PEBBLE PROJECT
ENVIRONMENTAL BASELINE DOCUMENT
2004 through 2008

CHAPTER 1.
INTRODUCTION

PREPARED BY:
PEBBLE LIMITED PARTNERSHIP

TABLE OF CONTENTS

LIST OF TABLES (following Section 1.10)

LIST OF FIGURES (following table)

ACRONYMS AND ABBREVIATIONS

ANCSA	Alaska Native Claims Settlement Act
CAE	Cominco Alaska Exploration
EBD	Environmental Baseline Document
FSO	Field Sampling Plan
GIS	geographical information system
NDML	Northern Dynasty Minerals Ltd.
PDF	portable document format
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SOW	Statement of work
SP	Study Plan
USGS	United States Geological Survey

1. INTRODUCTION

This environmental baseline document (EBD) has been completed to characterize the existing physical, chemical, biological, and social environments in the areas of the Bristol Bay and Cook Inlet regions where development and reclamation of the Pebble Project may occur. The Pebble Partnership has published this EBD to provide the public and regulatory agencies with a description of the environmental baseline studies that were conducted for the Pebble Project in 2004 through 2008, as well as the results of those studies.

Although this EBD presents primarily the results of the baseline studies conducted from 2004 through 2008, in a few cases, results from other years may be included as well. For example, for a few disciplines (e.g., meteorology and geology), data from studies earlier than 2004 are included. For other studies (e.g., bear and moose surveys), results for years after 2008 are included. Additionally, a few chapters present fewer than 5 years of data because fewer years of study were sufficient to adequately describe baseline conditions for those particular disciplines (e.g., noise and wood frog surveys). Also, several studies are ongoing, and their results will be provided in separate reports to PLP as additional baseline documentation.

When the environmental baseline studies were initiated, Northern Dynasty Mines Inc. was the project proponent. In 2007, Northern Dynasty Mines Inc. joined with Anglo American to form the Pebble Partnership, which assumed responsibility for continuation of the environmental baseline studies in July 2007. Although Northern Dynasty Mines Inc. has been succeeded by the Pebble Partnership, the name Northern Dynasty Mines Inc. appears occasionally in the EBD as necessary for historical accuracy.

1.1 Project Location

The Pebble Deposit is located approximately 200 miles southwest of Anchorage, Alaska, and north of Iliamna Lake, approximately 17 miles northwest of the communities of Iliamna and Newhalen in southwestern Alaska (Figure 1-1).

The Pebble Deposit is located at the headwaters of the Upper Talarik Creek drainage and the South Fork Koktuli River drainage and adjacent to the headwaters of the North Fork Koktuli River drainage (Figure 1-2a). The Kaskanak Creek drainage lies south of the South Fork Koktuli River drainage. These drainages are located in two of the ten hydrologic units that comprise the Bristol Bay watershed (Figure 1-2b). The north and south forks of the Koktuli River are in the Nushagak River watershed and comprise 1.6 percent (by area) of that watershed. These forks of the Koktuli River are two of 24 tributaries of similar or larger size in the 315-mile-long Nushagak River system. The headwaters of the Nushagak River system are at the source of the Mulchatna River above Turquoise Lake, approximately 86 miles northeast of the Pebble Deposit. Upper Talarik Creek is in the Kvichak River watershed and comprises 1.4 percent of that watershed's area. Kaskanak Creek also lies in the Kvichak watershed and comprises 0.27 percent (by area) of the watershed. Both Kaskanak and Upper Talarik creeks are in the 225-mile-long Kvichak River system. The headwaters of the Kvichak River system are approximately 109 miles northeast of the Pebble Deposit at the source of the Tlikakila River at Lake Clark Pass.

The infrastructure necessary to support the Pebble Project would include a transportation corridor extending eastward from the Pebble Deposit area north of Iliamna Lake to the coast and a port on Cook Inlet in the vicinity of Iliamna and Iniskin bays.

1.2 Place Names

While most place names used in this document are found on standard U.S. Geological Survey (USGS) topographic maps, some names not found on the USGS maps are used. Figures 1-3a, 1-3b, and 1-3c show common place names that may be used in this document.

For certain study disciplines, rivers and tributaries are labeled with codes composed of numbers and/or letters. When this is the case, the naming convention is explained within the relevant chapter.

1.3 Project History

Cominco Alaska Exploration (CAE) began investigations in the Pebble Deposit area in 1986 and filed its claims for the Pebble Deposit with the State of Alaska in 1988. Early exploration focused on color anomalies visible from aircraft. The near-surface Pebble West deposit was discovered during the first drilling season in 1988. CAE continued annual drilling and other work through 1993, the results of which indicated a calculated resource of 3 million metric tons of copper metal and 11 million ounces of gold contained in 1,000 million metric tons of ore. After 1993, the only drilling for nearly a decade occurred in 1997.

Northern Dynasty Minerals Ltd. (NDML, the parent company of Northern Dynasty Mines Inc.) optioned the property from Teck Cominco (the successor company to CAE's parent company) in 2001 and, in 2002, began an extensive exploration program that is still in progress 9 years later. By 2004, NDML had expanded the estimate of the known resources at Pebble West to include 4,100 million metric tons of ore. In 2004, detailed engineering and physical, biological, and socioeconomic baseline studies commenced. In 2005, NDML discovered the deep-underground Pebble East deposit. Also that year, NDML acquired 100 percent ownership of the Pebble mining claims from Teck Cominco. Through 2008, the Pebble Partnership and its predecessors had drilled 1,053 holes on the Pebble Claim Block; the holes comprised 548 exploration and delineation core holes and 505 holes for groundwater monitoring, metallurgical testing, and geotechnical purposes.

1.4 Pebble Deposit

The Pebble Deposit is classified geologically as a porphyry copper deposit. Like many porphyry deposits, the Pebble Deposit contains, in addition to copper, other potentially economic minerals. The deposit is among the largest copper-gold porphyry systems in the world. As of 2008, the measured and indicated categories of the Pebble Deposit were estimated to contain 48 billion pounds of copper, 57 million ounces of gold, and 2.9 billion pounds of molybdenum. In addition, the deposit was estimated to contain inferred resources of 24 billion pounds of copper, 37 million ounces of gold, and 1.9 billion pounds of molybdenum, as well as economically significant quantities of silver, palladium, and rhenium. (As of February 2010 the measured and indicated categories were estimated to contain 55 billion pounds of copper, 67 million ounces of gold, and 3.3 billion pounds of molybdenum, while the inferred resource

was estimated to contain 25 billion pounds of copper, 40 million ounces of gold, and 2.3 billion pounds of molybdenum.)

1.5 Project Overview (Basis for Study Design)

A mining project such as the Pebble Project is a combination of many possible individual components that together have the potential to be developed into a working mine. Examples of possible components, in addition to a mine pit or workings, include access infrastructure, power facilities, a mill, tailings storage, low-grade-ore stockpiles, warehousing, administrative facilities, and worker housing. As the Pebble Project evolves, the possible locations, sizes, and initial designs of many of these possible components continue to change to address increased reserve size, baseline study results, and changing technical and economic conditions. The study areas have changed, as follows, to provide baseline characterization for possible variations in the project:

- The Pebble Deposit itself has been further delineated from a single near-surface deposit (Pebble West) to include a second, much deeper deposit to the east (Pebble East). Study areas have been expanded to encompass new lands and drainages that are associated with Pebble East.
- Various road alignments are under consideration in efforts to define options that minimize effects on communities, the number of anadromous fish stream crossings, and the filling of wetlands. Studies have been conducted within a transportation-corridor study area that encompasses the area that would most likely accommodate a transportation route. In some chapters, a specific representative road alignment is used as the basis for the transportation-corridor study area. The chapters on transportation (Chapters 19 and 47) address the route described in the *Revised Southwest Alaska Transportation Plan* prepared for the State of Alaska Department of Transportation and Public Facilities (PB Consult, 2004). Marine studies have been conducted in Iliamna and Iniskin bays to characterize areas that could be associated with possible port facilities.
- Determining a power source for the Pebble Project involves ongoing investigations of numerous, varied options and is not directly addressed in this EBD, with the exception of existing power resources.

1.6 Baseline Study Program

The baseline study program commenced in 2004 and has consisted entirely of research conducted by independent, third-party consultants and, in some cases, cooperating government agencies. Forty-four separate consulting firms and testing laboratories were selected by the Pebble Partnership (or by Northern Dynasty Mines Inc.) to conduct studies based on their specific expertise, Alaskan experience, and reputation in the scientific and regulatory communities.

Consultants characterize biophysical and cultural conditions, collect data through detailed surveys and mapping, and analyze the collected information. The disciplines for which baseline conditions are being characterized for the Pebble Project and the associated consultants involved in the baseline studies are listed in Table 1-1. For several disciplines, the lead consultants listed used subcontractors to assist them with the studies.

Each EBD chapter, except this one, was written by an independent consultant (or consultants), not by the Pebble Partnership. Chapters were then reviewed for technical content by a discipline expert. The Pebble Partnership then reviewed all chapters for completeness and consistency across the entire EBD document. In all cases, the original independent consultants made the final determination to accept or reject the Pebble Partnership comments. Some appendices of the EBD were compiled, but not authored, by the Pebble Partnership. In all cases the final chapters reflect the independent judgment of the author(s) and were finalized in accordance with the professional standards of the author's field of expertise.

1.6.1 EBD Study Disciplines

The EBD addresses a wide scope of study disciplines to fully characterize the study areas. These disciplines are as follows:

- **Climate and Meteorology**—the range and seasonality of precipitation, evaporation, temperatures, and wind data collected in the mine and Cook Inlet study areas are discussed along with comparisons to other regional data.
- **Geology and Mineralization**—surficial and bedrock geology, geological structure, deposit types, alteration and mineralization based on previous studies, exploration drilling programs, test pits, and aerial photographs are discussed. This information is important to understanding the mining potential and structural stability of the area. Geology and mineralization may also affect water quality, hydrology, and soils.
- **Physiography**—these chapters present information on topography, landforms, permafrost, and stream drainage patterns from previous studies, geotechnical site investigations, maps, and aerial photos.
- **Soils**—these chapters provide a comprehensive overview of soil types in the study areas based on the *Exploratory Soil Survey of Alaska* completed by the U.S. Department of Agriculture, Soil Conservation Service (Rieger et al., 1979).
- **Geotechnical Studies, Seismicity and Volcanism**—based on-site geotechnical investigations and previous literature, these chapters discuss aspects of surficial geology, overburden and bedrock geology, hydrogeology, physiography, topography, and surficial materials in their relation to rock mass characterization, movement of water through these materials, and seismicity. Regional volcanism and active fault systems also are addressed.
- **Surface Water Hydrology**—an overview of regional hydrology is presented for the greater Bristol Bay drainages based on published government information. Localized hydrology for the mine study area is described in detail based on extensive streamflow gaging and snow survey programs. Data on localized hydrology for the transportation-corridor and Cook Inlet study areas are presented as estimates, with some site-specific input.
- **Groundwater Hydrology**—these chapters describe the groundwater flow regime, including interactions between surface water and groundwater as determined through extensive field studies and water balance modeling. Information is provided on groundwater storage, hydraulic conductivity, flow rates, water-level fluctuations, and pathways.
- **Water Quality**—data on physical and chemical parameters related to surface water quality and groundwater quality are presented. The data are based on extensive year-round field sampling.

Temporal and spatial trends are described, and data are compared to Alaska Department of Environmental Conservation water quality standards to provide a comparative context.

- **Trace Elements and Other Naturally Occurring Constituents**—trace elements and other analytes that occur naturally in the environment are assessed for baseline concentrations and spatial and temporal variability in soil, vegetation, sediments, and fish tissue.
- **Geochemical Characterization**— waste characterization is presented for various rock types found in the mine study area and for representative Pebble Deposit tailings (based on simulated tailings). Extensive testing was conducted to determine geochemical properties. Tests included a wide variety of field, static, and kinetic methods that address reaction rates over time under conditions that include exposure to air, alternating cycles of wetting and drying, and saturated conditions. Testing will be ongoing for some time before final waste characterization is complete. Additional results will be presented in separate reports to PLP as baseline documentation.
- **Noise**—noise-monitoring data collected to establish baseline noise levels are presented. Noise can be perceived as desired, beneficial, or detrimental.
- **Vegetation**—these chapters discuss dominant vegetation types as well as typical plant-species composition and distribution, as determined based on existing literature, extensive field work, and aerial photography. Maps present groupings of vegetation types across the study areas.
- **Wetlands**—the extent and types of wetlands in the study areas are discussed and mapped based on existing literature, aerial photography, and extensive field work.
- **Fish and Aquatic Invertebrates**—These chapters present the results from extensive field studies addressing fish and aquatic invertebrate distribution, density, and abundance; channel morphology; habitat; flow/habitat relationships; fluvial geomorphology; and water temperature modeling. The discussion addresses spatial and temporal trends.
- **Wildlife and Habitat**—this diverse discipline covers data from a wide variety of ground-based and aerial surveys and aerial photography. Baseline studies of habitat availability and habitat-value assessments for bird and mammal habitat were based on aerial photography, and the results are presented and mapped for the study areas. The chapters also present the study results for presence, distribution and abundance, and/or habitat use for terrestrial mammals, raptors, waterbirds, shorebirds, landbirds, wood frogs, and seals in Iliamna Lake.
- **Threatened and Endangered Species**—literature reviews and information from field surveys were used to determine the potential for rare plant species to be present in the study areas and to summarize the occurrence and conservation status of protected wildlife and plant species and species of conservation concern found or likely to occur in the study areas.
- **Land and Water Use**—existing land ownership, present use, and management status of private and public lands and surface waters are described and mapped based on existing data sources and publications. Federal, state, and local regulatory powers and plans also are discussed.
- **Regional Transportation**—land, water, and air transportation facilities and services, both existing and proposed, are described for the greater Bristol Bay area. The information presented is based on existing transportation studies, regional plans, and interviews with representatives of service providers from the area.

- **Power**—these chapters describe existing services and facilities for supplying electrical power and petroleum fuels to the Bristol Bay communities, as determined based on various publications and online information resources.
- **Socioeconomics**—information on demographics, economy, infrastructure, and history are provided for several communities in the Lake and Peninsula Borough, Bristol Bay Borough, and the Dillingham Census Area. A general discussion of socioeconomics for the Municipality of Anchorage, Kenai Peninsula Borough and the Matanuska Susitna Borough are also provided. The discussion is based on the most recent government data available at the time of preparation.
- **Cultural Resources**—existing data on prehistory, ethnography, and history are summarized. Additionally, information from interviews with tribes and other interested local parties and from field surveys are provided.
- **Subsistence**—the role of subsistence in local communities, information about current and historical subsistence harvests and use areas, traditional knowledge about changes in subsistence resources, and local concerns related to subsistence are presented based on household harvest surveys conducted by the Alaska Department of Fish and Game, and subsistence mapping and traditional knowledge interviews conducted by Pebble Project researchers with active and/or knowledgeable harvesters.
- **Visual Resources**—the scenic quality of the landscape is analyzed using U.S. Forest Service methods. The analysis provides information on viewed areas, constituent viewer groups and their sensitivities and expected exposure, and an analysis of the landscape's existing character and quality.
- **Recreation**—outdoor recreational resources and activities are described and mapped. An estimate of their economic contribution to the study areas' economy also is presented. The information presented is based on state and federal land use plans, Alaska Department of Fish and Game reports on sportfishing and big game hunting, and an inventory of recreational lodges.
- **Oceanography and Marine Water Quality**—the shape and depth of Iliamna and Iniskin bays, tidal range and currents, wave and ice-scour action in the vicinity, and a brief analysis of some of the inputs to and outputs from the bays are addressed through literature searches of previous study results and through field investigations. Marine water quality data for physical and chemical parameters sampled in the field are presented, and the results for the inorganic chemical parameters are compared to the Environmental Protection Agency's National Recommended Water Quality Criteria to give context.
- **Marine Nearshore Habitat**—the chapter describes the diverse range of habitats in the vicinity of Iliamna and Iniskin bays, based on information drawn from the marine investigators' long history of work in the area and from field observations during these studies.
- **Marine Benthos**—the benthic flora and fauna of the intertidal and subtidal habitats of Iliamna and Iniskin bays are presented. The information presented is based on the marine investigators' long history of work in the area and field investigations during these studies.
- **Nearshore (Marine) Fish and Invertebrates**—marine investigations included beach seine sampling, gill net and trammel net sampling, and trawl net sampling for fish and invertebrates. Herring-spawn surveys and fish-stomach content analyses also were conducted. The data from

these investigations, along with information from previous studies, are presented by species with discussions on seasonal trends and distinct habitat usage.

- **Marine Wildlife**—the seasonal distribution and abundance of marine-oriented wildlife (birds and mammals) is presented. The information presented is based on previous literature, boat surveys, fixed-wing aircraft surveys, and helicopter surveys. The chapter addresses seasonal and interannual patterns, taxonomic patterns, and spatial patterns

1.6.2 Quality Assurance/ Quality Control (QA/QC) Program

The Pebble Project QA/QC program is specific to the collection, review and management of field and laboratory data. The QA component of the program is a systematic process of verifying that activities are meeting specified requirements. It strengthens the confidence in the data generated from various activities that help form the interpretations and conclusions made for baseline conditions. This strength is accomplished by establishing consistency and building in efficiencies that provide benefits throughout the project. Study plans (SPs), field sampling plans (FSPs), quality assurance project plans (QAPPs) and statements of work (SOWs) document the QA program and processes. The QC component of the program is implemented through field and laboratory audits, peer review, data validation, and statistical analyses. Field and laboratory QA/QC protocols are presented in the consolidated SPs (EBD Appendix E), FSPs (EBD Appendix F) and QAPPs (EBD Appendix G) for each year of the study.

SPs were prepared for each discipline (e.g., fish, wetlands, geochemistry, etc.) by consultants to describe how the study would be conducted. The specific objectives of the SPs were to:

- Describe the study for characterizing baseline environmental conditions
- Define the methods and approach for data gathering and analysis
- Define the objectives of each environmental component of the baseline studies

FSPs were developed for some disciplines to describe in detail the procedures and protocols researchers would use to collect physical samples in the field for laboratory analysis. The FSPs acted as instructions for use in the field to ensure proper field techniques, and to provide documentation for reviewers of the data. Not all disciplines have FSPs because many do not require collection of physical samples for laboratory analysis. FSPs were not necessarily developed each year for a given discipline, because once a refined plan existed there was no need to change it.

QAPPs were updated each year to define analytical QA/QC specification for water, soil, sediment, vegetation and tissue samples collected for laboratory analysis. These plans document all data quality objectives necessary to obtain data that is defensible and representative of the environment. Analytical laboratory QA/QC results are presented in EBD Appendix A.

The specification for QC review of field data is as follows.

Field data are considered final when quality control (QC) is completed as defined below.

> Level 1 QC – The individual collecting field data reviews the data for completeness, legibility and logic on all information recorded. The field team leader then conducts the same review on 100 percent of the data collected. This is typically completed in the field at the end of each day.

Level 2 QC – For field data that are manually entered into either a spreadsheet or database at least 20 percent of the data entries are checked by a peer who did not enter the data. If errors are found then the check is conducted on 100 percent of the entries. Shorthand codes are often used in the field, to represent species, location names, crew, equipment, etc. These shorthand codes must be deciphered into standard or more meaningful values during QC level 2 data entry.

Level 3 QC – This is senior level review of the data for possible data quality issues observed in trends and statistical analyses. It is understood QC level 3 continues during data analyses for report writing and or modeling applications. Statistical outliers and questionable data should be thoroughly reviewed for QA/QC to determine the cause. Should data be deemed not useable (i.e., invalid) during this process PLP must be notified so that the archived data can be qualified accordingly.

These QA/QC processes are based on a defined and documented set of criteria, which are accepted by industry and comply with relevant regulatory guidelines. The result of this program is a baseline data set of known quality for characterizing environmental conditions. The data are managed to ensure the data quality is maintained and secure. EBD consultants reported their study findings in draft EBD documents that were subject to rigorous scientific peer reviews, technical editing and consistency reviews. All of the reviews included quality checks on study findings. Discrepancies identified during this process were resolved by study authors for all disciplines.

1.7 EBD Package Structure

The EBD package being published by the Pebble Partnership is composed of two parts: a technical summary and the EBD itself.

1.7.1 Technical Summary

The technical summary consists of summaries for each chapter and appendix of the EBD. Each chapter of the technical summary briefly describes the given discipline's study objectives and methods, but focuses on the results and discussion. The purpose of the technical summary is to provide one document of reasonable length that introduces the disciplines covered by the baseline studies and broadly describes the results of those studies. Based on the technical summary, readers can better determine what chapters of the EBD they might wish to delve into. The technical summary is being published as a stand-alone document for distribution in electronic and paper formats, although it will be distributed in conjunction with the EBD.

1.7.2 Environmental Baseline Document

This document contains the details of all the baseline studies. Each of the 53 chapters describes the study objectives, study area, scope of work, methods, and results and discussion for its particular discipline. As previously noted, the EBD was written by the Pebble Partnership's consultants and is a product of their efforts and professional judgment. The printed version contains approximately 20,000 pages, including text, tables, figures, photographs, and some appendices (other appendices are available only electronically because of their length). Because of the inclusion of the additional appendices, the electronic version has approximately 27,000 pages. Because of its size, the EBD is being published primarily in electronic

format, with a limited distribution of paper copies. The electronic version will be available on a website at pebbleresearch.com.

1.8 EBD Document Structure

1.8.1 Geographical Division

The chapters in the EBD are organized into two parts to reflect the geographical realities of the Pebble Project study areas. Chapters 1 through 25 comprise the first part, by far the larger part, which (except for this chapter) presents information for study areas in the Bristol Bay drainages (Figure 1-4). The second part, Chapters 26 through 53, presents information for the Cook Inlet drainages study area, which encompasses a much smaller area than the study areas in the Bristol Bay drainages. This division was made because the Cook Inlet study area is almost completely defined by the coastal and marine environments of Cook Inlet, which have substantially different characteristics than the interior environments of the study areas in the Bristol Bay drainages.

Each chapter of the EBD addresses one discipline (e.g., meteorology, water quality, land use, etc.). The chapters for the Bristol Bay drainages are often organized into two subsections—one for the mine study area that is centered around the Pebble Deposit and another for the transportation-corridor study area that extends from the mine study area to the boundary between the Bristol Bay and Cook Inlet drainages. The chapters for the Cook Inlet drainages address the terrestrial environment from the drainages boundary eastward to and surrounding Iliamna and Iniskin bays, and also include the marine environments of those bays on Cook Inlet. Additionally, a few chapters are specific to only the Bristol Bay drainages (e.g., geochemistry) or the Cook Inlet drainages (e.g., marine benthos).

1.8.2 Study Areas

The study areas for many of the environmental disciplines have evolved over time as data have been collected and various project design options have been considered. In 2004 and 2005, the studies centered on the area immediately surrounding the deposit as it was then delineated, later defined as the Pebble West Deposit. By 2006 and 2007, the mine study area had been expanded considerably around the newly discovered Pebble East Deposit. Additional changes in study areas occurred over the years to include new areas of interest as different possibilities for infrastructure were considered.

Figure 1-4 shows the location of the four generalized study areas:

- The mine study area (in the vicinity of the Pebble Deposit).
- The transportation-corridor study area (the linear area north of Iliamna Lake stretching from the mine study area approximately 50 miles eastward to the boundary between the Bristol Bay and Cook Inlet drainages).
- Iliamna Lake study area.
- The Cook Inlet drainages study area, including marine areas in and near Iliamna and Iniskin bays (for certain disciplines, the entire Iniskin Peninsula and Chinitna Bay were included in the study area).

The study areas for a few disciplines extend beyond these generalized study areas. These extended study areas are described in the section on study area in the chapters for those disciplines.

The term "project area" has been intentionally avoided in this EBD because a project design has not yet been defined. Additionally, because of the potential size of a project associated with the Pebble Deposit, defining a general project study area for all disciplines is difficult. The areas of interest for different disciplines vary tremendously. Each chapter, therefore, describes a study area (or areas) specific to the baseline studies for the given discipline.

1.8.3 Discipline Grouping

The many study disciplines have been organized in the EBD into three categories: physical and chemical environment (e.g., climate, water quality, trace elements, etc.), biological environment (wetlands, fish and aquatic invertebrates, wildlife and habitat, etc.), and human environment (land and water use, socioeconomics, subsistence, etc.). These categories and the disciplines within them are presented in the same order for both the Bristol Bay drainages and the Cook Inlet drainages (with the few exceptions of disciplines, such as marine studies, that are discussed for only one of the drainage areas).

1.8.4 Chapter Structure

Each chapter of this EBD is self-contained, with its own table of contents and, as applicable, definitions of acronyms and abbreviations used in the chapter, a list of references cited in the chapter, and a glossary of terms used in the chapter. All tables, figures, photographs, and/or appendices associated with each chapter are included with that chapter.

Most chapters have the following elements, generally presented in the order shown below (elements enclosed in brackets are not always present):

- Acronyms and Abbreviations
- Introduction
- Study Objectives
- Study Area
- [Previous Studies]
- Scope of Work
- Methods
- Results and Discussion
- Summary
- [References]
- [Glossary]
- [Tables]
- [Figures]

- [Photographs]
- [Appendices]
  - [Attachments (to Appendices)]
    - [Supplements (to Attachments)]

Many of the chapters for the Bristol Bay drainages are separated into primary subsections based on study area (i.e., mine study area and transportation-corridor study area). Because for most disciplines the objectives, scope of work, and methods were the same for both study areas, to minimize duplication the subsections for the transportation-corridor study area often refer readers to the descriptions of these elements for the mine study area.

For most chapters, the tables, figures, and/or photographs are located at the end of the chapter. In some cases, these elements are placed at the end of primary subsections within the chapter. In a few chapters that contain many tables and figures, these elements are interspersed throughout the text of the chapter to allow for smoother reading.

Many chapters include appendices that contain supporting information or other data, for example, tables of laboratory analytical data. In some chapters, for example Chapter 15 (fish and aquatic invertebrates for the Bristol Bay drainages), appendices contain reports on specialized research that supports but may not be directly addressed in the body of the chapter. Readers are referred to all appendices as appropriate.

In Chapter 23 (subsistence and traditional knowledge for the Bristol Bay drainages), the nature of the information being presented does not fit well into the standard format of EBD. The main body of the chapter is essentially an introduction to and overview of the methodology for collecting detailed information about each community. The detailed community information is provided in a series of appendices formatted to more effectively present the information.

Chapters 32 (groundwater hydrology for the Cook Inlet drainages) and Chapter 51 (subsistence and traditional knowledge for the Cook Inlet drainages) exist as placeholders only with no content. These studies have not yet been conducted. Results will be provided in reports to PLP as additional baseline documentation.

Note there may be some minor inconsistencies in certain dynamic data presented in more than one place in the EBD. For example, values for average annual precipitation in the Pebble Deposit area may be slightly different in different chapters of the EBD depending on the most current information available at the time a given chapter was written.

1.8.5 EBD Appendices

Many chapters have appendices that provide additional information relevant only to that chapter; however, the overall EBD itself has seven appendices containing information that is relevant to multiple chapters. These appendices appear at the end of the entire EBD and are described briefly below.

- **Appendix A, Analytical Quality Assurance/Quality Control Review.** This appendix presents an overview of the analytical quality assurance/quality control program for the Pebble Project. This program is specific to the collection and handling of, laboratory analyses of, and

data deliverables for samples collected in the field during the environmental baseline studies. The findings of the data-quality assessment of analytical data are reported for surface water, groundwater, sediment, vegetation, soil, freshwater fish and mussel tissues, marine fish and bivalve tissue, marine sediment, and marine water.

- **Appendix B, Iliamna Lake Studies.** This appendix describes and reports the findings of studies of surface water, sediment, mussel tissue, and zooplankton from Iliamna Lake during 2005, 2006, and 2007.
- **Appendix C, Data Management and Geographic Information System.** This appendix describes the Pebble Project geographic information system (GIS), as well as the data management program, which includes meteorological, wetlands, laboratory analytical, and other types of data for the Pebble Project.
- **Appendix D, Chemical Abbreviation.** This appendix defines chemical abbreviations that may be used throughout the EBD.
- **Appendix E, Consolidated Study Program.** This appendix presents the environmental baseline study program for individual disciplines. The consolidated study program was compiled by the Pebble Partnership based on individual study plans developed by consultants each year. The consolidated study program for each discipline describes the study areas, approach and methods, and major activities for each year of the study period.
- **Appendix F, Field Sampling Plans**. This appendix contains the detailed annual field sampling plans for the following studies:
  - Surface water quality and hydrology.
  - Groundwater quality and hydrology.
  - Trace elements and other naturally occurring constituents in vegetation, soil, freshwater sediment, and freshwater fish and bivalve tissues.
  - Metal leaching and acid rock drainage.
  - Small pools.
  - Fish.
  - Macroinvertebrates and periphyton.
  - Iliamna Lake studies.
  - Marine studies.
- **Appendix G, Quality Assurance Project Plans.** This appendix contains the annual quality assurance project plans (QAPPs). These QAPPs specify detailed field sampling and laboratory analytical protocols, as well as quality assurance/quality control requirements and data quality assessment procedures for the Pebble Project.

1.9 EBD Formats

The EBD has been produced in three formats: electronically online, electronically on DVD, and printed on paper.

1.9.1 Electronic Versions

Electronic versions of the EBD in portable document format (PDF) are online and on DVD. For ease of navigation, each chapter in the electronic versions has bookmarks corresponding to the entries in the tables of contents. In addition, hyperlinks in the PDF files allow readers to jump to cited tables, figures, and other cited elements.

1.9.1.1 Online EBD

The complete EBD is available online at pebbleresearch.com. The entire EBD or individual chapters may be read and/or downloaded there in PDF format. Please note that some navigational functions, including certain hyperlinks, may not be available in the online version. The website that provides access to the online EBD also includes basic instructions for how to access and navigate through a PDF file.

1.9.1.2 EBD on DVD

A DVD containing the complete EBD was delivered with each paper copy of the EBD (see below). In addition, individual DVDs containing the EBD were distributed to a limited number of recipients. In Bristol Bay communities, contact the tribal council, ANCSA (Alaska Native Claims Settlement Act) corporation, and/or the municipal government to find out where the nearest DVD is housed. The DVD includes a READ ME file that provides basic instructions on how to access and navigate through a PDF file.

1.9.2 Paper Version

Paper versions of the EBD are available for review at a limited number of locations. In Anchorage, a copy is housed at the Alaska Resources Library and Information Service (ARLIS) in the Consortium Library on the University of Alaska, Anchorage, campus at 3211 Providence Drive (907-272-7547). In Bristol Bay communities, contact the tribal council, ANCSA Corporation, and/or the municipal government to determine if a particular community has chosen to have a paper copy.

Please note that some very large appendices, a small number of figures, and a few other elements are available only in the electronic versions. A few tables and figures contain too much detail to be large enough for easy reading when printed—these few elements are more easily read in the electronic versions.

1.10 References

PB Consult Inc. 2004. Revised Southwest Alaska Transportation Plan. Prepared for the Alaska Department of Transportation and Public Facilities, Central Region.

Rieger, S., D.B. Schoephorster, and C. E. Furbush. 1979. Exploratory Soil Survey of Alaska. U.S. Department of Agriculture, Soil Conservation Service. Washington, D.C.: U.S. Government Printing Office.

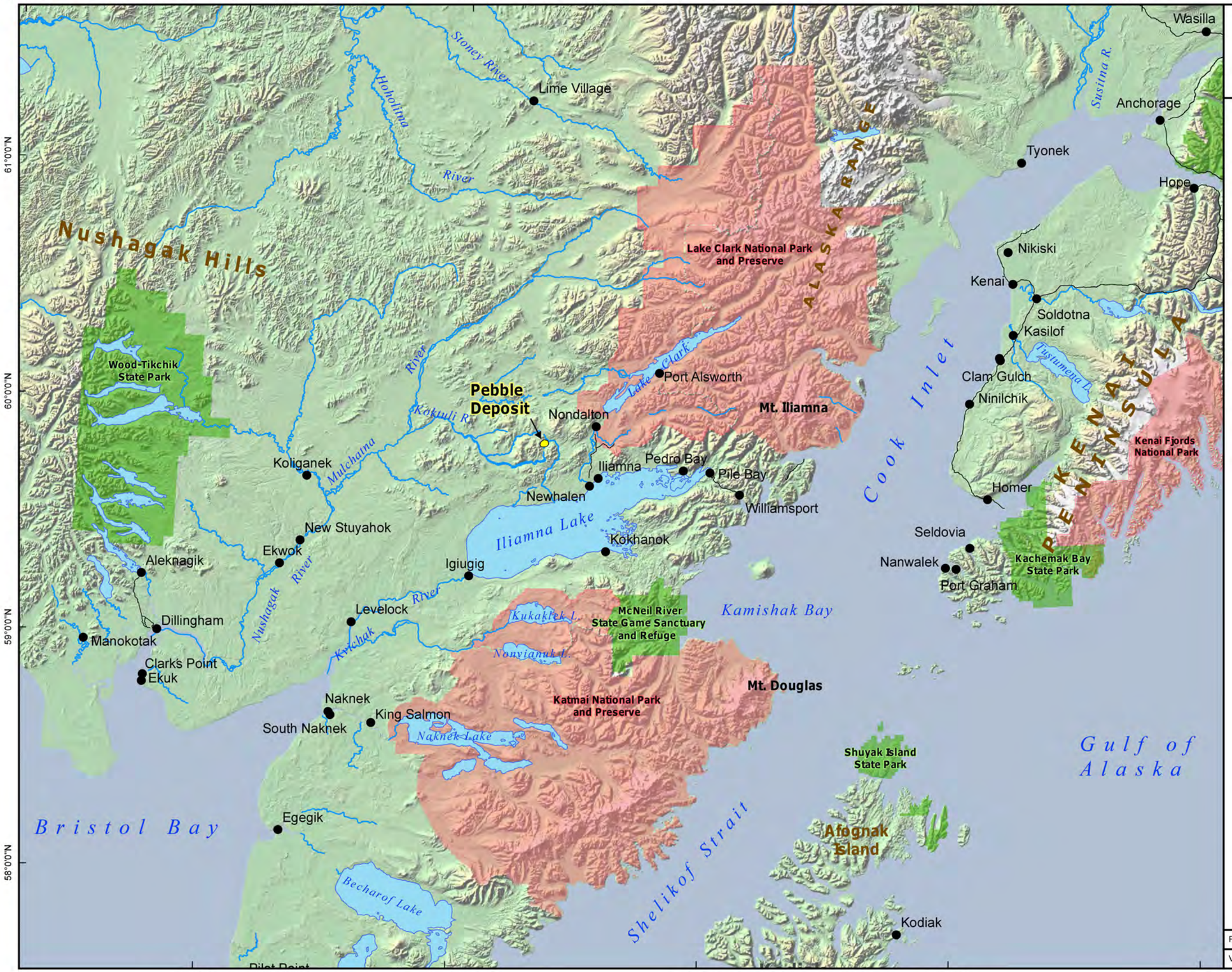
TABLES

TABLE 1-1
Baseline Study Disciplines and Associated Consultants

Discipline	Consultant(s)
Climate and Meteorology	Hoefler Consulting Group, CH2M Hill
Geology and Mineralization	Knight Piésold, Thomas Hamilton, SLR International Corp.
Physiography	Knight Piésold
Soils	Three Parameters Plus, Inc.
Geotechnical Studies, Seismicity and Volcanism	Knight Piésold, Water Management Consultants Inc., Schlumberger Water Services, Frontier Geosciences Inc.
Surface Water Hydrology	*Mine Study Area* — Knight Piésold; HDR Alaska, Inc.; ABR, Inc.; APC Services, LLC , CH2M Hill *Transportation Corridor/Cook Inlet Study Areas* — Bristol Environmental and Engineering Services Corp.
Groundwater Hydrology	*Mine Study Area* — Water Management Consultants; Schlumberger Water Services; SLR International Corp., Bristol Environmental and Engineering Services Corp., HDR Alaska, Inc., CH2M Hill
Water Quality (Surface Water, Groundwater, and Marine)	*Mine Study Area* — Water Management Consultants; Schlumberger Water Services; HDR Alaska, Inc.; APC Services, LLC; SLR International Corp.; CH2M Hill *Transportation Corridor/Cook Inlet Study Areas* — Bristol Environmental and Engineering Services Corp., Pentec Environmental/Hart Crowser, Inc.
Trace Elements and Other Naturally Occurring Constituents	*Mine Study Area* — SLR International Corp.; HDR Alaska, Inc.; CH2M Hill *Transportation Corridor/Cook Inlet Study Areas* — Bristol Environmental and Engineering Services Corp., SLR International Corp., Pentec Environmental/Hart Crowser, Inc.
Geochemical Characterization	*Mine Study Area* — SRK Consulting, Inc.
Noise	Michael Minor & Associates
Vegetation	Three Parameters Plus, Inc.; HDR Alaska, Inc.
Wetlands	Three Parameters Plus, Inc.; HDR Alaska, Inc.
Fish and Aquatic Invertebrates (Freshwater and Marine)	R2 Resource Consultants, Inc.; HDR Alaska, Inc.; Buell & Associates; Bailey Environmental; Northern Ecological Services; EcoFish; Inter-fluve; Pacific Hydrologic, Inc.; Pentec Environmental/Hart Crowser, Inc.
Wildlife and Habitat (Terrestrial and Marine)	ABR, Inc.; Bristol Environmental and Engineering Services Corp.; Pentec Environmental/Hart Crowser, Inc.; RWJ Consulting
Threatened and Endangered Species	ABR., Inc.
Land and Water Use	Kevin Waring Associates
Transportation	Kevin Waring Associates
Power	Kevin Waring Associates
Socioeconomics	Kevin Waring Associates, McDowell Group

Discipline	Consultant(s)
Cultural Resources	Stephen R. Braund & Associates
Subsistence and Traditional Knowledge	Stephen R. Braund & Associates
Visual Resources	Land Design North
Recreation	Kevin Waring Associates
Analytical Quality Assurance/Quality Control	Shaw Alaska. Inc.; Argon, Inc.
Iliamna Lake Studies	HDR Alaska, Inc.
Data Management	Resource Data Inc.; DES.IT; Shaw Alaska, Inc.; Argon, Inc.
Analytical Laboratories	SGS North America; Columbia Analytical Services;; SGS CEMI; SGS Lakefield; TestAmerica Laboratories, Inc.; University of Waterloo; ACZ Laboratories, Inc.; Texas A&M University; Frontier GeoSciences
Aerial Photography	Aerometric, Eagle Mapping, Kodiak Mapping, Dudley Thompson Mapping

FIGURES



THE pebble PARTNERSHIP

Figure 1-1
Pebble Project Environmental Baseline Studies
Regional Map

Legend

- Pebble Deposit
- National Park or Preserve
- AK State Park
- Communities
- Existing Roads

Miles
0 10 20 30 40 50 60 70

Kilometers
0 20 40 60 80 100 120

Scale 1:1,800,000

N

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

File: RDI_ND_PEBANC_1Fig1-1_1X17L_1of1_D02mxd	Date: September 13, 2011
Version: 2	Author: JG-PLP, LS-RDI

155°50'0"W 155°40'0"W 155°30'0"W 155°20'0"W 155°10'0"W 155°0'0"W

60°0'0"N
59°55'0"N
59°50'0"N
59°45'0"N
59°40'0"N

Black Lake
Lilly Lake
Big Wiggly Lake
North Fork Koktuli
Koktuli River
North Fork Koktuli River
Upper Talarik
Frying Pan Lake
Upper Talarik Creek
Koktuli River
North Fork Koktuli River
South Fork Koktuli
South Fork Koktuli River
Kaskanak Creek
Chiquita Lake
Kaskanak Creek
Lake #2
Lower Talarik Creek
Iliamna Lake

155°50'0"W 155°40'0"W 155°30'0"W 155°20'0"W 155°10'0"W 155°0'0"W

THE pebble PARTNERSHIP

Figure 1-2a
Drainages in the Mine Study Area

Legend

- Mine Study Area
- Drainage Boundaries in Mine Study Area
- General Deposit Location

Miles
0 1 2 3 4 5 6

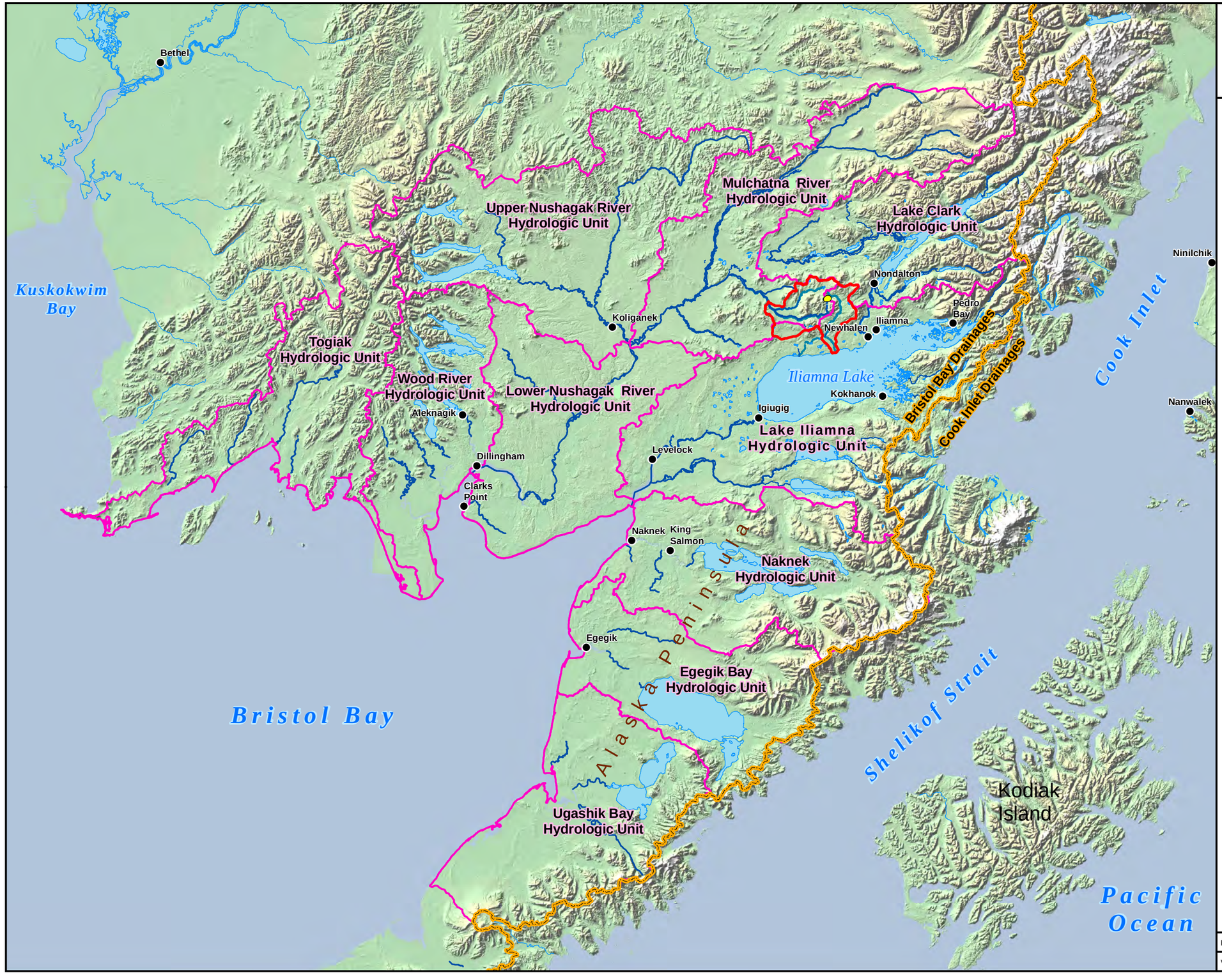
Kilometers
0 1 2 3 4 5 6 7 8

N

Scale 1:170,000

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

File: RDI_SLR_StudyAreaDrainages_Fig1-2a_11X17L_1of1_D04.mxd	Date:September 7, 2011
Version: 4	Author: RDI- MRA, LS



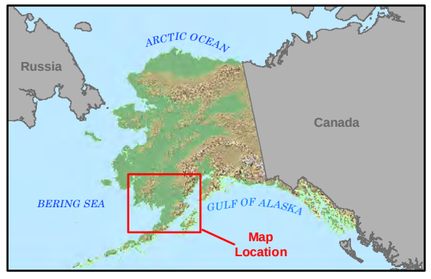
THE pebble PARTNERSHIP

Figure 1-2b
Hydrologic Units within the
Bristol Bay Watershed

Legend

- Mine Study Area
- USGS, EROS Sub-basin Hydrologic Unit Boundaries of the Bristol Bay Watershed
- Bristol Bay/Cook Inlet Drainages Boundary
- Major Rivers Draining into Bristol Bay
- General Deposit Location
- Communities

Source for sub-basin units: U.S. Geologic Survey, Earth Resources Observation and Science Center. 1994. Alaska Hydrologic Units 1:250,000 mapping.



Miles
0 20 40 60 80

Kilometers
0 20 40 60 80 100

N

Scale 1:2,000,000

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

File: RDI_SLR_StudyAreaDrainages_Fig1-2b_11X17L_1of1_D01.mxd	Date:September 13, 201
Version: 1	Author: RDI- MRA, LS

156°0'0"W 155°48'0"W 155°36'0"W 155°24'0"W 155°12'0"W 155°0'0"W

60°0'0"N
59°54'0"N
59°48'0"N
59°42'0"N
59°36'0"N

2133 1391 1165 2133 1741 1730 2290 1383 2500 1915 1671 1982 1250 1890 915 1253 2305 2592 1275 1645 1836 1791 3045

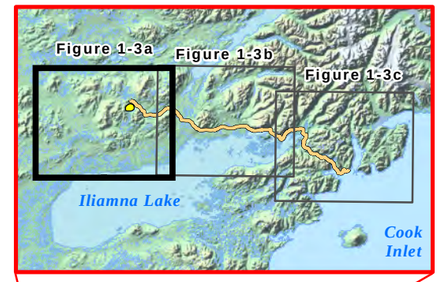
"Black Lake"
Cone (Black) Mountain
"Big Wiggly Lake"
Groundhog Mountain
Groundhog Creek
Pig Mountain
North Fork Koktuli River
Koktuli River
Stuyahok River
Kaskanak Mountain
"Frying Pan Lake"
Koktuli Mountain
"Northeast Tributary U.T."
Upper Talarik Creek
Koktuli Confluence
South Fork Koktuli River
South Fork Koktuli Springs (Upwelling Area)
The Flats
Sharp Mountain
"Chiquita Lake"
Kaskanak Creek
"Lake #2"
First Creek
Newhalen River
Iliamna Lake

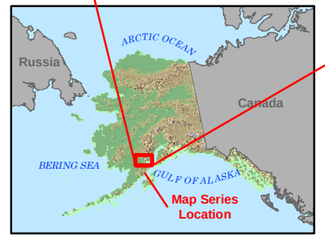
THE pebble PARTNERSHIP

Figure 1-3a
Place Names

Legend

- General Deposit Location
- × Reference Elevation





Miles 0 2 4 6 8
Kilometers 0 2 4 6 8 10
N

Scale 1:200,000

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

File: RDI_HDR_Placename_Fig1-3_11x17_1of3_D02.mxd	Date: September 11, 2011
Version: 2	Author: HDR - MC, RDI - LS

155°0'0"W 154°48'0"W 154°36'0"W 154°24'0"W 154°12'0"W 154°0'0"W

60°0'0"N

59°48'0"N

59°42'0"N

Lake Clark

Upper Tazimina Lake

Lower Tazimina Lake

Sixmile Lake

Pickerel Lakes

Nondalton

Fish Village

Tazimina River

Chekok Lake

Alexcy Lake

Negro Lake

Roadhouse Mountain

Knutson Mountain

Canyon Creek

Chekok Creek

Knutson Creek

Iliamna-Nondalton Road

Bear Creek

Newhalen River

Roadhouse Creek

Eagle Bay Creek

Chekok

Chekok Bay

Knutson Bay

Fox Bay

Knutson Valley

Pedro Bay

Pedro Mountain

Lonesome Bay

Lonesome Point

Pile Bay

Northeast Bay

Whistlewing Bay

Eagle Bay

Pike Lake

Iliamna

Roadhouse Bay

Jackrabbit Is.

Dog Is.

Eagle Bay Is.

Twomile Is.

Rabbit Is.

Newhalen

Millets Point

Chekok Point

Hat Is.

Grassy Is.

Flat Island

Porcupine Island

FRI Camp

Triangle Is.

Seal Is.

Iliamna River

Silver Creek

Meadow Lake

Iliamna Lake

1645 1405 1936 1791 3163 1728 3855 4403 3236 4430 3403 3150 3985 3987 804

155°0'0"W 154°48'0"W 154°36'0"W 154°24'0"W 154°12'0"W 154°0'0"W

59°48'0"N

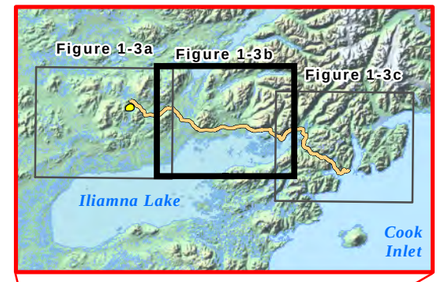
59°42'0"N

THE pebble PARTNERSHIP

Figure 1-3b
Place Names

Legend

- Communities
- Existing Roads
- × Reference Elevation



0 2 4 6 8 Miles

0 2 4 6 8 10 Kilometers

N

Scale 1:200,000

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

File: RDI_HDR_Placename_Fig1-3_11x17_1of3_D02.mxd	Date: September 11, 2011
Version: 2	Author: HDR - MC, RDI - LS

154°0'0"W 153°48'0"W 153°36'0"W 153°24'0"W 153°12'0"W 153°0'0"W

59°48'0"N 59°42'0"N 59°36'0"N

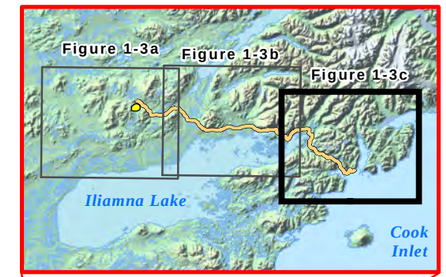
Knutson Creek
Pile River
Long Lake
Iliamna River
Lonesome Bay
Lonesome Point
Pile Bay
Pile Bay
Old Iliamna
Iliamna River
Chinkelyes Creek
Williamsport - Pile Bay Road
Summit Lakes
Williamsport
Williams Creek
Silver Creek
Ptarmigan Creek
Meadow Lake
Moose Lake
Diamond Point
Cottonwood Bay
Iliamna Bay
Iliamna River
Iniskin River
Mountains
Chigmit
Roscoe Peak
Mount Eleanor
Sugarloaf Mountain
Range Peak
Clearwater Creek
Chinitna River
Chinitna Bay
Seal Spit
Sea Otter Point
Tonnie Peak
Fire Creek
Portage Creek
Iniskin
Iniskin Peninsula
Iniskin Bay
Right Arm Iniskin Bay
Bow Creek
Brown Creek
Oil Bay
Mount Pomeroy
Back Range
Y Valley
Y Valley Creek
North Head
Black Reef
Knoll Head
Entrance Rock
Scott Island
Vert Is.
Mushroom Islets
Iniskin Rock
Iniskin Shoal
Iniskin Is.
Pomeroy Is
Big Rock
White Gull Is.
South Head
Turtle Reef
Cook Inlet

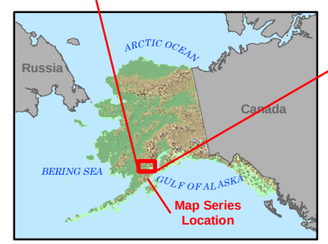
THE pebble PARTNERSHIP

Figure 1-3c
Place Names

Legend

- Communities
- Bristol Bay/Cook Inlet Drainages Boundary
- Existing Roads
- × Reference Elevation





Miles 0 2 4 6 8

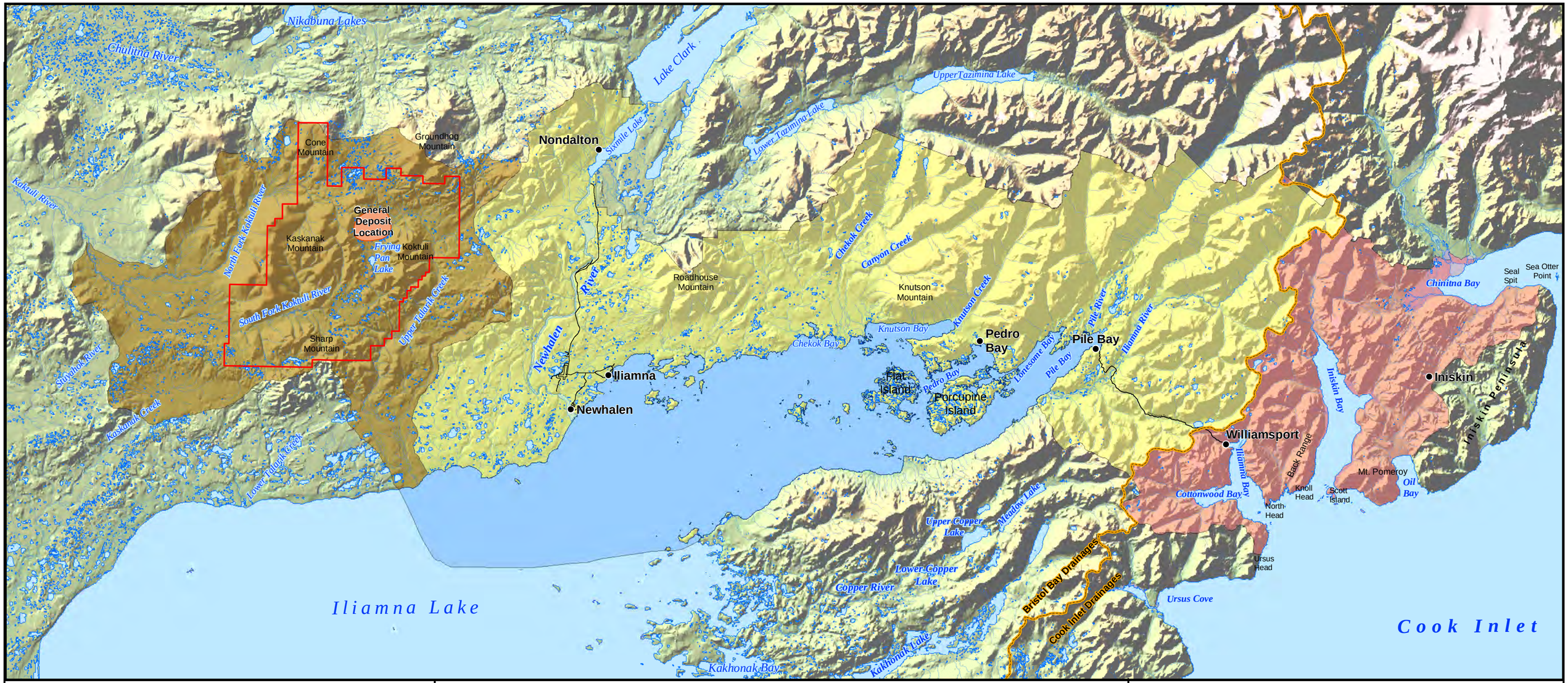
Kilometers 0 2 4 6 8 10

N

Scale 1:200,000

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

File: RDI_HDR_Placename_Fig1-3_11x17_1of3_D02.mxd	Date: September 11, 2011
Version: 2	Author: HDR - MC, RDI - LS



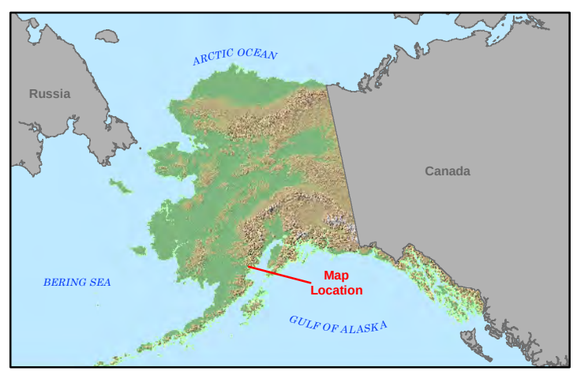
THE pebble PARTNERSHIP

Figure 1-4
Pebble Project
Environmental Baseline Studies
Generalized Study Areas

File: RDI_PLP_StudyAreas_Fig1-1_11X17L.1of1_D01.mxd	Date: September 12, 2011
Version: 2	Author: PLP - JG, RDI - LS

Legend

- General Deposit Location
- Pebble Claim Block
- Mine Study Area
- Bristol Bay Transportation Corridor Study Area
- Cook Inlet Study Area
- Iliamna Lake Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities
- Existing Roads



0 5 10 15 20 Miles

0 5 10 15 20 25 30 Kilometers

Scale 1:400,000

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