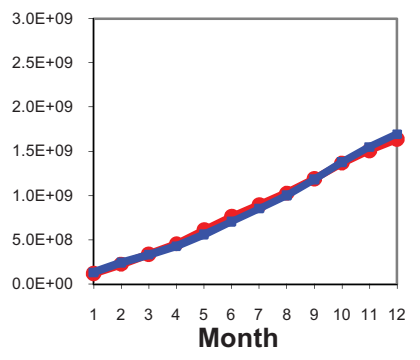
THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.41
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli: Area 1, 2, 8
(2007)

Project: 7126	Date: April 2011
Fig F5.52 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.52 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK Tributaries (2007).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE
SUB-CATCHMENT AREA 3 (SK100F)		
		
SUB-CATCHMENT AREA 5 (SK100C)		
		
SUB-CATCHMENT AREA 4 (SK100B)		
		



Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

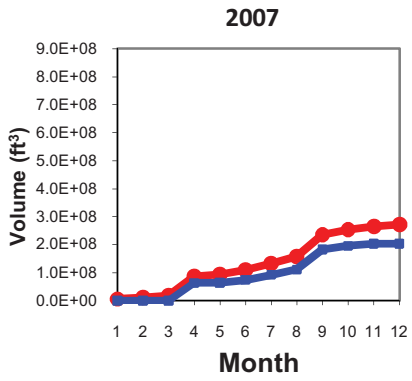
Figure 5.42
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - South Fork Koktuli Main Channel: Area 3, 4, 5 (2007)

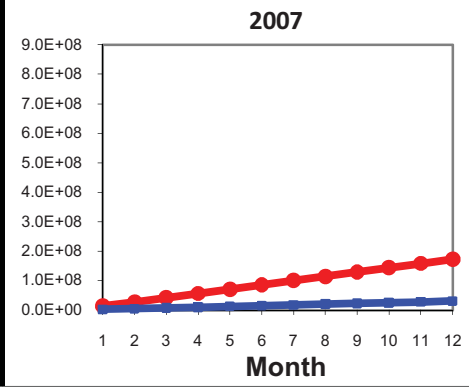
Project: 7126	Date: April 2011
Fig F5.53 Version: 1	Author: SWS-KB

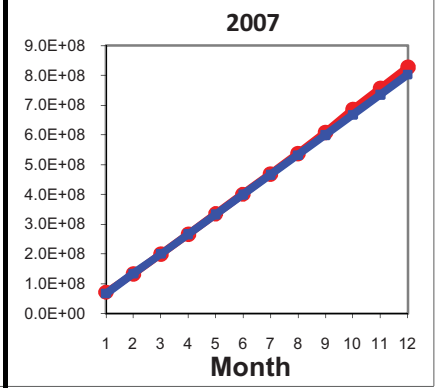
Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.53 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - SFK Main Channel (2007).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

SUB-CATCHMENT AREA 7 (UT119A)









Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

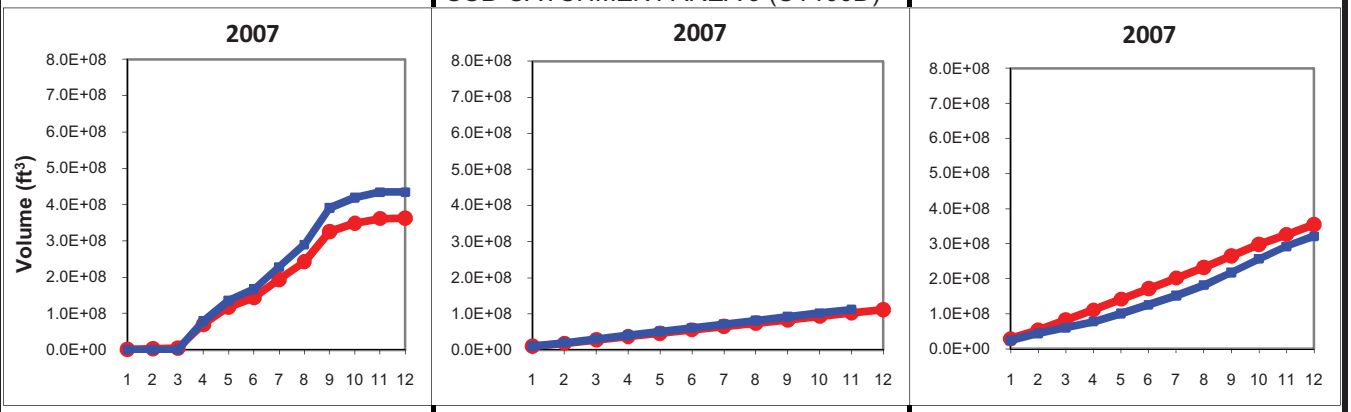
Figure 5.43
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik, Flow from SFK : Area 7 (2007)

Project: 7126	Date: April 2011
Fig F5.54 Version: 1	Author: SWS-KB

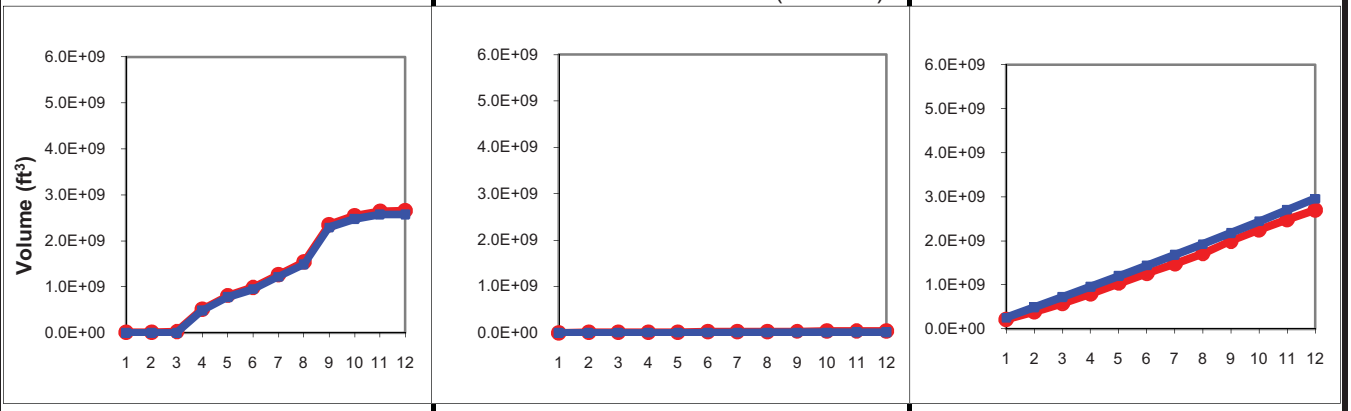
Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.54 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models -UT flow from SFK (2007).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

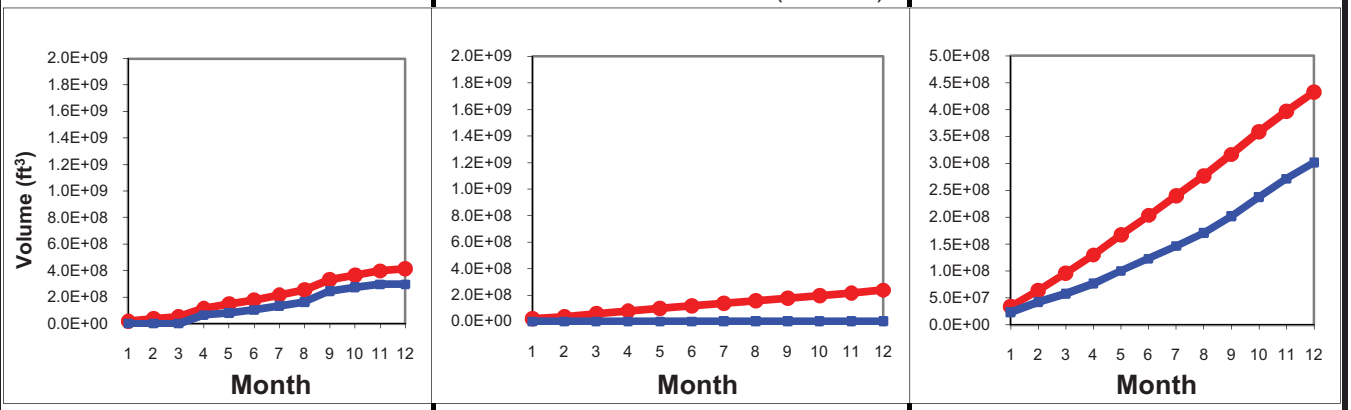
SUB-CATCHMENT AREA 9 (UT100D)



SUB-CATCHMENT AREA 10 (UT100B)



SUB-CATCHMENT AREA 11 (UT100A)





Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

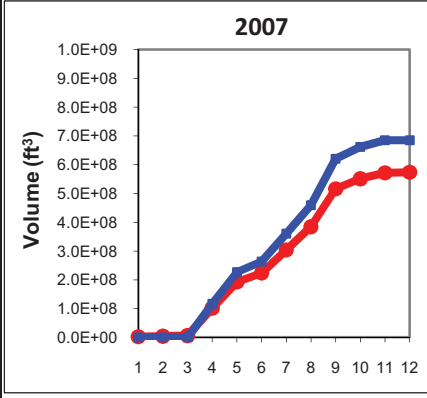
Figure 5.44
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - Upper Talarik, Main Channel: Area 9, 10, 11 (2007)

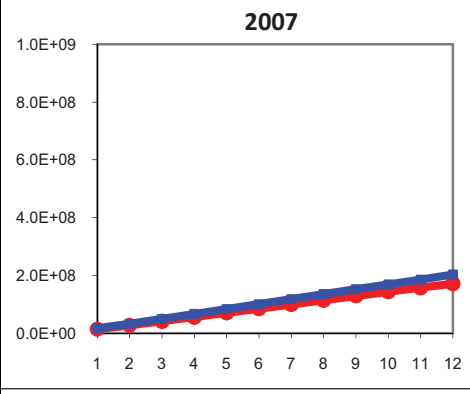
Project: 7126	Date: April 2011
Fig F5.55 Version: 1	Author: SWS-KB

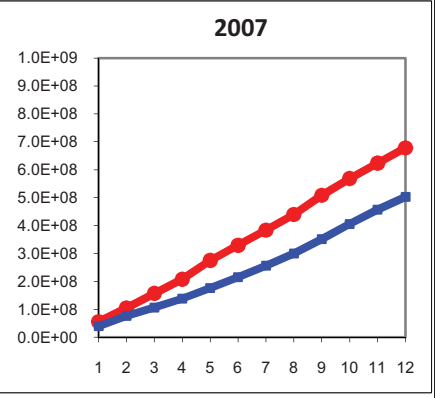
Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.55 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - UT Main Channel (2007).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

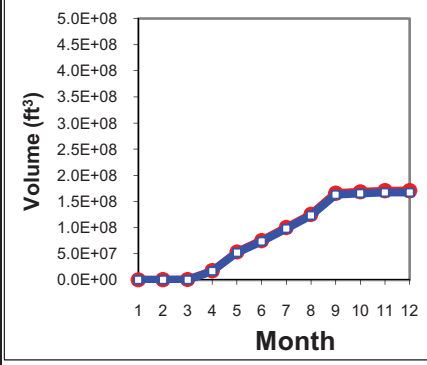
SUB-CATCHMENT AREA 13 (NK100B)

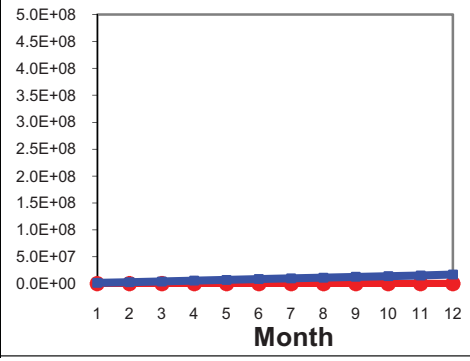


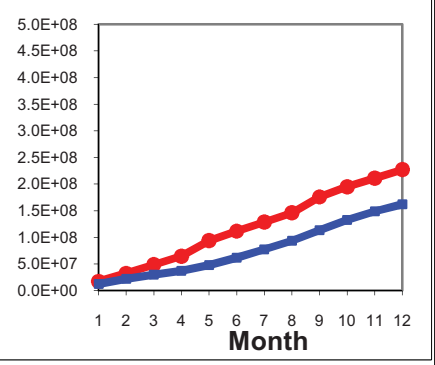




SUB-CATCHMENT AREA 14 (NK119A)









Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

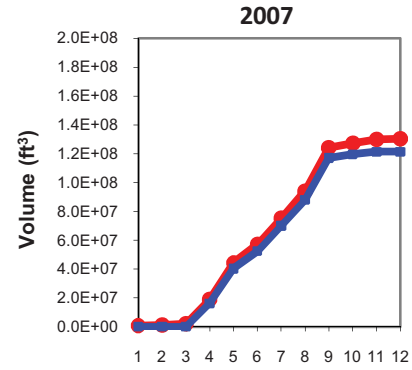
Figure 5.45
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli: Area 13, 14
(2007)

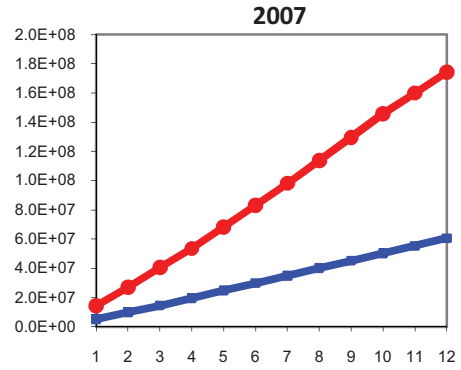
Project: 7126	Date: April 2011
Fig F5.56 Version: 1	Author: SWS-KB

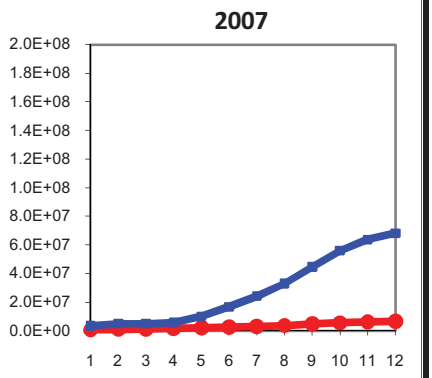
Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.56 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - NFK 13 and 14 (2007).xls

RECHARGE	OFF SITE DISCHARGE	ON SITE DISCHARGE

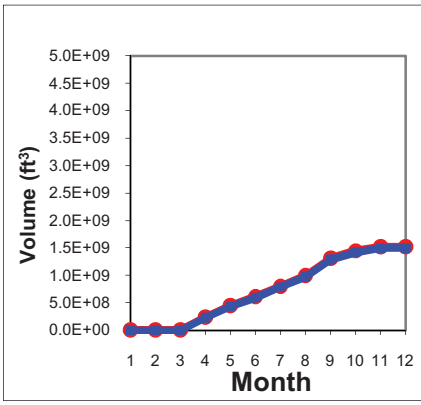
SUB-CATCHMENT AREA 12 (NK119B)

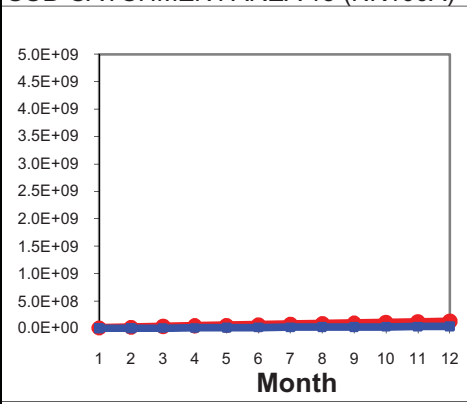


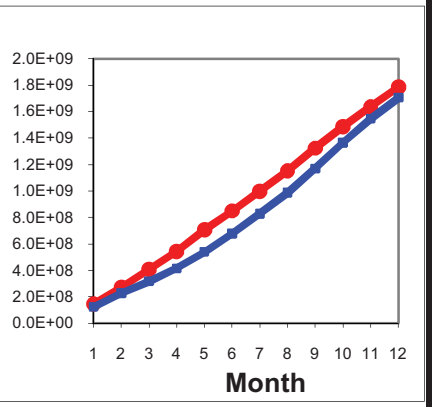




SUB-CATCHMENT AREA 15 (NK100A)









Legend

Groundwater Model

Water Balance Model

Note:
Each sub-catchment area has a corresponding stream guaging station to relate surface and groundwater flows (ex: Area 8 & SK100A)

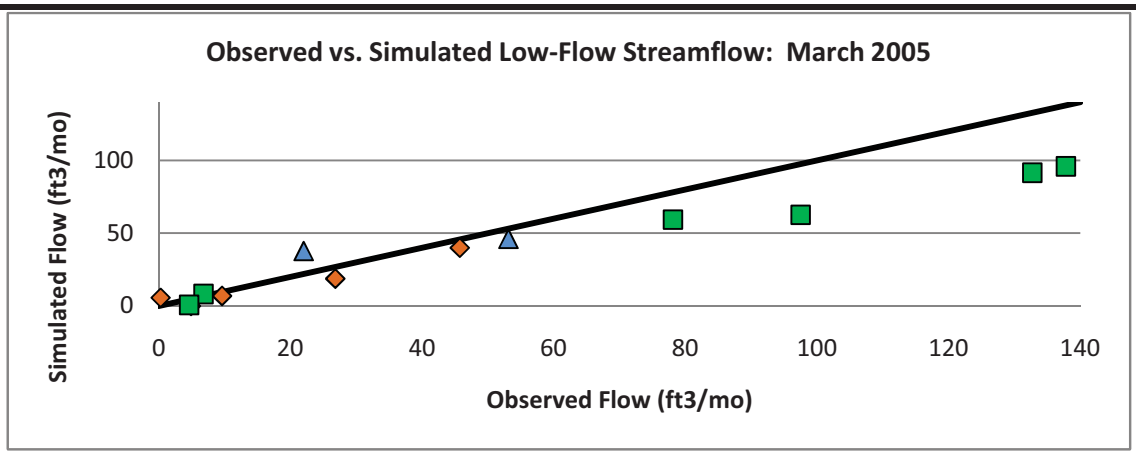
THE pebble PARTNERSHIP

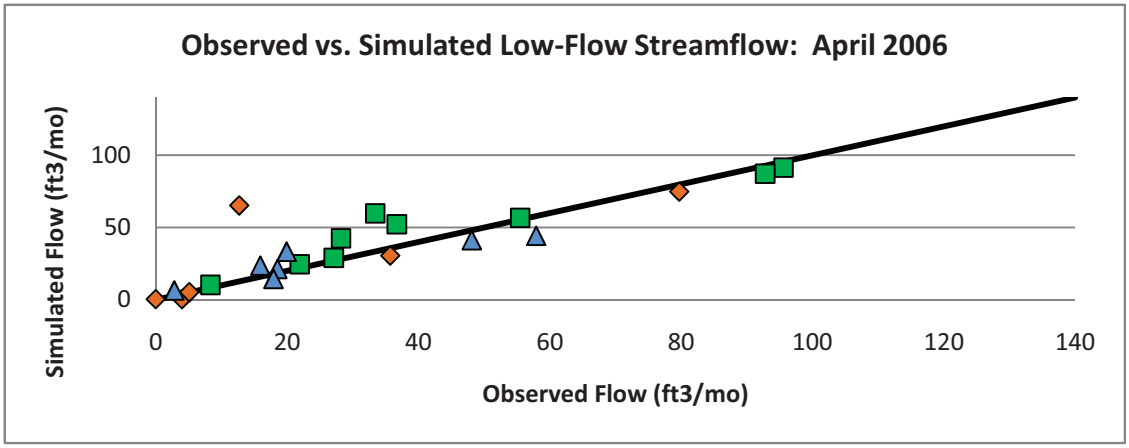
Appendix 8.1J
Groundwater Model Results

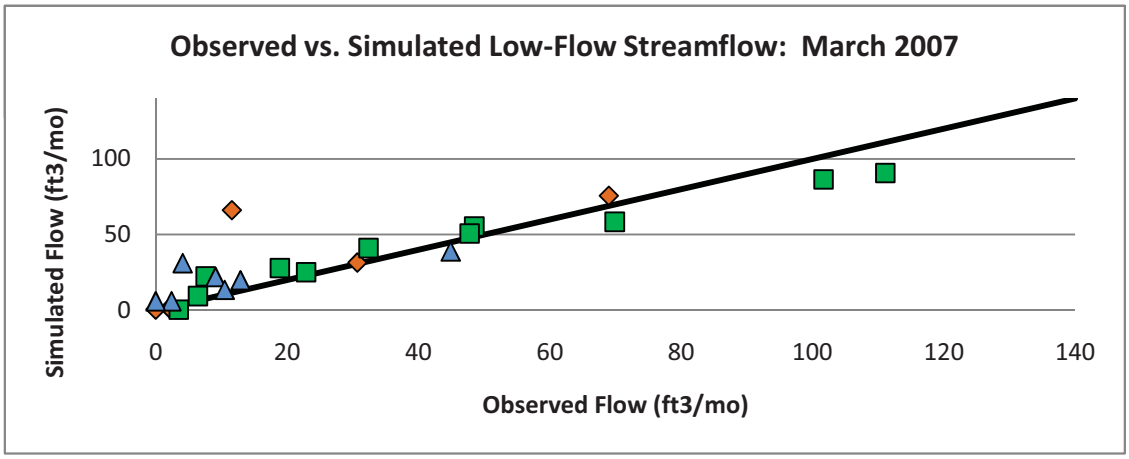
Figure 5.46
Comparison of Recharge and Discharge from Groundwater and Water Balance Models - North Fork Koktuli: Area 12, 15 (2007)

Project: 7126	Date: April 2011
Fig F5.57 Version: 1	Author: SWS-KB

Z:\Pebble_7126_2010\GIS\MXDs\T3987\Figure F5.57 - Comparison of Recharge and Discharge from Groundwater and Water Balance Models - NFK 12 and 15 (2007).xls









Legend

- South Fork Koktuli
- Upper Talarik
- North Fork Koktuli
- Simulated=Observed

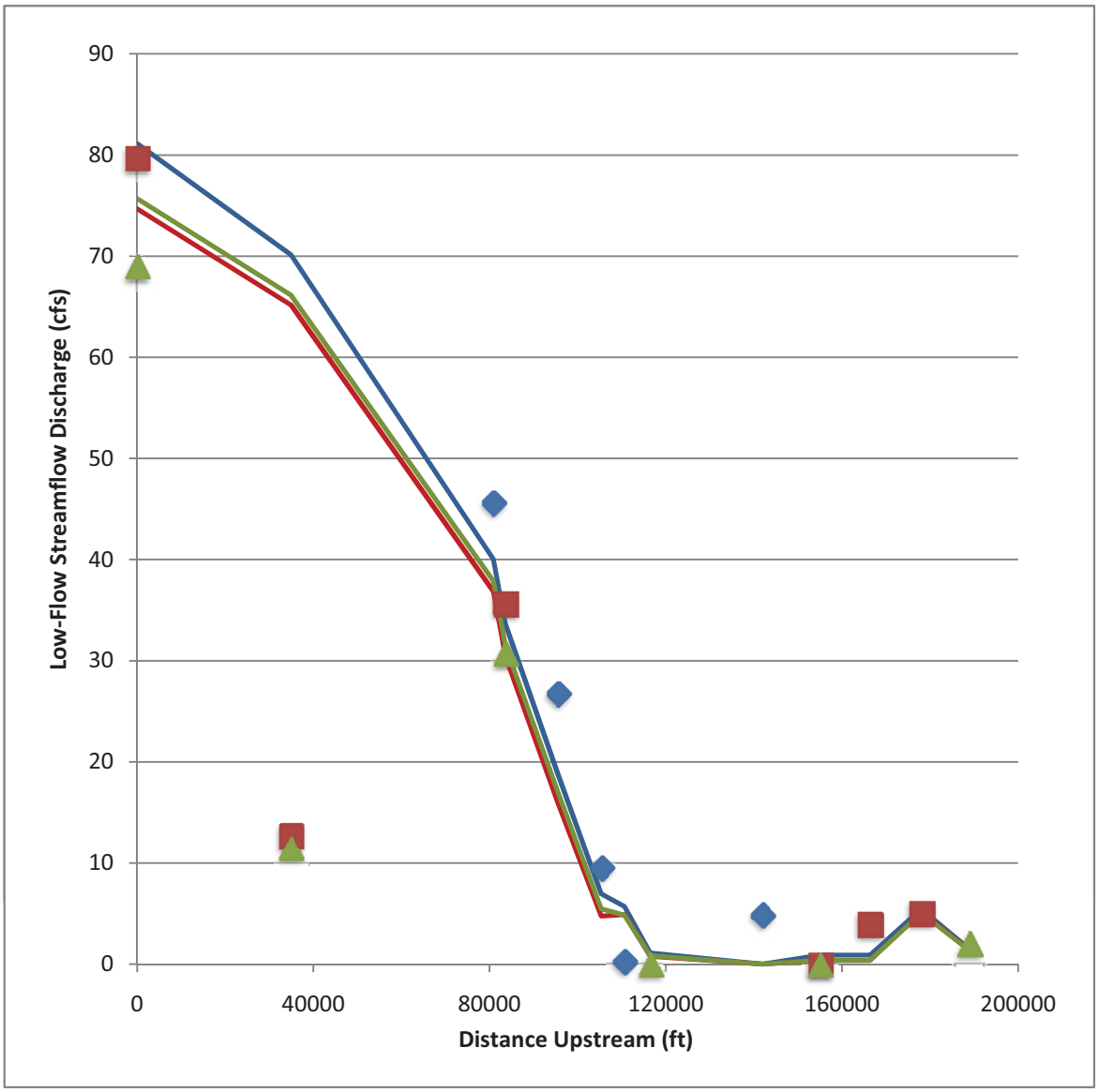
THE pebble PARTNERSHIP

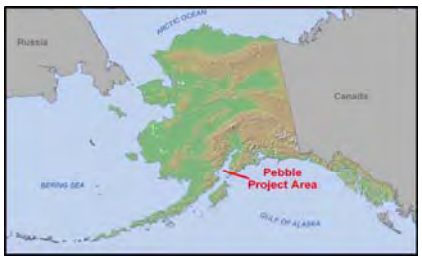
Appendix 8.1J
Groundwater Model Results

Figure 5.47
Observed vs. Simulated Low-Flow Streamflow Scatterplot (March 2005, April 2006, March 2007)

Project: 7126	Date: April, 2011
Fig F5.33 Version: 1	Author: SWS-RR

\\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F5-33 Observed vs Simulated Low-flow Streamflow Scatterplot (March 2005 April 2006 and March 20070.xls





Legend

- 2005-Observed
- 2006-Observed
- 2007-Observed
- 2005-Modeled
- 2006-Modeled
- 2007-Modeled

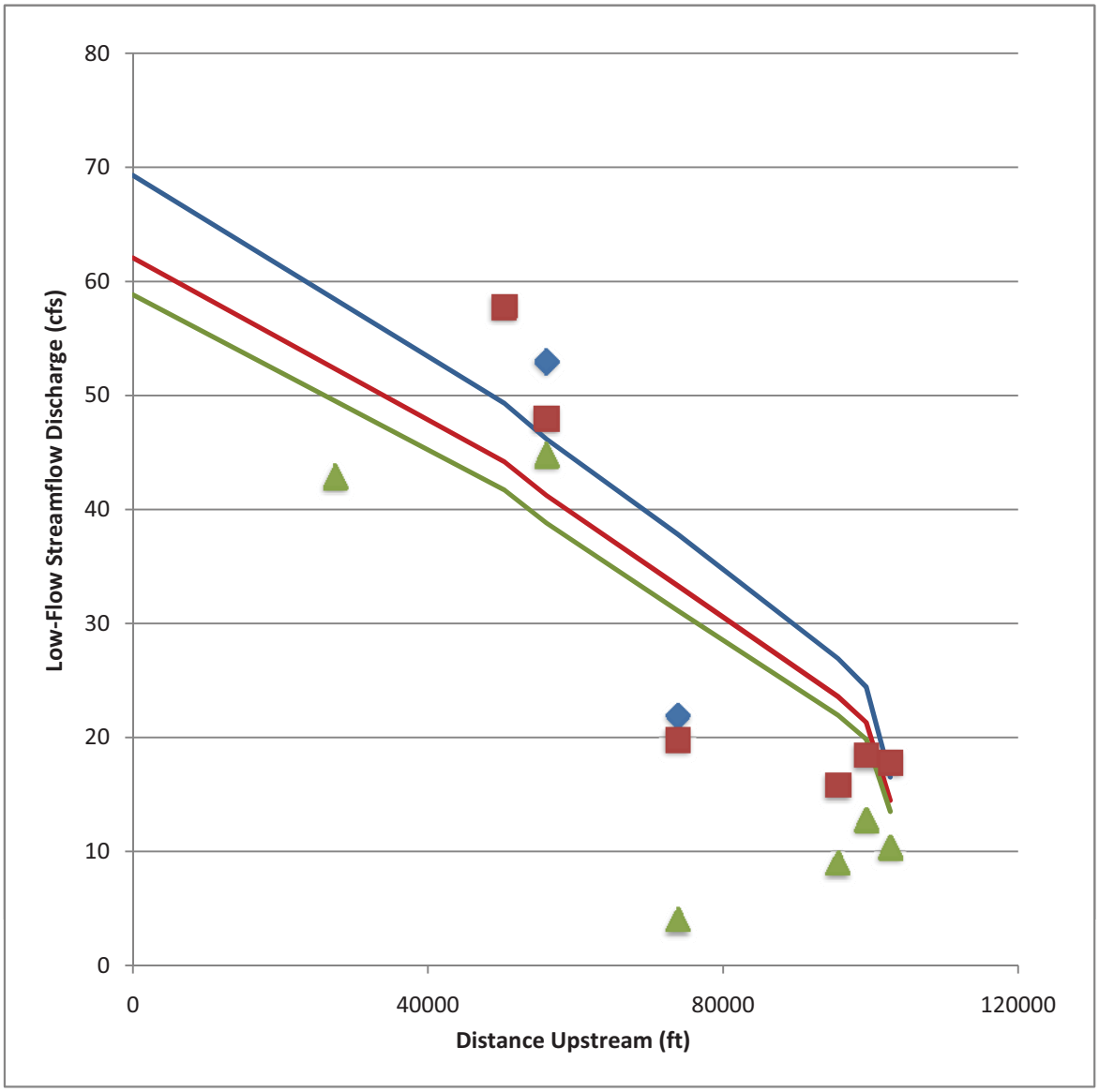
THE pebble PARTNERSHIP

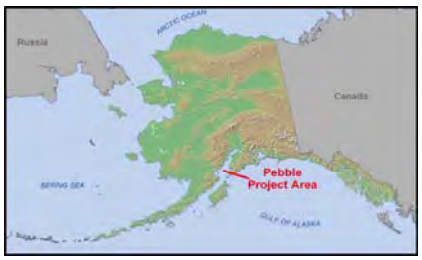
Appendix 8.1J
Groundwater Model Results

Figure 5.48
Streamflow vs Distance Upstream (SFK)

Project: 7126	Date: April, 2011
Fig F5.33 Version: 1	Author: SWS-RR

\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F5-35 Streamflow vs Distance Upstream (SFK).xls





Legend

- 2005-Observed
- 2006-Observed
- 2007-Observed
- 2005-Modeled
- 2006-Modeled
- 2007-Modeled

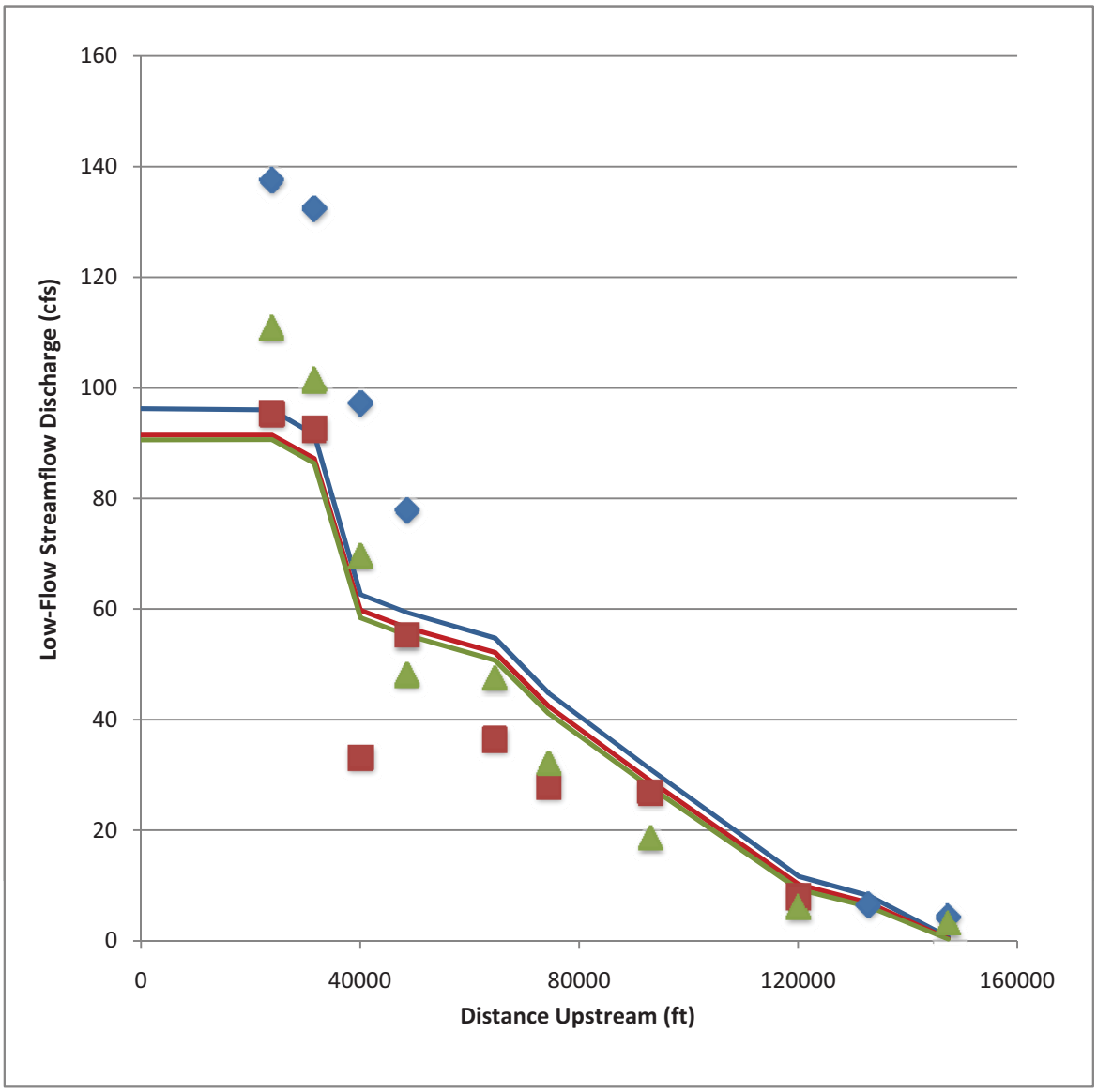
THE pebble PARTNERSHIP

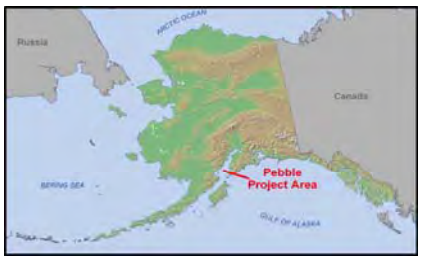
Appendix 8.1J
Groundwater Model Results

Figure 5.49
Streamflow vs Distance Upstream (NFK)

Project: 7126	Date: April, 2011
Fig F5.36 Version: 1	Author: SWS-RR

\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F5-36 Streamflow vs Distance Upstream (NFK).xls





Legend

- 2005-Observed
- 2006-Observed
- 2007-Observed
- 2005-Modeled
- 2006-Modeled
- 2007-Modeled

THE pebble PARTNERSHIP

Appendix 8.1J
Groundwater Model Results

Figure 5.50
Streamflow vs Distance Upstream (UT)

Project: 7126	Date: April, 2011
Fig F5.37 Version: 1	Author: SWS-RR

\Manu\projects\Pebble\reporting\WMC 2008 EBD\Appendix8.1J - Groundwater Model Results\Figure F5-37 Streamflow vs Distance Upstream (UT).xls

APPENDIX 8.1K

Multi-level Groundwater Monitoring System

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF TABLES iv
LIST OF FIGURES (following tables) v
ACRONYMS AND ABBREVIATIONS viii
1. INTRODUCTION 1
2. WESTBAY SYSTEM INSTALLATION AND MONITORING 1
2.1 Geologic Setting 1
2.2 Installation of Westbay Well WB-1 2
2.3 Piezometric Levels 3
2.4 Temperature Distribution 4
2.5 Response Tests 4
2.6 Groundwater Samples 5
3. WESTBAY CROSS HOLE TESTING 5
3.1 Introduction 5
3.2 Methodology 5
3.2.1 Installation of Mosdax Pressure Probes 5
3.2.2 Drilling 6
3.2.3 Air Lift Pumping 6
3.2.4 Recovery 6
3.3 Pre-test Piezometric Responses 6
3.4 Cross-Hole Test #1 - 205 to 640 ft 7
3.4.1 Drilling 8
3.4.2 Air Lift Pumping 8
3.4.3 Recovery 9
3.5 Cross Hole Test #2 – 640 to 950 ft 10
3.5.1 Drilling and Flushing 10
3.5.2 Air Lift Pumping 11
3.5.3 Recovery 12
3.6 Cross Hole Test #3 – 950 to 1,470 ft 12
3.6.1 Drilling and Flushing 12
3.6.2 Air Lift Pumping 13
3.6.3 Recovery 13
3.6.4 Packer testing 14

3.7 Cross Hole Test #4 – 1,506 to 1,906 ft 14
3.7.1 Drilling and Flushing 14
3.7.2 Air lift Pumping 15
3.7.3 Recovery 15
3.8 Cross Hole Test #5 – 1,906 to 2,356 ft 15
3.8.1 Drilling and Flushing 15
3.8.2 Air Lift Pumping 16
3.8.3 Recovery 16
3.9 Cross Hole Test #6 – 2,356 to 2,896 ft 16
3.9.1 Drilling and Flushing 16
3.9.2 Air Lift Pumping 17
3.9.3 Recovery 17
3.10 Cross Hole Test #7 – 2,896 to 3,317 ft 18
3.10.1 Drilling and Flushing 18
3.10.2 Air Lift Pumping 19
3.10.3 Recovery 19
3.11 Cross Hole Test #8 – 3,317 – 3,700 ft 19
3.11.1 Drilling and Flushing 19
3.11.2 Air Lift Pumping 20
3.11.3 Recovery 20
3.12 Cross Hole Test #9 - 3,700 to 4,050 ft 21
3.12.1 Drilling and Flushing 21
3.12.2 Air Lift Pumping 21
3.12.3 Recovery 21
3.13 Cross-Hole Testing Summary 22
3.14 Groundwater Sampling 22
4. CROSS HOLE TEST ANALYSIS 23
4.1 Introduction 23
4.2 Conceptual Setting of Cross Hole Tests 23
4.2.1 Method 23
4.2.2 Shallow Bedrock 24
4.2.3 Hydrogeologic Unit 1 (HGU1) 24
4.2.4 Hydrogeologic Unit 2 (HGU2) 24
4.2.5 Hydrogeologic Unit 3 (HGU3) 25
4.2.6 Hydrogeologic Unit 4 (HGU4) 25
4.2.7 Hydrogeologic Unit 5 (HGU5) 26
4.2.8 Hydrogeologic Unit 6 (HGU6) 26
4.2.9 Hydrogeologic Unit 7 (HGU7) 27

4.2.10 Hydrogeologic Unit 8 (HGU8) 27
4.2.11 Summary of Hydrogeologic Units 27
4.3 HGU1 Analysis 27
4.3.1 Test #1 27
4.3.2 Test #2 28
4.4 HGU2 Analysis 28
4.4.1 Test #2 28
4.4.2 Test #3 29
4.5 HGU3 Analysis 29
4.5.1 Test #3 29
4.5.2 Packer Test 29
4.5.3 Test #4 29
4.6 HGU4 Analysis 30
4.6.1 Test #4 30
4.6.2 Test #5 30
4.6.3 Test #6 30
4.7 HGU5 Analysis 30
4.7.1 Test #6 31
4.7.2 Test #7 31
4.8 HGU6 and HGU7 Analysis 31
4.8.1 Test #7 31
4.8.2 Test #8 31
4.8.3 Test #9 32
4.9 Summary of Cross Hole Test Analysis 32

LIST OF TABLES

Table 2.1, Simplified Geology of Drillholes

Table 2.2, Dip and Azimuth Survey

Table 2.3, WB-1 Pressure Profiling Dates

Table 3.1, Location of Monitoring Zones and Pressure Probes in WB-1

Table 3.2, Test Zones in DH-8417

Table 3.3, Calculated Difference Between WB-1 Pressure Profiles on May 21 and May 25

Table 3.4, Test #1 Sequence of Activity

Table 3.5, Measured Air Lift Rates During Test #1

Table 3.6, Summary of Pressure Response to Test #1

Table 3.7, Test #2 Sequence of Activities

Table 3.8, Measured Air Lift Rates During Test #2

Table 3.9, Summary of Pressure Response to Test #2

Table 3.10, Test #3 Sequence of Activities

Table 3.11, Summary of Pressure Response to Test #3

Table 3.12, Test #4 Sequence of Activities

Table 3.13, Summary of Pressure Response to Test #4

Table 3.14, Test #5 Sequence of Activities

Table 3.15, Pumping Rate During Test #5

Table 3.16, Summary of Pressure Response to Test #5

Table 3.17, Recovery from Test #5 in DH-8417

Table 3.18, Test #6 Sequence of Activities

Table 3.19, Summary of Pressure Response to Test #6

Table 3.20, Test #7 Sequence of Activities

Table 3.21, Summary of Pressure Response to Test #7

Table 3.22, Test #8 Sequence of Activities

Table 3.23, Summary of Pressure Response to Test #8

Table 3.24, Test #9 Sequence of Activities

Table 3.25, Summary of Pressure Response to Test #9

Table 3.26, DH-8417 Water Sample Characteristics

Table 4.1, Summary of Hydrogeologic Units (HGUs)

Table 4.2, Summary of Estimated Hydraulic Conductivities from Cross-Hole Testing

LIST OF FIGURES (following tables)

Figure 1.1, Location Plan

Figure 2.1, Section through WB-1

Figure 2.2, Piezometric Profiles Measured in WB-1

Figure 2.3, Time Histories for Depths of 150 to 700 ft in WB-1

Figure 2.4, Time Histories for Depths of 700 to 1300 ft in WB-1

Figure 2.5, Time Histories for Depths of 1300 to 2800 ft in WB-1

Figure 2.6, Time Histories for Depths of 2800 to 4000 ft in WB-1

Figure 3.1, Estimated Pumping Rate with 200 ft of BQ air line in HQ rods

Figure 3.2, Comparison of Mosdax Pressure Data with Pre-test Pressure Data

Figure 3.3, Test #1, Variation of Pre-test Piezometric Levels in Probes #1 to #9

Figure 3.4, Test #1, Variation of Pre-test Piezometric Levels in Probes #10 to #15

Figure 3.5, Test #1, Variation of Pre-test Piezometric Levels in Probes #15 to #20

Figure 3.6, Test #1, Piezometric Response to Drilling and Testing

Figure 3.7, Test #1, Pressure Change in WB-1 as a Result of Air Lift

Figure 3.8, Test #1, Manual Water Level Recovery Measurements in DH-8417

Figure 3.9, Test #2, Piezometric Response to Drilling and Testing

Figure 3.10, Test #2, Pressure Change in WB-1 as a Result of Air Lift, probes #1 to #14

Figure 3.11, Test #3, Piezometric Response to Drilling and Testing, probes #1 to #9

Figure 3.12, Test #3, Piezometric Response to Drilling and Testing, probes #10 to #14

Figure 3.13, Test #3, Pressure Change in WB-1 as a Result of Air Lift, probes #1 to #16

Figure 3.14, Test #3, DH-8417 Recovery after Pumping

Figure 3.15, Test #4, Piezometric Response to Drilling and Testing

Figure 3.16, Test #5, Piezometric Response to Drilling and Testing, upper probes

Figure 3.17, Test #5, Piezometric Response to Drilling and Testing, lower probes

Figure 3.18, Test #5, Pressure Change in WB-1 as a Result of Air Lift, probes #19 to #8

Figure 3.19, Test #5, DH-8417 Response to Air Lift

Figure 3.20, Test #6, Response of WB-1 to Coring through Granodiorite

Figure 3.21, Test #6, Piezometric Response to Drilling and Testing

Figure 3.22, Test #6, Pressure Change in WB-1 due to Pumping, probes #19 to #8

Figure 3.23, Test #6, Pressure Measured in DH-8417 during Air Lifting and Recovery

Figure 3.24, Test #7, Piezometric Response to Drilling and Testing, probes #10 to #14

Figure 3.25, Test #7, WB-1 Response, probes #6 to #10

Figure 3.26, Test #7, Pressure Change in WB-1, probes #2, 4, 5, and 15 to 19

Figure 3.27, Test #7, Pressure Change in WB-1, probes #15 to #4

Figure 3.28, Test #7, DH-8417 Response to Airlifting and Recovery

Figure 3.29, Test #8, Piezometric Response to Drilling and Testing

Figure 3.30, Test #8, Response to Drilling and Testing, upper probes

Figure 3.31, Test #8, Pressure Change in WB-1, probes #15 to #4

Figure 3.32, Test #8, DH-8417 Recovery after Air Lift

Figure 3.33, Test #9, WB-1 Response to Coring

Figure 3.34, Test #9, Piezometric Response to Drilling and Testing

Figure 3.35, Test #9, Pressure Change in WB-1 as a Result of Pumping

Figure 3.36, Test #9, Pressure Recorded in DH-8417 during Pumping and Recovery Tests

Figure 3.37, Cross-Hole Testing – Summary of Field Results

Figure 4.1, Conceptual Setting for HGU1 Pumping Tests

Figure 4.2, Test #1, Response of MX Probes #1 to #5

Figure 4.3, Test #1, Drawdowns and Constant Head in Leaky Aquifer Simulations

Figure 4.4, Test #1, Double Porosity Simulation, probe #2

Figure 4.5, Test #1, Double Porosity Simulation, probe #3

Figure 4.6, Test #1, Double Porosity Simulation, probe #4

Figure 4.7, Test #1, Double Porosity Simulation, probe #5

Figure 4.8, Conceptual Setting for HGU2 Pumping Tests

Figure 4.9, Test #1, 2, 3, Drawdowns Measured during Air Lift, probe #2

Figure 4.10, Test #3, Double Porosity Analytic Simulation, probe #8

Figure 4.11, Conceptual Setting for HGU3 Pumping Tests

Figure 4.12, Packer Test Pressure Flow Plot

Figure 4.13, Conceptual Setting for HGU4 Pumping Tests

Figure 4.14, Test #4, Dual Porosity Curve Fit, probe #18

Figure 4.15, Test #5, Semi-Log Drawdown Plots, probes #10 to #18

Figure 4.16, Test #6, Semi-Log Drawdown Plot, probes #14 through 19

Figure 4.17, Conceptual Setting for HGU5 Pumping Tests
Figure 4.18, Test #6, Drawdown Observed in HGU5
Figure 4.19, Test #6, Recovery Observed in HGU5
Figure 4.20, Test #7, Recovery Observed in HGU5
Figure 4.21, Conceptual Setting for HGU6 Pumping Tests
Figure 4.22, Conceptual Setting for HGU7 Pumping Tests
Figure 4.23, Test #7, Drawdown Observed in HGU6
Figure 4.24, Test #8, Drawdown Observed in HGU6
Figure 4.25, Test #9, Drawdown Observed in HGU6
Figure 4.26, Hydraulic Conductivity Summary

ACRONYMS AND ABBREVIATIONS

ags	above ground surface
bgs	below ground surface
btoc	below top of casing
$CaCl_2$	calcium chloride
EC	electrical conductivity
ft	foot/feet
gpm	gallon(s) per minute
HGU	hydrogeologic unit
ID	inside diameter
IPI	Inflatable Packers International
KP	Knight Piésold
m/s	meters per second
MP	multi-piezometer
OD	outside diameter
^oC	degree Celsius
psi	pound(s) per square inch
SLR	SLR of Alaska
ft^2/day	square feet per day
SWS	Schlumberger Water Services
TOC	top of casing
µS	microSiemens

MULTI-LEVEL GROUNDWATER MONITORING SYSTEM

1. INTRODUCTION

The Pebble Deposit is located in southwestern Alaska. The site is about 200 miles southwest of Anchorage in the Bristol Bay region. The nearest communities to the Pebble Deposit are Iliamna, Nondalton, and Newhalen. Schlumberger Water Services (SWS), formerly Water Management Consultants, was responsible for characterizing the groundwater conditions in the Pebble study.

Packer testing was one of the methods used to evaluate the hydraulic conductivity of the bedrock in the deposit area. Packer testing data collected between 2005 and 2008 in the deposit area were generally limited to the upper 1,000 feet (ft) of bedrock. Limited packer testing in 2008, which targeted faults, provided some additional information about hydraulic conductivity at deeper depths. To augment the data collected from packer testing, a Westbay® multi-piezometer (MP) system was installed in drillhole 6349 (WB-1) to collect hydrogeologic information to a depth of approximately 4,000 ft. This installation was used to monitor resulting piezometric response due to air lift pumping in an adjacent drillhole (DH-8417). Unlike packer testing, which is limited to monitoring the response in the same hole that is pressurized, this cross-hole approach provides a more in-depth understanding of the hydraulic conductivity distribution at depth.

The Westbay system was installed in drillhole 6349 between October 24 and November 19, 2006, and was completed with 50 packers, 50 measurement ports, and 25 pumping ports. The location of 6349, labeled WB-1 in this report, is illustrated on Figure 1.1. Several test procedures were intended to be carried out at the Westbay system monitoring well including response testing, water quality sampling, piezometric profiling, and cross-hole testing. However, WB-1 was drilled with bentonite mud and, therefore, some of the formation was damaged near the hole. The Westbay system, therefore, was used only for piezometric profiling and monitoring of pressure changes while DH-8417 was pumped (cross-hole testing).

Eighteen sets of piezometric levels were collected from the Westbay system up to the end of 2008. These data provide an understanding of the vertical gradients at the site and the influence of seasonal recharge, barometric variations, and earth tides on piezometric pressures.

These activities and the results are presented in this document.

2. WESTBAY SYSTEM INSTALLATION AND MONITORING

2.1 Geologic Setting

The bedrock geology at the location of the Westbay installation includes the following (Figure 2.1):

- Over the lower portion of the hole, the pre-tertiary granitic intrusion is present (white zone on Figure 2.1) and is overlain by a pre-tertiary mudstone.
- The upper portion of the hole is logged as interbedded tertiary sediments and volcanics.
- Both WB-1 and the adjacent drillhole DH-8417 intersect two steeply dipping faults: ZE and ZEc. These faults strike approximate west to east and dip towards the south. Other broken zones are present in the core, which may be faults but have not been traced through several holes, as have the ZE and ZEc structures.

Table 2.1 summarizes lithology profiles of WB-1 and DH-8417 with interpreted ZE and ZEc fault intersections (in feet below ground).

The true dip and azimuth of WB-1 was surveyed at three depths and DH-8417 was surveyed at seven depths. Table 2.2 presents the measured dip and azimuth for both DH-8417 and B-1 locations. There are no measurements in WB-1 below the 3,000 foot depth. If the same trend of dip and azimuth is applied for deeper depth intervals, the distance between the drillholes increases but the small deviation in distance does not impact the validity of the test.

2.2 Installation of Westbay Well WB-1

Westbay well WB-1 was installed in borehole NDM-6349 between October 24 and November 19, 2006, by Westbay Instruments Inc. (Westbay). The purpose of WB-1 was to provide hydrogeologic characterization of the deep bedrock in the Pebble Deposit area. The description of the WB-1 installation provided in this section is based on the Completion Report Westbay System Monitoring Well: NDM 6349 dated January 15, 2007, prepared by Westbay.

NDM-6349 was drilled to a depth of 4,054 ft using wire-line coring methods. PQ-size (3.4-inch inside diameter [ID]/4.9-inch outside diameter [OD]) surface casing was installed and cemented to a depth of 150 feet. The borehole was drilled at HQ-size (3.4-inch OD) to a reported depth of 4,054 ft. Bentonite mud was used as the drilling fluid during drilling. Geophysical logs, including caliper logs, were run in the borehole. Near the end of drilling, the installation design for WB-1 was developed based on the core, core logs, and information available from geophysical logs. Knight Piésold (KP), SWS, and Westbay had input regarding the installation design. The WB-1 installation design included the following elements:

- 50 monitoring intervals (monitoring zones), varying in length from 10 to 125 ft from a depth of 148.4 to 4,054 ft.
- 50 measurement ports (varying in depth from 158.4 to 4,034 ft) to permit the measurement of fluid pressure and collection of fluid samples from all of the monitoring zones.
- 24 pumping ports (varying in depth from 173.4 to 3,967 ft) to provide purging and hydraulic conductivity testing capabilities in 24 of the 50 monitoring zones.

The borehole was flushed with clean water for several days in an attempt to remove residual drill mud and cuttings prior to the WB-1 installation. The HQ rods (2.5-inch ID/3.4-inch OD) acting like a guide tube were used as a guide to lower the WB-1 casing components into the borehole. The MP packers were inflated sequentially beginning at the bottom of the well using clean water with some biodegradable

antifreeze to permit handling of the water in cold weather. After packer inflation was completed, fluid pressures were measured at each measurement port.

Westbay representatives provided training to SLR Alaska (SLR) to operate and maintain the installed WB-1 system.

2.3 Piezometric Levels

Eighteen pressure profiles were collected from the 50 measuring ports from the time of installation to the end of 2008 as shown in Table 2.3. In late 2007, equipment problems resulted in no measurements for a period of 3 months. Cross-hole testing activities resulted in no profiles collected from June 2008 through September 2008. However, over that time period, data was collected from WB-1 almost continuously.

The piezometric head at a measurement port on the WB-1 system can be calculated using the following two alternative equations:

Equation 1 (Equation 1)

$$H = D - \left(\frac{P_2 - P_{atm}}{\gamma} \right)$$

where

H is the piezometric head measured based on the ground surface as datum (ft).

D is the depth to the measurement port (ft).

P_2 is the pressure at the measurement port outside the Westbay casing (pounds per square inch [psi]) (i.e., formation pressure).

P_{atm} is the atmospheric pressure (psi).

γ is the specific weight of the water column above P_2 (psi/ft).

and

Equation 2 (Equation 2)

$$H = L - \left(\frac{P_2 - P_1}{\gamma} \right)$$

where

L is the depth to water inside the casing (ft).

P_1 is the pressure at the measurement port inside the Westbay casing (psi).

γ is the specific weight of the water column represented by the differential pressure zone (psi/ft).

Equation 2 is based on a differential pressure approach and is typically preferable to using Equation 1, because there is generally less uncertainty associated with the calculation for the following reasons:

- The differential pressure approach (Equation 2), unlike the alternative method, is not based on the measurement port depths, which are typically not well constrained in a deep hole.

- The differential pressure measurement, unlike the alternative approach, is not based on the specific weight of the entire water column but only the portion of the column corresponding to the differential pressure zone. Since the specific weight of water changes with depth as a function of temperature and salinity, there is some uncertainty associated with compensating the specific weight for temperature that is decreased by basing the calculation on a smaller portion of the water column.

The piezometric levels to December 2008, shown on Figures 2.2 through 2.6, were calculated based on Equation 1 when water levels were available and based on Equation 2 using an adjusted port depth when water levels were not available. Figures 2.3 through 2.6 show the piezometric levels measured at selected monitoring ports with time compared with the water level measurements collected at a nearby piezometer, P-05-32D. P-05-32D was drilled to 101 ft and screened from a depth of 84 to 99 ft below ground surface (bgs) within bedrock. Bedrock was encountered at P-05-32D at 79 ft bgs.

The following observations are based on the monthly WB-1 pressure measurements to December 2008 (Figures 2.2 to 2.6):

- In the upper 800 ft, the piezometric pressures vary seasonally, with little variation of piezometric distribution with depth. Depth to water varies seasonally from 7 to 20 ft bgs in the upper 800 ft of bedrock
- Between depths of 800 and 1,100 ft, piezometric levels are higher compared to piezometric levels measured in the upper 800 ft of bedrock. The seasonal response decreases with increasing depth (Figure 2.4). Depth to water varies seasonally from 5 to 7 ft bgs at 1,105 ft.
- The measured piezometric pressures at depth of 1485 ft (3 to 7 ft below ground surface in 2008) and a depth of 1625 ft (21 to 28 ft below ground surface in 2008) identified a strong downward gradient in this depth interval.
- The vertical piezometric gradient is close to zero from 1,500 ft bgs (approximate location of the base of the Tertiary) to 3,700 ft bgs. The water levels in this section were generally decreasing over time. Any seasonal response was difficult to define.
- From 3,700 ft to 4,050 ft bgs, the gradient is upwards (water level increasing with depth, Figure 2.6). However, over time, the gradient has been flattening, so that the pressures are more consistent with the zone between 1,500 and 3,700 ft bgs.
- Monthly profiles indicate that the muting of the surface seasonal effects starts at a depth of 800 ft, with very little seasonal response below a depth of 1,100 ft.

2.4 Temperature Distribution

During the measurement process, the temperature of the transducer is also recorded. These data provide an indication of the ground temperature with depth as a result of the geothermal gradient. The temperature recorded at 1,500 ft depth was approximately 17 degrees Celsius (^{o}C) and at 4,000 ft was 35 ^{o}C.

2.5 Response Tests

Response tests were attempted at several monitoring zones in WB-1. Three types of tests were attempted:

- Pulse tests were attempted by allowing a short-term flow through the sampling probe into the casing, then shutting the valve and monitoring the pressure recovery of the test zone.
- Pulse tests were attempted by flowing into a sample bottle to improve the control on the volume of water extracted before the valve was closed.
- Rising head tests were attempted by lowering the water level in the MP casing, then opening a pumping port and allowing water to flow from the test zone into the casing.

None of the above tests provided suitable piezometric and/or flow data for an analysis. The underlying issue was probably the bentonite in the drilling fluid plugging the formation.

2.6 Groundwater Samples

Groundwater sampling was attempted from WB-1. The volumes of water collected were small, presumably because of the bentonite plugging of the drillhole. A pumping port was therefore opened and the water level depressed for an extended period of time in an attempt to bring formation water into the MP casing. A sample was collected and sent to the analytical laboratory. However, due to the low volume removed from the test zone, the sample collected was more representative of casing water than formation water.

3. WESTBAY CROSS HOLE TESTING

3.1 Introduction

The Westbay cross-hole test was carried out from July 4, 2008, to September 22, 2008. The testing consisted of the following steps:

- Installation of 20 pressure probes at selected measurement ports in WB-1.
- Drilling for Test #1.
- Flushing of hole for Test #1.
- Air lift pumping for Test #1.
- Monitoring recovery from Test #1.
- Cementing of Test #1.
- Carrying out the above steps for Tests #2 to #9, although not all hole sections required cementing.

After Test #3, the 20 pressure probes were shifted into the lower portion of WB-1.

3.2 Methodology

3.2.1 Installation of Mosdax Pressure Probes

A string of 20 pressure probes and a datalogger were installed in WB-1 on May 24, 2008, by Westbay. The probes provided continuous multi-level pressure and temperature measurements for the monitoring

zones in WB-1 within the upper 2,522 ft of bedrock. The WB-1 installation design is discussed in section 2.2.

The monitoring zones equipped with a probe for the cross-hole testing to be carried out in the upper 2,500 ft varied in length from 10 to 125 ft with an average length of 70 ft. Table 3.1 shows the design probe and monitoring zone depths, as well as the numbering system assigned for each of the probes as provided by the MOSDAX Probe String Installation Field Record dated May 24, 2008. The probes were moved on August 10, 2008, to provide monitoring of the lower portion of WB-1 (2,500 to 4,050 ft) during drilling of deeper test zones in DH-8417. Table 3.1 also provides the locations of the probes for the August 10 installation.

3.2.2 Drilling

Rig 4 was set up to drill DH-8417. The drilling contractor was Quest Drilling based in the Fraser Valley of British Columbia. SLR was responsible for the supervision of the drilling, air lift testing and recovery portions of the cross-hole testing.

DH-8417 was drilled in nine stages that varied in length from 310 to 550 ft. The test zones were field adapted based on the lithology and drilling conditions encountered in the field during coring of DH-8417 (Table 3.2). The drilling mud used included Purevis 5-08 manufactured by Poly-Drill Drilling Systems, as well as EZ Mud and Penetrol. During drilling, the piezometric response was recorded by the probes in WB-1. In some test zones, the interval was grouted with bentonite cement before proceeding to drill the next test zone. In some cases, where there were flow rates, the hole was not grouted. Packers were used to isolate the test zone in some of these cases.

3.2.3 Air Lift Pumping

After drilling each test zone in DH-8417, the borehole was flushed with clean water and the drill rods were pulled back to the top of the test zone to prepare for hydraulic testing. Air lifting was selected as the pumping method because the diameter of DH-8417 was too small to fit a submersible pump that would produce reasonable flow rates. Air lifting was accomplished by inserting an air line (BQ rods – 1.4-inch ID/2.4 inch OD) approximately 200 ft long into the hole and applying the air pressure to the air line. The head loss through the HQ packer assembly when used was 25 ft of water at a flow rate of 25 gallons per minute (gpm). Figure 3.1 illustrates measured pressure drops and flow rates as a result of pumping from the HQ and NQ (1.9-inch ID/3.0 inch OD) drill rods.

3.2.4 Recovery

The pressure recovery in WB-1 after air lifting was monitored to complement the analysis of the air lifting phase of the cross-hole testing. The recovery monitoring continued until relatively static water level conditions were recovered. During recovery, water levels were measured in the pumped well, DH-8417, when possible, and monitored by the probes in WB-1.

3.3 Pre-test Piezometric Responses

Hourly pressure measurements prior to the start of the cross-hole test were recorded by the MX probes installed in WB-1 from 2:00 pm May 24 to 9:00 am June 21, 2008. Pressure measurements to record the

responses to cross-hole testing activities were begun at 11:19 am on July 4, 2008. All times referenced in this report are with respect to Alaska daylight savings time. The pressure measurements recorded from May 24 to June 21 showed the following results:

- Monthly pressure profiles were measured in WB-1 since the 2006 installation (discussed in section 2.2). The pressures based on the monthly profile carried out on May 21, 2008 (3 days before the installation of the probes), were compared to the measurements by the MX probes on May 25 at 12:00 am, soon after installation. The pressure measurements collected on the two dates were in close agreement as shown on Figure 3.2. The difference between the measurements varied from 0.1 to 1.3 ft as shown in Table 3.3. This difference between the measurements is expected given the 4-day duration between the measurement dates. The comparison indicated that the MX probe measurements starting on May 24 were within the expected range.
- Probes 1 to 8 (150 to 915 ft) increased from the start of the measurements on May 24 to about July 14 when the pressures become more stable. The total increase was 3 ft as shown on Figure 3.3. The increasing pressure trend for probes 1 to 8 is likely a seasonal response to snowmelt recharge. Such seasonal groundwater trends have previously been observed in the top 915 ft of this installation. P05-32D also showed an increase in groundwater level of 4 ft between measurements taken on May 6 and June 24, 2008 (Figure 2.3).
- Monthly profiles indicate that the muting of surface seasonal effects continue with depth from 900 ft, with very little seasonal response below a depth of 1,100 ft.
- Probe 9 (920 to 980 ft) indicates a small seasonal rise in water level from May 24 to June 21, consistent with surface seasonal effects.
- Probes 10 through 20 (Figure 3.4 and Figure 3.5) were relatively stable from week to week once a correction for barometric response was applied.
- Several probes respond to earth tides. This response is most clear with probes 6 to 9. The deeper probes (10 to 20, Figure 3.4 and Figure 3.5) have less sensitive transducers, which may blind any earth tide responses.
- A sharp increase in pressure of 1 ft was observed on June 19 by probes 1 to 5 (to a depth of 630 ft) as shown on Figure 3.3. This sharp increase may have been a response to nearby drilling. A preliminary review of drilling activity (i.e., drill circulation logs provided by SLR and packer test summary sheets) was not successful in identifying the location of the drilling rigs on June 19.

The transducer readings illustrated in Figures 3.3 to 3.5 have been adjusted to remove the influence of barometric pressure changes. Probes 1 to 8 have been adjusted with the full barometric pressure, probe 9 at 75 percent, and the remaining at 35 percent. The piezometric levels have been calculated using nominal port elevations, with no correction for potential casing stretch or changes in density with depth. Therefore, although the piezometric changes are expected to be representative, the absolute piezometric levels may be shifted. For an interpretation of expected piezometric levels with depth, see Section 2.2.

3.4 Cross-Hole Test #1 - 205 to 640 ft

A summary of the activities related to Cross-Hole Test #1 is presented in Table 3.4. PQ surface casing was installed to the top of test zone #1. On July 4, 2008, at 4:15 pm, the surface casing was sealed at 205 ft with bentonite slurry. Following the installation of the surface casing at 205 ft, HQ (2.5-inch ID) coring

from the top of test zone #1 (205 ft) was started at about 5:30 pm July 4 and continued until 8:50 pm July 5. The geology of the interval between 205 and 640 ft was interbedded basalt and volcanic breccias.

WB-1 pressure monitoring during test zone #1 activities was started at 11:19 am July 4 and measured hourly during drilling to a depth of 440 ft, and then measured at 10 minute intervals. Drilling depths and times in DH-8417 that were recorded by SLR were compared to the pressure measurements by WB-1 probes. Figure 3.6 shows drilling depths compared with the pressure measurements during drilling. The pressure-measurement frequency increased at about 6:00 am on July 5, 2008. Following are WB-1 responses to drilling:

- Probe 1 (monitoring zone 148 to 193 ft bgs) did not appear to respond to drilling.
- Probe 2 (268 to 278 ft) first responded to the drilling with a peak of 0.5 ft of water pressure, when DH-8417 was at 233 to 266 ft deep. The variation in pressure until the hole reached 640 ft appears to be due to pressure increases during core runs and decreases between core runs. The ability to see that detail was not available until after the frequency was increased to 10 minutes.
- Probe 3 (328 to 430 ft) first responded when drilling from 266 to 346 ft. As with probe 2, there was continuing response with core runs. An extra increase above that registered by probe 2 occurred when drilling was at 466 to 486 ft.
- Probe 4 (435 to 480 ft) may have responded a little to core runs, but did respond to the larger increase when drilling was at 466 to 486 ft.
- Probe 5 (560 to 630 ft) was very responsive to drilling at a depth of 466 to 486 ft. This probe also responded to core runs, but this was a 2,000 psi transducer compared to 250 psi transducers for probes 1 through 4. The transducer noise, therefore, is nearly the same amplitude as the core runs.

3.4.1 Drilling

Prior to the start of air lifting test zone #1, DH-8417 was flushed with water for 9 hours from about 8:50 pm July 5 to 12:05 am July 6, and again from 12:45 am to 7:30 am July 6. Probes 2, 3, and 5 responded similarly (up to 1 ft of pressure change). The response of probe 4 was slower but reached the same pressure change by the end of the flushing. Probe 5 responded quickest to the flushing, and probe 6 and deeper had very little to no response to flushing. A period of no inactivity after flushing allowed the piezometric levels to approach steady state prior to pumping.

3.4.2 Air Lift Pumping

In preparation for air lifting, the following was carried out:

- The water level in DH-8417 was measured at 10:50 am July 6. The water level measurement was 21.5 ft bgs, which was in agreement with a water level measurement taken earlier by the night crew.
- HQ rods were set at approximately 242 ft bgs, and the air lift line (BQ rods) and stinger (5 ft 3 inches) were advanced to approximately 206 ft bgs.

The air compressor was started at about 12:00 pm July 6 with a pressure of 75 psi. The air lift flow rate was monitored using bucket test measurements. The first airlifting flow rate measurement was recorded at

12:15 pm, followed by additional measurements taken about every 30 minutes until the end of the air lift testing at 5:00 pm July 6 (5 hours of air lifting). The measured air lifting rate was 12 gpm for the duration of the air lifting as shown in Table 3.5.

About 2 hours prior to the end of the airlifting (3:00 pm), SLR measured water pH and electrical conductivity (EC). A pH value of 7.06 and EC value of 253 microSiemens (μS) were measured.

The response to air lifting (Figures 3.6 and 3.7) was as follows:

- Probes 1 to 6 showed the most observable pressure decreases during air lifting.
- The magnitude of the pressure responses at probes 1 to 6 varied from 5.3 ft at probe 2 to 0.7 ft at probe 6 (635 to 725 ft).
- Pressure measurements of the remaining deeper probes showed little (0.2 ft or less) to no change during air lifting.

Similar to drilling, probes 2 through 5 showed the most observable response, further supporting a hydraulic connection between WB-1 and DH-8417. A summary of the pressure responses based on the pressures measured immediately prior to the start of the air lifting at the probes (11:50 am July 5, 2008) and at the end of air lifting (5:00 pm July 5, 2008) is presented in Table 3.6. The drawdown in the air lifting hole DH-8417 was not monitored.

3.4.3 Recovery

The water level recovery in DH-8417 was monitored by transducer and manual measurements. However, the transducer installed in DH-8417 provided suspect data during the recovery period. The first manual water level measurement in DH-8417 was taken about 4 minutes (5:04 pm) after air lifting was stopped and measurements were taken at the following intervals:

- 0.5 to 1 minutes until 5:35 pm July 6 (46 measurements).
- 5 minutes from 5:35 to 5:55 pm July 6 (5 measurements).
- 10 to 20 minutes from 5:55 to 7:00 pm July 6 (5 measurements).
- 30 to 35 minutes from 7:00 to 9:00 pm July 6 (4 measurements).
- 55 to 70 minutes from 9:00 pm July 6 to 12:20 am July 7 (3 measurements).
- 95 minutes from 12:20 to 1:55 am (1 measurement).
- 2 hours and 45 minutes from 1:55 to 4:40 am (last measurement).

As shown on Figure 3.8, the water level in DH-8417 appears to stabilize about 5 hours after air lifting stopped (10:00 pm July 6). The manual water level measurements increased from 49.4 ft below top of casing (btoc) (5:04 pm July 6) to 32.23 ft btoc (4:40 am July 7) for a total recovery of 17.9 ft during this approximately 12-hour period. Given a top of casing of 10 ft above ground surface (ags), the water level recovered from 39.4 ft bgs to 22.23 ft bgs. This final water level of 22.23 ft is 0.7 ft lower than the water level of 21.5 ft measured prior to the air lift test.

The measurement frequency of the probes in WB-1 was set to record recovery after air lifting stopped with the following intervals:

- 30 second intervals for the first hour.
- 1 minute intervals for the next 3 hours.
- 5 minute intervals from hour 4 to 24 hours.
- 1 hour intervals after 24 hours.

Figure 3.6 includes the recovery until the drillers began to trip the rods at 8:30 am July 7 prior to cementing test zone #1. As shown on Figure 3.6, the probes that responded to air lifting (probes 1 to 6) began to stabilize between 4 to 6 hours (10:00 to 12:00 pm July 6) after air lifting stopped. However, the pressures measured by the probes did not recover to the pressures measured immediately prior to air lifting. The difference in the pressures measured immediately prior to air lifting and just before the rods were tripped to initiate cementing test zone #1 (8:00 am July 7) varied from 1.2 ft at probe 4 to 0.5 ft at probe 6. This was similar to the pumped well recovery (0.7 ft below starting water levels).

The incomplete recovery may suggest one or a combination of the following factors:

- The recovery time period was insufficient in order to observe the recovery. However, since the pressures appear to have stabilized, it is unlikely that the incomplete recovery was a result of an insufficient recovery period.
- The pressures measured by probes 2 to 4 were decreasing after the flushing activity was carried out and before air lifting (Figure 3.6). This could indicate that the starting piezometric water levels did not reach static conditions. However, probe 5 appeared to be stable prior to the test.
- Seasonal and barometric decreases occurred over the observational period. However, barometric changes have been accounted for, and the observed decrease is rather large over the short time period.
- The pressure probes are within a fully bounded groundwater system (compartmentalized). Pumping from the compartment reduced the volume of water and therefore the “static” water level within the compartment.

3.5 Cross Hole Test #2 – 640 to 950 ft

3.5.1 Drilling and Flushing

Cross-Hole Test #2 activities are summarized in Table 3.7. The first tested interval (from 205 to 640 ft) was cemented with a cement-water mixture with calcium chloride ($CaCl_2$) as an accelerant. Pumping well DH-8417 was drilled through the cured cement from 236 (tagged top of cement) to 640 ft on June 10. A soft patch of cement was encountered from 243 to 245 ft. From June 10 to 11, 2008, DH-8417 was drilled through Tertiary volcano-sedimentary formation (mostly compact basalt) to 950 ft. Only the bottom 10 ft of rock of test zone #2 was significantly broken with vertically oriented fractures. No drilling mud losses or gains were reported. The drillhole was flushed with clear water from the evening of July 11 to the next morning.

Following is a summary of the response to drilling monitored by each of the probes in WB-1 (Figure 3.9):

- Probe 1 did not noticeably respond to drilling.
- Probe 2 (268 to 278 ft) responded to drilling the cement and responded a little more to coring of the test section.
- Probes 3 and 4 did not respond noticeably to drilling.
- With probe 5, the transducer noise on this high-range transducer is of the same magnitude as any response to drilling that might be occurring.
- A pressure reduction of 0.4 ft in probe 6 and reduction of 1.1 ft in probe 7 (740 to 810 ft) was recorded when drilling was at a depth of 710 ft. There appears to be some response to drilling following that event.
- A pressure increase of 0.3 ft in probe 8 (815 to 915 ft) and increase of 1.0 ft in probe 9 (920 to 980 ft) was recorded when drilling was at 710 ft. There is response to drilling following that event.
- Probe 2 slightly responded to DH-8417 flushing with a minor pressure increase.

3.5.2 Air Lift Pumping

Pumping test #2 at a depth from 640 to 950 ft started at 5:45 pm on July 12 with a static level in DH-8417 20 ft below ground. The MX probes were set for 1-minute reading intervals. Air pressure for the air lifting was set to 75 psi, and the flow rate stabilized shortly at 4.45 gpm. Measured air lift flow rates are presented in Table 3.8. SLR monitored the flow rate every minute, and measured the pH and electrical conductivity of the pumped water. The pumping was stopped after 19.5 hours the next day at 1:20 pm, at which time the probes were set to 0.5-minute reading intervals. Prior to completion of the pumping test, SLR collected a water sample and measured the flow rate (6 gpm).

The response to pumping is presented on Figure 3.9 and 3.10 and in Table 3.9. There were a number of irregular responses to pumping, including the following:

- The piezometric response to pumping in probes 2 to 5 was about 40 percent of the response to test #1. The pumping rate during test #2 was also 40 to 50 percent of the pumping rate from test zone #1. The implication is that most of the pumping for test #2 tested the same ground as test #1.
- Piezometric levels at probes 6 and 7 increased at the start of the pump test and decreased at the end of the pump test, inverted to the expected behavior. These two probes also dropped in pressure during drilling at the same time as probes 8 and 9 increased.
- Probes 8 and 9 did respond to pumping. However, the response to other drivers, probably primarily earth tides, made definition of the drawdown response difficult.
- The piezometric levels below probe 9 did not respond to pumping, although there was some piezometric shift in probe 18 (2,120 to 2,235 ft). Examination of the plot indicates that it was not related to pumping.

The response to drilling and pumping implies that there was connection to the same “aquifer” that was pumped during test #1. This could be the result of ineffective grouting. However, it is likely that this

indicates that drilling started within the same hydrogeologic "unit" as was pumped by test #1 and that vertical permeability was relatively high.

While drilling at 710 ft, probes 6, 7, 8, and 9 responded: 8 and 9 positively and 6 and 7 negatively. Over the remainder of the drilling, these responses remained opposite. The implication is that probes 8 and 9 connected to a new pathway intersected by the drillhole at a depth of 710 ft. The change in head within this pathway caused a transfer of load to adjacent zones monitored by 6 and 7. Within these zones, the load shift was carried by the water rather than by the structure. This is indicative of relatively low hydraulic conductivity of the materials monitored by these two zones. This low hydraulic conductivity adjacent to the pumped zone is also apparent in the pressure response to drilling.

3.5.3 Recovery

The response of the probes in WB-1 was recorded for 24 hours up to 1:00 pm on July 14, 2008. Monitoring intervals were set the same as during test #1. Then the probes were set to the background reading interval. Recovery was clear in the same monitoring zones where obvious drawdown occurred due to pumping:

- Probes 1, 2, 3, 4, and 5 clearly responded to the end of pumping.
- Some response to the end of the pumping was also noticed by probes 6, 7, 8, and 9.
- It is clear from the response that probes 6 and 7 are not well connected to the pumped horizon.
- Probes 8 and 9 are clearly in a separate hydrogeologic unit from the zone monitored by probes 2 to 5.

The recovery in DH-8417 was monitored, but only a few readings are available. SLR mentioned in an email of July 14, 2008, that static level was reached after 95 minutes.

3.6 Cross Hole Test #3 – 950 to 1,470 ft

3.6.1 Drilling and Flushing

Test interval #2, from 640 to 950 ft, was cemented with a cement-water mixture with $CaCl_2$ as an accelerant. When drilling through the cemented interval, some voids were observed, so the interval was re-cemented up to 300 ft below ground. The hole was then redrilled through the cured cement to 950 ft; through basalt to 1,042 ft; reddish mudstone to 1,186 ft; and volcaniclastic breccia, sandstone, and boulder conglomerate to 1,470 ft on July 18 and 19. There was no significant broken rock or fault zone reported. The drillhole was flushed with clear water, and HQ rods were pulled up to 250 ft below surface. Activities are summarized in Table 3.10.

The WB-1 responses to drilling of test zone #3 are listed below:

- Probes 1 to 5 responded to the cementing with a 1- to 1.5-ft pressure increase from 8:00 pm July 14 to 9:00 am July 16. Then they responded to drilling with a slow pressure drop to July 21 late night, when pumping test #3 started (Figure 3.11).

- Probes 6 and 7 recorded a sudden pressure drop at 3:00 pm July 14 followed by a steady pressure increase of 2 ft until 10:00 pm July 16. After 3 days of steady pressures, the pressure slowly decreased before the pumping test.
- At the same time at 3:00 pm July 14, pressure in probes 8 and 9 increased suddenly. This type of response was also documented during drilling and pumping of test zone #2. The monitoring zones equipped with probes 8 and 9 apparently responded to the increased pressure of the grout in DH-8417.
- Probes 6, 7, 8, and 9 continued to respond to earth tides through the drilling period.
- Probes 10 (1,060 to 1,090 ft) and 11 (1,140 to 1,220 ft) marginally responded to drilling and flushing on July 21. Deeper probes did not show any significant response to the cementing and drilling (Figure 3.12).

3.6.2 Air Lift Pumping

The pumping test started several minutes before midnight on July 22, 2008 and was finished 24.2 hours later. The pumping rate was relatively stable and varied from 5 to 7 gpm. Test #3 was interrupted at about 4:00 pm for about 20 minutes to check the water level in the air line. The level was at 73.3 ft below the top of rods 10 minutes after the interruption. Seven minutes later the level was measured at 45 ft. The pressure response prior to air lifting and at the end of the test is presented in Table 3.11.

The response to the pumping test was as follows (Figures 3.11 through 3.13):

- Probe 1 showed a 0.9-ft drop.
- The pressure drop was more than 2 ft in probe 3 and only slightly less in probes 2, 4, and 5.
- Probes 6 and 7 show some limited response to the pumping (a drop of 0.6 and 0.8 ft, respectively).
- Probe 8 (815 to 915 ft) responded to the pumping with a pressure drop exceeding 3.5 ft.
- A marginal pressure drop in probe 9 was likely due to the recovery after drilling.
- Probe 11 recorded a pressure drop. However, there was a pressure increase recorded by probe 11 (1,140 to 1,220 ft) of 1.5 ft just before the pumping test.

3.6.3 Recovery

The recovery in DH-8417 was recorded by a transducer and datalogger, which was above the dynamic level in the hole. This transducer started to measure groundwater level about 24 minutes after the pumping test was finished. Figure 3.14, which shows the recovery in DH-8417, illustrates that the groundwater level did not reach the pre-pumping static level after more than 10 hours of recovery.

The probes in WB-1 recorded the recovery after the pumping test. The recovery was somehow affected by rig activities. HQ rods were lowered during a day shift of July 24. The rods had to be reamed through a depth interval from 1,100 to 1,200 ft, formed by mudstone with red clay, which was possibly a fault.

Recovery observations in WB-1 are:

- The recovery in probes 1 to 5 stabilized in 12 hours at 60 percent recovery in probes 3 and 5 and 30 percent recovery in probe 1.
- Probes 6, 7, and 9 did not respond to the recovery.
- Probe 8 kept dropping for 6 hours, followed by a very slow pressure increase. The next day, the pressure increase was more distinct and reached 70 percent recovery on June 28, likely due to drilling activity in DH-8417.
- Deeper probes did not respond to the recovery.
- Probe 11 pressure recovery started before the end of the pumping test, and it was likely corresponding to the pressure recovery after the drilling stopped.

3.6.4 Packer testing

Probes 10 (1,060 to 1,090 ft) through 15 (1,520 to 1,640 ft), which correspond to the depth interval of test zone #3, did not show any obvious response to pumping. Based on this, this zone was not cemented. To confirm that zone #3 had low permeability, a packer test was performed at a depth interval from 1,170 to 1,470 ft. Prior to the packer test, HQ rods were reamed through clayey seams. The packer was inflated in competent rock at 1,170 to 1,280 ft. The test started at 12:55 am on July 24, and the packer was deflated at 2:20 am.

During packer testing, water was flowing from the tested zone into the HQ rods with injection pressures of 25 and 75 psi. With an injection pressure step of 100 psi, water flowed into the formation. Based on the probes in WB-1, the static water level should have been close to ground surface or slightly above.

Probes 10 to 13 did not record any pressure increase due to packer testing. The pressure actually increased well before the packer testing, due to the reaming of HQ rods (probes 8 to 13). When reaming stopped, the pressures decreased with the exception of probe 11. Other probes above and below the packer test zone did not obviously respond to this reaming and testing. Packer testing was completed when probes 10 to 14 were elevated due to reaming. These probes had not responded when these sections were first drilled, indicating that new pathways were opened as a result of the reaming activity.

3.7 Cross Hole Test #4 – 1,506 to 1,906 ft

On August 10, 2008, the string of pressure probes was removed and a new string installed in WB-1, from a depth of 1,485 ft to the final depth of 4,034 ft. The sequence of activities associated with Test #4 is presented in Table 3.12. The probes were labeled from #20 (top) to #1 (at 4,034 ft) (Table 3.13).

3.7.1 Drilling and Flushing

DH-8417 was re-drilled from the surface to 1,060 ft with PQ rods, after the HQ rods were stuck in the hole in an attempt to lower the rods after a bit change on July 25. Test zone #4 was drilled from August 12 to August 16 with HQ rods, from 1,506 to 1,906 ft. A broken zone between 1,717 and 1,738 ft was interpreted as the ZE fault, which intersected WB-1 220 ft higher. Granodiorite was encountered at 1,717 ft, below Cretaceous mudstone. The drillers did not notice any loss or gain of drilling fluid. The granodiorite was broken and sericite alteration was abundant. Three probes, 17, 18, and 19, measured

pressure in the WB-1 monitoring zones corresponding to the zone #4 depth interval. Probe 20 (1,485 to 1,515 ft) was monitoring the pressure near the ZE fault.

None of the probes (the first string) responded to re-drilling up to August 8. All probes recorded rather stable readings showing a continuous pressure drop and earth tide fluctuation.

After the installation of the second string of probes, pore pressure ranged close to 15 to 20 ft below ground surface. Probe 3 (3,837 ft) did not function properly. Probe 20 (1,485 ft, same zone as probe 14 on first installation) recorded quite stable pressure close to ground surface.

There was no flushing of the test zone prior to pumping.

3.7.2 Air lift Pumping

The HQ rods were pulled up to a depth of 1,506 ft, and the seal was "naturally" provided by two clayey zones encountered between 1,038 and 1,109 ft. The previous packer test confirmed low yield from the zone to 1,470 ft. Static water level in DH-8417 was measured at 32 ft below surface.

The pumping started at 3:19 pm on August 16 and was finished 23 hours later. The air compressor was set to 65 psi. The pumping rate, which was measured every 5 minutes, was 0.3 gpm and relatively stable during the test. The pressure drop due to air lifting reached 1.6 ft in probe 18 (Figure 3.15). There was no response to pumping in other monitoring zones (Figure 3.15).

3.7.3 Recovery

Only one probe (18) recorded an obvious recovery after the pumping test. The recovery became obvious about 2 hours after pumping had stopped and reached almost 100 percent in 24 hours.

3.8 Cross Hole Test #5 – 1,906 to 2,356 ft

3.8.1 Drilling and Flushing

As the previous zone was tight, the drillhole was not cemented before drilling resumed. Test zone #5 was drilled from August 20 to August 22 with HQ rods. Activities are summarized in Table 3.14. Granodiorite with obvious fractured zones was encountered at 1,986 to 2,106 ft and 2,170 to 2,186 ft. No obvious drilling fluid loss or gain was observed.

Ten WB-1 probes responded to the drilling (Figures 3.16 and 3.17):

- Pressure readings were corresponding to a pore pressure 16 to 22 ft below ground surface.
- Pressure increases due to drilling reached 1 foot as measured by probes 15 (2,240 to 2,360 ft) to 17 (1,890 to 1,965 ft). The pressure measured by probe 16 fluctuated more than others.
- Probe 20 (1,475 to 1,515 ft) showed stable pressure close to ground surface.

Prior to the air lift test, DH-8417 was flushed for 35 minutes with light-weight mud to clear out cuttings but not expose clay zones to fresh water.

3.8.2 Air Lift Pumping

The HQ rods were pulled back to 1,916 ft. After the BQ rods were lowered in preparation for air lifting, the water level was measured at 35.2 ft below surface.

Test #5 started at 3:09 pm on August 22 with the air compressor pressure at 60 psi and an initial pumping rate of 18 gpm. The test was finished at 3:35 pm 1 day later. The pumping rate was 16.5 gpm and was quite stable. Flow measurements are presented in Table 3.15.

Probes 19 (1,520 to 1,610 ft) to 6 (3,360 to 3,480 ft) responded to the pumping test (Figures 3.16 and 3.17) as follows:

- The pressure drop due to pumping greatly exceeded the pressure increase recorded during drilling.
- The pressure drop reached a maximum of 16 ft in the zone monitored by probe 16 (2,120 to 2,235 ft).
- A smaller response ranging from 6 to 12 ft was recorded by probes 19 (1,520 to 1,610 ft) to 10 (2,950 to 2,980 ft).
- The most responsive probes showed an obvious pressure drop within 10 minutes.
- The deeper probes (9 to 6, below ZEc fault) also responded to the pumping test, but their response was delayed by 6 to 8 hours and the response magnitude was only 1 to 2 ft.

A summary of the pressure drops recorded is presented in Table 3.16 and on Figure 3.18.

3.8.3 Recovery

The recovery monitoring started at 3:35 pm on August 23 and was continued for 11 hours. Measurements within DH-8417 during recovery August 23 through 24, 2008, are listed in Table 3.17.

Drawdown measured by a pressure transducer in DH-8417 was recorded every minute (Figure 3.19). The initial steep part of both curves resembled the effect of wellbore storage. As the datalogger also responded to the air pressure applied by the air lifting, the actual water level in DH-8417 during pumping was lower than recorded.

Probes 19 to 10 recorded the pressure recovery after the pumping test (Figures 3.17 and 3.18). The recovery was delayed 10 to 200 minutes from the time when the pumping stopped and reached up to two-thirds of the total drawdown. Tripping rods and cementing on August 24 ended effective recovery monitoring

3.9 Cross Hole Test #6 – 2,356 to 2,896 ft

3.9.1 Drilling and Flushing

Test zone #5 was backfilled with cement grout to a depth of 1,740 ft on August 24, 2008. Drilling through the cured cement started on August 27 with HQ rods. Some poorly cemented intervals were encountered above 1,900 ft and between 2,166 and 2,202 ft. Drilling through granodiorite from 2,356 to 2,896 ft was

normal, without any obvious drilling fluid loss or gain observed. Core was described from competent to very broken with occasional gouge.

The water level in DH-8417 during drill breaks was 35 ft below ground. A detailed summary of activities related to cross-hole test #6 is presented in Table 3.18.

Drilling depths and pressure measurements during drilling are illustrated on Figures 3.20 and 3.21. Following are responses of WB-1 monitoring zones to drilling:

- Three of the WB-1 probes (11, 12, and 13) showed a significant response to drilling with pressure head fluctuations of 6 ft during drilling through the depth interval from approximately 2,720 to 2,896 ft.
- The smaller pressure changes measured by probes 15, 16, and 17 also corresponded to drilling activities (coring, pulling core, pumping in a core tube).
- The remaining probes, with the exception of probes 20 and 3, recorded similar responses with pressure readings corresponding to water level close to 16 to 22 ft below ground surface.
- Probe 20 showed stable pressure close to ground surface.
- Probe 3 (3,287 to 3,867 ft) was not functional.

There was no flushing of DH-8417 prior to test #6.

3.9.2 Air Lift Pumping

The HQ rods were pulled back to 2,356 ft by 10:14 am on September 3, 2008. The static level at 12:35 pm was measured 35.2 ft below ground. Airlift testing started at 13:03, interrupted at about 1:28 pm, and restarted at 5:51 pm on September 3. Compressor air pressure ranged between 65 and 70 psi. The pumping rate was adjusted at about 7:00 pm on September 3 to between 3 and 4.5 gpm. The test was completed at 9:55 am on September 4.

Following is a summary of WB-1 monitoring zone responses (Table 3.19, Figure 3.20, Figure 3.21, and Figure 3.22):

- The pressure drop due to the air lifting reached a maximum of 6 ft in probes 11, 12, and 13. These probes were monitoring at depth zone from 2,619 to 2,820 ft, near the center of pump test zone #6.
- Probes 10 and 14 to 19 also responded to the pumping test, but the magnitude of the response was smaller, ranging from 2 to 4 ft.
- Probes 6 to 9 showed only marginal drop of 1 ft.
- There was no obvious response in monitoring zones with probes 1 to 5.

3.9.3 Recovery

During pump test #6, a pressure transducer recorded pressure changes due to pumping and recovery in DH-8417. Similar to the previous tests, this pressure corresponded to the hydrostatic pressure of water

column above the transducer plus a portion of air pressure applied during air lifting. Measured pressure versus time is shown on Figure 3.23.

WB-1 probes 16 to 10 clearly recorded the recovery after the pumping test. The recovery was obvious 25 to 40 minutes after the pumping stopped and reached about 80 percent of total drawdown after 10 hours, at 8:00 pm on September 5, 2008. Other probes did not respond to the recovery of DH-8417 (Figure 3.21).

3.10 Cross Hole Test #7 – 2,896 to 3,317 ft

3.10.1 Drilling and Flushing

The HQ rods, which were advanced to 2,896 ft, were tripped out on September 4, and the drilling bit was replaced with a shoe. Then the HQ rods were tripped in to case the hole above 2,896 ft. The cased hole allowed DH-8417 to be drilled with NQ rods without cementing test zone #6.

Mostly competent granodiorite was encountered when drilling through zone #7. Fault ZEc was logged from 3,133 to 3,259 ft. This same fault was logged at a depth of 3,010 to 3,036 ft in WB-1 (between probes 9 and 10). Drilling was stopped at a depth of 3,317 ft. Figures 3.24, 3.25, and 3.26 show probe pressure measurements during drilling and the corresponding drilling depths. The sequence of activities related to the cross-hole test #7 is presented in Table 3.20.

Following are WB-1 responses to DH-8417 drilling:

- As soon as drilling commenced, probes 10 to 13 (Figure 3.24) responded to coring with a pressure fluctuation of 4 to 6 ft., similar to zone #6 drilling. This continued to the end of drilling.
- Probes 14 through 17 also responded to drilling, but at a much reduced response compared to 10 through 13.
- Probes 18 and 19 recorded a slight increase due to drilling. Probe 20 did not respond.
- At 3,247 ft, mud circulation was lost; but, after another drilling run (to 3,257 ft), the hole became artesian. This loss and gain may have been drill induced.
- At a depth of 3,240 ft, probes 6 to 10 showed significant pressure increase (Figure 3.25). This is the first time that WB-1 monitoring zone responded so much to drilling, reaching up to 170 ft of a pressure increase in the zone monitored by probe 9.
- Probes 4 and 5 also slightly responded at the same time as probes 6 to 10.
- There is an overlap with probe 10 responding both to early drilling and to the drilling below 3,240 ft. It is probable that the probe 10 response to later drilling is transmitted across the packer underlying probe 10, as the logged fault is within this underlying zone.

DH-8417 was flushed with clean water for several hours before pumping.

3.10.2 Air Lift Pumping

Air lift testing started at 15:51 on September 9 with the compressor pressure set to 100 psi. The test was completed at 12:40 pm on September 10. The pumping rate was fairly stable at close to 6 gpm. Pre-pumping levels were 10 to 12 ft above the pre-drilling levels.

The response to pumping was:

- Pressure drop due to airlifting reached a maximum of 90 ft at probe 9, 45 ft at 8, and 35 ft at 7, and 25 ft at 6. These probes were monitoring at depth zones from 3,115 to 3,480 ft.
- Probes 10 to 13 also responded to the pumping test, but the magnitude of the responses was smaller, ranging from 3 to 4 ft.
- Obvious response (pressure drop) was also recorded by probes 4 to 5 (6 and 9 ft) and 14 to 17 (up to 1 ft).

The pressure response for each probe is summarized in Table 3.21.

The pressure immediately before test #7 was still elevated due to drilling and flushing. That pressure difference varied from 10 to 17 ft for the most responsive monitoring zones (probes 9 to 6). The maximum pressure changes versus depth due to pumping are summarized on Figure 3.27.

3.10.3 Recovery

During test #7, pressure was recorded with a transducer in DH-8417. Calculated drawdown for the pumping and recovery stages is shown on Figure 3.28.

The pressure recovery was monitored for 21 hours in WB-1. The recovery in the most responsive monitoring zones (probes 6 through 9) reached more than 90 percent. Probes 10 to 13 also recorded an incomplete recovery after the pumping test. No recovery was observed by probes 4, 14 to 17, and possibly probe 5.

3.11 Cross Hole Test #8 – 3,317 – 3,700 ft

3.11.1 Drilling and Flushing

DH-8417 was drilled from 3,317 to 3,700 ft with NQ rods. The test zone was sealed with a packer, so there was no cementing of test zone #7. Drilling started immediately after the recovery test in zone #7 on September 11 at 9:30 am. The drillhole encountered mostly broken and faulted granodiorite. Drilling through zone #8 was finished on September 14 in the early morning at a depth of 3,700 ft. The sequence of activities associated with this test is presented in Table 3.22. WB-1 probes responded to drilling (Figures 3.29 and 3.30) as follows:

- General response was very similar to the lower part of zone #7.
- Maximum response of 180 ft was measured by probe 9 and 50 to 80 ft by probes 6 to 8 similar to drilling for test #7.

- Probes 4 and 5 responded with a 20-ft pressure increase, more than observed during drilling for test #7.
- The rest of probes (10 to 19) showed a 1- to 4-ft pressure increase.

When drilling and flushing of DH-8417 was stopped, most of WB-1 probes began to recover. However, when the pumping test started, piezometric pressures in WB-1 (probes 4 to 15) were still recovering and still higher than before drilling for this test began.

3.11.2 Air Lift Pumping

The NQ rods were pulled back to 3,300 ft. The top of zone #8 was sealed with a packer inflated in competent rock at 3,300 to 3,307 ft. None of the WB-1 probes recorded any response to the packer inflation (a water-inflated packer manufactured by Inflatable Packers International [IPI]).

Air lift testing started at 11:15 am on September 14, and the test was completed at 10:05 am on September 15 (duration of 22:50 hours). The pumping rate gradually dropped over the night shift from the initial 11 gpm to the final 5.6 gpm as measured at 7:25 am on September 15. The summary of the pressure response for each probe during this test is presented in Table 3.23.

The response to pumping (Figures 3.29, 3.30, and 3.31) was as follows:

- A maximum pressure drop of 72 ft was recorded by probe 9.
- Pressure drops were recorded of 60 ft (probe 8), 45 ft (probe 7), and 65 ft (probe 6). These probes were monitoring a depth interval from 3,115 (monitoring zone with probe 9) to 3,480 ft (probe 6).
- Probes 10 to 13 responded to the pumping test but the magnitude was smaller, ranging from 5 to 2 ft.
- A pressure drop was recorded by probes 4 and 5 (32 and 36 ft).
- The recorded pressure drop could be affected by previously increased levels due to drilling.

3.11.3 Recovery

Recovery in DH-8417 was measured with a pressure transducer. Calculated drawdown versus logarithm of time is shown in Figure 3.32.

The pressures recorded by probes 4 to 13 recovered after pumping test #8. In contrast, the pressures recorded by probes 1 to 3 and 14 to 20 did not recover. In all cases, the recovery was only 40 to 60 percent (compared to pre-pumping readings) despite a duration of almost 23 hours. When those pressure readings after the recovery test are compared with pre-drilling readings (September 11, morning), the pressure recovery seems to be full or sometimes exceeding 100 percent.

3.12 Cross Hole Test #9 - 3,700 to 4,050 ft

3.12.1 Drilling and Flushing

DH-8417 was drilled from 3,717 to 4,050 feet with NQ rods. Test zone #8 was not cemented but was isolated from test zone #9 with a packer. The drillhole encountered competent granodiorite to 3,857 feet. Below 3,857 feet the recovered core was mostly faulted and broken. Shortly after drilling started, most of the probes showed a pressure increase as shown in Figures 3.33 and 3.34 that was similar to drilling through zones #7 and #8:

- A maximum pressure increase of 120 feet was recorded in the monitoring zone equipped with probe 9, the same as during drilling through zones #7 and #8, which is probably because the zone monitored by probe 9 was open while drilling zones 7, 8, and 9.
- A pressure increase of 40 ft was recorded by probes 6 to 8.
- Probes 4 and 5 responded with a 20-ft pressure increase.
- The rest of the probes (10 to 19) showed a 1- to 4-ft pressure increase.

The hole was flushed for 2.5 hours.

The summary of activities associated with test #9 is presented in Table 3.24.

3.12.2 Air Lift Pumping

The IPI packer was installed in competent rock at a depth of 3,700 feet to seal the top of zone #9. Air lift testing started at 11:37 am on September 20, and the test was completed at 12:10 pm on September 21. The pumping rate varied from 3 to 4 gpm during the first 30 minutes of the test, then varied between 2 and 3 gpm, which was much less than the pumping rate from test zone #8.

The response to airlifting (Figures 3.34 and 3.35 and Table 3.25) was as follows:

- The pressure drop due to air lifting reached a maximum of 30 ft in probe 9, the same zone as during zone #7 and #8 pumping.
- The pressure drop varied from 25 ft in probe 6 to 20 ft in probe 8, and 15 ft in probe 7. These probes were monitoring a depth zone from 3,115 (probe 9) to 3,480 ft (probe 6).
- There was a pressure drop recorded by probes 4 to 5 of 18 and 17 ft.
- Probes 10 to 13 responded to pumping, but the magnitude of pressure drop was smaller than 1 ft.

3.12.3 Recovery

During air lift testing of zone #9, a pressure transducer was placed in DH-8417. The recorded pressure is shown on Figure 3.36.

WB-1 recovery after pumping test #9 (as well as the response to pumping and drilling) resembles test #8. The following response was documented with the WB-1 probes:

- Probes 4 to 9 clearly showed a recovery after the pumping test.
- The pressures measured by probes 1 to 3 and 10 to 20 did not recover.
- In all cases, the recovery was up to 25 to 50 percent, despite more than a 28-hour duration (compared to pre-pumping readings).
- If pre-drilling readings are considered as "static" levels, then the recovery reached more than 100 percent.

3.13 Cross-Hole Testing Summary

Nine test zones in DH-8417 were air lifted between July 6 and Sep 22, 2008. Response was monitored by 20 MX probes installed in monitoring zones of WB-1 located 100 ft NE (collar distance).

The field results can be summarized as follows (Figure 3.37):

- The highest pumping rate was produced from zone #5 (top of granodiorite from 1,907 to 2,350 feet).
- The second highest rate was produced from zone #1 (volcaniclastic from 205 to 640 ft) and zone #8 (deep granodiorite from 3,300 to 3,700 feet).
- The lowest flow was produced from zone #4 (mudstone and top of granodiorite below ZE fault from 1,470 to 1,907 feet).
- Of the twenty probes installed, only one probe (18) slightly responded to pumping test #4.
- Depth interval of responsive probes reached the maximum when zones #5 and #7 were tested (14), followed by #6 and #8 (10), and #2 (9).
- The test in zone #4 with a very low pumping rate and only one responsive probe looks rather suspicious compared to test #5 which has the highest inflow and wide-spread response – including those installed within zone #4 depth interval. Packer testing in this zone #4 confirmed very low conductivity.
- Pressure responses were rather low during drilling and pumping of test zones #1 to #4 and #6. Low responses to drilling and medium responses to pumping were observed during test zone #5.
- Very high responses to drilling and pumping were observed during test zones #7 to #9.

A graphic summary of pumping rates and range of measured responses is provided as Figure 3.37.

3.14 Groundwater Sampling

Groundwater samples were collected from the air lift return near the end of each pumping period. Because pumping rates and durations were variable as were borehole volumes, the quality of each sample was variable. Table 3.26 summarizes the volume of water pumped, the volume of the borehole and the ratio between these two volumes for each sample. Higher ratios imply higher potential for collecting a representative sample as the majority of the sample water would have been from the surrounding aquifer as opposed to being just from within the borehole. Also presented is the method applied to seal the hole above each test/sample interval. In some cases the overlying zones were cemented, which may have

impacted some aspects of the water quality by either restricting flows locally or altering the near hole hydrochemistry. In all samples, the water was collected by air lifting, which would have had some effect on measured water-quality parameters, particularly those that are redox sensitive, such as iron, arsenic, and cobalt. The water quality data are presented and discussed in Chapter 9 of the Environmental Baseline Document.

4. CROSS HOLE TEST ANALYSIS

4.1 Introduction

The flow regime within the bedrock affected by the cross-hole test activities is assumed to be influenced by a network of fractures and/or faults. The majority of groundwater flows along the fractures. If fractures are densely interconnected, they may form a fracture network continuum. Whether a fracture network can be considered as a continuum or not is determined by the representative elementary volume, fracture connectivity, and the difference in conductivity between the fracture and rock matrix.

The spatial distribution of fracture flow towards a borehole will also depend on the properties of the fracture network, such as fracture permeability, fracture density, and connectivity. The flow towards a fully penetrating borehole may be radial (two-dimensional) throughout a rock aquifer consisting of a highly connected fracture system with a fairly isotropic distribution. The flow may be spherical (three-dimensional) if the borehole is only partially penetrating the fractured aquifer.

The approach used to analyze the cross-hole testing data for each of the nine test zones was as follows:

- Interpret a geological conceptual model based on geological logs and pressure responses in WB-1 to drilling and air lifting in DH-8417.
- Support the geological conceptual model by identifying potential boundaries and groundwater flow regimes based on the characteristics of the drawdown during air lifting and recovery after air lifting measured by the WB-1 probes.
- Calculate a representative hydraulic conductivity and, if possible, storage values using standard well testing methods when applicable based on an understanding of the proposed geological conceptual model and groundwater flow regime.

4.2 Conceptual Setting of Cross Hole Tests

4.2.1 Method

The conceptual setting was established in order to identify hydrogeologic units that could be characterized. The information used to establish the conceptual setting was:

- Geologic units penetrated by WB-1 and DH-8417.
- Pressure profiles measured monthly, establishing vertical gradients and seasonal responses.

- Time histories established with the MOSDAX probes when installed in the upper portion of WB-1, further defining seasonal variations and providing an indication of units responding to atmospheric pressure variations and earth tides.
- Response of probes monitoring zones in WB-1 to drilling in DH-8417.
- Response and recovery of WB-1 probes to air lift pumping from DH-8417.

Nine hydrogeologic units have been delineated based on the above information, starting from near surface. The following sub-sections discuss each of these units.

4.2.2 Shallow Bedrock

This unit was defined as a bedrock unit below the high-permeability, disturbed rock near the ground surface. The upper monitoring zone of WB-1 is within this shallow bedrock. The geology is predominantly Tertiary volcano-sedimentary rocks. Response to drilling and pump testing from DH-8417 was never as strong in shallow bedrock (probe 1) as underlying zones. Probe 1 monitored a zone from 148 to 193 feet deep. Although the shallow bedrock is not well defined, for the purposes of this conceptual setting, the base of the shallow bedrock was set at a depth of 200 feet in WB-1 and DH-8417. No cross-hole tests were carried out within this shallow bedrock.

4.2.3 Hydrogeologic Unit 1 (HGU1)

HGU1 is interpreted to lie between 200 and 630 feet in WB-1 and 200 and 710 feet in DH-8417. This unit is characterized by the following:

- Within the volcano-sedimentary sequence.
- In a relatively shallow zone with nearly hydrostatic piezometric conditions.
- Within a zone that is influenced by seasonal variations in piezometric conditions similar to near-surface piezometric variations (could be as deep as 915 feet in WB-1).
- Responded to pump test #1 and pump test #2 in WB-1, including probes from 198 to 630 feet.
- Does not include an unusual response to drilling (and later pumping) in probes 6 through 9 of WB-1 while advancing DH-8417 to the depth of 710 feet.

This unit is expected to have relatively high hydraulic conductivity.

4.2.4 Hydrogeologic Unit 2 (HGU2)

HGU2 is interpreted to lie between 630 feet and 958 feet (958 is within the zone monitored by probe 9, from 920 to 980 feet, and at the location of a logged flow top) in WB-1 and between 710 feet and 1,040 feet in DH-8417. The available information indicates that HGU2 is a relatively low permeability horizon with some permeable fractures, but also with the presence of discontinuous permeable fractures. This unit still responds to barometric pressure (although decreased in the zone monitored by probe 9 compared to overlying probes). Below the zone monitored by probe 9, piezometric pressures were higher than overlying zones during the pre-test period. This could be interpreted to indicate that probe 9 is within a transitional zone between HGU2 and HGU3.

The probes in HGU2 monitor pressures in the lower section of the upper sedimentary material (probe 6) and in the upper part of the basalt (probes 7, 8, and 9). Following are the responses to drilling and pumping:

- Very little response to pump test #1 (205 to 640 feet) by probe 6 and essentially none in probes 7, 8, and 9.
- During pump test #2 (640 to 950 feet), these four probes had unusual responses to drilling and pumping, with probes 8 and 9 having short-term responses opposite to that expected. Probes 8 and 9 responded to pumping, but only after a significant time lag.
- During pump test #3 (950 to 1,470 feet), the inverted response to drilling and pumping was not observed. Probe 8, however, responded to pumping, but recovered very slowly.
- During the packer test carried out within the pump test #3 interval, only zones 8 and 9 responded, but by less than 0.5 feet.
- During pump test #4 (1,506 to 1,906 feet) with a pump rate of 0.3 gpm, no response was observed in probes 6 through 9.

4.2.5 Hydrogeologic Unit 3 (HGU3)

HGU3 is interpreted to lie between 958 feet and 1,575 feet in WB-1 and between 1,040 and 1,738 feet in DH-8417. In WB-1, the main characteristic of HGU3 is a zone of elevated piezometric level, isolated from much seasonal variation, and isolated from barometric fluctuations. This zone is continuous down to and including the ZE fault, which is the interpreted boundary between Tertiary and Cretaceous rock.

Although apparently isolated and of low permeability, this zone must be connected to a source of higher head, while being isolated from the nearby lower head zones both above and below. This may imply anisotropy with relatively higher permeability (though still low in context of surrounding hydrogeologic units) parallel to the steeply dipping ZE fault.

4.2.6 Hydrogeologic Unit 4 (HGU4)

HGU4 is interpreted to be a relatively permeable unit that lies between 1,575 feet and 2,570 in WB-1 and 1,738 and 2,720 feet in DH-8417. HGU4 is interpreted to include Cretaceous granodiorite (and a little mudstone) below the ZE fault. The vertical gradient throughout this section is near hydrostatic. The TDS of water in this and underlying zones is higher than the overlying units. Response to drilling and pumping include the following:

- No response to pump test #4 (1,506 to 1,906 feet).
- Response in probes 10 to 19 (1,520 ft to 2,980 feet) was observed during drilling and pumping for test #5 (1,900 to 2,350 feet) with maximum observed in zone monitored by probe 16 (2,120 to 2,235 feet).
- Response in probes 10 to 19 (1,520 feet to 2,980 feet) was observed during drilling for test #6 (2,350 to 2,900 feet).

- When drilling reached a depth of 2,720 feet, probes 11, 12, and 13 (2,619 to 2,820 feet) responded much more to drilling than previously, indicating a new high permeability connection had been completed.

4.2.7 Hydrogeologic Unit 5 (HGU5)

HGU5 is interpreted to be a relatively permeable unit that lies between 2,570 and 2,990 feet in WB-1 and 2,720 and 3,240 feet in DH-8417. The top of HGU5 is interpreted to correspond to the depth at which there was a large increase in response of probes to drilling. The top in DH-8417 was, therefore, selected at 2,720 feet and the top in WB-1 was selected at 2,570 feet. The bottom of the zone is defined to include the ZEc fault.

- When drilling reached a depth of 2,720 feet for test #6, probes 11, 12, and 13 (2,619 to 2,820 feet) responded much more to drilling than previously, indicating a new connection had been completed.
- The test #6 pumping resulted in the maximum drawdown in probes 11, 12, and 13, with somewhat less drawdown in probes 14 to 19 and little drawdown in the remainder of the probes.
- At the start of drilling for test zone #7, there was response monitored by probes 10 through 13, with less response by probes 14 to 17 and even less in probes 18 and 19.
- At a drill depth of approximately 3,240 feet while drilling test zone #7, there was a sudden mud loss, then an artesian response. At about the same time, or at a slightly deeper depth, there was a large increase in response to drilling in probes 6 to 9. This is approximately the depth that DH-8417 passes through the ZEc fault.
- The location of ZEc fault in WB-1 is less certain. However, in terms of response, it appears to be between zones 9 and 10, and closer to Zone 10.

4.2.8 Hydrogeologic Unit 6 (HGU6)

HGU6 is a relatively permeable unit below fault ZEc and is interpreted to lie between 2,990 and 3,350 feet (core loss) in WB-1, and 3,240 and 3,600 ft in DH-8417.

Following are some conditions defining HGU6:

- At a drill depth of approximately 3,240 feet while drilling test zone #7, there was a sudden mud loss, then an artesian response. At about the same time, or at a slightly deeper depth, there was a large increase in response to drilling in probes 6 to 9.
- The maximum response was recorded by probe 9 with smaller but still large responses in probes 7 and 8. Small responses to drill activity were recorded by probe 10, and probe 6 pressures slowly increased over the drilling period.
- The maximum response to pumping test zone #7 was by probe 9, with decreasing responses with depth.
- While drilling for test #8, probe responses were very similar to the responses for zone 7 below 3,240 feet and for pumping from test zone #7.

- While drilling for test #9, probe responses were very similar to the responses for zone 7 below 3,240 feet. For pumping, the drawdown was considerably less than for test #7 or test #8.

4.2.9 Hydrogeologic Unit 7 (HGU7)

HGU7 is interpreted to be a less permeable unit than HGU6 from 3,350 to 3,906 feet in WB-1, and from 3,600 feet to 4,050 feet (hole bottom) in DH-8417. The response to pumping adjacent zone HGU6 was a much slower response, probably not in response to the pump hole but from leakage into the adjacent higher permeability material. This response is observed with probes 4, 5, and 6. Unfortunately, probe 3 did not function properly. No response was observed in probe 2. Based on long-term piezometric trends, probe 3 monitored a zone that would be consistent with HGU7. The core log indicates a fault between 3,880 and 3,906 feet in WB-1, which is consistent with this response. During pump test #9, the response to pumping was less in HGU6, possibly inferring that this test was near the boundary of HGU6.

4.2.10 Hydrogeologic Unit 8 (HGU8)

HGU8 is interpreted to be a very low permeability unit encountered only in WB-1 between 3,766 feet and the hole bottom at 4,053 feet. The effects of drilling WB-1 and installing the Westbay system required more than 2 years to dissipate in this hydrogeologic unit.

4.2.11 Summary of Hydrogeologic Units

Table 4.1 provides a listing of the HGUs, including identification of WB-1 probes in each HGU and the relationship of air lift tests to HGUs in DH-8417.

4.3 HGU1 Analysis

The relative positions of pumping test zones and monitored horizons with respect to HGU1 are presented on Figure 4.1.

Pump test #1 (12 gpm) was within the interpreted boundaries of HGU1 and pump test #2 (4.5 gpm) was partially within the boundaries of HGU1. Based on the relative response of monitoring zones to these two tests, it appears that much of the pumping volume of pump test #2 originated from HGU1.

4.3.1 Test #1

The monitored water levels near the end of the pump test #1 were lower than the pre-test water levels. The time history illustrated on Figure 3.6 indicates that probes 2, 3, and 4 were still falling at the start of the pump test. The drawdown was, therefore, adjusted to account for a time varying background water level. The resulting drawdown and recovery are presented on Figure 4.2.

Each monitoring zone was assumed to represent a pumped horizon. The quantity of water pumped from each of these zones was not known. A methodology that provided approximately correct flow rates was a constant head analyses. Based on the drawdown curves presented on Figure 4.2, a source of leakage into the dominant flow path is apparent. This could be a recharge boundary, a leaky aquifer boundary, or double porosity. Double porosity is a reasonable possibility as the presence of a recharge boundary and/or

leakage are considered less likley. Two analytical solutions were therefore completed, a constant head within a leaky aquifer and a double porosity analyses.

Figure 4.3 presents the results of simulating measured drawdowns in the monitoring zones assuming a constant head in a leaky aquifer. The simulation included a drawdown in the pumped well of 40 feet and resulted in a transmissivity of 56 square feet per day (ft^2/day) with a corresponding value of storativity of $1x10^{-4}$). The bulk hydraulic conductivity was therefore $5x10^{-7}$ meters per second (m/s). The resulting flow rates (assuming no interaction between zones) were 4.7, 3.1, 1.1, and 3.1 gpm, respectively, for probes 2, 3, 4, and 5.

As the additional water may have been supplied as a result of double porosity, these flow rates were input to a double porosity analysis for refinement. The resulting transmissivity did not result in a sensible solution (zone 2 did not end up with the highest transmissivity). To provide an alternative, the flow rates were increased for probe 2 until the transmissivity distribution was just acceptable. The resulting flow rates were 8, 1.5, 1, and 1.5 gpm, respectively, for probes 2, 3, 4, and 5. The bulk transmissivity from this analysis was 82 square feet per day ($feet^2$/day) which is 50 percent higher than the previous estimate. The bulk hydraulic conductivity was therefore $7x10^{-7}$ m/s. The curves for this analysis are presented as Figures 4.4 to 4.7.

4.3.2 Test #2

Test #2, described below, did not define any new information for HGU1, as most of the pumped volume was derived from HGU1. Pumping rates and measured drawdowns were both reduced from Test #1 by the same ratio (see below).

4.4 HGU2 Analysis

The conceptual setting for HGU2 is presented on Figure 4.8. The test zones for Test #2 and Test #3 intersected HGU2, Test #2 more than Test #3. Probes 6, 7, and 8 are within HGU2, and probe 9 straddled HGU2 and HGU3.

4.4.1 Test #2

Test #2 could result in response of monitoring zones within HGU1 and HGU2 because it straddles both units. Figure 4.9 illustrates drawdowns measured by probe 2 during test #1, 2, and 3. At 5 hours in each test, the drawdown and related pumping rates were as follows:

- 5 feet with 12 gpm pumping rate in test #1.
- 1.94 feet (39 percent of test #1) with 4.7 gpm pumping rate (39 percent of test #1) in test #2.
- 0.74 feet (15 percent of test #1) with 6 gpm pumping rate (50 percent of test #1) in test #3.

It appears clear that most, if not all, of the pumping carried out in test #2 came from the same units as test #1. For this reason, it appears that the upper section of HGU2 has very low hydraulic conductivity. In terms of the ability to estimate hydraulic conductivity with these testing procedures, the hydraulic conductivity of this zone was assumed to be less than $1x10^{-8}$ m/s.

4.4.2 Test #3

Test #3 included the lower portion of HGU2 and the upper section of HGU3. As will be discussed below, the hydraulic conductivity of HGU3 is very low. All of the effective hydraulic conductivity of HGU2 resulted in response of probe 8. Bypass leakage (or possibly a hydrogeologic linkage) resulted in drawdown of probes in HGU1 of about 15 percent of pumping test #1. Assuming drawdown was proportional to the quantity pumped from HGU1, the leakage from HGU1 was 1.8 gpm (0.15x12 gpm). The pumping rate from HGU2 was therefore approximately 4.2 gpm (6.0 - 1.8 = 4.2 gpm).

A fractured rock (double porosity) analysis was therefore completed using drawdown measured by probe 8. The curve fit is presented on Figure 4.10. The resulting transmissivity was 10 square feet per day and the storativity was $2.7x10^{-3.}$ The hydraulic conductivity over the bottom 90 ft of HGU2 was therefore $4x10^{-7}$ m/s. The high storage may indicate relatively poor connections between the two holes.

Averaged over all of HGU2, the hydraulic conductivity was estimated to be $1x10^{-7}$ m/s.

4.5 HGU3 Analysis

HGU3 represents a very low permeability section of the hole. Test #3 and Test #4 included sections of HGU3. The conceptual setting for HGU3 is presented on Figure 4.11.

4.5.1 Test #3

Test #3, which was pumped at 6 gpm, was interpreted to mostly pump from HGU2. This was based on the clayey materials in the top 230 ft and the low hydraulic conductivity estimated from a packer test carried out over the remainder of HGU3. The lower permeability clayey zone (950 to 1,179 ft depth) is estimated to have a hydraulic conductivity of less than $1x10^{-8}$ m/s.

4.5.2 Packer Test

The packer test was performed from 1,170 ft to the bottom of the hole (1,470 ft) below the low permeability clayey zone. Late on July 23, prior to the packer test while the hole was reamed, an increase of piezometric pressure (Figure 3.12) indicates that fluid pressure was injected as a result of the drilling activity into an otherwise very low permeability horizon. During the packer test, water was flowing from the well with injection pressures up to 75 psi.

The packer test flow pressure plot is presented on Figure 4.12. The straight line indicates a flow change of 0.5 gpm for every 100 ft of head change. The interpreted hydraulic conductivity for the packer test was $4x10^{-8}$ m/s. It is likely that this hydraulic conductivity was higher than pre-drilling conditions, as a result of drilling-induced hydraulic jacking. Averaged over the full thickness of HGU3, the bulk hydraulic conductivity was $2x10^{-8}$ m/s.

4.5.3 Test #4

Test #4 included the lower section of the Tertiary (bottom of HGU3) and the top of the pre-Tertiary (HGU4). The only probe to respond during testing was probe 18 (second probe deployment at a depth of

1,700 ft). As this probe was within HGU4, test #4 indicated that the lower portion of HGU3 has a very low hydraulic conductivity. The estimated value for this portion of the hole was less than $1x10^{-8}$ m/s.

Based on the above packer test, a bulk hydraulic conductivity of $2x10^{-8}$ m/s was estimated for HGU3.

4.6 HGU4 Analysis

HGU4 was included in tests #4, #5, and #6. Test #4 was across the boundary of HGU3 and HGU4, and Test #6 was across the boundary of HGU4 and HGU5. Test #5 was entirely within HGU4. Probes 14 through 19 were in HGU4. Figure 4.13 illustrates the conceptual setting for HGU4.

4.6.1 Test #4

Test #4, pumping at 0.3 gpm, resulted in response only at probe 18, located at a depth of 1,700 ft within HGU4. This test was analyzed for response at probe 18 with a dual porosity solution (Figure 4.14). If we assumed the fractured zone monitored by probe 18 was 55-ft thick, the hydraulic conductivity was $4x10^{-7}$ m/s (0.11 ft/day).

4.6.2 Test #5

Test #5, pumped at approximately 16.5 gpm, was entirely within HGU4. There was clear drawdown response at probes 14 through 19, with the most drawdown at probe 16. Response was also recorded at probes 10 through 13 in HGU5. The larger drawdown closer to the pumped horizon could be the influence of partial penetration (some probes were closer to pumped interval than others and were less influenced by vertical components of flow) or might indicate a variation in hydraulic conductivity within the hydrogeologic unit. Figure 4.15 illustrates that the slope of most of the drawdown curves are similar, indicating that the bulk hydraulic conductivity of HGU4 is relatively consistent. The recovery curves are very similar. There was clearly some leakage into HGU5. If we assume the leakage resulted in an apparent reduction in volume pumped from HGU4, a simple balance indicates that the leakage to HGU5 was 2 gpm, leaving a pumping rate of 14.5 gpm from HGU4. The calculated transmissivity was $5.4x10^{-4}$ square meters per second. With an HGU4 thickness of 990 ft (301 meters), the bulk hydraulic conductivity is $2x10^{-7}$ m/s.

4.6.3 Test #6

Test #6 was pumped at 4 gpm from an interval that crosses the interpreted boundary between HGU4 and HGU5. Estimating the volume expected from each of the units based on drawdown, 1.35 gpm was estimated from HGU5 and 2.65 gpm was estimated from HGU4. This was based on the average drawdown within HGU4 for test #5 of approximately 10.5 and for test #6 of 1.9 ft. The drawdown (Figure 4.16) within HGU4 as a result of pumping 2.65 gpm results in a transmissivity consistent with the estimate for test #5, $5.4x10^{-5}$ square meters per second.

4.7 HGU5 Analysis

HGU5 was included in tests #6 and #7. Test #6 was across the boundary of HGU4 and HGU5, and Test #7 was across the boundary of HGU5 and HGU6. Probes 10 through 13 were within HGU5. The conceptual layout for HGU5 is presented on Figure 4.17.

4.7.1 Test #6

During test #6, some of the yield was derived from HGU4 and some of the yield was derived from HGU5. The estimated split was 1.35 gpm from HGU5 and 2.65 gpm from HGU4. The observed drawdown is illustrated in semi-log form on Figure 4.18. Figure 4.18 illustrates that the slope of probes 11, 12, and 13 are almost identical, indicating that the bulk hydraulic conductivity of HGU5 is relatively consistent. The slopes of the recovery curves are very similar to drawdown (Figure 4.19) but without the change in slope at 3 hours. The indication is that the change in slope may have been variations in the pumping rate. With a pumping rate of 1.35 gpm, the calculated transmissivity from the recovery semi-log straight line is $1.3x10^{-5}$ square meters per second. With an aquifer thickness of 470 ft (143 meters), the calculated hydraulic conductivity is $9x10^{-8}$ m/s.

4.7.2 Test #7

Test #7 was pumped from HGU5 and HGU6. The boundary between these two units was set at 3,240 ft depth in the pumped well; as at this depth, there was a sudden increase in WB-1 response to drilling, particularly in probes 7, 8 and 9. During pumping, a small amount of drawdown was observed in HGU6, HGU5, and HGU4. The HGU5 drawdown for test #7 was about half that observed during test #6. The estimated flow rate from HGU5 for test #7 was therefore set at half that assumed from test #6, or 0.7 gpm. The semi-log recovery response of the HGU5 probes to test #7 pumping is provided on Figure 4.20. The estimated transmissivity based on the measured drawdown and estimated extraction was similar to test #6, $1.3x10^{-5}$ square meters per second.

4.8 HGU6 and HGU7 Analysis

The boundary between HGU6 and HGU7 is predominantly based on the difference in response of pressure probes to drilling, with a change between probes 6 and 7. However, during pumping tests #7, #8, and #9, this lower section behaved essentially as a single aquifer (albeit with minor variations). The conceptual layout for HGU6 is presented on Figure 4.21 and for HGU7 is on Figure 4.22. HGU6 was included in tests #7 and #8. Test #7 was across the boundary of HGU5 and HGU6, and Test #7 was across the boundary of HGU6 and HGU7.

4.8.1 Test #7

The pumping rate for Test #7 was 6 gpm. As noted above, approximately 0.7 gpm of the total pumping was extracted from HGU5, leaving a pumping rate of 5.3 gpm from HGU6 and HGU7. A semi-log plot of the drawdown observed as a result of the pumping is presented on Figure 4.23. The nature of the curve suggests some double porosity effects. The late time slope was selected as indicative of the bulk transmissivity of HGU6 and HGU7. The estimated transmissivity is $7.2x10^{-6}$ square meters per second. With an aquifer thickness of 360 ft (110 m), the bulk hydraulic conductivity is $6.6x10^{-8}$ m/s. With a thicker aquifer including both HGU6 and HGU7 (900 feet or 275 m), the bulk hydraulic conductivity is $2.6x10^{-8}$ m/s.

4.8.2 Test #8

Pumping test #8 pumped from HGU6 and HGU7. As a result, there was a response to pumping in probes 4 to 9, which were completed in both HGUs. The test section was isolated by a packer from zones higher

in the hole. The average pumping rate over the test period was approximately 6 gpm. The largest response to pumping was by probe 9 in HGU6. The response at probe 8, also in HGU6, was delayed and smaller. Using the late time slope of the semi-log plot illustrated on Figure 4.24 results in a bulk transmissivity of $6.5x10^{-6}$ square meters per second. This is very similar to test #7 (within the error of flow measurements).

4.8.3 Test #9

Pumping test #9 pumped from HGU7. However, there was a response from probes in both HGU6 and HGU7 (probes 4 to 9). The average pumping rate over the test period was approximately 3.5 gpm. Using the late time slope of the semi-log plot illustrated on Figure 4.25 results in a bulk transmissivity of $6.6x10^{-6}$ square meters per second. This is very similar to test #6 and test #7 (within the error of flow measurements).

4.9 Summary of Cross Hole Test Analysis

The results of the analysis of the cross-hole tests are presented in Table 4.2 and on Figure 4.26. The hydraulic conductivity decreases with depth through the Tertiary sequence, with the lowest in HGU3 immediately above fault ZE. Most of HGU3 is within a unit identified on Figure 2.1 as TCR.

Immediately below the Tertiary and the ZE fault, the hydraulic conductivity is elevated in HGU4, but not as high as the HGU1. HGU4 includes Cretaceous mudstone and granodiorite. The elevated hydraulic conductivity, although not directly related to the ZE fault, may be related to stress relief generated by the presence of this and related normal faults.

The test results indicate that the hydrogeologic responses have allowed classification into broad zones, and bulk hydraulic conductivities were assigned to these zones. However, there is a wide range of local hydrogeologic conditions, with a few fractures/faults responsible for much of the groundwater flow.

Finally, the evaluation of the data indicates the presence of boundaries that result in compartmentalization of groundwater within the bedrock. The strongest, in the area of HGU4 was the ZE fault, but other sub-parallel structures clearly impair flow perpendicular to these structures.

TABLES

TABLE 2.1
Simplified Geology of Drillholes

Unit	WB-1 (ft bgs)	DH-8417 (ft bgs)
Upper Sediments	90 to 726	90 to 726
Basalt	726 to 1,056	686 to 1,167
Lower Sediments	1,056 to 1,522	1,167 to 1,716
Granodiorite	1,522 to 1,608	not present
Mudstone	1,608 to 1,731	1,716 to 1,738
Granodiorite	1,731 to 4,054	1,738 to 4,050
ZE 85/85	1,489 to 1,575	1,716 to 1,738
ZEc 58/69	2,970	3,133 to 3,259

TABLE 2.2
Dip and Azimuth Survey

Drill Hole	Depth	Dip Angle	True Azimuth
	ft	degree	degree
WB-1	1,500	89.5	77.8
WB-1	2,000	89.3	123
WB-1	3,000	87.7	155
DH-8417	500	89.9	54
DH-8417	1,000	89.6	23.4
DH-8417	1,500	89.5	335
DH-8417	2,035	89.3	336
DH-8417	3,000	89.4	223
DH-8417	3,500	89.7	17.9
DH-8417	4,000	89.3	126

TABLE 2.3
WB-1 Pressure Profiling Dates

WB-1 Profiling Dates		
2006	**2007**	**2008**
	19-Jan-07	30-Jan-08
	11-Feb-07	26-Feb-08
	3-Mar-07	25-Mar-08
	10-Apr-07	29-Apr-08
	7-May-07	21-May-08
	14-Jun-07	
	10-Jul-07	
	23-Aug-07	
	25-Sep-07	
		5-Oct-08
		11-Nov-08
7-Dec-06		1-Dec-08

TABLE 3.1
Locations of Monitoring Zones and Pressure Probes in WB-1

WB-1 Monitoring Zone Number	WB-1 Probe Number May 24 Installation	WB-1 Probe Number Aug 10 Installation	Design Probe Depth [a] (ft)	WB-1 Monitoring Zone		Monitoring Zone Length (ft)
				From	To	
50	1	n/a	158.4	148.4	193.3	44.9
49	n/a	n/a	208.3	198.3	263.2	64.9
48	2	n/a	268.2	268.2	278.2	10
47	n/a	n/a	293.1	283.2	323.1	39.9
46	3	n/a	338.1	328.1	430	101.9
45	4	n/a	445	435	480	45
44	n/a	n/a	495	485	555	70
43	5	n/a	570	560	630	70
42	6	n/a	695	635	725	90
41	n/a	n/a	730	730	735	5
40	7	n/a	750	740	810	70
39	8	n/a	825	815	915	100
38	9	n/a	930	920	980	60
37	n/a	n/a	1,025	985	1,055	70
36	10	n/a	1,070	1,060	1,090	30
35	n/a	n/a	1,105	1,095	1,135	40
34	11	n/a	1,180	1,140	1,220	80
33	n/a	n/a	1,235	1,225	1,285	60
32	12	n/a	1,300	1,290	1,340	50
31	13	n/a	1,440	1,345	1,470	125
30	14	20	1,485	1,475	1,515	40
29	15	19	1,580	1,520	1,610	90
28	n/a	n/a	1,625	1,615	1,680	65
27	16	18	1,695	1,685	1,740	55
26	n/a	n/a	1,755	1,745	1,885	140
25	17	17	1,935	1,890	1,965	75
24	n/a	n/a	1,980	1,970	2,050	80
23	n/a	n/a	2,085	2,055	2,115	60
22	18	16	2,130	2,120	2,235	115
21	19	15	2,320	2,240	2,360	120
20	n/a	n/a	2,375	2,365	2,460	95
19	20	14	2,475	2,465	2,522	57
18	n/a	n/a	2,584	2,527	2,614	87
17	n/a	13	2,629	2,619	2,693	74
16	n/a	12	2,698	2,698	2,713	15
15	n/a	11	2,790	2,718	2,820	102
14	n/a	n/a	2,835	2,825	2,945	120

WB-1 Monitoring Zone Number	WB-1 Probe Number May 24 Installation	WB-1 Probe Number Aug 10 Installation	Design Probe Depth [a] (ft)	WB-1 Monitoring Zone		Monitoring Zone Length (ft)
				From	To	
13	n/a	10	2,960	2,950	2,980	30
12	n/a	n/a	3,050	2,985	3,110	125
11	n/a	9	3,125	3,115	3,215	100
10	n/a	8	3,290	3,220	3,330	110
9	n/a	7	3,345	3,335	3,355	20
8	n/a	6	3,440	3,360	3,480	120
7	n/a	5	3,495	3,485	3,582	97
6	n/a	4	3,682	3,587	3,712	125
5	n/a	n/a	3,727	3,717	3,822	105
4	n/a	3	3,837	3,827	3,867	40
3	n/a	2	3,952	3,872	3,982	110
2	n/a	n/a	3,997	3,987	4,029	42
1	n/a	1	4,034	4,034	4,054	20

Note:

a. The design depth of the probe is based on the top of the multi-piezometer (MP) system coupling.

TABLE 3.2
Test Zones in DH-8417

Test Zone in DH-8417	Depth (ft)		Length (ft)
	To	From	
1	205	640	435
2	640	950	310
3	950	1,470	520
4	1,470	1,900	430
5	1,900	2,350	450
6	2,350	2,900	550
7	2,900	3,300	400
8	3,300	3,700	400
9	3,700	4,050	350

TABLE 3.3
Calculated Difference between WB-1 Pressure Profiles on May 21 and May 25

Probe	Depth (ft)	Difference Between WB-1 May 25 Measurement and WB-May 21 Profile (ft)
1	158.4	-0.19
2	268.2	-0.14
3	338.1	0.01
4	445	0.12
5	570	0.17
6	695	0.64
7	750	-0.1
8	825	0.58
9	930	-0.15
10	1,070	0.2
11	1,180	0.11
12	1,300	1.22
13	1,440	1.32
14	1,485	0.24
15	1,580	0.32
16	1,695	0.14
17	1,935	0.36
18	2,130	0.31
19	2,320	0.36
20	2,475	0.15

TABLE 3.4
Test # 1 Sequence of Activity

Date	Time	Activity (Test #1)
July 4	11:19 AM	Begin continuous monitoring of MX probes for responses during drilling (hourly measurements)
July 4	4:15 PM	Finished installation of surface casing to a depth of 205 ft for DH-8417
July 4	5:30 PM	Started coring test zone 1 at DH-8417 (205 ft)
July 5	8:40 PM	Ended coring test zone 1 at DH-8417 (640 ft)
July 5	6:00 AM	Measurement frequency of MX probes changes from hourly to every 10 minutes
July 6	10:10 AM	Measured manual water level in DH-8417 (21.5 ft bgs)
July 6	12:00 PM	Started compressor for airlift test 1 (75 psi)
July 6	12:15 PM	Measured flow rate using bucket test (12 gpm)
July 6	12:45 PM	Measured flow rate using bucket test (12 gpm)
July 6	1:15 PM	Measured flow rate using bucket test (12 gpm)
July 6	2:00 PM	Measured flow rate using bucket test (12 gpm)
July 6	3:00 PM	Water quality measurements collected (pH=7.06 and EC=253 μS)
July 6	3:25 PM	Measured flow rate using bucket test (12 gpm)
July 6	5:00 PM	Stop compressor
July 6	5:00 PM	Measurement frequency changes from every 10 minutes to 1 minute
July 6	5:04 PM	First manual recovery measurement in DH-8417 (38.9 ft bgs)
July 7	4:40 AM	Last manual recovery measurement in DH-8417 (21.73 ft bgs)
July 7	8:30 AM	Begin tripping rods in to initiate cementing test zone #1

TABLE 3.5
Measured Air Lift Rates during Test #1

Time	Air Lifting Flow Rate (gpm)
12:15 PM	12
12:45 PM	12
1:15 PM	12
2:00 PM	12
2:55 PM	12
3:25 PM	12

TABLE 3.6
Summary of Pressure Responses to Test # 1

Probe	Pressure Before Air Lifting (ft) (7/6/2008 11:50)	Pressure at End Pumping (ft) (7/6/2008 17:00)	Change in Pressure (ft)
1	12.04	13.17	1.1
2	11.01	16.32	5.3
3	10.63	13.88	3.3
4	10.07	13.03	3.0
5	9.17	12.17	3.0
6	9.70	10.39	0.7
7	10.02	10.23	0.2
8	7.81	7.97	0.2
9	7.46	7.69	0.2
10	5.62	5.55	-0.1
11	2.25	2.35	0.1
12	-0.42	-0.19	0.2
13	0.22	0.29	0.1
14	0.42	0.79	0.4
15	20.94	21.03	0.1
16	20.82	21.07	0.3
17	19.86	20.23	0.4
18	19.13	19.23	0.1
19	19.00	19.00	0.0
20	19.51	19.60	0.1

TABLE 3.7
Test # 2 Sequence of Activities

Time	Activity (Test # 2)
7/7/08 3:00 PM	Cementing test zone #1
7/10/08 1:20 AM	Begin cement coring 238 ft
7/10/08 7:45 PM	Cement cored to 640 ft
7/10/08 10:45 PM	Begin coring rock @ 646 ft
7/11/08 7:50 PM	Complete coring to 950 ft
7/11/08 8:45 PM	Begin flushing well
7/11/08 10:10 PM	Stop flushing well
7/12/08 4:25 PM	Start air lifting
7/12/08 4:35 PM	Stop compressor b/c leak
7/12/08 5:45 PM	Start air lifting
7/12/08 5:55 PM	Bucket test 9 gpm
7/12/08 6:05 PM	Bucket test 6-8 gpm
7/13/08 2:00 AM	Bucket test 4.5 gpm
7/13/08 1:20 PM	Stop pumping, rate ~ 6 gpm
7/13/08 1:35 PM	WL 69.8 ft btoc, stick up is 10.5 ft
7/13/08 3:20 PM	WL 23 ft bgs in DH-8417
7/13/08 8:45 PM	Recovery period ends
7/14/08 day shift	Cementing zone 2 from 600 to 950 ft

TABLE 3.8
Measured Air Lift Rates During Test # 2

Time	Air Lift Flow Rate (gpm)
22:05	4.2
22:15	4.3
22:25	5.0
22:35	4.5
22:45	4.3
22:55	5.1
23:05	4.0
23:15	5.0
23:25	4.8
23:35	3.8
23:45	4.2

TABLE 3.9
Summary of Pressure Responses to Test # 2

Probe	Pressure Before Air Lifting (ft) 7/12/2009 17:40	Pressure at End of Pumping (ft) 7/13/2008 13:20	Change in Pressure (ft)
1	12.06	13.01	0.95
2	11.4	13.9	2.5
3	10.93	12.24	1.31
4	10.72	11.83	1.11
5	9.17	10.46	1.29
6	9.88	10.18	0.3
7	9.54	10.23	0.69
8	6.91	7.81	0.9
9	7.56	8.43	0.87
10	6.22	6.13	-0.09
11	2.87	2.76	-0.11
12	0.06	-0.03	-0.09
13	0.54	0.53	-0.01
14	0.9	0.88	-0.02
15	21.28	21.3	0.02
16	21.16	21.15	-0.01
17	20.32	20.39	0.07
18	19.45	19.66	0.21
19	19.12	19.16	0.04
20	19.99	20.2	0.21

TABLE 3.10
Test # 3 Sequence of Activities

Date	Activity (Test #3)
14-Jul-08	Day shift cementing
16-Jul-08	Night shift re-cementing
17-Jul-08	Night shift re-cementing
18-Jul-08	Drilling cement
19-Jul-08	Drilling to 1,058 ft, slow progress, rods were stuck in clay
20-Jul-08	Day shift drilling to 1,186 ft
21-Jul-08	Complete drilling, prepare for air lifting, static level at 20.5 ft bgs
21-Jul-08	23:58, start air lift test, 6 gpm
22-Jul-08	20 to 25 min interruption in pumping to measure drawdown
23-Jul-08	End pump test at 00:17 ,
23-Jul-08	DH-8417 and WB-1 recovery till approximately 12:00.
23-Jul-08	16:20 - reaming HQ to 1,170 ft
24-Jul-08	Packer test (1,180 to 1,470 ft)
24-Jul-08	Snapped HQ rods after bit change, rod fishing on Jul 25
26-Jul-08	PQ drilling from the top
8-Aug-08	PQ reamed to 850 ft , last measurements in WB-1

TABLE 3.11
Summary of Pressure Responses to Test # 3

Probe #	Probe Depth (ft)	Pressure Before Air Lifting (ft) 7/21/08 22:50	Pressure at End of Pumping (ft) 7/22/08 23:59	Change in Pressure (ft)
1	158.4	12.92	13.77	0.85
2	268.2	12.35	13.94	1.59
3	338.1	12.06	13.79	1.73
4	445	11.64	13.14	1.50
5	570	10.44	12.12	1.69
6	695	10.11	10.67	0.55
7	750	10.27	10.76	0.48
8	825	7.65	10.24	2.59
9	930	7.02	7.11	0.09
10	1,070	5.59	5.73	0.14
11	1,180	1.69	1.92	0.23
12	1,300	-0.86	-1.16	-0.30
13	1,440	0.19	0.16	-0.02
14	1,485	0.28	0.14	-0.14
15	1,580	20.77	20.75	-0.02
16	1,695	20.95	20.93	-0.02
17	1,935	19.86	19.83	-0.02
18	2,130	19.11	19.22	0.11
19	2,320	18.76	18.74	-0.02
20	2,475	19.78	19.76	-0.02

TABLE 3.12
Test # 4 Sequence of Activities

Date	Activity (Test # 4)
25-Jul-08	HQ fishing
26-Jul-08	PQ drilling from the top
8-Aug-08	PQ reamed to 850 ft , last measurements in WB-1
10-Aug-08	Probes re-installed in WB-1
11-Aug-08	PQ rods end at 1,060 ft
12-Aug-08	HQ reaming and drilling, clay at 1,038-1,068 and 1,090-1,109 ft
15-Aug-08	DH-8417 is 1,717 ft deep at 10:30 (KT contact), 1,816 ft at 17:00
15-Aug-08	DH-8417 is 1,846 ft deep at 21:00
16-Aug-08	HQ rods pulled back up to 1,506 ft
16-Aug-08	Pumping started at 15:19, no flushing before, static level 32 ft
17-Aug-08	End of pumping at 14:20, recovery test starts
18-Aug-08	End of recovery test at 14:30, water level in DH-8417 was 32 ft bgs
20-Aug-08	Drilling, broken GD from 1,986 to >2,035 ft

TABLE 3.13
Summary of Pressure Responses to Test # 4

Probe #	Probe Depth (ft)	Pressure Before Pumping (ft) Aug 16, 3:19 PM	Pressure at End of Pumping (ft) Aug 17, 2:20 PM	Change of Pressure (ft)
1	4,034	21.25	21.15	-0.09
2	3,952	16.69	16.55	-0.14
3	3,837	29.55	30.13	0.58
4	3,682	17.31	17.01	-0.30
5	3,495	19.48	19.30	-0.18
6	3,440	17.66	17.52	-0.14
7	3,345	18.18	18.04	-0.14
8	3,290	18.84	18.43	-0.42
9	3,125	18.35	18.24	-0.12
10	2,960	18.28	18.28	0.00
11	2,790	18.07	17.80	-0.28
12	2,698	17.09	16.95	-0.14
13	2,629	18.28	18.30	0.02
14	2,475	19.58	19.76	0.18
15	2,320	19.11	18.88	-0.23
16	2,130	20.68	20.80	0.12
17	1,935	20.37	20.48	0.12
18	1,695	21.72	23.54	1.82
19	1,580	21.61	21.75	0.14
20	1,485	-0.45	-0.75	-0.30

TABLE 3.14
Test # 5 Sequence of Activities

Date	Activity (Test # 5)
Aug-19	HQ coring – likely evening
Aug-20	GD - heavily fractured from 1,986 ft to more than 2,035 ft
	GD cored to 2,106 ft - still some fractured and weathered zones
Aug-21	2,198 ft this morning, less fractured from 2,106 to 2,170 ft, then more fractured
	no obvious mud loss or gain, not artesian
	2,196 to 2,246 ft during day shift, competent GD with six 1- to 3-ft-long broken zones
Aug-22	Night shift 2,256-2,326 ft, competent rock 2,246-2,326 ft, three zones with fractures and clay: 2,291-2,293 ft, 2,304 ft, and 2,312-2,316 ft
Aug-22	Dayshift, 2,356 ft - preparation for test #5, flushing for 35 minutes
Aug 22	14:45 – water level in DH-8417 at 35.2 ft bgs
Aug-22	15:09 - start of pumping test #5, Q = 18 --> 16.5 gpm
Aug-23	15:35 - groundwater sample, compressor off, recovery
24-Aug	2:40 - end of recovery test
Aug-24	7:30 - 13:20 - cementing DH-8147 up to 1,800 ft in three stages
Aug-25	Cement tagged at 1,740 ft, no drilling
Aug-26	Cement curing

TABLE 3.15
Pumping Rate During Test # 5

Clock Time	Rate (gpm)
7:30	16.5
8:45	15
9:45	18
10:45	16.5
11:45	16.5
12:45	15
13:45	16.5

TABLE 3.16
Summary of Pressure Responses to Test # 5

Probe #	Probe Depth (ft)	Pressure Before Pumping (ft)	Pressure at End of Pumping (ft)	Change of Pressure (ft)
		Aug 22, 15:09	Aug 23, 15:35	
1	4,034	21.09	21.13	0.05
2	3,952	16.64	16.39	-0.25
3	3,837	32.69	33.04	0.35
4	3,682	16.97	17.13	0.16
5	3,495	19.39	19.78	0.39
6	3,440	17.47	17.77	0.30
7	3,345	17.99	18.36	0.37
8	3,290	18.38	19.21	0.83
9	3,125	18.31	19.58	1.27
10	2,960	18.07	25.67	7.60
11	2,790	17.57	26.71	9.14
12	2,698	16.49	25.86	9.37
13	2,629	17.82	27.45	9.63
14	2,475	19.12	29.09	9.97
15	2,320	18.51	29.71	11.20
16	2,130	20.24	35.55	15.31
17	1,935	19.93	31.68	11.75
18	1,695	21.26	29.36	8.10
19	1,580	21.28	27.98	6.70
20	1,485	-1.15	-0.89	0.25

TABLE 3.17
Recovery from Test # 5 in DH-8417

Clock Time	Elapsed Time (hours)	Depth to Water (ft *TOC)
15:35	0	63.7
16:35	1	57
17:35	2	55.82
18:35	3	55.24
static	11	44.7

*TOC – Top Of Casing

TABLE 3.18
Test # 6 Sequence of Activities

Dates	Activity (Test # 6)
27-Aug	Coring through cement from 1,740 to 1,996 ft
28-Aug	Coring through cement to 2,356 ft
29-Aug	Coring through cement and GD to 2,396 ft
30-Aug	Coring GD to 2,557 ft, then bit change
31-Aug	Coring GD to 2,615 ft
1-Sep	Coring GD to 2,742 ft
2-Sep	Coring GD to 2,866 ft
3-Sep	Coring to 2,896 ft, test #6 preparation, no flushing
3-Sep	Start test at 13:03 but stopped about 55 minutes later
3-Sep	Restart the test at 16:50
3-Sep	Air pressure was changed at 19:15 (?)
4-Sep	Test # 6 completed at 9:55
4-Sep	End of recovery test at 20:00
4-Sep	22:00 - Tripping HQ rods out

TABLE 3.19
Summary of Pressure Responses to Test # 6

Probe #	Probe Depth (ft)	Pressure Before Pumping (ft)	Pressure at End of Pumping (ft)	Change of Pressure (ft)
		Sep 3, 1:03 PM	Sep 4, 9:55 AM	
1	4,034	21.92	21.99	0.07
2	3,952	17.06	17.22	0.16
3	3,837	34.52	34.75	0.23
4	3,682	18.15	18.56	0.42
5	3,495	21.28	21.28	0.00
6	3,440	18.67	19.02	0.35
7	3,345	19.21	19.45	0.23
8	3,290	19.81	20.18	0.37
9	3,125	19.76	20.27	0.51
10	2,960	19.87	23.75	3.88
11	2,790	19.20	25.30	6.10
12	2,698	18.11	24.27	6.16
13	2,629	19.39	25.76	6.37
14	2,475	20.66	23.76	3.09
15	2,320	20.06	22.51	2.45
16	2,130	21.70	23.78	2.08
17	1,935	21.18	22.70	1.52
18	1,695	22.80	24.00	1.20
19	1,580	22.49	23.57	1.09
20	1,485	-1.22	-1.24	-0.02

TABLE 3.20
Test # 7 Sequence of Activities

Dates	Activity (Test # 7)
Sep 04	21:00 – tripping out BQ rods and stinger
Sep 04	22:10 – tripping out HQ rods (till 1:15)
Sep 05	2:40 – tripping in HQ rods – till 7:00
Sep 05	Tripping in NQ rods, reaming bottom 40 ft
Sep-05	21:05 coring from 2,916 ft in GD
Sep-06	4:00 – pulling NQ rods then tripping in
Sep 06	Afternoon – coring from 2,907 to 2,936 ft
Sep 07	Morning – DH-8417 depth is 3,047 ft
Sep-07	Coring in GD to 3,080 ft
Sep 07	16:30 – tripping NQ rods out
Sep 08	1:55 – coring to 3,137 ft by 6:40
Sep 08	Coring to 3,217 ft by 18:40
Sep-08	22:00 - lost circulation around 3,247 ft
Sep-08	24:00 - hole artesian at 3,257 ft
Sep-09	5:00 - coring in GD to 3,317 ft
Sep-09	Flushing the hole
Sep-09	15:51 - pumping test #7 started
Sep-10	12:40 - end of pumping
Sep 10	18:30 DH-8417 level at 62 ft bgs
Sep-11	9:30 - end of recovery, no cementing
Sep-11	10:00 - drilling deeper with NQ rods

TABLE 3.21
Summary of Pressure Responses to Test # 7

Probe #	Probe Depth (ft)	Pressure Before Pumping (ft)	Pressure at End of Pumping (ft)	Change of Pressure (ft)
		Sep 9, 3:50 PM	Sep 10, 12:40 PM	
1	4,034	21.94	21.89	-0.05
2	3,952	16.85	16.92	0.07
3	3,837	35.81	36.30	0.48
4	3,682	15.37	19.18	3.81
5	3,495	16.92	25.42	8.50
6	3,440	9.09	35.67	26.58
7	3,345	5.48	41.24	35.76
8	3,290	10.76	53.85	43.08
9	3,125	9.09	98.96	89.86
10	2,960	17.42	23.96	6.53
11	2,790	17.27	21.51	4.25
12	2,698	16.17	19.75	3.58
13	2,629	17.45	20.54	3.09
14	2,475	19.51	21.10	1.59
15	2,320	18.90	19.94	1.04
16	2,130	20.87	21.44	0.58
17	1,935	20.39	20.88	0.48
18	1,695	21.90	22.46	0.55
19	1,580	22.07	22.14	0.07
20	1,485	-1.82	-1.77	0.05

TABLE 3.22
Test # 8 Sequence of Activities

Dates	Times	Activity (Test # 8)
11-Sep	9:30	Recovery monitoring for test # 7 ended and drilling restarted
11-Sep		Coring in GD from 3,317 to 3,337 ft (day shift)
12-Sep	7:00	Coring in GD - depth 3,447 ft
12-Sep	18:00	Coring in GD - depth 3,536 ft
13-Sep	6:00	Coring in GD - depth 3,610 ft
14-Sep	1:33	Coring in GD - depth 3,700 ft, bottom of zone #8
14-Sep	2:30	Began set up for airlift test, flushing the hole for 2.5 hours
14-Sep	7:00	Packer inflated at a depth of 3,700 ft
14-Sep	11:15	Air lift test # 8 began (compressor turned on, 100 psi)
15-Sep	7:25	Flow rate decreasing over night from 10.9 to 5.6 gpm
15-Sep	10:05	Compressor off (100 psi)
16-Sep	10:32	Recovery monitoring for test #8 ended
16-Sep	12:30	Packer was removed, tripping NQ rods back to 3,700 ft
16-Sep	13:10	Coring began again

TABLE 3.23
Summary of Pressure Responses to Test # 8

Probe #	Probe Depth (ft)	Pressure Before Pumping (ft)	Pressure at End of Pumping (ft)	Change of Pressure (ft)
		Sep 14, 11:15 AM	Sep 15, 10:05 AM	
1	4,034	22.38	22.40	0.02
2	3,952	16.99	17.08	0.09
3	3,837	36.50	37.71	1.20
4	3,682	4.38	30.96	26.58
5	3,495	6.28	36.15	29.88
6	3,440	5.88	53.79	47.91
7	3,345	2.59	33.83	31.24
8	3,290	11.85	48.67	36.83
9	3,125	21.54	62.31	40.78
10	2,960	19.45	20.98	1.52
11	2,790	16.16	18.95	2.79
12	2,698	15.15	17.41	2.26
13	2,629	16.69	18.79	2.10
14	2,475	18.40	19.65	1.25
15	2,320	17.93	18.81	0.88
16	2,130	20.03	20.47	0.44
17	1,935	19.86	20.00	0.14
18	1,695	21.56	21.49	-0.07
19	1,580	21.49	21.52	0.02
20	1,485	-1.84	-1.93	-0.09

TABLE 3.24
Test # 9 Sequence of Activities

Dates	Times	Activity (Test # 8)
16-Sep	13:10	Drilling started, bit change at 3,704 ft
17-Sep	18:00	Coring in GD to 3,817 ft
18-Sep		Coring in GD from 3,797 to 3,902 ft (night shift)
18-Sep		Coring in GD to 3,966 ft (day shift)
19-Sep		Coring in GD from 3,966 to 4,047 ft (night shift)
19-Sep		Coring in GD to 4,050 ft - competent rock
19-Sep	13:00	Flushing
19-Sep	15:30	Packer installed correctly at 3,700 ft
20-Sep	7:15	Air lift test # 9 began, difficulty with compressor
20-Sep	11:37	Air lift test # 9 re-started 3 to 4 gpm
21-Sep	12:10	Air lift test # 9 ended - 2 to 3 gpm
Sep-22	12:00	Transducer removed, packer deflated and removed
Sep-22	16:20	Groundwater sampling at 3,800 ft, one more sample
Sep-22	16:20	End of recovery test

TABLE 3.25
Summary of Pressure Responses to Test # 9

Probe #	Probe Depth (ft)	Pressure Before Pumping (ft) Sep 20, 11:37 AM	Pressure at End of Pumping (ft) Sep 21, 12:10 PM	Change of Pressure (ft)
1	4,034	22.31	22.54	0.23
2	3,952	16.39	16.62	0.23
3	3,837	37.47	38.70	1.22
4	3,682	4.04	22.35	18.31
5	3,495	7.71	24.84	17.13
6	3,440	3.46	30.77	27.31
7	3,345	4.02	18.29	14.27
8	3,290	6.65	25.86	19.21
9	3,125	6.90	32.09	25.19
10	2,960	16.04	18.05	2.01
11	2,790	16.20	17.29	1.09
12	2,698	15.08	16.17	1.09
13	2,629	16.46	17.43	0.97
14	2,475	18.31	18.88	0.58
15	2,320	17.61	18.12	0.51
16	2,130	19.80	19.99	0.18
17	1,935	19.05	19.47	0.42
18	1,695	21.00	21.14	0.14
19	1,580	20.71	21.08	0.37
20	1,485	-2.19	-2.09	0.09

TABLE 3.26
DH-8417 Water Sample Characteristics

Test #	Depth (ft) Top	Depth (ft) Bottom	Date	Hole Size	Volume Volume (gal)	Volume Pumped (gal)	Ratio	Seal
1	205	640	6-Jul-08	H	431	3,600	8	casing
2	640	950	13-Jul-08	H	640	5,265	8	cement
3	950	1,470	23-Jul-08	H	991	8,712	9	cement
4	1,506	1,906	no sample					
5	1,906	2,356	23-Aug-08	H	1588	24,186	15	none
6	2,356	2,896	4-Sep-08	H	1952	3,857	2	cement
7	2,896	3,317	10-Sep-08	N	1267	7,495	6	casing
8	3,317	3,700	15-Sep-08	N	1413	8,111	6	packer
9	3,700	4,050	21-Sep-08	N	1547	4,450	3	packer

TABLE 4.1
Summary of Hydrogeologic Units (HGUs)

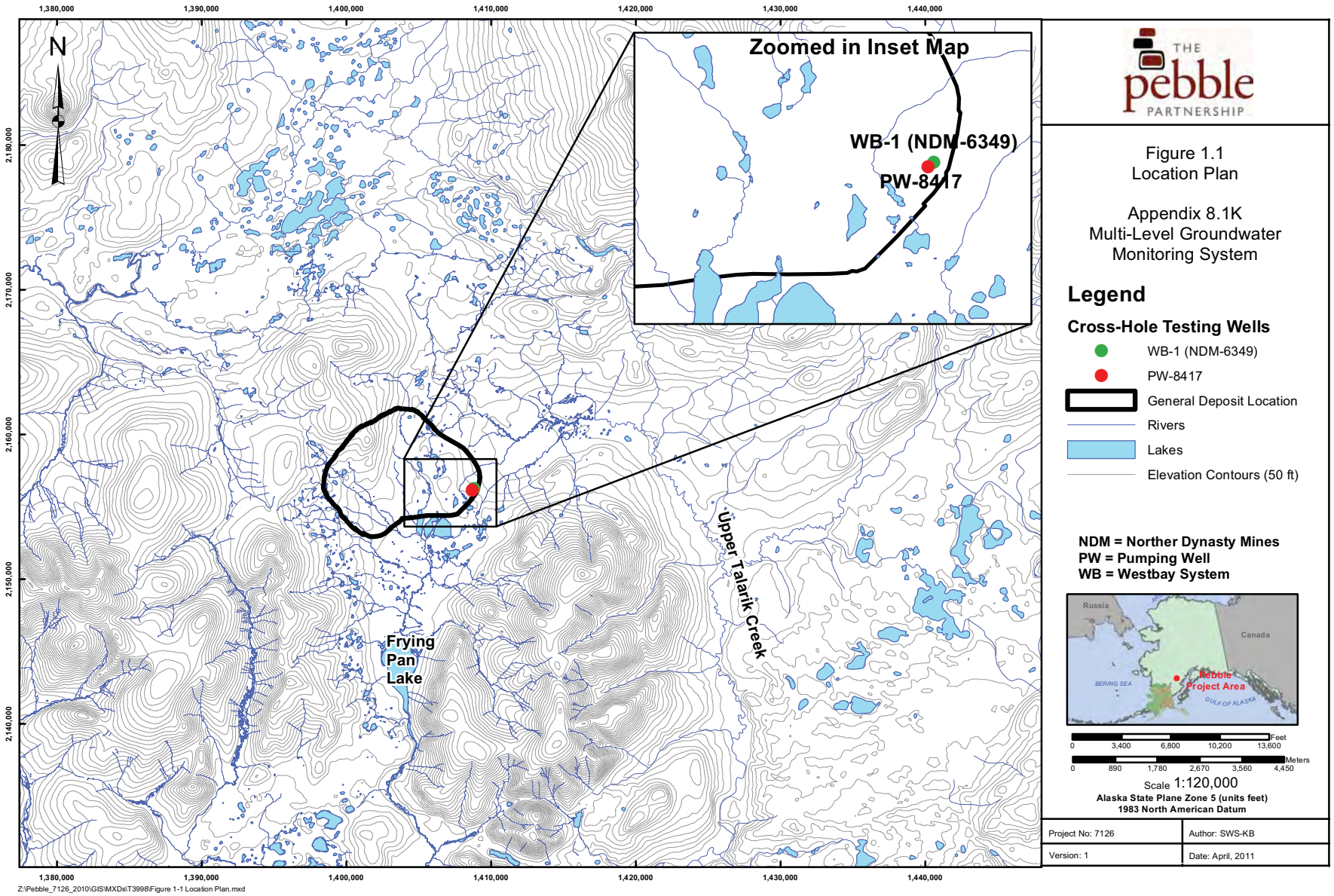
HGU	WB-1					DH-8417				
	Depth Interval (ft bgs)		Probe Number	Depth Interval (ftbgs)		Depth Interval (ft bgs)		Test Number	Depth Interval (ft bgs)	
	Top	Bottom		Top	Bottom	Top	Bottom		Top	Bottom
Shallow Bedrock		200					200			
1	200	630	2	268	278	200	710	1	205	640
			3	328	430			2	640	950
			4	435	480					
			5	560	630					
2	630	958	6	635	725	710	1040	2	640	950
			7	740	810			3	950	1470
			8	815	915					
			9	920	980					
3	958	1575	9	920	980	1040	1738	3	950	1470
			10	1060	1090			4	1506	1906
			11	1180	1140					
			12	1290	1340					
			13	1345	1470					
			14	1475	1515					
			15	1520	1610					
			20	1475	1515					
			19	1520	1610					
4	1575	2580	19	1520	1610	1738	2720	4	1506	1906
			18	1685	1740			5	1906	2356
			17	1890	1965			6	2356	2896
			16	2120	2235					
			15	2240	2360					
			14	2465	2522					
5	2580	2990	13	2619	2693	2720	3240	6	2356	2896
			12	2698	2713			7	2896	3317
			11	2718	2820					
			10	2950	2980					
6	2990	3350	9	3115	3215	3240	3600	7	2896	3317
			8	3220	3330			8	3317	3700
			7	3335	3355					
7	3350	3906	7	3335	3355	3600	>4050	8	3317	3700
			6	3360	3480			9	3700	4050
			5	3485	3582					
			4	3587	3712					
8	3906	4053	2	3872	3982	>4050		n/a		
			1	4034	4054					

TABLE 4.2
Summary of Estimated Hydraulic Conductivities from Cross-Hole Testing

	WB-1		DH-8417		Average		
	Depth Interval (ft bgs)		Depth Interval (ft bgs)		Depth Interval (ft bgs)		Estimated
HGU #	top	bottom	top	bottom	top	bottom	K (m/s)
1	200	630	200	710	200	670	7.0E-07
2	630	958	710	1,040	670	999	1.0E-07
3	958	1,575	1,040	1,738	999	1,656.5	2.0E-08
4	1,575	2,580	1,738	2,720	1,656.5	2,650	2.0E-07
5	2,580	2,990	2,720	3,240	2,650	3,115	9.0E-08
6	2,990	3,350	3,240	3,600	3,115	3,475	3.0E-08
7	3,350	3,906	3,600	>4,050	3,475		3.0E-08

K (L/T) is hydraulic conductivity which is the rate of flow (L^3/T) through a cross section of unit area (L^2) under a unit hydraulic gradient (dimensionless). HGU – Hydrogeologic unit.

FIGURES



THE pebble PARTNERSHIP

Figure 1.1
Location Plan

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

Cross-Hole Testing Wells

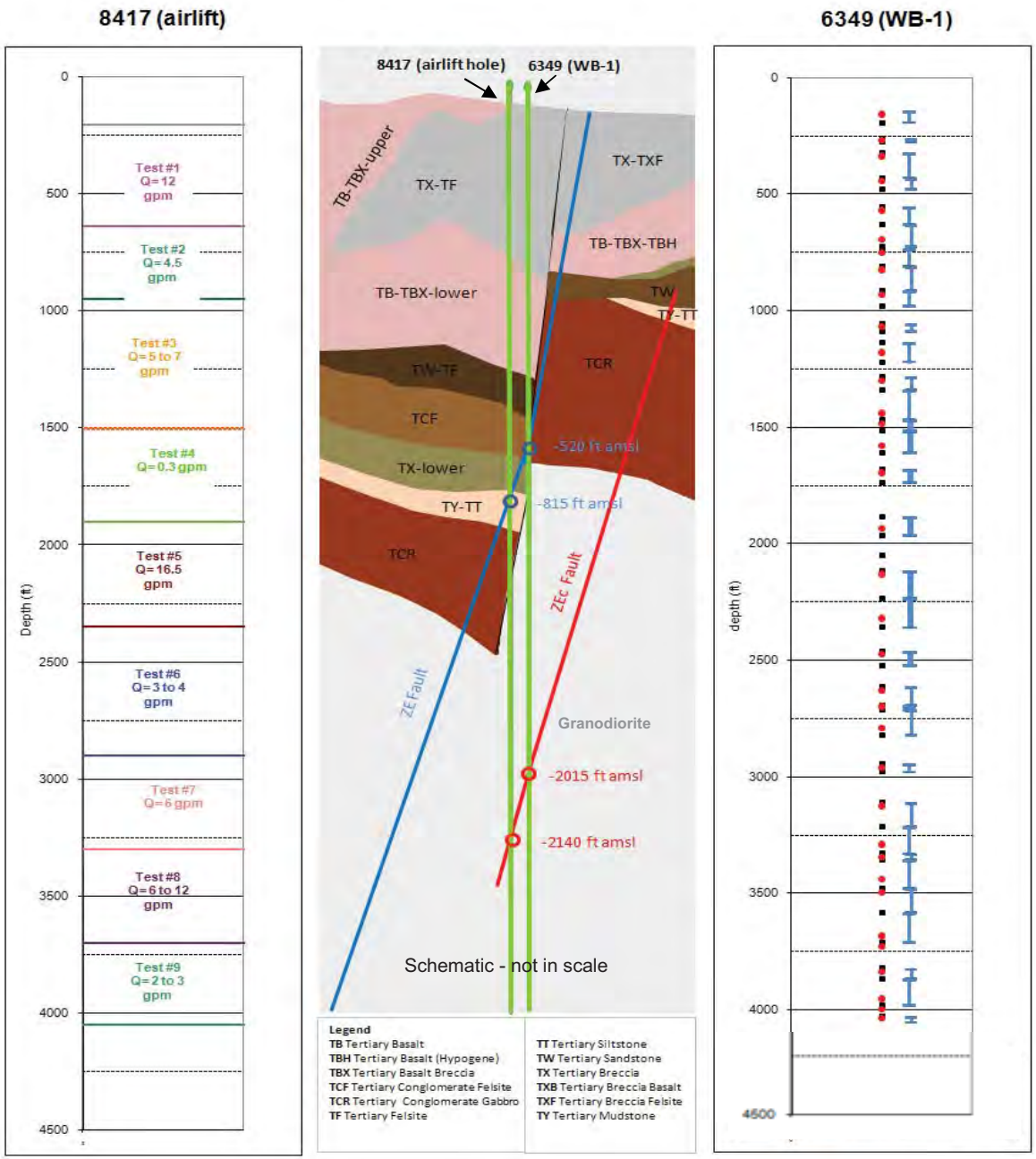
- WB-1 (NDM-6349)
- PW-8417
- General Deposit Location
- Rivers
- Lakes
- Elevation Contours (50 ft)

NDM = Norther Dynasty Mines
PW = Pumping Well
WB = Westbay System

Feet
0 3,400 6,800 10,200 13,600
Meters
0 890 1,780 2,670 3,560 4,450

Scale 1:120,000
Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Author: SWS-KB
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 2.1
Schematic Cross-Section through 6349 (WB-1) and 8417 (airlift hole)

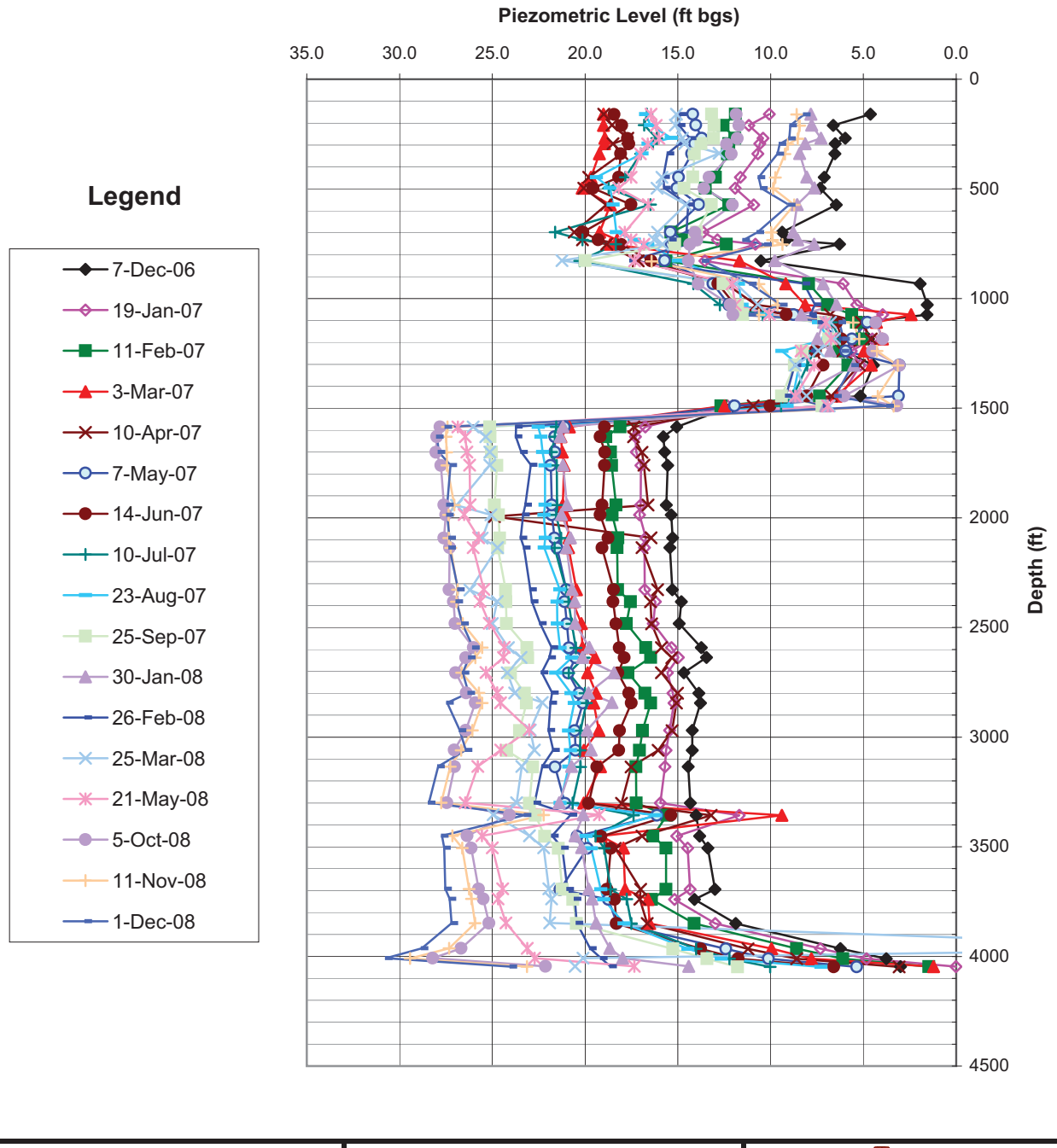
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Packers
- Ports
- Monitoring zones



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010





Dates correspond to dates of measurements

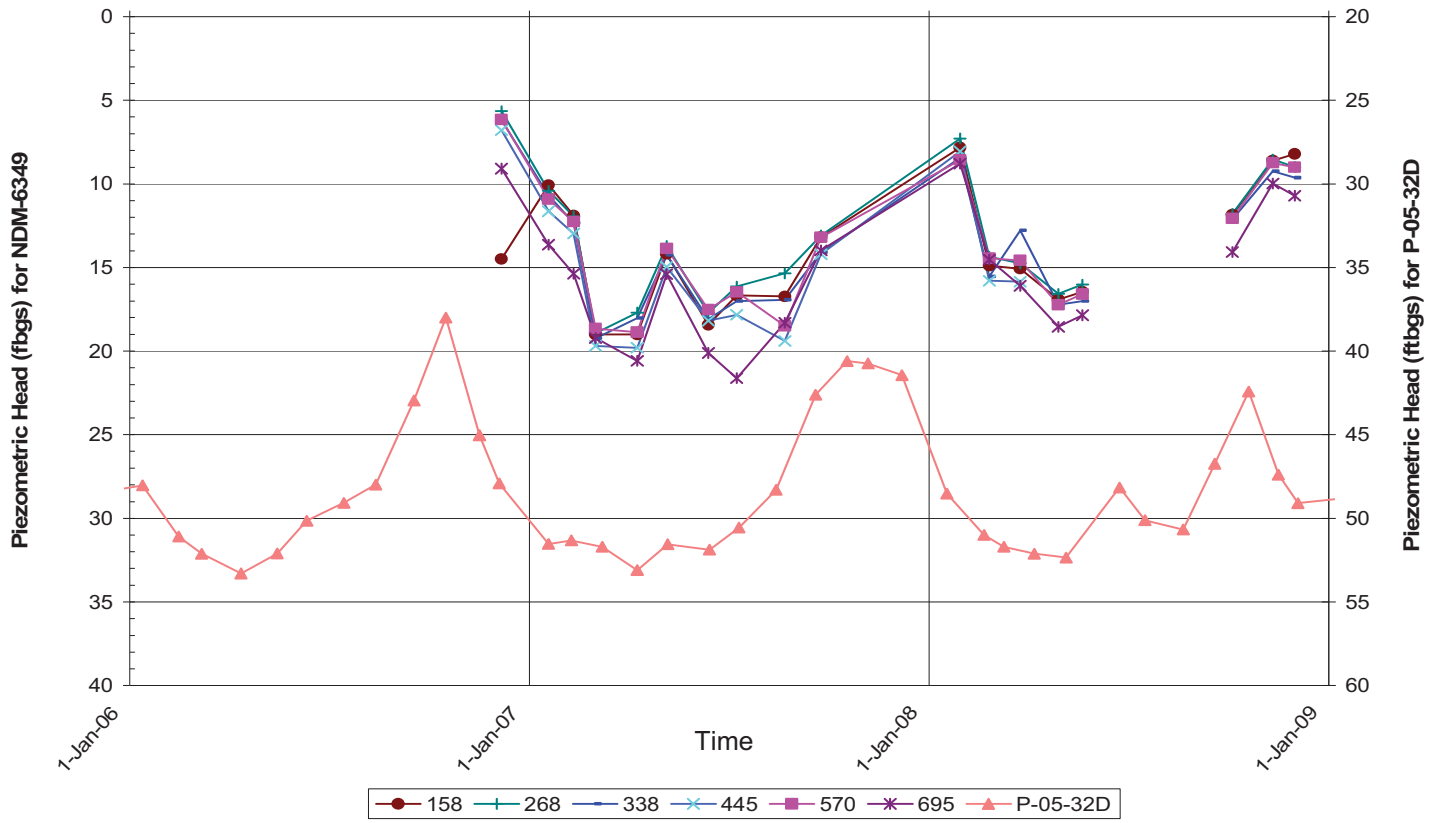
Symbols above corresponds to WB-1 measuring port depths

THE pebble PARTNERSHIP

Figure 2.2: Piezometric Profiles Measured in WB-1

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 2.3
Time History for Depths of 150 to 700 ft in WB-1

Appendix 8.1K
Multi-Level Groundwater Monitoring System

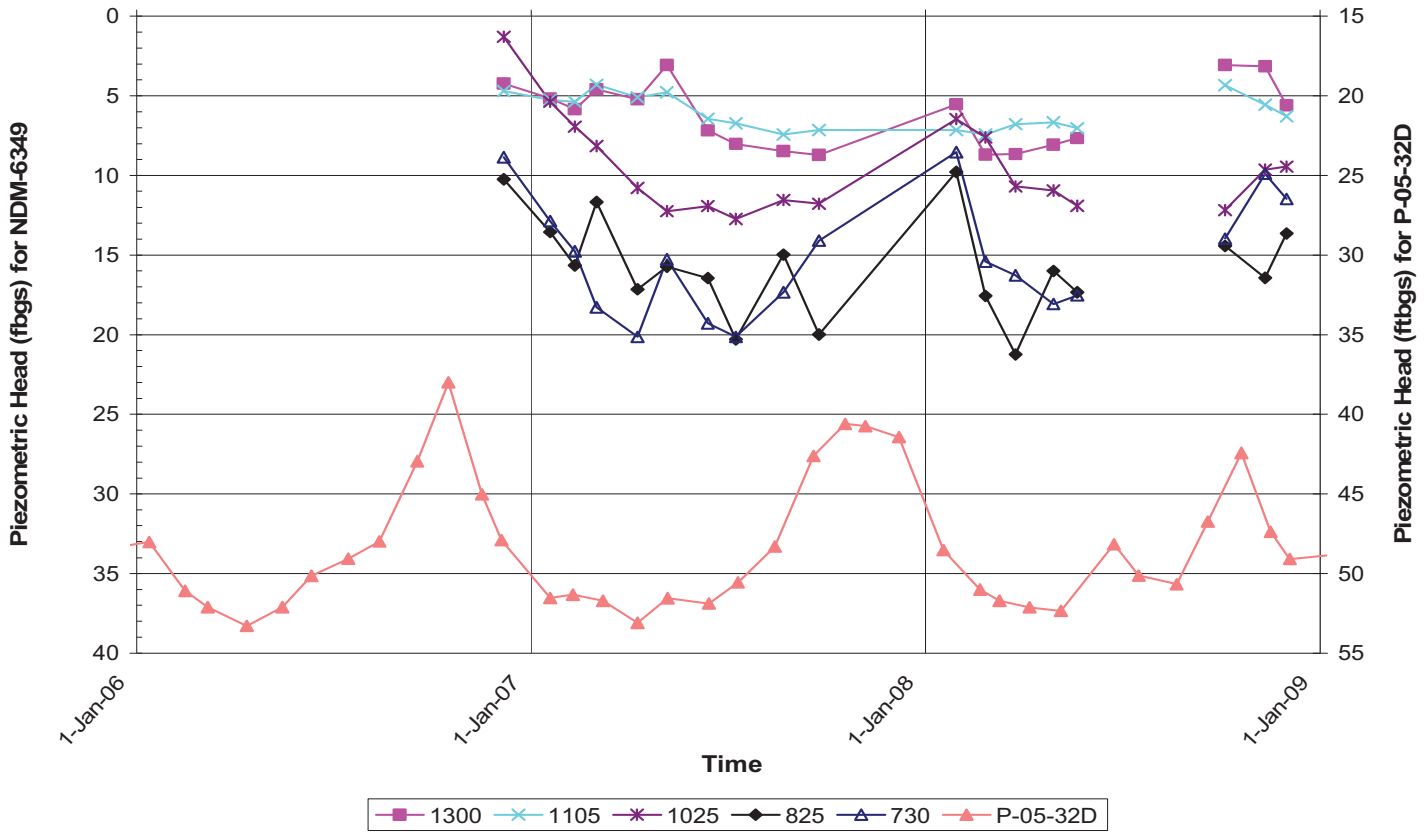
Note

Numbers in plot's legend stand for WB-1 port depths.

P-05-32D is a conventional monitoring well.



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 2.4
Time History for Depths of 700 to 1300 ft in WB-1

Appendix 8.1K
Multi-Level Groundwater Monitoring System

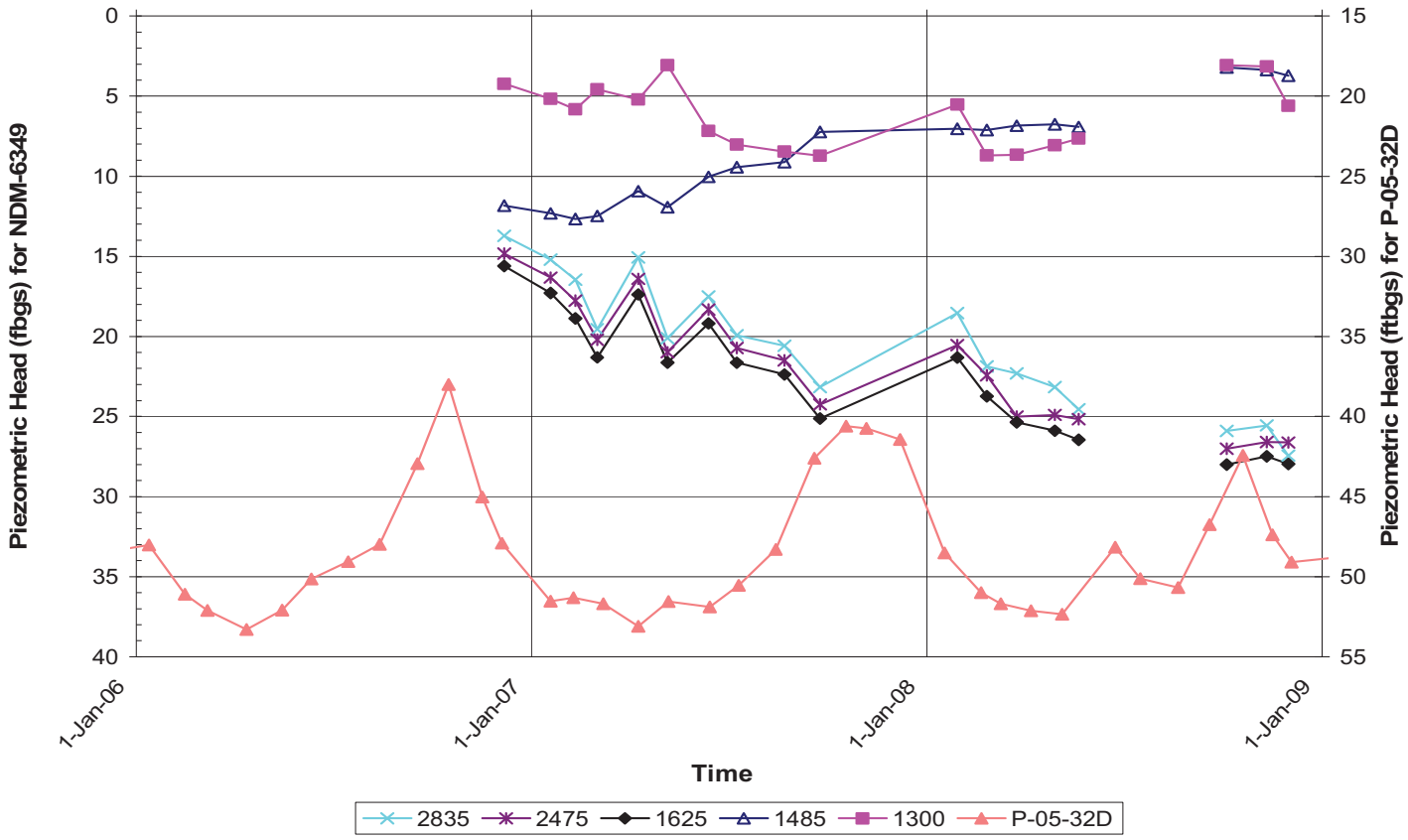
Note

Numbers in plot's legend stand for WB-1 port depths.

P-05-32D is a conventional monitoring well.



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 2.5
Time History for Depths of 1300 to 2800 ft in WB-1

Appendix 8.1K
Multi-Level Groundwater Monitoring System

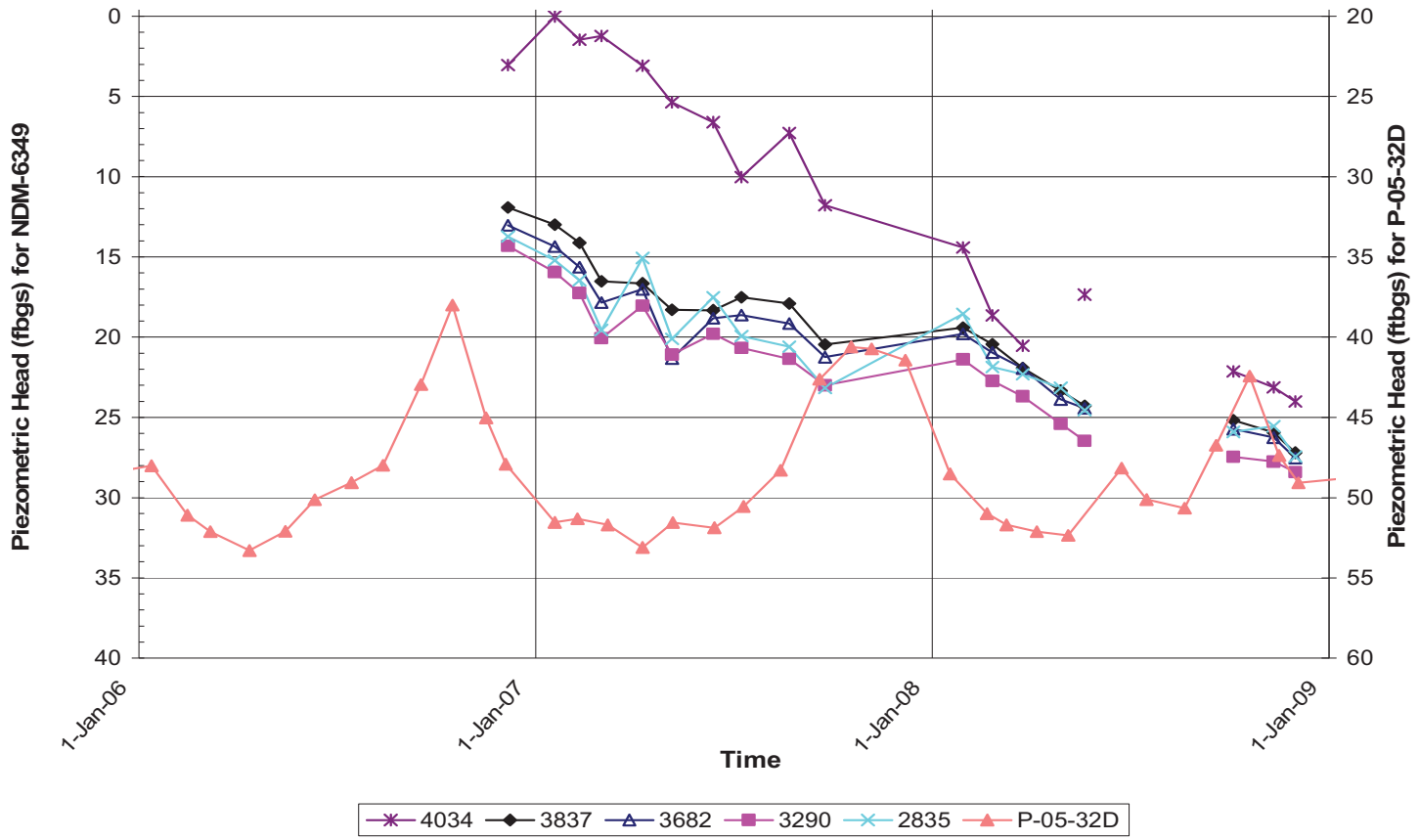
Note

Numbers in plot's legend stand for WB-1 port depths.

P-05-32D is a conventional monitoring well



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 2.6
Time History for Depths of 2800 to 4000 ft in WB-1

Appendix 8.1K
Multi-Level Groundwater Monitoring System

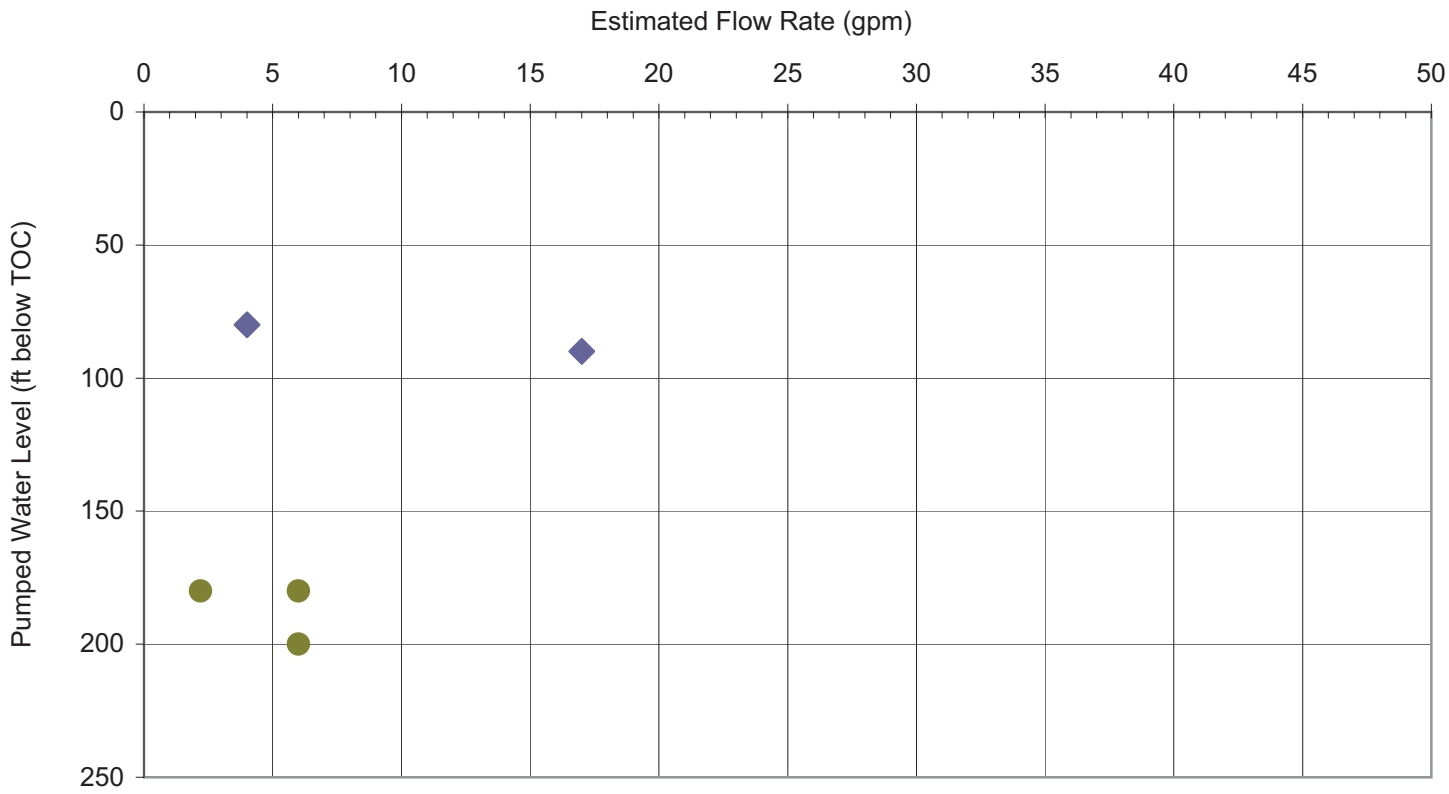
Note

Numbers in plot's legend stand for WB-1 port depths.

P-05-32D is a conventional monitoring well



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.1
Estimated Pumping Rate with 200 ft of BQ Air Line in HQ and NQ Rods

Appendix 8.1K
Multi-Level Groundwater Monitoring System

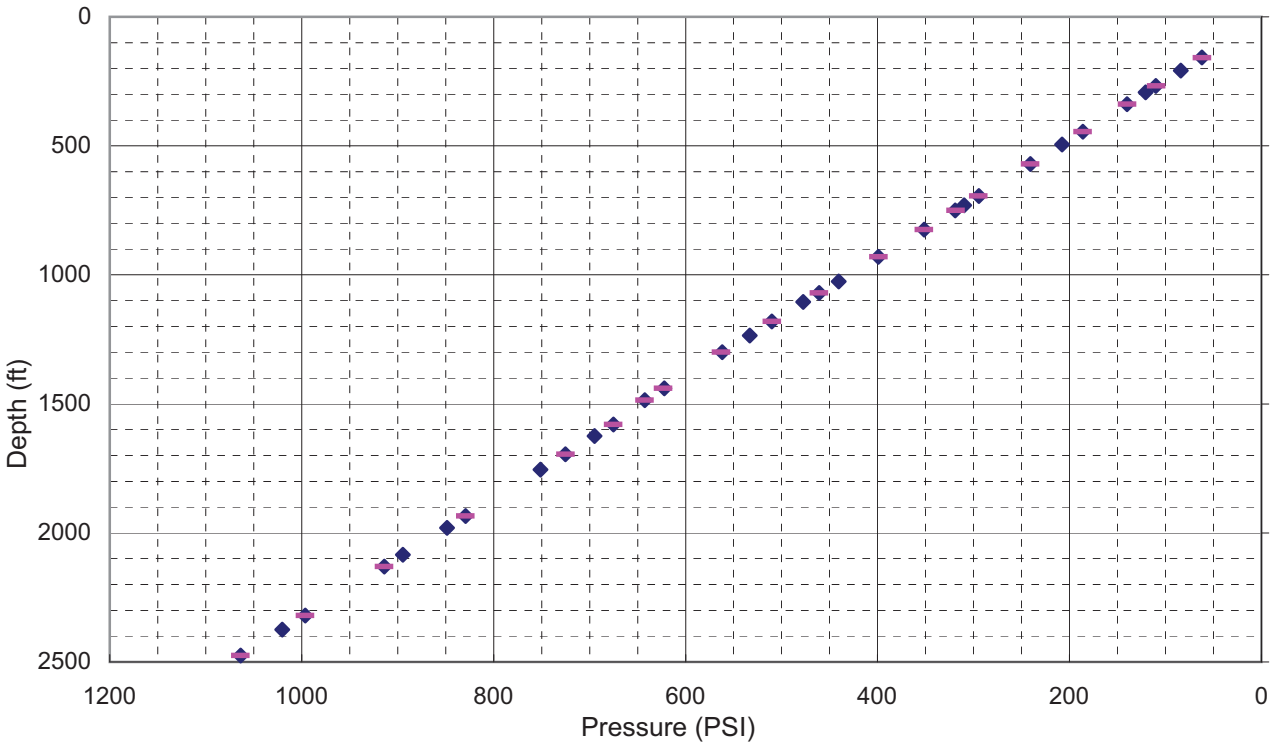
Legend

- HQ Pump Tests
- NQ Pump Tests

BQ, HQ and NQ depict a size of Board-Longyear drilling rods



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.2
Comparison of Mosdax Pressure Data with Pre-test Pressure Data

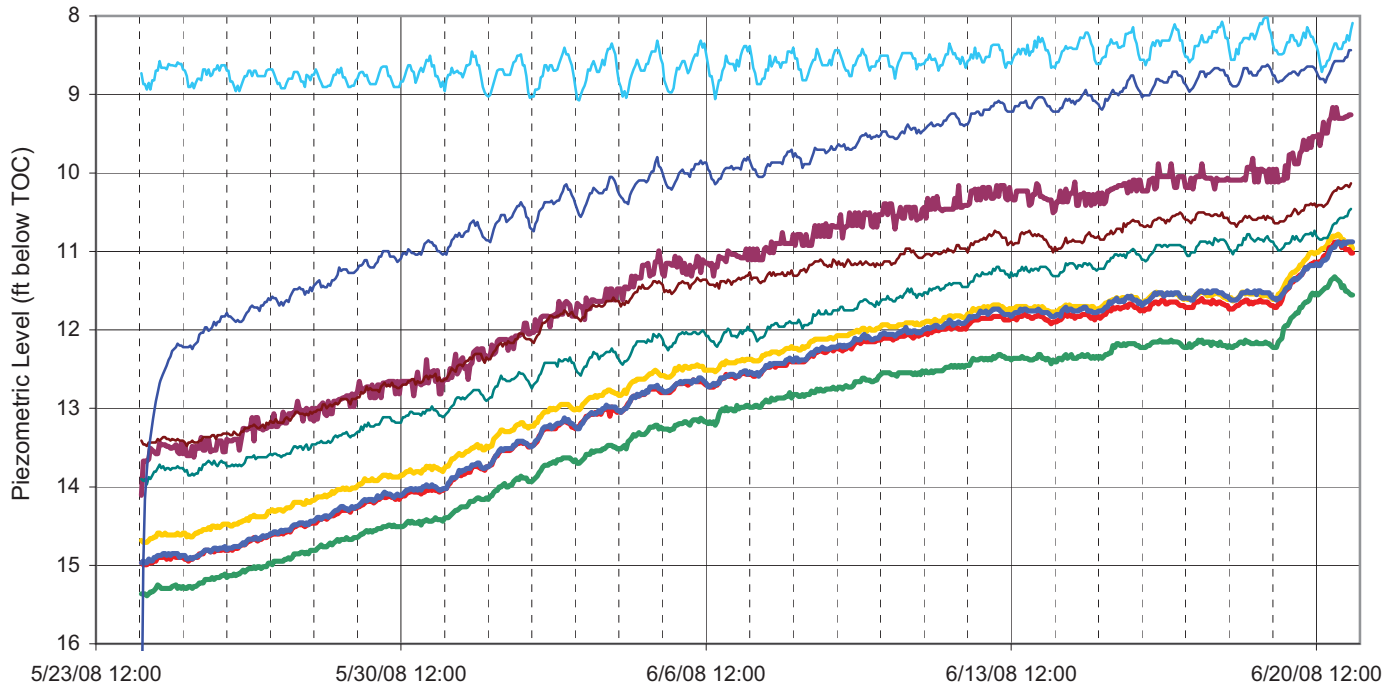
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- WB Profile (May 21, 2008)
- WB String Measurement (March 25 12:00 AM)



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.3
Test # 1, Variation of Pre-test Piezometric Levels in Probes #1 to #9

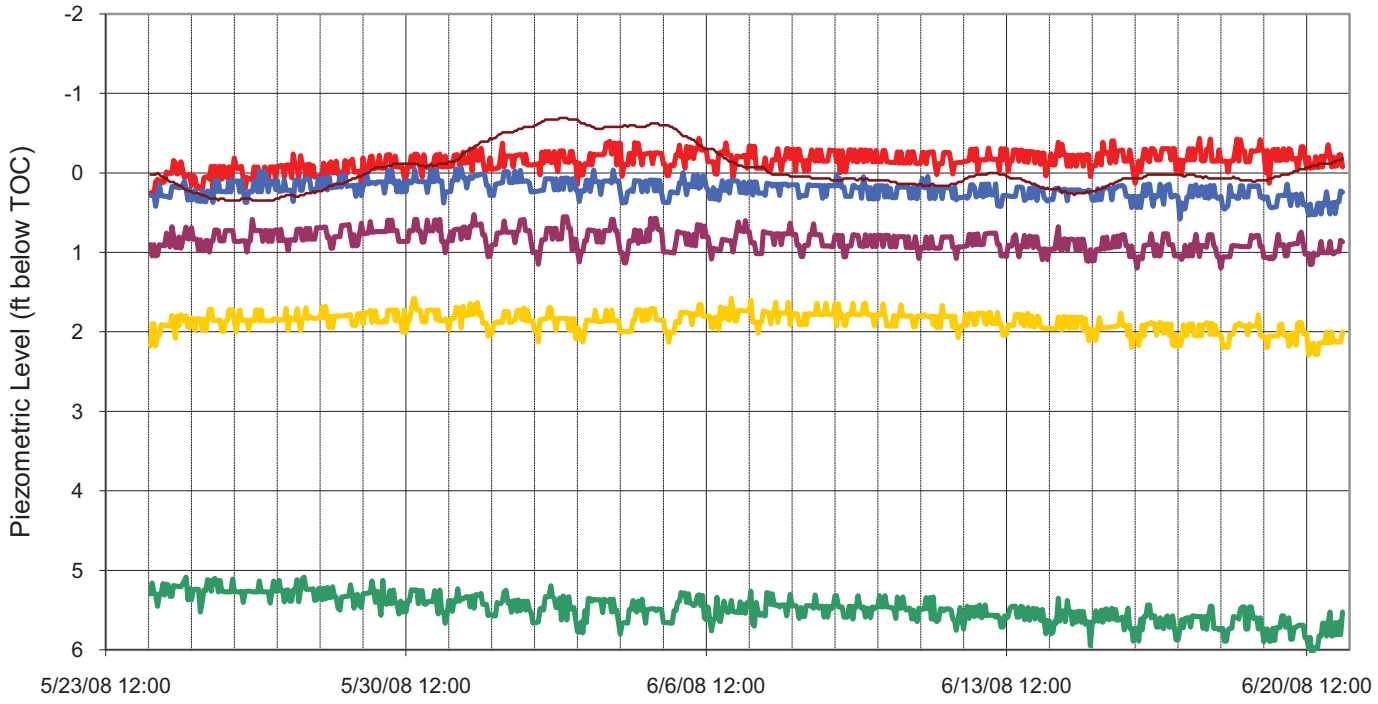
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Probe 1
- Probe 2
- Probe 3
- Probe 4
- Probe 5
- Probe 6
- Probe 7
- Probe 8
- Probe 9



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.4
Test # 1, Variation of
Pre-test Piezometric Levels
in Probes
#10 to #15

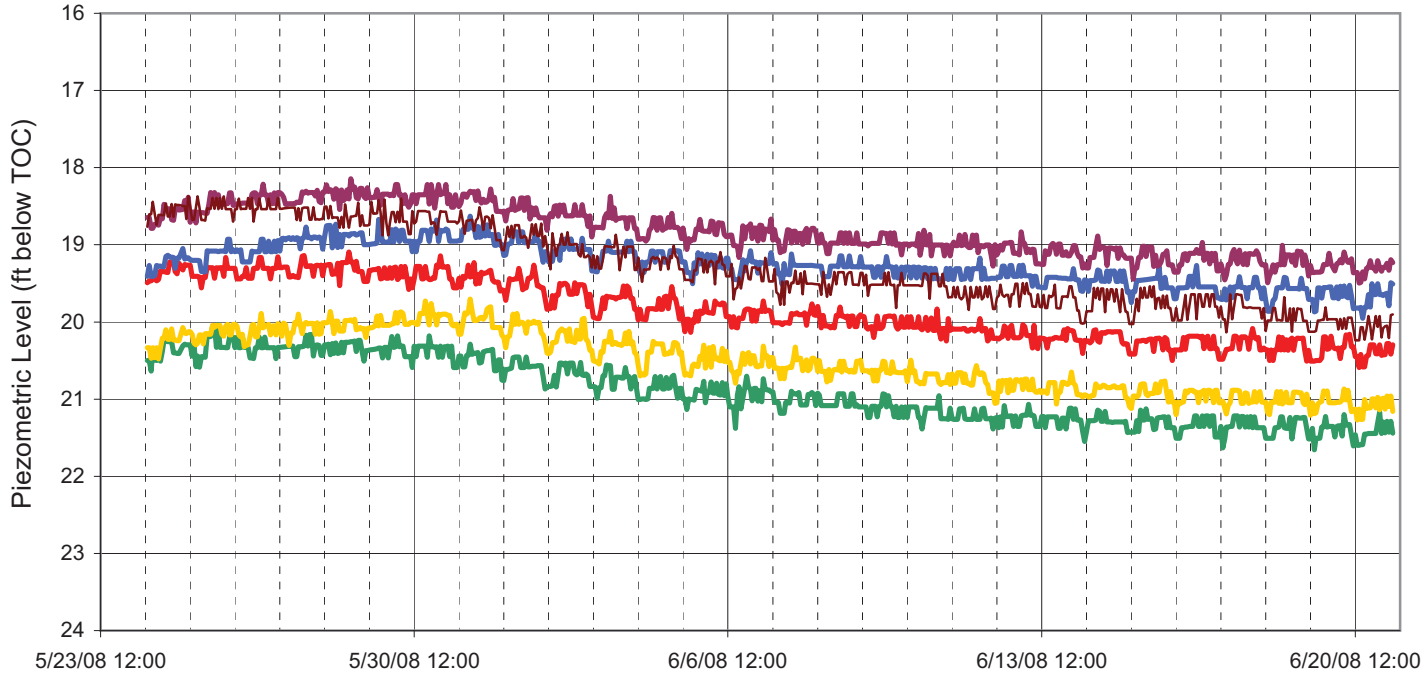
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Legend

- Probe 10
- Probe 11
- Probe 12
- LP-13
- LP-14
- Atmospheric



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.5
Test # 1, Variation of
Pre-test Piezometric Levels
in Probes
#15 to #20

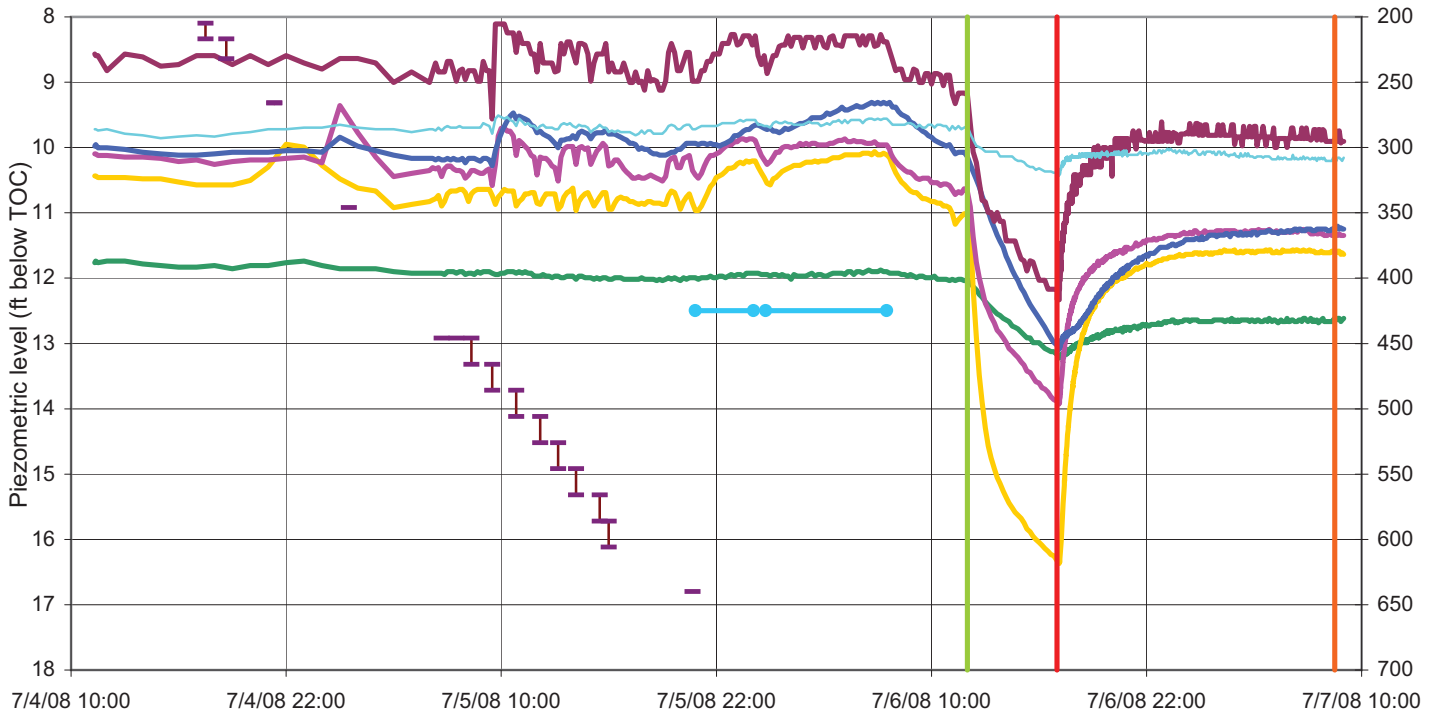
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Legend

- LP-15
- LP-16
- LP-17
- LP-18
- LP-19
- LP-20



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.6
Test # 1, Piezometric Response to Drilling and Testing

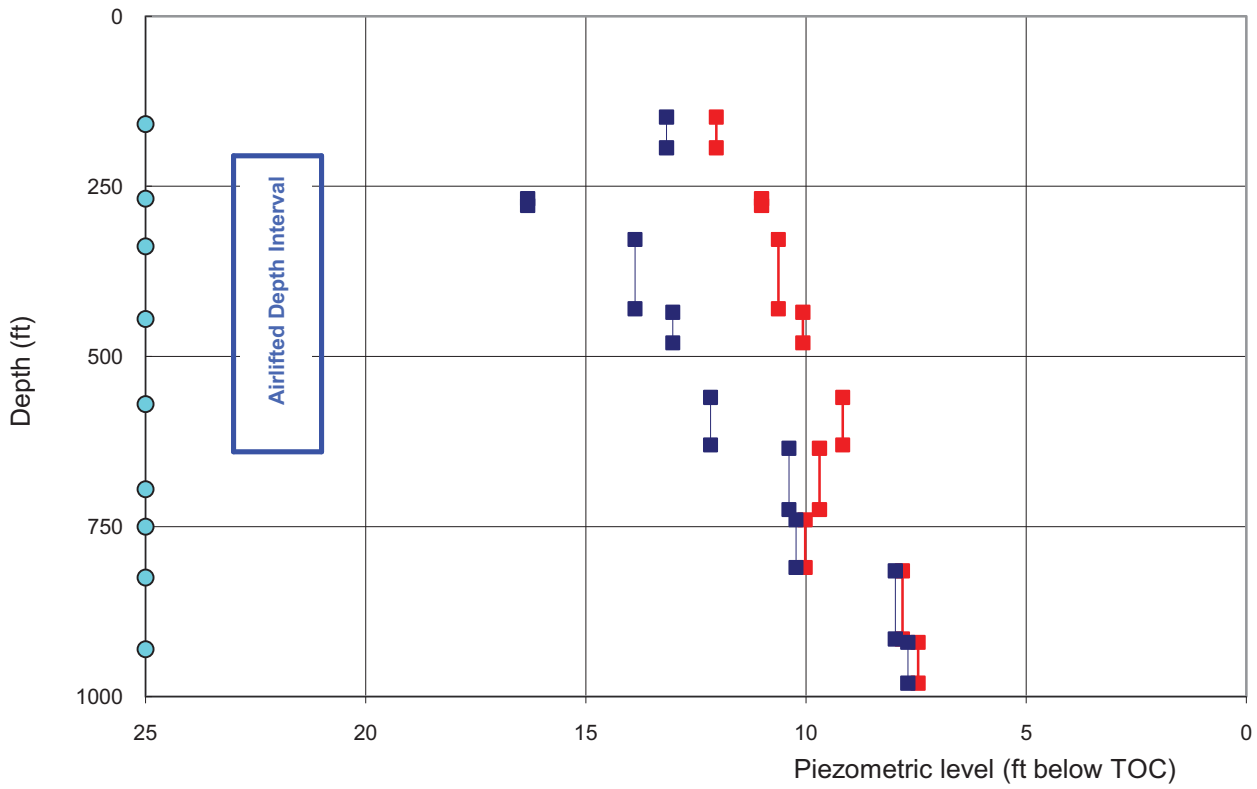
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- LP-1 158.4
- LP-2 268.2
- LP-3 338.1
- LP-4 445
- LP-5 570
- LP-6 695
- Start Airlifting
- Stop Airlifting
- Tripping Rods
- Flushing
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.7
Test # 1, Pressure Change in WB-1 as a Result of Air Lifting

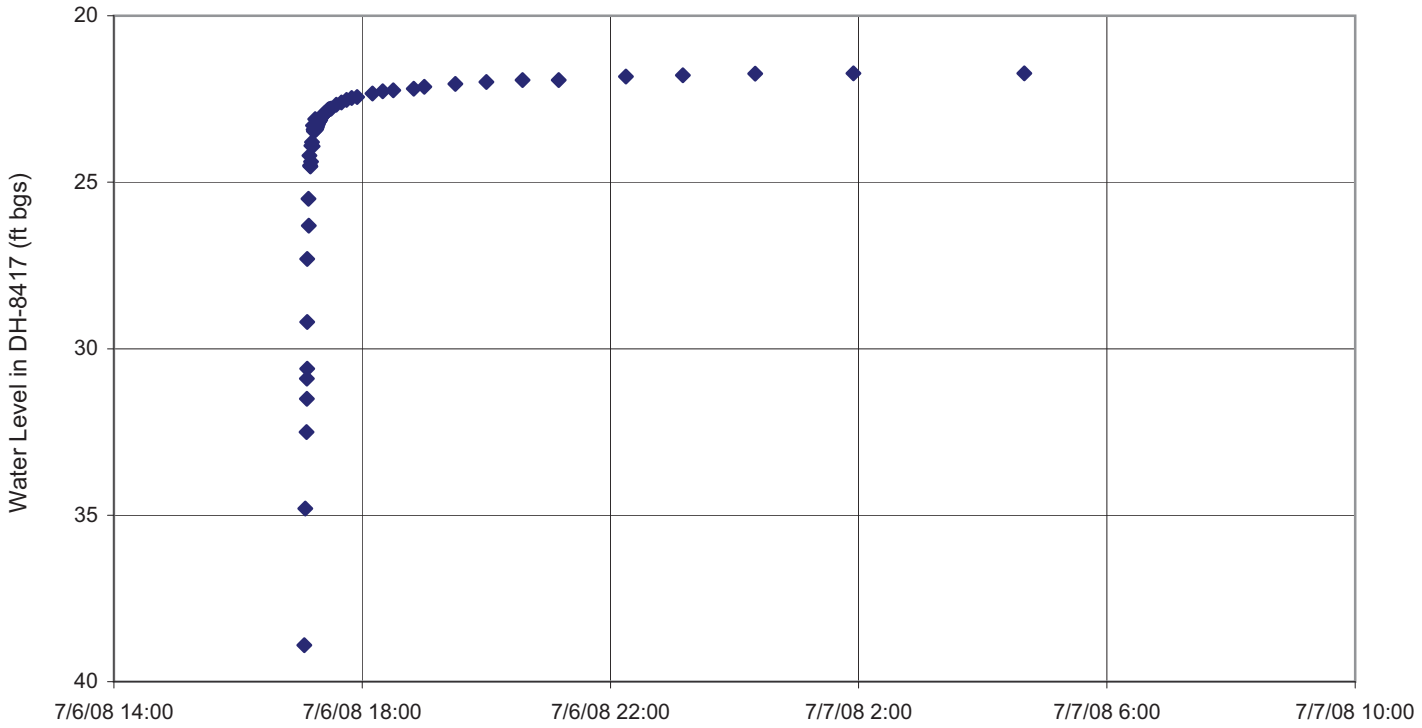
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 1 (08-Jul-6 11:50 AM)
- After Test 1 (08-Jul-06 5:00 PM)
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.8
Test # 1, Manual Water Level Recovery Measurements in DH8417

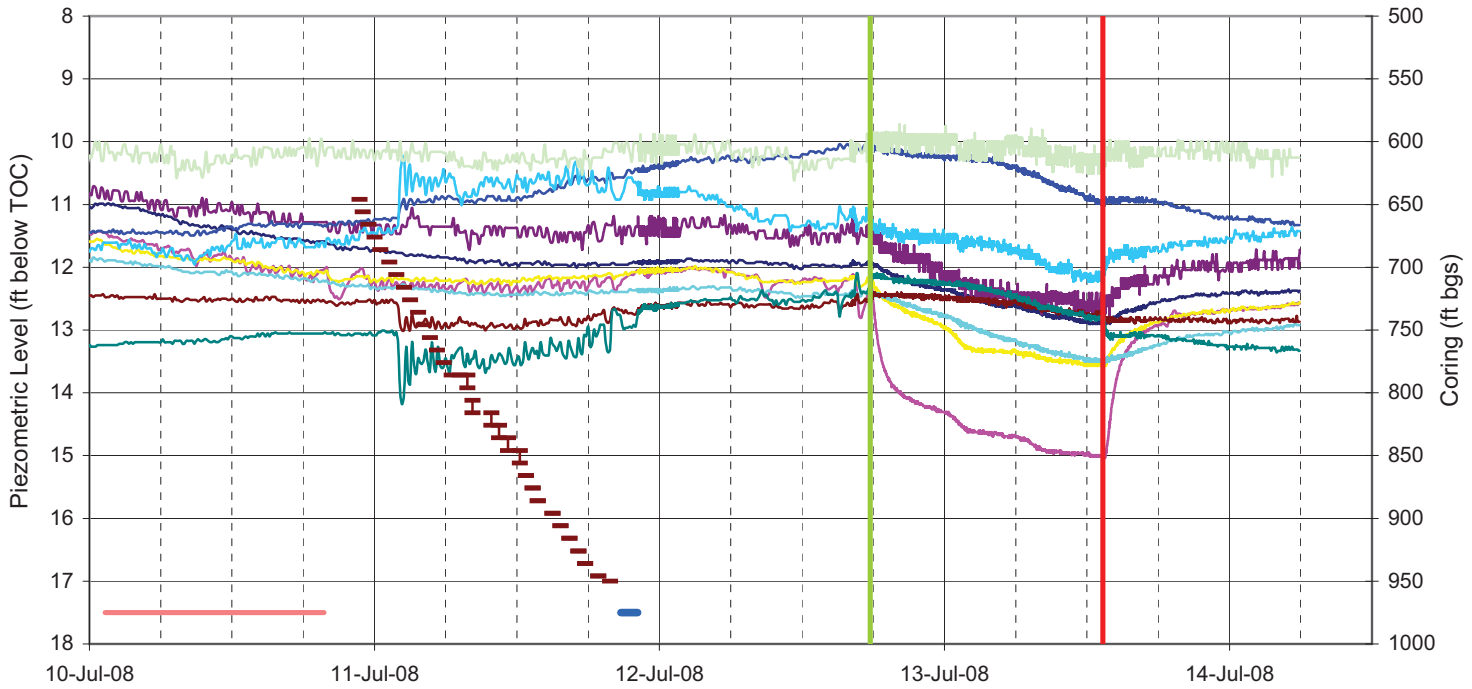
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

◆ Manual Measurements



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.9
Test # 2, Piezometric Response to Drilling and Testing

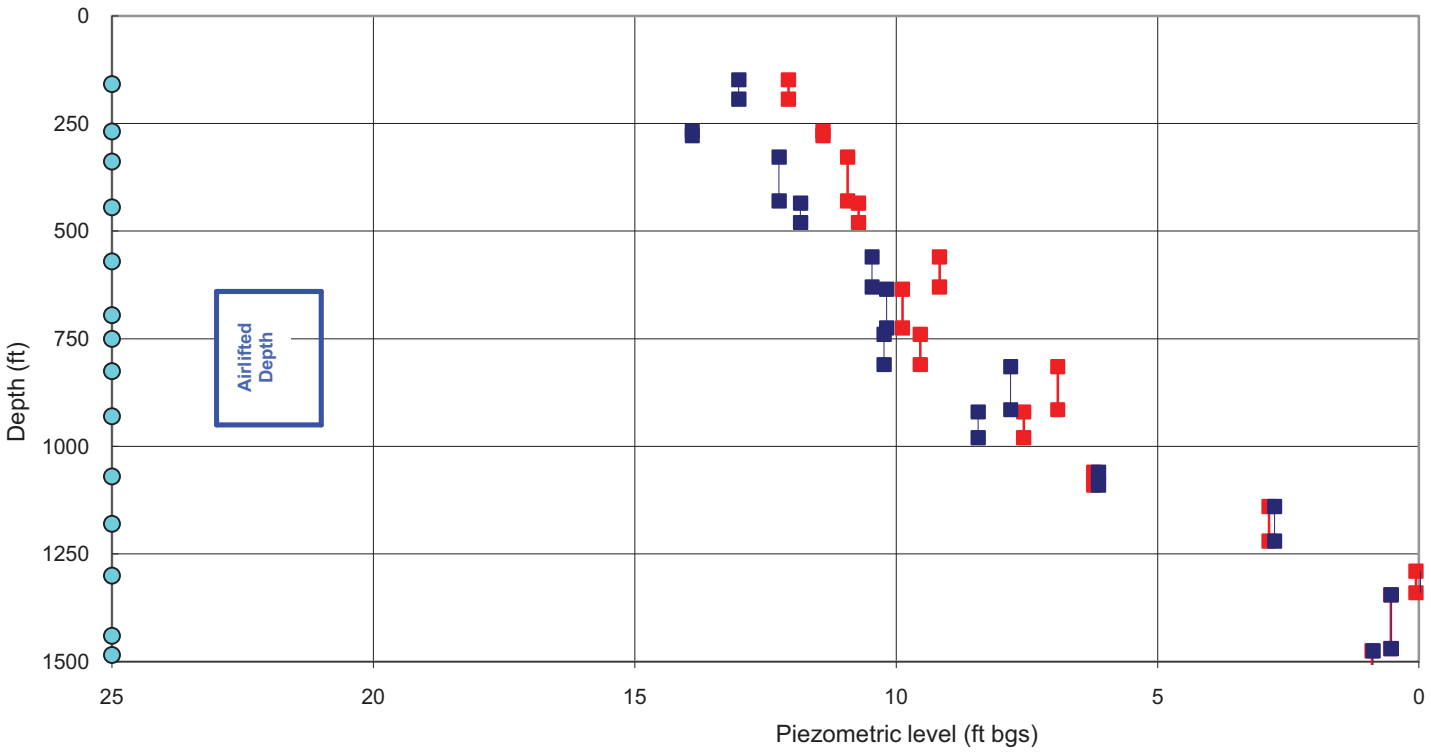
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- LP-1 158
- LP-2 268
- LP-3 338
- LP-4 445
- LP-5 570
- LP-6 695
- LP-7 750
- LP-8 825
- LP-9 930
- LP-10 1070
- Cement coring
- Flushing
- Begin air lifting
- Stop air lifting
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.10
Test # 2, Pressure Change in WB-1 as a Result of Air Lift, Probes #1 to #14

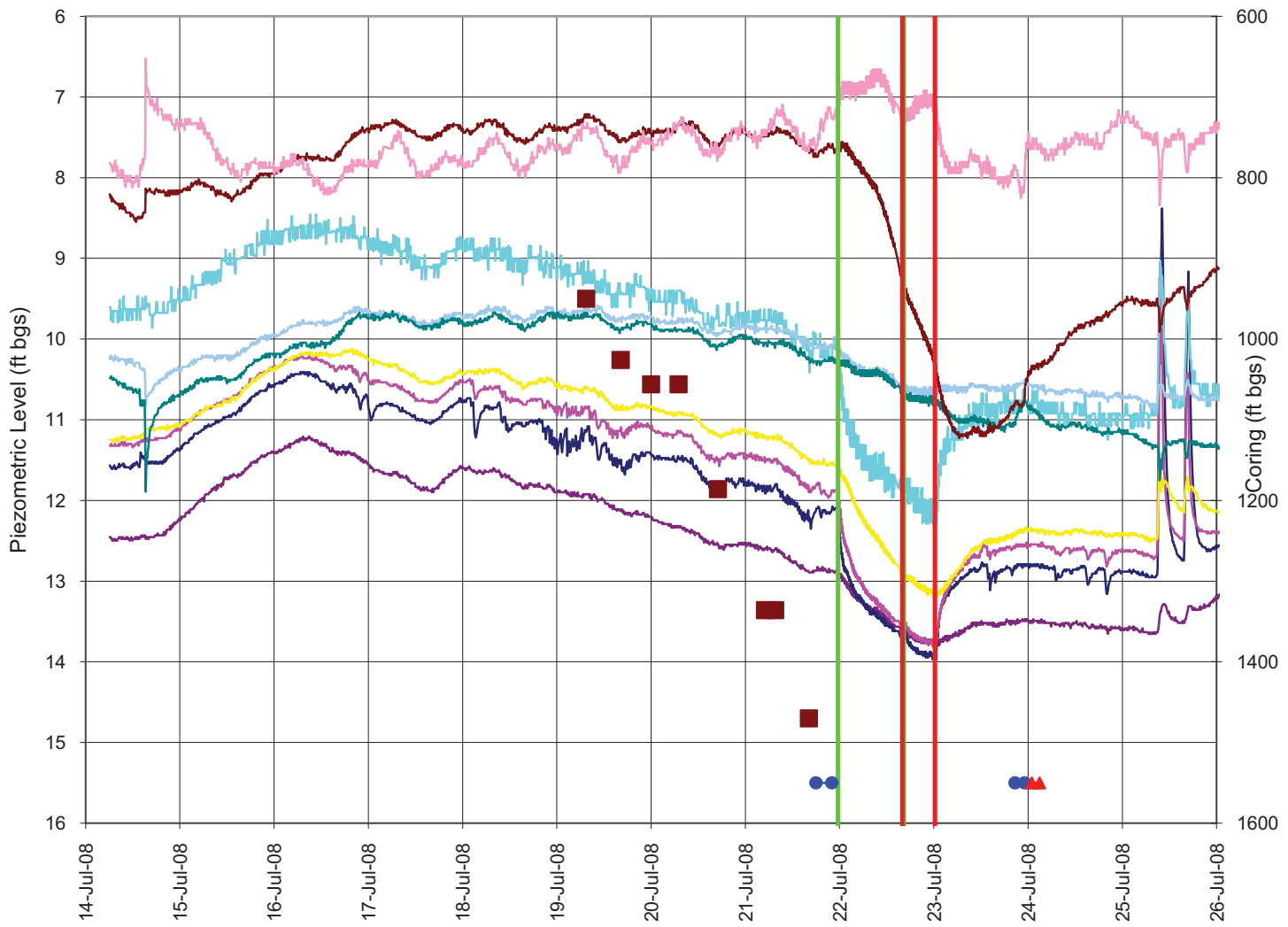
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 1
- After Test 1
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.11
Test # 3, Piezometric Response to Drilling and Testing, Probes #1 to #9

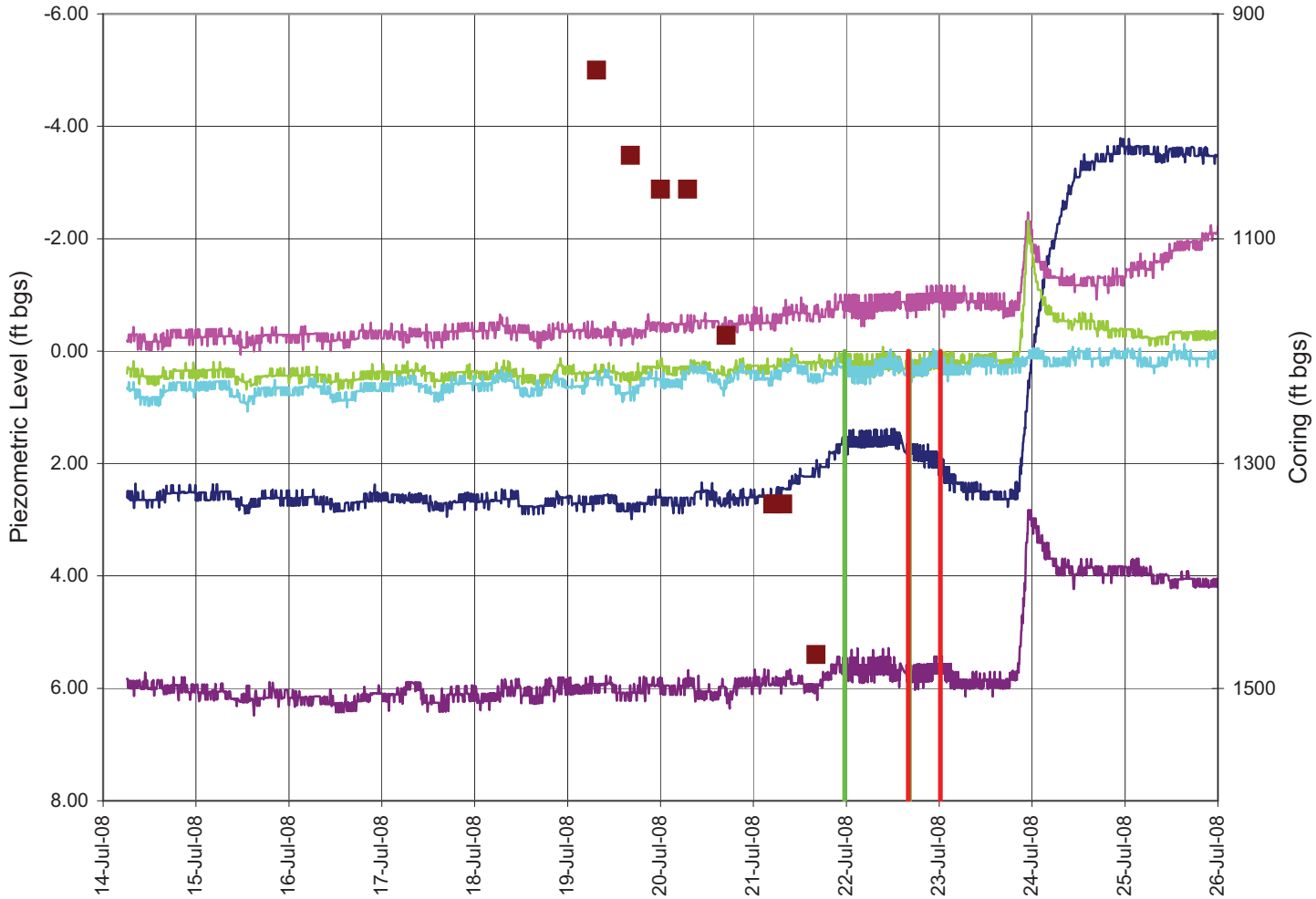
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- LP-1
- LP-2
- LP-3
- LP-4
- LP-5
- LP-6 695
- LP-7 750
- LP-8
- LP-9 930
- Start Airlifting
- Stop airlifting
- Flushing
- Packer test
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.12
Test # 3, Piezometric Response to Drilling and Testing,
Probes #10 to #14

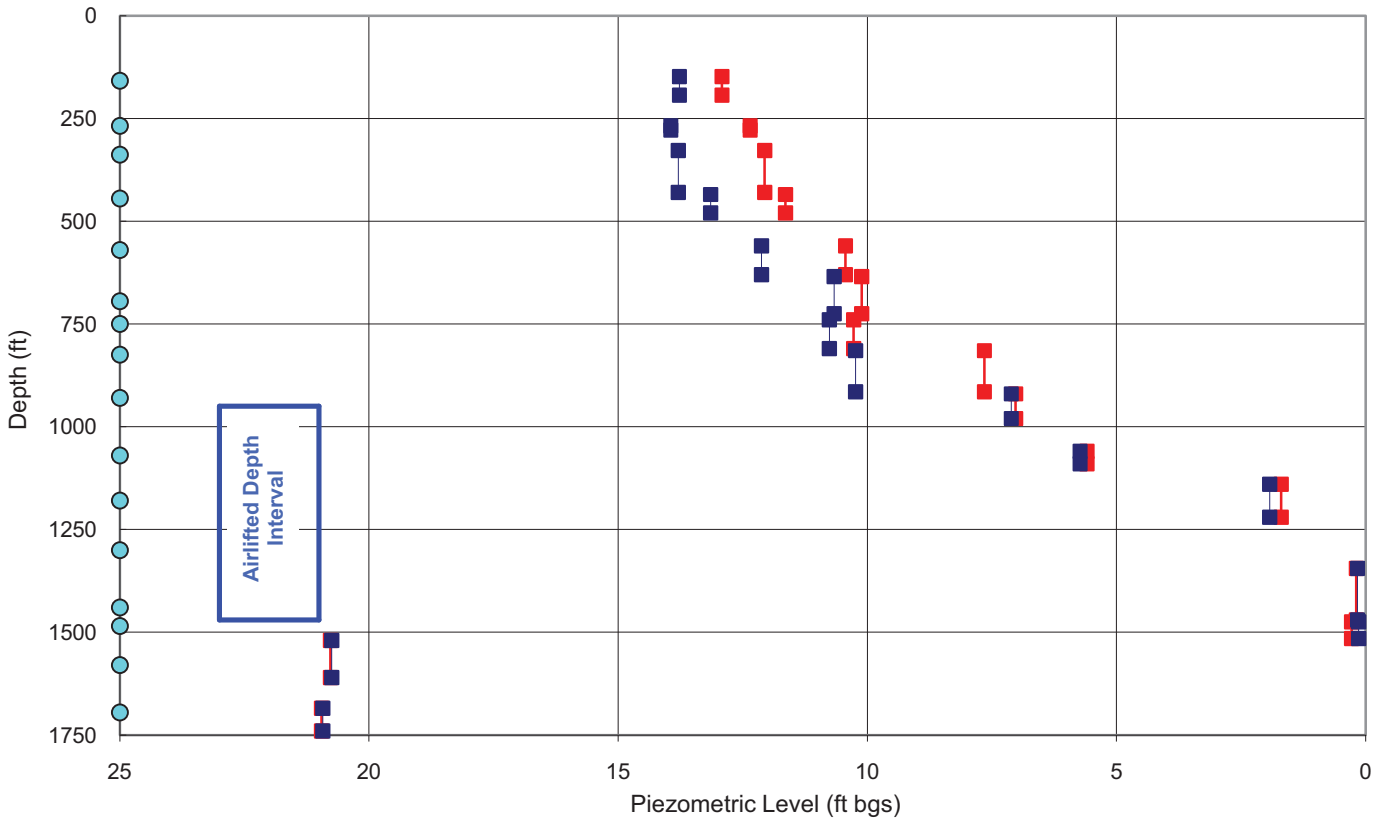
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- LP-10 1070
- LP-11 1180
- LP-12 1300
- LP-13 1440
- LP-14 1485
- Start Airlifting
- Stop airlifting
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.13
Test # 3, Pressure Change in WB-1 as a Result of Air Lift , Probes # 1 to # 16

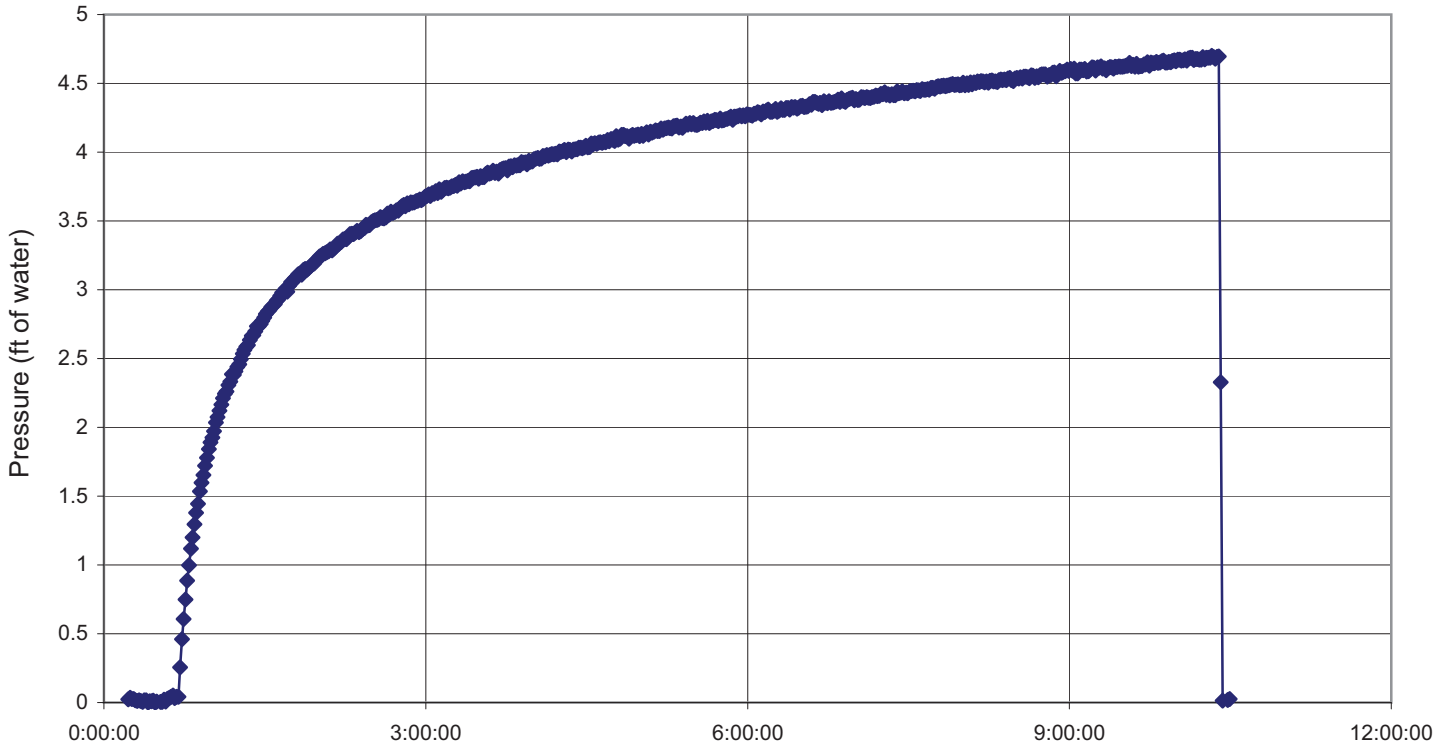
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 3
- After Test 3
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.14
Test # 3, DH-8417 Recovery after Pumping

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

Test #3

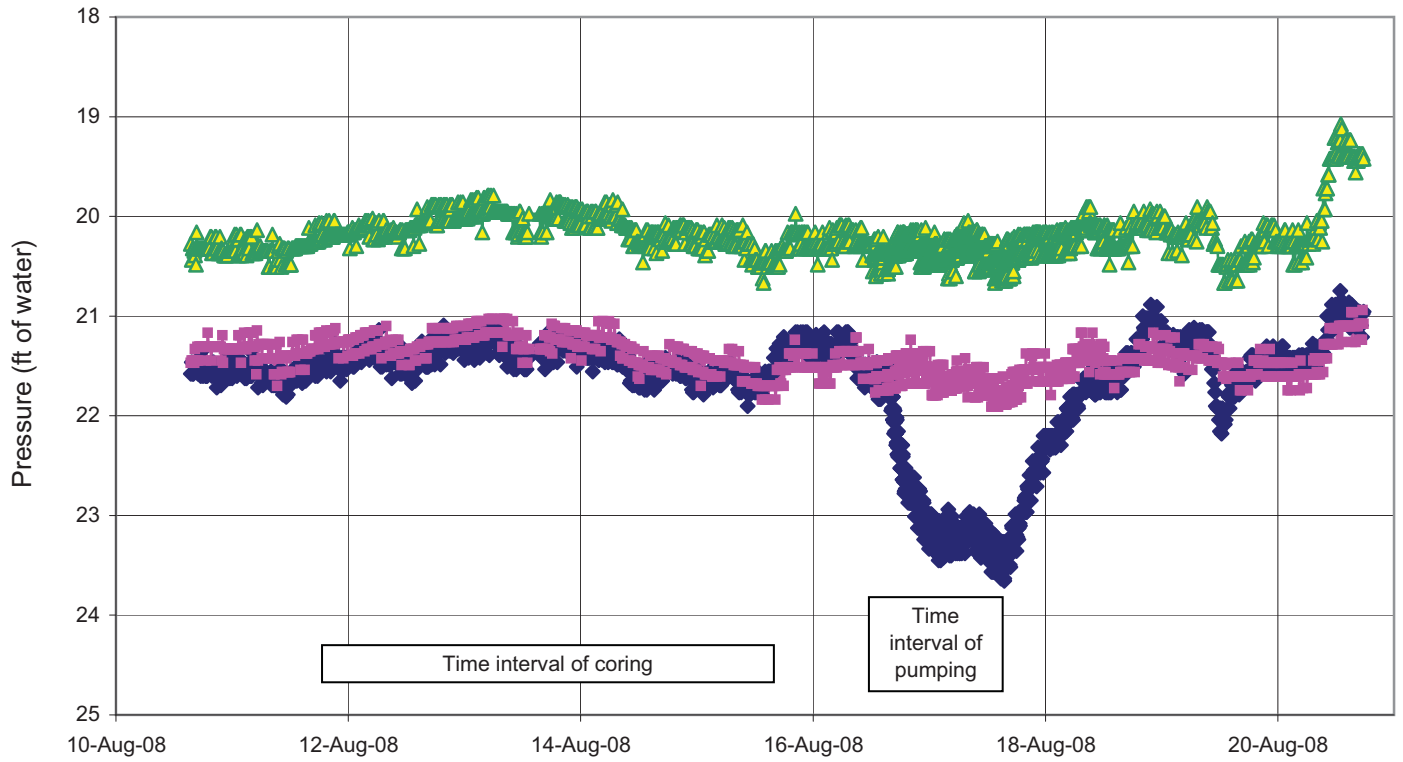
Note:

Recovery started 17 minutes after midnight

Pressure probe was likely above the pumped water level



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.15
Test # 4, Piezometric Response to Drilling and Testing, Probes #17 to #19

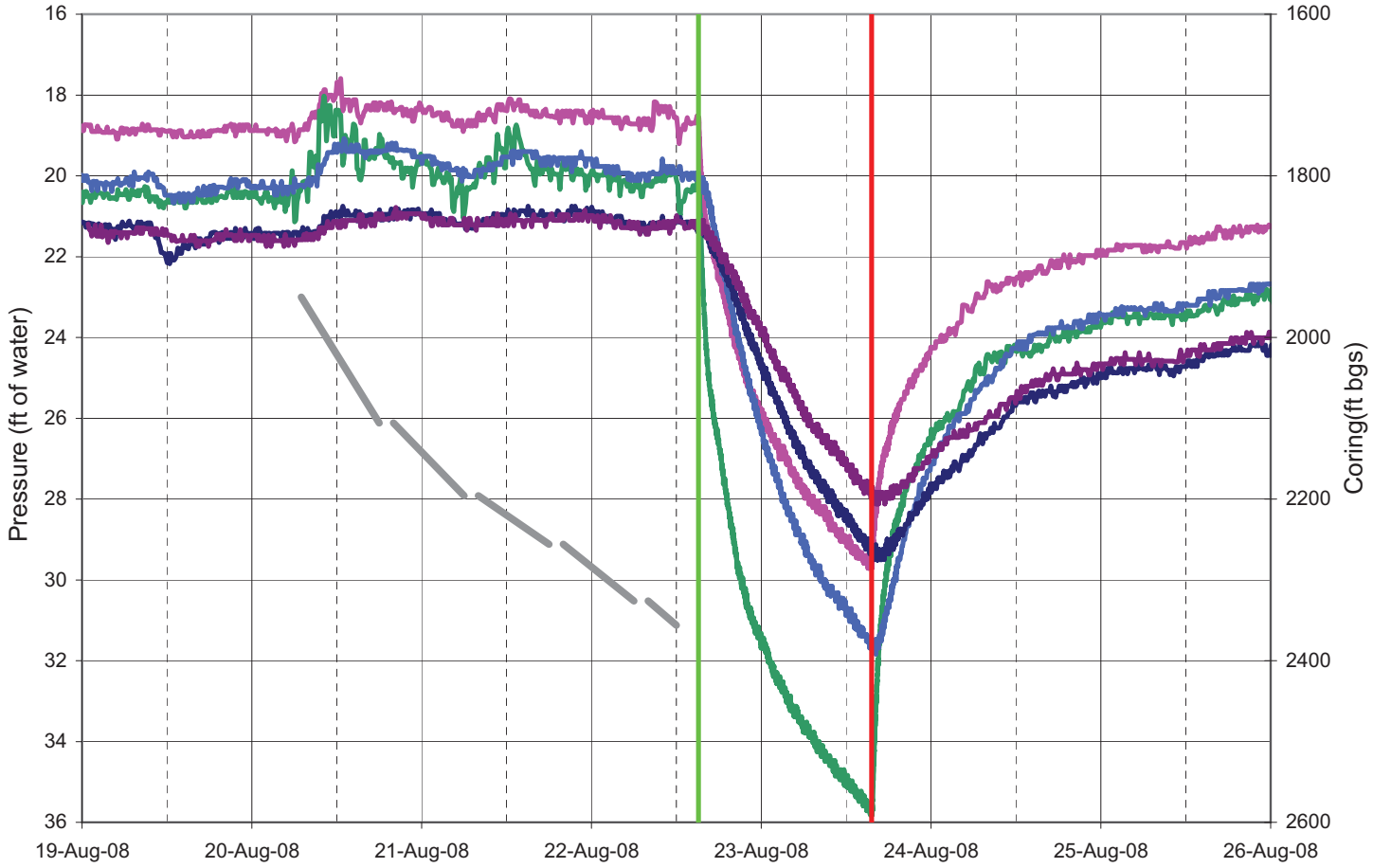
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- LP-17 1935
- LP-18 1695
- LP-19 1580



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.16
Test # 5, Piezometric Response to Drilling and Testing, Probes #15 to #19

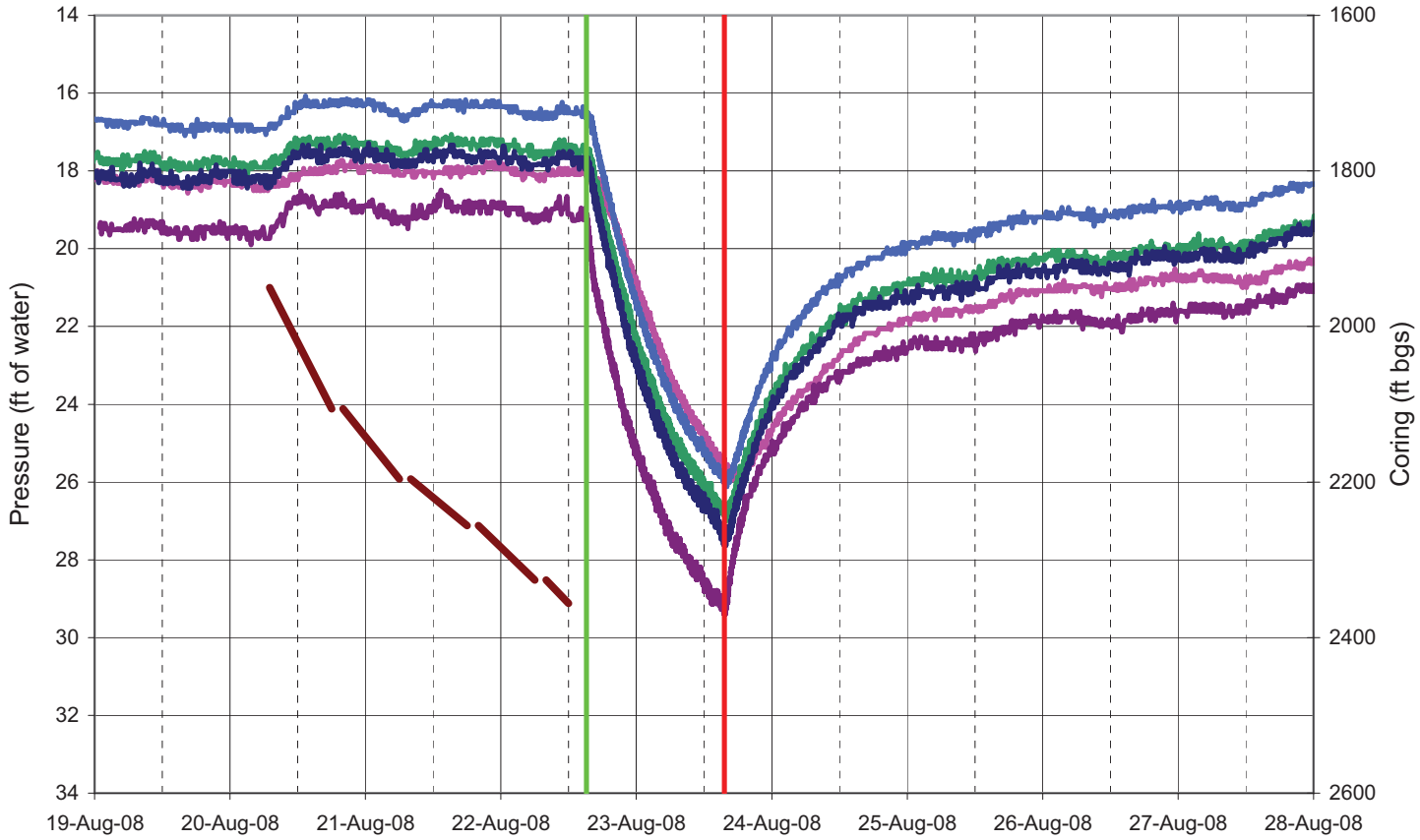
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 15 2320
- 16 2130
- 17 1935
- 18 1695
- 19 1580
- Start Pumping
- End Pumping
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.17
Test # 5, Piezometric Response to Drilling and Testing, Probes #10 to #14

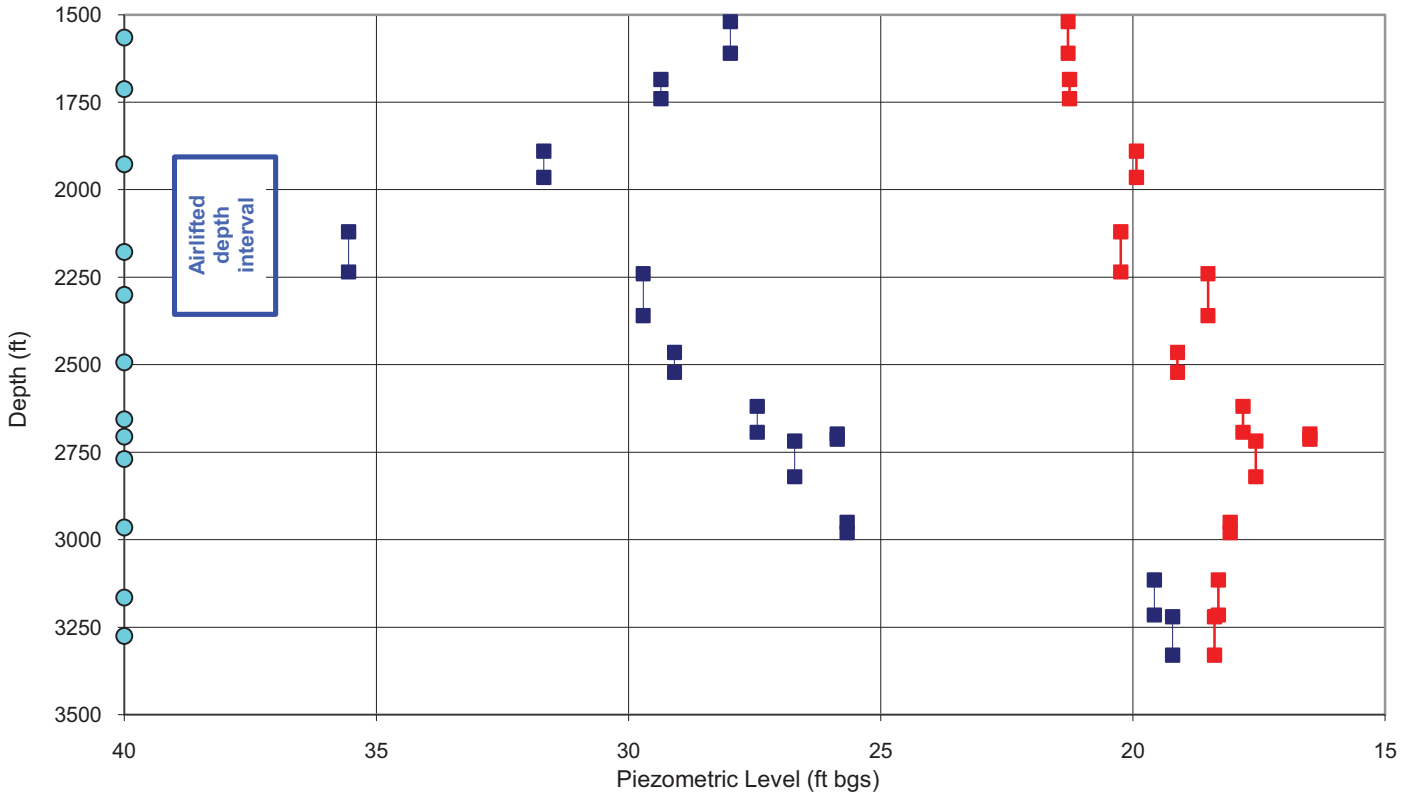
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629
- 14 2475
- Start Pumping
- End Pumping
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.18
Test # 5, Pressure Change in WB-1 as a Result of Air Lift , Probes #19 to #8

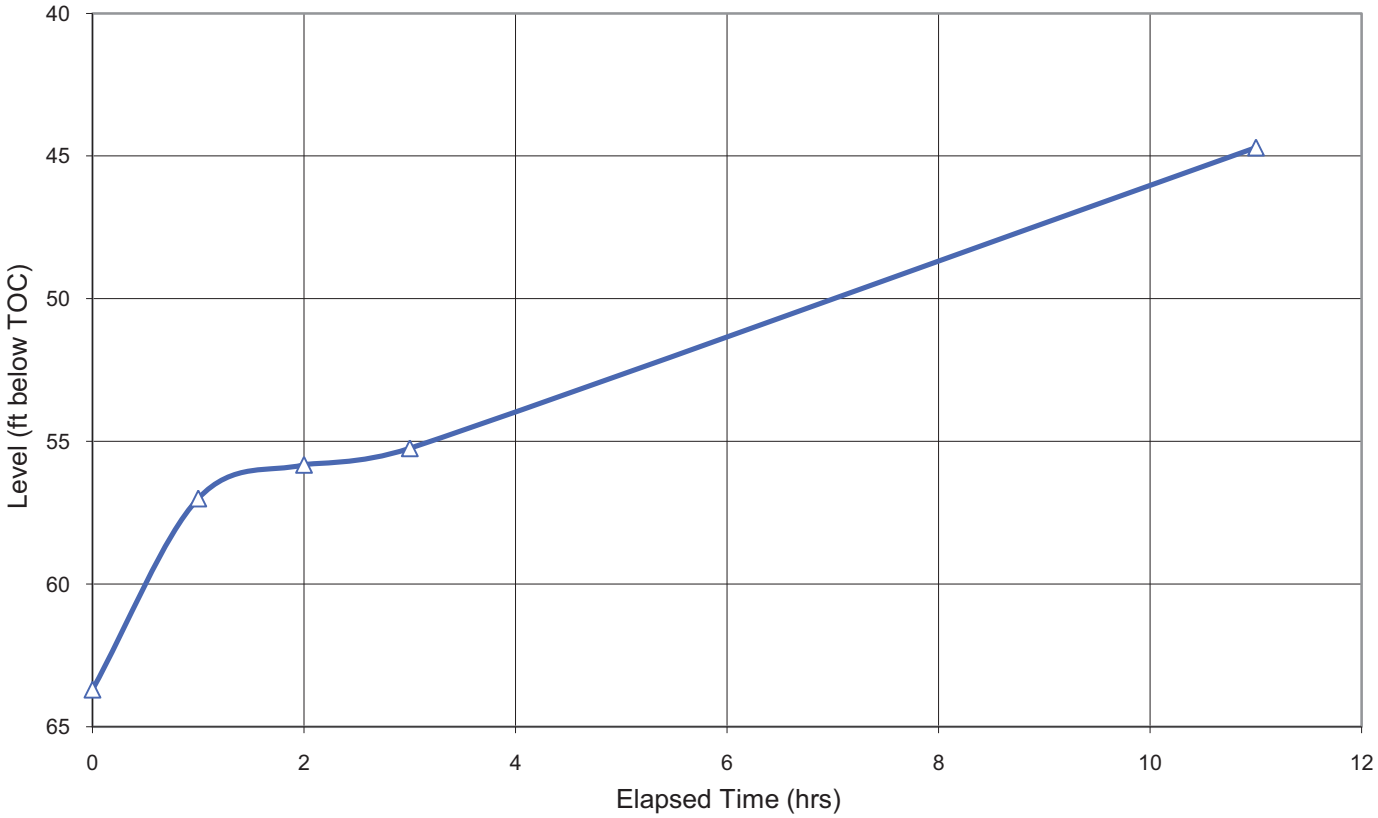
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 3
- After Test 3
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.19
Test # 5, DH-8417
Response to Air Lift

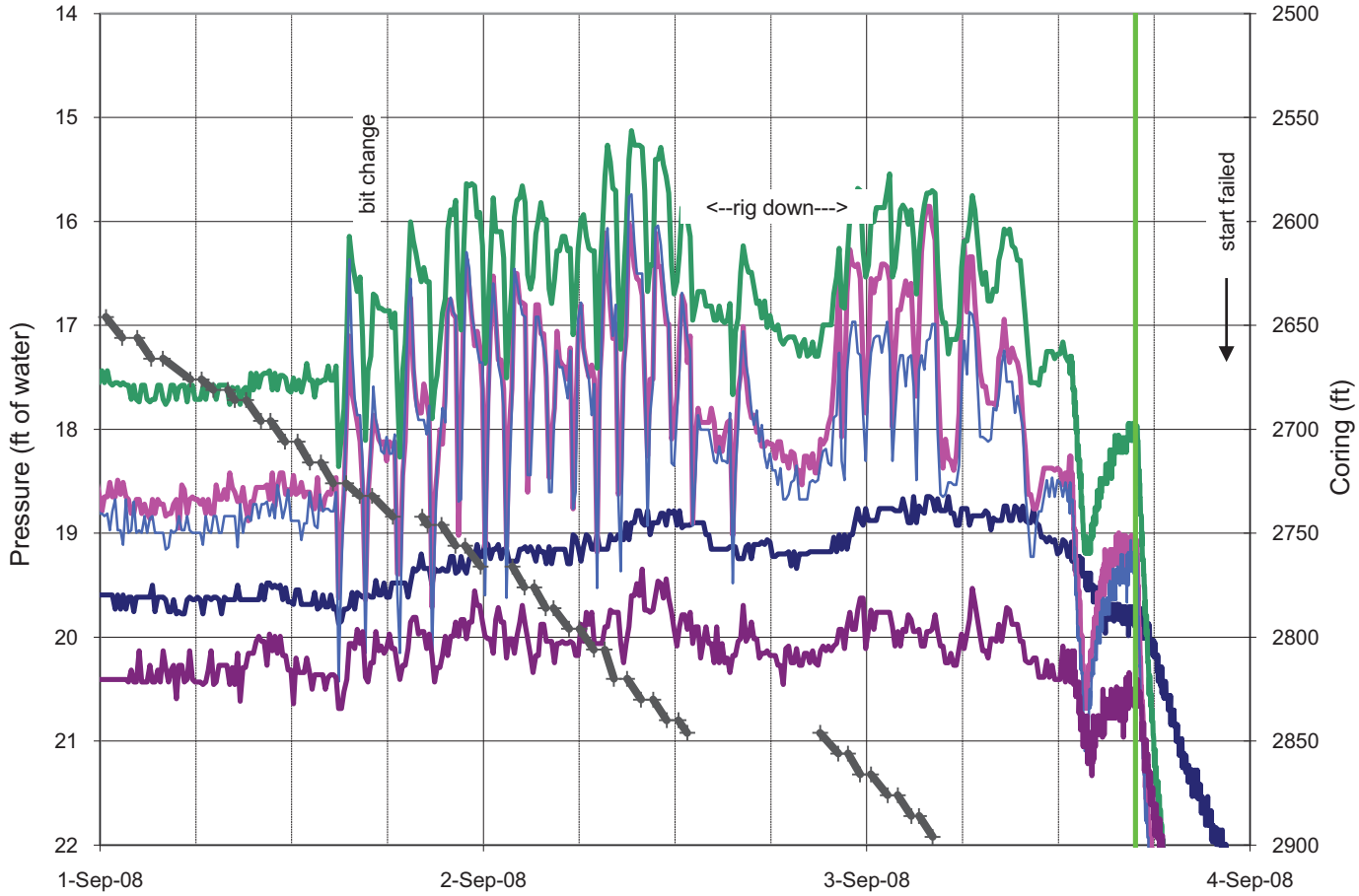
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Legend

8417 Recovery



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.20
Test # 6, Response of WB-1 to Coring through Granodiorite, Probes #10 to #14

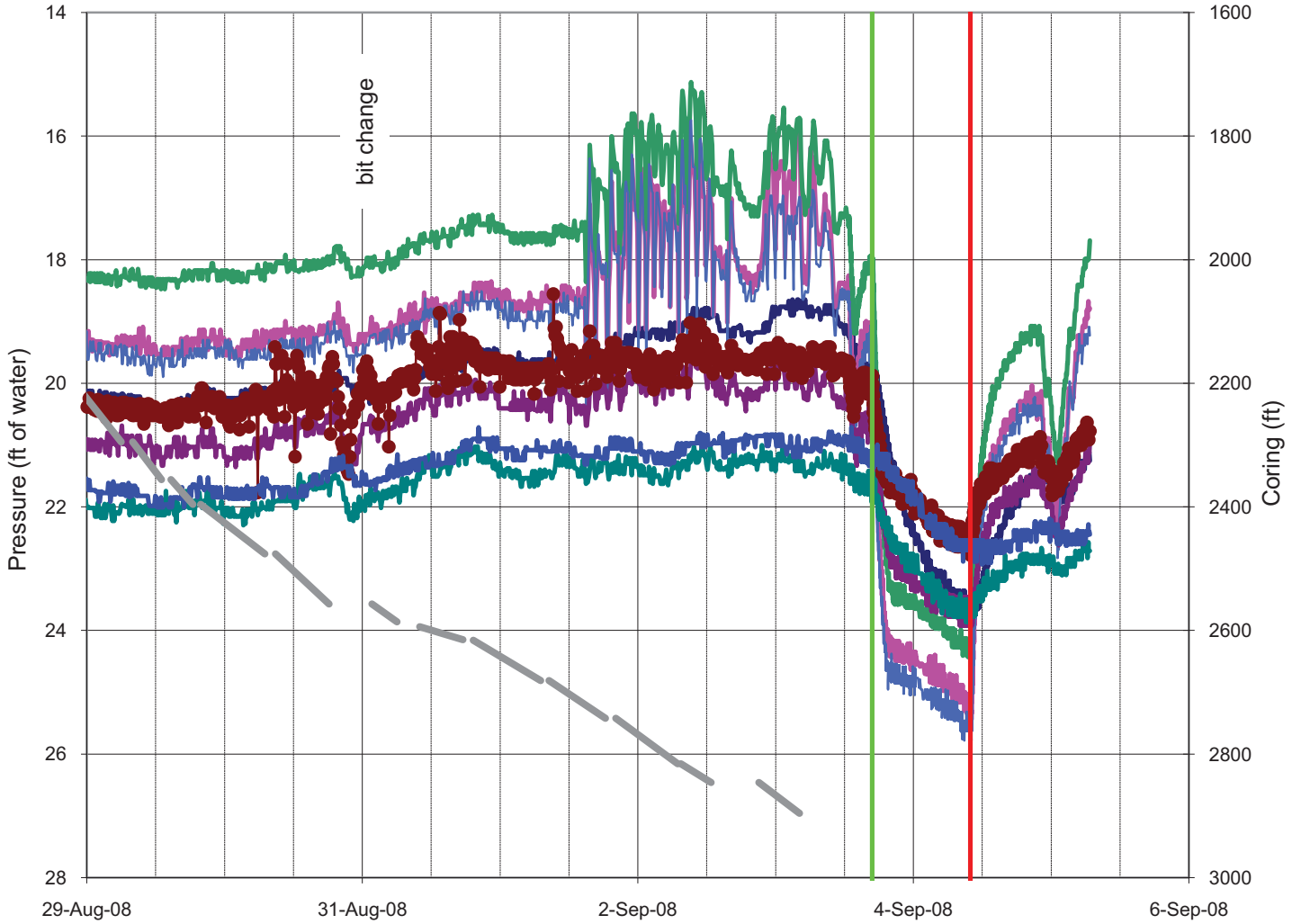
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629
- 14 2475
- Start Pumping
- End Pumping
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.21
Test # 6, Piezometric Response to Drilling and Testing, Probes #10 to #17

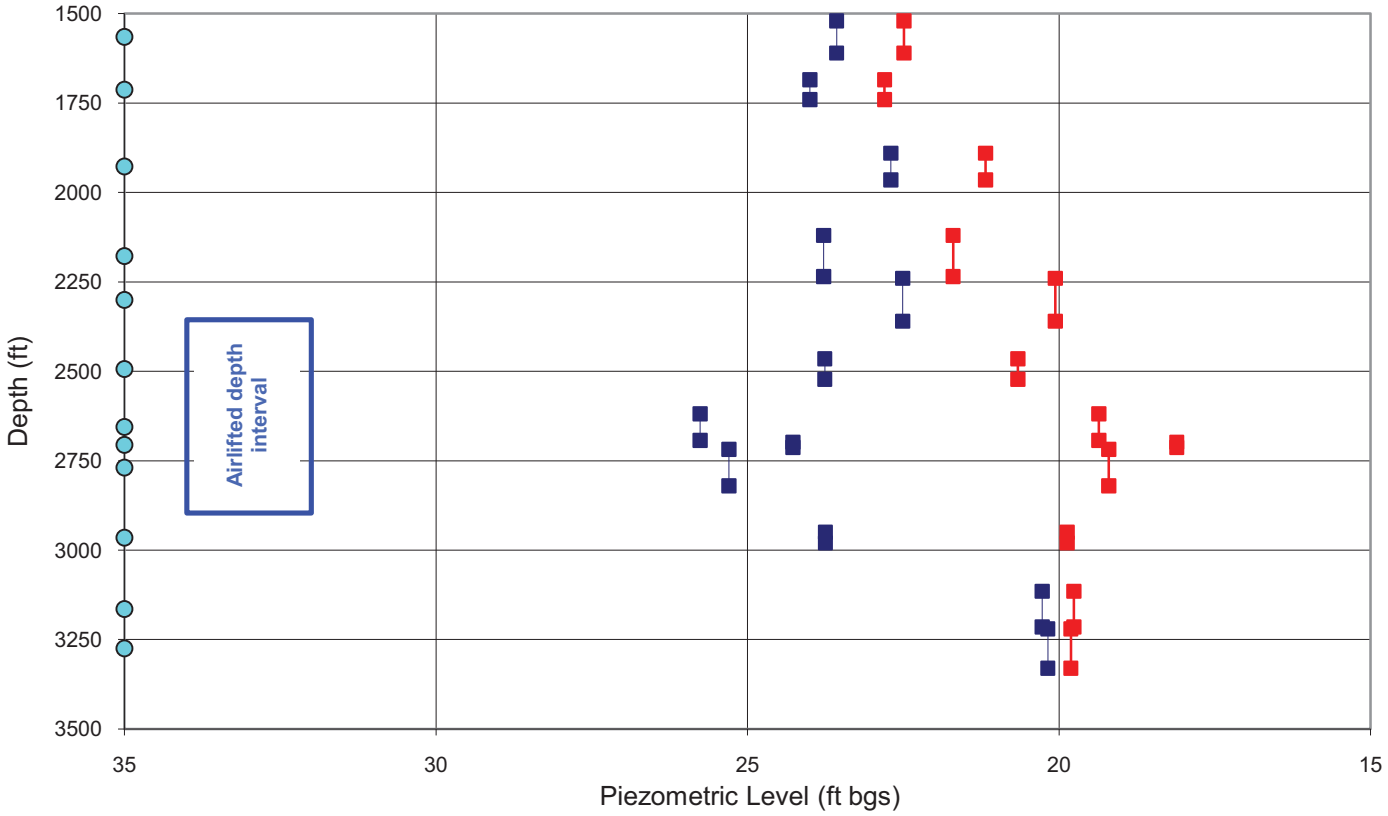
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629
- 14 2475
- 15 2320
- 16 2130
- 17 1935
- Start Pumping
- End Pumping
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.22
Test # 6, Pressure Change in WB-1 due to Pumping, Probes #19 to #8

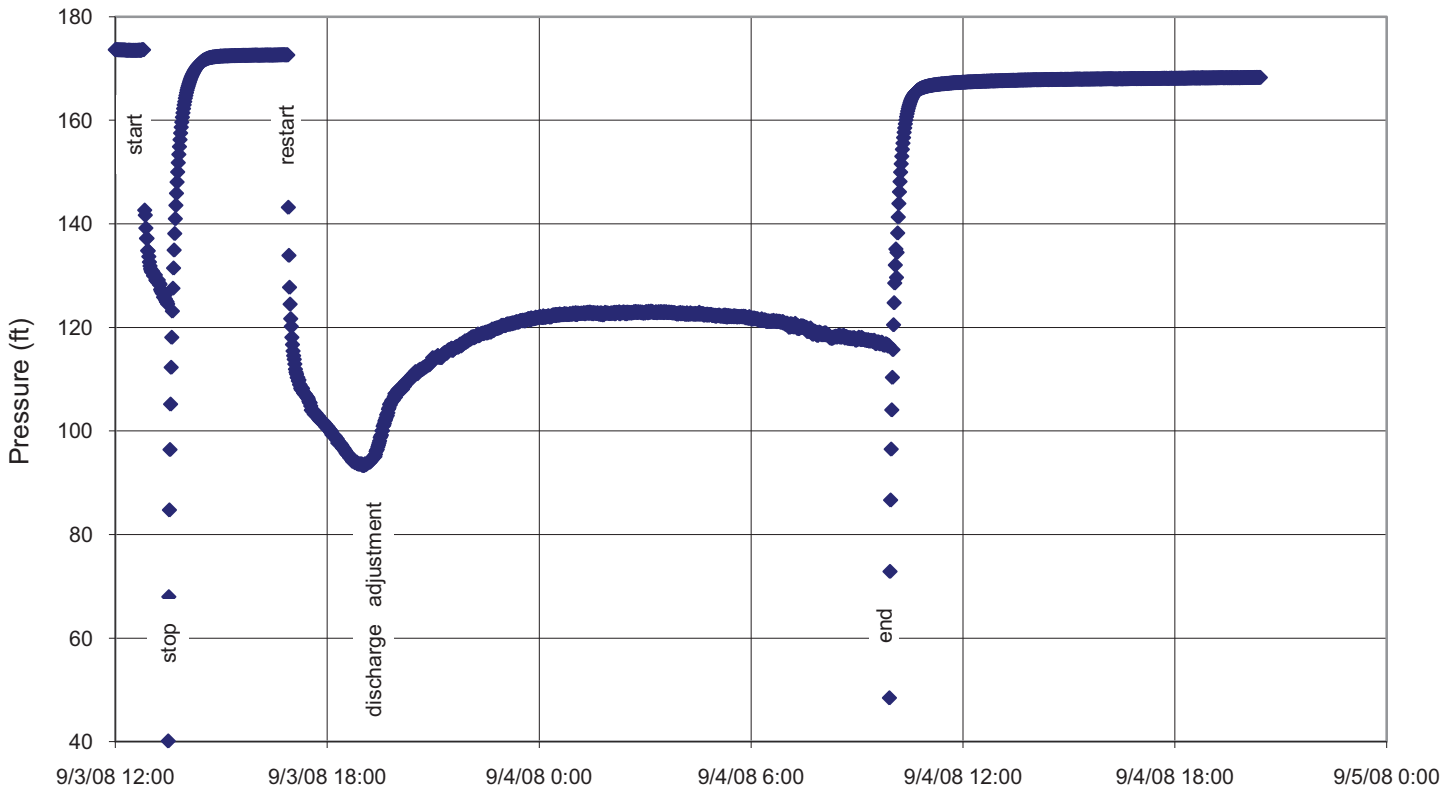
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 6
- After Test 6
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.23
Test # 6, Pressure Measured in DH-8417 during Air Lifting and Recovery

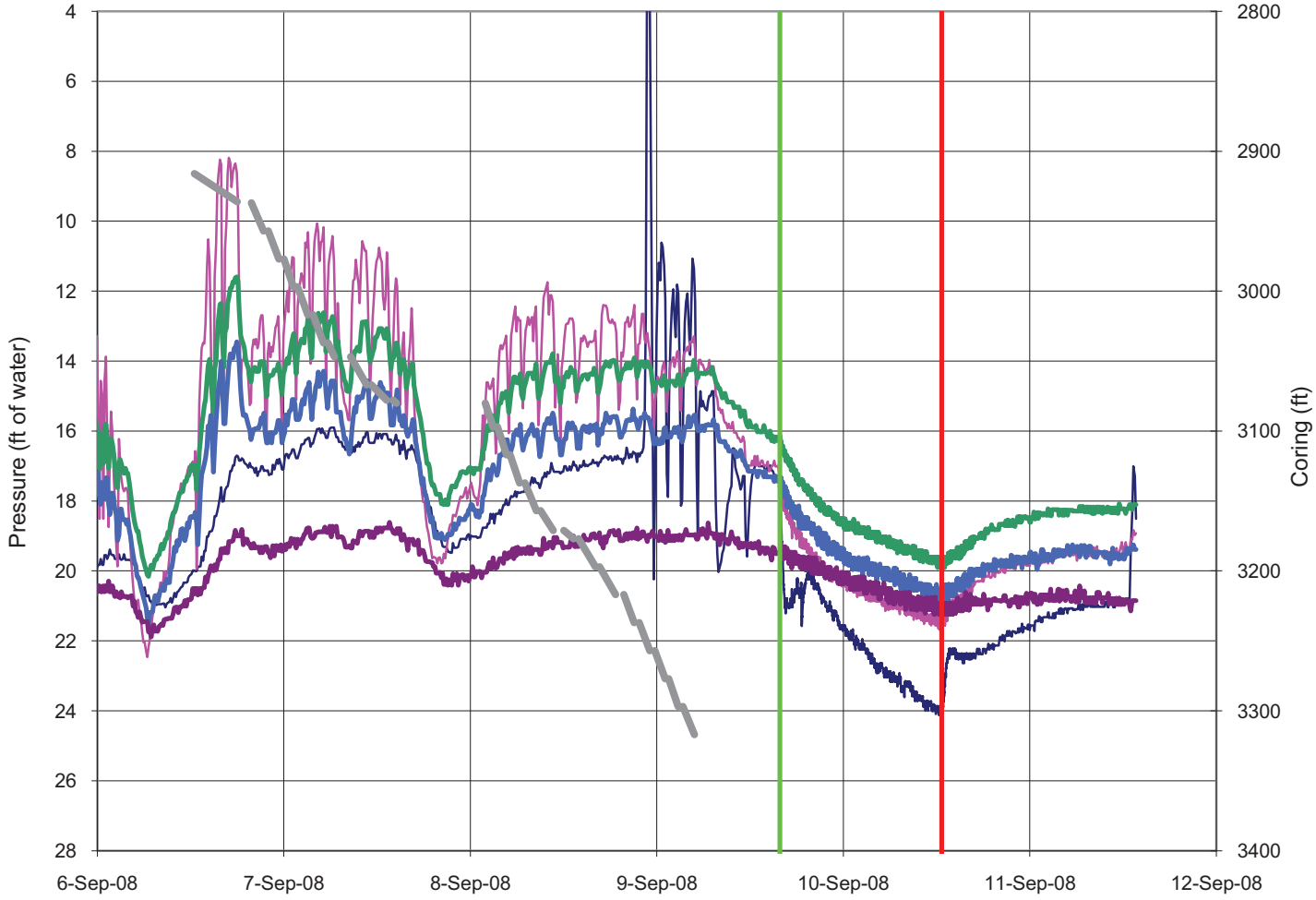
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

◆ 8417 Response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.24
Test # 7, Piezometric Response to Drilling and Testing, Probes #10 to #14

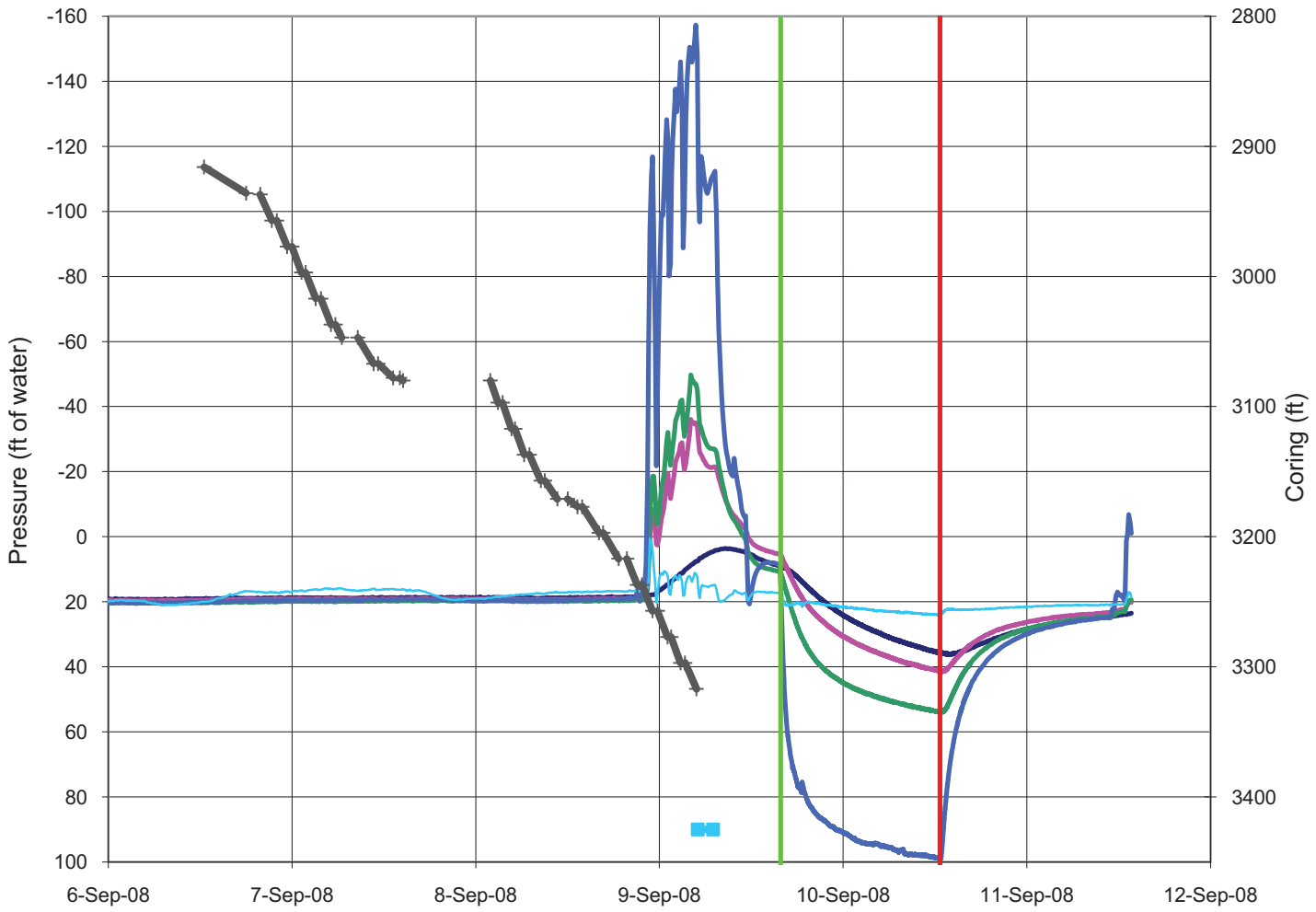
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629
- 14 2475
- Start Pumping
- End Pumping
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.25
Test # 7, WB-1 Response,
Probes #6 to #10

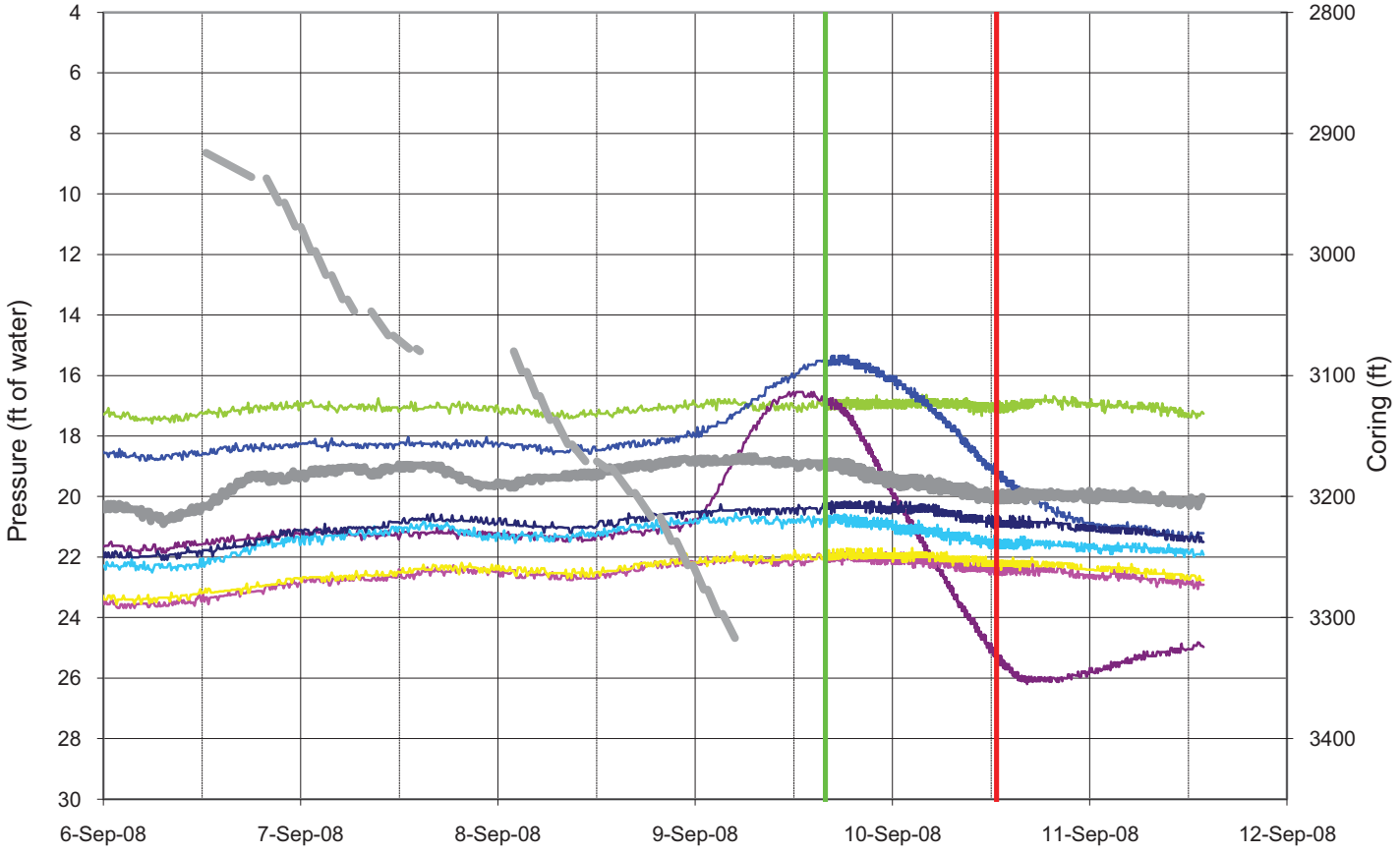
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629
- 14 2475
- Start Pumping
- End Pumping
- Flushing
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.26
Test # 7, Pressure Change in WB-1, Probes #2, 4, 5 and 15 to 19

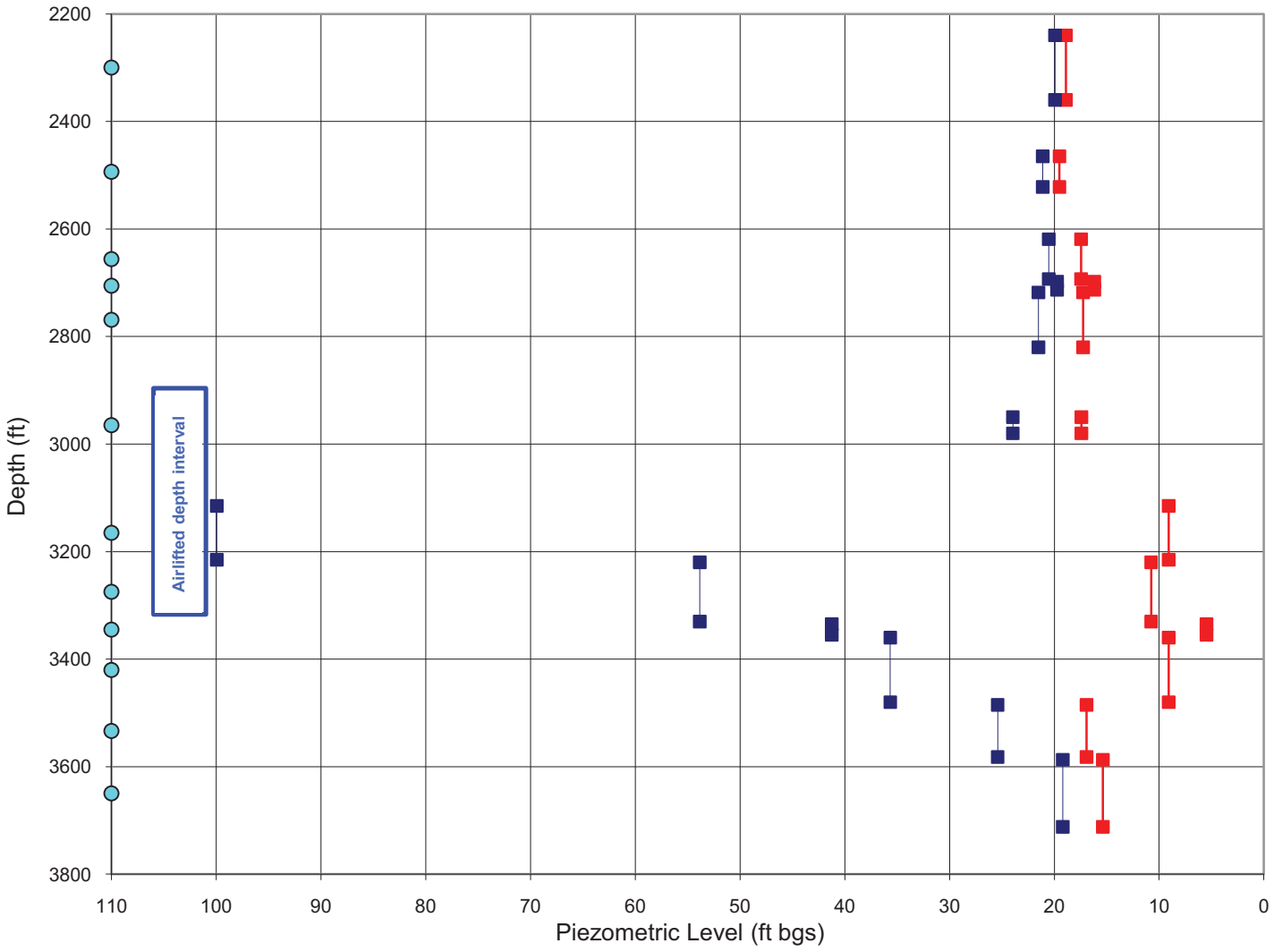
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- LP-2 3952
- LP-4 3682
- 5 3495
- LP-15 2320
- LP-16 2130
- LP-17 1935
- LP-18 1695
- LP-19 1580
- Start Pumping
- End Pumping
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.27
Test # 7, Pressure Change in WB-1,
Probes #15 to #4

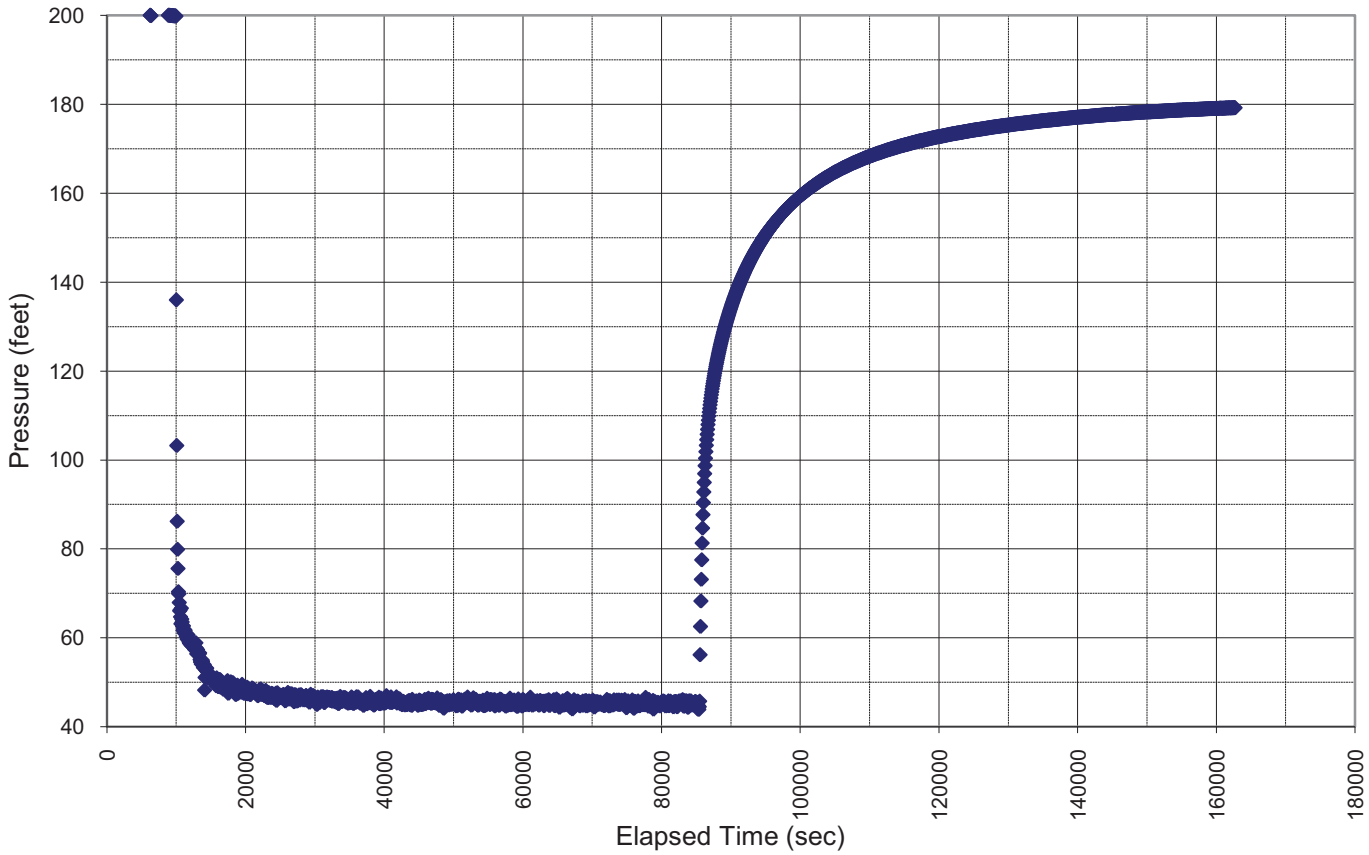
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 7
- After Test 7
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.28
Test # 7, DH-8417
Response to Air Lifting
and Recovery

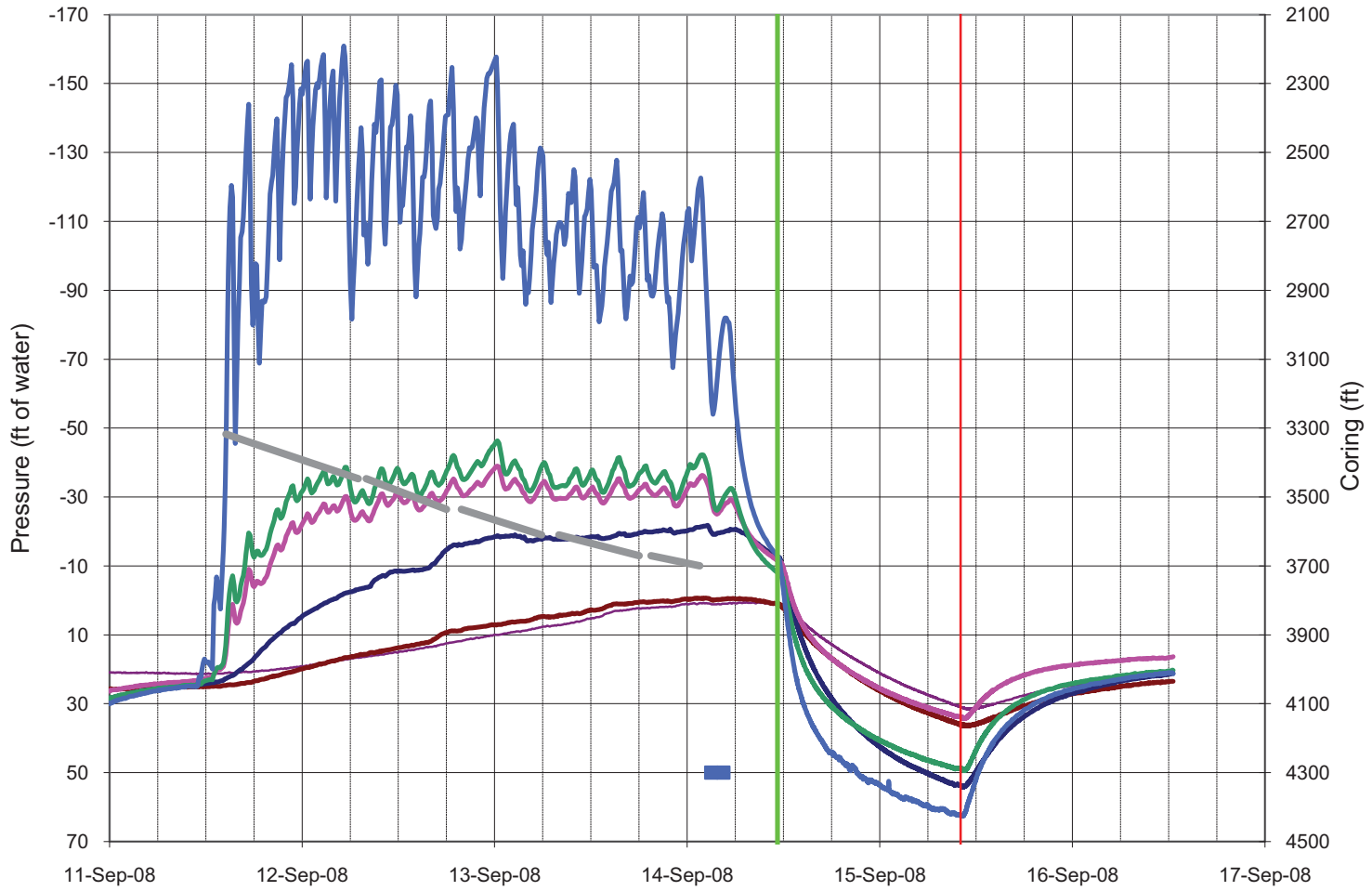
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Legend

◆8417 Response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.29
Test # 8, Piezometric Response to Drilling and Testing, Probes #4 to #9

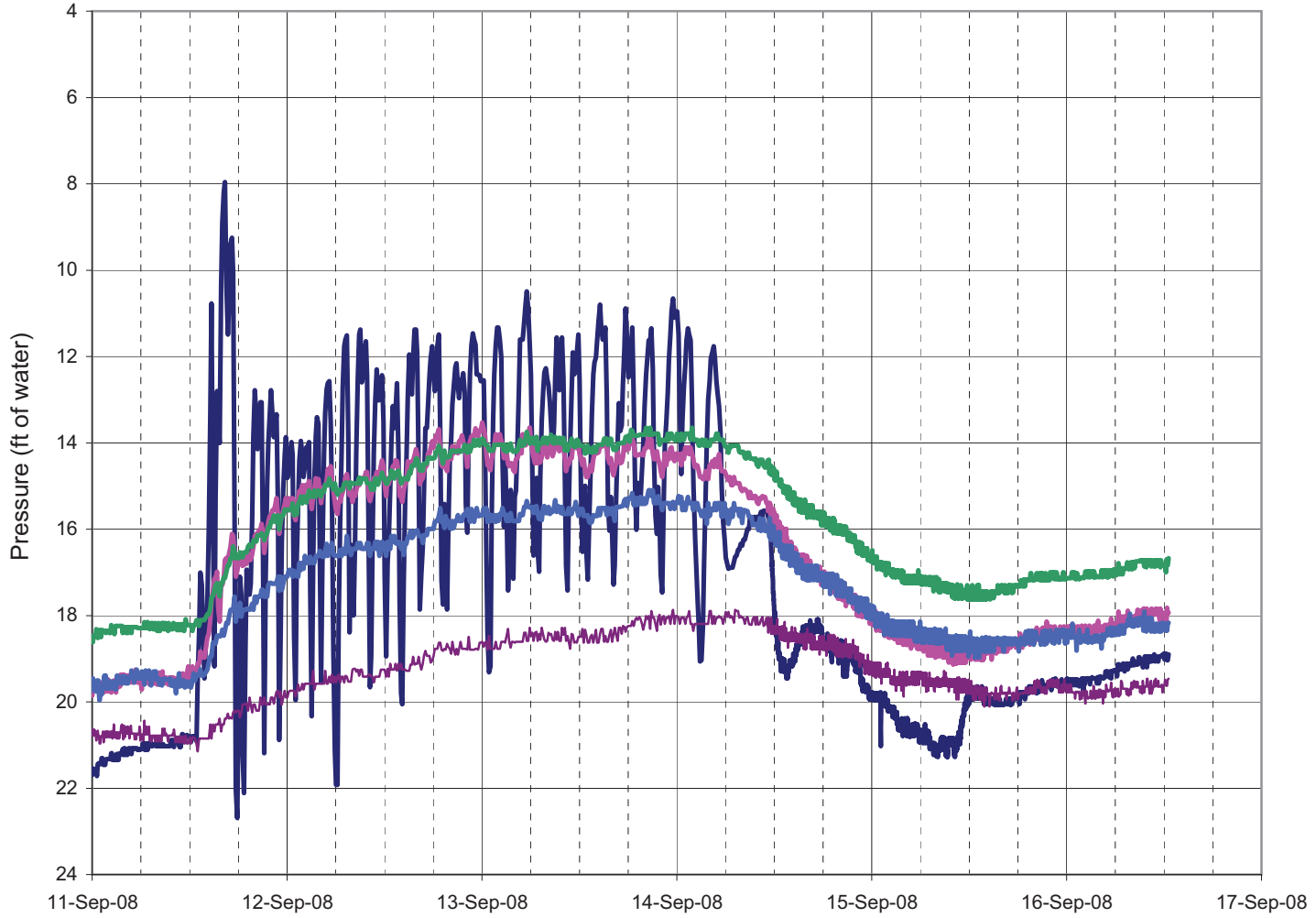
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 4 3682
- 5 3495
- 6 3440
- 7 3345
- 8 3290
- 9 3125
- Start Pumping
- End Pumping
- Flushing
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.30
Test # 8, Response to Drilling and Testing, Probes #10 to #14

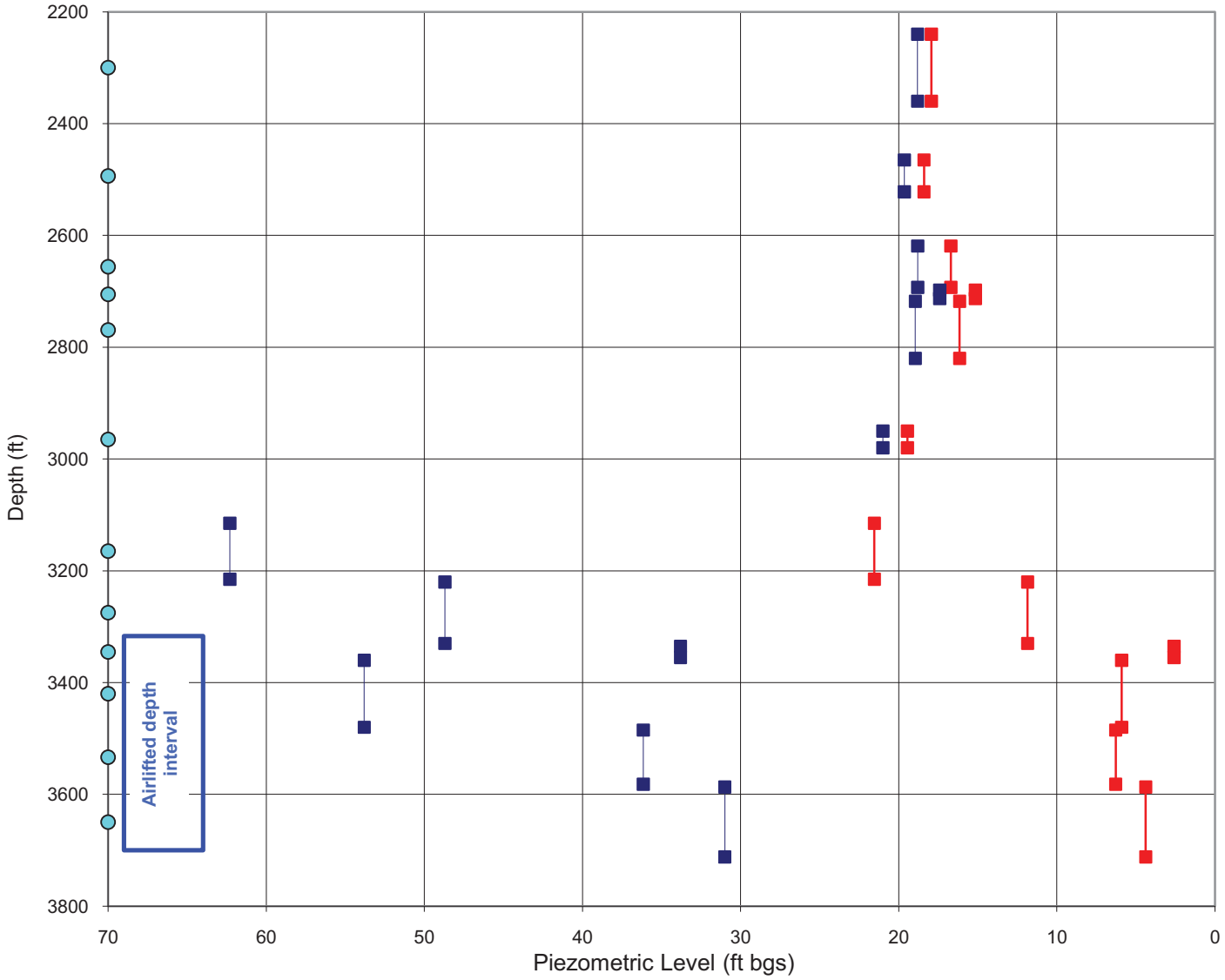
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629
- 14 2475



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.31
Test # 8, Pressure Change in WB-1,
Probes #15 to #4

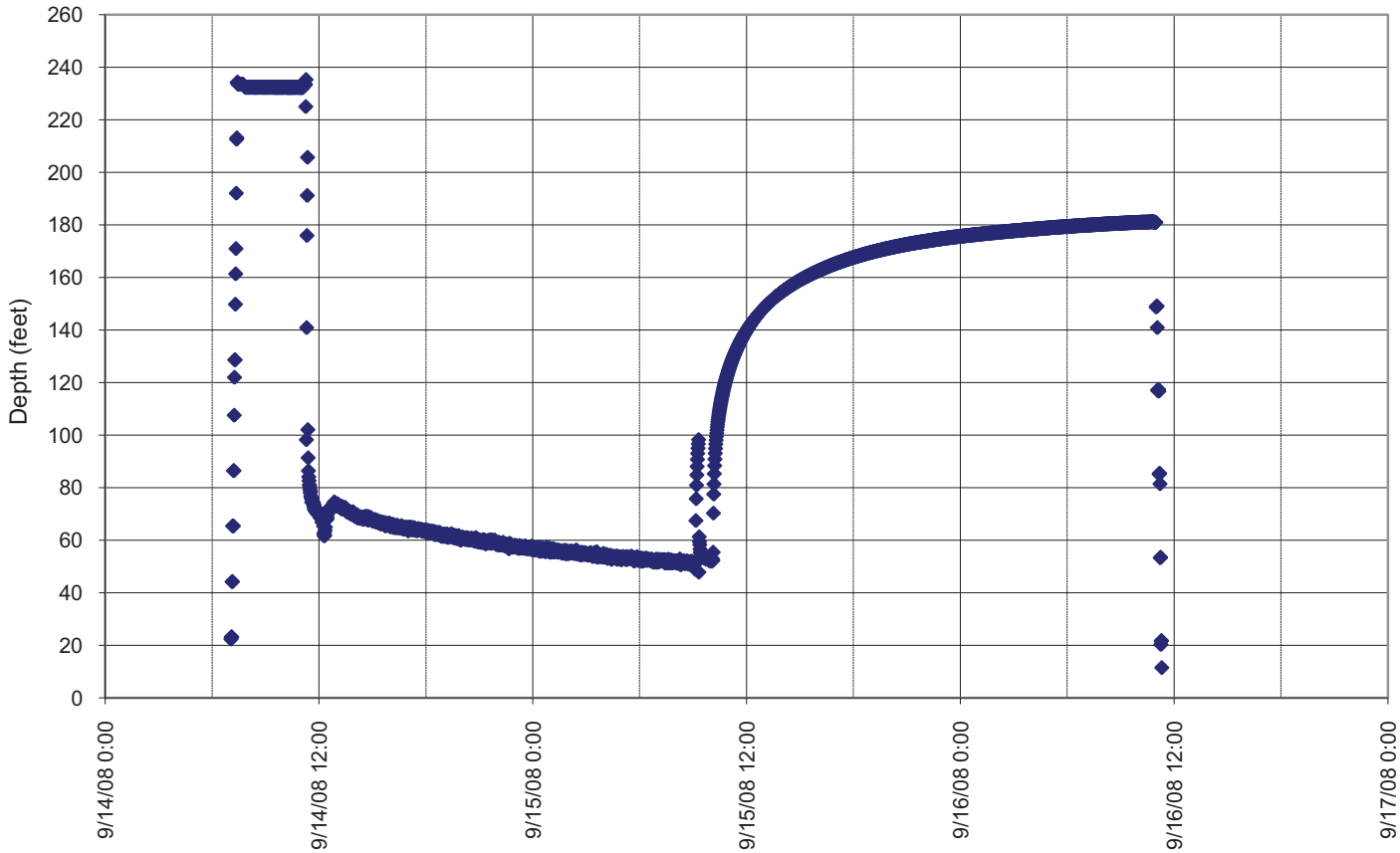
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 8
- After Test 8
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.32
Test # 8, DH-8417 Recovery after Air Lift

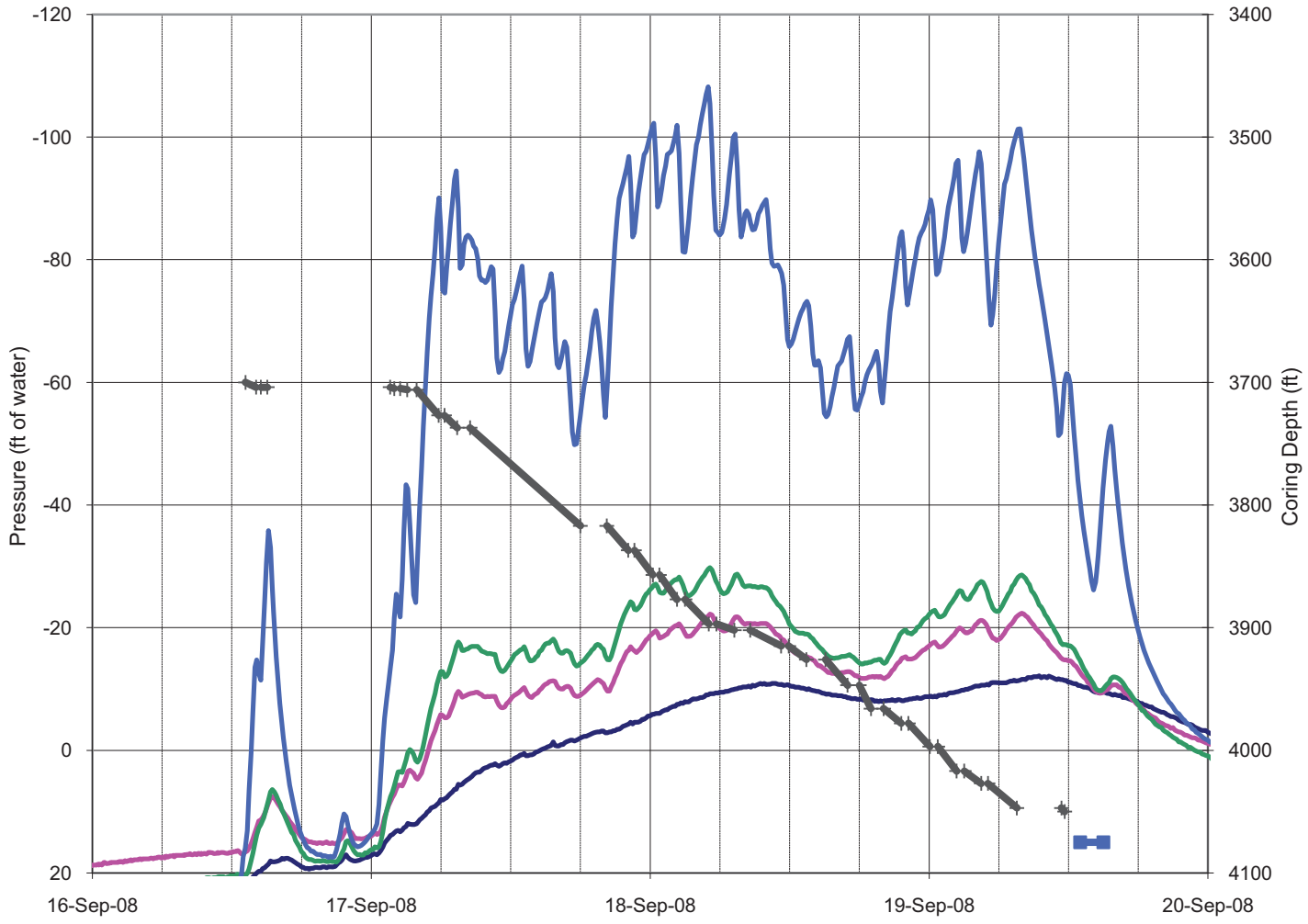
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

◆8417 Response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.33
Test # 9, WB-1 Response to Coring, Probes #6 to #9

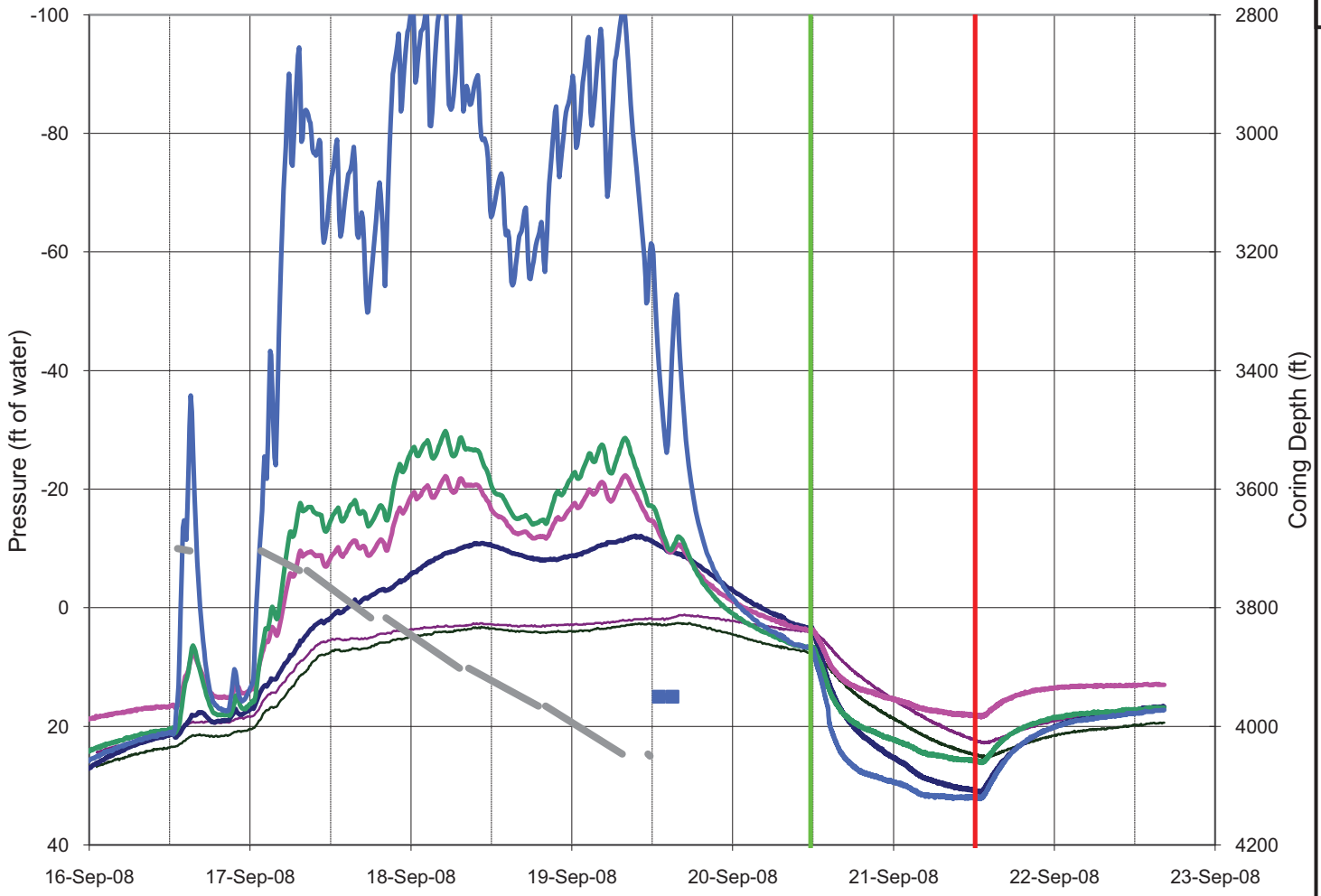
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 6 3440
- 7 3345
- 8 3290
- 9 3125
- Pumping - Start
- Pumping - End
- Flushing
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.34
Test # 9, Piezometric Response to Drilling, Probes #4 to #9

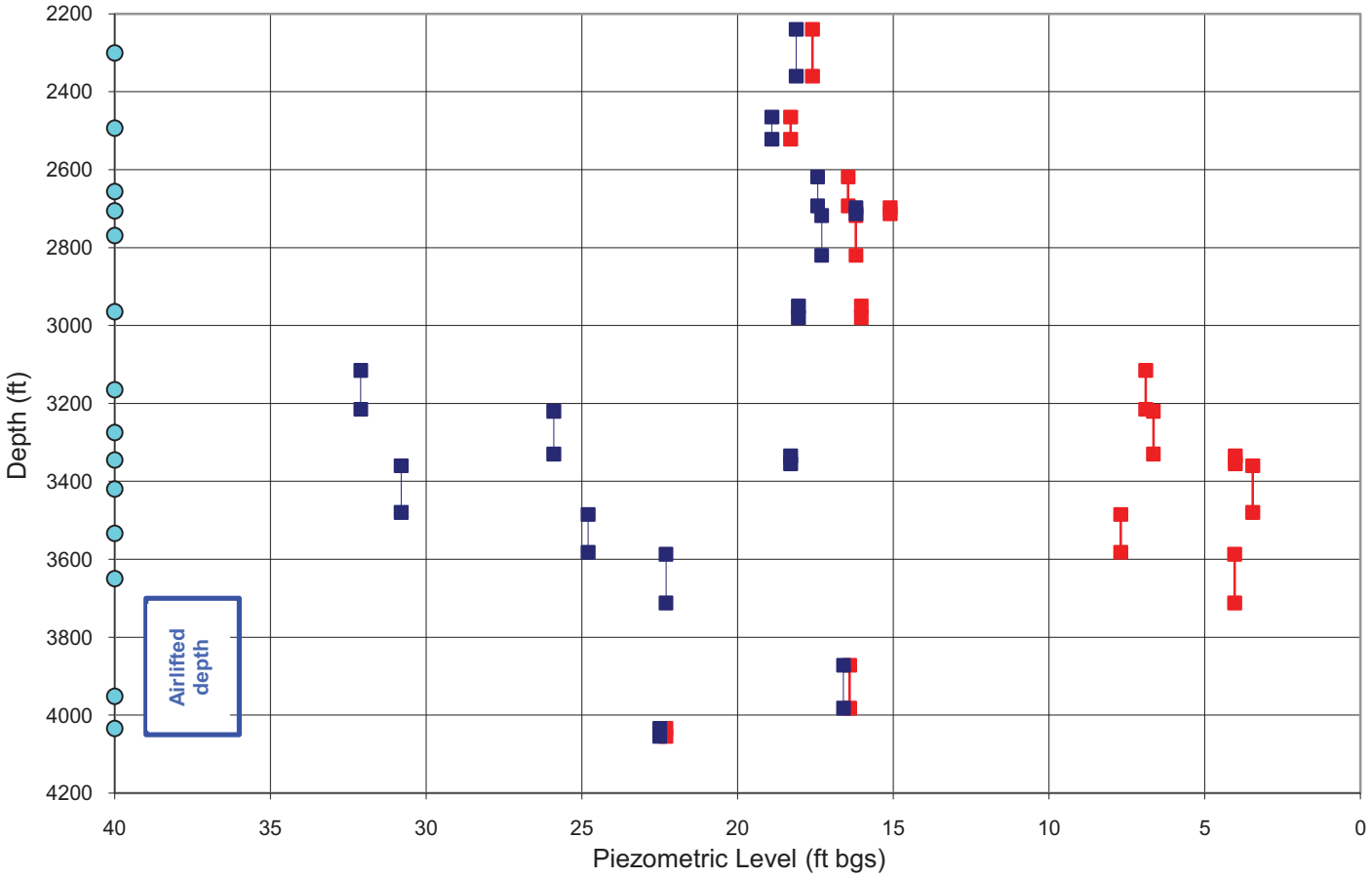
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 4 3682
- 5 3495
- 6 3440
- 7 3345
- 8 3290
- 9 3125
- Pumping Start
- Pumping - End
- Flushing
- Coring



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.35
Test # 9, Pressure Change in WB-1 as a Result of Pumping, Probes #2 to #14

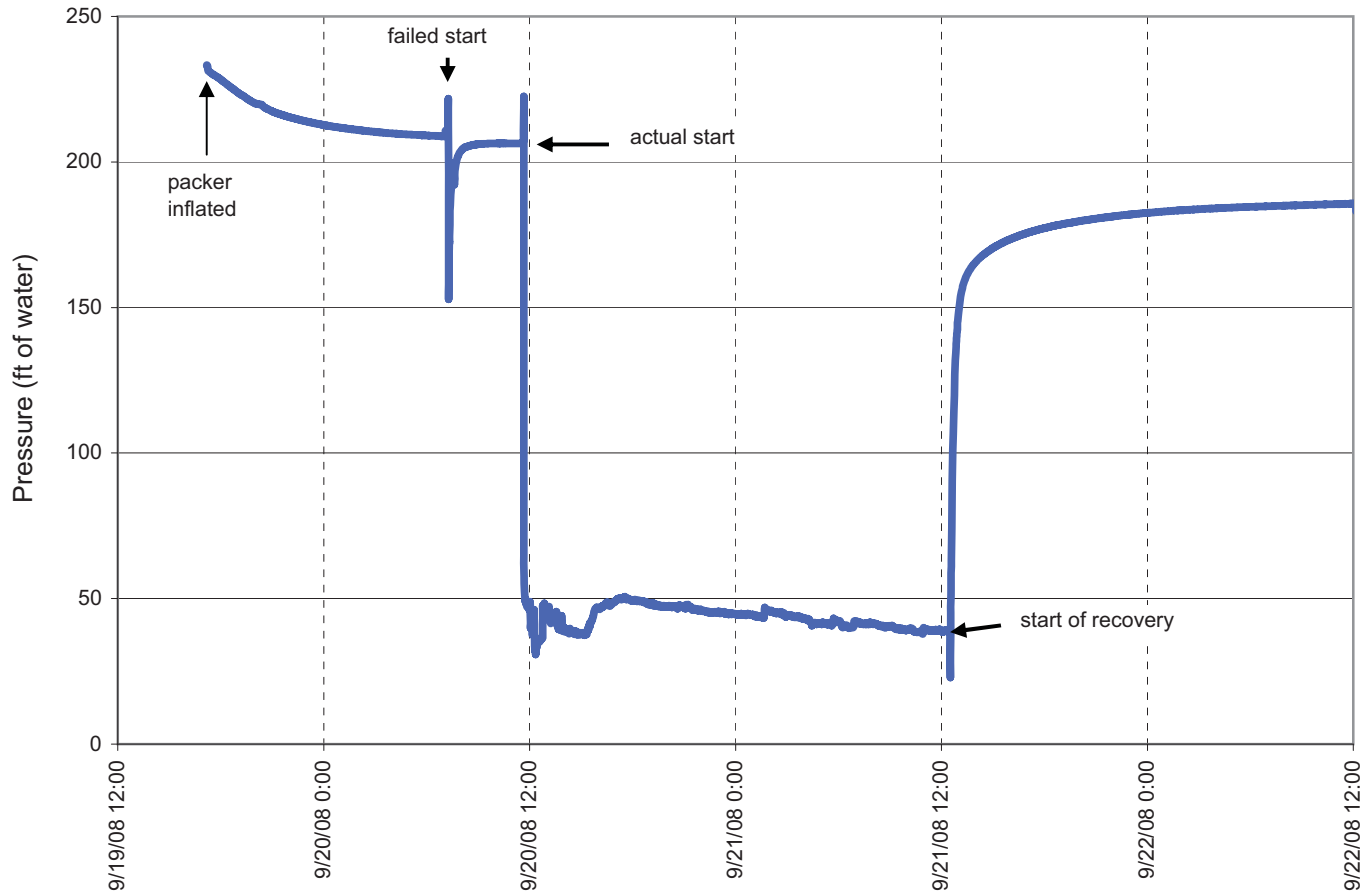
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Before Test 9
- After Test 9
- Probe Depth



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 3.36
Test # 9, Pressure Recorded in DH-8417 during Pumping and Recovery Tests

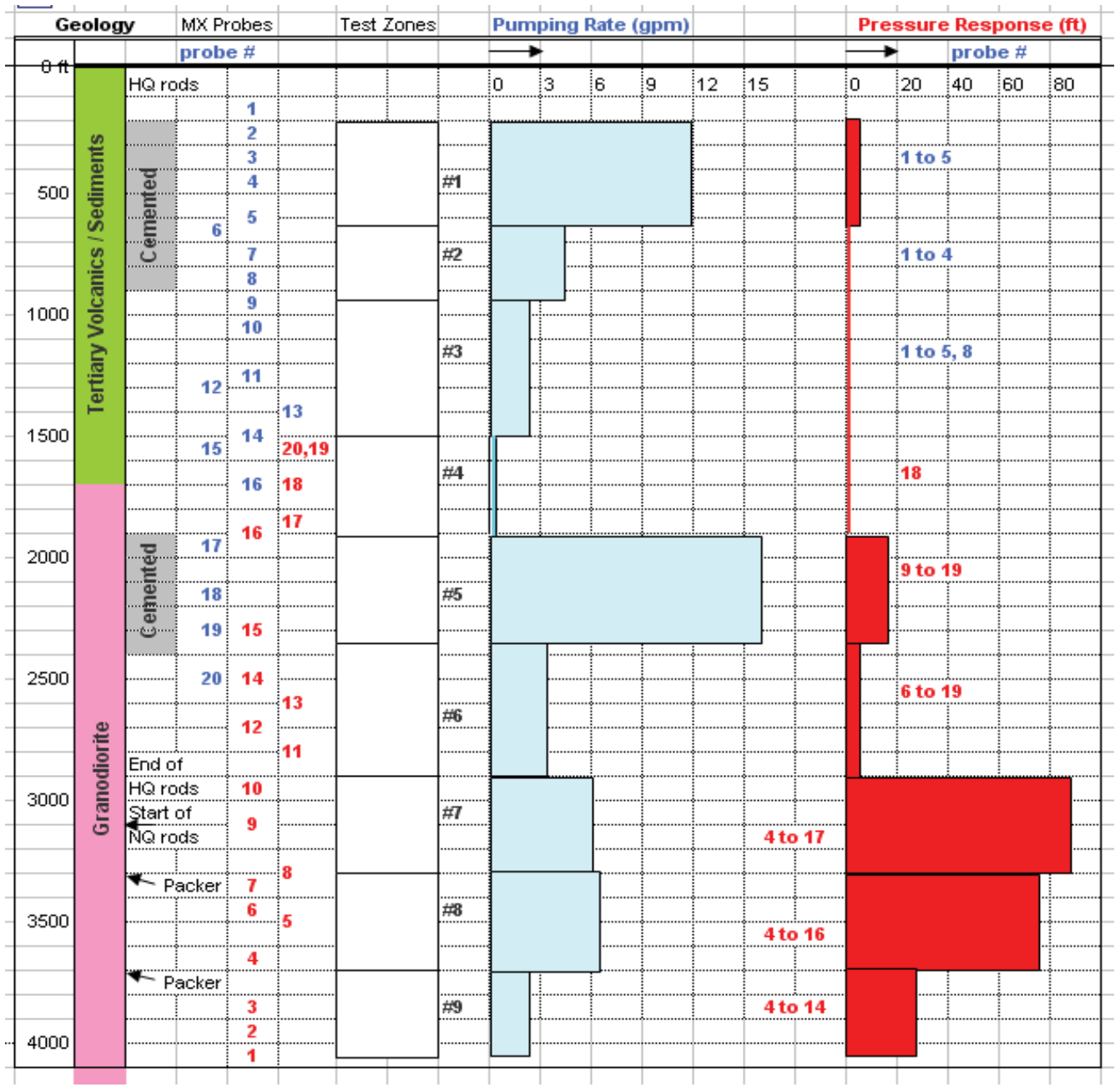
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

Test #9 - 8417



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 3.37
Cross-Hole Testing -
Summary of Field Results

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Legend

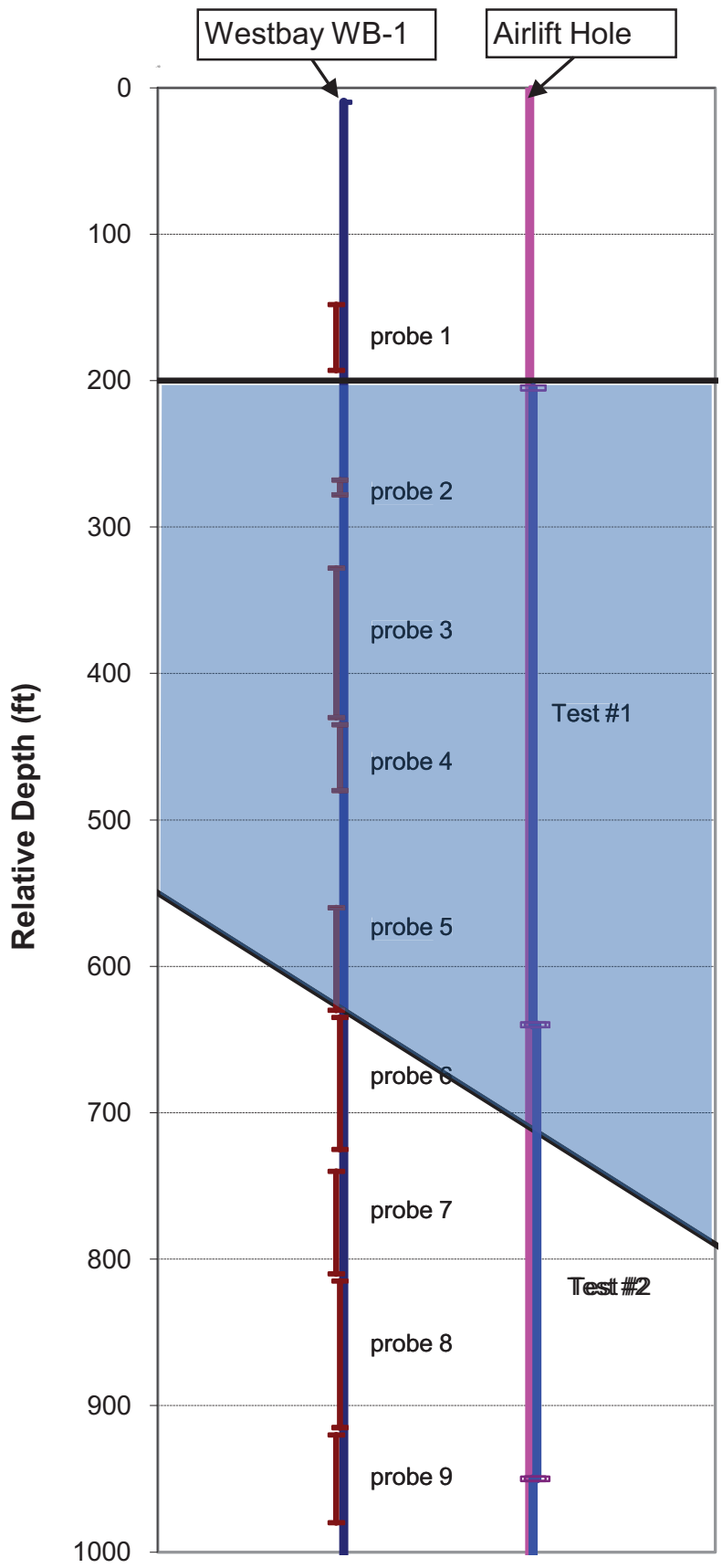
3 First Set of Probes

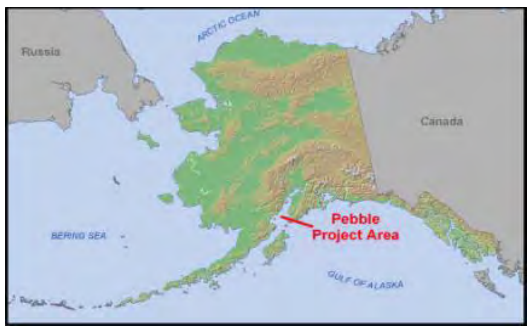
6 Second Set of Probes

Cemented after Airlift Test



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010





Legend

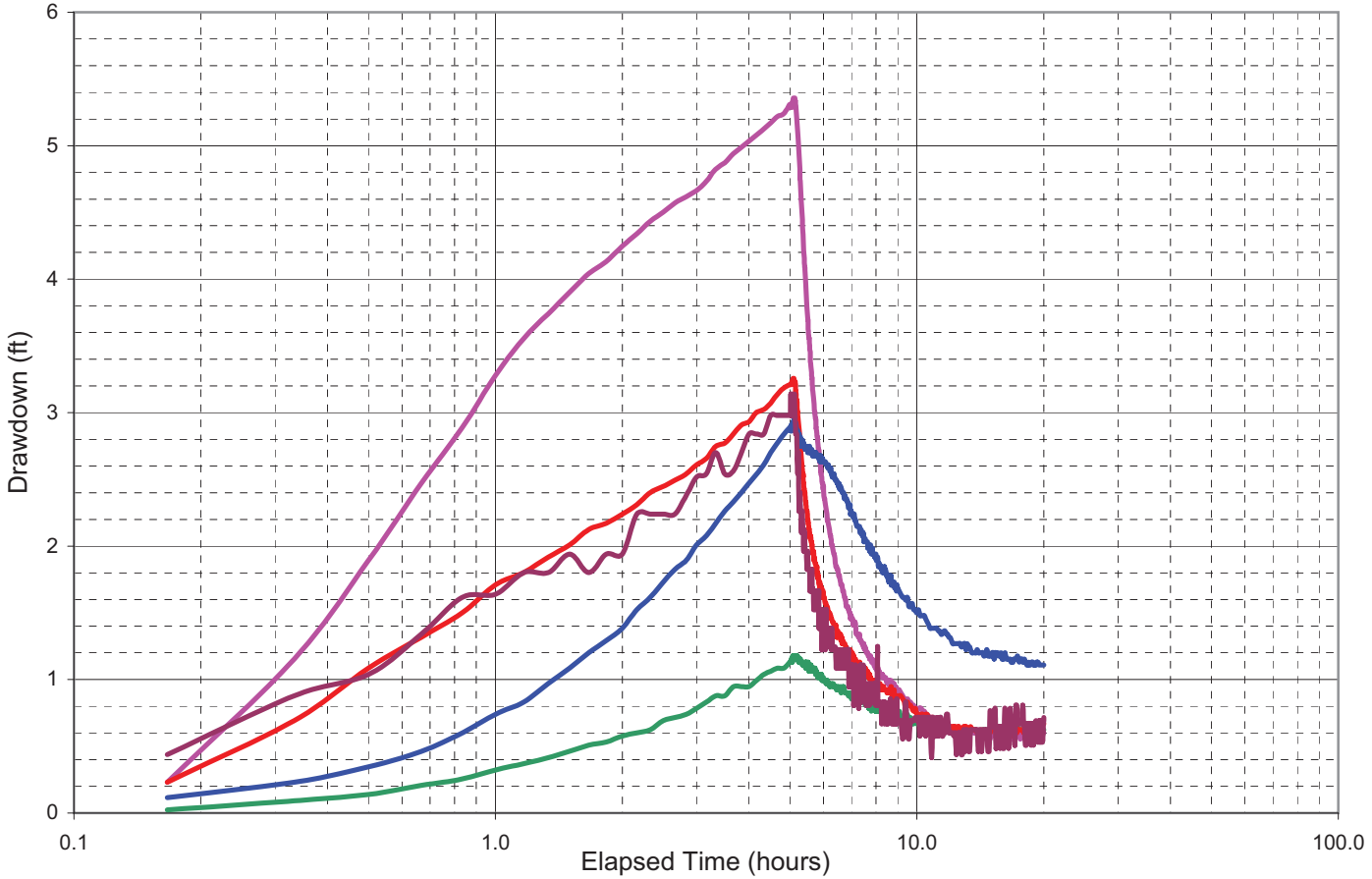
- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- First Set of Probes
- Hydrogelogic Unit 1

THE pebble PARTNERSHIP

Figure 4.1
Conceptual Setting for
Hydrogeologic Unit 1
Pumping Tests

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 4.2
Test # 1, Response of MX Probes #1 to #5

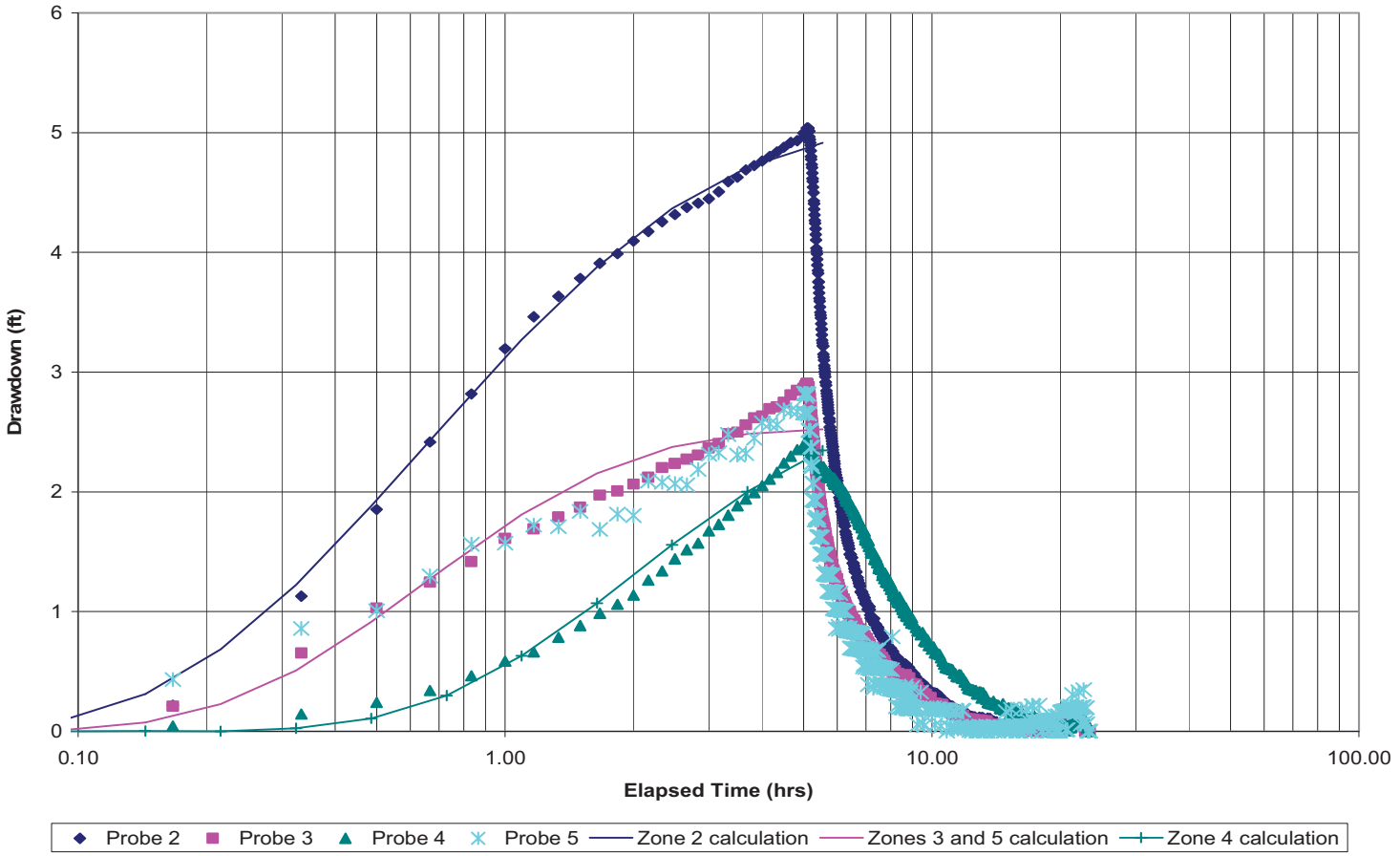
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- Probe #1
- Probe #2
- Probe #3
- Probe #4
- Probe #5



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 4.3
Test # 1, Drawdowns and Constant Head in Leaky Aquifer Simulations

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Note

Symbols show measured response

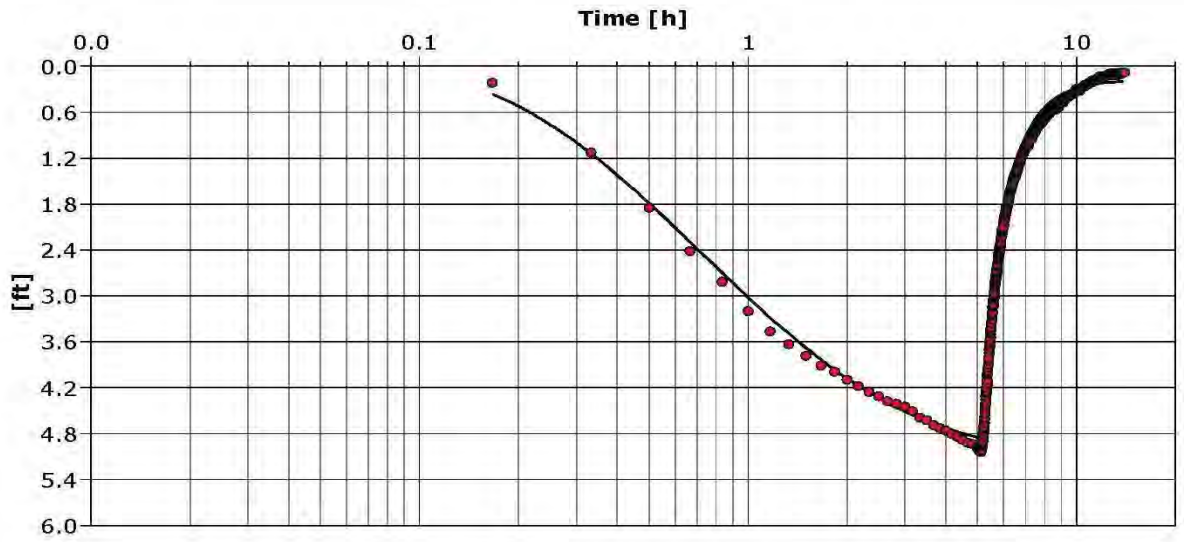
Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010

Schlumberger Water Services 130-10691 Shellbridge Way Richmond, B.C. Canada V6X 2W8	Pumping Test Analysis Report
	Project: Pebble Project
	Number: 7126
	Client: Pebble Limited Partnership

Location: Iliamna Alaska	Pumping Test: Cross Hole Test #1	Pumping well: 8417 Test #1
Test conducted by: SLR		Test date: 7/4/2008
Analysis performed by:	Time vs Drawdown	Analysis date: 1/19/2010
Aquifer Thickness: 430.00 ft	Discharge: variable, average rate 2.6667 [U.S. gal/min]	



Calculation after Double Porosity

Observation well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Specific storage	Sigma	Lambda	Radial distance to PW [ft]
Probe #2	3.50×10^{1}	8.14×10^{-2}	1.40×10^{-4}	3.00×10^{1}	4.50×10^{-1}	100.0

THE pebble PARTNERSHIP

Figure 4.4
Test # 1, Double Porosity Simulations, Probe # 2

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Note

Symbols show measured response

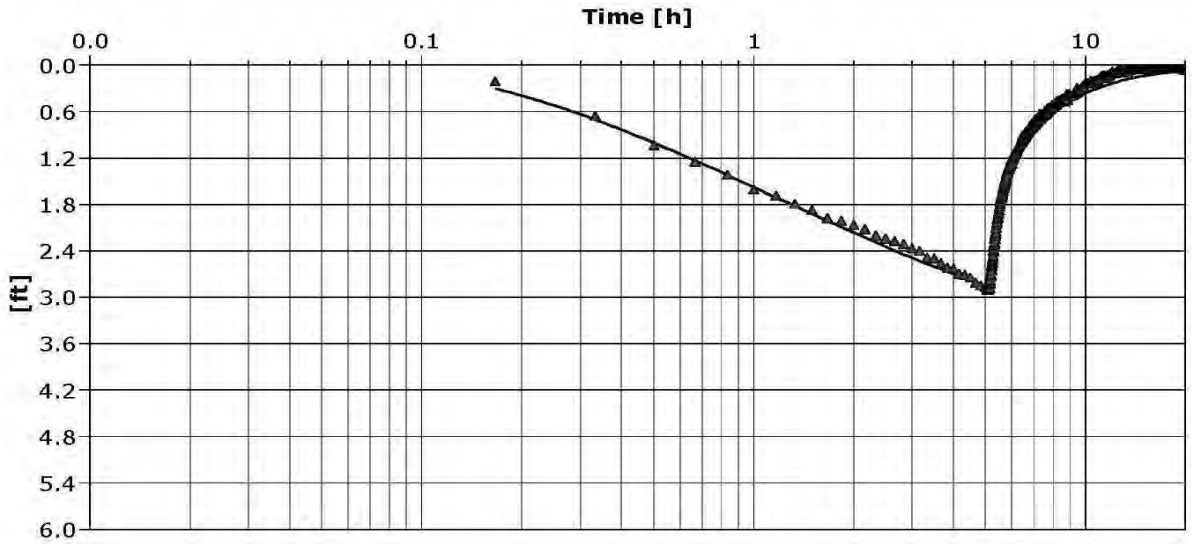
Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011

Schlumberger Water Services 130-10691 Shellbridge Way Richmond, B.C. Canada V6X 2W8	Pumping Test Analysis Report
	Project: Pebble Project
	Number: 7126
	Client: Pebble Limited Partnership

Location: Iliamna Alaska	Pumping Test: Cross Hole Test #1	Pumping well: 8417 Test #1
Test conducted by: SLR		Test date: 7/4/2008
Analysis performed by:	Time vs Drawdown	Analysis date: 1/19/2010
Aquifer Thickness: 430.00 ft	Discharge: variable, average rate 0.5 [U.S. gal/min]	



Calculation after Double Porosity

Observation well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Specific storage	Sigma	Lambda	Radial distance to PW [ft]
Probe #3	2.10×10^{1}	4.88×10^{-2}	5.00×10^{-5}	2.00×10^{1}	6.00×10^{-2}	100.0

THE pebble PARTNERSHIP

Figure 4.5
Test # 1, Double Porosity Simulations, Probe # 3

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Note

Symbols show measured response

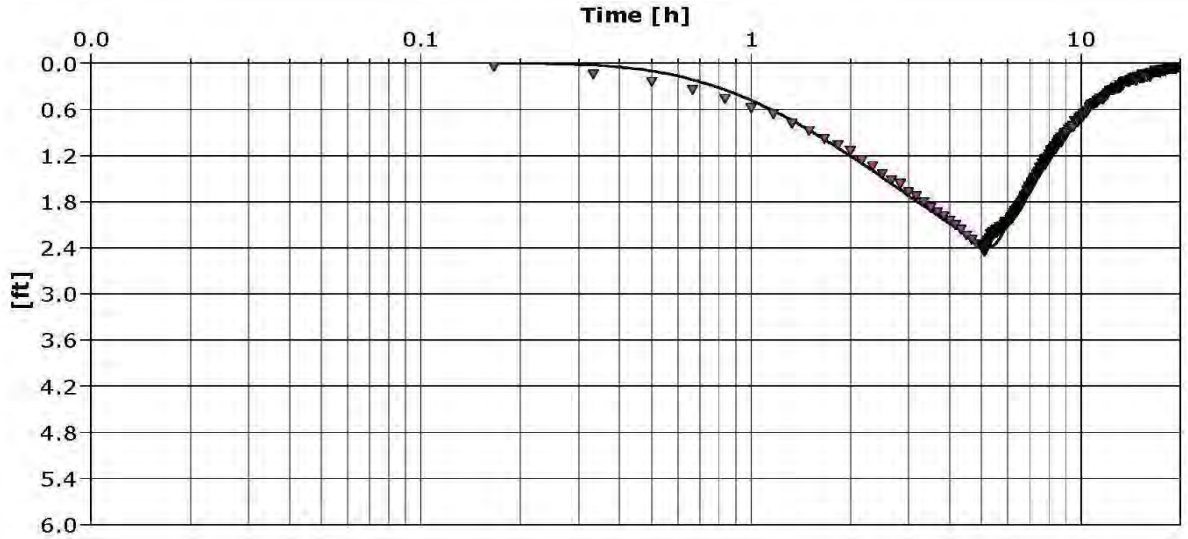
Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011

Schlumberger Water Services 130-10691 Shellbridge Way Richmond, B.C. Canada V6X 2W8	Pumping Test Analysis Report
	Project: Pebble Project
	Number: 7126
	Client: Pebble Limited Partnership

Location: Iliamna Alaska	Pumping Test: Cross Hole Test #1	Pumping well: 8417 Test #1
Test conducted by: SLR		Test date: 7/4/2008
Analysis performed by:	Time vs Drawdown	Analysis date: 1/19/2010
Aquifer Thickness: 430.00 ft	Discharge: variable, average rate 0.33333 [U.S. gal/min]	



Calculation after Double Porosity

Observation well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Specific storage	Sigma	Lambda	Radial distance to PW [ft]
Probe #4	5.50×10^{0}	1.28×10^{-2}	1.00×10^{-4}	4.00×10^{1}	6.00×10^{-1}	100.0

THE pebble PARTNERSHIP

Figure 4.6
Test # 1, Double Porosity Simulations, Probe # 4

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Note

Symbols show measured response

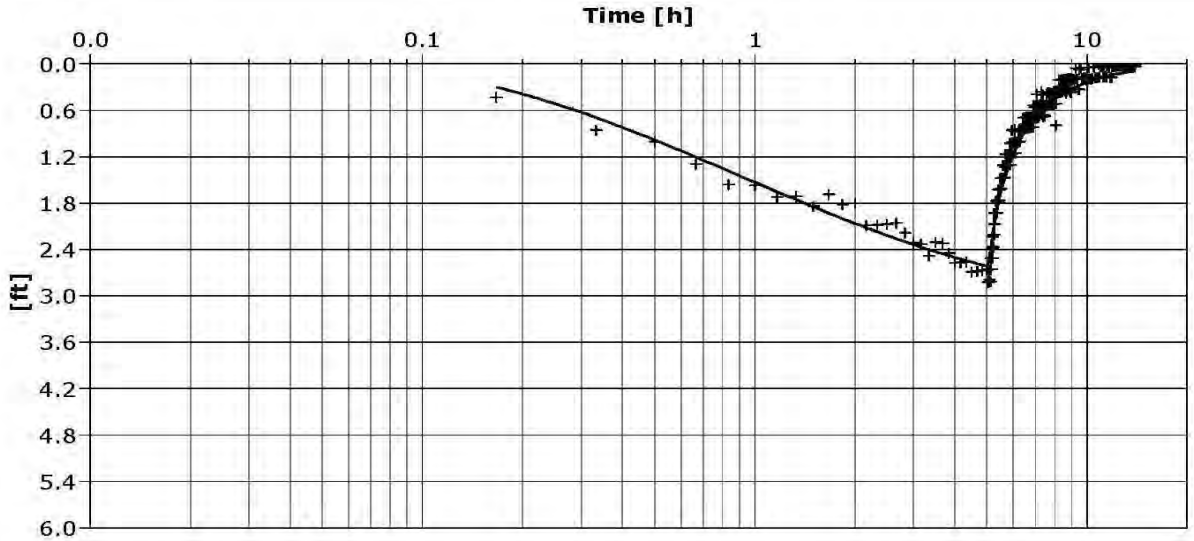
Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011

Schlumberger Water Services 130-10691 Shellbridge Way Richmond, B.C. Canada V6X 2W8	Pumping Test Analysis Report
	Project: Pebble Project
	Number: 7126
	Client: Pebble Limited Partnership

Location: Iliamna Alaska	Pumping Test: Cross Hole Test #1	Pumping well: 8417 Test #1
Test conducted by: SLR		Test date: 7/4/2008
Analysis performed by:	Time vs Drawdown	Analysis date: 1/19/2010
Aquifer Thickness: 430.00 ft	Discharge: variable, average rate 0.5 [U.S. gal/min]	



Calculation after Double Porosity

Observation well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Specific storage	Sigma	Lambda	Radial distance to PW [ft]
Probe #5	2.10×10^{1}	4.88×10^{-2}	5.00×10^{-5}	3.00×10^{1}	1.00×10^{-1}	100.0

THE pebble PARTNERSHIP

Figure 4.7
Test # 1, Double Porosity Simulations, Probe # 5

Appendix 8.1K
Multi-Level Groundwater Monitoring System

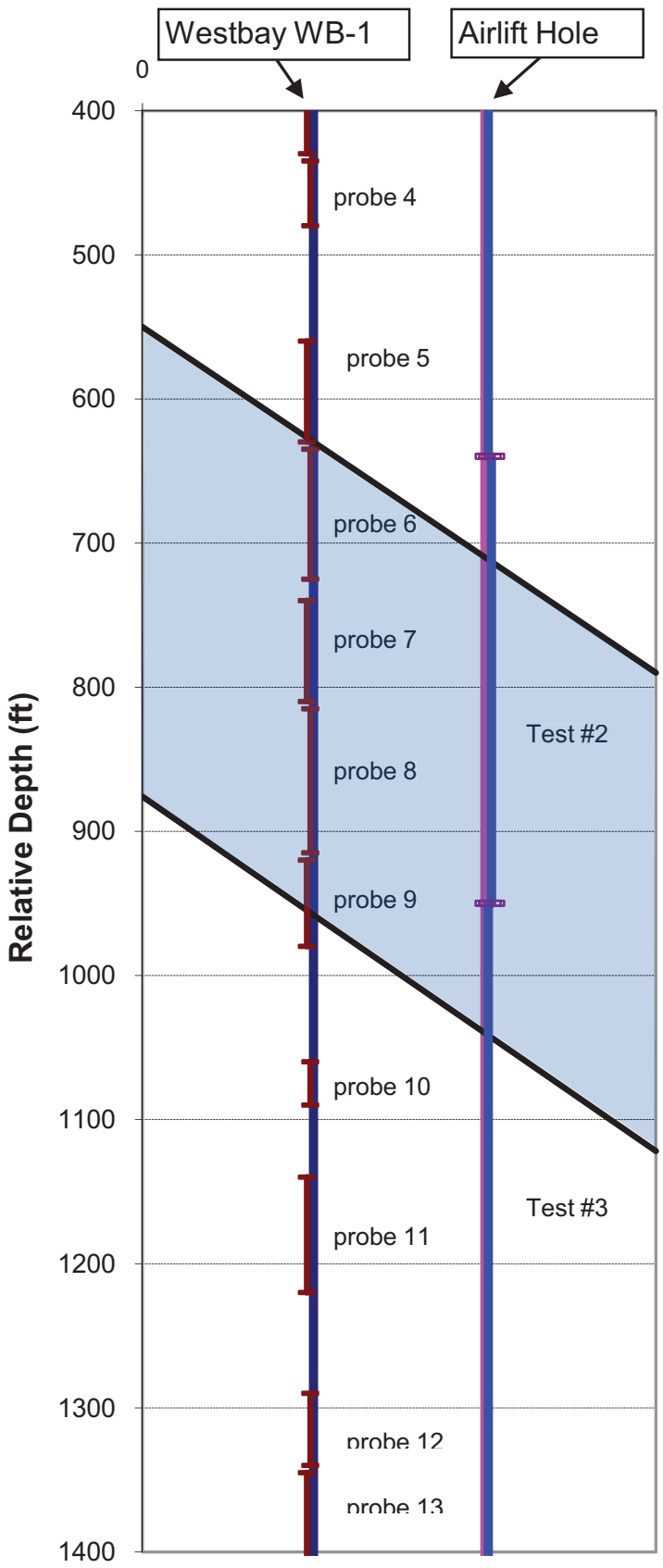
Note

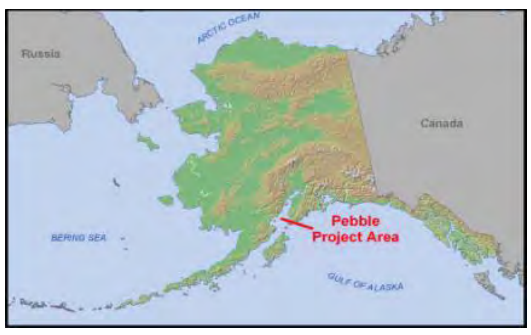
Symbols show measured response

Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011





Legend

- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- First Set of Probes
- Hydrogeologic Unit 2

THE pebble PARTNERSHIP

Figure 4.8
Conceptual Setting for
Hydrogeologic Unit 2
Pumping Tests
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011

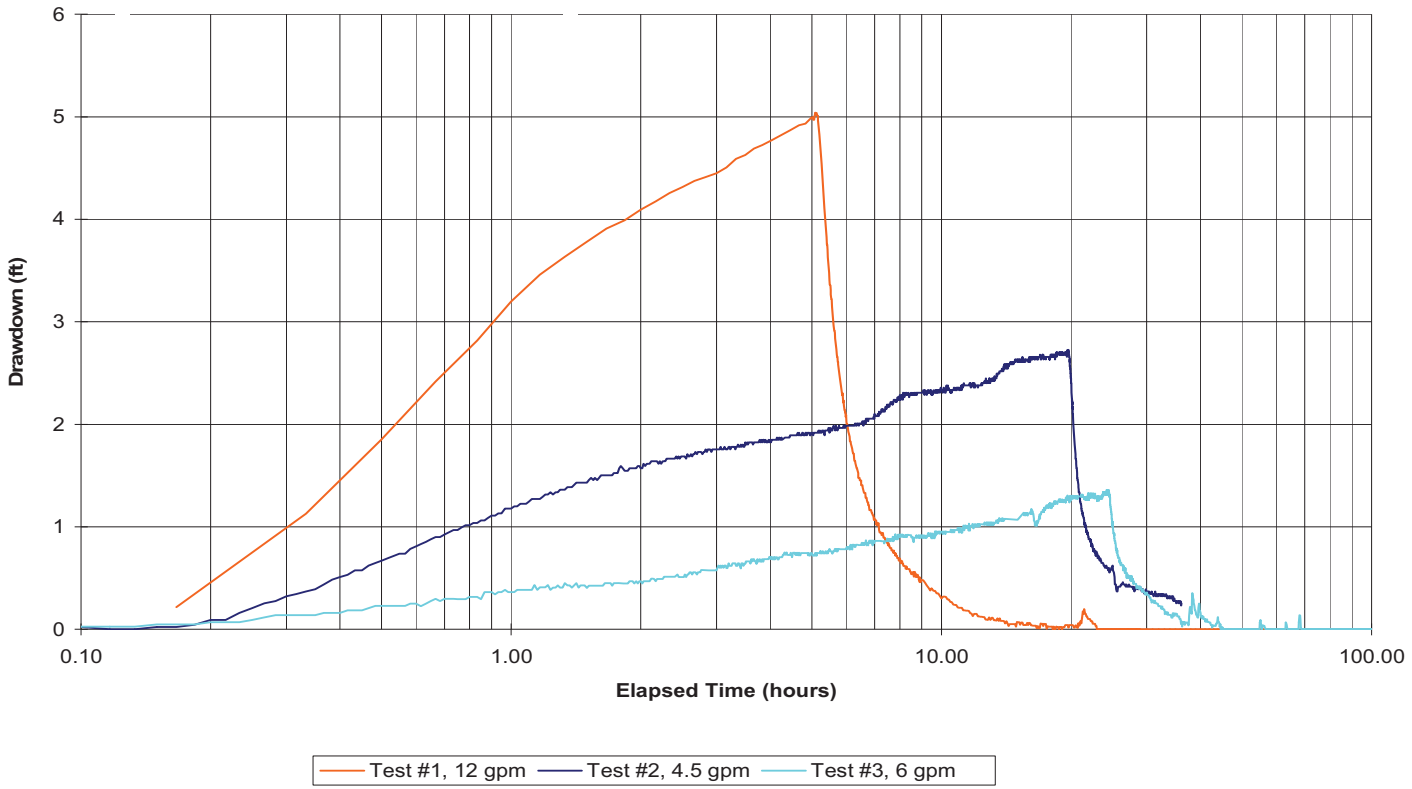


Figure 4.9
Test # 1, 2, 3, Drawdowns Measured during Air Lift, Probe # 2

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Note

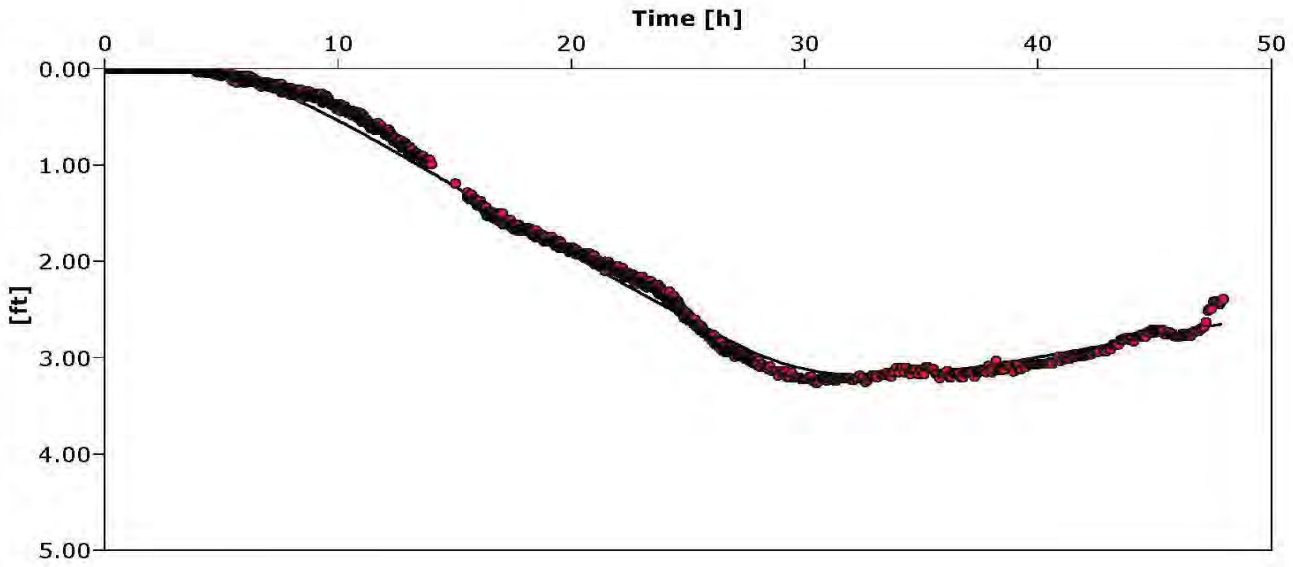
The plot illustrates pressure response of Probe #2 of WB-1 to three different air lift tests performed in air lift hole 8417



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010

Schlumberger Water Services 130-10691 Shellbridge Way Richmond, B.C. Canada V6X 2W8	Pumping Test Analysis Report
	Project: Pebble Project
	Number: 7126
	Client: Pebble Limited Partnership

Location: Iliamna Alaska	Pumping Test: Cross Hole Test #3	Pumping well: Well 1
Test conducted by: SLR		Test date: 7/21/2008
Analysis performed by: RS	Probe #8	Analysis date: 1/25/2010
Aquifer Thickness: 329.00 ft	Discharge: variable, average rate 2.128 [U.S. gal/min]	



Calculation after Double Porosity

Observation well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Specific storage	Sigma	Lambda	Radial distance to PW [ft]
Probe #8	1.00×10^{1}	3.04×10^{-2}	2.70×10^{-3}	1.00×10^{1}	1.00×10^{-1}	100.0

THE pebble PARTNERSHIP

Figure 4.10
Test # 3, Double Porosity
Analytic Simulation, Probe #8

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

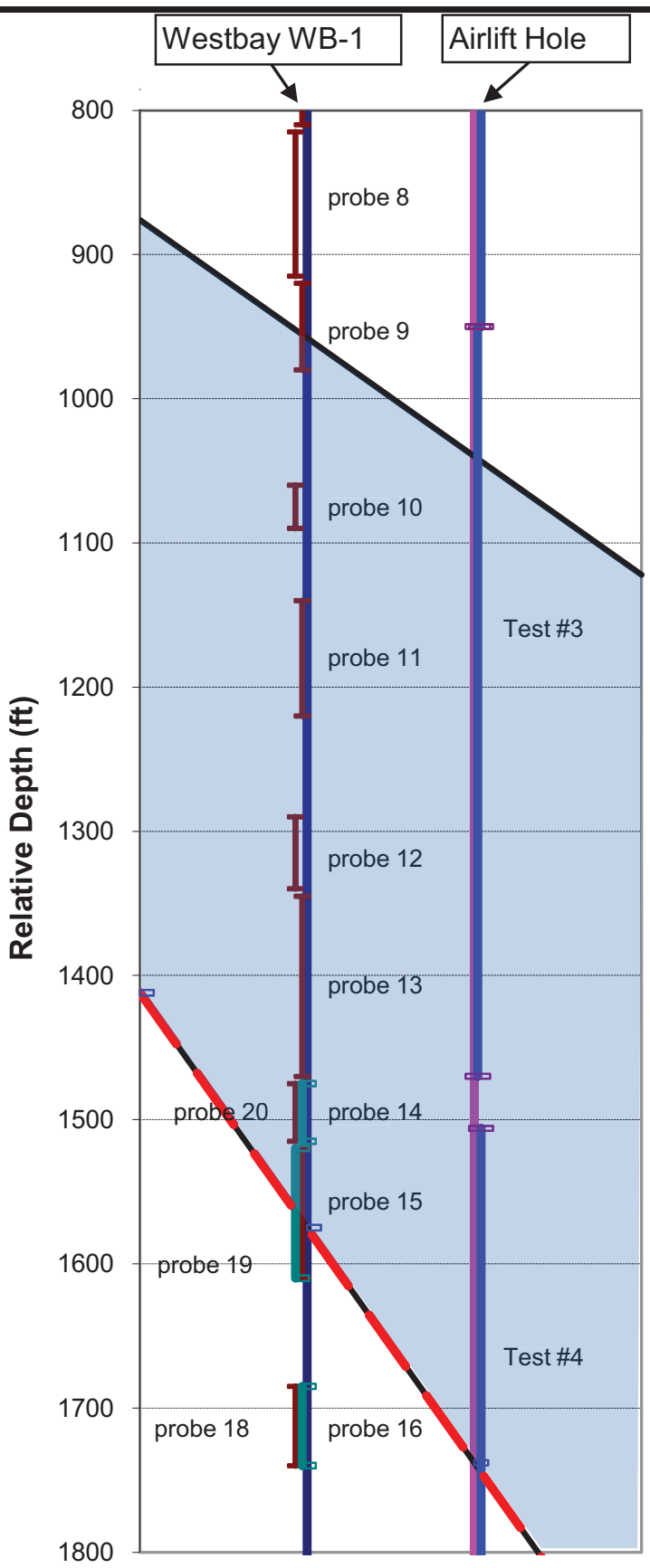
Note

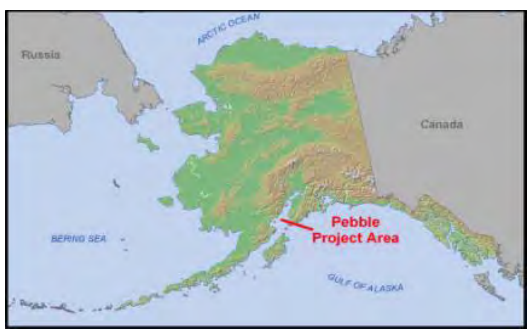
Symbols show measured response

Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011





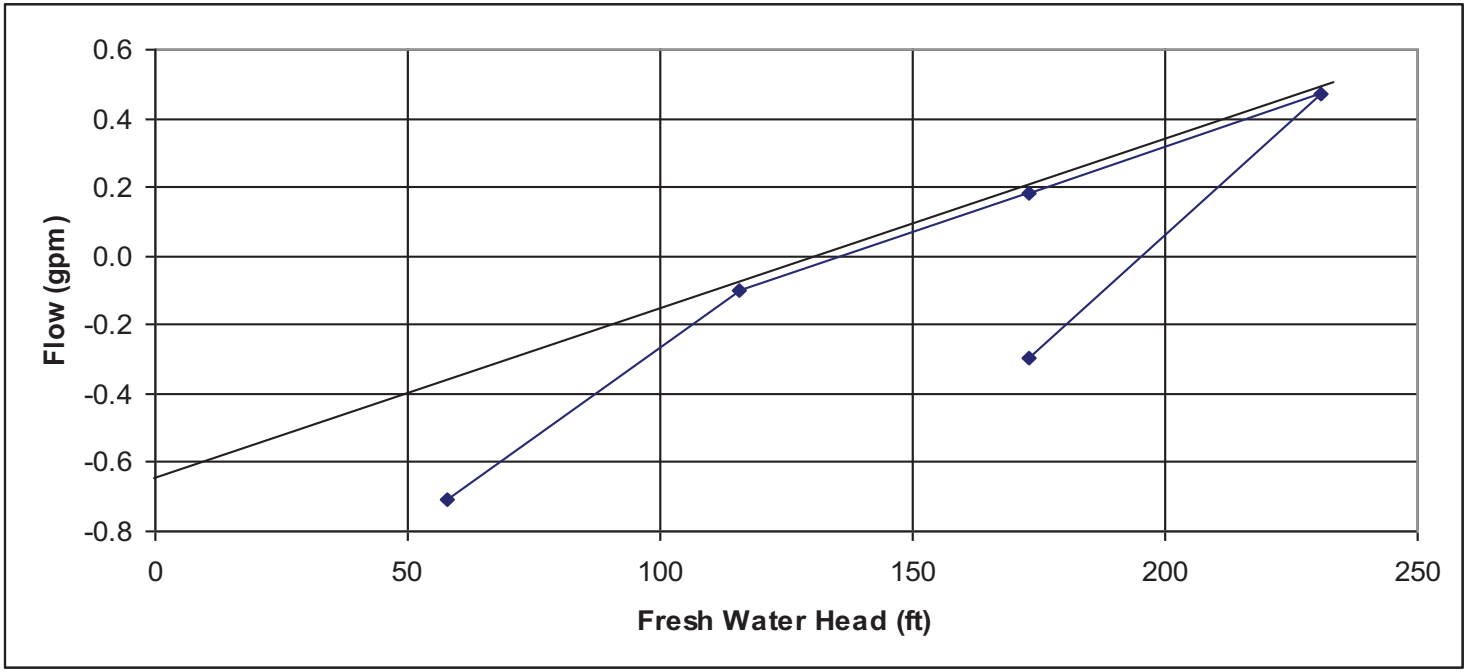
Legend

- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- First Set of Probes
- Second Set of Probes
- ZE Fault
- Hydrogeologic Unit 3

THE pebble PARTNERSHIP

Figure 4.11
Conceptual Setting for Hydrogeologic Unit 3 Pumping Test
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 4.12
Packer Test
Pressure Flow Plot

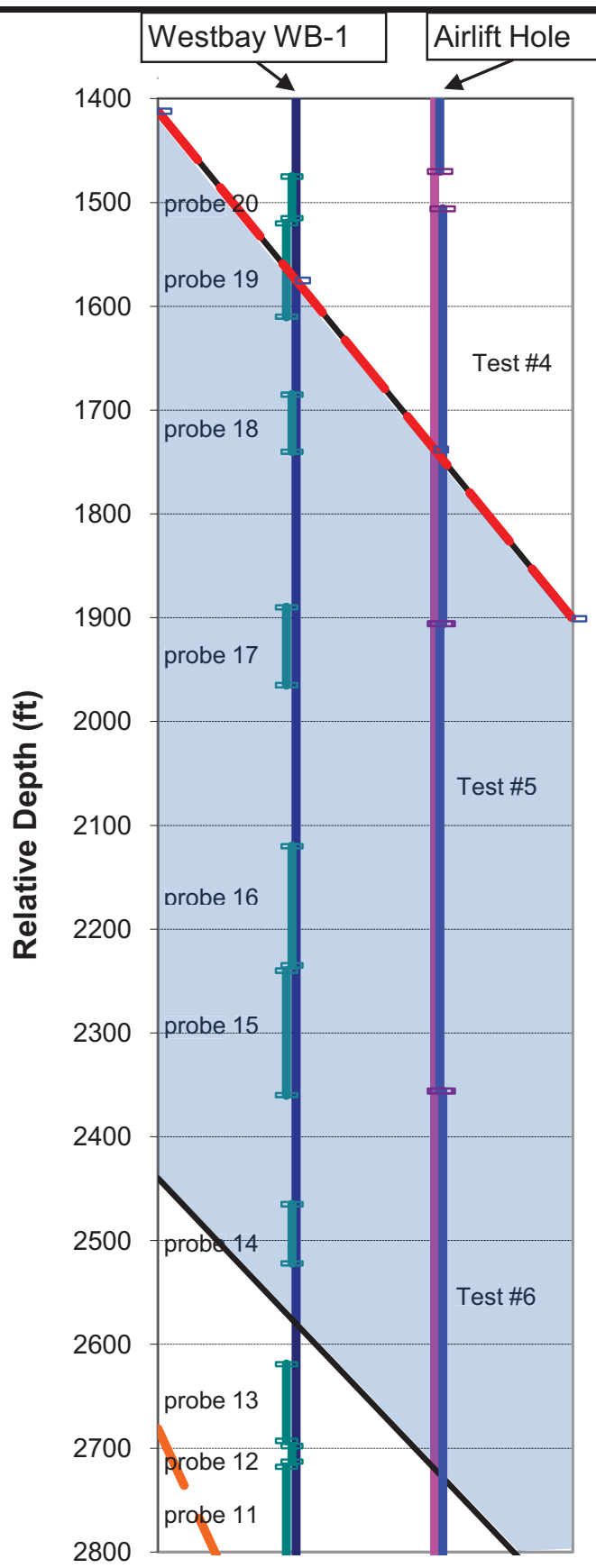
Appendix 8.1K
Multi-Level Groundwater
Monitoring System

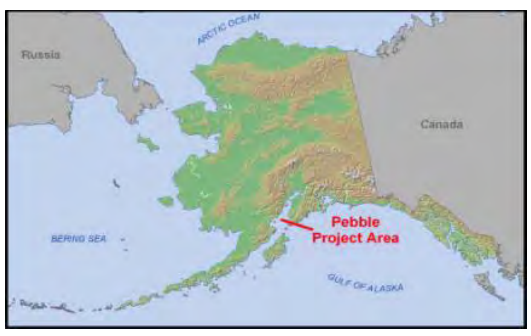
Note

Negative value indicates
artesian flow



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011





Legend

- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- Second Set of Probes
- ZE Fault
- Zec Fault
- Hydrogeological Unit 4

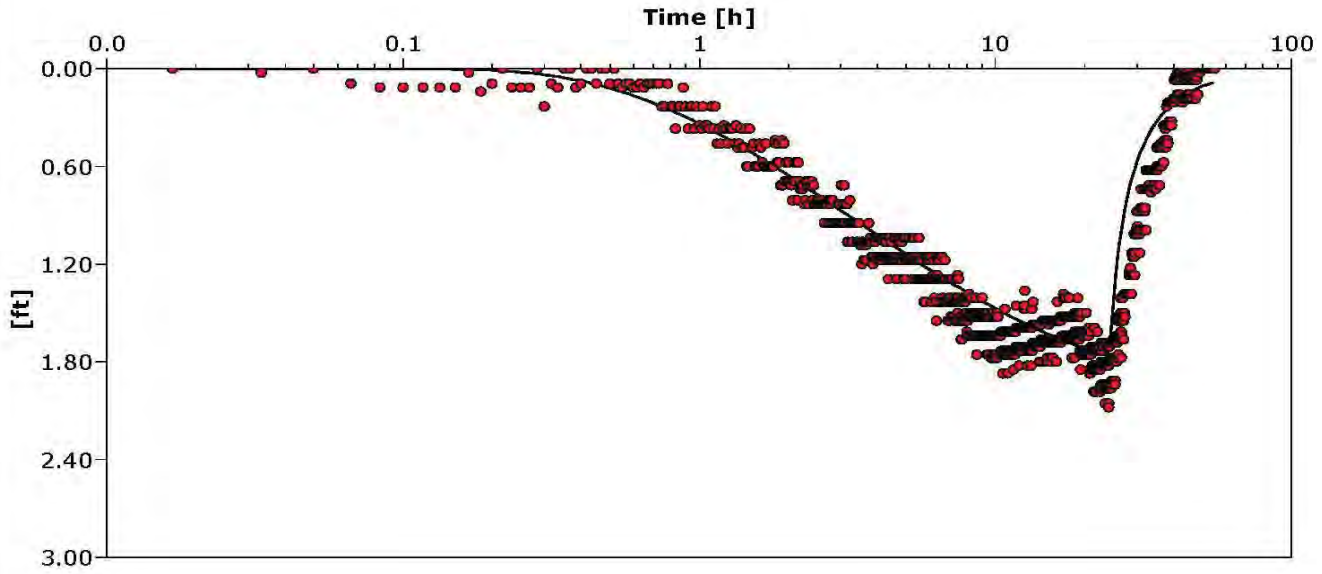
THE pebble PARTNERSHIP

Figure 4.13
Conceptual Setting for Hydrogeologic Unit 4 Pumping Tests
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011

Schlumberger Water Services 130-10691 Shellbridge Way Richmond, B.C. Canada V6X 2W8	Pumping Test Analysis Report
	Project: Probe #18
	Number: 7126
	Client: Pebble Limited Partnership

Location: Iliamna Alaska	Pumping Test: Cross Hole Test #4	Pumping well: Well 1
Test conducted by: SLR		Test date: 8/22/2008
Analysis performed by: RS	Cross Hole Test #4, Probe 18	Analysis date: 2/18/2010
Aquifer Thickness: 657.00 ft	Discharge: variable, average rate 0.12 [U.S. gal/min]	



Calculation after Double Porosity

Observation well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Specific storage	Sigma	Lambda	Radial distance to PW [ft]
Probe #18	6.00×10^{0}	9.13×10^{-3}	6.00×10^{-5}	2.00×10^{1}	1.30×10^{-1}	100.0

THE pebble PARTNERSHIP

Figure 4.14
Test # 4, Dual Porosity
Curve Fit, Probe # 18

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

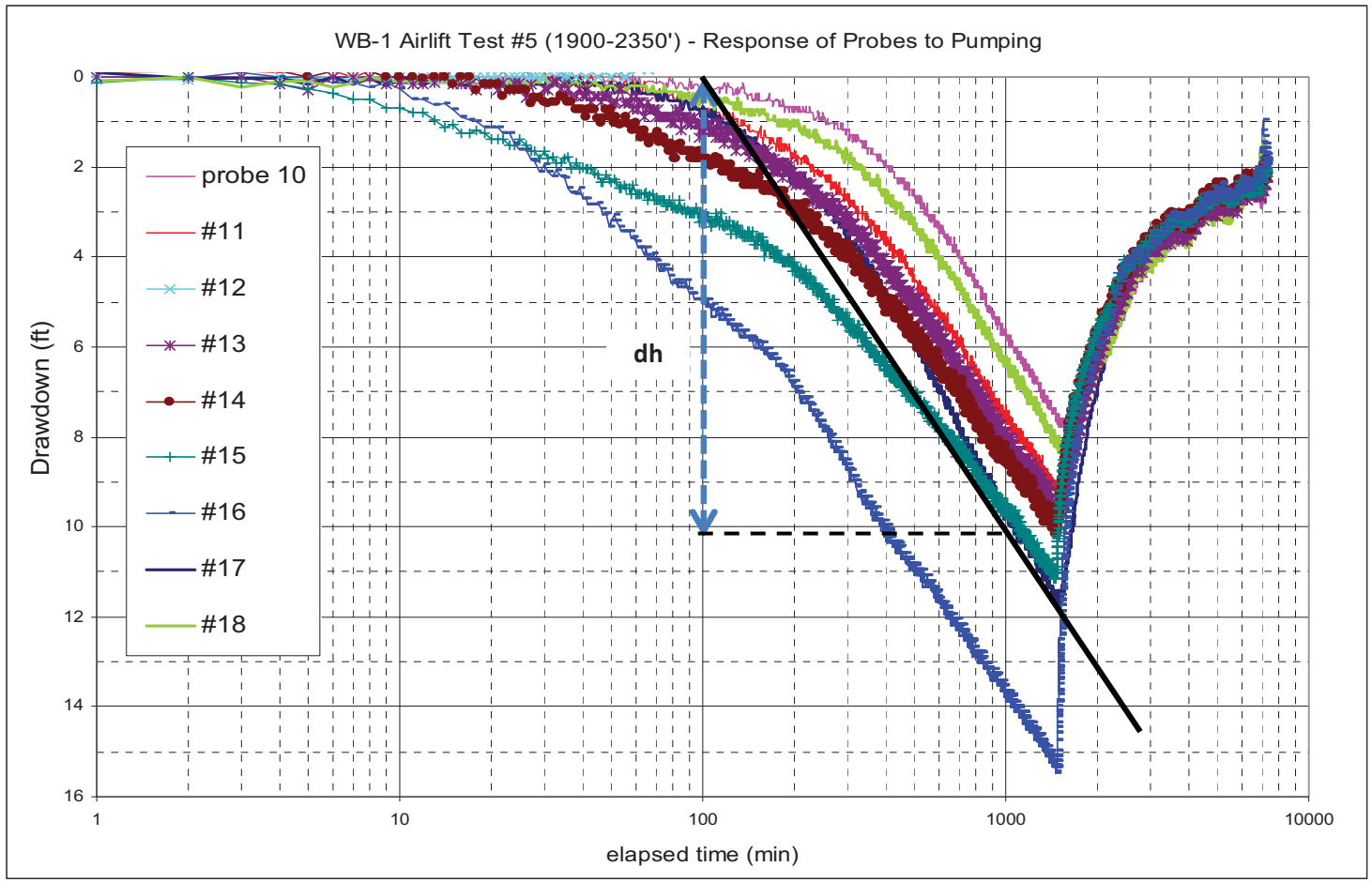
Note

Symbols show measured response

Solid lines indicate simulated response



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 4.15
Test # 5, Semi-Log
Drawdown Plots,
Probes #10 to #18

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Calculation :

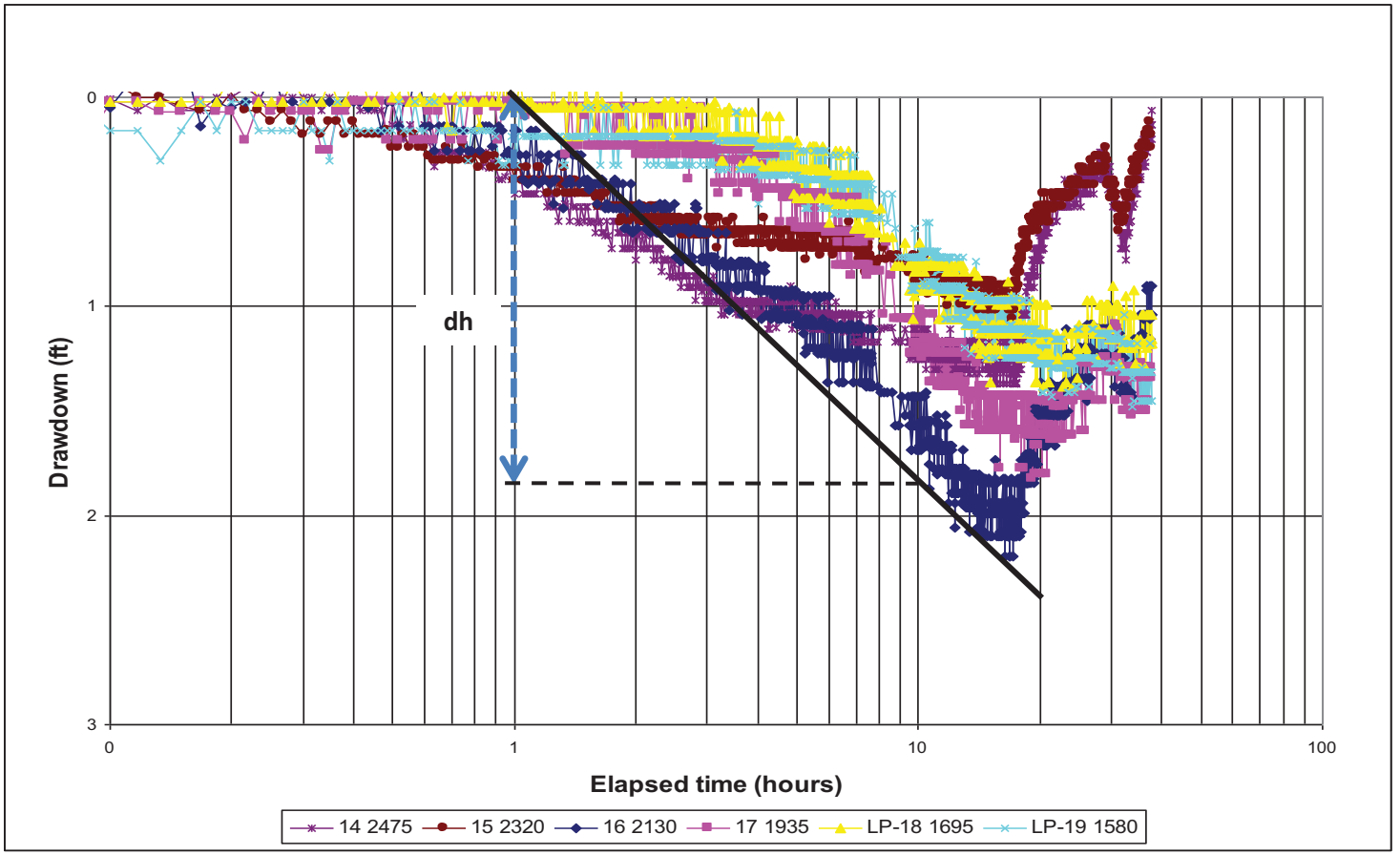
dh = 10.2 ft or 3.11 m

Q = 14.5 gpm or 9.15×10^{-4} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 5.4 \times 10^{-5} \ m^2/s$$



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 4.16
Test # 6, Semi-Log Drawdown Plot, Probes # 14 through # 19

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Calculation :

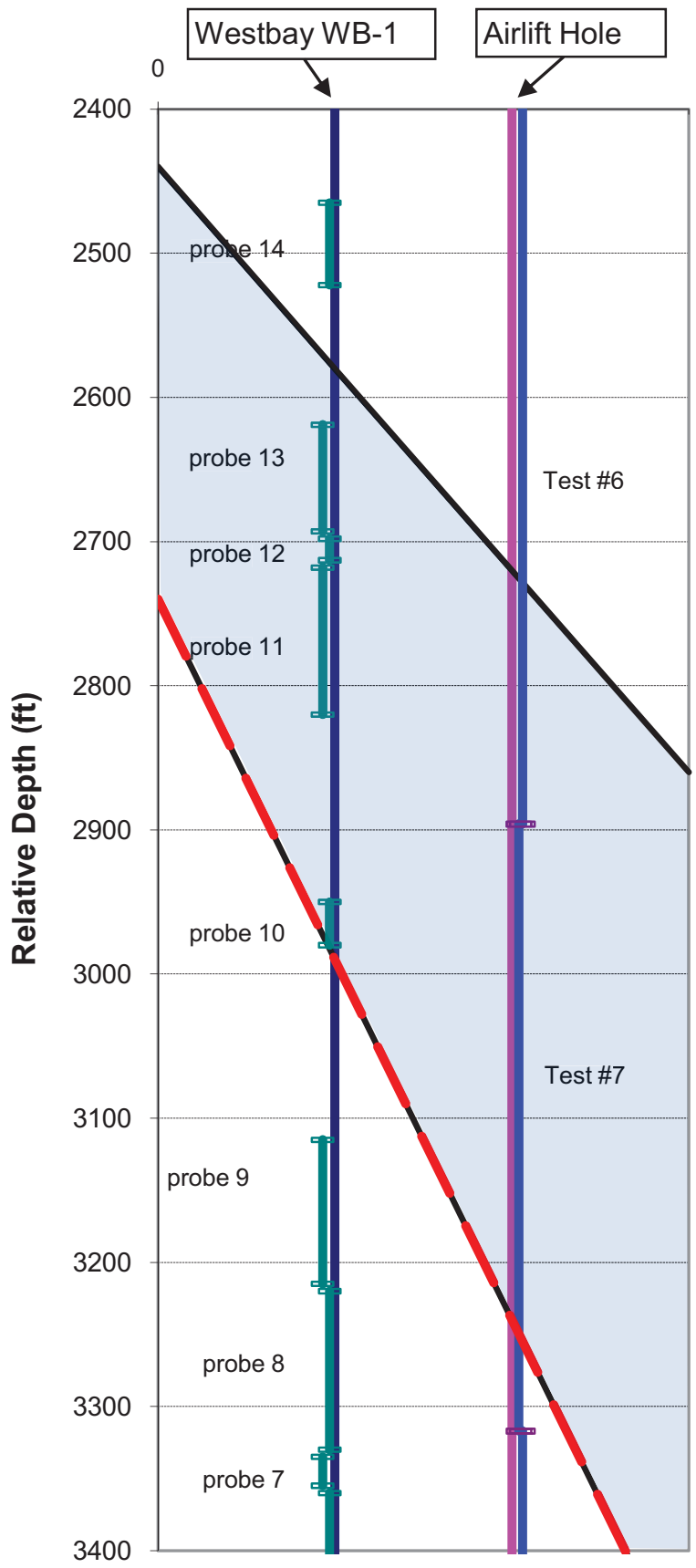
dh = 1.86 ft or 0.57 m

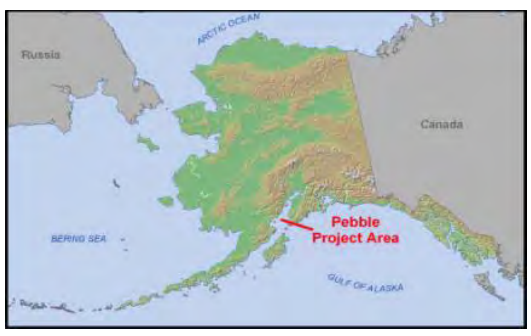
Q = 2.65 gpm or 1.67×10^{-4} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 5.4 \times 10^{-5} \; m^2/s$$



Project No: 7126	Author: SWS
Version: 1	Date: April, 2011





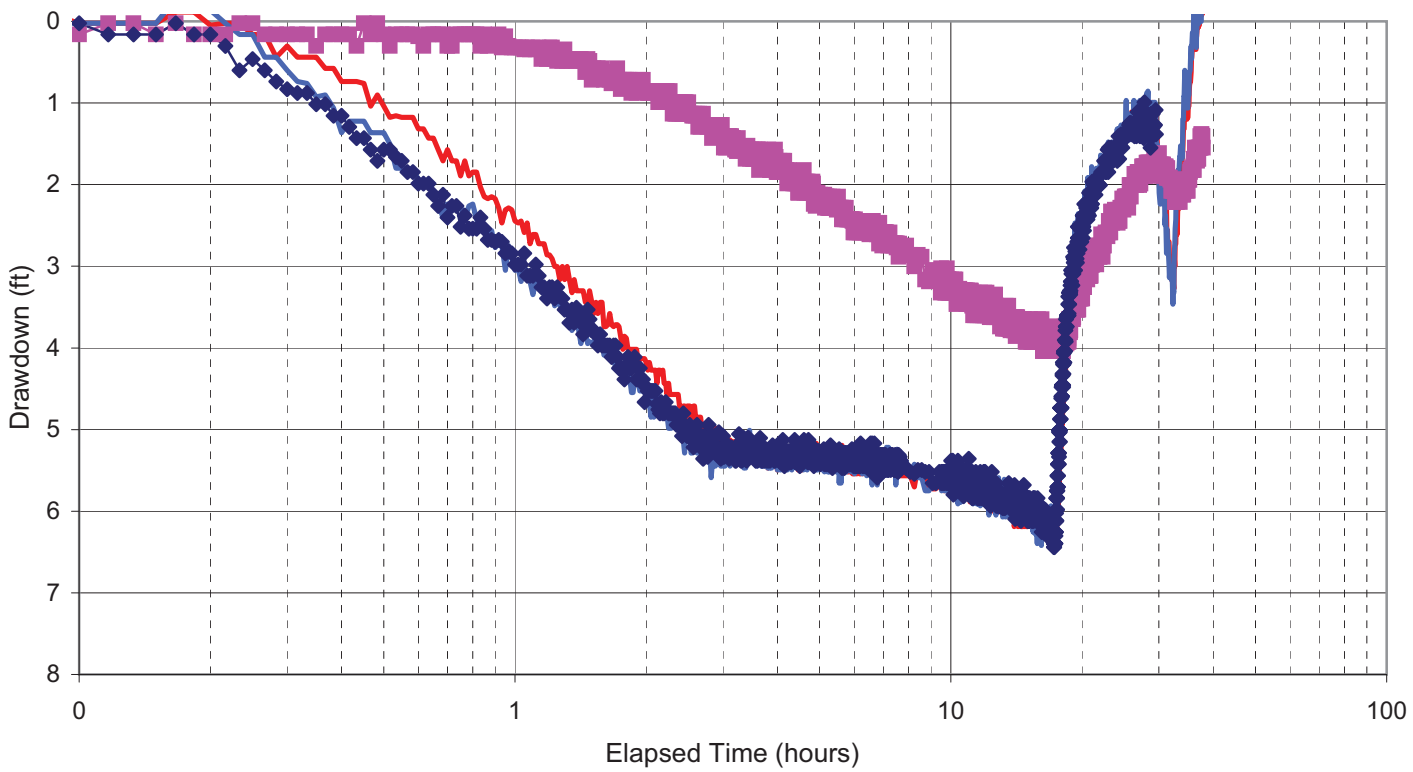
Legend

- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- First Set of Probes
- Second Set of Probes
- ZEC Fault
- Hydrogeologic Unit 5

THE pebble PARTNERSHIP

Figure 4.17
Conceptual Setting for Hydrogeologic Unit 5 Pumping Tests
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 4.18
Test # 6, Drawdown Observed in Hydrogeologic Unit 5, Probes #10 to #13

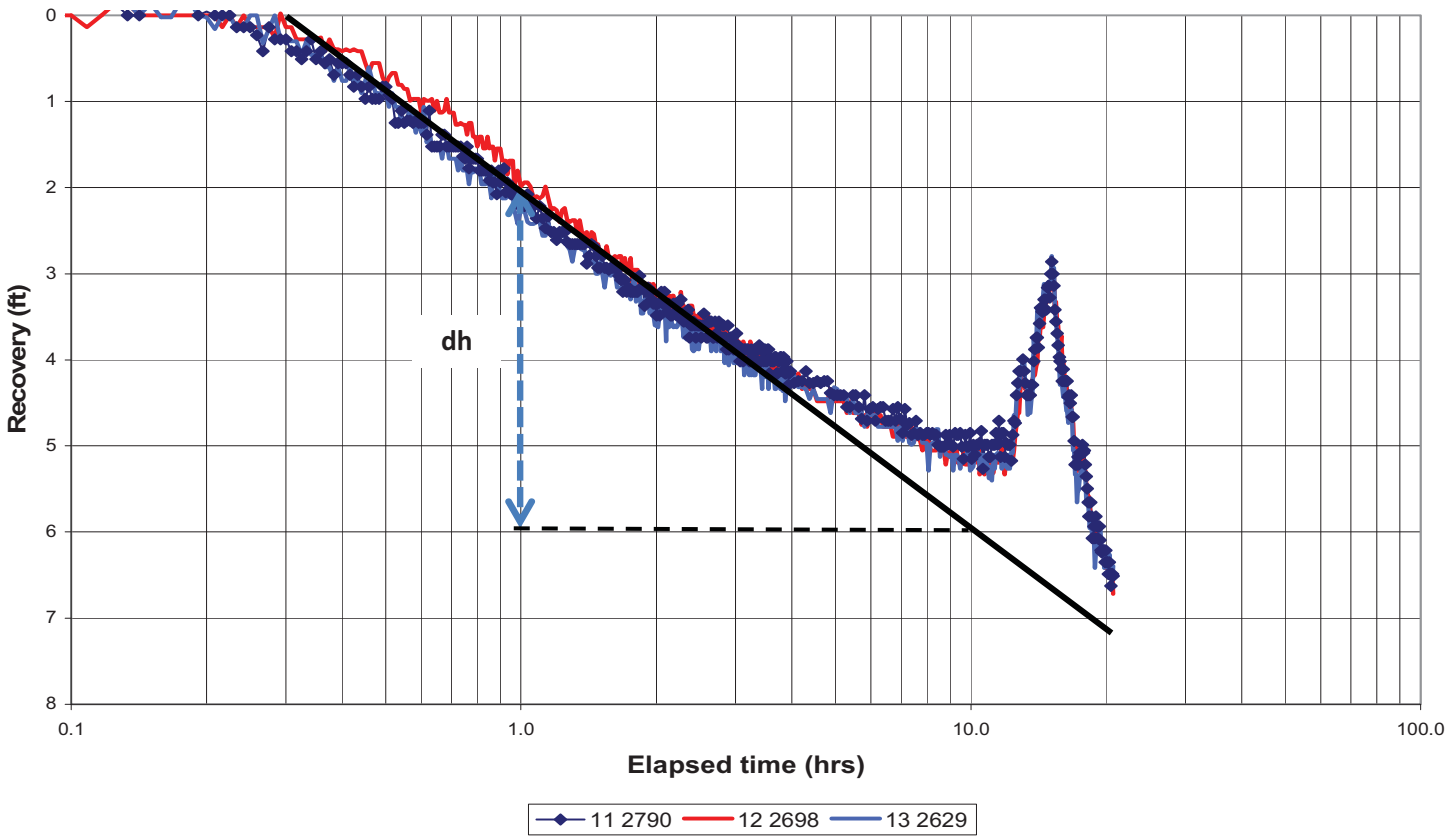
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Legend

- 10 2960
- 11 2790
- 12 2698
- 13 2629



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 4.19
Test # 6, Recovery Observed in HGU5

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Calculation :

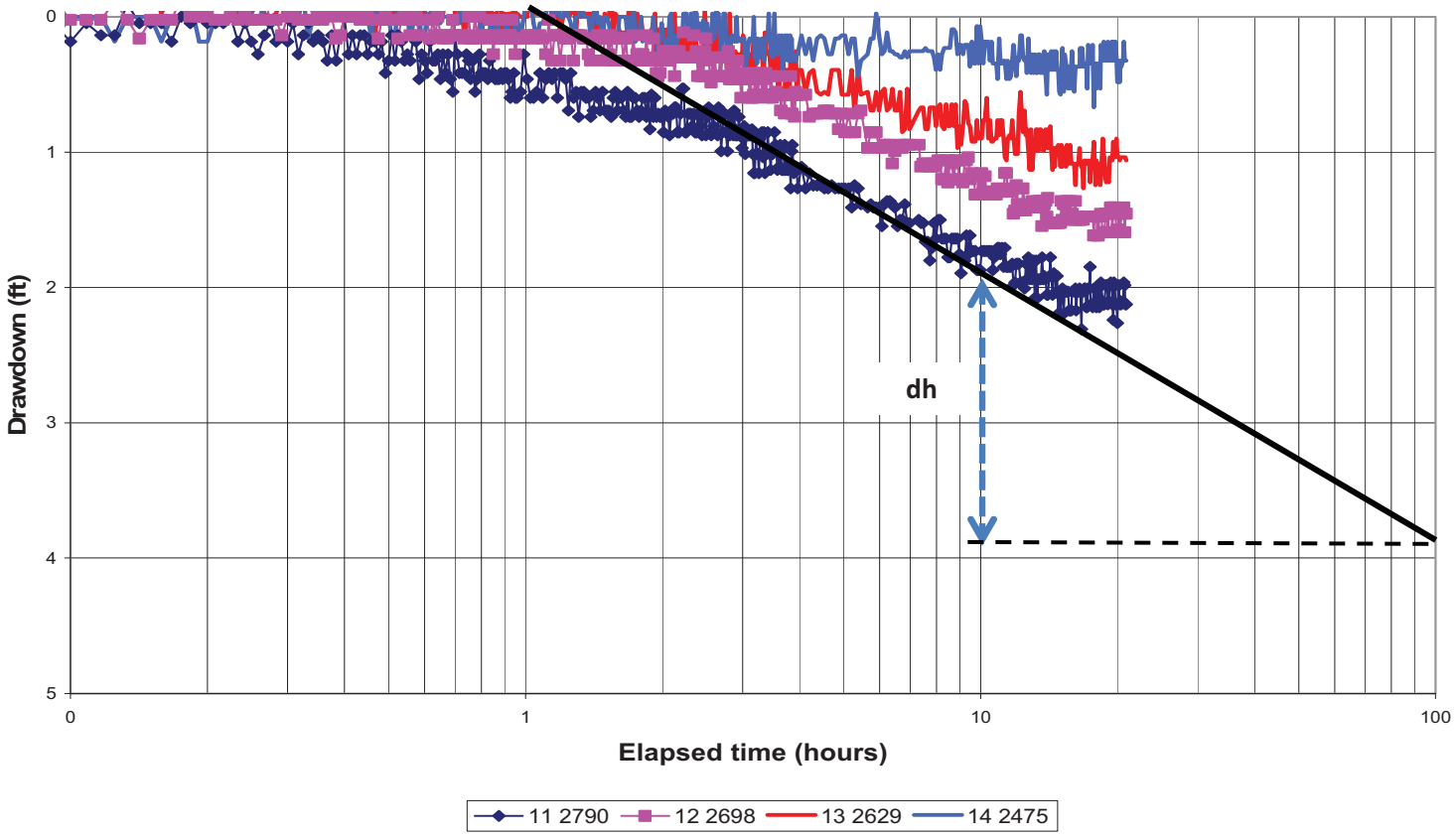
dh = 4.0 ft or 1.22 m

$Q = 1.35$ gpm or 8.52×10^{-5} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 1.3 \times 10^{-5} \; m^2/s$$



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 4.20
Test # 7, Recovery Observed in Hydrogeoligic Unit 5, Probes #11 to #14

Appendix 8.1K
Multi-Level Groundwater Monitoring System

Calculation :

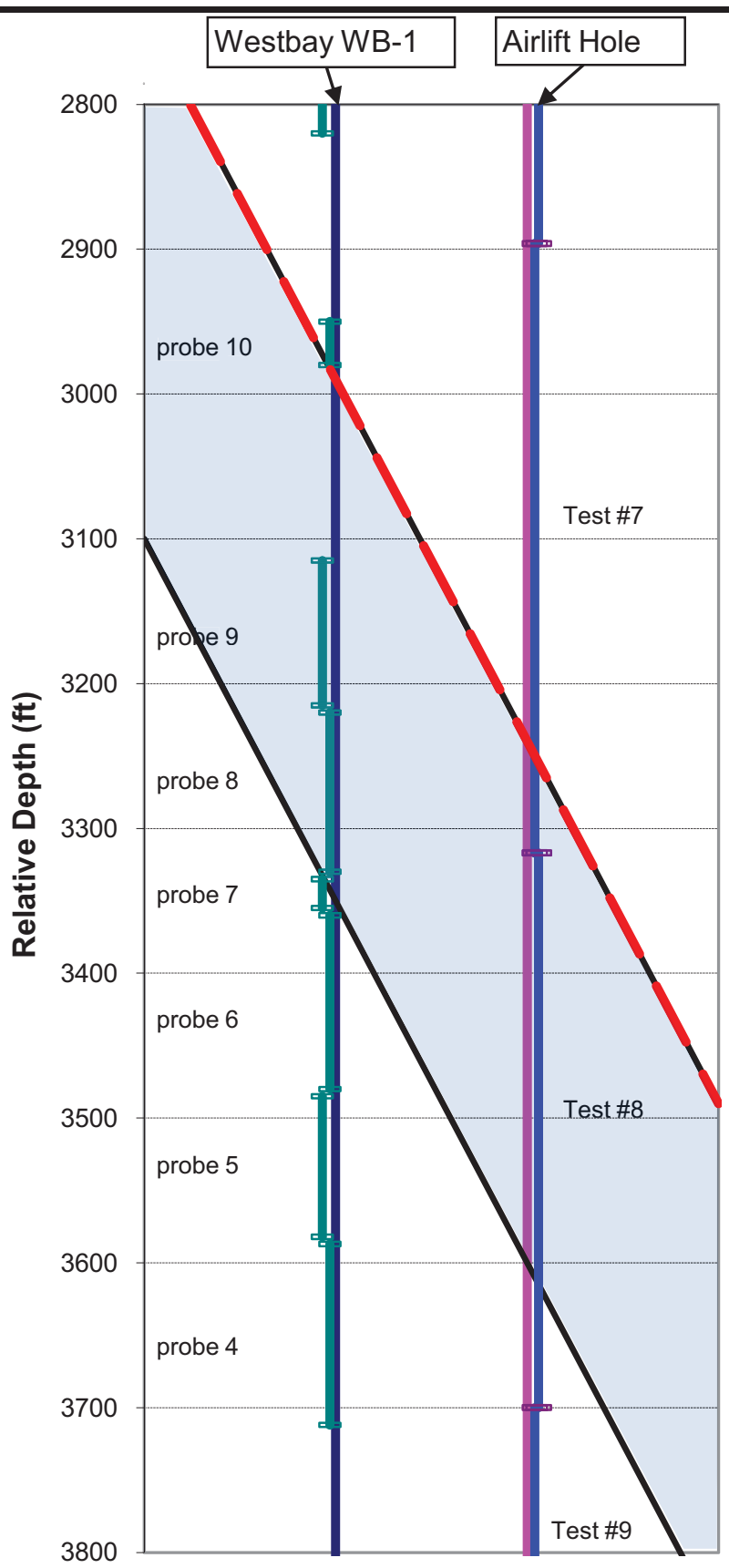
dh = 2.0 ft or 0.61 m

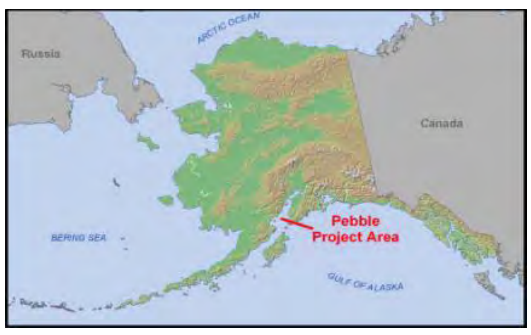
$Q = 0.7$ gpm or 4.4×10^{-5} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 1.3 \times 10^{-5} \; m^2/s$$



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010





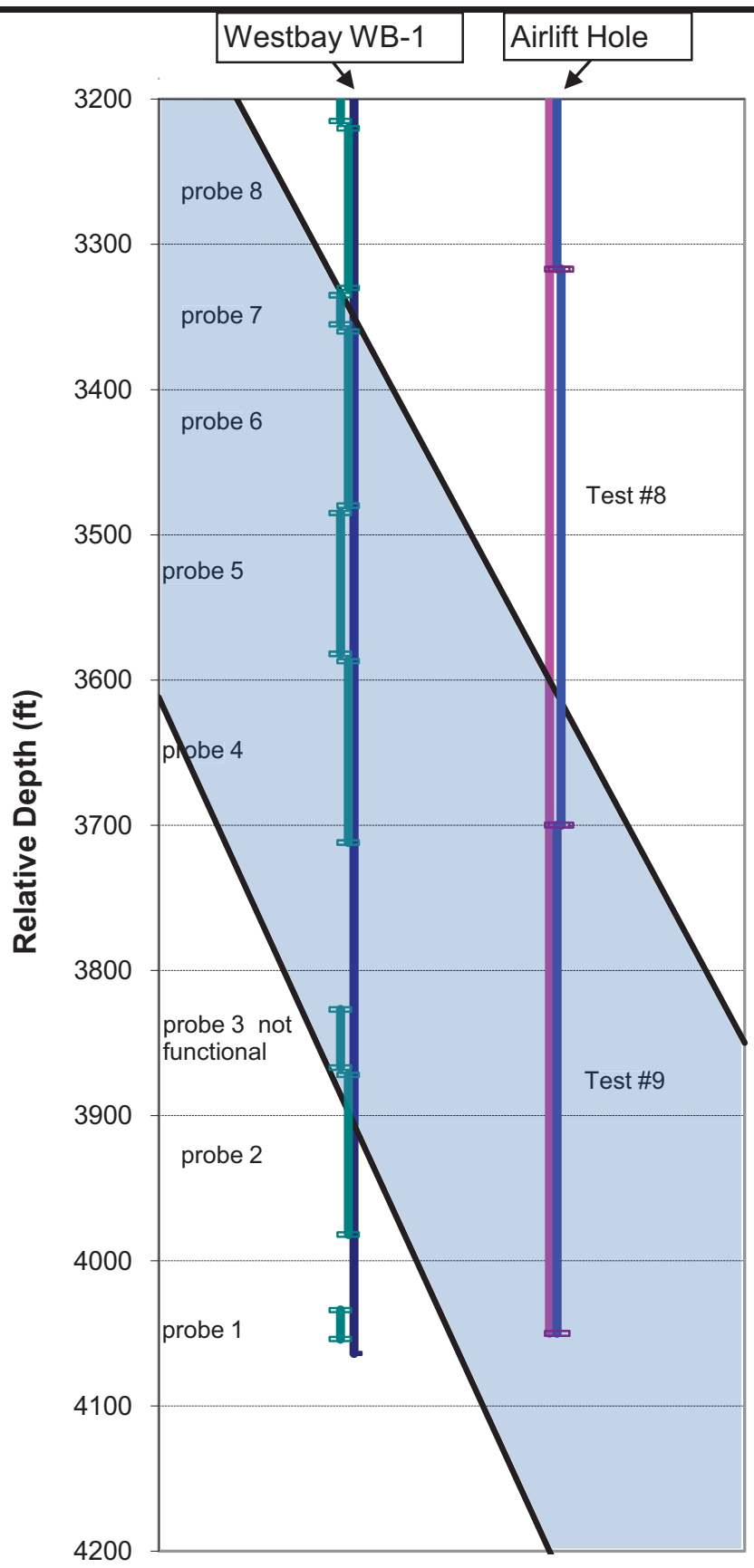
Legend

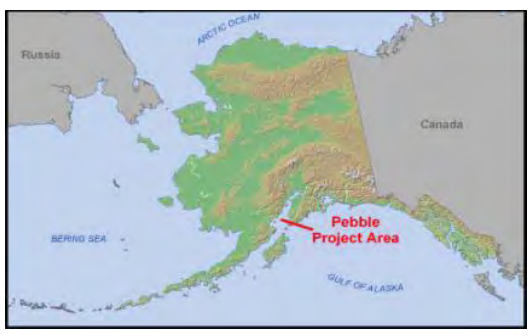
- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- First Set of Probes
- Second Set of Probes
- ZEC Fault
- Hydrogeologic Unit 6

THE pebble PARTNERSHIP

Figure 4.21
Conceptual Setting for Hydrogeologic Unit 6 Pumping Tests
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011





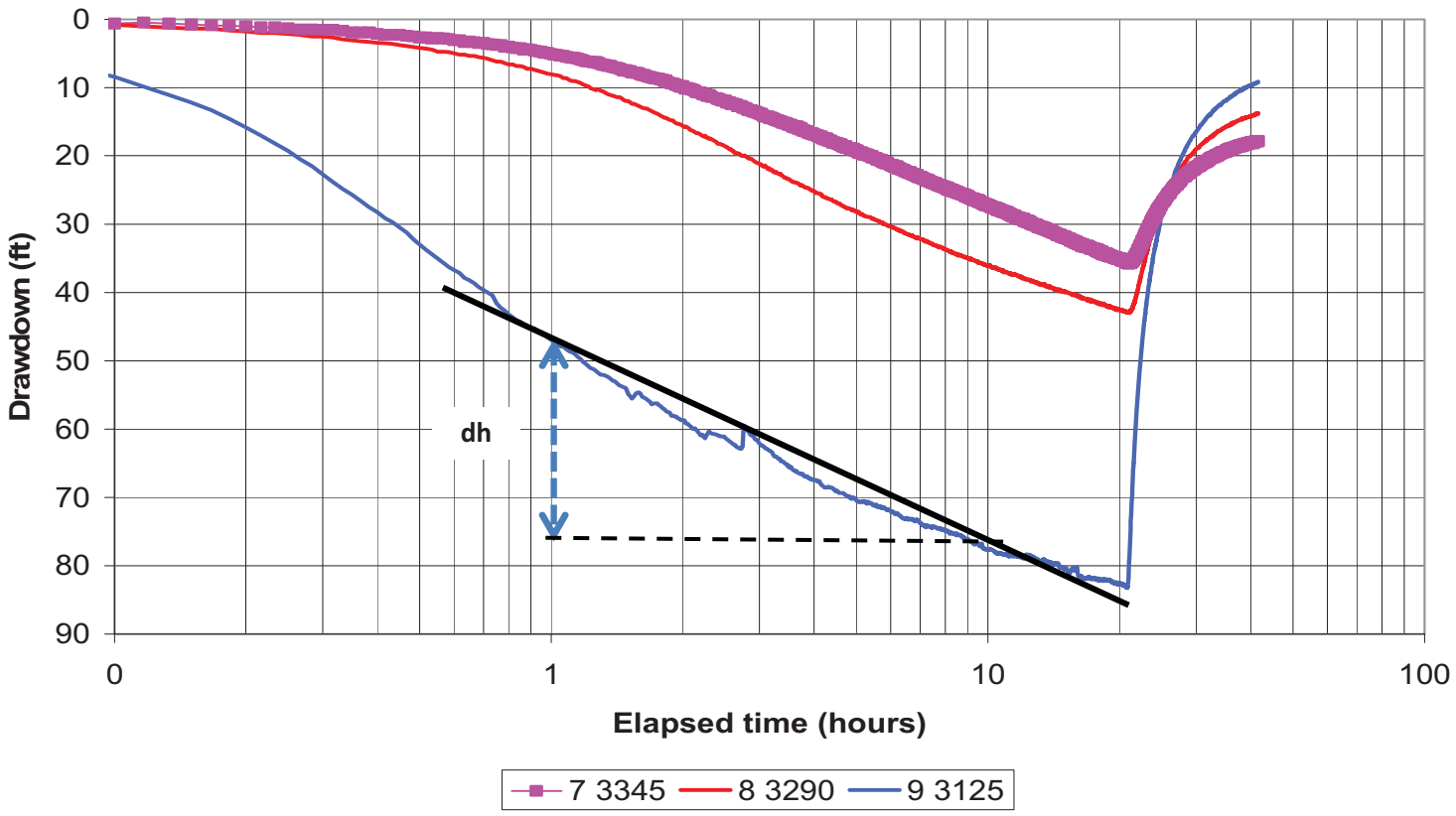
Legend

- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- Second Set of Probes
- Hydrogeologic Unit 7

THE pebble PARTNERSHIP

Figure 4.22
Conceptual Setting for Hydrogeologic Unit 7 Pumping Tests
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011



THE pebble PARTNERSHIP

Figure 4.23
Test # 7, Drawdown
Observed in HGU6

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Calculation :

dh = 28 ft or 8.53 m

$Q = 5.3$ gpm or 3.34×10^{-4} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 8.9 \times 10^{-6}\ m^2/s$$



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010

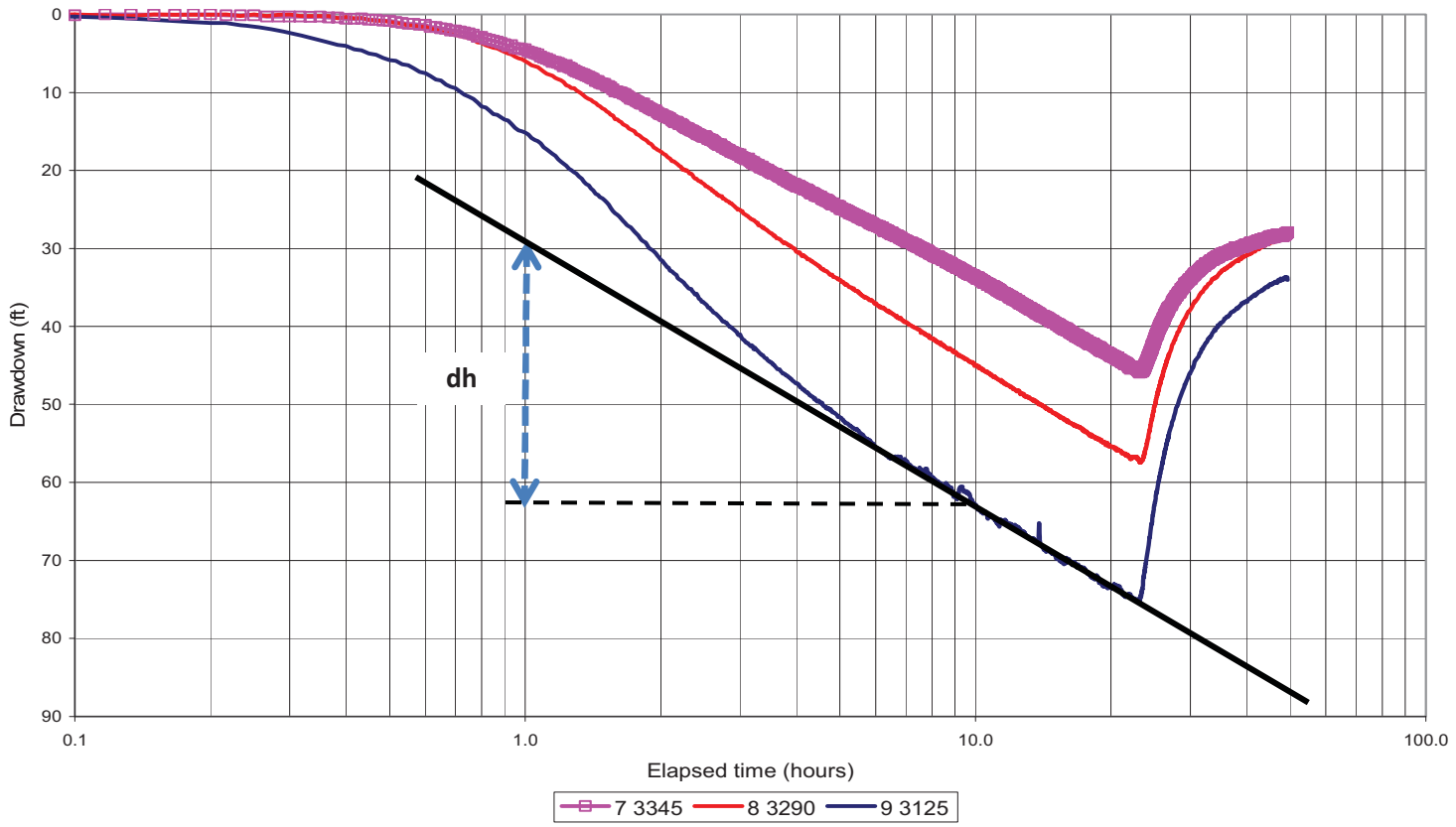


Figure 4.24
Test # 8, Drawdown
Observed in HGU6

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Calculation :

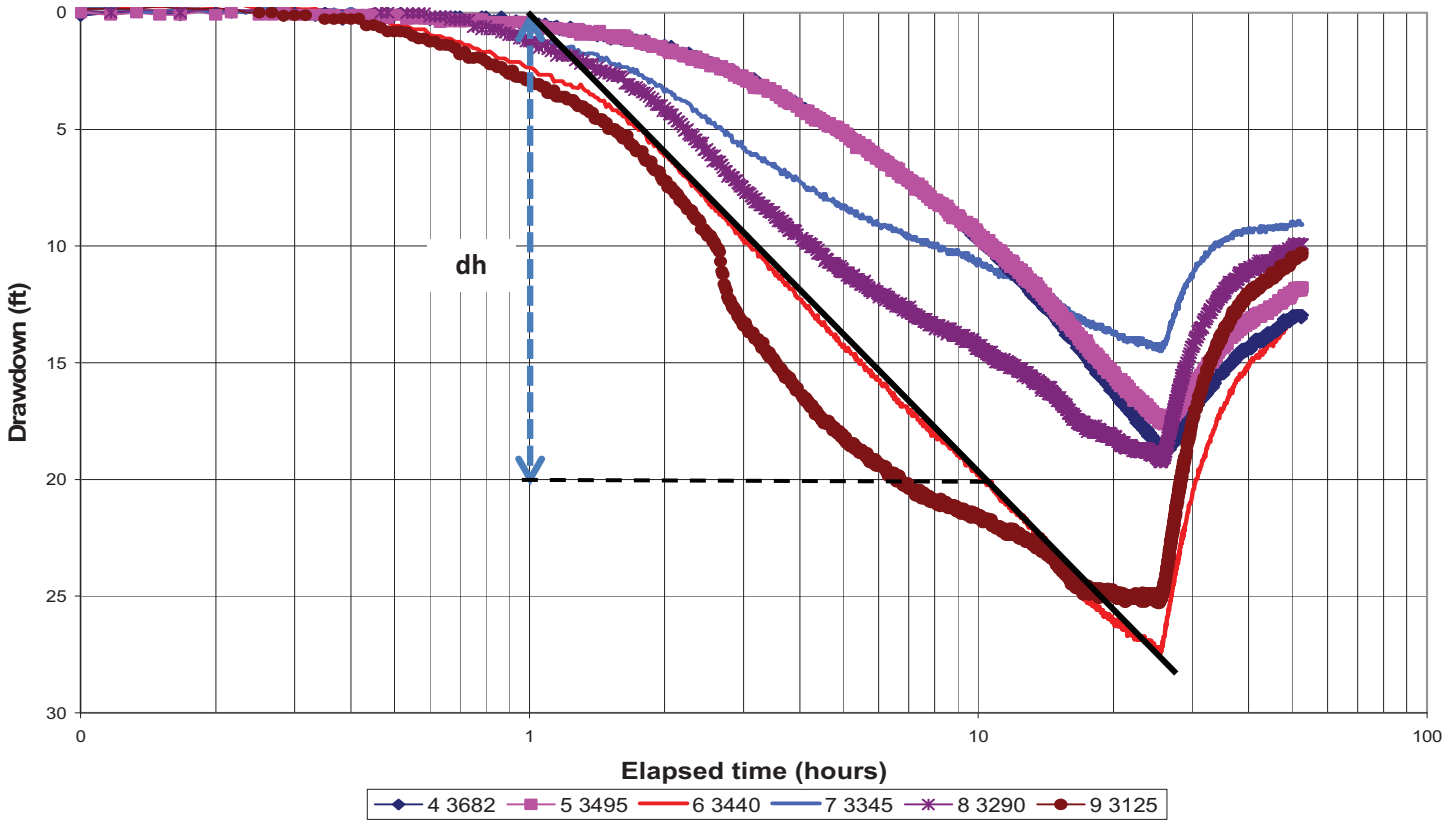
dh = 35 ft or 10.7 m

$Q = 6.9$ gpm or 3.8×10^{-4} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 6.5 \times 10^{-6}\ m^2/s$$



Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010



THE pebble PARTNERSHIP

Figure 4.25
Test # 9, Drawdown
Observed in HGU6

Appendix 8.1K
Multi-Level Groundwater
Monitoring System

Calculation :

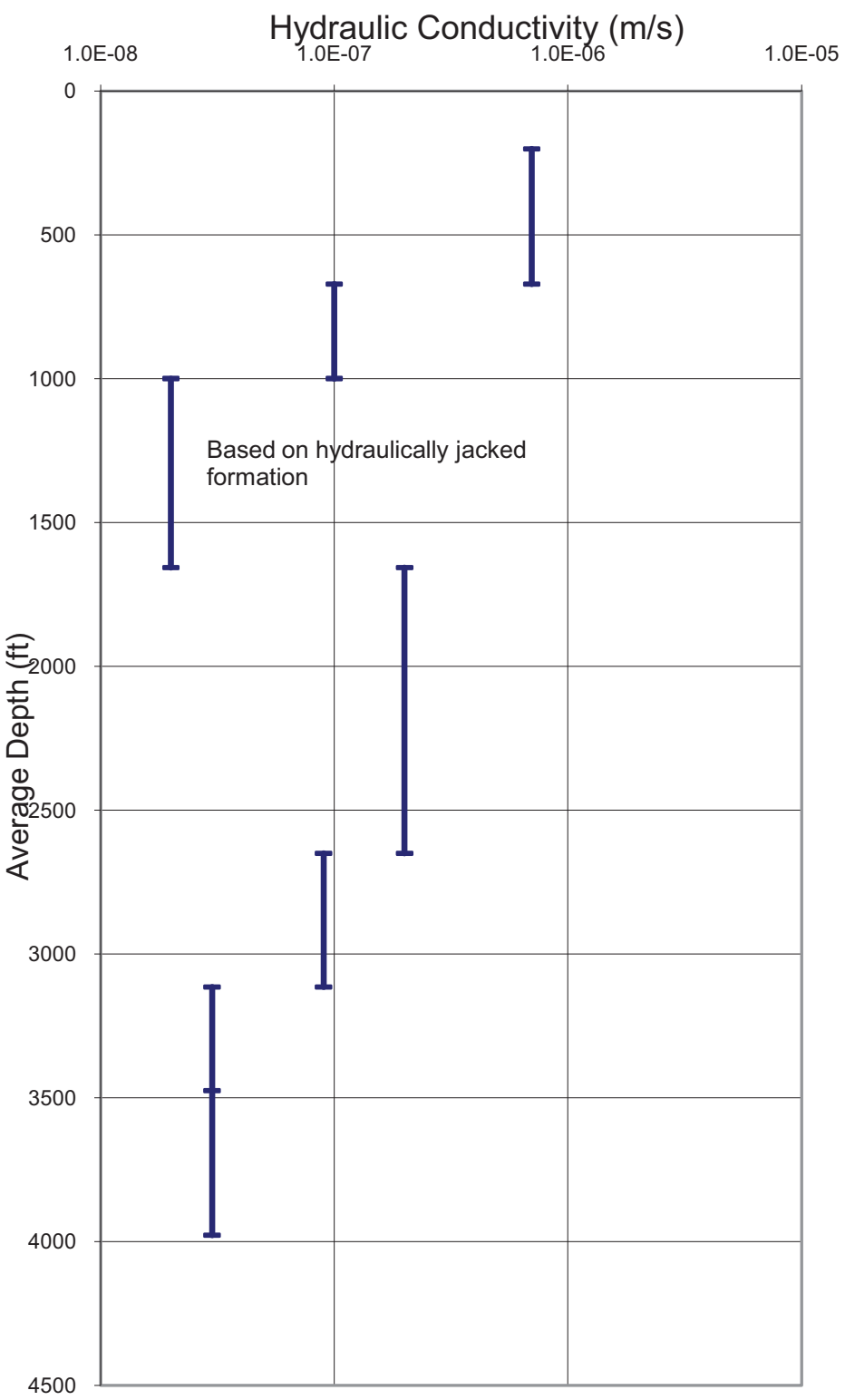
dh = 20 ft or 6.1 m

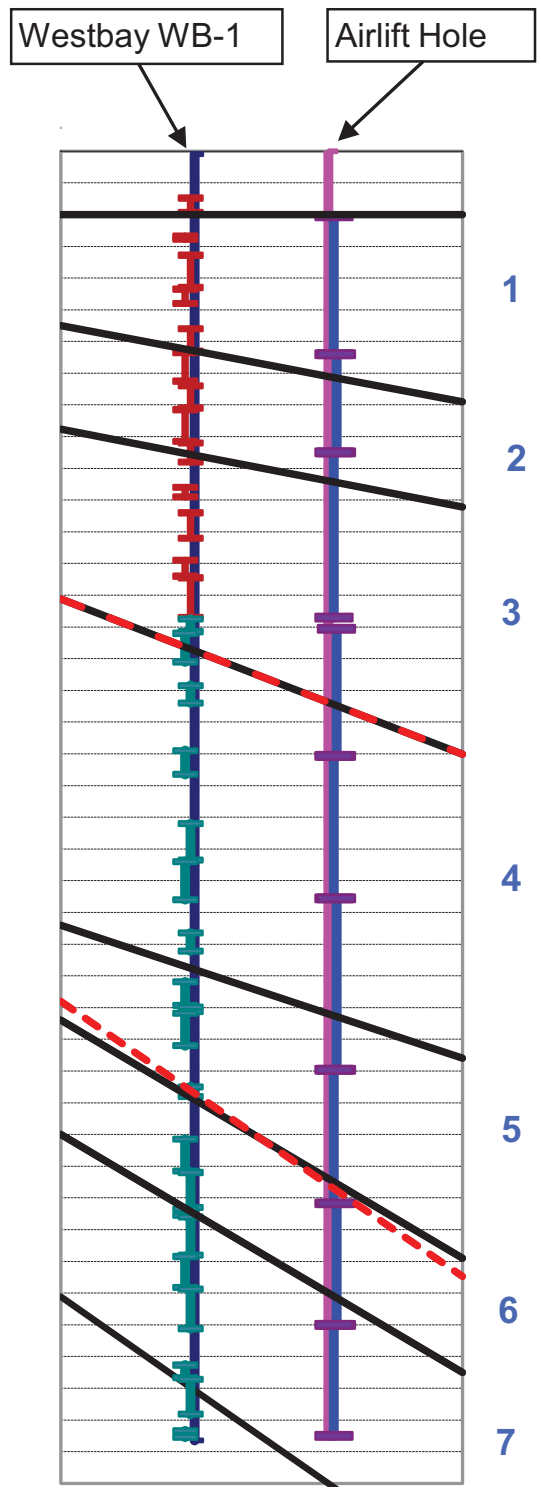
Q = 3.5 gpm or 2.2×10^{-4} m^3/s

$$T = \frac{2.303Q}{4\pi dh} = 6.6 \times 10^{-6}\ m^2/s$$

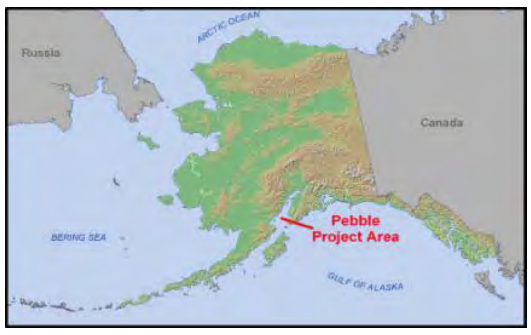


Project No: 7126	Author: SWS
Version: 1	Date: May 5, 2010





Schematic Cross-hole Test Setting with Hydrogeologic Units



Legend

Hydraulic Conductivity Intervals

- WB-1
- DH-8417
- Top of HGU
- Bottom of HGU
- Pump Test Intervals
- 1st Set of Probes
- 2nd Set of Probes
- HGU1
- HGU2 Top
- HGU3 Top
- HGU4 Top
- HGU6 Top
- HGU5 Top
- HGU7 Top
- ZE
- ZEC

THE pebble PARTNERSHIP

Figure 4.26
Hydraulic Conductivity Summary
Appendix 8.1K
Multi-Level Groundwater Monitoring System

Project: 7126	Author: SWS
Version: 1	Date: April, 2011

APPENDIX 8.1L

Packer Testing Results

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF TABLES ii
LIST OF FIGURES (following tables) ii
ATTACHMENT (following figures) ii
1. INTRODUCTION 1
2. PACKER TESTING 1
2.1 Bedrock Geology 1
2.2 Methodology 2
3. PACKER TESTING RESULTS 2
3.1 General 2
3.2 Deposit Area 3
3.2.1 Depth and Stress Distribution 3
3.2.2 Rock Type 3
3.2.3 Faults and Fracture Zones 3
3.3 Area G 4
3.4 Frying Pan Lake 4
3.5 North Fork Koktuli 4
3.6 South Fork Koktuli 4
4. REFERENCES 5

LIST OF TABLES

Table 1, SLR Packer Testing Results Summary, 2008
Table 2, Summary of All Packer Tests, 2004 to 2008

LIST OF FIGURES (following tables)

Figure 1, Packer Testing Location Site Map
Figure 2, Packer Testing Results with Depth (All Tests)
Figure 3, Packer Testing Location Map (Deposit Area)
Figure 4, Packer Testing Results with Depth (Deposit Area)
Figure 5, Median and Average Packer Testing Results (Deposit Area)
Figure 6, Packer Testing Results with Depth and Rock Type (Deposit Area)
Figure 7, Hydraulic Conductivity Distribution with Rock Type (Deposit Area)
Figure 8, Packer Testing Location Map (Area G)
Figure 9, Packer Testing Results with Depth (Area G)
Figure 10, Packer Testing Location Map (Frying Pan Lake)
Figure 11, Packer Testing Results with Depth (Frying Pan Lake)
Figure 12, Packer Testing Location Map (North Fork Koktuli)
Figure 13, Packer Testing Results with Depth (North Fork Koktuli)
Figure 14, Packer Testing Location Map (South Fork Koktuli)
Figure 15, Packer Testing Results with Depth (South Fork Koktuli)

ATTACHMENT (following figures)

Attachment 1, 2008 Schlumberger Packer Test Sheets

ACRONYMS AND ABBREVIATIONS

EBD	Environmental baseline document
FPL	Frying Pan Lake
KP	Knight Piésold
m/s	meters per second
NFK	North Fork Koktuli
SFK	South Fork Koktuli
SLR	SLR of Alaska
SWPS	standard wireline packer system
SWS	Schlumberger Water Services
UT	Upper Talarik

PACKER TESTING RESULTS

1. INTRODUCTION

The Pebble Deposit is located in southwestern Alaska. The deposit is located about 200 miles southwest of Anchorage in the Bristol Bay region. The nearest communities to the site are Iliamna, Nondalton, and Newhalen. Schlumberger Water Services (SWS) is responsible for characterizing the groundwater conditions in the vicinity of the Pebble Deposit.

Packer testing was used to help characterize the distribution of hydraulic conductivity of bedrock as it was penetrated by the borehole. This type of hydraulic testing was more economical and practical than a nest of wells and provided a more continuous record of hydraulic properties with depth. Packer testing was used at the Pebble study area since 2004 as a site-investigation method to evaluate the hydraulic conductivity of the bedrock. Packer testing data that were collected between 2004 and 2008 were generally limited to the upper 1,500 feet of bedrock. The testing between 2004 and 2007 were carried out under the direction of Knight Piésold (KP), and hydraulic conductivities for the tests were calculated by KP.

There was some limited packer testing undertaken in 2008, which targeted faults and fracture zones, and provided some additional information about hydraulic conductivity below 1,500 feet. This testing was carried out under the direction of SLR Alaska (SLR), and hydraulic conductivities for the tests were calculated by SWS. Calculation sheets for these tests are included with this document (Attachment 1). The locations for all packer tests completed between 2004 and 2008 at the Pebble Deposit area are presented on Figure 1.

The key objective of this document is to summarize and provide a general interpretation of the packer testing results from 2004 and 2008.

2. PACKER TESTING

2.1 Bedroc Geology

The overall bedrock geology in the deposit area includes rocks that were present during mineralization (Cretaceous) and after mineralization (Tertiary). The earlier units include meta-sedimentary rocks that have been intruded by granodiorite and quartz monzonite. The intrusions include plutons, stocks, dikes, and sills. These units were eroded and the overlying Tertiary materials were deposited. The Tertiary deposits include volcanic flows, pyroclastics, and deposits of coarse sediments within relatively steep active environments.

During the Tertiary depositional period, the region was likely undergoing spreading activity. Many of the mapped structures are steeply dipping normal faults consistent with interpreted graben on the east boundary of the deposit. There is likely low residual horizontal stress associated with this tectonic

activity. Additional discussion on the bedrock geology is available in Chapter 3 of this Environmental Baseline Document (EBD).

Hydrogeologic properties of bedrock include hydraulic conductivity, specific storage, drainable porosity, and geometric dimensions of bedrock hydrogeologic units. Hydraulic conductivity influences the rate at which groundwater can move through the ground. Specific storage is a measure of the volume of water that can be removed from the ground as the water pressure is reduced. Drainable porosity is a measure of the volume of water that is removed from the ground as the water table is lowered. These hydrogeologic properties vary depending on a number of factors, including the following: 1) rock type, 2) jointing, 3) faults and fracture zones, and 4) stress distribution.

2.2 Methodology

Packer testing was carried out in exploration and geotechnical drill holes at the Pebble site since 2004. At a certain depth during drilling, a depth interval above the current bottom of the drill hole would be sealed by a packer assembly and tested, typically in four pressure stages. Injection pressure and water intake were recorded for the test evaluation. KP directed packer testing from 2004 through 2008 and analyzed these tests to estimate hydraulic conductivity (Knight Piésold 2005a, 2005b, 2005c, 2007, 2008a, 2008b, 2009). SLR directed packer testing in the deposit area in 2008 (Table 1). The general procedure for packer testing by SLR was based on a standard wireline packer system (SWPS) produced by IPI Ltd. in Australia. The analysis of the packer testing directed by SLR the analyses of which was carried out by SWS is attached to this report (Attachment 1).

3. PACKER TESTING RESULTS

3.1 General

Four hundred ninety four packer tests in 149 holes were completed in the Pebble study area between 2004 and 2008. Of these 494 tests, 3 tests reported leaks and were not analyzed, 51 tests had no water take, and 176 tests had no hydraulic conductivity reported. As indicated on Figure 1, the majority of these packer tests were carried out in the deposit area. A summary of the packer testing results is in Table 2.

Packer test data have been analyzed (by KP for KP tests and by SWS for SLR tests) to define a hydraulic conductivity for each test zone. Within each test zone, the distribution of hydraulic conductivity along the hole is not known. For example, the majority of the response for a test is typically generated by just a few fractures. This is taken into consideration in developing bulk hydraulic conductivities for this study.

The estimated hydraulic conductivity values with depth for all the packer tests is presented on Figure 2. The packer tests that had no water take were assigned a relatively low hydraulic conductivity of $1x10^{-10}$ meters per second (m/s) for presentation purposes on Figure 2. The majority of the packer tests were within the upper 1,000 feet of bedrock with a lower and upper bound for the estimated hydraulic conductivity for these tests of about $1x10^{-10}$ m/s and $1x10^{-5}$ m/s, respectively. The hydraulic conductivity values estimated for the bedrock from 1,000 to 4,000 feet were influenced by faults and fractured zones that were targeted for the packer testing and, therefore, do not provide representative bulk hydraulic values with depth. However, the results suggest that at deeper depths, material with faults or fractures may have a hydraulic conductivity value as high as $4x10^{-6}$ m/s.

The packer testing results were summarized based on location areas in the following sections. The location areas were categorized as Deposit Area, Area G, Frying Pan Lake (FPL), North Fork Koktuli (NFK), South Fork Koktuli (SFK), and Upper Talarik (UT).

3.2 Deposit Area

Twenty-seven holes were tested in the deposit area and 117 packer tests were completed (Figure 3). Of the packer tests completed, nine did not have a hydraulic conductivity value reported.

3.2.1 Depth and Stress Distribution

On Figure 4, the results of the packer testing in the deposit area are plotted with depth. The upper and lower bound of hydraulic conductivity generally decreased with depth down to 1,500 feet. The values ranged from $9.4x10^{-11}$ to $4x10^{-6}$ m/s, with an average of $2x10^{-7}$ m/s and a median of $3x10^{-8}$ m/s for testing in the upper 1,500 feet. Below 1,500 feet, most packer testing was focused on fault structures. The hydraulic conductivity values estimated for the bedrock from 1,500 to 4,000 feet were influenced by faults and fractured zones that were explicitly targeted for packer testing and, therefore, did not provide a representative hydraulic conductivity value with depth. However, the results suggest that at greater depths, faults or fractures may have hydraulic conductivity values as high as $4x10^{-6}$ m/s. These few deeper tests are, therefore, typically representative of the structures at depth rather than the overall hydraulic conductivity.

The distribution of average and median hydraulic conductivity values calculated in 6-foot-depth increments for the upper 1,500 feet are plotted on Figure 5. The lower hydraulic conductivity at depth is presumed to be the result of increased compressive stress with depth, which would tend to decrease fracture aperture and therefore hydraulic conductivity. This plot indicates that testing in the deposit area implies a zone of higher hydraulic conductivity to a depth of about 600 feet (average generally between $1x10^{-7}$ m/s and $1x10^{-6}$ m/s), decreasing slowly to an average of about $2x10^{-8}$ m/s at a depth of about 1,000 feet. These distributions are based on small scale in situ tests. As such, these tests may be representative of a range of fractures and fracture openings that may have been encountered in the drill holes. These tests do not identify hydrogeologic boundaries responsible for the formation of groundwater "compartments" typical of bedrock environments.

3.2.2 Rock Type

Bulk hydraulic conductivity values of the bedrock are influenced by factors like lithology, weathering, and tectonic disturbances. Packer testing was carried out in contrasting lithologies, namely Tertiary volcanics and sediments, and granodiorite. Faults, weathering, and fracturing of these materials were also tested. Figures 6 and 7 present a summary of the distribution of hydraulic conductivity based on rock type. The differences in the hydraulic conductivity values between the rocks were not sufficient to separate the results by rock type.

3.2.3 Faults and Fracture Zones

Faulting, fracturing and weathering generally increase the hydraulic conductivity of bedrock. As expected, relatively high hydraulic conductivity values were calculated within fractured or fault zones

(Figure 7). Typically, groundwater inflows to underground openings, and open pits are concentrated along such structures. Inflows are usually particularly noticeable along structures with recent (unhealed) deformation through brittle rock. Also important is the tendency for movement along structures to form fault gouge along the deformation zone, inhibiting the flow of groundwater across faults. It is this low permeability fault material that creates the groundwater "compartments" common in bedrock groundwater regimes. Faults and fractures, therefore, typically enhance groundwater flow along the structure and inhibit flow across the structure.

The packer testing is not capable of identifying the fault gouge material. Rather the presence of such material is inferred by core logging and structural interpretations, with the potential for verification based on calibration of groundwater models with measured piezometric levels, and measurement of pumping rates and groundwater levels during dewatering activities.

The higher hydraulic conductivity measurements in the packer testing program are expected to represent the faulted bedrock. The product of the reported hydraulic conductivity and the test length (transmissivity) must be carried into the inflow calculations, if individual structures are to be simulated.

3.3 Area G

Area G is the drainage area for a North Fork Koktuli tributary with the designation NK1.190. The location of the area adopted for this discussion is presented on Figures 1 and 8. Although the central portion of Area G is underlain by intrusives, Tertiary volcanoclastic breccia is mapped in the southeast, and pre-Tertiary sediments and volcanics are mapped in the north. One hundred sixty-two packer tests were completed in 40 boreholes in Area G. The distribution of test results with depth is presented on Figure 9. All but two of the reported results are shallower than 300 feet. The holes with the higher hydraulic conductivity were located near the center of Area G (GH-07-95) and near the southern boundary of Area G (GH07-90 and 93).

3.4 Frying Pan La e

The Frying Pan Lake area, defined on Figures 1 and 10, extends from the southern boundary of the deposit area to the downstream extent of Frying Pan Lake. Thirty packer tests were completed in 23 boreholes. The hydraulic conductivity ranged from no take to $6x10^{-6}$ m/s over depths of up to 270 feet. The distribution of hydraulic conductivity with depth is plotted on Figure 11.

3.5 North For Ko tuli

The North Fork Koktuli area, defined on Figures 1 and 12, is primarily within the drainage area for a North Fork Koktuli River tributary that has flows measured by NK119B. Thirty-eight packer tests were completed in 14 boreholes in this area. The hydraulic conductivity ranged from no take to $1.4x10^{-6}$ m/s to depths of 100 feet. The distribution of hydraulic conductivity with depth is plotted on Figure 13.

3.6 South For Ko tuli

The South Fork Koktuli area, as defined on Figures 1 and 14, includes South Fork Koktuli drainage below Frying Pan Lake and as far downstream as the confluence with tributary SK1.190. One hundred thirty-

eight packer tests were completed in 41 boreholes within this area. The hydraulic conductivity ranged from no take to $5x10^{-6}$ m/s. The distribution of hydraulic conductivity with depth is plotted on Figure 15.

4. REFERENCES

Knight Piésold Ltd. (KP). 2009. Pebble Project — 2008 Geotechnical Site Investigation Data Report. 3 Volumes. Ref. No. VA101-176/23-4. October.

Knight Piésold Ltd. (KP). 2008a. Pebble Project — 2007 Geotechnical Site Investigation Data Report. Ref. No. VA101-176/20-4. November.

Knight Piésold Ltd. (KP). 2008b. Pebble Project — 2006 Geotechnical Site Investigation Data Report. 2 Volumes. Ref. No. VA101-176/8-9. March.

Knight Piésold Ltd. (KP). 2007. Pebble Project — 2005 Geotechnical Site Investigation Data Report. Ref. No. VA101-176/8-6. March.

Knight Piésold Ltd. (KP). 2005a. Pebble Project—2005 Open Pit Geotechnical Investigations. Ref. No. VA101-176/8-5. December.

Knight Piésold Ltd. (KP). 2005b. Pebble Project — Geotechnical Site Investigation Data Report. 2 Volumes. Ref. No. VA101-176/8-3. March.

Knight Piésold Ltd. (KP). 2005c. Pebble Project—2004 Open Pit Geotechnical Investigations. Ref. No. VA101-176/8-2. January

TABLES

TABLE 1
SLR Pac er Testing Results Summary, 2008

			Depth Range (feet along hole)		Test Zone	Vertical Depth (feet)			Average K	Lugeon (L/min/m) at	
Date	Hole #	Test #	from	to	feet	from	to	Dip (deg)	(m/sec)	145 psi	Comment/Purpose
11-May-08	8410	1	2,102	2,118	16	1,935	1,950	67	4.0E-06	9.5	Fractured zone, volcanoclastics
15-May-08	8410	2	2,598	2,667	69	2,391	2,455	67	1.3E-06	2.9	ZG1 Fault, Basalt x GD contact
1-May-28	8412	0	1,470	1,490	20	1,420	1,439	75	7.1E-08	0.3	Moderately fractured basalt
3-Jun-08	8412	1	2,005	2,025	20	1,937	1,956	75	3.7E-07	1.4	Volcanoclastics - weathered, mudstone below
15-Jun-08	8412	2	2,567	2,632	65	2,480	2,542	75	5.4E-09	0.0	Fault - Tertiary volcanics
18-Jun-08	8412	3	3,140	3,165	25	3,033	3,057	75	2.4E-08	0.1	Fractures in GD - hole makes water
18-Jun-08	8413	1	4,379	4,471	92	4,379	4,471	90	3.7E-09	0.0	Deep Granodiorite
9-Jun-08	8415	1	1,842	1,864	22	1,779	1,800	75	1.9E-08	0.1	Altered volcanoclastics
30-Jun-08	8415	2	2,694	2,837	143	2,602	2,740	75	1.6E-06	3.6	ZG1 Fault - Volc x Granodiorite
30-Jun-08	8415	3	2,754	2,837	83	2,660	2,740	75	8.3E-08	0.2	Granodiorite below contact
24-Jul-08	8417	1	1,177	1,470	293	1,177	1,470	90	1.1E-08	0.1	Sediments-volcanics
25-Jul-08	8418	1	490	500	10	444	453	65	3.9E-09	0.0	Representative/Volcanics
26-Jul-08	8418	2	686	700	14	622	634	65	3.0E-08	0.1	Representative/Volcanics
28-Jul-08	8418	3	941	950	9	853	861	65	4.8E-09	0.1	Representative/Volcanics
30-Jul-08	8418	4	1,191	1,200	9	1,079	1,088	65	1.1E-05	49.0	Fault - Granodiorite
30-Jul-08	8418	5	1,291	1,300	9	1,170	1,178	65	1.0E-07	0.5	Representative/Granodiorite
5-Aug-08	8418	6	1,691	1,712	21	1,533	1,552	65		*	Granodiorite

TABLE 2
Summary of All Pac er Tests, 2004 through 2008

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Area G	GH04-25	125	185	1.2E-06	TB	Basalt
Area G	GH06-66	24	69	no take	R	Basalt
Area G	GH06-66	69	88	no take	R	Basalt
Area G	GH06-67	68	123	1.6E-09	TB	Basalt
Area G	GH06-68	54	84	2.3E-08	R	Gabbro
Area G	GH06-68	84	119	6.8E-09	R	Gabbro
Area G	GH06-69	80	129	5.8E-09	R	Gabbro
Area G	GH06-69	129	160	5.6E-10	R	Gabbro
Area G	GH07-100	40	60	8.0E-07	TX	Tertiary Breccia
Area G	GH07-100	60	80	3.9E-07	TX	Tertiary Breccia
Area G	GH07-100	80	100	1.6E-07	TX	Tertiary Breccia
Area G	GH07-100	100	120	---	TX	Tertiary Breccia
Area G	GH07-100	120	140	6.6E-08	TX	Tertiary Breccia
Area G	GH07-100	140	160	7.4E-08	TX	Tertiary Breccia
Area G	GH07-100	160	180	> 30 gal/min	TX	Tertiary Breccia
Area G	GH07-101	39.5	69.5	3.6E-08	TB	Basalt
Area G	GH07-101	69.5	99.5	2.6E-08	TB	Basalt
Area G	GH07-101	99.5	119.5	3.0E-08	TB	Basalt
Area G	GH07-103S	95	135	1.4E-08	TB	Basalt
Area G	GH07-81	44.5	99.5	1.6E-07	M	Granodiorite
Area G	GH07-81	100	129.5	2.1E-08	M	Granodiorite
Area G	GH07-81	130	164.5	1.9E-09	M	Granodiorite
Area G	GH07-82D	130	155	---	TB	Basalt
Area G	GH07-82D	155	175	---	TB	Basalt
Area G	GH07-82D	175	195	---	TB	Basalt
Area G	GH07-82D	195	215	---	TB	Basalt
Area G	GH07-83D	95	115	---	M/Y/G	Granodiorite
Area G	GH07-83D	115	134.5	No take	M/Y/G	Siltstone
Area G	GH07-83D	134.5	164.5	No take	M/Y/G	Granodiorite
Area G	GH07-83D	50	68	2.1E-07	M/Y/G	Siltstone
Area G	GH07-83S	28.5	55	No take	M/Y/G	Siltstone
Area G	GH07-83S	55	75	---	M/Y/G	Siltstone
Area G	GH07-83S	75	95	---	M/Y/G	Siltstone
Area G	GH07-83S	6	23	6.5E-07	M/Y/G	Siltstone
Area G	GH07-84	20.5	44.5	1.9E-08	Y	Cretaceous Sandstone
Area G	GH07-84	44.5	65.5	---	Y	Cretaceous Sandstone
Area G	GH07-84	65.5	85.5	---	Y	Cretaceous Sandstone

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Area G	GH07-84	85.5	105	---	Y	Cretaceous Sandstone
Area G	GH07-84	105	135	---	Y	Cretaceous Sandstone
Area G	GH07-84	135	165	---	Y	Cretaceous Sandstone
Area G	GH07-85	25	50	6.4E-08	YW	Cretaceous Mudstone to Sandstone
Area G	GH07-85	75	95	---	YW	Cretaceous Mudstone to Sandstone
Area G	GH07-85	95	125	---	YW	Cretaceous Mudstone to Sandstone
Area G	GH07-85	125	154.5	---	YW	Cretaceous Mudstone to Sandstone
Area G	GH07-86	30	60	---	M	Granodiorite
Area G	GH07-86	60	100	3.7E-08	M	Granodiorite
Area G	GH07-86	100	130	2.8E-09	M	Granodiorite
Area G	GH07-86	125	165	---	M	Granodiorite
Area G	GH07-86	7	24	5.1E-06	M	Granodiorite
Area G	GH07-87D	100	140	4.0E-08	G	Granodiorite
Area G	GH07-87D	140	160	1.9E-07	G	Granodiorite
Area G	GH07-87D	160	180	9.5E-09	G	Granodiorite
Area G	GH07-87D	240	260	1.5E-08	G	Granodiorite
Area G	GH07-88	15	35	8.9E-08	R	Gabbro
Area G	GH07-88	35	55	no take	R	Gabbro
Area G	GH07-88	62	85	---	R	Gabbro
Area G	GH07-88	85	115	---	R	Gabbro
Area G	GH07-88	115	155	5.3E-09	R	Gabbro
Area G	GH07-89D	130	147.6	---	M/G	Granodiorite
Area G	GH07-90D	30	50	4.6E-08	M	Granodiorite
Area G	GH07-90D	50	75	4.7E-07	M	Granodiorite
Area G	GH07-90D	95	115	>20 gal/min	M	Granodiorite
Area G	GH07-90D	115	135	2.7E-07	M	Granodiorite
Area G	GH07-90D	150	170	3.4E-07	M	Granodiorite
Area G	GH07-90S	15	35	9.5E-07	M	Granodiorite
Area G	GH07-91	30	50	2.6E-08	M/TB	Granodiorite
Area G	GH07-91	50	70	1.5E-08	M/TB	Granodiorite
Area G	GH07-91	70	90	1.3E-08	M/TB	Granodiorite
Area G	GH07-91	85	110	8.7E-08	M/TB	Granodiorite
Area G	GH07-91	110	130	6.1E-08	M/TB	Granodiorite
Area G	GH07-91	130	155	6.0E-08	M/TB	Granodiorite
Area G	GH07-92D	80	100	1.2E-10	Mx	Granodiorite
Area G	GH07-92D	100	120	2.1E-09	Mx	Granodiorite
Area G	GH07-92D	120	140	---	Mx	Granodiorite

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Area G	GH07-92D	140	160	4.8E-09	Mx	Granodiorite
Area G	GH07-93	55	80	1.3E-07	TA/TX/TD	Andesite
Area G	GH07-93	80	100	5.8E-07	TA/TX/TD	Andesite
Area G	GH07-93	100	124.5	4.7E-07	TA/TX/TD	Andesite
Area G	GH07-93	120	140	1.2E-07	TA/TX/TD	Andesite
Area G	GH07-93	140	160	6.7E-07	TA/TX/TD	Andesite
Area G	GH07-93	160	185	---	TA/TX/TD	Andesite
Area G	GH07-93	185	205	1.4E-07	TA/TX/TD	Andesite
Area G	GH07-94	39	59	3.2E-08	M	Granodiorite
Area G	GH07-94	59	79	2.8E-07	M	Granodiorite
Area G	GH07-94	79	99	7.7E-08	M	Granodiorite
Area G	GH07-94	99	119	3.4E-08	M	Granodiorite
Area G	GH07-94	119	139	---	M	Granodiorite
Area G	GH07-95	30	50	1.3E-06	TX	Tertiary Breccia
Area G	GH07-95	50	70	1.2E-06	TX	Tertiary Breccia
Area G	GH07-95	70	90	1.0E-06	TX	Tertiary Breccia
Area G	GH07-95	90	110	4.5E-07	TX	Tertiary Breccia
Area G	GH07-95	110	130	6.7E-07	TX	Tertiary Breccia
Area G	GH07-96D	115	135	8.2E-09	TX	Tertiary Breccia
Area G	GH07-96D	135	155	7.9E-09	TX	Tertiary Breccia
Area G	GH07-96D	155	175	1.7E-07	TX	Tertiary Breccia
Area G	GH07-96D	175	195	1.5E-07	TX	Tertiary Breccia
Area G	GH07-97D	95	115	4.2E-07	TX	Tertiary Breccia
Area G	GH07-97D	115	135	1.1E-08	TX	Tertiary Breccia
Area G	GH07-97D	115	135	1.5E-08	TX	Tertiary Breccia
Area G	GH07-97D	155	175	>20 gal/min	TX	Tertiary Breccia
Area G	GH07-98D	129.5	149.5	---	TX/M	Granodiorite
Area G	GH07-98D	149.5	169.5	---	TX/M	Granodiorite
Area G	GH07-98D	169.5	189.5	1.2E-07	TX/M	Granodiorite
Area G	GH07-98D	189.5	209.5	1.9E-08	TX/M	Granodiorite
Area G	GH07-98D	209.5	249.5	1.6E-07	TX/M	Granodiorite
Area G	GH07-99	24.5	44.5	4.4E-09	M	Granodiorite
Area G	GH07-99	44.5	70	---	M	Granodiorite
Area G	GH07-99	70	90	3.3E-08	M	Granodiorite
Area G	GH07-99	90	110	1.3E-08	M	Granodiorite
Area G	GH07-99	110	135	>15 gal/min	M	Granodiorite
Area G	GH07-99	135	160	---	M	Granodiorite
Area G	GH08-138	29	105	---	b/r	
Area G	GH08-138	99	170	---	b/r	

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Area G	GH08-138	169	275	---	b/r	
Area G	GH08-141	15	40	4.9E-08	b/r	
Area G	GH08-141	39	65	---	b/r	
Area G	GH08-141	64	87	1.4E-07	b/r	
Area G	GH08-144	19	45	1.7E-06	b/r	
Area G	GH08-144	44	70	No Take	b/r	
Area G	GH08-144	69	95	No Take	b/r	
Area G	GH08-146	19	45	2.0E-07	b/r	
Area G	GH08-146	44	70	---	b/r	
Area G	GH08-146	64	105	---	b/r	
Area G	GH08-148	34	60	---	b/r	
Area G	GH08-148	59	85	No Take	b/r	
Area G	GH08-148	84	110	2.2E-08	b/r	
Area G	GH08-148	109	135	---	b/r	
Area G	GH08-148	134	175	---	b/r	
Area G	GH08-148	164	243	3.4E-08	b/r	
Area G	GH08-151	89	115	---	b/r	
Area G	GH08-151	109	140	6.3E-07	b/r	
Area G	GH08-151	129	170	---	b/r	
Area G	GH08-151	164	215	---	b/r	
Area G	GH08-151	199	280	---	b/r	
Area G	GH08-156	29	65	No Take	b/r	
Area G	GH08-156	64	95	---	b/r	
Area G	GH08-156	94	155	---	b/r	
Area G	GH08-156	154	180	1.4E-07	b/r	
Area G	GH08-158	29	64	1.3E-07	b/r	
Area G	GH08-158	64	105		b/r	
Area G	GH08-158	104	145	---	b/r	
Area G	GH08-158	144	185	---	b/r	
Area G	GH08-158	185	220	No Take	b/r	
Area G	GH08-158	219	260	No Take	b/r	
Area G	GH08-158	259	300	---	b/r	
Area G	GH08-158	299	340	---	b/r	
Area G	GH08-158	339	395	---	b/r	
Area G	GH08-158	394	435	8.7E-08	b/r	
Area G	GH08-158	434	475	---	b/r	
Area G	GH08-158	474	500	No Take	b/r	
Area G	GH08-163	34	60	---	b/r	
Area G	GH08-163	55	90	---	b/r	

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Area G	GH08-163	154	190	---	b/r	
Area G	GH08-163	184	215	---	b/r	
Area G	GH08-166	204	235	1.5E-07	b/r	
Area G	GH08-168	294	335		b/r	
Area G	GH08-169	109	160	---	b/r	
Area G	GH08-169	159	225	---	b/r	
Area G	GH08-169	230	300	---	b/r	
Area G	GH08-169	305	350	---	b/r	
Area G	GH08-169	449.5	499.5	---	b/r	
Area G	GH08-187	84	105	8.3E-07	b/r	
Area G	GH08-187	104	135	---	b/r	
Area G	GH08-188	19	55	---	b/r	
Area G	GH08-188	59	85	1.2E-06	b/r	
Deposit Area	5326	68	93	2.5E-06	b/r	Tertiary andesitic siltstone
Deposit Area	5326	93	111	6.6E-07	b/r	Tertiary andesitic siltstone
Deposit Area	5326	111	128	4.1E-07	b/r	Tertiary siltstone
Deposit Area	5326	145	163	5.3E-08	b/r	Tertiary siltstone
Deposit Area	5326	163	180	1.4E-07	b/r	Tertiary siltstone
Deposit Area	5326	206	232	6.0E-07	b/r	Tertiary andesitic siltstone
Deposit Area	5326	301	345	2.7E-07	b/r	Tertiary conglomerate/mudstone
Deposit Area	5326	345	388	4.7E-09	b/r	Tertiary conglomerate/mudstone
Deposit Area	5326	388	431	4.8E-07	b/r	Tertiary andesitic siltstone
Deposit Area	5326	431	474	7.2E-08	b/r	Tertiary andesitic siltstone
Deposit Area	5326	474	518	4.7E-08	b/r	Tertiary mudstone/conglomerate
Deposit Area	5327	266	283	1.4E-06	b/r	Tertiary formation
Deposit Area	5327	309	326	2.2E-07	b/r	Tertiary formation
Deposit Area	5327	353	353	6.3E-07	b/r	Tertiary formation
Deposit Area	5327	404	422	2.4E-06	b/r	Tertiary formation
Deposit Area	5327	448	465	2.2E-07	b/r	Tertiary formation
Deposit Area	5327	534	552	2.1E-07	b/r	Tertiary formation
Deposit Area	5328	198	216	3.4E-09	b/r	Tertiary formation
Deposit Area	5328	306	324	1.2E-09	b/r	Tertiary formation
Deposit Area	8410	1935	1950	4.0E-06	b/r	Fractured zone, volcanoclastics

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Deposit Area	8410	2391	2455	1.3E-06	b/r	ZG1 Fault, Basalt x GD contact
Deposit Area	8412	1420	1439	7.1E-08	b/r	Moderately fractured basalt
Deposit Area	8412	1937	1956	3.7E-07	b/r	Volcanoclastics
Deposit Area	8412	2480	2542	5.4E-09	b/r	Fault - Tertiary volcanics
Deposit Area	8412	3033	3057	2.4E-08	b/r	Fractures in GD - hole makes water
Deposit Area	8413	4379	4471	3.7E-09	b/r	Granodiorite
Deposit Area	8415	1779	1800	1.9E-08	b/r	Altered volcanoclastics
Deposit Area	8415	2602	2740	1.6E-06	b/r	ZG1 Fault - Volc x Granodiorite
Deposit Area	8415	2660	2740	8.3E-08	b/r	Granodiorite
Deposit Area	8417	1177	1470	1.1E-08	b/r	Sediments-volcanics
Deposit Area	8418	444	453	3.9E-09	b/r	Representative / Volcanics
Deposit Area	8418	622	634	3.0E-08	b/r	Representative / Volcanics
Deposit Area	8418	853	861	4.9E-09	b/r	Representative / Volcanics
Deposit Area	8418	1079	1088	---	b/r	Granodiorite
Deposit Area	8418	1170	1178	1.0E-07	b/r	Representative / Granodiorite
Deposit Area	8418	1533	1552	leak	b/r	Granodiorite
Deposit Area	GH04-26	35	135	2.1E-06	TY/TW	Wacke 35' to 45'; Siltstone to 135'
Deposit Area	GH04-27	55	125	8.6E-07	TY	Siltstone
Deposit Area	GH05-57	25	125	2.0E-08	G	Granodiorite
Deposit Area	GH05-58	55	155	6.3E-09	Y/G	Andesite 35' to 83'; Granodiorite to 155'
Deposit Area	GH06-80	189	217	4.8E-08	TB	Basalt
Deposit Area	GH08-107	64	90	---	b/r	
Deposit Area	GH08-107	89	115	3.8E-07	b/r	
Deposit Area	GH08-107	114	145	2.7E-07	b/r	
Deposit Area	GH08-107	144	170	3.3E-07	b/r	
Deposit Area	GH08-107	169	205	1.6E-08	b/r	
Deposit Area	GH08-107	204	229.5	7.7E-09	b/r	
Deposit Area	GH08-107	229	255.5	2.6E-08	b/r	
Deposit Area	GH08-107	254	279.5	4.7E-08	b/r	
Deposit Area	GH08-107	279	305	3.7E-07	b/r	
Deposit Area	GH08-107	309	330	2.9E-06	b/r	
Deposit Area	GH08-107	329	355	9.0E-07	b/r	

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Deposit Area	GH08-108	44	75	3.9E-06	b/r	
Deposit Area	GH08-112	109	135	1.8E-07	b/r	
Deposit Area	GH08-112	134	160	3.7E-08	b/r	
Deposit Area	GH08-112	159	185	3.1E-07	b/r	
Deposit Area	GH08-112	189	210	4.6E-07	b/r	
Deposit Area	GH08-112	205	235	---	b/r	
Deposit Area	GH08-112	259	285	---	b/r	
Deposit Area	GH08-112	294	320	---	b/r	
Deposit Area	GH08-112	319	345	4.8E-07	b/r	
Deposit Area	GH08-112	355	380	6.0E-08	b/r	
Deposit Area	GH08-128	154	180	---	b/r	
Deposit Area	GH08-128	204	230	---	b/r	
Deposit Area	GH08-128	229	255	---	b/r	
Deposit Area	KP-01	167	228	2.1E-07	b/r	Cretaceous mudstone
Deposit Area	KP-01	245	323	3.7E-08	b/r	Cretaceous mudstone
Deposit Area	KP-01	321	427	4.8E-08	b/r	Cretaceous mudstone
Deposit Area	KP-01	419	557	1.5E-07	b/r	Cretaceous mudstone
Deposit Area	KP-01	557	669	2.5E-08	b/r	Cretaceous mudstone
Deposit Area	KP-01	670	782	4.5E-08	b/r	Porphyritic monzonite
Deposit Area	KP-01	795	908	5.3E-10	b/r	Cretaceous mudstone
Deposit Area	KP-01	1038	1168	6.6E-09	b/r	Porphyritic monzonite
Deposit Area	KP-02	133	191	1.5E-08	b/r	Cretaceous siltstone
Deposit Area	KP-02	340	410	4.1E-07	b/r	Diorite
Deposit Area	KP-02	471	557	4.6E-08	b/r	Diorite
Deposit Area	KP-02A	77	158	1.4E-06	b/r	Granodiorite
Deposit Area	KP-02A	158	279	8.7E-07	b/r	Granodiorite
Deposit Area	KP-02A	279	408	7.4E-08	b/r	Diorite
Deposit Area	KP-02A	457	586	1.4E-09	b/r	Diorite
Deposit Area	KP-02A	586	716	3.4E-08	b/r	Diorite
Deposit Area	KP-02A	716	846	3.5E-08	b/r	Diorite
Deposit Area	KP-02A	846	976	9.4E-11	b/r	Diorite
Deposit Area	KP-02A	976	1150	2.8E-09	b/r	Diorite
Deposit Area	KP-04	144	189	6.4E-07	b/r	Cretaceous siltstone
Deposit Area	KP-04	245	275	1.0E-07	b/r	Cretaceous siltstone
Deposit Area	KP-04	272	293	2.5E-08	b/r	Cretaceous siltstone
Deposit Area	KP-04	284	301	1.3E-08	b/r	Cretaceous siltstone
Deposit Area	KP-04	300	315	2.6E-08	b/r	Cretaceous siltstone
Deposit Area	KP-04	315	340	6.7E-09	b/r	Cretaceous siltstone
Deposit Area	KP-04	499	513	5.0E-08	b/r	Cretaceous mudstone

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Deposit Area	KP-04	515	531	4.6E-08	b/r	Cretaceous mudstone
Deposit Area	KP-04	568	609	1.7E-09	b/r	Cretaceous mudstone
Deposit Area	KP-04	602	661	2.0E-08	b/r	Granodiorite
Deposit Area	KP-04	663	799	3.2E-09	b/r	Cretaceous mudstone
Deposit Area	KP-04	994	1168	1.0E-08	b/r	Granodiorite
Deposit Area	KP-04	973	1345	2.5E-08	b/r	Cretaceous mudstone
Deposit Area	KP-05A	542	690	3.9E-08	b/r	Diorite
Deposit Area	KP-05A	671	757	4.5E-08	b/r	Diorite
Deposit Area	KP-05A	802	975	1.3E-08	b/r	Granodiorite
Deposit Area	KP-05A	958	1127	5.0E-09	b/r	Granodiorite
Deposit Area	KP-06	156	286	8.2E-07	b/r	Monzonite
Deposit Area	KP-06	292	394	2.1E-07	b/r	Cretaceous mudstone
Deposit Area	KP-06	394	515	2.1E-07	b/r	Monzonite
Deposit Area	KP-06	515	602	3.2E-08	b/r	Monzonite
Deposit Area	KP-06	606	710	4.7E-08	b/r	Monzonite
Deposit Area	KP-06	896	1000	6.0E-08	b/r	Monzonite
Deposit Area	KP-06	1000	1113	3.9E-07	b/r	Monzonite
Deposit Area	KP-08	254	323	8.2E-07	b/r	Monzonite
Deposit Area	KP-08	297	394	8.4E-07	b/r	Monzonite
Deposit Area	KP-08	423	535	2.8E-06	b/r	Monzonite
Deposit Area	KP-08	522	635	1.8E-07	b/r	Cretaceous mudstone
Deposit Area	KP-08	570	657	3.7E-09	b/r	Cretaceous mudstone
Deposit Area	KP-08	661	789	8.3E-10	b/r	Monzonite
Deposit Area	KP-08	795	908	1.7E-08	b/r	Monzonite
Deposit Area	KP-08	1003	1211	2.5E-08	b/r	Monzonite
Frying Pan Lake	GH04-28	45	145	3.1E-06	M	Granodiorite
Frying Pan Lake	GH04-31	95	195	9.7E-08	TD	Latite
Frying Pan Lake	GH04-41	25	125	4.5E-06	TY/TW	Tertiary Sedimentary Brecciated rock
Frying Pan Lake	GH04-45A	125	225	9.4E-07	D	Diorite
Frying Pan Lake	GH04-46	35	135	2.1E-06	TD/TY/TA	Andesite
Frying Pan Lake	GH04-47	185	270	2.9E-06	TD	Latite
Frying Pan Lake	GH05-51	305	395	2.2E-08	G	Granodiorite
Frying Pan Lake	GH05-52	207	307	1.0E-09	Y	Bedded Andesites
Frying Pan Lake	GH05-53	35	135	1.8E-08	Y	Bedded Andesites
Frying Pan Lake	GH05-54	25	125	1.3E-07	Y	Bedded Andesites
Frying Pan Lake	GH05-55	25	125	1.9E-08	D	Diorite
Frying Pan Lake	GH05-56	45	145	1.2E-08	D/G/Y	Diorite/Granodiorite
Frying Pan Lake	GH05-59	95	175	7.4E-08	G	Granodiorite
Frying Pan Lake	GH05-60	145	245	9.0E-09	G	Granodiorite

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
Frying Pan Lake	GH05-61	205	305	1.6E-09	G	Granodiorite
Frying Pan Lake	GH05-63	35	135	1.2E-08	D	Diorite
Frying Pan Lake	GH05-64	85	185	9.1E-10	Y/C	Bedded Andesite
Frying Pan Lake	GH06-74	85	140	2.2E-08	TB	Basalt
Frying Pan Lake	GH06-76	215	275	1.1E-08	G/TA	Granodiorite
Frying Pan Lake	GH08-133	15	45	2.4E-06	b/r	
Frying Pan Lake	GH08-133	44	70	No Take	b/r	
Frying Pan Lake	GH08-133	69	95	No Take	b/r	
Frying Pan Lake	GH08-135	19	45	No Take	b/r	
Frying Pan Lake	GH08-135	30	70	No Take	b/r	
Frying Pan Lake	GH08-135	69	95	No Take	b/r	
Frying Pan Lake	GH08-136	19	45	---	b/r	
Frying Pan Lake	GH08-136	49	70	---	b/r	
Frying Pan Lake	GH08-136	69	95	---	b/r	
Frying Pan Lake	GH08-136	94	120	7.9E-08	b/r	
Frying Pan Lake	GH08-137	120	150	3.3E-07	b/r	
Frying Pan Lake	GH08-137	204	230	---	b/r	
Frying Pan Lake	GH08-196	24	105	---	b/r	
Frying Pan Lake	GH08-204	189	215	2.0E-06	b/r	
Frying Pan Lake	GH08-207D	79	115	---	b/r	
Frying Pan Lake	GH08-207S	29	55	5.2E-06	b/r	
Frying Pan Lake	GH08-207S	54	80	5.8E-06	b/r	
Frying Pan Lake	GH08-209	94	120	4.5E-06	b/r	
Frying Pan Lake	GH08-209	119	145	---	b/r	
Frying Pan Lake	GH08-210D	119	145	---	b/r	
Frying Pan Lake	GH08-210S	94	120	---	b/r	
North Fork Koktuli	GH08-178	154	260	---	b/r	
North Fork Koktuli	GH08-179	140	165	3.7E-08	b/r	
North Fork Koktuli	GH08-179	165	190	---	b/r	
North Fork Koktuli	GH08-179	190	215	---	b/r	
North Fork Koktuli	GH08-180	89	135	No Take	b/r	
North Fork Koktuli	GH08-180	125	190	---	b/r	
North Fork Koktuli	GH08-180	199	240	---	b/r	
North Fork Koktuli	GH08-181D	94	120	No Take	b/r	
North Fork Koktuli	GH08-181S	32	85	No Take	b/r	
North Fork Koktuli	GH08-182	64	90	No Take	b/r	
North Fork Koktuli	GH08-182	89	115	No Take	b/r	
North Fork Koktuli	GH08-182	115	140	No Take	b/r	
North Fork Koktuli	GH08-182	139	165	No Take	b/r	

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
North Fork Koktuli	GH08-183	44	70	---	b/r	
North Fork Koktuli	GH08-189D	289	315	No Take	b/r	
North Fork Koktuli	GH08-189D	304	350	---	b/r	
North Fork Koktuli	GH08-189S	234	260	---	b/r	
North Fork Koktuli	GH08-189S	234	290	2.0E-08	b/r	
North Fork Koktuli	GH08-192	89	115	---	b/r	
North Fork Koktuli	GH08-192	119	145	No Take	b/r	
North Fork Koktuli	GH08-192	149	170	No Take	b/r	
North Fork Koktuli	GH08-192	169	195	No Take	b/r	
North Fork Koktuli	GH08-192	194	220	No Take	b/r	
North Fork Koktuli	GH08-192	219	255	No Take	b/r	
North Fork Koktuli	GH08-194	104	130	9.3E-07	b/r	
North Fork Koktuli	GH08-194	129	155	3.6E-07	b/r	
North Fork Koktuli	GH08-194	154	180	No Take	b/r	
North Fork Koktuli	GH08-194	179	205	8.7E-07	b/r	
North Fork Koktuli	GH08-194	189	225	7.8E-07	b/r	
North Fork Koktuli	GH08-198	64	90	---	b/r	
North Fork Koktuli	GH08-198	89	115	---	b/r	
North Fork Koktuli	GH08-198	114	140	No Take	b/r	
North Fork Koktuli	GH08-198	139	165	No Take	b/r	
North Fork Koktuli	GH08-198	164	200	No Take	b/r	
South Fork Koktuli	GH04-38	95	190	3.5E-06	TY/G	Andesitic Mud/Siltstone
South Fork Koktuli	GH04-40A	194	255	1.1E-06	TA	Andesite
South Fork Koktuli	GH08-139	19	45	---	b/r	
South Fork Koktuli	GH08-139	49	75	No Take	b/r	
South Fork Koktuli	GH08-139	74	125	No Take	b/r	
South Fork Koktuli	GH08-140	50	80	---	b/r	
South Fork Koktuli	GH08-140	79	105	1.3E-07	b/r	
South Fork Koktuli	GH08-140	104	135	---	b/r	
South Fork Koktuli	GH08-142	140	164.5	---	b/r	
South Fork Koktuli	GH08-143	49	75	2.1E-06	b/r	
South Fork Koktuli	GH08-143	100	125	---	b/r	
South Fork Koktuli	GH08-143	125	150	---	b/r	
South Fork Koktuli	GH08-143	204	230	4.4E-07	b/r	
South Fork Koktuli	GH08-143	229	255	---	b/r	
South Fork Koktuli	GH08-143	254	280	6.0E-07	b/r	
South Fork Koktuli	GH08-143	314	335	7.9E-08	b/r	
South Fork Koktuli	GH08-143	304	335	7.2E-07	b/r	
South Fork Koktuli	GH08-145	25	50	2.1E-07	b/r	

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
South Fork Koktuli	GH08-145	35	60	1.3E-07	b/r	
South Fork Koktuli	GH08-145	60	85	3.5E-08	b/r	
South Fork Koktuli	GH08-145	85	110	---	b/r	
South Fork Koktuli	GH08-147	24.5	49.5	---	b/r	
South Fork Koktuli	GH08-147	49.5	74.5	5.0E-08	b/r	
South Fork Koktuli	GH08-147	73.2	104.7	1.8E-07	b/r	
South Fork Koktuli	GH08-149	34.5	59.5	1.6E-07	b/r	
South Fork Koktuli	GH08-149	79.5	104.5	---	b/r	
South Fork Koktuli	GH08-150	50	75	1.8E-06	b/r	
South Fork Koktuli	GH08-150	74	100	2.4E-06	b/r	
South Fork Koktuli	GH08-150	105	135	1.1E-06	b/r	
South Fork Koktuli	GH08-150	135	160	---	b/r	
South Fork Koktuli	GH08-150	159	185	2.0E-07	b/r	
South Fork Koktuli	GH08-150	184	210	5.7E-07	b/r	
South Fork Koktuli	GH08-150	210	235	---	b/r	
South Fork Koktuli	GH08-150	235	260	4.7E-07	b/r	
South Fork Koktuli	GH08-150	259	285	4.9E-07	b/r	
South Fork Koktuli	GH08-150	284	320	---	b/r	
South Fork Koktuli	GH08-152	23	50	2.2E-07	b/r	
South Fork Koktuli	GH08-152	49	74.5	2.5E-06	b/r	
South Fork Koktuli	GH08-152	74.5	104.5	6.9E-07	b/r	
South Fork Koktuli	GH08-154	64	90	1.5E-07	b/r	
South Fork Koktuli	GH08-154	85	110	---	b/r	
South Fork Koktuli	GH08-154	110	135	3.8E-08	b/r	
South Fork Koktuli	GH08-154	145	165	---	b/r	
South Fork Koktuli	GH08-155	80	140	4.7E-07	b/r	
South Fork Koktuli	GH08-155	139	165	7.8E-07	b/r	
South Fork Koktuli	GH08-155	185	215	5.1E-07	b/r	
South Fork Koktuli	GH08-155	214	240	---	b/r	
South Fork Koktuli	GH08-157	24.5	49.5	5.3E-07	b/r	
South Fork Koktuli	GH08-157	94.5	114.5	2.2E-07	b/r	
South Fork Koktuli	GH08-157	114.5	139.5	2.0E-07	b/r	
South Fork Koktuli	GH08-157	149	298.75	5.9E-08	b/r	
South Fork Koktuli	GH08-159	40	70	4.5E-06	b/r	
South Fork Koktuli	GH08-159	84	110	---	b/r	
South Fork Koktuli	GH08-159	99	135	---	b/r	
South Fork Koktuli	GH08-159	130	160	4.9E-07	b/r	
South Fork Koktuli	GH08-159	155	185	2.2E-07	b/r	
South Fork Koktuli	GH08-159	180	210	5.2E-08	b/r	

Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
South Fork Koktuli	GH08-159	205	235	---	b/r	
South Fork Koktuli	GH08-160	44.5	69.5	8.9E-08	b/r	
South Fork Koktuli	GH08-160	69.5	94.5	---	b/r	
South Fork Koktuli	GH08-160	94.5	119.5	---	b/r	
South Fork Koktuli	GH08-160	119.5	144.5	1.7E-08	b/r	
South Fork Koktuli	GH08-160	144.5	169.5	2.5E-09	b/r	
South Fork Koktuli	GH08-160	169.5	194.5	---	b/r	
South Fork Koktuli	GH08-160	274.5	329.5	4.1E-09	b/r	
South Fork Koktuli	GH08-161	28	55	1.6E-06	b/r	
South Fork Koktuli	GH08-161	49	101	2.3E-07	b/r	
South Fork Koktuli	GH08-162	70	95	---	b/r	
South Fork Koktuli	GH08-162	95	120	---	b/r	
South Fork Koktuli	GH08-162	120	145	9.0E-08	b/r	
South Fork Koktuli	GH08-162	145	170	1.4E-07	b/r	
South Fork Koktuli	GH08-162	170	200	9.9E-08	b/r	
South Fork Koktuli	GH08-170	169	210	2.1E-08	b/r	
South Fork Koktuli	GH08-170	209	250	---	b/r	
South Fork Koktuli	GH08-170	259	300	2.8E-07	b/r	
South Fork Koktuli	GH08-170	334	375	---	b/r	
South Fork Koktuli	GH08-170	374	415	---	b/r	
South Fork Koktuli	GH08-170	414	460	---	b/r	
South Fork Koktuli	GH08-170	459	500	---	b/r	
South Fork Koktuli	GH08-171	74	100	---	b/r	
South Fork Koktuli	GH08-171	130	150	---	b/r	
South Fork Koktuli	GH08-172	94	125	---	b/r	
South Fork Koktuli	GH08-172	124	155	---	b/r	
South Fork Koktuli	GH08-172	174	200	No Take	b/r	
South Fork Koktuli	GH08-172	199	235	---	b/r	
South Fork Koktuli	GH08-173	144	175	1.0E-06	b/r	
South Fork Koktuli	GH08-173	194	220	2.9E-07	b/r	
South Fork Koktuli	GH08-173	164	220	4.6E-07	b/r	
South Fork Koktuli	GH08-174	104	160	---	b/r	
South Fork Koktuli	GH08-175	69	95	2.4E-06	b/r	
South Fork Koktuli	GH08-175	89	120	2.8E-06	b/r	
South Fork Koktuli	GH08-176	64	90	3.0E-06	b/r	
South Fork Koktuli	GH08-176	89	115	1.7E-06	b/r	
South Fork Koktuli	GH08-176	114	145	---	b/r	
South Fork Koktuli	GH08-190	64	85	---	b/r	
South Fork Koktuli	GH08-190	89	115	---	b/r	

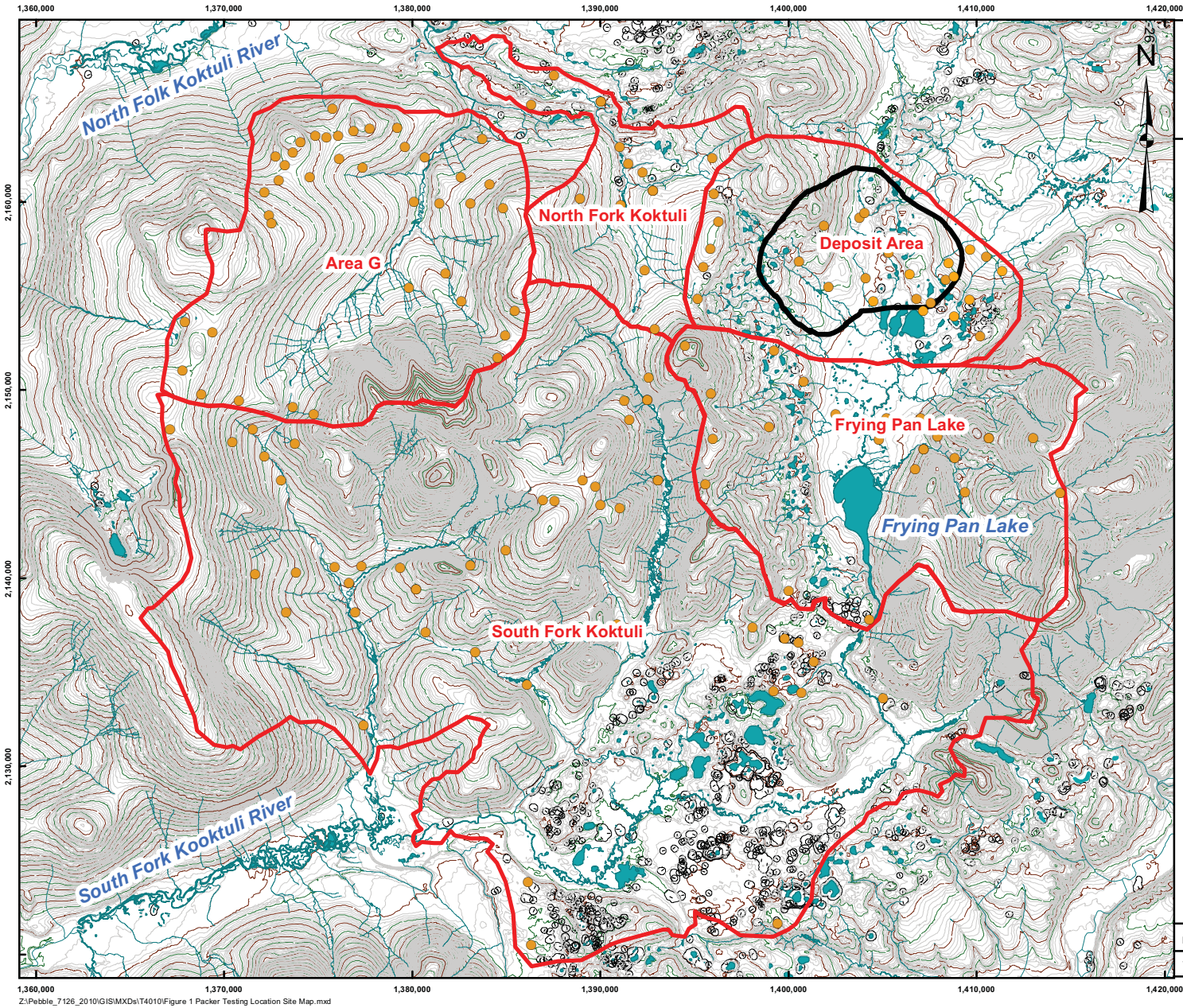
Location_Area	Drillhole #	From (feet)	To (feet)	K (m/s)	Lithocode	Bedrock Type
South Fork Koktuli	GH08-190	119	145	---	b/r	
South Fork Koktuli	GH08-191	104	130	No Take	b/r	
South Fork Koktuli	GH08-191	129	155	No Take	b/r	
South Fork Koktuli	GH08-191	154	180	No Take	b/r	
South Fork Koktuli	GH08-193	44	70	2.8E-07	b/r	
South Fork Koktuli	GH08-193	74	100	No Take	b/r	
South Fork Koktuli	GH08-193	99	125	No Take	b/r	
South Fork Koktuli	GH08-193	124	150	No Take	b/r	
South Fork Koktuli	GH08-195	44	69.75	No Take	b/r	
South Fork Koktuli	GH08-195	74	99.5	---	b/r	
South Fork Koktuli	GH08-195	94	125	No Take	b/r	
South Fork Koktuli	GH08-195	124	165.5	No Take	b/r	
South Fork Koktuli	GH08-197B	44	70	---	b/r	
South Fork Koktuli	GH08-197B	69	100	---	b/r	
South Fork Koktuli	GH08-197B	99	130	1.1E-06	b/r	
South Fork Koktuli	GH08-197B	199	225	1.5E-06	b/r	
South Fork Koktuli	GH08-197B	224	250	3.5E-07	b/r	
South Fork Koktuli	GH08-197B	249	275	6.7E-07	b/r	
South Fork Koktuli	GH08-197B	274	300	1.1E-06	b/r	
South Fork Koktuli	GH08-197B	299	325	9.7E-09	b/r	
South Fork Koktuli	GH08-197B	324	350	---	b/r	
South Fork Koktuli	GH08-197B	349	375	---	b/r	
South Fork Koktuli	GH08-197B	374	400	8.5E-09	b/r	
South Fork Koktuli	GH08-199D	189	245	8.3E-07	b/r	
South Fork Koktuli	GH08-199D	159	245	1.4E-06	b/r	
South Fork Koktuli	GH08-199S	219	245	7.1E-08	b/r	
South Fork Koktuli	GH08-203	54	85	9.4E-07	b/r	
South Fork Koktuli	GH08-203	84	115	4.7E-07	b/r	
South Fork Koktuli	GH08-203	114	140	---	b/r	
South Fork Koktuli	GH08-203	149	170	---	b/r	
South Fork Koktuli	GH08-203	169	195	1.1E-08	b/r	
South Fork Koktuli	GH08-203	194	230	5.1E-09	b/r	
South Fork Koktuli	GH08-205D	109	135	---	b/r	
South Fork Koktuli	GH08-205S	214	240	2.2E-07	b/r	
South Fork Koktuli	GH08-206D	204	230	---	b/r	
South Fork Koktuli	GH08-206D	224	270	---	b/r	
South Fork Koktuli	GH08-206S	179	205	---	b/r	
South Fork Koktuli	GH08-208	69	95	---	b/r	
South Fork Koktuli	GH08-208	94	135	---	b/r	
South Fork Koktuli	GH08-208	134	165	---	b/r	
South Fork Koktuli	GH08-208	164	200	---	b/r	

K (L/T) is hydraulic conductivity which is the rate of flow (L^3/T) through a cross section of unit area (L^2) under a unit hydraulic gradient (dimensionless).

Key To Lithocode :

b/r	Bedrock
C	Quartz-Felsite Pebble Conglomerate
D	Diorite
G	Granodiorite
M	Early Monzonite
Mx	Brecciated Early Monzonite
R	Gabbro
TA	Andesite
TB	Basalt
TD	Dacite
TX	Fragmented Volcanic Rock
TY	Mudstone
TW	Pebble Conglomerate to Sandstone
Y	Mudstone
YW	Mudstone and Wacke

FIGURES



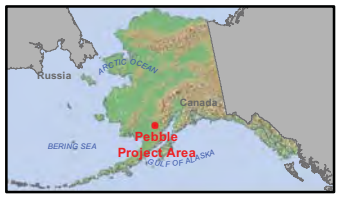
THE pebble PARTNERSHIP

Figure 1
Packer Testing Location Site Map

Appendix 8.1L
Packer Testing Results

Legend

- Packer Testing Location
- Testing Areas
- Deposit Area
- Lakes
- Rivers
- Elevation Contour (Interval 10 feet)



0 2,900 5,800 8,700 11,600 Feet

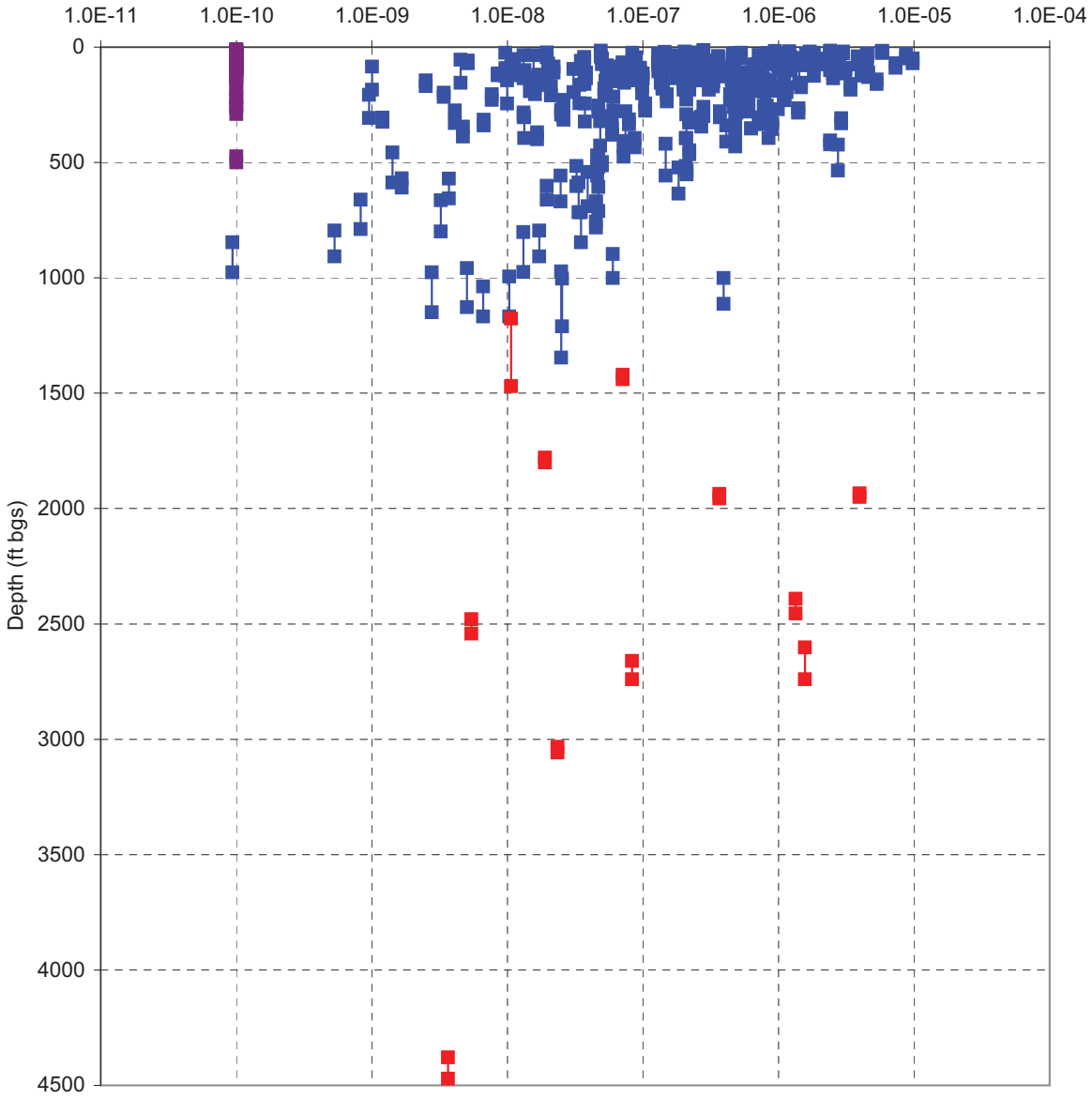
0 840 1,680 2,520 3,360 4,200 Meters

Scale 1:97,531

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T4010\Figure 1 Packer Testing Location Site Map.mxd





Legend

Packer Testing by KP (2004 through 2008)

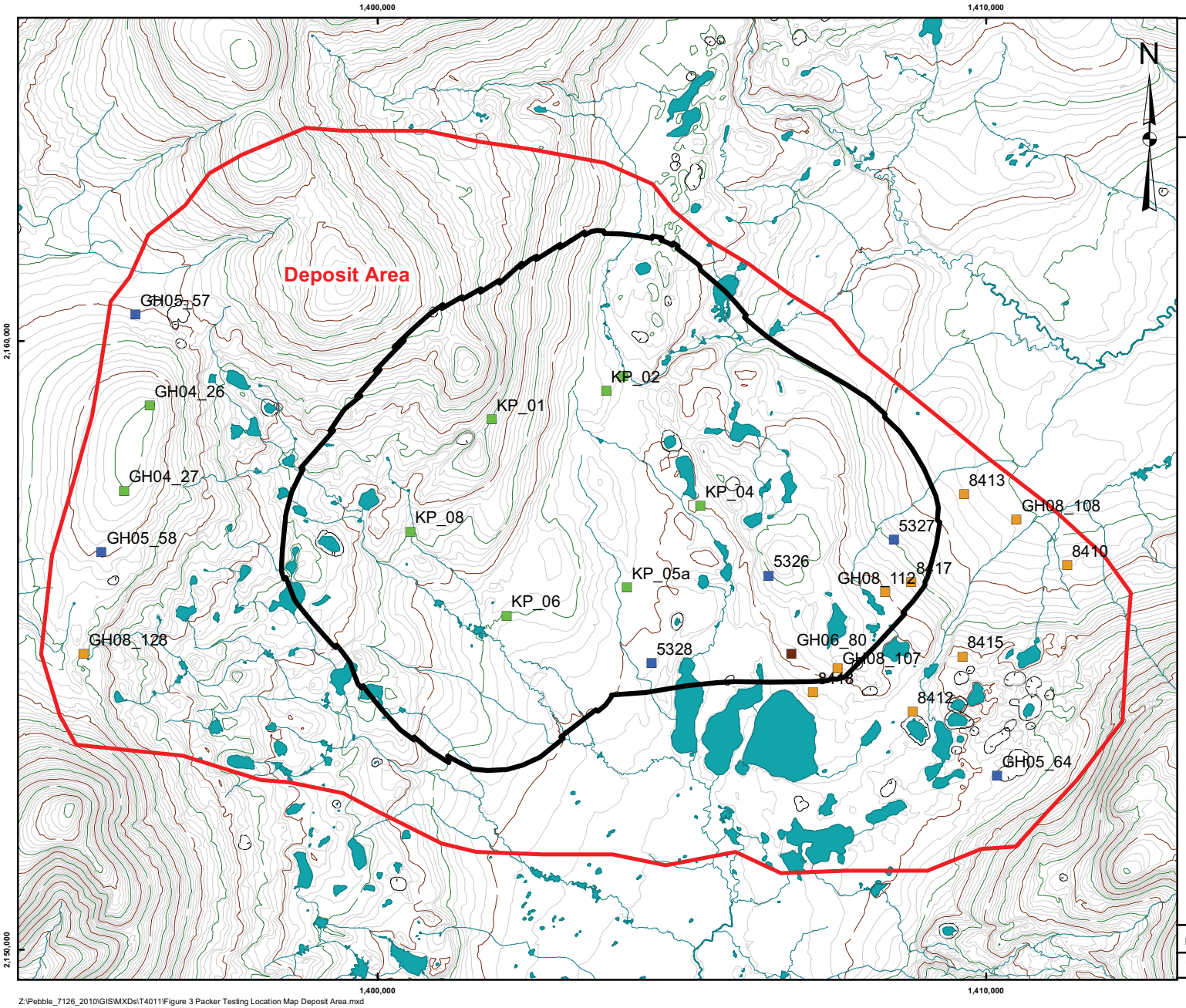
Packer Testing by SLR (2008)

Packer Testing with No Water Take

THE pebble PARTNERSHIP

Figure 2: Packer Testing Results with Depth (All Tests)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010



Z:\Pebble_7126_2010\GIS\MXDs\T4011\Figure 3 Packer Testing Location Map Deposit Area.mxd

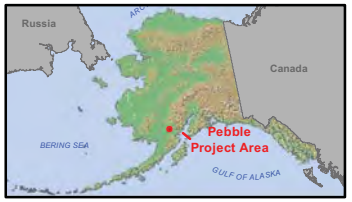
THE pebble PARTNERSHIP

Figure 3
Packer Testing Location Map (Deposit Area)

Appendix 8.1L
Packer Testing Results

Legend

- 2004 Packer Testing Location
- 2005 Packer Testing Location
- 2006 Packer Testing Location
- 2007 Packer Testing Location
- 2008 Packer Testing Location
- Testing Area
- Deposit Area
- Lakes
- Rivers
- Elevation Contour (Interval 10 feet)



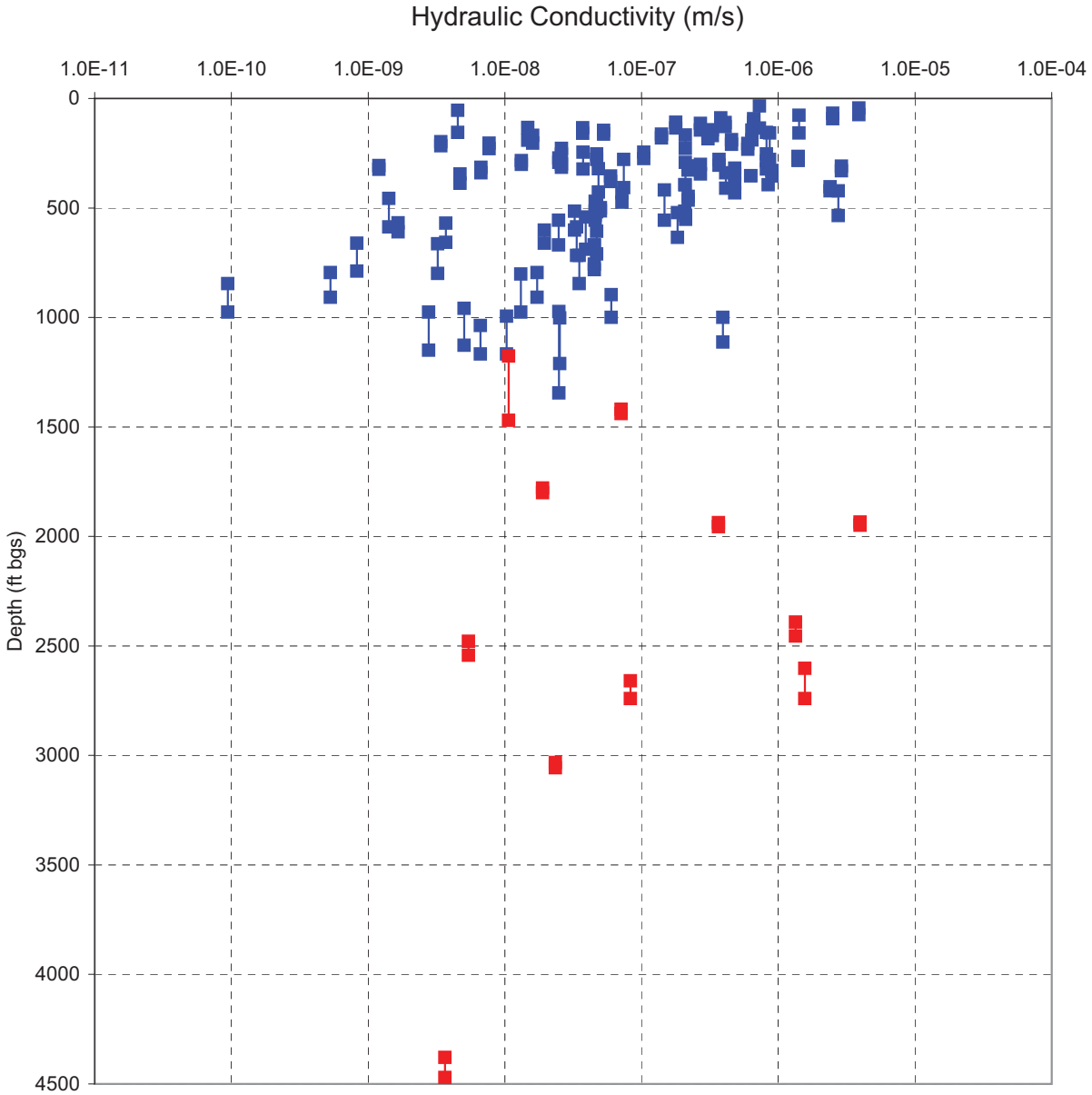
Feet
0 1,000 2,000 3,000 4,000

Meters
0 250 500 750 1,000 1,250

Scale 1:29,204

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL





Legend

Packer Testing by KP (2004 through 2008)

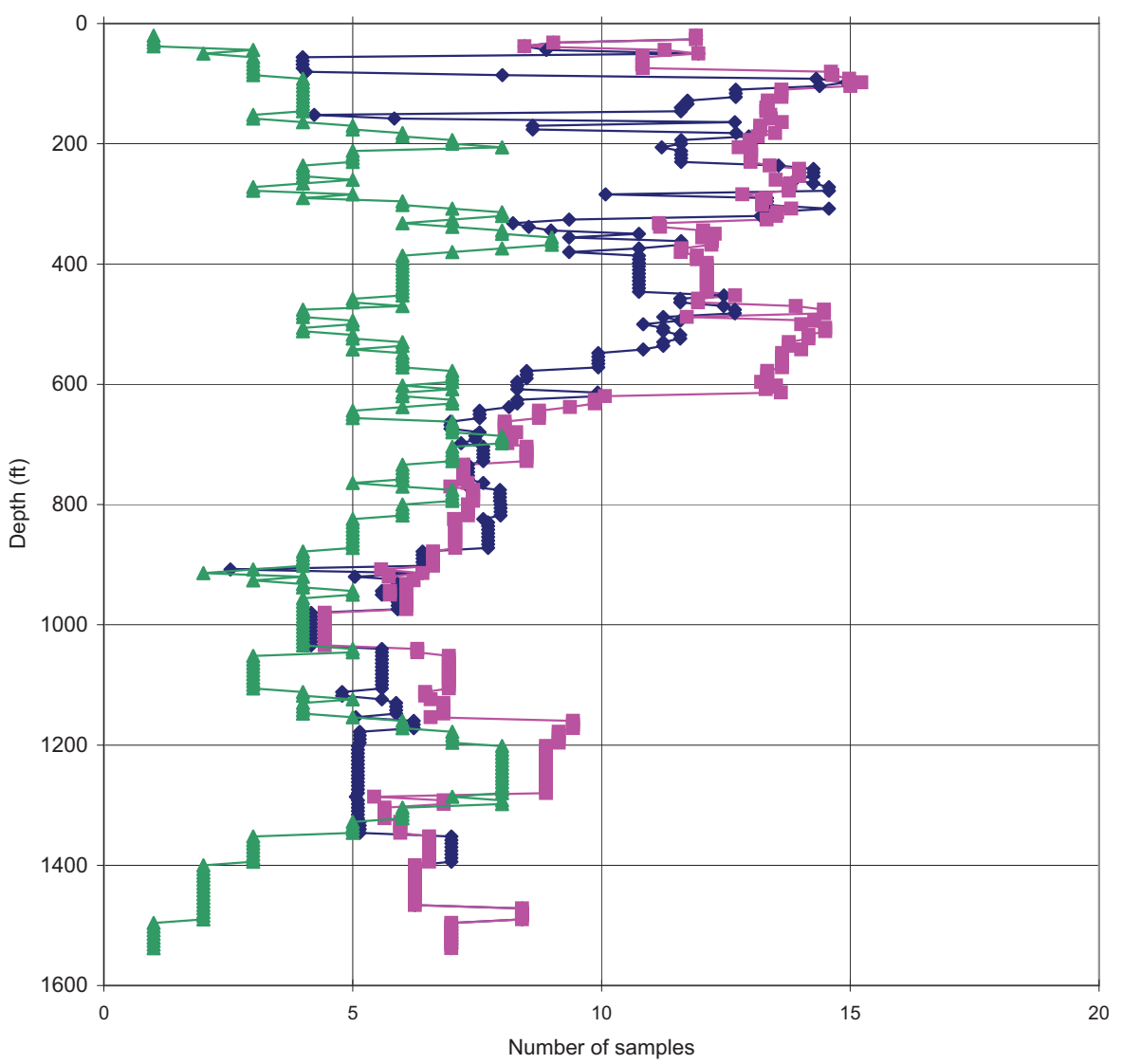
Packer Testing by SLR (2008)

Packer Testing with No Water Take

THE pebble PARTNERSHIP

Figure 4: Packer Testing Results with Depth (Deposit Area)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010





Legend

Median

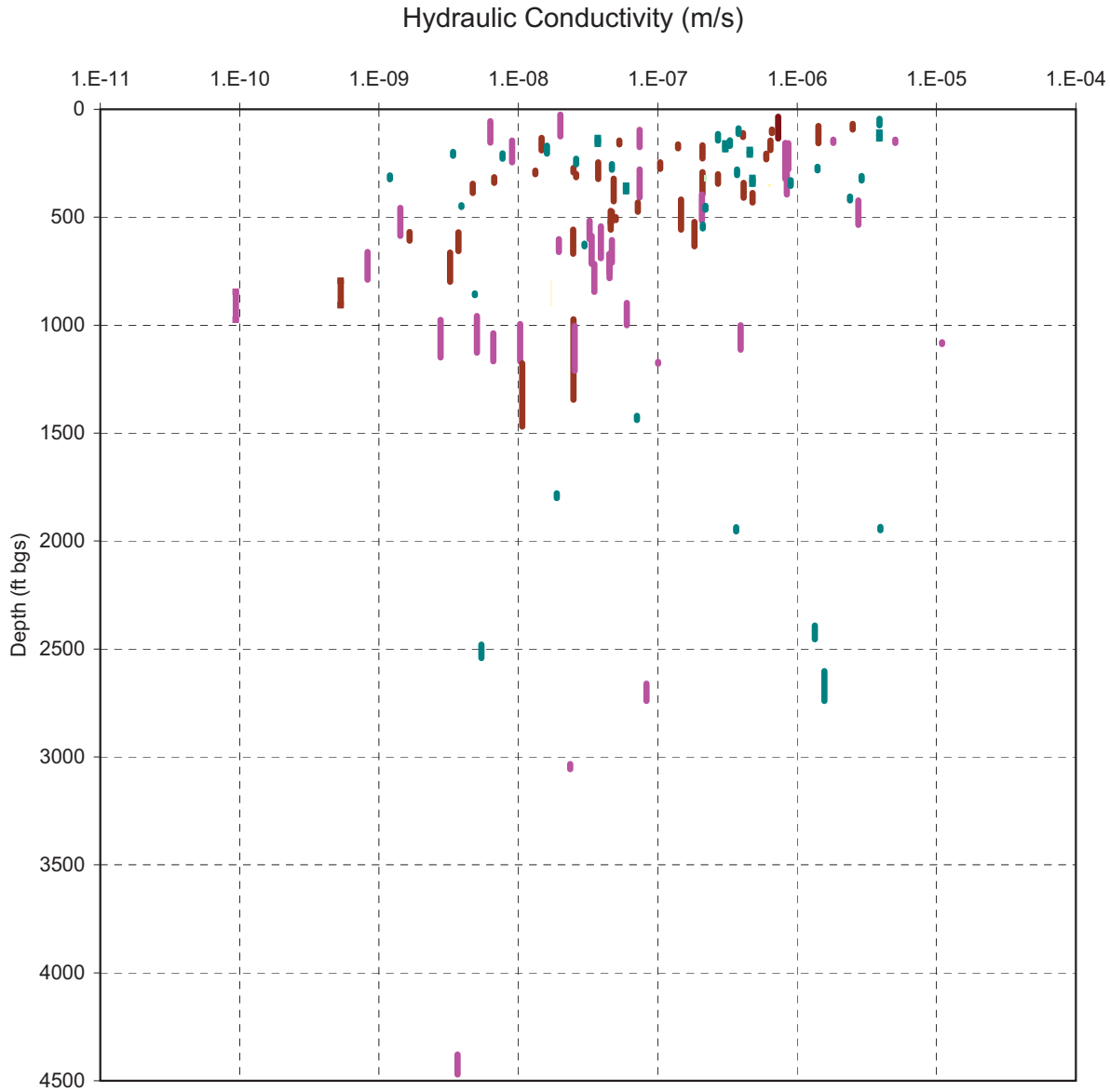
Average

Number of Samples

THE pebble PARTNERSHIP

Figure 5:
Median and Average Packer Testing Results
(Deposit Area)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010





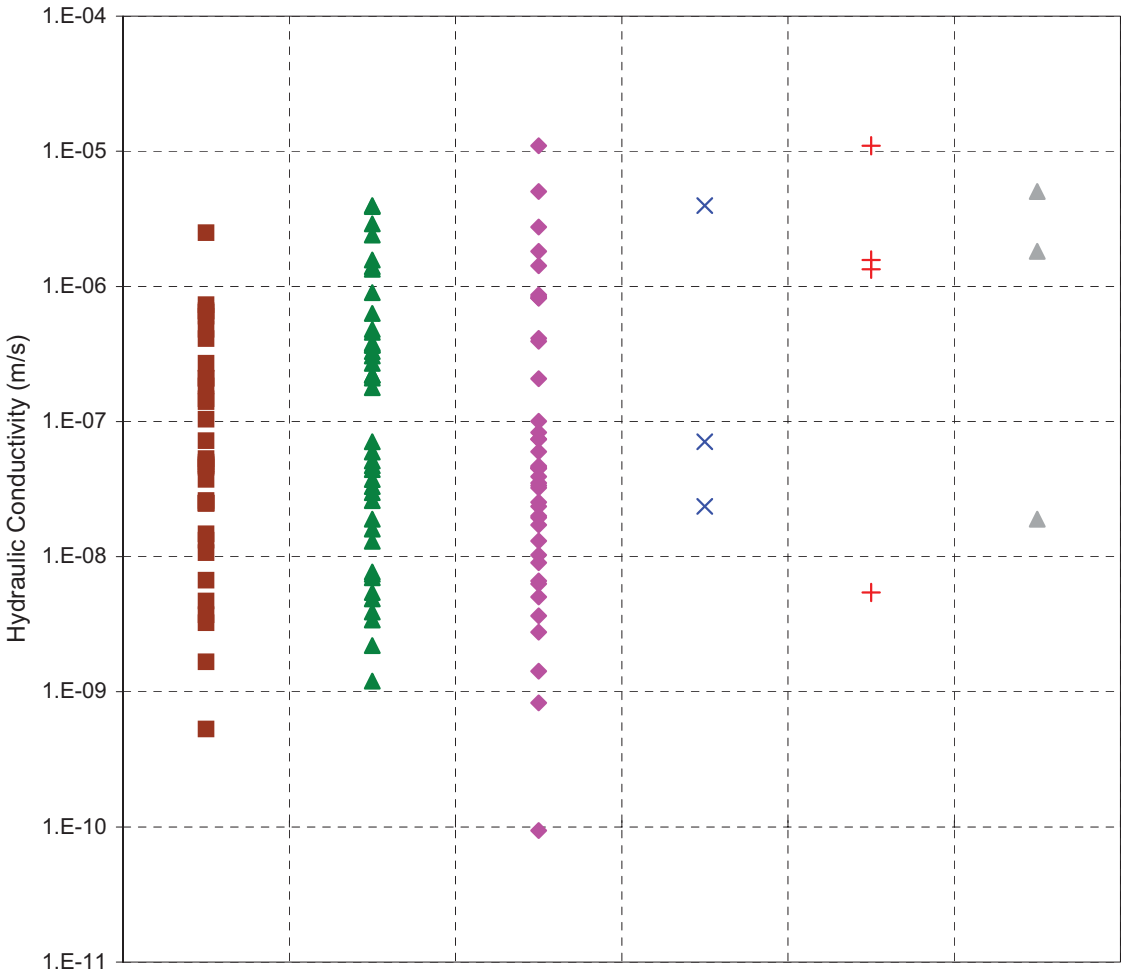
Legend

- Tertiary-Cretaceous Sediments
- Tertiary Volcanics
- Granodiorite

THE pebble PARTNERSHIP

Figure 6: Packer Testing Results with Depth and Rock Type (Deposit Area)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010



THE pebble PARTNERSHIP

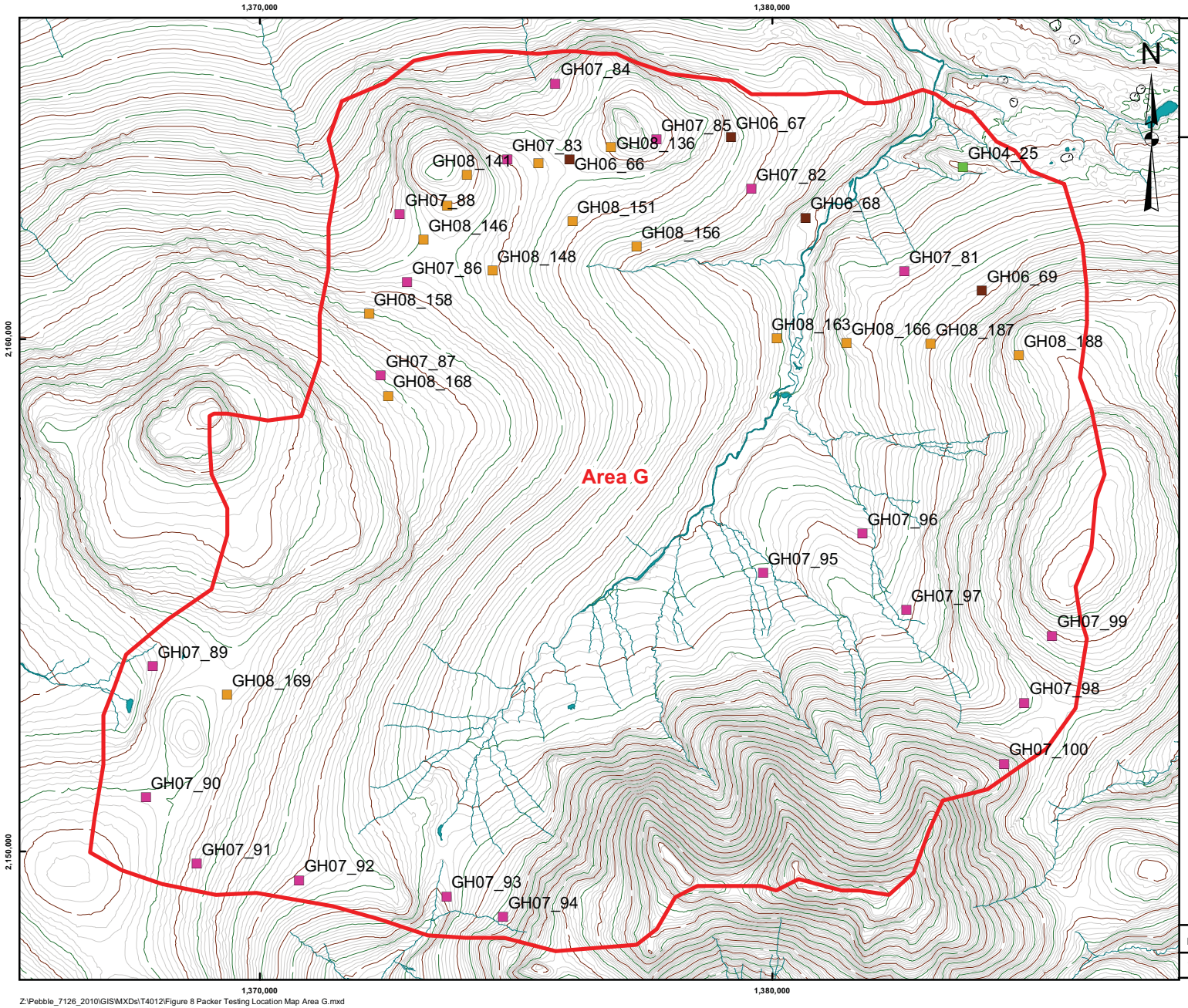
Figure 7
Hydraulic Conductivity Distribution with Rock Type (Deposit Area)

Legend

- Sediments
- Tertiary Volcanics
- Granodiorite
- Fractured
- Faulted
- Weathered



Project No: 7126	Author: SWS-CS
Version: 1	Date:May 4, 2010



Z:\Pebble_7126_2010\GIS\MXDs\T4012\Figure 8 Packer Testing Location Map Area G.mxd

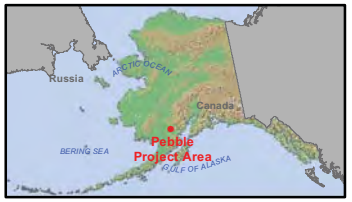
THE pebble PARTNERSHIP

Figure 8
Packer Testing Location Map (Area G)

Appendix 8.1L
Packer Testing Results

Legend

- 2004 Packer Testing Location
- 2005 Packer Testing Location
- 2006 Packer Testing Location
- 2007 Packer Testing Location
- 2008 Packer Testing Location
- Testing Areas
- Deposit Area
- Lakes
- Rivers
- Elevation Contour (Interval 10 feet)



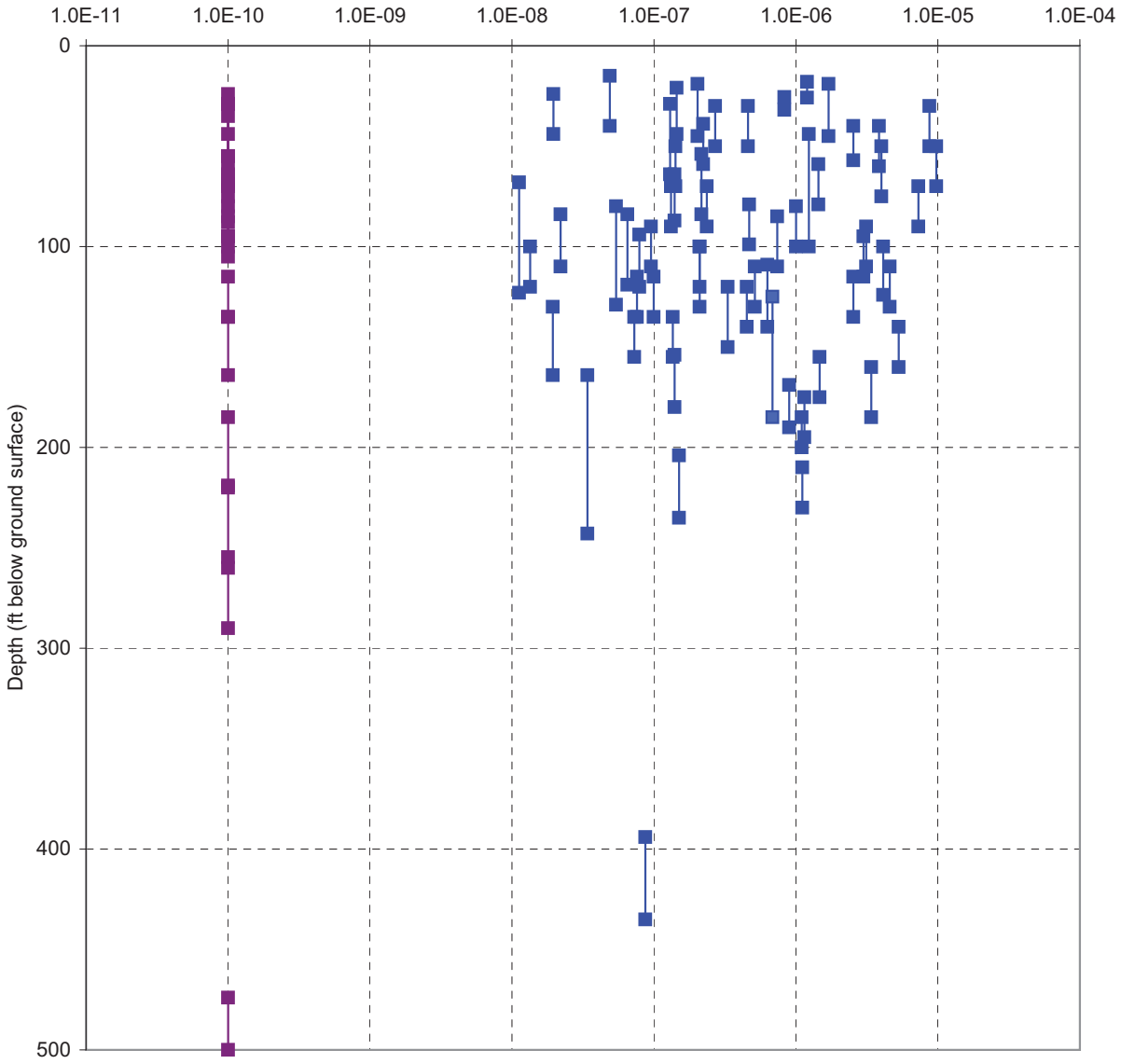
Feet
0 1,100 2,200 3,300 4,400

Meters
0 275 550 825 1,100 1,375

Scale 1:34,672

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL





Legend

Packer Testing by KP (2004 through 2008)

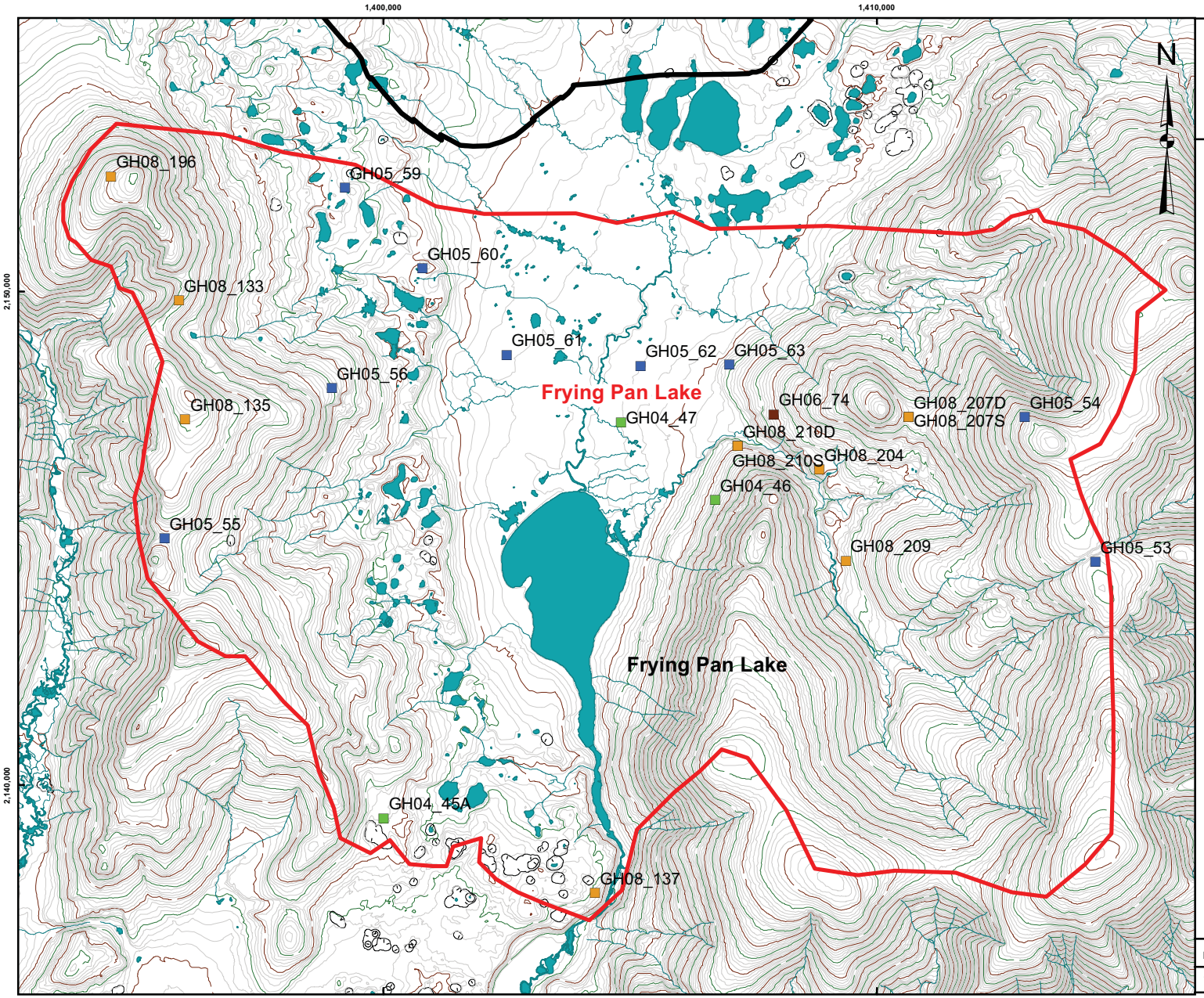
Packer Testing by SLR (2008)

Packer Testing with No Water Take

THE pebble PARTNERSHIP

Figure 9: Packer Testing Results with Depth (Area G)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010



Z:\Pebble_7126_2010\GIS\MXDs\T4013\Figure 10 Packer Testing Location Map Frying Pan Lake.mxd

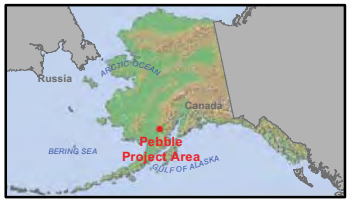
THE pebble PARTNERSHIP

Figure 10
Packer Testing Location Map
(Frying Pan Lake)

Appendix 8.1L
Packer Testing Results

Legend

- 2004 Packer Testing Location
- 2005 Packer Testing Location
- 2006 Packer Testing Location
- 2007 Packer Testing Location
- 2008 Packer Testing Location
- Testing Areas
- Deposit Area
- Lakes
- Rivers
- Elevation Contour (Interval 10 feet)



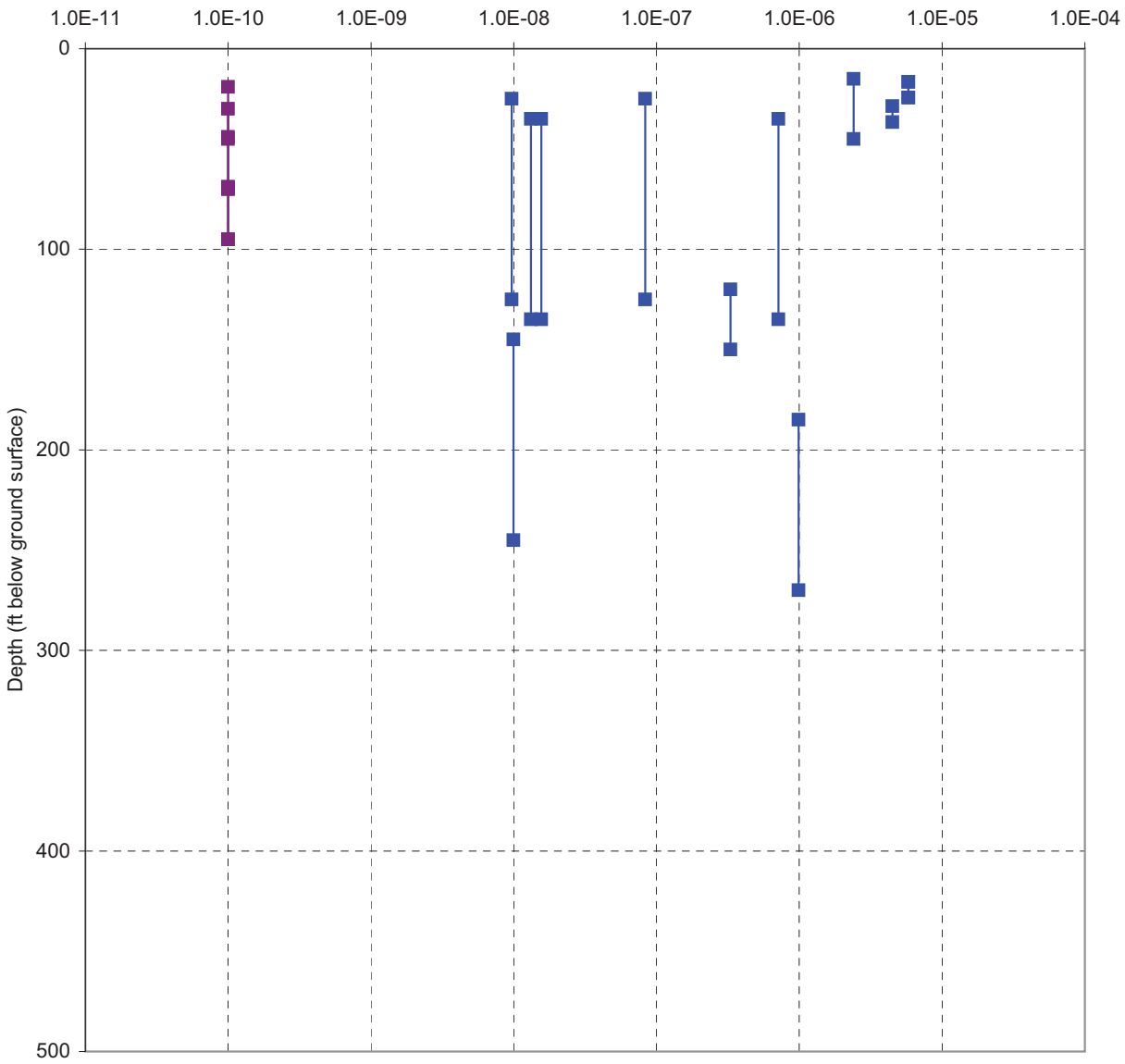
Feet
0 1,200 2,400 3,600 4,800

Meters
0 300 600 900 1,200 1,500

Scale 1:36,547

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL





Legend

Packer Testing by KP (2004 through 2008)

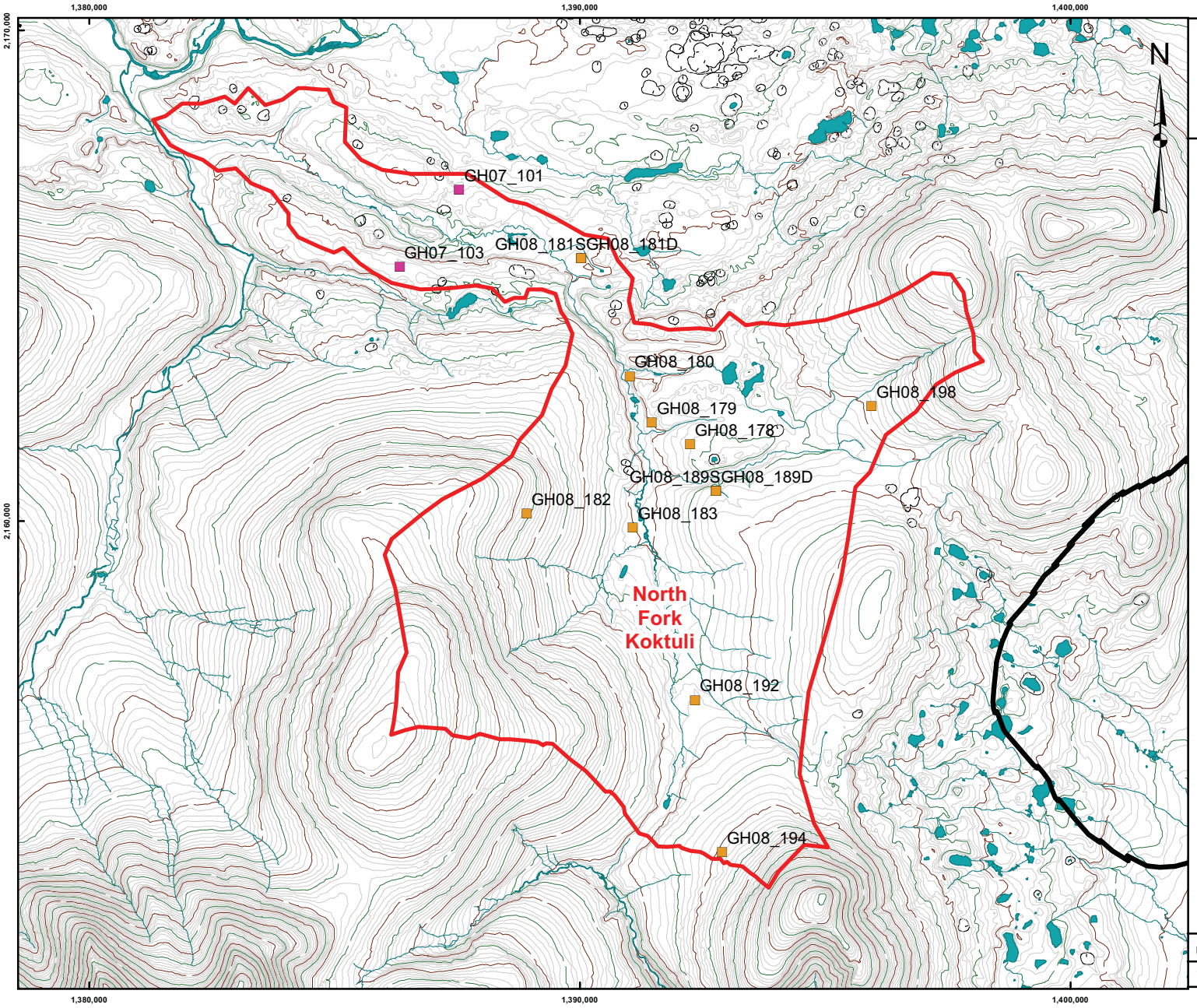
Packer Testing by SLR (2008)

Packer Testing with No Water Take

THE pebble PARTNERSHIP

Figure 11: Packer Testing Results with Depth (FPL)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010



Z:\Pebble_7126_2010\GIS\MXDs\T4014\Figure 12 Packer Testing Location Map North Fork Koktuli.mxd

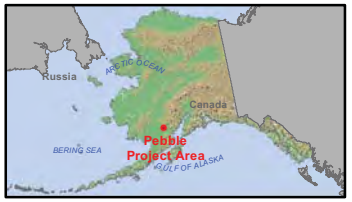
THE pebble PARTNERSHIP

Figure 12
Packer Testing Location Map (North Fork Koktuli)

Appendix 8.1L
Packer Testing Results

Legend

- 2004 Packer Testing Location
- 2005 Packer Testing Location
- 2006 Packer Testing Location
- 2007 Packer Testing Location
- 2008 Packer Testing Location
- Testing Areas
- Deposit Area
- Lakes
- Rivers
- Elevation Contour (Interval 10 feet)



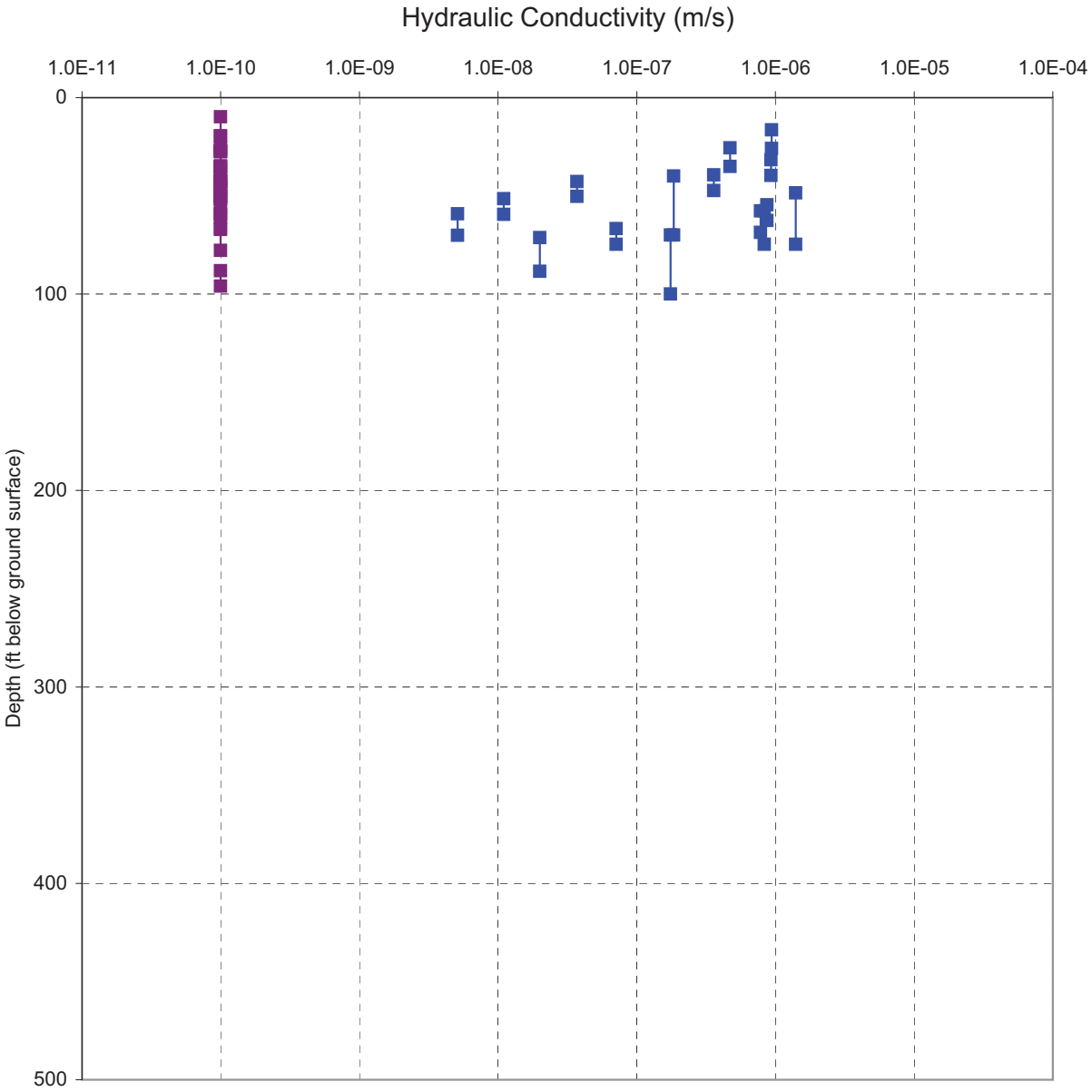
0 1,200 2,400 3,600 4,800 Feet

0 300 600 900 1,200 1,500 Meters

Scale 1:36,547

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL





Legend

Packer Testing by KP (2004 through 2008)

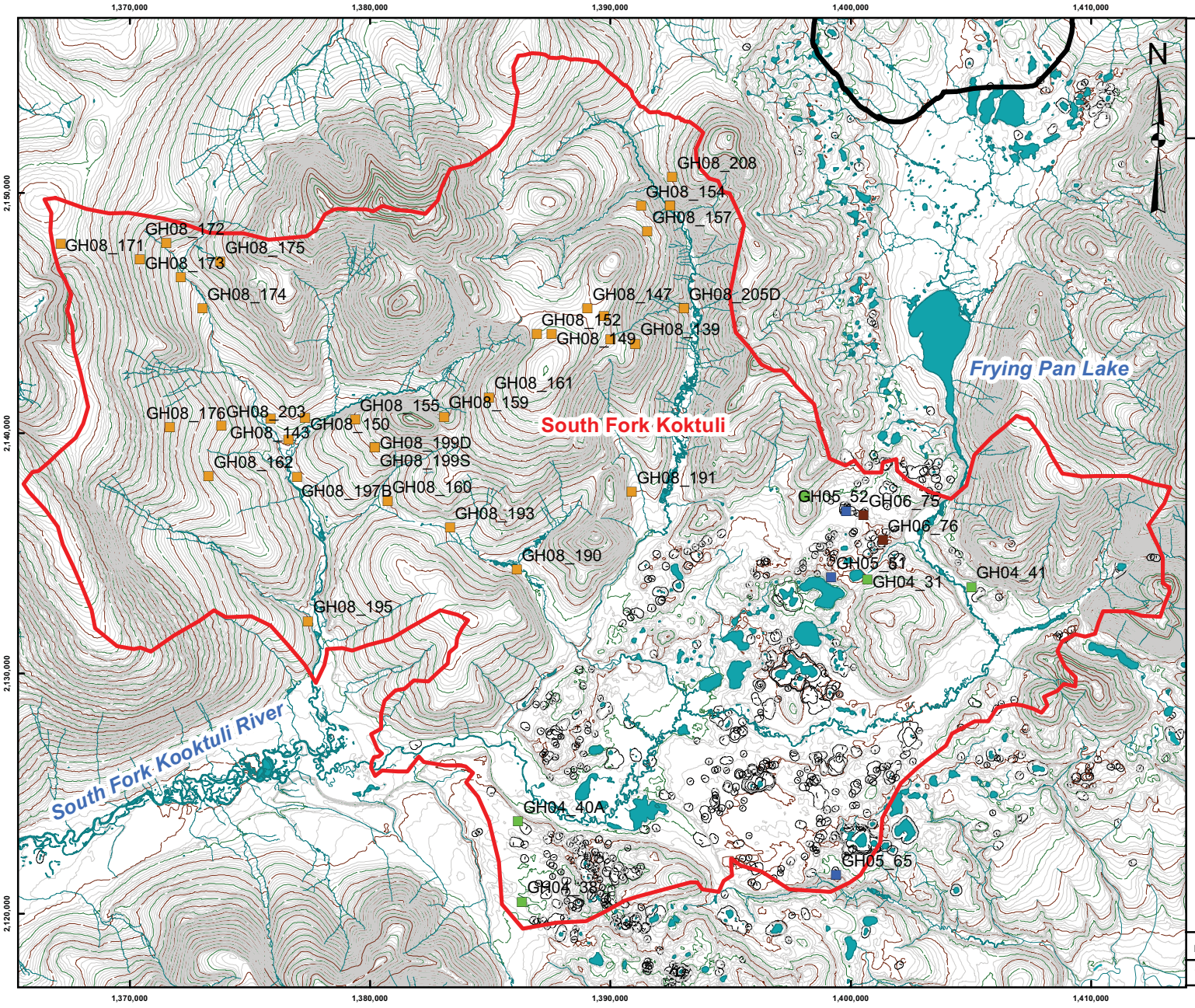
Packer Testing by SLR (2008)

Packer Testing with No Water Take

THE pebble PARTNERSHIP

Figure 13: Packer Testing Results with Depth (NFK)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010



THE pebble PARTNERSHIP

Figure 14
Packer Testing Location Map
(South Fork Koktuli)

Appendix 8.1L
Packer Testing Results

Legend

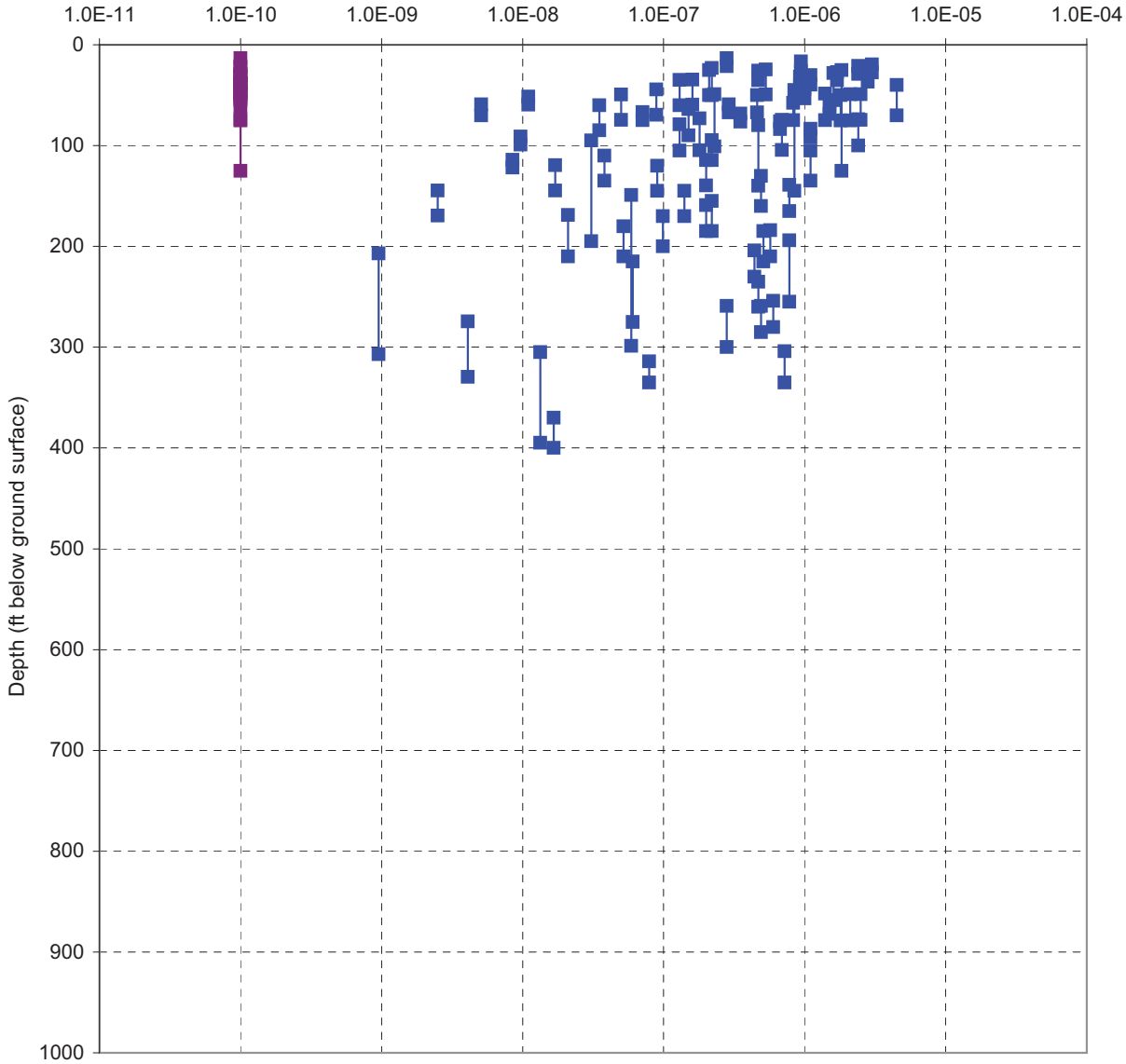
- 2004 Packer Testing Location
- 2005 Packer Testing Location
- 2006 Packer Testing Location
- 2007 Packer Testing Location
- 2008 Packer Testing Location
- Testing Areas
- Deposit Area
- Lakes
- Rivers
- Elevation Contour (Interval 10 feet)

Scale 1:74,503

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Project No: 7126	Date: April, 2011
Version: 1	Author: SWS-BL

Z:\Pebble_7126_2010\GIS\MXDs\T4015\Figure 14 Packer Testing Location Map South Fork Koktuli.mxd





Legend

Packer Testing by KP (2004 through 2008)

Packer Testing by SLR (2008)

Packer Testing with No Water Take

THE pebble PARTNERSHIP

Figure 15: Packer Testing Results with Depth (SFK)

Project: 7126	Author: SWS-CS
Version: 1	Date: May 4, 2010

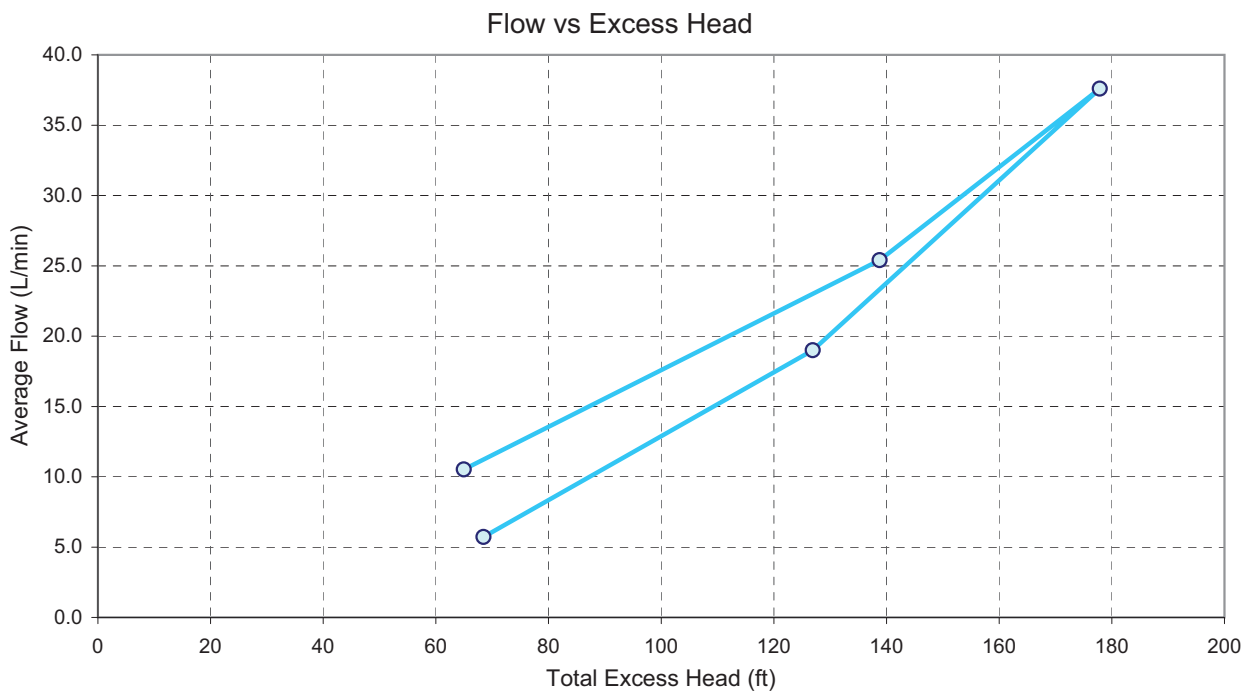
ATTACHMENT

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	11-May-08	Apparent Current Depth of Drill Hole (ft):			**2118.0**
Drill Hole No:	**8410**	Test Section from (ft):	**2102.0**	to:	2118.0
Test No:	#1	Length of Test Section (ft):			**16.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	500	Height of Gauge (ft above datum):			5.0
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			67
Diameter of Drill Hole (mm):	75.5	Vertical Depth of Drill Hole (ft):			1949.6
ID of Drilling Rods (mm):	72.0	Vertical Depth of the Center of Test Section (ft):			1942.3

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
Zero		0	0.0	0	0	0	0.00	Pressures converted from bar to psi
#1	5.0	29.0	52.6	7.0	0.0	65.0	10.52	Drilled by NQ rods
#2	5.0	65.3	127.0	17.0	0.0	138.8	25.40	Leaking threaded joints of rods
#3	5.0	87.0	188.0	28.0	0.0	177.9	37.60	
#2	5.0	58.0	95.0	12.0	0.0	126.9	19.00	
#1	5.0	29.0	28.6	3.5	0.0	68.5	5.72	
Zero								



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	1.4E-06	1.4E-05	1.8E-06	---	---	1.3E-06	7.2E-07	**3.8E-06**	**10.62**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

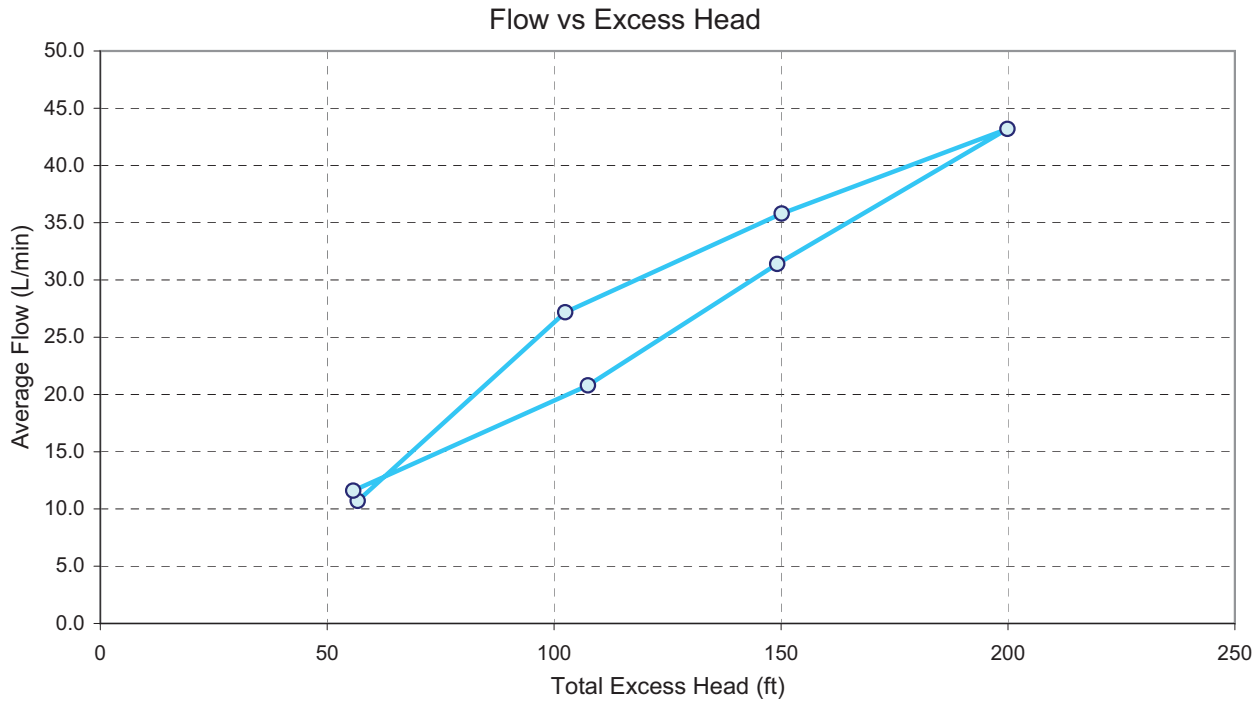
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8410 Testing @ 2102 to 2118 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	1

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	15-May-08	Apparent Current Depth of Drill Hole (ft):			**2667.0**
Drill Hole No:	**8410**	Test Section from (ft):	**2598.0**	to:	2667.0
Test No:	#2	Length of Test Section (ft):			**69.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	500	Height of Gauge (ft above datum):			5.0
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			67
Diameter of Drill Hole (mm):	75.7	Vertical Depth of Drill Hole (ft):			2455.0
ID of Drilling Rods (mm):	72.0	Vertical Depth of the Center of Test Section (ft):			2423.2

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero		0	0.0	0	0	0	0.0	
#1	5.0	25.0	53.5	6.0	0.0	56.7	10.7	Drilled by NQ rods
#2	5.0	50.0	135.9	18.0	0.0	102.4	27.2	Packer tested **ZG1** fault.
#3	5.0	75.0	179.0	28.0	0.0	150.2	35.8	Fault zone commenced at 2617'.
#4	5.0	100.0	216.0	36.0	0.0	199.9	43.2	Possibly leaking joints of rods
#3	5.0	75.0	157.0	29.0	0.0	149.2	31.4	
#2	5.0	50.0	104.0	13.0	0.0	107.4	20.8	
#1	5.0	25.0	58.0	7.0	0.0	55.7	11.6	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	4.9E-07	6.1E-06	6.2E-07	5.7E-07	5.5E-07	5.1E-07	5.4E-07	**1.3E-06**	**3.39**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

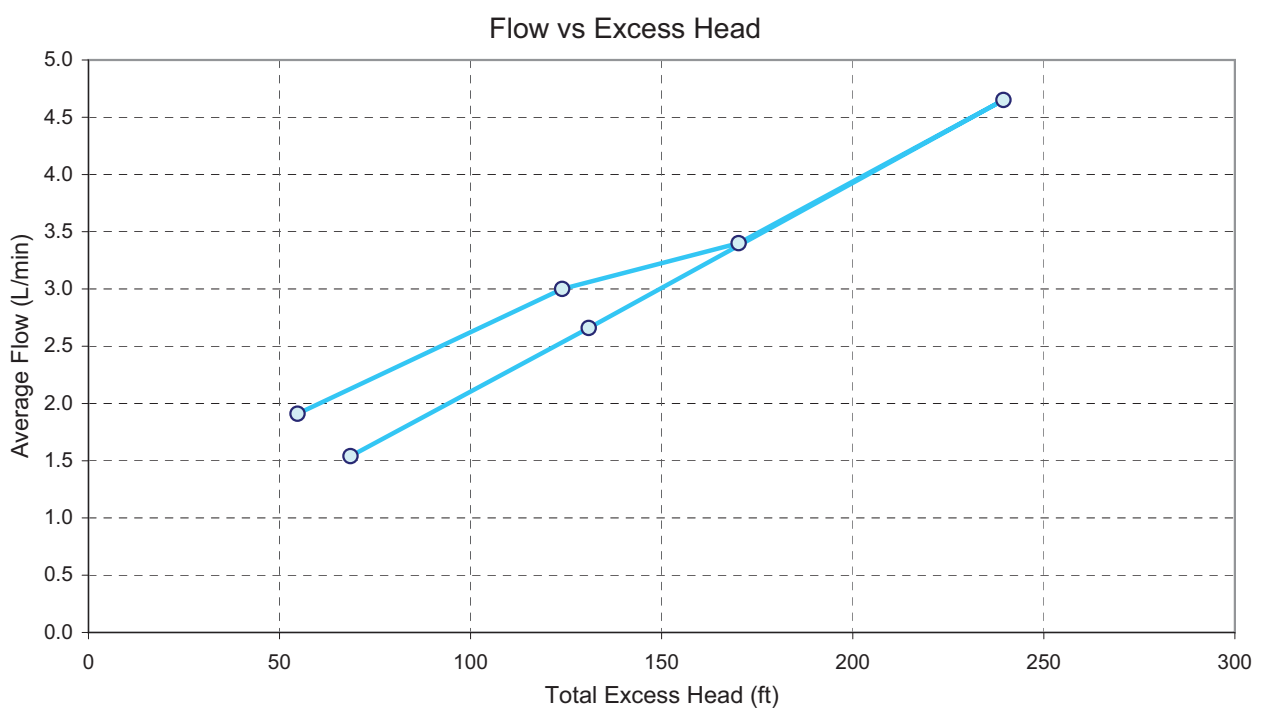
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8410 Testing @ 2598 to 2667 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	2

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	3-Jun-08	Apparent Current Depth of Drill Hole (ft):			**2025.0**
Drill Hole No:	**8412**	Test Section from (ft):	**2005.0**	to:	2025.0
Test No:	#1.2	Length of Test Section (ft):			**20.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	300	Height of Gauge (ft above datum):			-3.0
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			75
Diameter of Drill Hole (mm):	114.3	Vertical Depth of Drill Hole (ft):			1956.0
ID of Drilling Rods (mm):	82.0	Vertical Depth of the Center of Test Section (ft):			1946.3

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Flowmeter	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero		0	2742.1	0	0	0	0.00	
#1	10.0	25.0	2761.2	0.0	0.0	54.7	1.91	Drilled by PQ rods
#2	10.0	55.0	2797.4	0.0	0.0	124.0	3.00	altered volcanoclastics
#3	10.0	75.0	2833.7	0.0	0.0	170.2	3.40	possible fault zone from
#4	10.0	105.0	2880.7	0.0	0.0	239.4	4.65	2020 to 2025, high torque
#3	10.0	58.0	2907.3	0.0	0.0	130.9	2.66	
#2	10.0	31.0	2922.7	0.0	0.0	68.6	1.54	possibly leaking threaded joints
#1								of rods, difficulty to retrieve packer



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	2.3E-07	1.4E-06	1.3E-07	1.3E-07	1.4E-07	1.5E-07	-	**3.7E-07**	**1.27**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

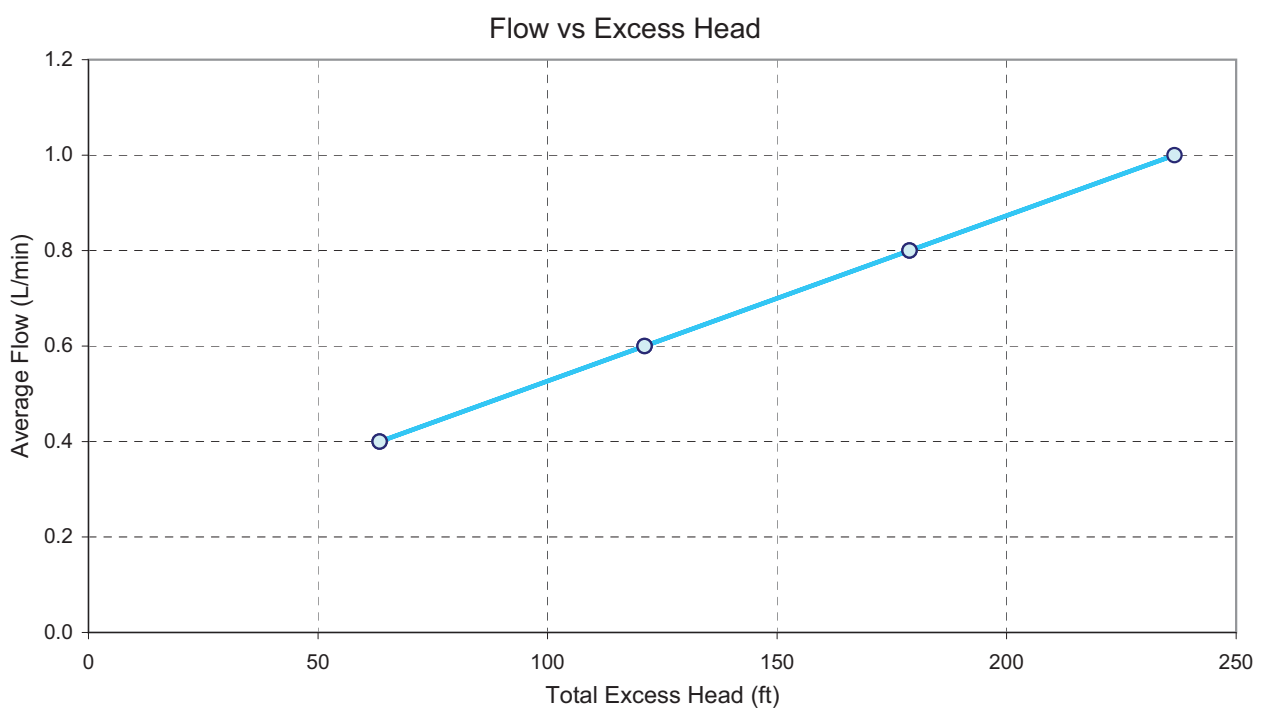
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8412 Testing 2005 to 2025 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	3

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	28-May-08	Apparent Current Depth of Drill Hole (ft):			**1490.0**
Drill Hole No:	**8412**	Test Section from (ft):	**1470.0**	to:	1490.0
Test No:	#1	Length of Test Section (ft):			**20.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	500	Height of Gauge (ft above datum):			5.7
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			80
Diameter of Drill Hole (mm):	114.3	Vertical Depth of Drill Hole (ft):			1467.4
ID of Drilling Rods (mm):	82.0	Vertical Depth of Test Section (ft):			1457.5

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Flowmeter	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero		0	2729.0	0	0	0	0.00	
#1	5.0	25.0	2732.0	0.0	0.0	63.4	0.40	Drilled by PQ rods
#2	5.0	50.0	2736.0	0.0	0.0	121.1	0.60	competent basalt
#3	5.0	75.0	2738.0	0.0	0.0	178.9	0.80	tight joints
#4	5.0	100.0	2741.0	0.0	0.0	236.6	1.00	
#3	5.0	75.0	2742.0	0.0	0.0	178.9	0.80	
#2	5.0	50.0	2743.0	0.0	0.0	121.1	0.60	
#1	5.0	25.0	2743.5	0.0	0.0	63.4	0.40	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	4.2E-08	2.9E-07	3.0E-08	2.8E-08	3.0E-08	3.3E-08	4.2E-08	**7.1E-08**	**0.27**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

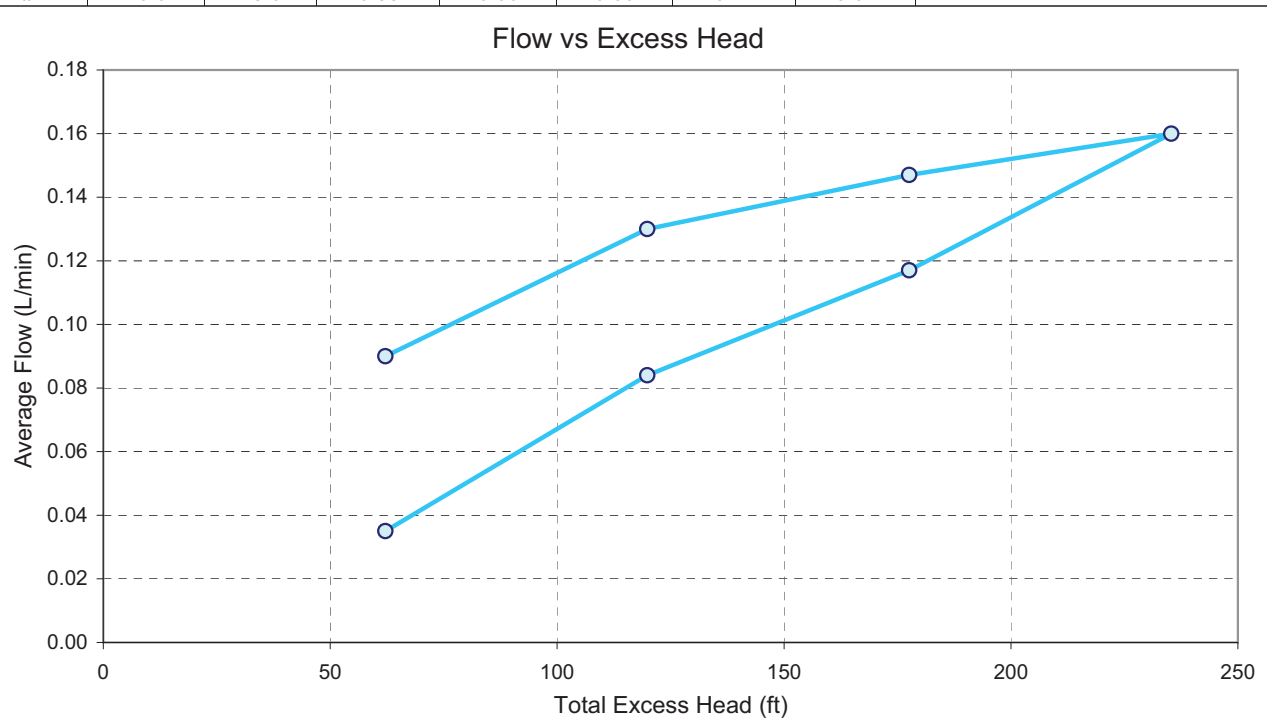
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8410 Testing 1470 to 1490 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	4

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	15-Jun-08	Apparent Current Depth of Drill Hole (ft):			**2632.0**
Drill Hole No:	**8412**	Test Section from (ft):	**2567.0**	to:	2632.0
Test No:	#2	Length of Test Section (ft):			**65.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	350	Height of Gauge (ft above datum):			4.4
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			75
Diameter of Drill Hole (mm):	96.0	Vertical Depth of Drill Hole (ft):			2542.3
ID of Drilling Rods (mm):	82.0	Vertical Depth of the Center of Test Section (ft):			2510.9

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.00	0	0	0	0.00	
#1	10.0	25.0	0.90	0.00	0.00	62.1	0.09	Drilled with HQ rods
#2	10.0	50.0	1.30	0.00	0.00	119.9	0.13	Possible fault zone
#3	10.0	75.0	1.47	0.00	0.00	177.6	0.15	
#4	10.0	100.0	1.60	0.00	0.00	235.3	0.16	
#3	10.0	75.0	1.17	0.00	0.00	177.6	0.12	
#2	10.0	50.0	0.84	0.00	0.00	119.9	0.08	
#1	10.0	25.0	0.35	0.00	0.00	62.1	0.04	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	3.8E-09	2.5E-08	2.2E-09	1.8E-09	1.7E-09	1.9E-09	1.5E-09	**5.4E-09**	**0.01**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

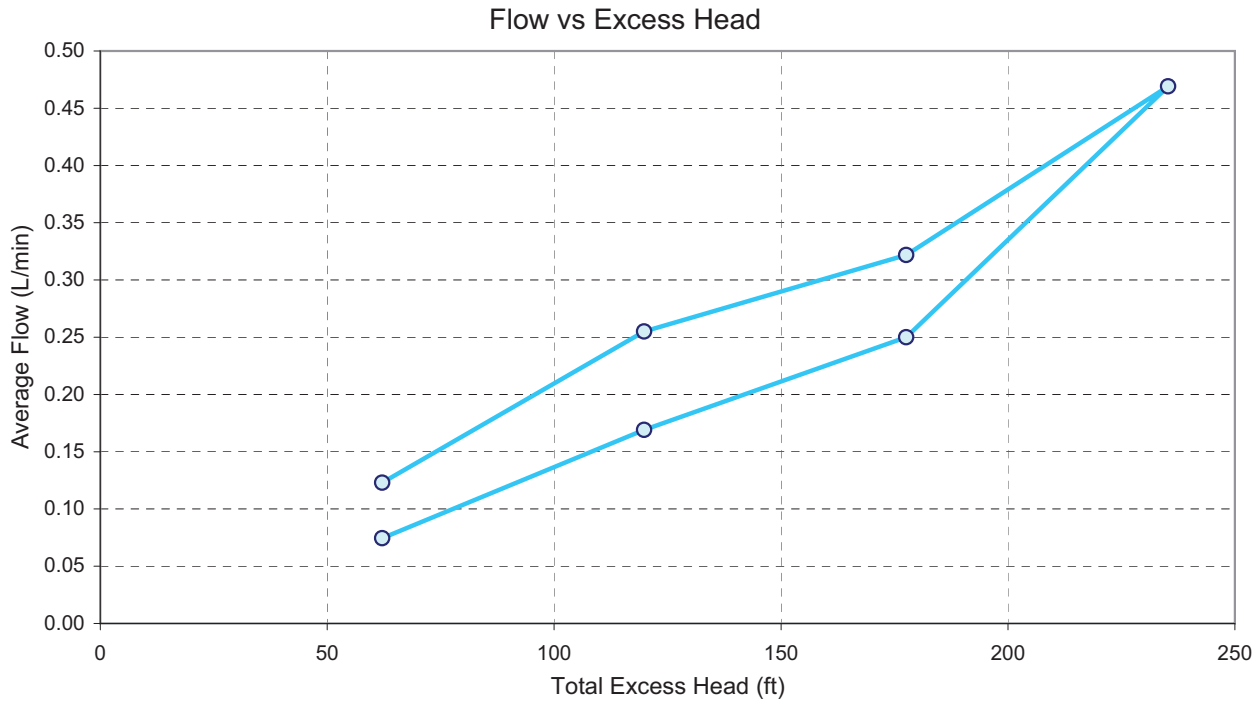
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8412 Testing 2567 to 2632 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	5

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	18-Jun-08	Apparent Current Depth of Drill Hole (ft):			**3165.0**
Drill Hole No:	**8412**	Test Section from (ft):	**3140.0**	to:	3165.0
Test No:	#3	Length of Test Section (ft):			**25.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	500	Height of Gauge (ft above datum):			4.4
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			75
Diameter of Drill Hole (mm):	96.0	Vertical Depth of Drill Hole (ft):			3057.2
ID of Drilling Rods (mm):	82.0	Vertical Depth of the Center of Test Section (ft):			3045.1

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	25.0	1.2	0.0	0.0	62.1	0.12	Drilled with HQ rods
#2	12.0	50.0	3.1	0.0	0.0	119.8	0.26	Borehole making water
#3	11.0	75.0	3.5	0.0	0.0	177.6	0.32	Difficulty with flow stabilization
#4	11.0	100.0	5.2	0.0	0.0	235.3	0.47	
#3	12.0	75.0	3.0	0.0	0.0	177.6	0.25	
#2	11.0	50.0	1.9	0.0	0.0	119.8	0.17	
#1	11.0	25.0	0.8	0.0	0.0	62.1	0.07	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	1.1E-08	1.1E-07	1.0E-08	1.2E-08	8.1E-09	8.2E-09	6.9E-09	**2.4E-08**	**0.07**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

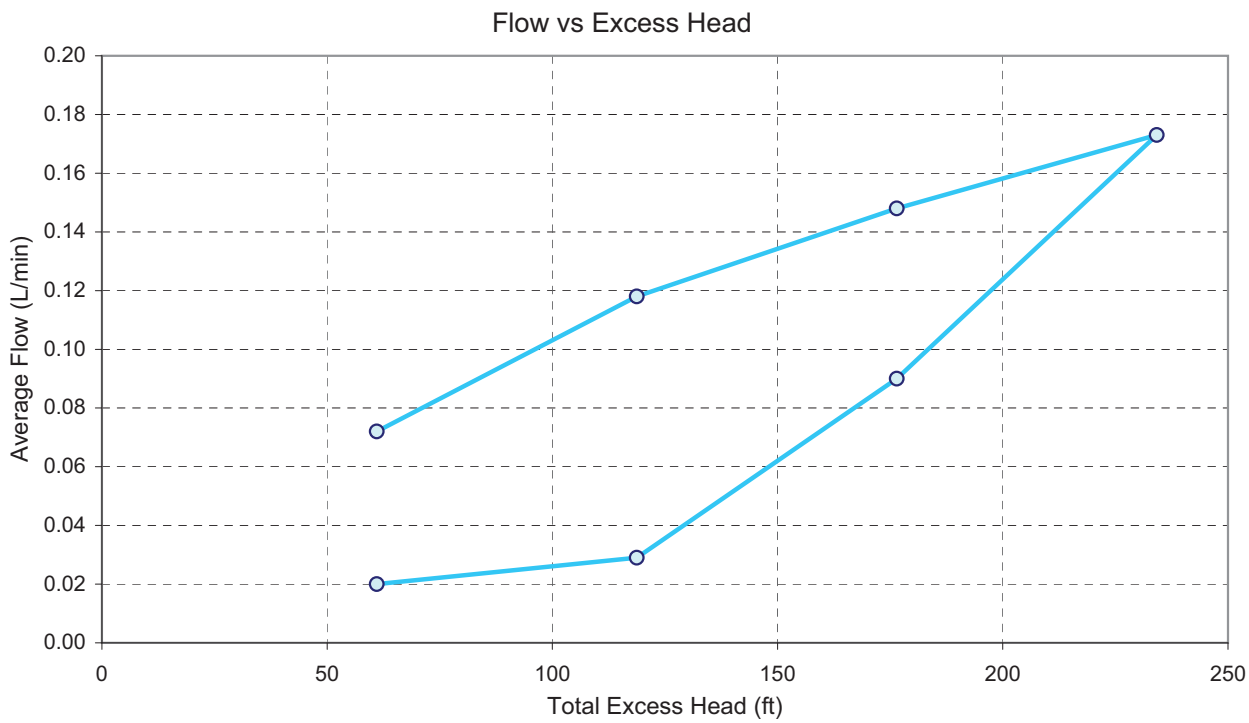
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8412 Testing @ 3140 to 3165 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	6

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	18-Jun-08	Apparent Current Depth of Drill Hole (ft):			**4471.0**
Drill Hole No:	**8413**	Test Section from (ft):	**4379.0**	to:	4471.0
Test No:	#1	Length of Test Section (ft):			**92.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	500	Height of Gauge (ft above datum):			3.3
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			90
Diameter of Drill Hole (mm):	75.5	Vertical Depth of Drill Hole (ft):			4471.0
ID of Drilling Rods (mm):	72.0	Vertical Depth of the Center of Test Section (ft):			4425.0

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.00	0	0	0	0.00	
#1	10.0	25.0	0.72	0.0	0.0	61.0	0.07	Drilled by NQ rods
#2	10.0	50.0	1.18	0.0	0.0	118.7	0.12	Packer tested end of hole conductivity.
#3	10.0	75.0	1.48	0.0	0.0	176.5	0.15	Test section in low-grade granodiorite
#4	10.0	100.0	1.73	0.0	0.0	234.2	0.17	Possibly leaking threaded joints of rods
#3	10.0	75.0	0.90	0.0	0.0	176.5	0.09	Difficulty to retrieve packer, rubber glanc
#2	10.0	50.0	0.29	0.0	0.0	118.7	0.03	was destroyed during retrieval.
#1	10.0	25.0	0.20	0.0	0.0	61.0	0.02	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	2.4E-09	1.8E-08	1.7E-09	1.5E-09	1.0E-09	5.0E-10	6.7E-10	**3.7E-09**	**0.01**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

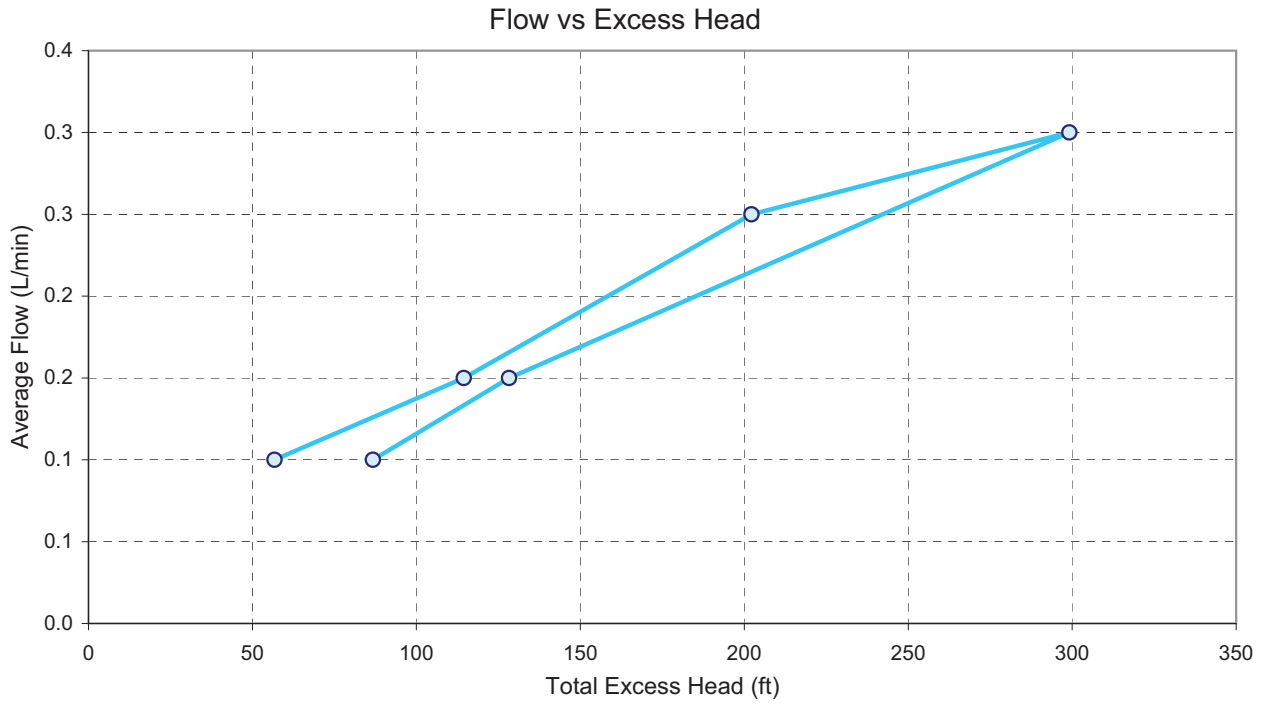
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8413 Testing @ 4379 to 4471 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	7

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	9-Jun-08	Apparent Current Depth of Drill Hole (ft):			**1864.0**
Drill Hole No:	**8415**	Test Section from (ft):	**1842.0**	to:	1864.0
Test No:	#1	Length of Test Section (ft):			**22.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	300	Height of Gauge (ft above datum):			-1.0
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			75
Diameter of Drill Hole (mm):	96.0	Vertical Depth of Drill Hole (ft):			1800.5
ID of Drilling Rods (mm):	82.0	Vertical Depth of the Center of Test Section (ft):			1789.9

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Flowmeter	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero		0	2940.2	0	0	0	0.00	
#1	5.0	25.0	2941.9	0.00	0.00	56.7	0.10	Drilled by HQ rods
#2	5.0	50.0	2943.0	0.00	0.00	114.4	0.15	altered volcanoclastics
#3	5.0	88.0	2944.5	0.00	0.00	202.2	0.25	possible fault zone from
#4	10.0	130.0	2947.4	0.00	0.00	299.2	0.30	1859 to 1864 ft, higher torque
#3	7.0	56.0	2948.1	0.00	0.00	128.3	0.15	
#2	5.0	38.0	2947.3	0.00	0.00	86.7	0.10	
#1								difficulty to retrieve packer



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	1.1E-08	7.4E-08	7.9E-09	6.4E-09	7.5E-09	7.4E-09	-	**1.9E-08**	**0.06**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

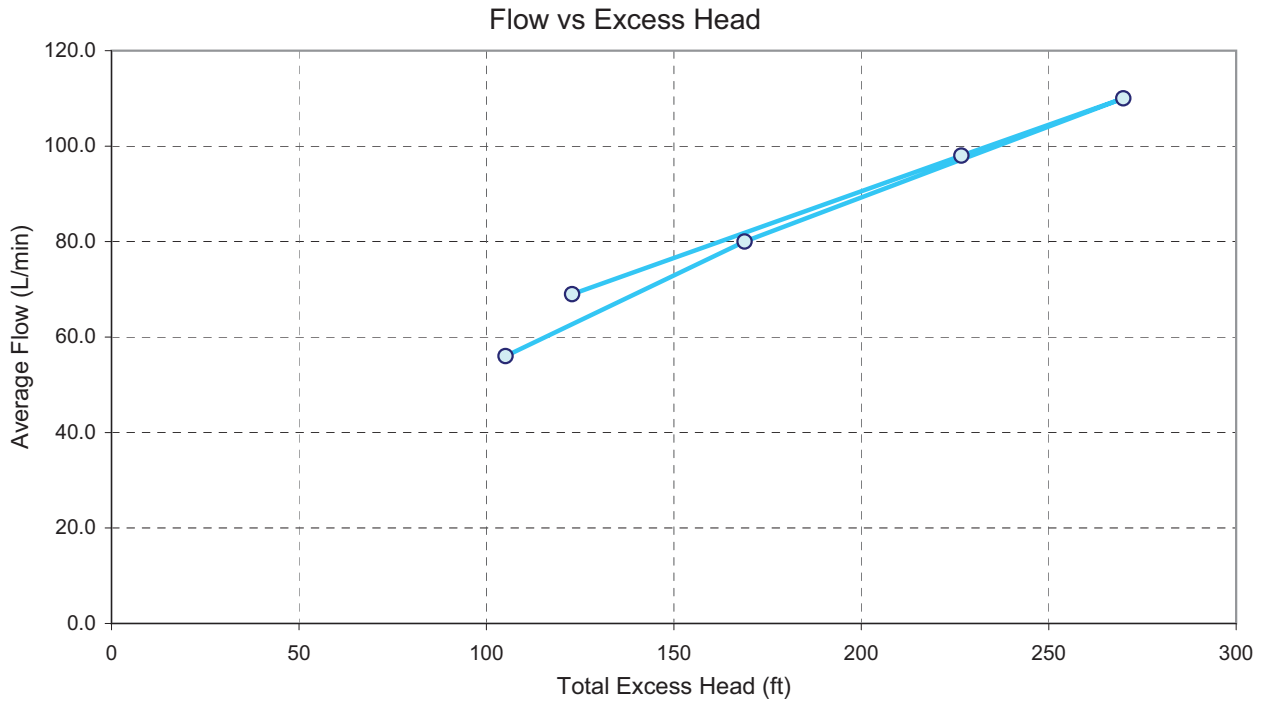
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8415 Testing @ 1842 to 1864 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	8

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	30-Jun-08	Apparent Current Depth of Drill Hole (ft):			**2837.0**
Drill Hole No:	**8415**	Test Section from (ft):	**2694.0**	to:	2837.0
Test No:	#2	Length of Test Section (ft):			**143.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			60.0
Inflation Pressure (psi):	300	Height of Gauge (ft above datum):			4.0
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			75
Diameter of Drill Hole (mm):	96.0	Vertical Depth of Drill Hole (ft):			2740.3
ID of Drilling Rods (mm):	82.0	Vertical Depth of the Center of Test Section (ft):			2671.3

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero		0	3306.0	0	0	0	0.00	
#1	10.0	32.0	3995.0	15.0	0.0	122.9	69.00	Drilled by HQ rods
#2	10.0	80.0	4968.0	22.0	0.0	226.7	98.00	altered volcanoclastics
#3	5.0	100.0	5505.0	25.0	0.0	269.9	110.00	GD contact at 2703
#4	10.0	53.0	6312.0	17.5	0.0	168.9	80.00	
#3	5.0	23.0	6599.0	12.0	0.0	105.1	56.00	
#2								Good seal, no obvious leaks
#1								



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	7.6E-07	5.1E-06	5.5E-07	6.4E-07	7.2E-07	-	-	**1.6E-06**	**3.62**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

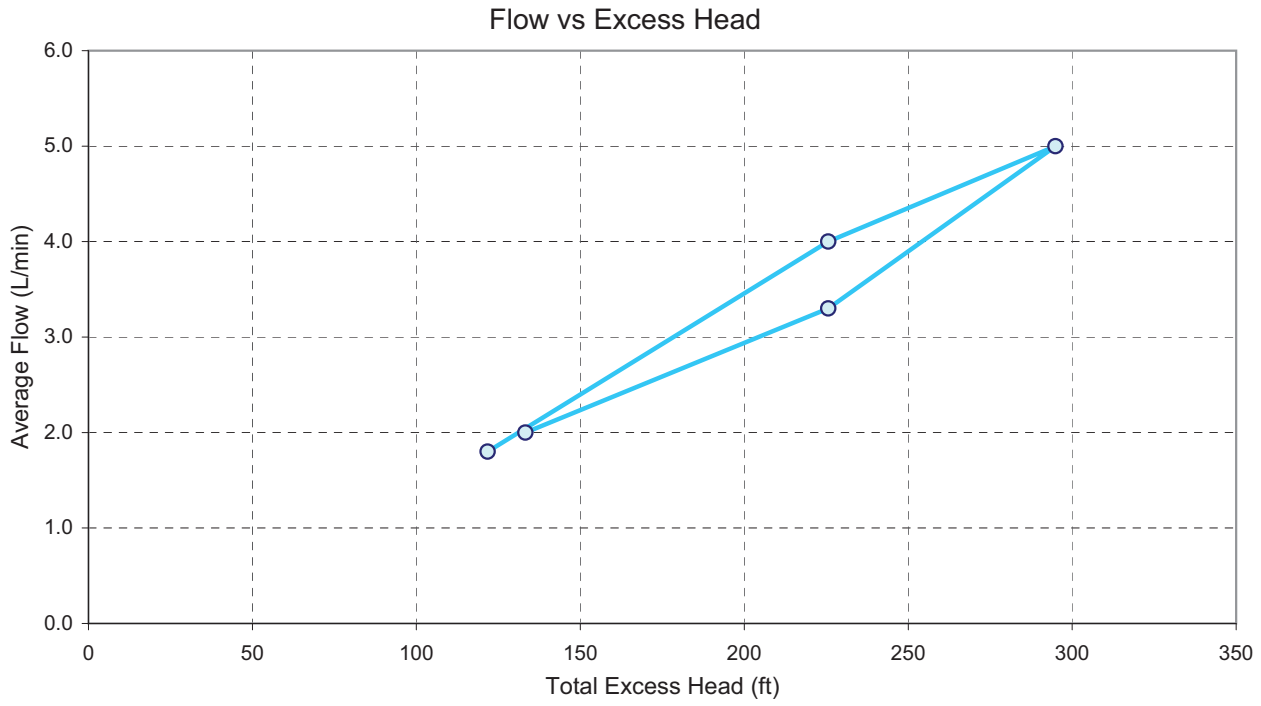
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8415 Testing @ 2694 to 2837 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	9

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	30-Jun-08	Apparent Current Depth of Drill Hole (ft):			**2837.0**
Drill Hole No:	**8415**	Test Section from (ft):	**2754.0**	to:	2837.0
Test No:	#3	Length of Test Section (ft):			**83.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			60.0
Inflation Pressure (psi):	300	Height of Gauge (ft above datum):			4.0
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			75
Diameter of Drill Hole (mm):	96.0	Vertical Depth of Drill Hole (ft):			2740.3
ID of Drilling Rods (mm):	82.0	Vertical Depth of the Center of Test Section (ft):			2700.2

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero		0	6625.0	0	0	0	0.00	
#1	5.0	30.0	6636.0	0.0	0.0	133.3	2.00	Drilled by HQ rods
#2	5.0	70.0	6654.0	0.0	0.0	225.6	3.30	Granodiorite with sulfides
#3	5.0	100.0	6680.0	0.0	0.0	294.9	5.00	high RQD
#4	5.0	70.0	6690.0	0.0	0.0	225.6	4.00	
#3	5.0	25.0	6696.0	0.0	0.0	121.7	1.80	
#2								Good seal, no obvious leaks
#1								



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	3.2E-08	2.8E-07	3.7E-08	3.8E-08	3.2E-08	-	-	**8.3E-08**	**0.21**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

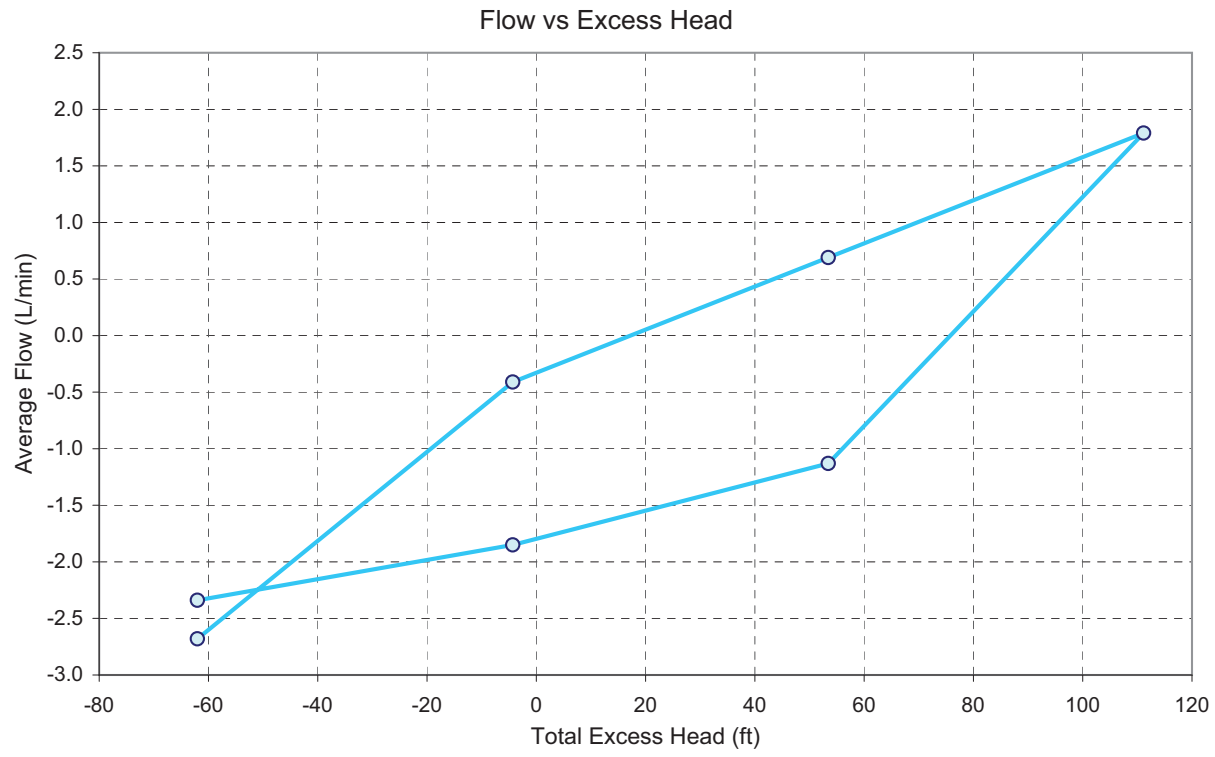
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8415 Testing @ 2754 to 2837 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	10

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	24-Jul-08	Apparent Current Depth of Drill Hole (ft):			**1470.0**
Drill Hole No:	**8417**	Test Section from (ft):	**1177.0**	to:	1470.0
Test No:	#1	Length of Test Section (ft):			**293.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			-20.0
Inflation Pressure (psi):	300	Height of Gauge (ft above datum):			4.2
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			90
Diameter of Drill Hole (mm):	96.0	Vertical Depth of Drill Hole (ft):			1470.0
ID of Drilling Rods (mm):	82.0	Vertical Depth of Test Section (ft):			1323.5

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	-20.0	-26.8	0.0	0.0	-62.0	-2.68	Drilled by HQ rods
#2	10.0	5.0	-4.1	0.0	0.0	-4.3	-0.41	acker tested conductivity in WB-1 Zone
#3	10.0	30.0	6.9	0.0	0.0	53.4	0.69	Test section in basalt and mudstone
#4	10.0	55.0	17.9	0.0	0.0	111.2	1.79	
#3	10.0	30.0	-11.3	0.0	0.0	53.4	-1.13	
#2	10.0	5.0	-18.5	0.0	0.0	-4.3	-1.85	
#1	10.0	-20.0	-23.4	0.0	0.0	-62.0	-2.34	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	3.2E-08	6.1E-07	9.5E-09	1.2E-08	-1.6E-08	3.2E-07	-	**1.1E-08**	**0.05**

Schlumberger WATER SERVICES

130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

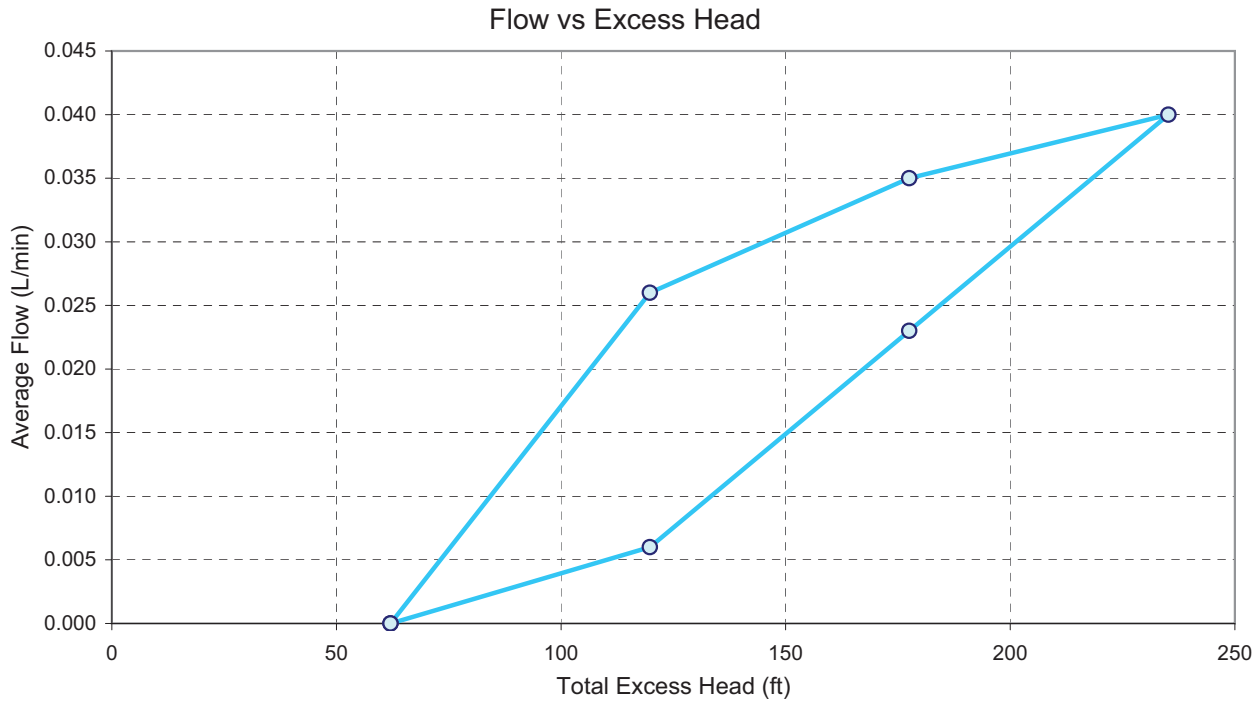
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8417 Testing @ 1177 to 1470 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	11

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	25-Jul-08	Apparent Current Depth of Drill Hole (ft):			**500.0**
Drill Hole No:	**8418**	Test Section from (ft):	**490.0**	to:	**500.0**
Test No:	#1	Length of Test Section (ft):			**10.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	300	Height of Gauge (ft above datum):			4.3
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			65
Diameter of Drill Hole (mm):	122.6	Vertical Depth of Drill Hole (ft):			453.2
ID of Drilling Rods (mm):	110.0	Vertical Depth of the Center of Test Section (ft):			448.6

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	25.0	0.00	0.0	0.0	62.1	0.000	Drilled with PQ rods.
#2	10.0	50.0	0.26	0.0	0.0	119.8	0.026	Tested bulk K of current lithology
#3	10.0	75.0	0.35	0.0	0.0	177.5	0.035	Tested in competent rock.
#4	10.0	100.0	0.40	0.0	0.0	235.2	0.040	Packer destroyed during deflation
#3	10.0	75.0	0.23	0.0	0.0	177.5	0.023	
#2	10.0	50.0	0.06	0.0	0.0	119.8	0.006	
#1	10.0	25.0	0.00	0.0	0.0	62.1	0.000	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	0.0E+00	2.1E-08	2.2E-09	1.9E-09	1.4E-09	5.6E-10	0.0E+00	**3.9E-09**	**0.01**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

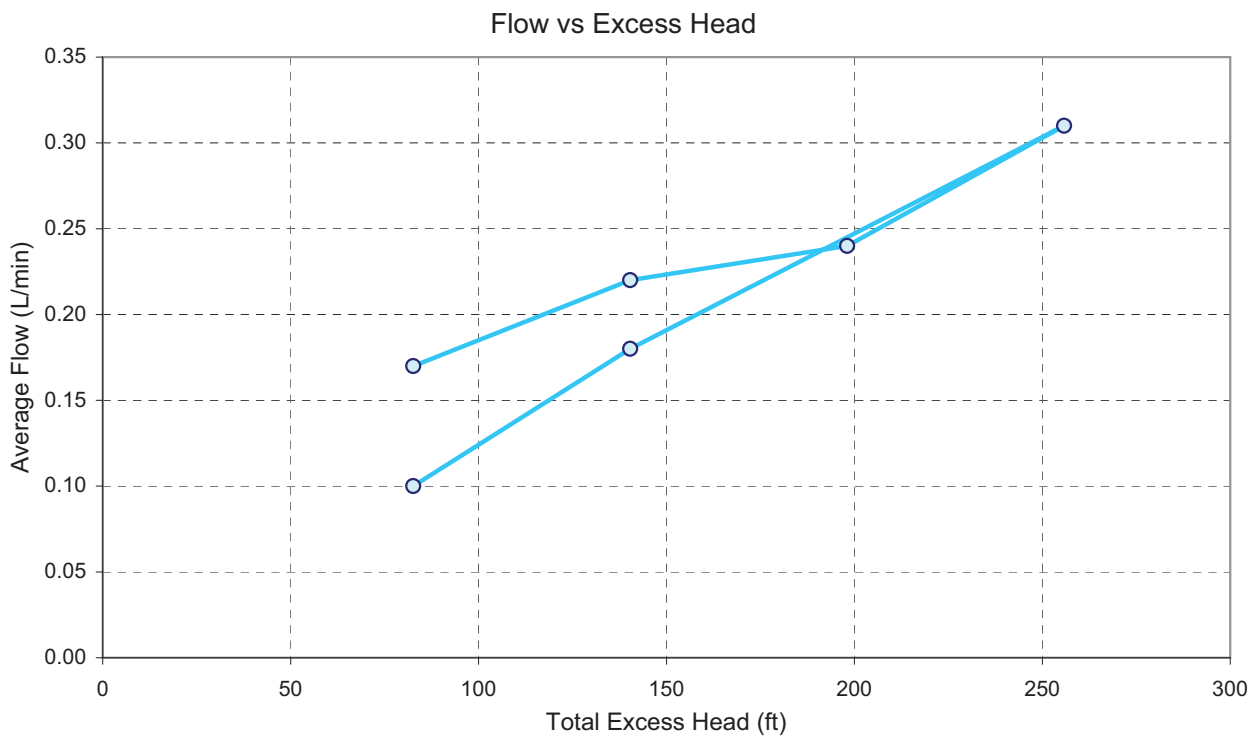
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8418 Testing @ 490 to 500 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	12

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	26-Jul-08	Apparent Current Depth of Drill Hole (ft):			**700.0**
Drill Hole No:	**8418**	Test Section from (ft):	**686.0**	to:	700.0
Test No:	#2	Length of Test Section (ft):			**14.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			20.5
Inflation Pressure (psi):	350	Height of Gauge (ft above datum):			4.42
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			65
Diameter of Drill Hole (mm):	122.6	Vertical Depth of Drill Hole (ft):			634.4
ID of Drilling Rods (mm):	118.0	Vertical Depth of the center of Test Section (ft):			628.1

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	25.0	1.7	0.0	0.0	82.6	0.17	Drilled with PQ rods
#2	10.0	50.0	2.2	0.0	0.0	140.4	0.22	Packer tested K of current lithology
#3	10.0	75.0	2.4	0.0	0.0	198.1	0.24	Test section in basalt and mudstone
#4	10.0	100.0	3.1	0.0	0.0	255.8	0.31	#3 back was not completed
#2	10.0	50.0	1.8	0.0	0.0	140.4	0.18	
#1	10.0	25.0	1.0	0.0	0.0	82.6	0.10	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	1.8E-08	1.2E-07	1.0E-08	1.0E-08	---	1.1E-08	1.0E-08	**3.0E-08**	**0.11**

Schlumberger WATER SERVICES

130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

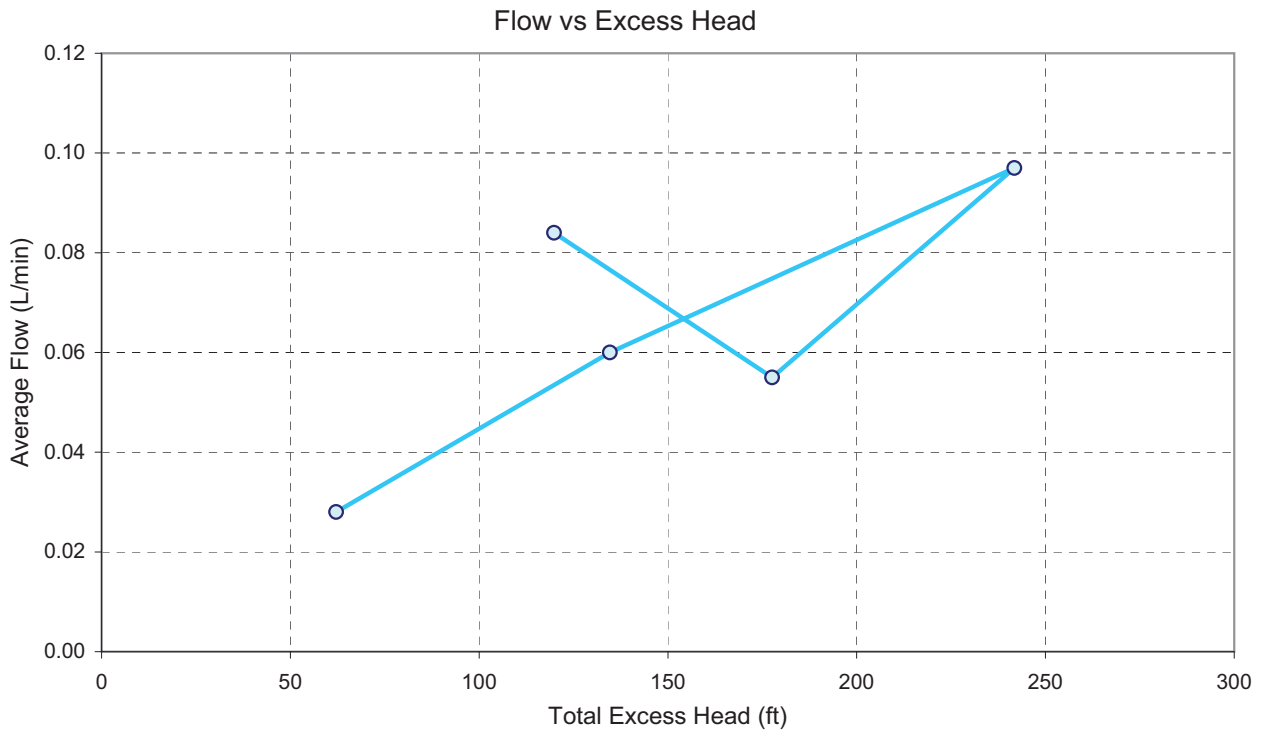
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8418 Testing @ 686 to 700 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	13

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	28-Jul-08	Apparent Current Depth of Drill Hole (ft):			**950.0**
Drill Hole No:	**8418**	Test Section from (ft):	**941.0**	to:	950.0
Test No:	#3	Length of Test Section (ft):			**9.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	350	Height of Gauge (ft above datum):			4.42
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			65
Diameter of Drill Hole (mm):	122.6	Vertical Depth of Drill Hole (ft):			861.0
ID of Drilling Rods (mm):	110.0	Vertical Depth of the Center of Test Section (ft):			856.9

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	25.0	7.84	0.0	0.0	62.1	0.78	Drilled with PQ rods
#2	10.0	50.0	0.84	0.0	0.0	119.9	0.08	Packer tested K of current lithology
#3	10.0	75.0	0.55	0.0	0.0	177.6	0.06	Test section in volcanoclastics
#4	10.0	102.8	0.97	0.0	0.0	241.8	0.10	#3 back was not completed
#2	10.0	56.4	0.60	0.0	0.0	134.6	0.06	
#1	10.0	25.0	0.28	0.0	0.0	62.1	0.03	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	1.5E-07	7.4E-08	3.7E-09	4.8E-09	---	5.4E-09	5.4E-09	**4.8E-09**	**0.05**

Schlumberger WATER SERVICES
130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

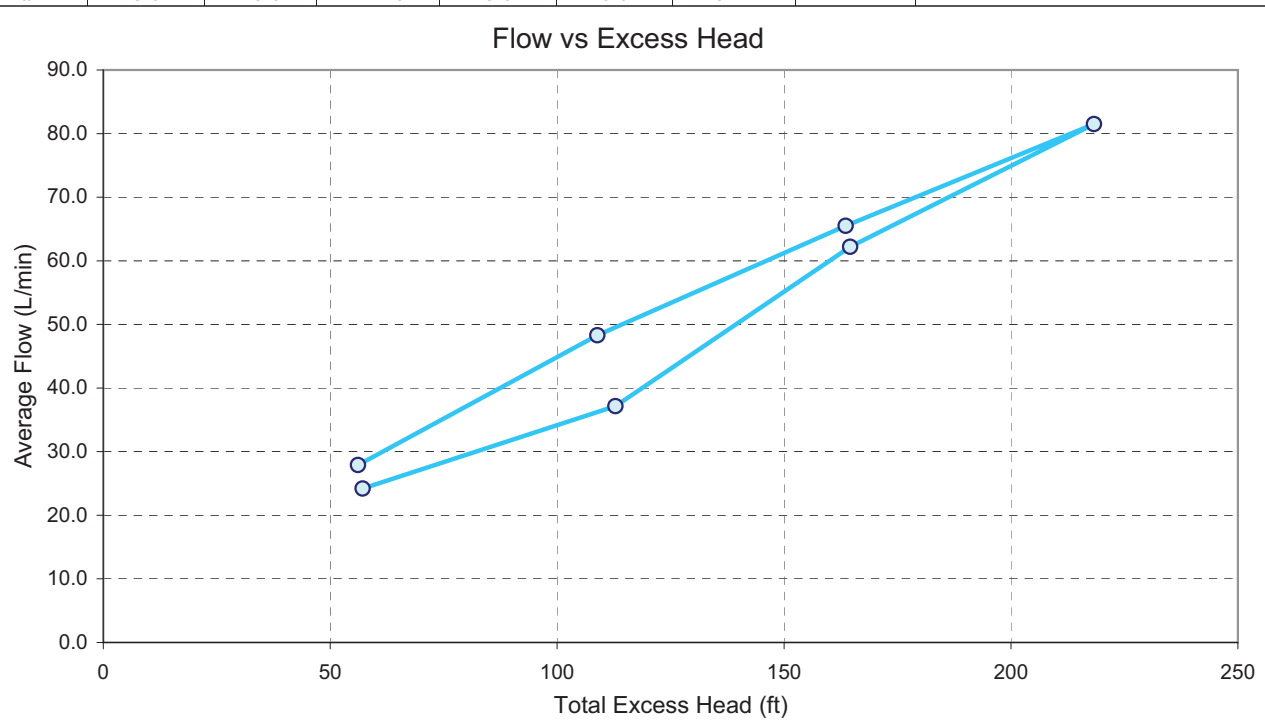
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8418 Testing @ 941 to 950 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	14

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	30-Jul-08	Apparent Current Depth of Drill Hole (ft):			**1200.0**
Drill Hole No:	**8418**	Test Section from (ft):	**1191.0**	to:	1200.0
Test No:	#4	Length of Test Section (ft):			**9.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	350	Height of Gauge (ft above datum):			4.4
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			65
Diameter of Drill Hole (mm):	122.6	Vertical Depth of Drill Hole (ft):			1087.6
ID of Drilling Rods (mm):	110.0	Vertical Depth of the Center of Test Section (ft):			1083.5

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	25.0	279.0	6.0	0.0	56.1	27.9	Drilled by PQ rods.
#2	10.0	50.0	483.0	11.0	0.0	108.9	48.3	Tested K of current lithology
#3	10.0	75.0	655.0	14.0	0.0	163.6	65.5	Fractured at 1193.5' and 1196'
#4	10.0	100.0	815.0	17.0	0.0	218.3	81.5	
#3	5.0	75.0	311.0	13.0	0.0	164.6	62.2	Water leak from casing, water loss
#2	7.0	50.0	260.0	7.0	0.0	112.9	37.1	not used in Lugeon calculation
#1	5.0	25.0	121.0	5.0	0.0	57.1	24.2	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	6.0E-06	4.7E-05	4.8E-06	4.5E-06	4.6E-06	4.0E-06	5.1E-06	**1.1E-05**	**48.60**

Schlumberger WATER SERVICES

130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

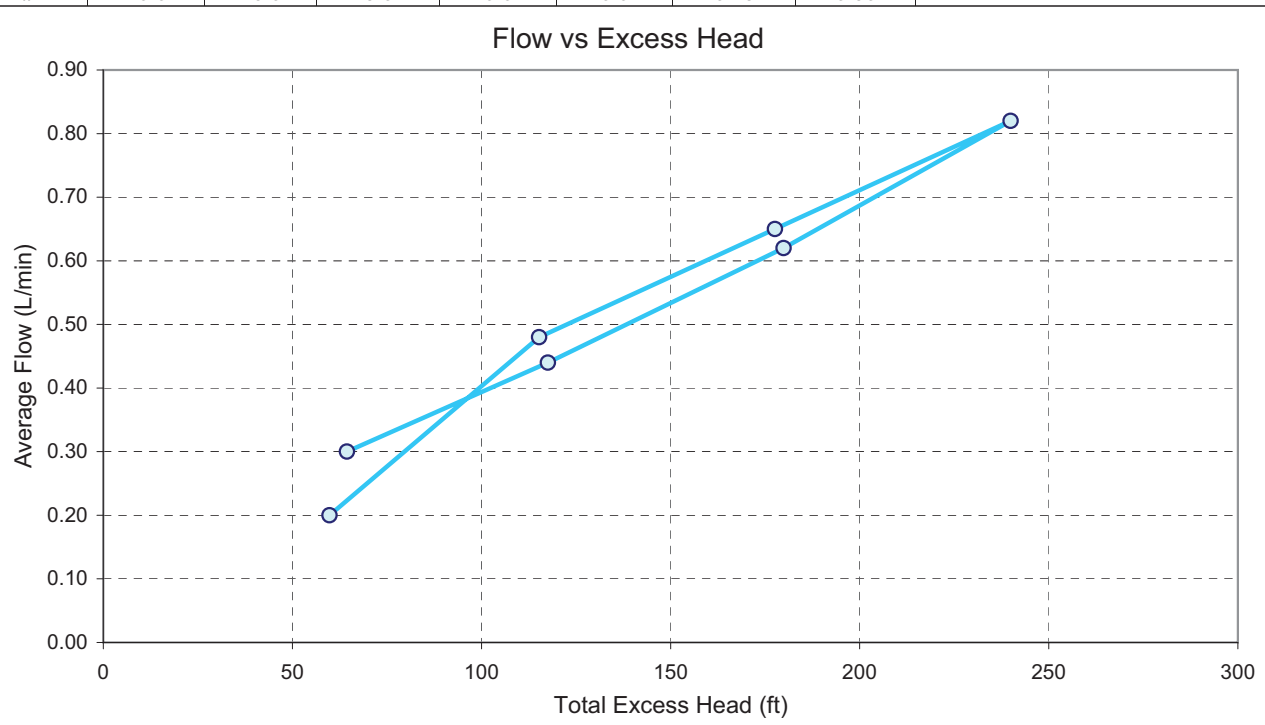
PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8418 Testing @ 1191 to 1200 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	15

PACKER TESTING - CONSTANT HEAD TEST (Hvorslev, 1951)

Date of Test:	30-Jul-08	Apparent Current Depth of Drill Hole (ft):			**1300.0**
Drill Hole No:	**8418**	Test Section from (ft):	**1291.0**	to:	1300.0
Test No:	#5	Length of Test Section (ft):			**9.0**
Packer Type:	Single	Static Groundwater Level (vertical ft below datum):			0.0
Inflation Pressure (psi):	350	Height of Gauge (ft above datum):			4.4
Casing Details:	n/a	Drill Hole Dip (deg from horizontal):			65
Diameter of Drill Hole (mm):	122.6	Vertical Depth of Drill Hole (ft):			1178.2
ID of Drilling Rods (mm):	110.0	Vertical Depth of the Center of Test Section (ft):			1174.1

If groundwater level is unknown during the test use depth of test center section

Injection Data				Friction Head Loss		Excess Head	Represent. Rate	Note
Stage	Duration	Pressure	Volume	Packer	Hose			
no.	min	psi	liters	ft	ft	ft	L/min	
zero	0	0	0.0	0	0	0	0.00	
#1	10.0	24.0	2.0	0.0	0.0	59.8	0.20	Drilled by PQ rods.
#2	10.0	48.0	4.8	0.0	0.0	115.3	0.48	Tested K of current lithology
#3	10.0	75.0	0.0	0.0	0.0	177.6	0.65	Flow meter stuck during #3
#4	10.0	102.0	8.2	0.0	0.0	239.9	0.82	
#3	10.0	76.0	6.2	0.0	0.0	179.9	0.62	
#2	10.0	49.0	4.4	0.0	0.0	117.6	0.44	
#1	10.0	26.0	3.0	0.0	0.0	64.5	0.30	



Bulk K (m/sec)	Stage no.							**Average K**	Lugeon
	#1	#2	#3	#4	#3 back	#2 back	#1 back		
	4.0E-08	4.4E-07	4.4E-08	4.1E-08	4.2E-08	4.5E-08	5.6E-08	**1.0E-07**	**0.45**

Schlumberger WATER SERVICES

130-10691 Shellbridge Way
Richmond, B. C. V6X 2W8
CANADA

PROJ. NO.:	7126		
PROJECT:	Pebble Project		
DETAILS:	8418 Testing @ 1291 to 1300 ft		
ENG.	VS	Checked:	
DATE	Jan 23/09	Sheet:	16

APPENDIX 8.1M

Drillhole Coordinates and Installation Details

Drillhole Coordinates and Installation Details

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
GH04-01	NFK	13	1386179.412	2171584.481	1065.20	0.60	1064.60	197	17.0	27.0	867.5	1047.5	1037.5
GH04-02	UTC	9	1405880.703	2170919.112	1149.30	1.10	1148.20	125	15.0	25.0	1022.5	1132.5	1122.5
GH04-03	SFK	5	1400582.038	2125932.278	933.81	0.30	933.51	405	47.0	57.0	529.7	887.7	877.7
GH04-04	SFK	5	1383248.191	2123685.942	923.08	0.50	922.58	304	64.9	74.9	619.9	859.0	849.0
GH04-05	SFK	4	1365294.721	2121512.331	771.24	0.30	770.94	210	28.0	38.0	561.3	743.3	733.3
GH04-06	SFK	3	1402985.621	2146959.178	966.23	0.85	965.38	213	26.0	36.0	754.8	941.8	931.8
GH04-07	NFK	14	1382512.408	2164276.637			1238.60	110		1.0	1130.6	1240.6	1239.6
GH04-08	SFK	1	1373554.055	2149963.472	1526.07	1.00	1525.07	135	26.0	36.0	1388.2	1497.2	1487.2
GH04-09	SFK	1	1377954.165	2135077.341			906.74	115	68.4	68.5	794.5	841.1	841.0
GH04-10	SFK	5	1395410.091	2123101.283	906.56	0.50	906.06	330	46.0	56.0	578.1	862.1	852.1
GH04-11	UTC	10	1406016.435	2128320.842	975.37	0.50	974.87	170	14.6	24.6	805.6	961.0	951.0
GH04-12 [a]			1392743.753	2123132.831			872.48						
GH04-12A	SFK	5	1393588.742	2122286.271	882.43	0.50	881.93	130	53.0	63.0	752.7	829.7	819.7
GH04-13	UTC	7	1392019.847	2117580.751	1053.70	0.50	1053.20	210	33.0	43.0	843.8	1020.8	1010.8
GH04-14	SFK	4	1382416.844	2121519.946	927.46	0.50	926.96	185	63.0	73.0	742.5	864.5	854.5
GH04-15	SFK	4	1380423.956	2123254.783			900.42	135	-0.1		768.2	903.3	903.2
GH04-16	SFK	5	1381837.721	2125117.155	889.72	0.16	889.56	175	89.0	99.0	711.2	797.1	787.1
GH04-17	SFK	5	1381593.211	2126016.392	841.41	0.26	841.15	195	27.0	37.0	645.6	813.6	803.6
GH04-18	SFK	5	1382119.535	2126851.246	832.43	0.40	832.03	177	44.5	54.5	653.6	786.1	776.1
GH04-19	SFK	1	1377771.816	2133668.227	880.92	0.90	880.02	120	5.0	15.0	760.1	875.1	865.1
GH04-20	SFK	1	1380419.612	2135284.213	1224.64	1.18	1223.46	105	4.0	14.0	1118.2	1219.2	1209.2
GH04-21	SFK	1	1376083.698	2135310.286			1216.56	105	68.0	68.1	1113.1	1150.1	1150.0
GH04-22	SFK	2	1382097.885	2136338.091	1133.80	1.11	1132.69	150	5.0	16.0	981.1	1126.1	1115.1
GH04-23	NFK	14	1381014.64	2164416.894	1365.32	0.56	1364.76	155	7.0	17.0	1210.3	1358.3	1348.3
GH04-24	NFK	15	1383094.122	2165121.486			1119.29	120		1.0	1001.7	1121.7	1120.7
GH04-25	NFK	14	1383711.501	2163357.987	1313.73	0.29	1313.44	185	65.0	75.0	1130.6	1250.6	1240.6
GH04-26	NFK	12	1396244.746	2158942.161	1556.28	0.20	1556.08	135	18.0	28.0	1423.0	1540.0	1530.0
GH04-27	SFK	3	1395817.398	2157550.194	1552.19	1.64	1550.55	125	22.0	32.0	1428.2	1531.2	1521.2
GH04-28	SFK	5	1398090.824	2137380.19	1155.94	0.31	1155.63	63	47.5	57.5	1093.5	1109.0	1099.0
GH04-29A	SFK	5	1399082.372	2135596.273	1028.03	0.20	1027.83	159	47.4	57.4	870.4	982.0	972.0
GH04-30	SFK	5	1394721.54	2132942.944	937.03	0.27	936.76	175	67.0	77.0	764.3	872.3	862.3
GH04-31	SFK	5	1400679.877	2133912.445	1009.90	0.30	1009.60	195	52.0	62.0	815.5	958.5	948.5
GH04-32	SFK	5	1401400.011	2132210.489	1213.06	0.50	1212.56	135	28.5	38.5	1077.4	1183.9	1173.9
GH04-33	SFK	5	1399306.726	2129091.446	903.56	0.13	903.43	335	46.5	57.0	569.5	858.0	847.5
GH04-34	SFK	5	1394853.66	2125647.611			895.20	300	300.0	300.0	597.5	597.5	597.5
GH04-35	SFK	5	1397713.311	2126745.952	889.49	0.76	888.73	190	56.0	66.0	700.1	834.1	824.1
GH04-36	UTC	7	1392907.738	2119651.062			950.62	155	155.0	155.0	797.8	797.8	797.8
GH04-37	SFK	5	1389713.099	2119794.874	975.91	0.33	975.58	295	139.0	149.0	681.7	837.7	827.7

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
GH04-38	SFK	5	1386306.241	2120506.915	942.39	0.14	942.25	190	50.0	60.0	752.9	892.9	882.9
GH04-39	SFK	5	1389231.256	2122704.719	910.25	0.50	909.75	120	23.0	33.0	791.7	888.7	878.7
GH04-40 [a]			1386099.664	2123815.026			926.13						
GH04-40A	SFK	5	1386139.394	2123860.218			926.71	255	255.0	255.0	673.8	673.8	673.8
GH04-41	SFK	5	1405003.465	2133603.733	941.05	0.30	940.75	120	83.0	93.0	822.7	859.7	849.7
GH04-42	SFK	5	1404565.985	2135122.128	1063.66	0.10	1063.56	150	81.0	91.0	916.2	985.2	975.2
GH04-43	SFK	5	1405208.345	2137829.183	1121.40	0.75	1120.65	110	90.0	100.0	1011.2	1031.2	1021.2
GH04-44	SFK	3	1402136.296	2138687.219	1097.58	0.30	1097.28	165	87.0	97.0	934.1	1012.1	1002.1
GH04-45A	SFK	3	1399992.345	2139344.609	1120.80	0.50	1120.30	255	73.0	84.0	868.4	1050.4	1039.4
GH04-46	SFK	3	1406713.369	2145789.649	1141.56	0.53	1141.03	135	73.0	84.0	1007.8	1069.8	1058.8
GH04-47	SFK	3	1404804.37	2147367.773	971.67	0.99	970.68	270	31.0	41.0	702.6	941.6	931.6
GH04-48	SFK	3	1399496.452	2147104.113	1182.42	0.62	1181.80	185	40.0	50.0	998.8	1143.8	1133.8
GH04-49 [a]			1407258.65	2158179.121			1020.25						
GH04-50 [a]			1411050.418	2159385.905			840.99						
GH05-51	SFK	5	1399172.627	2133996.613	999.16	1.00	998.16	445	215.0	225.0	555.7	785.7	775.7
GH05-52	SFK	5	1399788.06	2136767.709	1021.86	1.55	1020.31	308	110.0	120.0	714.6	912.6	902.6
GH05-53	UTC	10	1414412.912	2144518.002	1942.73	1.21	1941.52	135	20.0	30.0	1808.7	1923.7	1913.7
GH05-54	SFK	3	1412981.782	2147460.452	1997.22	0.54	1996.68	125	25.0	35.0	1874.6	1974.6	1964.6
GH05-55	SFK	3	1395551.856	2144992.728	1589.34	0.71	1588.63	125	3.5	13.0	1465.9	1587.4	1577.9
GH05-56	SFK	3	1398946.415	2148042.068	1356.89	0.84	1356.05	65	34.5	44.5	1293.5	1324.0	1314.0
GH05-57	NFK	12	1396011.772	2160438.915	1406.69	0.80	1405.88	125	26.0	37.0	1283.2	1382.2	1371.2
GH05-58	NFK	12	1395456.393	2156534.221	1503.89	0.85	1503.03	155	28.0	38.0	1350.2	1477.2	1467.2
GH05-59	SFK	3	1399205.431	2152099.626	1183.35	1.48	1181.87	175	68.0	78.0	1009.3	1116.3	1106.3
GH05-60	SFK	3	1400784.178	2150474.167	1105.73	0.86	1104.87	245	89.0	99.0	862.3	1018.3	1008.3
GH05-61	SFK	3	1402484.935	2148723.276	974.54	0.71	973.83	305	160.0	169.0	671.0	816.0	807.0
GH05-62	SFK	3	1405196.399	2148499.763			969.02	245	246.9	247.0	727.0	725.1	725.0
GH05-63	SFK	3	1406995.728	2148517.594	1039.85	1.58	1038.27	135	49.0	59.0	906.5	992.5	982.5
GH05-64	UTC	9	1410176.461	2152866.269	1017.78	0.84	1016.94	185	49.0	60.0	834.6	970.6	959.6
GH05-65	UTC	7	1399387.403	2121629.606	834.88	1.96	832.92	495	0.0	0.0	345.3	840.3	840.3
GH06-65	SFK	1	1372647.344	2149019.806	1645.98	2.68	1643.30	100	83.0	93.0	1549.0	1566.0	1556.0
GH06-66	NFK	15	1376040.162	2163509.359			1559.63	88	36.0	46.0	1477.3	1529.3	1519.3
GH06-67	NFK	14	1379185.348	2163943.477	1477.25	0.50	1476.75	123	33.0	43.0	1359.0	1449.0	1439.0
GH06-68	NFK	14	1380642.049	2162369.064	1209.20	0.50	1208.70	119	96.0	116.0	1095.2	1118.2	1098.2
GH06-69	NFK	14	1384085.425	2160942.854	1492.55	2.49	1490.06	159.5	45.0	55.0	1337.2	1451.7	1441.7
GH06-70D	SFK	3	1400212.092	2147905.264	1103.26	0.50	1102.76	139.8	117.5	137.5	969.5	991.8	971.8
GH06-70S	SFK	3	1400212.092	2147905.264	1103.26	0.50	1102.76	139.8	84.5	94.5	969.5	1024.8	1014.8
GH06-71 [b]	SFK	3	1401484.139	2147079.894			1010.83	90		1.0	920.8	1010.8	1009.8
GH06-71A	SFK	3	1401484.656	2147079.507	1005.87	0.50	1005.37	206	84.0	94.0	805.2	927.2	917.2
GH06-72	SFK	3	1403789.743	2147128.202	961.52	0.50	961.02	215	64.0	74.0	751.9	902.9	892.9
GH06-73	SFK	3	1406063.079	2146875.399			1000.80	158.5		1.0	848.1	1006.6	1005.6

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
GH06-74	SFK	3	1407904.629	2147513.692	1193.31	1.40	1191.91	140	34.0	44.0	1057.2	1163.2	1153.2
GH06-75	SFK	5	1400526.816	2136597.363	1020.56	2.17	1018.39	414.5	150.0	170.0	611.1	875.6	855.6
GH06-76	SFK	5	1401320.265	2135577.865	983.91	2.20	981.71	274.5	112.0	122.0	714.0	876.5	866.5
GH06-77	SFK	5	1400131.093	2135458.028			1019.86	482	126.0	136.0	544.6	900.6	890.6
GH06-78	UTC	9	1409794.115	2155946.301			909.02	149	33.5	43.5	766.4	881.9	871.9
GH06-79	UTC	9	1410562.221	2155392.95			950.81	120		1.0	837.0	957.0	956.0
GH06-80	SFK	3	1406799.942	2154863.876	1012.88	1.77	1011.11	217	38.0	48.0	799.7	978.7	968.7
GH07-81	NFK	14	1382565.817	2161332.286	1380.11	4.20	1375.91	164.5	11.0	21.0	1013.2	1030.2	1020.2
GH07-82D	NFK	14	1379583.623	2162942.037	1403.13	2.76	1400.37	215	116.6	126.6	948.2	1002.2	1001.2
GH07-82S	NFK	14	1379583.623	2162942.037	1403.36	2.99	1400.37	215	34.5	44.5	1032.1	1095.3	1085.2
GH07-83D	NFK	15	1374824.858	2163509.385		3.22	1598.16	164.5	20.0	30.0	1104.4	1168.0	1158.0
GH07-83S	NFK	15	1374824.858	2163509.385	1601.22	3.05	1598.16	164.5	9.0	19.0	1119.2	1139.7	1129.7
GH07-84	NFK	15	1375762.391	2164988.469	1477.59	3.08	1474.50	165	20.0	30.0	1143.6	1180.5	1160.7
GH07-85	NFK	14	1377732.729	2163903.879	1624.74	2.79	1621.95	154.5	44.0	54.0	849.9	861.6	851.6
GH07-86	NFK	15	1372867.754	2161120.808	1686.90	2.89	1684.02	165	10.0	20.0	1098.1	1126.6	1106.6
GH07-87D	NFK	14	1372353.55	2159295.68	1851.60	2.13	1849.46	260	189.0	199.0	1161.9	1191.9	1186.9
GH07-87S	NFK	14	1372353.55	2159295.68		2.20	1849.46	260	82.0	92.0	701.0	718.5	703.0
GH07-88	NFK	15	1372730.124	2162437.235	1622.89	2.33	1620.56	155	4.0	15.0	780.2	797.3	782.3
GH07-89D	NFK	15	1367910.547	2153619.02	1887.43	2.64	1884.79	154.1	70.0	80.0	815.1	834.1	824.1
GH07-89S	NFK	15	1367910.547	2153619.02		2.56	1884.79	154.1	40.0	50.0	872.2	884.2	879.2
GH07-90D [b]	NFK	15	1367772.548	2151061.026	1959.48	2.92	1956.57	170	80.0	90.0	769.5	780.9	770.9
GH07-90S	NFK	15	1367772.548	2151061.026		3.08	1956.57	170	20.0	30.0	814.1	819.1	814.1
GH07-91	SFK	1	1368765.366	2149767.098	1885.40	3.08	1882.32	155	19.5	29.5	684.0	694.0	684.0
GH07-92D	SFK	1	1370764.808	2149447.327	1695.45	2.23	1693.22	160	65.0	75.0	718.9	756.9	746.9
GH07-92S	SFK	1	1370764.808	2149447.327		2.17	1693.22	160	20.0	30.0	783.3	803.3	793.3
GH07-93	SFK	1	1373639.993	2149128.762	1513.34	2.58	1510.76	205	33.7	43.5	1065.8	1079.8	1069.8
GH07-94	SFK	1	1374743.145	2148733.327	1672.11	2.95	1669.16	139	15.0	25.0	736.7	757.7	747.7
GH07-95	NFK	14	1379810.507	2155439.693	1364.45	2.73	1361.72	129.7	18.0	28.0	770.2	781.6	771.6
GH07-96D	NFK	14	1381752.557	2156210.551	1390.26	2.43	1387.83	195	70.0	80.0	799.7	832.6	812.6
GH07-96S	NFK	14	1381752.557	2156210.551		2.49	1387.83	195	30.0	40.0	685.6	712.6	697.6
GH07-97D	NFK	14	1382608.647	2154726.287	1493.92	2.79	1491.13	185	70.0	80.0	731.2	767.2	757.2
GH07-97S	NFK	14	1382608.647	2154726.287		2.79	1491.13	185	30.0	40.0	821.1	847.1	832.1
GH07-98D	NFK	14	1384912.694	2152902.133	1742.72	2.89	1739.83	229.5	79.5	89.5	956.5	996.5	986.5
GH07-98S	NFK	14	1384912.694	2152902.133		3.05	1739.83	229.5	40.0	50.0	871.0	890.0	875.0
GH07-99	NFK	14	1385450.921	2154210.09	1896.64	2.99	1893.65	160	10.0	20.0	910.5	930.5	920.5
GH07-100	NFK	14	1384518.431	2151718.465	1911.60	3.18	1908.42	180	24.5	34.5	300.0	939.2	929.2
GH07-101	NFK	13	1387533.358	2166748.817	1164.46	3.01	1161.45	119.5	15.0	25.0	894.6	909.1	899.1
GH07-102D	NFK	13	1383762.883	2168707.375	1141.58	1.83	1139.75	133	90.0	100.0	868.0	881.4	871.4
GH07-102S	NFK	13	1383762.883	2168707.375		1.83	1139.75	133	30.0	40.0	885.4	912.1	902.1
GH07-103D	NFK	12	1386316.031	2165174.042	1237.04	2.70	1234.34	130	75.0	85.0	856.3	1006.3	1005.3
GH07-103S	NFK	12	1386316.031	2165174.042		2.55	1234.34	130	16.0	26.0	823.4	873.4	863.4

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
GH07-104	SFK	3	1408702.633	2153136.385	999.46	3.22	996.24	195	175.0	184.8	1009.1	1009.1	1009.1
GH07-105	SFK	3	1406897.562	2152552.068	991.92	3.08	988.84	170	153.0	163.0	966.5	977.5	967.5
GH07-106	SFK	3	1406499.985	2150670.451	978.35	2.40	975.96	115	69.5	79.5	992.5	1004.5	994.5
GH08-107	SFK	3	1407556.95	2154629.547	1028.02	2.53	1025.50	355	125.0	135.0	933.0	954.0	944.0
GH08-108	UTC	9	1410500.71	2157069.087	862.72	3.10	859.62	75			1020.6	1039.6	1029.6
GH08-109	UTC	9	1408606.954	2154403.861	991.61	1.97	989.64	139.5	97.5	107.5	1470.3	1484.3	1474.3
GH08-110	UTC	9	1409305.416	2157259.197	896.63	2.43	894.21	75	58.5	68.5	1512.3	1527.3	1517.3
GH08-111	SFK	3	1407626.615	2153774.22	989.55	3.81	985.75	119.5	92.0	102.0	1014.4	1030.4	1020.4
GH08-112	UTC	9	1408340.802	2155882.418	1006.35	2.82	1003.53	380	238.0	258.0	1062.5	1085.5	1070.5
GH08-113	SFK	3	1408278.082	2151708.235	1000.11	2.36	997.74	105	59.0	79.0	1097.4	1109.4	1099.4
GH08-114	UTC	9	1408781.049	2159451.935	885.07	2.82	882.25	34.7	12.5	22.5	1447.9	1469.9	1455.9
GH08-115	UTC	9	1409718.586	2154431.312	1014.86	2.13	1012.73	200	164.5	174.5	1081.4	1107.1	1097.1
GH08-116	UTC	9	1409245.013	2158612.768	889.70	3.05	886.65	30	12.5	22.5	1214.8	1227.3	1217.3
GH08-117	UTC	9	1415033.754	2157484.803	1042.27	2.56	1039.71	75	35.0	44.0	1245.1	1260.9	1250.9
GH08-118	UTC	9	1415045.382	2156297.745	1036.32	3.97	1032.35	85	20.0	30.0	857.8	918.5	903.5
GH08-119	UTC	9	1411549.419	2157798.482	846.03	3.31	842.71	105	14.5	25.5	978.8	982.8	979.8
GH08-120	UTC	9	1410536.224	2158438.651	850.76	3.51	847.25	50	21.5	31.5	705.2	717.2	707.2
GH08-121	UTC	9	1411364.434	2154708.698	1041.65	3.67	1037.98	135	105.0	115.0	813.7	823.2	813.2
GH08-122D	UTC	9	1411477.406	2156616.94	868.42	2.36	866.06	115	101.0	111.0	680.4	697.3	682.3
GH08-122S	UTC	9	1411477.406	2156616.94	868.29	2.23	866.06	115	36.0	56.0	768.3	781.3	771.3
GH08-123	SFK	3	1404831.653	2151512.066	971.14	2.00	969.14	42.7	18.0	28.0	823.0	830.4	825.4
GH08-124	UTC	9	1412342.426	2163597.153	905.80	3.28	902.52	155	134.5	144.5	732.0	809.8	789.8
GH08-125	SFK	3	1405927.423	2154974.703	979.28	2.53	976.76	150	95.0	105.0	762.6	775.6	765.6
GH08-126	UTC	9	1411129.408	2163433.789	923.99	3.18	920.81	65	25.0	35.0	768.7	782.9	772.9
GH08-127	UTC	9	1407492.961	2165461.798	1066.85	2.53	1064.32	155	110.0	120.0	848.7	865.6	850.6
GH08-128	SFK	3	1395164.96	2154862.132	1461.81	2.89	1458.92	285	95.0	105.0	737.6	750.7	740.7
GH08-129	SFK	3	1399033.736	2160023.877	1547.75	2.76	1545.00	70	35.0	45.0	781.1	796.9	786.9
GH08-130	UTC	9	1400918.586	2161359.427	1462.57	2.92	1459.65	240	34.0	44.0	715.7	734.5	724.5
GH08-131	UTC	9	1405027.768	2162692.578	1059.44	3.18	1056.26	79.5	60.0	70.0	774.1	783.1	778.1
GH08-132	UTC	9	1403062.729	2162315.418	1159.11	2.56	1156.56	172.5	30.0	41.0	800.1	810.3	805.3
GH08-133	SFK	3	1395849.324	2149819.801	1666.69	3.31	1663.37	115	14.5	24.5	840.3	847.3	842.3
GH08-134	UTC	9	1400788.394	2163080.656	1352.50	2.99	1349.51	160	62.5	72.5	772.0	779.3	774.3
GH08-135	SFK	2	1395978.918	2147417.867	1764.48	2.69	1761.79	110	90.0	100.0	846.3	854.9	849.9
GH08-136	NFK	14	1376848.155	2163749.275	1612.79	2.62	1610.17	120	100.0	110.0	789.8	862.5	852.5
GH08-137	SFK	5	1404282.911	2137817.337	1041.61	3.54	1038.07	250	128.0	138.0	739.6	812.1	802.1
GH08-138	NFK	15	1375431.094	2163441.147	1579.60	2.39	1577.21	275	140.0	160.0	845.4	855.6	845.6
GH08-139	SFK	2	1391026.78	2143730.309	1713.68	2.85	1710.82	125	105.0	115.0	909.4	921.8	911.8
GH08-140	SFK	1	1376604.725	2139746.138	1028.83	3.64	1025.19	135	114.5	124.5	943.3	949.4	944.4
GH08-141	NFK	15	1374035.844	2163203.612	1727.91	2.92	1724.99	87	40.0	50.0	791.2	811.7	791.7
GH08-142	SFK	2	1389982.839	2143921.258	1805.06	2.69	1802.37	164.5	140.0	150.0	875.1	884.4	874.4
GH08-143	SFK	1	1375861.529	2140606.253	1064.24	3.58	1060.66	335	165.0	175.0	945.1	953.7	948.7

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
GH08-144	NFK	15	1373646.932	2162614.441	1699.28	2.39	1696.88	95	20.0	30.0	757.1	778.6	768.6
GH08-145	SFK	2	1389707.48	2144874.07	1878.57	2.46	1876.11	110	40.0	50.0	890.9	904.7	894.7
GH08-146	NFK	15	1373192.631	2161934.115	1658.21	3.02	1655.20	105	40.0	50.0	762.5	773.3	763.3
GH08-147	SFK	2	1389042.85	2145197.513	1901.54	2.26	1899.28	104.5	84.0	94.0	865.2	871.2	866.2
GH08-148	NFK	14	1374534.395	2161336.571	1614.63	2.56	1612.07	243	205.0	225.0	863.4	873.9	863.9
GH08-149	SFK	2	1387537.799	2144120.477	1972.95	3.12	1969.84	119.5	60.0	70.0	822.4	851.5	836.8
GH08-150	SFK	1	1377288.851	2140641.317	1081.38	3.71	1077.67	320	40.0	50.0	910.3	922.9	912.9
GH08-151	NFK	14	1376095.94	2162304.655	1521.78	2.23	1519.55	280	80.0	90.0	981.7	992.2	982.2
GH08-152	SFK	1	1386914.784	2144131.037	1950.80	2.99	1947.82	104.5	85.0	95.0	725.4	739.4	729.4
GH08-153	SFK	2	1386570.415	2146741.526	1821.88	3.12	1818.77	59.5	20.0	30.0	797.9	813.9	803.9
GH08-154	SFK	2	1391260.226	2149451.296	1491.07	3.05	1488.01	165	40.0	50.0	835.6	843.4	838.4
GH08-155	SFK	1	1379360.444	2140570.483	1311.29	3.64	1307.64	240	200.0	220.0	869.2	892.7	872.7
GH08-156	NFK	14	1377347.737	2161809.061	1420.91	2.43	1418.48	180	120.0	130.0	960.7	967.9	957.9
GH08-157	SFK	2	1391522.398	2148412.842	1548.50	3.71	1544.80	298.75	212.0	222.0	873.2	879.4	869.4
GH08-158	NFK	15	1372125.916	2160505.777	1754.00	2.69	1751.31	500	280.0	290.0	874.8	885.7	875.7
GH08-159	SFK	1	1383070.262	2140693.468	1400.06	3.12	1396.94	235	20.0	30.0	940.2	952.5	942.5
GH08-160	SFK	1	1380710.931	2137160.134	1097.57	3.08	1094.49	329.5	20.0	30.0	969.2	974.6	969.6
GH08-161	SFK	1	1384942.267	2141486.016	1764.14	3.77	1760.37	101	20.0	30.0	858.9	878.4	868.4
GH08-162	SFK	1	1373274.109	2138216.444	1339.07	2.53	1336.54	200	25.0	35.0	900.9	906.1	901.1
GH08-163	NFK	14	1380080.111	2160009.372	1266.48	1.97	1264.51	215	125.0	140.0	766.3	785.8	775.8
GH08-164	NFK	14	1385809.135	2155407.245	2026.65	3.77	2022.88	106	50.0	60.0	894.4	902.6	897.6
GH08-165	NFK	12	1388006.88	2156400.38	1828.96	2.72	1826.24	130	60.0	70.0	789.5	810.5	790.5
GH08-166	NFK	14	1381741.585	2159923.437	1400.80	1.94	1398.86	235	120.0	140.0	775.2	805.8	795.8
GH08-167	NFK	12	1386522.584	2157139.389	1986.30	2.89	1983.41	106	80.0	90.0	758.9	770.4	760.1
GH08-168	NFK	14	1372501.66	2158897.794	1867.75	3.35	1864.41	335	245.0	265.0	861.7	884.5	879.5
GH08-169	NFK	14	1369359.54	2153063.486	1939.09	2.76	1936.34	499.5	1.0	2.0	861.1	874.2	864.2
GH08-170	SFK	1	1367111.992	2147895.441	1979.18	3.97	1975.21	500	1.0	2.0	921.7	931.9	921.9
GH08-171	SFK	1	1370411.364	2147240.695	1588.01	2.39	1585.62	150	35.0	45.0	976.8	988.4	978.4
GH08-172	SFK	1	1371504.59	2147900.733	1456.77	2.82	1453.95	235	55.0	65.0	1024.9	1000.1	1000.0
GH08-173	SFK	1	1372111.637	2146474.632	1341.12	2.69	1338.43	220	130.0	140.0	935.4	947.9	937.9
GH08-174	SFK	1	1373009.881	2145190.781	1262.65	2.46	1260.19	170	150.0	160.0	955.7	966.7	956.7
GH08-175	SFK	1	1373749.319	2147146.486	1565.86	3.02	1562.84	145	125.0	135.0	997.6	1009.6	999.6
GH08-176	SFK	1	1371615.638	2140250.184	1574.74	2.99	1571.76	145	60.0	70.0	890.3	948.3	938.3
GH08-177	NFK	12	1392383.136	2162765.473	1335.57	2.62	1332.95	300	195.0	205.0	877.4	920.4	910.4
GH08-178	NFK	12	1392234.125	2161568.847	1344.68	2.30	1342.38	260	105.0	115.0	941.3	960.3	950.3
GH08-179	NFK	12	1391461.618	2162014.819	1308.49	2.89	1305.61	215	105.0	115.0	885.0	896.0	886.0
GH08-180	NFK	12	1391006.828	2162954.652	1271.86	2.66	1269.21	240	47.0	67.0	905.2	917.2	912.2
GH08-181D	NFK	12	1390020.037	2165357.406	1200.23	3.31	1196.92	120	50.0	60.0	955.3	973.3	963.3
GH08-181S	NFK	12	1390020.037	2165357.406	1200.17	3.25	1196.92	120	15.0	25.0	1134.7	1165.1	1155.1
GH08-182	NFK	12	1388906.635	2160151.941	1564.36	3.44	1560.92	165	25.0	35.0	939.0	957.0	947.0
GH08-183	NFK	12	1391073.986	2159866.113	1308.60	2.85	1305.74	270	170.0	180.0	1028.1	1066.4	1056.4

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
GH08-184	NFK	14	1377776.35	2158752.417	1467.01	3.05	1463.96	49.7	30.0	40.0	880.5	893.5	886.5
GH08-185	NFK	14	1379059.084	2158948.92	1372.98	3.28	1369.70	60	40.0	50.0	767.2	785.2	777.2
GH08-186	NFK	14	1379386.572	2160727.311	1315.98	3.41	1312.57	24.5	10.0	20.0	746.5	755.9	747.5
GH08-187	NFK	14	1383083.145	2159910.246	1497.27	3.38	1493.89	145	50.0	60.0	815.4	815.4	815.4
GH08-188 [b]	NFK	14	1384805.081	2159682.359	1763.98	3.18	1760.79	90	35.0	45.0	880.9	884.9	880.9
GH08-189D	NFK	12	1392769.528	2160624.14	1374.26	3.02	1371.25	350	210.0	220.0	836.5	848.8	837.8
GH08-189S	NFK	12	1392769.528	2160624.14	1374.26	3.02	1371.25	350	180.0	185.0	882.5	882.5	882.5
GH08-190	SFK	2	1386093.781	2134335.627	961.66	2.39	959.26	160	55.0	65.0	651.5	1009.7	999.7
GH08-191	SFK	2	1390876.479	2137550.92	1008.67	4.40	1004.27	180	75.0	85.0	928.9	965.5	955.5
GH08-192	NFK	12	1392336.928	2156357.508	1375.38	3.94	1371.45	255	155.0	165.0	747.4	772.4	752.4
GH08-193	SFK	2	1383319.96	2136060.458	1105.87	3.38	1102.49	150	30.0	40.0			
GH08-194	NFK	12	1392891.843	2153257.61	1511.26	2.79	1508.47	225	60.0	70.0	811.6	876.5	861.0
GH08-195	SFK	1	1377408.171	2132718.627	886.98	3.67	883.30	165.5	25.0	35.0	922.1	931.1	926.1
GH08-196	NFK	12	1394473.194	2152343.792	1906.95	3.87	1903.08	105	51.5	61.5	870.0	915.0	900.0
GH08-197A	SFK	1	1376956.645	2138198.227	968.14	2.66	965.49	45	32.5	42.5	1003.5	1014.0	1004.0
GH08-197B	SFK	1	1376948.078	2138184.175	967.97	2.66	965.31	400	138.0	148.0	735.7	756.2	736.2
GH08-198	NFK	12	1395936.149	2162342.141	1416.25	3.38	1412.87	200	35.0	45.0	813.1	819.1	814.1
GH08-199D	SFK	1	1380180.008	2139427.097	1329.77	2.59	1327.18	245	110.0	130.0	683.0	693.0	683.0
GH08-199S	SFK	1	1380180.008	2139427.097	1330.09	2.92	1327.18	245	70.0	85.0	762.7	772.7	762.7
GH08-200	UTC	9	1399869.46	2164707.681	1442.47	3.54	1438.93	150	60.0	70.0	806.0	811.8	806.8
GH08-201 [b]	UTC	9	1401338.067	2164346.093			1292.22	238		0.5	569.0	579.5	569.5
GH08-202	UTC	9	1404030.996	2163893.166			1069.34	125		0.5	706.8	716.8	706.8
GH08-203	SFK	1	1373795.095	2140308.643	1302.13	3.28	1298.85	230	33.0	43.0	727.5	734.0	729.0
GH08-204	SFK	3	1408822.867	2146401.722	1209.10	3.94	1205.16	240	123.0	133.0	1112.0	1142.0	1141.5
GH08-205D [b]	SFK	2	1393051.22	2145204.437	1111.59	3.02	1108.57	155	77.0	97.0	1159.0	1263.0	1262.5
GH08-205S [b]	SFK	2	1393051.22	2145204.437	1111.69	3.12	1108.57	155	30.5	50.5	1218.2	1371.7	1361.7
GH08-206D	SFK	2	1392479.493	2149488.013	1202.23	2.66	1199.57	270	155.0	165.0	1192.1	1290.5	1280.5
GH08-206S	SFK	2	1392479.493	2149488.013	1202.10	2.53	1199.57	270	100.0	110.0	1192.1	1372.6	1362.6
GH08-207D	SFK	3	1410638.545	2147465.691	1482.59	3.84	1478.75	115	94.0	104.0	1440.4	1584.9	1574.9
GH08-207S	SFK	3	1410638.545	2147465.691	1482.59	3.84	1478.75	115	35.0	45.0	1440.4	1595.9	1585.9
GH08-208	SFK	2	1392562.991	2150662.234	1518.29	3.08	1515.21	200	54.0	64.0	1316.0	1461.0	1451.0
GH08-209	SFK	3	1409363.915	2144556.732	1225.13	3.18	1221.95	165	64.0	74.0	1473.9	1584.4	1574.4
GH08-210D [b]	SFK	3	1407171.193	2146874.867	1096.86	4.33	1092.53	145	120.0	130.0	1525.0	1680.0	1670.0
GH08-210S [b]	SFK	3	1407171.193	2146874.867	1097.45	4.92	1092.53	145	75.0	85.0	1595.1	1666.1	1656.1
I-125	SFK	3	1404404.213	2155931.87	1005.94	0.29	1005.65	708.31	69.1	79.1	1595.1	1773.1	1763.1
I-172	UTC	9	1403968.337	2159322.439	1024.09	0.37	1023.72	132	117.4	127.5	1471.4	1622.4	1611.4
I-192	SFK	3	1404945.19	2158376.348	1003.22	0.29	1002.93	141.5	128.1	138.1	1736.3	1820.4	1810.4
I-201	SFK	3	1405669.355	2157742.466	1055.59	0.21	1055.38	170	143.3	153.3	1736.3	1850.4	1840.4
KP-04	SFK	3	1405309.772	2157301.874	1009.74	3.46	1006.28	150		1.0	1793.1	1883.1	1873.1
KP-P1/SRK-2	UTC	9	1406267.369	2159571.243	995.78	2.90	992.88	174	124.0	134.0	1793.1	1943.1	1933.1

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
KP-P2/SRK-4	SFK	3	1406397.037	2156162.99		no install	1044.18	39	39.0	39.0	1734.0	1869.5	1859.5
KP-P3D/SRK-5D	SFK	3	1401942.567	2154180.384	1045.26	2.20	1043.06	79	68.0	78.0	1538.8	1633.8	1623.8
KP-P3M/SRK-5M	SFK	3	1401951.863	2154192.385	1045.84	2.70	1043.14	53	41.0	51.0	1538.8	1678.8	1668.8
KP-P3S/SRK-5S	SFK	3	1401972.049	2154169.937	1045.41	2.82	1042.59	25	8.0	18.0	1312.2	1483.5	1473.7
KP-P4	SFK	3	1406223.045	2155591.009	1003.22	3.46	999.76	54		1.0	1537.2	1661.2	1651.2
M-12	SFK	3	1400378.436	2157544.63	1201.78	0.17	1201.61	100	36.4	46.4	1199.0	1324.0	1314.0
M-21	SFK	3	1400689.919	2157582.972	1216.15	0.28	1215.87	100	79.5	89.5	1199.0	1364.0	1354.0
M-62	SFK	3	1401231.576	2158728.515	1320.89	0.54	1320.35	180	143.1	163.0	1311.9	1426.9	1416.9
M-110	SFK	3	1402420.504	2159036.078	1179.24	0.13	1179.11	150	86.9	97.0	1238.6	1350.3	1340.3
MW-05-02M	UTC	7	1399436.503	2121667.139	832.99	1.73	831.26	63.9	52.5	62.5	1311.9	1466.9	1456.9
MW-05-02S	UTC	7	1399444.077	2121654.214	833.34	2.60	830.74	18.5	13.5	18.5	1516.9	1666.9	1656.9
MW-05-11SS	SFK	5	1398356.433	2126298.225	882.94	2.60	880.34	33	21.3	31.3	1516.9	1706.4	1696.4
MW-05-12D	SFK	3	1399175.088	2155571.378	1228.82	2.20	1226.62	130.5	102.0	122.0	1740.1	1890.1	1880.1
MW-05-12S	SFK	3	1399194.961	2155584.734	1228.21	2.30	1225.91	66	36.0	41.0	1735.6	1891.1	1881.1
MW-05-13D	SFK	4	1376781.553	2127182.091	813.62	2.37	811.25	112	94.5	110.0	1049.9	1154.4	1144.4
MW-05-13S	SFK	4	1376799.201	2127166.901	813.32	1.96	811.36	33	15.9	30.9	1012.5	1055.5	1045.5
MW-05-14D	SFK	5	1405519.742	2131539.53	925.33	2.60	922.73	110	91.0	101.0	1012.5	1115.5	1105.5
MW-05-14S	SFK	5	1405502.676	2131549.776	924.80	2.03	922.77	53	41.0	46.0	1111.4	1166.4	1156.4
MW-1D	SFK	4	1378224.506	2124912.641	819.12	2.52	816.60	134.5	124.5	134.5	1034.1	1049.1	1039.1
MW-1M	SFK	4	1378236.685	2124906.169	818.67	1.38	817.29	100	62.0	72.0	1108.0	1120.5	1111.5
MW-1S	SFK	4	1378206.184	2124920.496	820.10	3.86	816.24	35	15.0	25.0	1061.9	1066.9	1061.9
MW-2M	UTC	7	1399454.651	2121671.318	832.77	2.37	830.40	147	120.0	135.0	1123.5	1135.5	1125.5
MW-2S	UTC	7	1399459.36	2121655.204	832.45	2.42	830.03	101	65.0	75.0	1162.4	1173.6	1164.6
MW-3D	SFK	5	1400176.348	2136063.554	1026.97	2.87	1024.10	205	179.0	194.0	1390.3	1399.3	1394.3
MW-4	UTC	9	1407533.159	2158182.566	1011.54	2.69	1008.85	55	15.0	25.0	1456.7	1463.7	1458.7
MW-5D	SFK	3	1403272.445	2149287.525	980.31	2.35	977.96	109	90.0	105.0	1256.8	1271.8	1256.8
MW-5M	SFK	3	1403291.406	2149285.041	980.71	2.85	977.86	75	55.0	65.0	914.8	929.0	924.0
MW-5S	SFK	3	1403286.201	2149303.569	980.40	2.80	977.60	52	31.0	41.0	841.2	846.2	841.2
MW-6D	NFK	12	1382243.203	2168254.358	1120.55	2.58	1117.97	100	81.0	91.0	986.9	1001.9	991.9
MW-7D	NFK	14	1373316.039	2150205.354	1546.05	3.22	1542.83	75	61.0	71.0	1017.3	1030.2	1025.2
MW-7S	NFK	14	1373295.911	2150210.528	1547.51	3.05	1544.46	35	20.0	30.0	1018.1	1026.1	1021.1
MW-8D	NFK	13	1400005.758	2172701.569	1117.27	2.71	1114.56	103	87.0	97.0	1093.6	1100.6	1095.6
MW-8M	NFK	13	1399992.889	2172688.012	1117.12	2.56	1114.56	55	32.0	47.0	895.4	905.4	895.4
MW-8S	NFK	13	1399989.463	2172705.458	1117.53	3.16	1114.37	20	8.0	18.0	884.7	996.7	986.7
MW-9D	NFK	14	1373501.33	2150021.845	1528.19	2.90	1525.29	80	58.0	72.0	940.1	1037.1	1027.1
MW-10	NFK	15	1382987.693	2165426.137	1110.48	2.70	1107.78	44	30.0	40.0	1111.4	1225.4	1215.4
MW-11D	SFK	5	1398334.396	2126318.899	884.10	2.92	881.18	147	126.0	136.0	808.3	828.3	818.5
MW-11M	SFK	5	1398337.707	2126303.57	884.67	3.29	881.38	113.5	102.1	112.1	825.7	842.7	832.7
MW-11S	SFK	5	1398343.45	2126290.58	884.31	2.77	881.54	84	51.1	71.1	867.7	913.2	903.2
P-05-07D	SFK	3	1397003.162	2154758.319	1294.13	2.23	1291.90	213	187.3	197.3	1532.1	1581.6	1571.6
P-05-07S	SFK	3	1397024.777	2154737.179	1292.41	2.28	1290.13	77.8	65.3	75.3	1597.8	1607.8	1597.8

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
P-05-08	SFK	3	1397919.989	2157152.44	1322.32	2.30	1320.02	77.7	62.0	72.0	1796.8	1806.8	1796.8
P-05-09	UTC	9	1406040.751	2158727.621	999.78	2.40	997.38	142	81.3	96.3	1828.4	1838.4	1828.4
P-05-09S	UTC	9	1406040.751	2158727.621	999.68	2.30	997.38	21	17.0	20.0	894.3	904.3	894.3
P-05-10D	SFK	5	1387050.51	2125582.302	843.07	1.70	841.37	138	126.0	136.0	976.4	995.9	985.9
P-05-10S	SFK	5	1387027.258	2125596.795	843.63	2.40	841.23	29.5	20.1	30.1	1024.3	1034.3	1024.3
P-05-11D	SFK	5	1392611.268	2124160.241	846.84	2.30	844.54	166	149.2	164.2	956.7	966.5	956.7
P-05-11M	SFK	5	1392627.07	2124149.45	846.69	2.34	844.35	78	65.0	75.0	922.3	944.2	924.5
P-05-11S	SFK	5	1392610.523	2124148.702	845.90	1.85	844.05	23	15.6	20.6	874.5	884.3	874.5
P-05-12	SFK	5	1389591.881	2127784.392	870.42	2.30	868.12	138	60.2	80.2	846.1	857.3	847.3
P-05-13	SFK	5	1391481.808	2130680.997	879.90	2.20	877.70	117	104.0	114.0	889.4	899.4	889.4
P-05-14D	SFK	5	1395410.986	2130750.554	886.65	2.20	884.45	118	103.9	113.9	966.9	972.1	967.1
P-05-14S	SFK	5	1395391.179	2130773.679	886.61	2.20	884.41	38	21.1	36.1	791.0	801.2	791.3
P-05-15D	SFK	5	1394030.171	2127495.016	864.49	2.10	862.39	126.7	113.7	123.7	909.8	920.0	910.2
P-05-15S	SFK	5	1394023.461	2127475.935	863.95	2.00	861.95	83	67.2	77.2	953.0	977.8	968.0
P-05-16D	UTC	7	1395662.171	2120883.396	860.41	2.60	857.81	144	125.2	135.2	1430.1	1452.9	1433.2
P-05-16M	UTC	7	1395680.865	2120876.68	860.08	2.45	857.63	88	79.0	84.0	1486.0	1492.2	1488.2
P-05-16S	UTC	7	1395665.361	2120861.899	858.15	2.20	855.95	58	47.8	52.8	1327.8	1354.6	1335.0
P-05-16SS	UTC	7	1395645.074	2120868.718	858.99	2.60	856.39	18	11.0	16.0	1377.5	1389.5	1383.5
P-05-17D	SFK	5	1395676.416	2124063.965	909.71	2.40	907.31	137	129.7	134.7	870.6	889.6	876.6
P-05-17S	SFK	5	1395668.913	2124025.382	909.50	2.40	907.10	62.5	53.9	58.9	879.0	897.6	887.6
P-05-18	SFK	5	1397982.268	2124459.992	914.66	1.90	912.76	125	52.3	62.3	907.0	927.0	907.0
P-05-19M	UTC	7	1401987.4	2123990.502	883.33	2.20	881.13	143.5	71.0	81.0	589.1	598.5	589.1
P-05-19S	UTC	7	1402017.69	2123965.891	883.31	1.98	881.33	38	27.8	37.8	772.5	828.3	818.5
P-05-20D	SFK	3	1405009.647	2145704.914	972.35	2.40	969.95	63.5	51.1	61.1	874.5	886.0	876.2
P-05-20S	SFK	3	1405012.695	2145729.88	972.47	2.30	970.17	30	23.9	28.9	753.2	778.0	758.3
P-05-21D	SFK	3	1402601.37	2145774.533	964.64	2.30	962.34	173.5	153.0	173.0	800.7	811.5	801.7
P-05-21M	SFK	3	1402611.012	2145796.653	964.32	2.10	962.22	89	79.8	89.8	836.1	848.6	838.8
P-05-21S	SFK	3	1402618.181	2145817.502	964.13	1.90	962.23	19.5	10.9	15.9	823.3	844.0	834.1
P-05-22D	SFK	3	1402868.99	2142370.316	993.82	1.94	991.88	237	215.5	225.5	862.3	874.6	864.8
P-05-23	SFK	5	1399576.28	2131333.679	952.48	1.60	950.88	62.5	48.7	58.7	707.6	723.9	714.1
P-05-24D	SFK	5	1403034.713	2128064.528	903.83	1.80	902.03	142	131.2	141.1	749.5	761.0	751.0
P-05-24S	SFK	5	1403044.255	2128088.403	903.89	2.00	901.89	39	33.0	38.0	859.7	870.0	860.2
P-05-25D	SFK	5	1405574.998	2131539.797	924.98	2.10	922.88	62	51.5	61.5	1023.9	1036.0	1026.2
P-05-26D	SFK	5	1399727.704	2135000.27	1011.90	1.80	1010.10	190	160.9	175.6	1054.9	1059.9	1054.9
P-05-26M	SFK	5	1399709.489	2135007.319	1013.37	2.80	1010.57	102.6	90.0	100.0	997.3	1011.0	1001.4
P-05-26S	SFK	5	1399727.361	2134985.617	1011.82	2.60	1009.22	30	19.5	29.5	1030.4	1040.4	1030.4
P-05-27D	UTC	7	1399813.15	2123737.524	873.85	2.70	871.15	148	134.0	144.0	970.2	983.1	973.3
P-05-27M	UTC	7	1399827.248	2123723.992	873.07	2.50	870.57	75	59.0	69.0	977.0	1070.0	1069.0
P-05-27S	UTC	7	1399814.121	2123723.367	873.58	2.40	871.18	38	30.3	35.3	892.7	908.7	892.7
P-05-28	UTC	9	1410045.644	2153654.343	1032.28	2.00	1030.28	164	140.5	160.5	963.3	978.8	969.1
P-05-28S	UTC	9	1410031.087	2153664.219	1033.34	2.44	1030.90	73	65.8	75.8	1005.5	1009.5	1005.5

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
P-05-29D	SFK	3	1406633.255	2154703.505	998.35	3.33	995.02	124	117.8	127.8	1731.3	1765.2	1745.7
P-05-29D2	SFK	3	1406661.953	2154696.955	998.53	2.10	996.43	124.3	113.4	123.4	1778.3	1783.3	1778.3
P-05-29M	SFK	3	1406676.329	2154712.637	1000.07	2.38	997.69	60	47.7	57.7	1455.8	1479.8	1469.9
P-05-29S	SFK	3	1406637.934	2154722.007	999.22	3.30	995.92	28	22.7	27.7	1494.4	1497.4	1494.4
P-05-30D	UTC	9	1406447.867	2161592.285	973.62	2.57	971.05	115	95.5	105.5	1133.2	1153.2	1143.4
P-05-30S	UTC	9	1406457.761	2161605.45	973.46	2.40	971.06	73	67.8	72.8	1176.4	1180.5	1176.4
P-05-31D	UTC	9	1408340.935	2160140.699	921.72	2.54	919.18	156	136.5	146.5	1288.9	1306.7	1296.9
P-05-31S	UTC	9	1408354.572	2160159.474	920.96	1.69	919.27	28	19.8	24.8	1356.1	1371.2	1361.3
P-05-32	UTC	9	1409690.176	2159073.689	889.54	2.00	887.54	101	80.0	100.0	1277.6	1297.2	1287.2
P-05-33	UTC	9	1411247.206	2159456.169	838.63	1.09	837.54	65	34.4	44.4	1321.6	1332.0	1321.6
P-05-34	UTC	9	1409830.088	2160495.483	853.18	2.00	851.18	95	83.5	93.8	951.2	962.5	952.7
P-05-35	UTC	9	1407881.045	2162627.556	935.73	2.02	933.71	75	52.2	57.2	988.8	1015.5	995.9
P-05-36D	SFK	3	1405755.413	2157046.462	1011.61	2.30	1009.31	151	137.9	147.9	1083.4	1094.8	1084.8
P-05-36M	SFK	3	1405763.539	2157031.92	1012.53	3.10	1009.43	90.5	80.2	90.2	815.4	825.4	815.4
P-05-36S	SFK	3	1405746.046	2157061.145	1011.49	2.57	1008.92	35	23.5	33.5	915.6	928.6	918.6
P-06-37D	UTC	9	1409444.728	2163539.612		no install	945.27	205	180.0	200.0	880.7	894.7	884.7
P-06-37DA			1409444.728	2163539.612	948.07	2.80	945.27				951.0	961.3	951.5
P-06-37M	UTC	9	1409436.563	2163523.675	947.60	2.98	944.62	140	75.1	90.6	919.5	929.6	919.5
P-06-37S	UTC	9	1409432.049	2163507.877	947.08	2.97	944.11	29	20.0	25.0	978.0	989.0	979.0
P-06-38D	UTC	9	1406579.039	2166679.941	1066.18	2.97	1063.21	200	155.0	170.0	747.0	759.8	749.8
P-06-38M	UTC	9	1406562.607	2166690.207	1066.33	3.00	1063.33	68	57.5	67.5	829.1	839.9	830.1
P-06-39D	UTC	9	1412117.714	2160790.847	844.98	2.49	842.49	112.5	92.0	112.0	883.8	888.8	883.8
P-06-39S	UTC	9	1412125.791	2160809.261	845.24	2.50	842.74	36	30.0	35.0	702.6	712.6	702.6
P-06-40D	UTC	9	1412908.677	2158570.646	824.47	4.50	819.97	145	135.0	145.0	767.3	777.1	767.3
P-06-40M	UTC	9	1412942.608	2158592.458			820.05	63	53.0	63.0	813.3	817.9	813.6
P-06-40S	UTC	9	1412926.867	2158584.15	822.40	2.50	819.90	20	14.2	19.2	708.1	718.3	708.3
P-06-41D	UTC	9	1420118.746	2160960.167	765.72	2.60	763.12	200.5	190.0	200.0	745.6	752.1	747.1
P-06-41M	UTC	9	1420135.843	2160970.204	766.37	2.50	763.87	63	53.0	63.0	820.6	831.2	822.0
P-06-41S	UTC	9	1420151.349	2160981.771	767.70	3.50	764.20	43	36.5	41.5	842.8	852.8	842.8
P-07-42D	NFK	13	1404364.327	2171816.719	1158.20	1.90	1156.30	126	111.0	121.0	870.0	880.2	871.0
P-07-42S	NFK	13	1404365.567	2171794.518	1158.76	2.30	1156.46	52.5	40.0	49.0	733.3	743.1	733.3
P-07-43D	NFK	13	1408690.585	2171789.537	1194.47	2.70	1191.77	133.6	128.6	133.6	821.5	832.1	822.3
P-07-43M	NFK	13	1408707.058	2171782.696	1194.59	2.60	1191.99	72	60.0	70.0	880.9	890.5	880.9
P-07-43S	NFK	13	1408702.209	2171767.38	1194.49	3.30	1191.19	32	20.8	29.8	773.1	787.7	777.9
P-07-44D	UTC	9	1411817.508	2174231.55	1481.74	2.50	1479.24	93	84.0	89.0	821.1	830.7	821.1
P-07-44S	UTC	9	1411808.679	2174241.26	1482.14	2.50	1479.64	27	20.0	25.0	657.8	667.6	657.9
P-07-45D	UTC	10	1418783.246	2169419.931	1315.72	2.70	1313.02	60	45.0	60.0	762.2	771.8	762.2
P-07-46D	UTC	9	1419004.113	2163585.76	965.31	2.50	962.81	52	37.8	42.8	1047.7	1073.1	1063.3
P-07-47D	UTC	10	1418172.063	2158452.207	919.51	2.50	917.01	79.6	74.6	79.6	1089.4	1101.0	1091.2
P-07-48D	NFK	15	1380043.655	2172840.5	1048.36	2.80	1045.56	62	47.0	57.0	1071.4	1082.3	1072.3
P-07-48S	NFK	15	1380030.269	2172824.883	1047.69	2.30	1045.39	31.9	19.0	24.0	1090.3	1099.9	1090.3

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
P-07-49D	NFK	12	1384395.833	2167007.009	1116.86	2.50	1114.36	100	92.0	97.0	799.6	809.6	799.6
P-07-49S	NFK	12	1384409.83	2167025.051	1114.57	2.70	1111.87	22	15.0	20.0	873.7	885.6	875.7
P-07-50D	NFK	15	1379659.906	2171914.671	1056.41	2.90	1053.51	162	152.0	162.0	597.7	614.7	599.1
P-07-50S	NFK	15	1379684.931	2171909.765	1055.83	2.50	1053.33	172	60.0	70.0	622.8	840.7	840.6
P-07-50SS	NFK	15	1379684.33	2171931.263	1056.20	2.80	1053.40	117	20.0	30.0	690.5	700.4	690.5
P-07-51D	NFK	15	1372610.235	2162374.689	1615.53	2.08	1613.45	85	35.5	45.5	759.0	769.0	759.0
P-07-51S	NFK	15	1372628.214	2162386.836	1616.80	2.50	1614.30	20	10.0	20.0	674.3	904.3	894.3
P-07-52D	NFK	15	1367488.205	2153681.514	1855.99	2.60	1853.39	60	50.0	60.0			
P-07-52S	NFK	15	1367475.766	2153675.659	1855.27	2.60	1852.67	28	18.0	28.0	853.9	895.9	885.9
P-07-53D	NFK	15	1379645.904	2171900.255	1055.88	2.30	1053.58	163	153.0	163.0	823.0	839.5	829.5
P-07-53S	NFK	15	1379652.456	2171885.882	1056.04	2.50	1053.54	82	62.5	72.5	870.1	897.6	887.6
P-08-54D	SFK	3	1401548.037	2155637.9	1070.49	2.90	1067.59	114.7	104.9	114.7	627.3	769.3	749.3
P-08-54S	SFK	3	1401528.209	2155636.692	1070.32	2.78	1067.54	47	37.0	47.0	896.5	942.5	922.5
P-08-55D	SFK	3	1403813.073	2152841.746	988.75	2.80	985.95	115.33	105.5	115.3	851.4	873.6	863.6
P-08-55S	SFK	3	1403811.651	2152824.747	989.74	3.80	985.94	67.4	45.5	65.2	816.5	852.0	842.0
P-08-56D	SFK	3	1402965.322	2150855.098	985.95	2.50	983.45	141.2	130.0	140.0	860.5	878.0	868.0
P-08-56M	SFK	3	1402957.81	2150835.268	985.74	2.40	983.34	97.7	87.7	97.7	968.5	1008.5	999.5
P-08-56S	SFK	3	1402938.313	2150850.504	986.18	2.60	983.58	20.5	15.3	20.3	951.2	1016.2	1006.2
P-08-57D	UTC	9	1410050.432	2153566.719	1031.96	2.80	1029.16	242	231.8	241.7	741.5	832.0	821.0
P-08-58D	SFK	3	1408968.504	2151636.917	1013.89	2.60	1011.29	105.33	95.1	104.9	801.1	829.6	819.6
P-08-58M	SFK	3	1408926.353	2151634.839	1011.85	2.70	1009.15	60	35.2	45.0	906.8	936.8	926.8
P-08-59D	SFK	3	1396199.499	2149005.581	1534.11	2.70	1531.41	105.1	82.3	102.0	811.9	833.9	813.9
P-08-59S	SFK	3	1396219.388	2149025.461	1532.19	2.30	1529.89	47.67	41.5	45.5	754.9	768.9	758.9
P-08-60D	SFK	3	1397111.642	2144622.612	1409.77	1.80	1407.97	84	57.2	76.8	930.3	954.9	944.9
P-08-60S	SFK	3	1397093.033	2144603.124	1412.47	2.80	1409.67	36	24.0	30.0	751.3	771.8	761.8
P-08-61D	SFK	2	1391892.162	2136355.277	975.00	2.80	972.20	97	78.4	88.4	830.6	885.6	875.6
P-08-61S	SFK	2	1391886.151	2136406.084	977.31	2.90	974.41	71.2	51.2	71.2	859.6	899.6	889.6
P-08-62D	SFK	5	1395807.152	2130826.192	895.30	2.90	892.40	307.1	297.8	307.1	913.1	958.1	948.1
P-08-62M	SFK	5	1395836.397	2130810.588	894.37	2.70	891.67	123	67.2	77.0	1177.7	1367.7	1357.7
P-08-62S	SFK	5	1395827.578	2130829.687	894.97	3.30	891.67	21	9.5	19.3	1478.8	1513.8	1503.8
P-08-63D	SFK	5	1396023.506	2128300.739	882.16	3.00	879.16	129.8	105.0	124.7	1223.5	1429.5	1419.5
P-08-63M	SFK	5	1396055.907	2128305.182	882.37	2.50	879.87	83	72.2	82.0	980.6	1000.1	990.1
P-08-63S	SFK	5	1396029.368	2128349.287	882.55	2.80	879.75	47.5	35.0	44.8	987.9	1130.4	1119.4
P-08-64D	SFK	5	1397061.642	2127781.177	891.68	2.70	888.98	69.5	48.8	58.7	1552.2	1652.7	1642.7
P-08-64S	SFK	5	1397066.832	2127806.534	892.26	3.30	888.96	30.5	18.2	28.0	1193.3	1290.8	1280.8
P-08-65D	SFK	5	1396166.534	2126553.532	897.49	3.70	893.79	190	173.7	183.5	1655.6	1675.6	1665.6
P-08-65M	SFK	5	1396129.644	2126580.493	896.18	3.00	893.18	147.5	136.0	146.0	1494.0	1514.0	1504.0
P-08-65S	SFK	5	1396143.066	2126550.254	896.84	3.10	893.74	37.8	27.5	37.3	791.9	913.9	903.9
P-08-66D	SFK	2	1386752.462	2135964.561	1082.48	2.80	1079.68	59.6	47.5	57.3	1306.0	1441.0	1421.0
P-08-66S	SFK	2	1386730.419	2135942.336	1082.20	3.10	1079.10	28	23.0	28.0	1589.6	1609.6	1599.6
P-08-67D	SFK	2	1384345.215	2135489.767	1056.01	3.20	1052.81	59.27	45.6	55.3	894.0	914.5	904.5

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
P-08-67S	SFK	2	1384371.661	2135479.814	1057.28	3.30	1053.98	27.4	17.4	27.4	1641.8	1688.8	1678.8
P-08-68D	NFK	15	1379621.483	2171871.924	1056.46	3.10	1053.36	87	74.1	83.9	1641.7	1666.2	1656.2
P-08-69D	NFK	15	1379697.507	2170781.58	1022.51	3.00	1019.51	60	44.5	54.2	729.5	899.5	889.5
P-08-69S	NFK	15	1379734.461	2170789.731	1024.53	3.00	1021.53	19.8	15.8	19.8	1605.7	1680.7	1670.7
P-08-70D	NFK	15	1372333.482	2159960.412	1798.76	2.80	1795.96	68.5	34.6	54.1	1769.9	1839.9	1829.9
P-08-70S	NFK	15	1372325.961	2159988.269	1797.44	3.00	1794.44	19.9	14.9	19.9	1554.0	1619.0	1609.0
P-08-71D	NFK	14	1384970.817	2161557.07	1503.82	2.80	1501.02	49	25.1	34.9	1798.6	1819.1	1809.1
P-08-71S	NFK	14	1384944.9	2161558.797	1503.76	3.20	1500.56	10	7.0	10.0	1372.9	1410.9	1390.9
P-08-72D	NFK	13	1388955.775	2166366.382	1190.11	2.50	1187.61	58.2	38.2	48.0	1854.1	1913.6	1903.6
P-08-72S	NFK	13	1388916.982	2166379.664	1190.46	2.60	1187.86	15.3	11.2	15.3	761.5	1041.5	1031.5
P-08-73D	NFK	12	1393537.91	2158962.29	1401.67	2.60	1399.07	114	96.2	106.0	1243.3	1443.3	1433.3
P-08-73S	NFK	12	1393498.8	2158977.529	1400.26	3.30	1396.96	44.7	29.6	39.5	1847.1	1866.6	1856.6
P-08-74D	NFK	12	1392173.45	2156427.349	1371.24	2.70	1368.54	94.7	75.1	85.1	1763.1	1802.6	1792.6
P-08-74S	NFK	12	1392204.367	2156469.398	1371.64	2.40	1369.24	51.4	41.0	51.4	1326.8	1451.8	1441.8
P-08-75D	UTC	9	1403241.135	2170960.694	1124.96	2.60	1122.36	175	163.7	173.5	1071.4	1111.4	1091.4
P-08-75M	UTC	9	1403194.559	2170926.323	1124.80	2.80	1122.00	137	110.3	129.9	1242.3	1302.3	1292.3
P-08-75S	UTC	9	1403218.72	2170945.397	1125.19	3.10	1122.09	42.5	31.1	41.1	1249.9	1336.6	1326.6
P-08-76D	NFK	15	1367182.783	2170553.058	952.42	2.80	949.62	138.05	128.0	138.0	1255.1	1475.1	1465.1
P-08-76S	NFK	15	1367157.148	2170543.83	952.51	2.70	949.81	38	25.0	35.0	1165.7	1380.7	1370.7
P-08-77D	NFK	15	1368319.331	2173790.5	972.65	2.80	969.85	93	79.0	89.0	768.8	1078.3	1068.3
P-08-77S [a]	NFK	15	1368288.514	2173771.855	973.10	2.40	970.70	23.5	13.2	23.0	1663.2	1744.2	1734.2
P-08-78D	NFK	15	1368928.88	2176072.892	1011.23	3.00	1008.23	92.5	82.5	92.5	1140.3	1315.3	1305.3
P-08-78S	NFK	15	1368943.329	2176036.441	1010.74	3.50	1007.24	33	22.0	32.0	1053.3	1143.3	1128.3
P-08-79D	NFK	15	1361307.409	2166413.716	899.49	2.80	896.69	153.5	140.7	150.7	1920.7	1976.7	1966.7
P-08-79M	NFK	15	1361318.684	2166364.899	898.47	3.20	895.27	70	59.2	69.0	1700.0	1770.0	1760.0
P-08-79S	NFK	15	1361321.098	2166390.78	898.85	2.90	895.95	16	11.0	16.0	1167.7	1282.7	1262.7
P-08-80D	NFK	15	1355540.969	2154870.741	829.37	3.50	825.87	127.05	117.1	127.1	1881.2	1907.2	1897.2
P-08-80M	NFK	15	1355511.744	2154890.282	829.06	2.90	826.16	62.7	52.9	62.7	1533.2	1623.2	1603.2
P-08-80S	NFK	15	1355519.047	2154922.634	830.04	3.30	826.74	17.25	12.6	17.0	1440.6	1939.1	1938.1
P-08-81D	NFK	15	1350987.168	2143388.252	762.94	3.10	759.84	55.5	45.3	55.3	1449.0	1948.0	1947.0
P-08-81S	NFK	15	1350974.144	2143370.161	762.34	3.00	759.34	17.5	11.0	16.0	1439.4	1554.4	1544.4
P-08-82D	SFK	5	1400534.153	2127914.3	893.55	3.70	889.85	73	62.5	71.6	1222.8	1402.8	1392.8
P-08-82M	SFK	5	1400514.683	2127893.532	892.37	3.20	889.17	50.2	40.2	50.2	1122.2	1212.2	1202.2
P-08-82S	SFK	5	1400488.371	2127902.906	891.32	3.10	888.22	22	11.8	21.0	1094.0	1114.0	1104.0
P-08-83D	SFK	5	1405004.059	2130236.062	921.95	2.80	919.15	189.7	179.9	189.7	1421.6	1441.6	1431.6
P-08-83M	SFK	5	1405015.922	2130215.305	922.82	3.10	919.72	102	91.4	101.2	1430.6	1515.6	1505.6
P-08-83S	SFK	5	1405035.92	2130195.046	922.45	3.30	919.15	42	32.4	42.0	1036.7	1141.7	1131.7
P-08-84D	SFK	4	1378294.13	2130954.432	851.40	2.40	849.00	79.7	65.1	74.9	1086.2	1241.2	1231.2
P-08-84S	SFK	4	1378275.854	2130998.738	853.05	3.00	850.05	32.8	23.2	32.8	1094.4	1204.4	1194.4
P-08-85D	UTC	9	1417344.731	2159988.184	794.22	2.50	791.72	137.7	127.9	137.6	1033.0	1226.0	1206.0
P-08-85S	UTC	9	1417393.499	2160019.41	793.57	2.80	790.77	32.4	22.8	32.4	1170.7	1185.7	1175.7

Well	Location	Watershed ID	Easting	Northing	PVC Elevation	Stickup (ft)	Ground Surface Elev.	Total Depth	Screen Top Depth	Screen Bottom Depth	Hole Bottom Elev.	Top of Screen Elev.	Bottom of Screen Elev.
P-08-86D	NFK	13	1391936.262	2169841.824	1136.85	3.30	1133.55	89.6	64.2	74.0	1080.7	1150.7	1140.7
P-08-86S	NFK	13	1391946.96	2169864.639	1135.58	2.50	1133.08	47.5	35.9	45.7	1399.7	1539.7	1529.7
P-08-87D	NFK	13	1393970.239	2169843.61	1140.88	2.90	1137.98	70.4	59.5	69.5	1039.5	1139.5	1129.5
P-08-87S	NFK	13	1393988.057	2169867.279	1142.03	3.40	1138.63	52.1	42.5	52.1	1417.8	1437.8	1427.8
P-08-88D	UTC	10	1439761.983	2136887.077	905.22	3.20	902.02	106.17	96.3	106.2	1313.5	1333.5	1323.5
P-08-88S	UTC	10	1439763.596	2136853.284	904.52	2.60	901.92	32	20.1	30.0	1291.9	1306.4	1296.4
P-08-89D	UTC	10	1428724.455	2136845.392	842.44	2.50	839.94	246	229.0	244.6	1352.7	1447.7	1437.7
P-08-89DAbnd	UTC	10	1428818.7	2136887.17	abandoned		840.76	218	0.1	0.2	1674.6	1729.6	1719.6
P-08-89M	UTC	10	1428774.364	2136886.675	843.12	3.70	839.42	152.7	142.8	152.7	1185.0	1195.0	1190.0
P-08-89S	UTC	10	1428782.754	2136857.174	844.09	2.90	841.19	86	76.0	86.0	1025.0	1165.0	1155.0
P-1	SFK	3	1401319.018	2154315.713		no install	1074.90	44	68.8	68.9	803.1	908.1	898.1
P-2D	SFK	3	1402465.918	2154026.134		2.43	1021.83	88.5	76.0	86.0	828.1	933.1	923.1
P-2M	SFK	3	1402463.549	2154047.785	1024.37	2.01	1022.36	69	58.0	68.0	1120.2	1220.2	1210.2
P-3	SFK	3	1403273.49	2154762.759	1022.85	3.25	1019.60	24.5	12.5	22.5	956.3	1076.3	1066.3
P-4AD	SFK	3	1405203.45	2155653.938	1000.62	2.69	997.93	123	80.0	90.0	1287.3	1452.3	1442.3
P-4AS	SFK	3	1405220.928	2155638.388	1000.69	3.00	997.69	59	40.0	50.0	721.6	862.1	852.1
P-4M	SFK	3	1405026.992	2155079.185	993.27	2.50	990.77	103	45.0	55.0	1801.9	1855.4	1845.4
P-6	SFK	3	1405472.605	2155849.914	998.02	2.55	995.47	113	102.0	112.0	924.3	936.8	926.8
P-6M	SFK	3	1405472.863	2155834.917	998.77	3.00	995.77	93	81.0	86.0	569.1	831.1	821.1
P-6S	SFK	3	1405489.08	2155839.328	998.39	2.79	995.60	43	25.0	35.0	1216.7	1381.7	1371.7
PQ-4	SFK	3	1401054.113	2157430.466			1205.58	153.9	123.5	133.5	1241.0	1261.0	1246.0
PQ-8	SFK	3	1402885.771	2157357.785	1043.39	0.82	1042.57	106.94	88.9	98.9	1086.0	1221.0	1201.0
PQ-9	SFK	3	1400933.69	2156549.542	1145.18	0.34	1144.84	120	81.6	91.6	1292.7	1382.7	1372.7
PW08-9	UTC	9	1410042.164	2153613.224	1031.69	1.90	1029.79	163	144.0	157.0	1072.6	1269.6	1259.6
PW08-10-1	NFK	15	1379223.511	2173166.448			1070.00	93		1.0	1058.0	1296.0	1295.5
PW08-10-2	NFK	15	1379613.407	2171905.472	1056.05	3.00	1053.05	164.17	148.2	164.2	948.1	1073.1	1072.6
PW-1A	SFK	3	1405280.823	2155676.928			997.06	119	106.0	113.0	969.0	1086.0	1076.0
PW-3	SFK	5	1398365.244	2126322.118			882.19	115	97.0	105.0	1053.4	1081.9	1061.9
PW-4	SFK	4	1378248.805	2124921.327			817.54	71	61.6	70.0	957.4	1035.4	1015.4
PW-5	SFK	5	1405519.421	2131565.578	925.52	2.61	922.91	110	110.0	110.0	1088.4	1103.4	1093.4
PW-6	SFK	5	1405497.259	2131571.267	925.08	2.12	922.96	44.5	40.5	44.5	933.4	1048.4	1038.4
PW-7	SFK	5	1399713.731	2134992.203	1012.04	2.17	1009.87	177	164.8	175.7	1432.6	1447.6	1437.6
PW-8	SFK	3	1406676.985	2154693.609	999.03	2.06	996.97	117	117.0	117.0	1367.6	1388.6	1378.6
SRK-1	UTC	9	1403452.001	2161276.502			1067.86	420	61.8	71.8	1319.0	1465.0	1455.0
SRK-3	UTC	9	1406852.257	2158116.523	1024.34	0.12	1024.22	100	63.4	73.4	1060.7	1161.7	1151.7
SRK-6	SFK	3	1400247.066	2154694.833			1142.00	30		0.5	1006.3	1021.3	1011.3
SRK-7	SFK	3	1398910.78	2156256.434			1263.00	104		0.5	951.3	976.3	966.3

Notes: a. Not included in original survey.

b. Not included in 2009 re-survey, data from original survey.

Key: Elev.= elevation, ft = feet, NFK = North Fork Koktuli, SFK = South Fork Koktuli, and UTC = Upper Talarik.

APPENDIX 8.1N

Lugeon Tests by Knight Piésold Ltd.

Lugeon Tests by Knight Piesold Ltd.

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Area A	GH05-51	305	395	2.2E-06
Area A	GH05-52	207	307	1.0E-07
Area A	GH05-53	35	135	1.8E-06
Area A	GH05-54	25	125	1.3E-05
Area A	GH05-55	25	125	1.9E-06
Area A	GH05-56	45	145	1.2E-06
Area A	GH05-59	95	175	7.4E-06
Area A	GH05-60	145	245	9.0E-07
Area A	GH05-61	205	305	1.6E-07
Area A	GH05-63	35	135	1.2E-06
Area A	GH05-64	85	185	9.1E-08
Area A	GH06-74	85	140	2.2E-06
Area A	GH06-76	215	275	1.1E-06
Area A	GH08-136	19	45	-
Area A	GH08-136	49	70	-
Area A	GH08-136	69	95	-
Area A	GH08-136	94	120	7.9E-06
Area G	GH04-25	125	185	1.2E-04
Area G	GH06-65			
Area G	GH06-66	24	69	no take
Area G	GH06-66	69	88	no take
Area G	GH06-67	68	123	1.6E-07
Area G	GH06-68	54	84	2.3E-06
Area G	GH06-68	84	119	6.8E-07
Area G	GH06-69	80	129	5.8E-07
Area G	GH06-69	129	160	5.6E-08
Area G	GH07-100	40	60	8.0E-05
Area G	GH07-100	60	80	3.9E-05
Area G	GH07-100	80	100	1.6E-05
Area G	GH07-100	100	120	-
Area G	GH07-100	120	140	6.6E-06
Area G	GH07-100	140	160	7.4E-06
Area G	GH07-100	160	180	> 30 gal/min over interval
Area G	GH07-101	39.5	69.5	3.6E-06
Area G	GH07-101	69.5	99.5	2.6E-06
Area G	GH07-101	99.5	119.5	3.0E-06
Area G	GH07-103S	95	135	1.4E-06
Area G	GH07-81	44.5	99.5	1.6E-05
Area G	GH07-81	100	129.5	2.1E-06
Area G	GH07-81	130	164.5	1.9E-07
Area G	GH07-82D	130	155	-
Area G	GH07-82D	155	175	-
Area G	GH07-82D	175	195	-
Area G	GH07-82D	195	215	-
Area G	GH07-82D			
Area G	GH07-83D	50	68	2.1E-05
Area G	GH07-83D	95	115	-
Area G	GH07-83D	115	134.5	No take

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Area G	GH07-83D	134.5	164.5	No take
Area G	GH07-83S	6	23	6.5E-05
Area G	GH07-83S	28.5	55	No take
Area G	GH07-83S	55	75	-
Area G	GH07-83S	75	95	-
Area G	GH07-84	20.5	44.5	1.9E-06
Area G	GH07-84	44.5	65.5	-
Area G	GH07-84	65.5	85.5	-
Area G	GH07-84	85.5	105	-
Area G	GH07-84	105	135	-
Area G	GH07-84	135	165	-
Area G	GH07-85	25	50	6.4E-06
Area G	GH07-85	75	95	-
Area G	GH07-85	95	125	-
Area G	GH07-85	125	154.5	-
Area G	GH07-86	7	24	5.1E-04
Area G	GH07-86	30	60	-
Area G	GH07-86	60	100	3.7E-06
Area G	GH07-86	100	130	2.8E-07
Area G	GH07-86	125	165	-
Area G	GH07-87D	100	140	4.0E-06
Area G	GH07-87D	140	160	1.9E-05
Area G	GH07-87D	160	180	9.5E-07
Area G	GH07-87D	240	260	1.5E-06
Area G	GH07-88	15	35	8.9E-06
Area G	GH07-88	35	55	no take
Area G	GH07-88	62	85	-
Area G	GH07-88	85	115	-
Area G	GH07-88	115	155	5.3E-07
Area G	GH07-89D	130	147.6	-
Area G	GH07-90D	30	50	4.6E-06
Area G	GH07-90D	50	75	4.7E-05
Area G	GH07-90D	95	115	>20 gal/min over interval
Area G	GH07-90D	115	135	2.7E-05
Area G	GH07-90D	150	170	3.4E-05
Area G	GH07-90S	15	35	9.5E-05
Area G	GH07-91	30	50	2.6E-06
Area G	GH07-91	50	70	1.5E-06
Area G	GH07-91	70	90	1.3E-06
Area G	GH07-91	85	110	8.7E-06
Area G	GH07-91	110	130	6.1E-06
Area G	GH07-91	130	155	6.0E-06
Area G	GH07-92D	80	100	1.2E-08
Area G	GH07-92D	100	120	2.1E-07
Area G	GH07-92D	120	140	-
Area G	GH07-92D	140	160	4.8E-07
Area G	GH07-93	55	80	1.3E-05
Area G	GH07-93	80	100	5.8E-05
Area G	GH07-93	100	124.5	4.7E-05
Area G	GH07-93	120	140	1.2E-05
Area G	GH07-93	140	160	6.7E-05

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Area G	GH07-93	160	185	-
Area G	GH07-93	185	205	1.4E-05
Area G	GH07-94	39	59	3.2E-06
Area G	GH07-94	59	79	2.8E-05
Area G	GH07-94	79	99	7.7E-06
Area G	GH07-94	99	119	3.4E-06
Area G	GH07-94	119	139	-
Area G	GH07-95	30	50	1.3E-04
Area G	GH07-95	50	70	1.2E-04
Area G	GH07-95	70	90	1.0E-04
Area G	GH07-95	90	110	4.5E-05
Area G	GH07-95	110	130	6.7E-05
Area G	GH07-96D	115	135	8.2E-07
Area G	GH07-96D	135	155	7.9E-07
Area G	GH07-96D	155	175	1.7E-05
Area G	GH07-96D	175	195	1.5E-05
Area G	GH07-97D	95	115	4.2E-05
Area G	GH07-97D	115	135	1.1E-06
Area G	GH07-97D	115	135	1.5E-06
Area G	GH07-97D	155	175	>20 gal/min over interval
Area G	GH07-98D	0	20	1.9E-06
Area G	GH07-98D	20	40	1.6E-05
Area G	GH07-98D	129.5	149.5	-
Area G	GH07-98D	149.5	169.5	-
Area G	GH07-98D	169.5	189.5	1.2E-05
Area G	GH07-99	24.5	44.5	4.4E-07
Area G	GH07-99	44.5	70	-
Area G	GH07-99	70	90	3.3E-06
Area G	GH07-99	90	110	1.3E-06
Area G	GH07-99	110	135	>15 gal/min over interval
Area G	GH07-99	135	160	-
Area G	GH08-138	29	105	-
Area G	GH08-138	99	170	-
Area G	GH08-138	169	275	-
Area G	GH08-141	15	40	4.9E-06
Area G	GH08-141	39	65	-
Area G	GH08-141	64	87	1.4E-05
Area G	GH08-144	19	45	1.7E-04
Area G	GH08-144	44	70	No Take
Area G	GH08-144	69	95	No Take
Area G	GH08-146	44	70	-
Area G	GH08-146	64	105	-
Area G	GH08-147	24.5	49.5	-
Area G	GH08-148	84	110	2.2E-06
Area G	GH08-148	109	135	-
Area G	GH08-148	134	175	-
Area G	GH08-148	164	243	3.4E-06
Area G	GH08-151	129	170	-
Area G	GH08-151	164	215	-
Area G	GH08-151	199	280	-
Area G	GH08-152	23	50	2.2E-05

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Area G	GH08-156	64	95	-
Area G	GH08-156	94	155	-
Area G	GH08-156	154	180	1.4E-05
Area G	GH08-157	24.5	49.5	5.3E-05
Area G	GH08-158	219	260	No Take
Area G	GH08-158	259	300	-
Area G	GH08-158	299	340	-
Area G	GH08-158	339	395	-
Area G	GH08-158	394	435	8.7E-06
Area G	GH08-158	434	475	-
Area G	GH08-158	474	500	No Take
Area G	GH08-159	40	70	4.5E-04
Area G	GH08-159	84	110	-
Area G	GH08-159	99	135	-
Area G	GH08-163	55	90	-
Area G	GH08-163	154	190	-
Area G	GH08-163	184	215	-
Area G	GH08-166	204	235	1.5E-05
Area G	GH08-168	294	335	No Take
Area G	GH08-169	109	160	-
Area G	GH08-169	159	225	-
Area G	GH08-169	230	300	-
Area G	GH08-169	305	350	-
Area G	GH08-169	449.5	499.5	-
Area G	GH08-187	84	105	8.3E-05
Area G	GH08-187	104	135	-
Area G	GH08-188	19	55	-
Area G	GH08-188	59	85	1.2E-04
Deposit Area	5326	68	93	2.5E-04
Deposit Area	5326	93	111	6.6E-05
Deposit Area	5326	111	128	4.1E-05
Deposit Area	5326	145	163	5.3E-06
Deposit Area	5326	163	180	1.4E-05
Deposit Area	5326	206	232	6.0E-05
Deposit Area	5326	301	345	2.7E-05
Deposit Area	5326	345	388	4.7E-07
Deposit Area	5326	388	431	4.8E-05
Deposit Area	5326	431	474	7.2E-06
Deposit Area	5326	474	518	4.7E-06
Deposit Area	5327	266	283	1.4E-04
Deposit Area	5327	309	326	2.2E-05
Deposit Area	5327	353	353	6.3E-05
Deposit Area	5327	404	422	2.4E-04
Deposit Area	5327	448	465	2.2E-05
Deposit Area	5327	534	552	2.1E-05
Deposit Area	5328	198	216	3.4E-07
Deposit Area	5328	306	324	1.2E-07
Deposit Area	8410	1935	1950	4.0E-04
Deposit Area	8410	2391	2455	1.3E-04
Deposit Area	8412	1420	1439	7.1E-06
Deposit Area	8412	1937	1956	3.7E-05

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Deposit Area	8412	2480	2542	5.4E-07
Deposit Area	8412	3033	3057	2.4E-06
Deposit Area	8413	4379	4471	3.7E-07
Deposit Area	8415	1779	1800	1.9E-06
Deposit Area	8415	2602	2740	1.6E-04
Deposit Area	8415	2660	2740	8.3E-06
Deposit Area	8417	1177	1470	1.1E-06
Deposit Area	8418	444	453	3.9E-07
Deposit Area	8418	622	634	3.0E-06
Deposit Area	8418	853	861	4.9E-07
Deposit Area	8418	1079	1088	-
Deposit Area	8418	1170	1178	1.0E-05
Deposit Area	8418	1533	1552	-
Deposit Area	GH04-26	35	135	2.1E-04
Deposit Area	GH04-27	55	125	8.6E-05
Deposit Area	GH05-57	25	125	2.0E-06
Deposit Area	GH05-58	55	155	6.3E-07
Deposit Area	GH06-80	189	217	4.8E-06
Deposit Area	GH08-107	64	90	-
Deposit Area	GH08-107	89	115	3.8E-05
Deposit Area	GH08-107	114	145	2.7E-05
Deposit Area	GH08-107	144	170	3.3E-05
Deposit Area	GH08-107	169	205	1.6E-06
Deposit Area	GH08-107	204	229.5	7.7E-07
Deposit Area	GH08-107	229	255.5	2.6E-06
Deposit Area	GH08-107	254	279.5	4.7E-06
Deposit Area	GH08-107	279	305	3.7E-05
Deposit Area	GH08-107	309	330	2.9E-04
Deposit Area	GH08-107	329	355	9.0E-05
Deposit Area	GH08-108	44	75	3.9E-04
Deposit Area	GH08-112	109	135	1.8E-05
Deposit Area	GH08-112	134	160	3.7E-06
Deposit Area	GH08-112	159	185	3.1E-05
Deposit Area	GH08-112	189	210	4.6E-05
Deposit Area	GH08-112	205	235	-
Deposit Area	GH08-112	259	285	-
Deposit Area	GH08-112	294	320	-
Deposit Area	GH08-112	319	345	4.8E-05
Deposit Area	GH08-112	355	380	6.0E-06
Deposit Area	GH08-128	154	180	-
Deposit Area	GH08-128	204	230	-
Deposit Area	GH08-128	229	255	-
Deposit Area	KP-01	167	228	2.1E-05
Deposit Area	KP-01	245	323	3.7E-06
Deposit Area	KP-01	321	427	4.8E-06
Deposit Area	KP-01	419	557	1.5E-05
Deposit Area	KP-01	557	669	2.5E-06
Deposit Area	KP-01	670	782	4.5E-06
Deposit Area	KP-01	795	908	5.3E-08
Deposit Area	KP-01	1038	1168	6.6E-07
Deposit Area	KP-02	133	191	1.5E-06

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Deposit Area	KP-02	340	410	4.1E-05
Deposit Area	KP-02	471	557	4.6E-06
Deposit Area	KP-02A	77	158	1.4E-04
Deposit Area	KP-02A	158	279	8.7E-05
Deposit Area	KP-02A	279	408	7.4E-06
Deposit Area	KP-02A	457	586	1.4E-07
Deposit Area	KP-02A	586	716	3.4E-06
Deposit Area	KP-02A	716	846	3.5E-06
Deposit Area	KP-02A	846	976	9.4E-09
Deposit Area	KP-02A	976	1150	2.8E-07
Deposit Area	KP-04	144	189	6.4E-05
Deposit Area	KP-04	245	275	1.0E-05
Deposit Area	KP-04	272	293	2.5E-06
Deposit Area	KP-04	284	301	1.3E-06
Deposit Area	KP-04	300	315	2.6E-06
Deposit Area	KP-04	315	340	6.7E-07
Deposit Area	KP-04	499	513	5.0E-06
Deposit Area	KP-04	515	531	4.6E-06
Deposit Area	KP-04	568	609	1.7E-07
Deposit Area	KP-04	602	661	2.0E-06
Deposit Area	KP-04	663	799	3.2E-07
Deposit Area	KP-04	973	1345	2.5E-06
Deposit Area	KP-04	994	1168	1.0E-06
Deposit Area	KP-05A	542	690	3.9E-06
Deposit Area	KP-05A	671	757	4.5E-06
Deposit Area	KP-05A	802	975	1.3E-06
Deposit Area	KP-05A	958	1127	5.0E-07
Deposit Area	KP-06	156	286	8.2E-05
Deposit Area	KP-06	292	394	2.1E-05
Deposit Area	KP-06	394	515	2.1E-05
Deposit Area	KP-06	515	602	3.2E-06
Deposit Area	KP-06	606	710	4.7E-06
Deposit Area	KP-06	896	1000	6.0E-06
Deposit Area	KP-06	1000	1113	3.9E-05
Deposit Area	KP-08	254	323	8.2E-05
Deposit Area	KP-08	297	394	8.4E-05
Deposit Area	KP-08	423	535	2.8E-04
Deposit Area	KP-08	522	635	1.8E-05
Deposit Area	KP-08	570	657	3.7E-07
Deposit Area	KP-08	661	789	8.3E-08
Deposit Area	KP-08	795	908	1.7E-06
Deposit Area	KP-08	1003	1211	2.5E-06
Frying Pan Lake	GH04-28	45	145	3.1E-04
Frying Pan Lake	GH04-31	95	195	9.7E-06
Frying Pan Lake	GH04-41	25	125	4.5E-04
Frying Pan Lake	GH04-45A	125	225	9.4E-05
Frying Pan Lake	GH04-46	35	135	2.1E-04
Frying Pan Lake	GH04-47	185	270	2.9E-04
Frying Pan Lake	GH08-133	15	45	2.4E-04
Frying Pan Lake	GH08-133	44	70	No Take
Frying Pan Lake	GH08-133	69	95	No Take

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
Frying Pan Lake	GH08-135	19	45	No Take
Frying Pan Lake	GH08-135	30	70	No Take
Frying Pan Lake	GH08-135	69	95	No Take
Frying Pan Lake	GH08-137	120	150	3.3E-05
Frying Pan Lake	GH08-137	204	230	-
Frying Pan Lake	GH08-196	24	105	-
Frying Pan Lake	GH08-204	189	215	2.0E-04
Frying Pan Lake	GH08-205D	109	135	-
Frying Pan Lake	GH08-205S	214	240	2.2E-05
Frying Pan Lake	GH08-207D	79	115	-
Frying Pan Lake	GH08-207S	29	55	5.2E-04
Frying Pan Lake	GH08-207S	54	80	5.8E-04
Frying Pan Lake	GH08-209	94	120	4.5E-04
Frying Pan Lake	GH08-209	119	145	-
Frying Pan Lake	GH08-210D	119	145	-
Frying Pan Lake	GH08-210S	94	120	-
North Fork Koktuli River	GH08-178	154	260	-
North Fork Koktuli River	GH08-179	140	165	3.7E-06
North Fork Koktuli River	GH08-179	165	190	-
North Fork Koktuli River	GH08-179	190	215	-
North Fork Koktuli River	GH08-180	89	135	No Take
North Fork Koktuli River	GH08-180	125	190	-
North Fork Koktuli River	GH08-180	199	240	-
North Fork Koktuli River	GH08-181D	94	120	No Take
North Fork Koktuli River	GH08-181S	32	85	No Take
North Fork Koktuli River	GH08-182	64	90	No Take
North Fork Koktuli River	GH08-182	89	115	No Take
North Fork Koktuli River	GH08-182	115	140	No Take
North Fork Koktuli River	GH08-182	139	165	No Take
North Fork Koktuli River	GH08-183	44	70	-
North Fork Koktuli River	GH08-189D	289	315	No Take
North Fork Koktuli River	GH08-189D	304	350	-
North Fork Koktuli River	GH08-189S	234	260	-
North Fork Koktuli River	GH08-189S	234	290	2.0E-06
North Fork Koktuli River	GH08-192	89	115	-
North Fork Koktuli River	GH08-192	119	145	No Take
North Fork Koktuli River	GH08-192	149	170	No Take
North Fork Koktuli River	GH08-192	169	195	No Take
North Fork Koktuli River	GH08-192	194	220	No Take
North Fork Koktuli River	GH08-192	219	255	No Take
North Fork Koktuli River	GH08-194	104	130	9.3E-05
North Fork Koktuli River	GH08-194	129	155	3.6E-05
North Fork Koktuli River	GH08-194	154	180	No Take
North Fork Koktuli River	GH08-194	179	205	8.7E-05
North Fork Koktuli River	GH08-194	189	225	7.8E-05
North Fork Koktuli River	GH08-198	64	90	-
North Fork Koktuli River	GH08-198	89	115	-
North Fork Koktuli River	GH08-198	114	140	No Take
North Fork Koktuli River	GH08-198	139	165	No Take
North Fork Koktuli River	GH08-198	164	200	No Take
South Fork Koktuli River	GH04-38	95	190	3.5E-04

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
South Fork Koktuli River	GH04-40A	194	255	1.1E-04
South Fork Koktuli River	GH08-139	19	45	-
South Fork Koktuli River	GH08-139	49	75	No Take
South Fork Koktuli River	GH08-139	74	125	No Take
South Fork Koktuli River	GH08-140	50	80	-
South Fork Koktuli River	GH08-140	79	105	1.3E-05
South Fork Koktuli River	GH08-140	104	135	-
South Fork Koktuli River	GH08-142	140	164.5	-
South Fork Koktuli River	GH08-143	49	75	2.1E-04
South Fork Koktuli River	GH08-143	100	125	-
South Fork Koktuli River	GH08-143	125	150	-
South Fork Koktuli River	GH08-143	204	230	4.4E-05
South Fork Koktuli River	GH08-143	229	255	-
South Fork Koktuli River	GH08-143	254	280	6.0E-05
South Fork Koktuli River	GH08-143	304	335	7.2E-05
South Fork Koktuli River	GH08-143	314	335	7.9E-06
South Fork Koktuli River	GH08-145	25	50	2.1E-05
South Fork Koktuli River	GH08-145	35	60	1.3E-05
South Fork Koktuli River	GH08-145	60	85	3.5E-06
South Fork Koktuli River	GH08-145	85	110	-
South Fork Koktuli River	GH08-146	19	45	2.0E-05
South Fork Koktuli River	GH08-147	49.5	74.5	5.0E-06
South Fork Koktuli River	GH08-147	73.2	104.7	1.8E-05
South Fork Koktuli River	GH08-148	34	60	-
South Fork Koktuli River	GH08-148	59	85	No Take
South Fork Koktuli River	GH08-149	34.5	59.5	1.6E-05
South Fork Koktuli River	GH08-149	79.5	104.5	-
South Fork Koktuli River	GH08-150	50	75	1.8E-04
South Fork Koktuli River	GH08-150	74	100	2.4E-04
South Fork Koktuli River	GH08-150	105	135	1.1E-04
South Fork Koktuli River	GH08-150	135	160	-
South Fork Koktuli River	GH08-150	159	185	2.0E-05
South Fork Koktuli River	GH08-150	184	210	5.7E-05
South Fork Koktuli River	GH08-150	210	235	-
South Fork Koktuli River	GH08-150	235	260	4.7E-05
South Fork Koktuli River	GH08-150	259	285	4.9E-05
South Fork Koktuli River	GH08-150	284	320	-
South Fork Koktuli River	GH08-151	89	115	-
South Fork Koktuli River	GH08-151	109	140	6.3E-05
South Fork Koktuli River	GH08-152	49	74.5	2.5E-04
South Fork Koktuli River	GH08-152	74.5	104.5	6.9E-05
South Fork Koktuli River	GH08-154	64	90	1.5E-05
South Fork Koktuli River	GH08-154	85	110	-
South Fork Koktuli River	GH08-154	110	135	3.8E-06
South Fork Koktuli River	GH08-154	145	165	-
South Fork Koktuli River	GH08-155	80	140	4.7E-05
South Fork Koktuli River	GH08-155	139	165	7.8E-05
South Fork Koktuli River	GH08-155	185	215	5.1E-05
South Fork Koktuli River	GH08-155	214	240	-
South Fork Koktuli River	GH08-156	29	65	No Take
South Fork Koktuli River	GH08-157	94.5	114.5	2.2E-05

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
South Fork Koktuli River	GH08-157	114.5	139.5	2.0E-05
South Fork Koktuli River	GH08-157	149	298.75	5.9E-06
South Fork Koktuli River	GH08-158	29	64	1.3E-05
South Fork Koktuli River	GH08-158	64	105	No Take
South Fork Koktuli River	GH08-158	104	145	-
South Fork Koktuli River	GH08-158	144	185	-
South Fork Koktuli River	GH08-158	185	220	No Take
South Fork Koktuli River	GH08-159	130	160	4.9E-05
South Fork Koktuli River	GH08-159	155	185	2.2E-05
South Fork Koktuli River	GH08-159	180	210	5.2E-06
South Fork Koktuli River	GH08-159	205	235	-
South Fork Koktuli River	GH08-160	44.5	69.5	8.9E-06
South Fork Koktuli River	GH08-160	69.5	94.5	-
South Fork Koktuli River	GH08-160	94.5	119.5	-
South Fork Koktuli River	GH08-160	119.5	144.5	1.7E-06
South Fork Koktuli River	GH08-160	144.5	169.5	2.5E-07
South Fork Koktuli River	GH08-160	169.5	194.5	-
South Fork Koktuli River	GH08-160	274.5	329.5	4.1E-07
South Fork Koktuli River	GH08-161	28	55	1.6E-04
South Fork Koktuli River	GH08-161	49	101	2.3E-05
South Fork Koktuli River	GH08-162	70	95	-
South Fork Koktuli River	GH08-162	95	120	-
South Fork Koktuli River	GH08-162	120	145	9.0E-06
South Fork Koktuli River	GH08-162	145	170	1.4E-05
South Fork Koktuli River	GH08-162	170	200	9.9E-06
South Fork Koktuli River	GH08-163	34	60	-
South Fork Koktuli River	GH08-170	169	210	2.1E-06
South Fork Koktuli River	GH08-170	209	250	-
South Fork Koktuli River	GH08-170	259	300	2.8E-05
South Fork Koktuli River	GH08-170	334	375	-
South Fork Koktuli River	GH08-170	374	415	-
South Fork Koktuli River	GH08-170	414	460	-
South Fork Koktuli River	GH08-170	459	500	-
South Fork Koktuli River	GH08-171	74	100	-
South Fork Koktuli River	GH08-171	130	150	-
South Fork Koktuli River	GH08-172	94	125	-
South Fork Koktuli River	GH08-172	124	155	-
South Fork Koktuli River	GH08-172	174	200	No Take
South Fork Koktuli River	GH08-172	199	235	-
South Fork Koktuli River	GH08-173	144	175	1.0E-04
South Fork Koktuli River	GH08-173	164	220	4.6E-05
South Fork Koktuli River	GH08-173	194	220	2.9E-05
South Fork Koktuli River	GH08-174	104	160	-
South Fork Koktuli River	GH08-175	69	95	2.4E-04
South Fork Koktuli River	GH08-175	89	120	2.8E-04
South Fork Koktuli River	GH08-176	64	90	3.0E-04
South Fork Koktuli River	GH08-176	89	115	1.7E-04
South Fork Koktuli River	GH08-176	114	145	-
South Fork Koktuli River	GH08-190	64	85	-
South Fork Koktuli River	GH08-190	89	115	-
South Fork Koktuli River	GH08-190	119	145	-

Location Area	Drillhole #	Zone_From (ft)	Zone_To (ft)	K (cm/s)
South Fork Koktuli River	GH08-191	104	130	No Take
South Fork Koktuli River	GH08-191	129	155	No Take
South Fork Koktuli River	GH08-191	154	180	No Take
South Fork Koktuli River	GH08-193	44	70	2.8E-05
South Fork Koktuli River	GH08-193	74	100	No Take
South Fork Koktuli River	GH08-193	99	125	No Take
South Fork Koktuli River	GH08-193	124	150	No Take
South Fork Koktuli River	GH08-195	44	69.75	No Take
South Fork Koktuli River	GH08-195	74	99.5	-
South Fork Koktuli River	GH08-195	94	125	No Take
South Fork Koktuli River	GH08-195	124	165.5	No Take
South Fork Koktuli River	GH08-197B	44	70	-
South Fork Koktuli River	GH08-197B	69	100	-
South Fork Koktuli River	GH08-197B	99	130	1.1E-04
South Fork Koktuli River	GH08-197B	199	225	1.5E-04
South Fork Koktuli River	GH08-197B	224	250	3.5E-05
South Fork Koktuli River	GH08-197B	249	275	6.7E-05
South Fork Koktuli River	GH08-197B	274	300	1.1E-04
South Fork Koktuli River	GH08-197B	299	325	9.7E-07
South Fork Koktuli River	GH08-197B	324	350	-
South Fork Koktuli River	GH08-197B	349	375	-
South Fork Koktuli River	GH08-197B	374	400	8.5E-07
South Fork Koktuli River	GH08-199D	159	245	1.4E-04
South Fork Koktuli River	GH08-199D	189	245	8.3E-05
South Fork Koktuli River	GH08-199S	219	245	7.1E-06
South Fork Koktuli River	GH08-203	54	85	9.4E-05
South Fork Koktuli River	GH08-203	84	115	4.7E-05
South Fork Koktuli River	GH08-203	114	140	-
South Fork Koktuli River	GH08-203	149	170	-
South Fork Koktuli River	GH08-203	169	195	1.1E-06
South Fork Koktuli River	GH08-203	194	230	5.1E-07
South Fork Koktuli River	GH08-206D	204	230	-
South Fork Koktuli River	GH08-206D	224	270	-
South Fork Koktuli River	GH08-206S	179	205	-
South Fork Koktuli River	GH08-208	69	95	-
South Fork Koktuli River	GH08-208	94	135	-
South Fork Koktuli River	GH08-208	134	165	-
South Fork Koktuli River	GH08-208	164	200	-