Pebble Project
Environmental Baseline Document
2004 through 2008
(with updates through 2010)

CHAPTER 39.
WETLANDS
Cook Inlet Drainages

PREPARED BY:
HDR ALASKA, INC.
THREE PARAMETERS PLUS, INC.

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ACRONYMS AND ABBREVIATIONS

ENWI	Enhanced National Wetlands Inventory
FAC	facultative (indicator plant species category)
FACW	facultative wetland (indicator plant species category)
FACU	facultative upland (indicator plant species category)
GIS	geographic information system
HGM	hydrogeomorphic
LIDAR	light detection and ranging
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OBL	obligate wetland (indicator plant species category)
RDI	Resource Data, Inc.
RU	representative upland
RW	representative wetland
SC	stream crossing
UPL	obligate upland (indicator plant species category)
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WB	waterbody
WD	wetland determination

39. WETLANDS AND WATERBODIES—COOK INLET DRAINAGES

39.1 Introduction

This chapter of the environmental baseline document summarizes the wetlands and waterbodies study for the Cook Inlet drainages study area (overview map for Figure Series 39-1). The comparable study in the Bristol Bay drainages is described in Chapter 14. The study characterized and mapped wetlands, waterbodies, and non-wetlands based on U.S. Army Corps of Engineers (USACE) definitions and procedures. Investigators completed field work in the Cook Inlet study area primarily in 2004 and 2005. They used field data and office-available information to determine the locations of wetlands and waterbodies in 3,870 acres of the Cook Inlet study area.

The study areas and mapping areas were scaled to provide coverage of potential development areas and alternative development areas as well as additional surrounding area to provide comparative context. The U.S. Supreme Court has determined that some isolated wetlands that had previously been regulated under the Clean Water Act were no longer subject to USACE jurisdiction. Some of the ponds, lakes or wetlands described within this document may not be hydrologically, physically, or chemically connected to other wetlands, however, this EBD study is limited to baseline characterization of wetlands and does not address jurisdictional determination of the wetlands and waters.

Prior to field work, aerial photography was reviewed by wetland scientists who drew polygons around areas of similar visual vegetation signatures on the maps. Vegetation signatures are recognized by color, texture, site location, aspect and shadow.

Study sites were selected in the field to sample each type of aerial photograph vegetation signature (Chapter 38) across the full range of landscape positions in the study area. These study sites provided additional field information to determine which combinations of vegetation signature and landscape position indicate wetlands and which do not. Wetland and non-wetland areas were investigated and data related to vegetation, soils, and hydrology were recorded on field plot forms and used to determine whether each study site was a wetland or not. If a field plot was determined to be a wetland, then functional assessment data were gathered to provide information regarding habitat, flood control, water quality, and other wetland functions. Photos were also taken in the field (photo points) to document the vegetation type and wetland status of additional sites as a supplement to the more detailed-field plot forms. Stream crossings and waterbodies were also documented and limited water chemistry information was collected.

During field data collection, all wetlands and waterbodies were classified according to several classification systems. In addition to the vegetation type classification described in Chapter 38, wetlands and waterbodies were categorized according to the Hydrogeomorphic (HGM) classification system (Brinson, 1993), which is based on the wetland's landscape position, water source, and hydrodynamics of the water. Wetlands and waterbodies were also classified using an enhanced National Wetlands Inventory

(ENWI) Code. This classification is based on the principles of the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979) and National Wetland Inventory Mapping Conventions (USFWS, 1995).

Scientists used field data and office-available resources to determine the locations of wetlands and waterbodies in 3,870 acres of the Cook Inlet study area. In addition to wetlands, investigators mapped and described streams, lakes, and ponds in the study area. After field data collection, wetland or non-wetland status was assigned to each mapping polygon after careful review of field plot forms, aerial photo vegetation signature, photo point data, site photos, and topographic data. These data and the related determinations for each signature type were then applied to similar polygons mapped based on the aerial photography for the study area. When assigning wetland status to polygons that were not evaluated in the field, data from field plots in nearby or similar polygons were also evaluated.

In some cases, vegetation types within the study area are not always consistently associated with wetlands or non-wetlands. Scientists also considered the landscape position and other topographic and photo signature clues to assign wetland or non-wetland status to each mapping polygon. Further, a mapping polygon of a single Project Vegetation Type may include both wetland and non-wetland areas, depending on small topographic differences. In this situation, the polygons are mapped as mosaic mapping units.

The information presented here builds on the vegetation information presented in Chapter 38. The wetlands and waterbodies study overlaps with and relies on results of the vegetation study (Chapter 13), and the vegetation study is integral to the wetlands and waterbodies study. The vegetation work generates the data used to evaluate the presence of hydrophytic vegetation at individual study plots and describes and maps vegetation types, some of which are strong indicators of the presence of either wetlands or non-wetlands. The vegetation mapping is used as the basis for wetland mapping, and the vegetation descriptions are used to help characterize wetland types.

Information on the chemistry and characteristics of waterbodies in the Cook Inlet study area can be found in Chapter 33. Descriptions of the climate and the physiography of the Cook Inlet study area can be found in Chapters 26 and 28, respectively.

39.2 Study Objectives

Some of the objectives of the wetlands and waterbodies study in the Cook Inlet drainages study area were as follows:

- Determine the location and extent of wetlands and waterbodies using methods consistent with other mining projects in Alaska.
- Describe the types of wetlands and waterbodies in the Cook Inlet mapping area.
- Depict the location, extent, and type of wetlands and waterbodies in the Cook Inlet mapping area.
- Map the extent of existing human-caused soil or vegetation disturbance.

39.3 Study Area

The wetlands study area in the Cook Inlet drainages extends from the boundary between the Bristol Bay and Cook Inlet drainages to the southwestern shore of Iniskin Bay. Data have been collected throughout the study area, but mapping has been completed only for an approximately 2,000-foot-wide corridor within the study area, referred to as the "mapping area" (see overview map for Figure Series 39-1).

Wetland scientists consider the information gathered outside the mapping area to be useful for characterizing the environment surrounding the mapping area; therefore, data collected from all sites remain part of the study data set.

39.4 Previous Studies

Relevant past work in and near the study area is the National Wetlands Inventory (NWI) mapping developed by the U.S. Fish and Wildlife Service (USFWS) (USDOI, Various). NWI mapping exists for the Cook Inlet drainages mapping area (U.S. Geological Survey [USGS] quadrangles Iliamna C-2 and D-2). Non-digital NWI mapping that includes the study area is still classified as preliminary (i.e., draft). USFWS prepared the preliminary NWI maps using 1:65,000-scale, color-infrared aerial photography that was acquired in August 1978. Generally, the maps show larger, more obvious wetlands and aquatic systems, but do not include many transitional areas that also are regulated under the CWA. Because of the small scale of photography used, NWI maps generally do not show many smaller wetlands (i.e., less than 2 to 4 acres in size), and they also may overlook some forested wetland types (Smith, 1991).

Resource Data, Inc. (RDI) digitized the non-digital, preliminary NWI maps into a shapefile. Acreages and percentages for the NWI categories in the Cook Inlet drainages mapping area were derived from the digitized maps produced by RDI. Figure 39-2 shows the NWI mapping, with wetlands with similar vegetation structure grouped and color-coded for clearer presentation. Table 39-1 lists the acreages and proportions of NWI wetland and waterbody types in the Cook Inlet drainages mapping area; again, wetlands with similar vegetation structure have been grouped into the less-detailed categories listed in this table. Within the mapping area, the NWI mapped 37 acres of wetlands and 1,106 acres of open-water habitats, constituting 1 percent and 29 percent of the mapping area, respectively. The remaining 2,727 acres (70 percent) are "uplands" (neither wetland nor waterbody).

39.5 Scope of Work

HDR Alaska, Inc., collected data throughout the Cook Inlet drainages study area. Field work was conducted in 2004 and 2005. Work methods were coordinated with the mine study area wetlands consultant, Three Parameters Plus, Inc. (3PPI), to ensure consistency in methodology and data management throughout the project study areas.

Collection of field data was conducted according to the 1987 *Corps of Engineers Wetlands Delineation Manual* (USACE, 1987). Wetlands and non-wetlands were sampled at representative study plots across the study area. Photographs were collected at additional points in wetlands and non-wetlands and at stream crossings and waterbodies to supplement the more in-depth data collection at the study plots. In addition, features such as soil disturbance, habitat observations, or cultural sites, if encountered, also were documented with photographs to assist in the larger project efforts.

Data collected in the field were entered into a project database. Scientists then drew digital maps of the Cook Inlet mapping area and coded mapped areas in a geographic information system (GIS) using the field data from the project database, aerial photography, topographic contour data, and other digital resources listed in Section 39.6.1.

39.6 Methods

Wetlands and waterbodies analysis and mapping involved several major steps including evaluation of existing data, field work, data entry, final mapping, and characterization of wetlands in the study area. The identification of wetlands in the field required interpretation of the three main parameters used for wetland determinations: vegetation type, soil type, and hydrological characteristics.

Data for the transportation corridor study area were collected and analyzed using the criteria and methods found in the 1987 Corps of Engineers Wetland Delineation Manual (USACE, 1987). According to that manual, sites that are considered wetlands typically must have positive indicators of all three parameters: hydrophytic vegetation, wetland hydrology, and hydric soils (USACE, 1987).

Investigators used wetlands determinations made at the field-sampling level as the basis for assigning wetland status throughout the study area as they completed baseline mapping. Throughout the study area, scientists projected their conclusions from sampled study sites to polygons used in digital mapping, based on similarities in the landscape position and photo signatures.

39.6.1 Literature Review

Scientists sought literature and data at libraries, government agencies, and online sources to identify technical documents and digital data relevant to vegetation and wetlands in the Cook Inlet drainages study area. RDI imported existing data sets and digitized relevant hardcopy data and compiled it into the GIS for digital presentation and review.

The review of existing data resulted in the creation of project-specific GIS layers of the study area. In addition, Pebble Partnership commissioned several captures of aerial imagery. The following data sets were compiled by RDI for digital presentation and review for this study:

- NWI mapping from USFWS (as described in Section 39.4).
- USGS topographic mapping.
- Earth Resources Observation System land-cover mapping, and vegetation and land-cover types from the USGS.
- Vegetation mapping and cover classes found on the National Park Service's Lake Clark National Park and Preserve web site.
- Exploratory soil survey data (U.S. Department of Agriculture, Natural Resources Conservation Service [NRCS]).
- Color infrared photography from the National Aeronautics and Space Administration, taken in August 1978, orthorectified by Aero-Metric, Inc., at a photo scale of 1:60,000.

- Aerial photography acquired by Aero-Metric, Inc., in October of 2004 and 2005, captured at a scale of 1:8,000. This aerial photography was orthorectified at a scale of 1.5-foot pixels and used for analysis and interpretation in the Pebble Project GIS.
- Light detection and ranging (LIDAR) imagery acquired by Aero-Metric, Inc., in October 2004 and August 2008 and used to produce a layer of 4-foot contour lines for the study area.
- IKONOS (GeoEye) satellite imagery captured in July 2004 and used for some basemaps in 2004 and 2005.

39.6.2 Field Data Collection

39.6.2.1 Study Site Selection

Study sites (study plots and photo points) were selected to sample each photo signature and each Project Vegetation Type across the full range of landscape positions and soil types. In the second study year, priority was given to study sites in areas where vegetation signatures were unclear on photographic imagery or were underrepresented during past sampling events, in areas with complex wetland and non-wetland boundaries, and in areas where multiple sample points could efficiently be accessed.

39.6.2.2 Types of Study Sites

At each type of study site listed below, investigators followed the protocols for the designated type of data collection. Selection of the appropriate protocol was based on conditions found at each site.

- **Wetland Determination (WD) Plots.** At these plots investigators recorded detailed descriptions of vegetation, hydrology, soils, and—at wetlands plots—indicators of wetland functions. Data forms for the WD plots were based on standard forms in the 1987 wetlands-delineation manual (USACE, 1987), but were expanded to record additional supporting data and were refined over the course of the study. The full suite of vegetation, hydrology, and soils data collected at WD plots is described below under *Data Collection and Interpretation*. Wetlands status for these plots was determined and recorded after the field data collection for the plots was completed.
- **Representative Upland (RU)** and **Representative Wetland (RW) Photo Points.** Photographs were taken when scientists encountered vegetation communities and landscape positions that were clearly wetland (as indicated by the presence of primary indicators for vegetation, soil, and hydrology) or non-wetland (i.e., upland; as indicated by the absence of one or more indicators for vegetation, soil, or hydrology). Photographs also were used to document notable plant species and incidental observations of cultural resources and wildlife-habitat features. In 2004 and 2005, photo-point data collection did not include assigning landform or macro- and microtopography in the field. Scientists assigned these attributes after the field season for points photographed in 2004 and 2005.
- **Waterbody (WB)** and **Representative Stream Crossing (SC) Photo Points.** Photographs also were taken when the scientists encountered streams, ponds, and tidal waters. Photographs of the streams were taken looking upstream, downstream, and across. Two photographs, showing two views in different directions, were taken at ponds and tidal waters. In the database, for SC photo points, scientists recorded the Project Vegetation Type adjacent to streams if it could be determined by viewing the photographs and if the area adjacent to the stream was determined to

be wetlands. For WB photo points, the Project Vegetation Type recorded in the database represents the aquatic vegetation within the waterbody, not adjacent to it. If a WB photo point did not have substantial aquatic vegetation, its Project Vegetation Type was listed as "Open Water, BARE" (shorelines or drawn down seasonal ponds), or "Partially Vegetated" (for seasonal ponds or shorelines that had some vegetation).

39.6.2.3 Field Technology

At each study site, scientists determined and recorded the global positioning system (GPS) coordinates for the site; took photographs of the dominant vegetation, soils, and landscape features; entered key site attributes into a digital recording device; marked the site location on a field map; and recorded other key information on hardcopy data forms. Scientists used imaging systems equipped with digital cameras and GPS units (accuracy less than 50 feet) to record a subset of the field data, to watermark pictures with latitude and longitude, and to provide a direct interface to the GIS. RDI developed downloading procedures to efficiently process these data into the existing web-based database application. Investigators used backup GPS units and hand-recorded field notes if their primary systems failed.

39.6.2.4 Data Collection and Interpretation

Vegetation Data

Investigators collected vegetation data to determine whether the vegetation was hydrophytic. Detailed information was recorded for 1/10th-acre plots within representative stands of vegetation. Vegetation data collected at each plot generally included absolute percent coverage of all observed vascular plant species and estimated tree height and diameter at breast height. (Absolute percent coverage is the percentage of the ground surface that is covered by the leaves and stems of a plant species when viewed from above. Because of overlapping plant canopies, the sum of the absolute cover values for all species in a community or stratum may exceed 100 percent [USACE, 2007].) Absolute coverage for each vascular plant species was determined by visual estimation; species with less than 3 percent cover were recorded as trace. In many plots, total cover estimates for mosses and lichens also were recorded, along with their names, if known. Numerous taxonomic references and field guides were used to identify trees, shrubs, forbs, and graminoids over the course of field surveys (see Chapter 13, methods section).

The USFWS has assigned each plant species a wetland indicator status in the 1988 *National List of Plant Species that Occur in Wetlands: Alaska (Region A)* (Reed, 1988). The indicator status categories are as follows:

- **Obligate Wetland (OBL).** Almost always occur in wetlands (estimated probability greater than 99 percent).
- **Facultative Wetland (FACW).** Usually occur in wetlands (estimated probability 67 to 99 percent), but occasionally found in non-wetlands.
- **Facultative (FAC).** Equally likely to occur in wetlands or non-wetlands (estimated probability 34 to 66 percent).
- **Facultative Upland (FACU).** Usually occur in non-wetlands (estimated probability 67 to 99 percent), but occasionally found in wetlands (estimated probability 1 to 33 percent).

- **Obligate Upland (UPL).** Almost always occur in non-wetlands (estimated probability greater than 99 percent).
- **No Indicator (NI).** Insufficient information available to determine an indicator status. Species with NI status should be excluded from hydrophytic vegetation calculations according to the USACE guidance (Lichvar, pers. comm., 2007, and USACE, 2007).
- **Not listed (NL).** Plant species not included on the 1988 national list. These species are treated as UPL species (USACE, 2007).

A plant community is considered hydrophytic when more than 50 percent of dominant species are categorized as OBL, FACW, or FAC (USACE, 1987). Dominant species typically are determined for each vegetation stratum based on the "50/20" rule recommended in the on-line version of the 1987 wetlands-delineation manual and the current industry standard. Pebble researchers modified the standard "50/20" rule for determining dominance for Pebble Project, and in June 2004 the USACE approved this modification, known as the "50/20/20" rule. The 50/20/20 rule for calculating dominant species and then determining whether the vegetation is hydrophytic includes the following steps:

1. Assign indicator status and stratum to each species within the 1/10-acre plot. The strata used for the study area include tree, shrub (includes saplings), and herb (definitions of these strata are included in the glossary).
2. Visually estimate the absolute percent coverage of each species.

For each stratum, perform the following steps:

1. Sum the absolute percent coverage values for each species in a stratum to obtain the total percent coverage for that stratum.
2. Determine 20 percent and 50 percent of this total percent coverage value.
3. Assign dominant species status to the following
   - Species with absolute percent coverage values greater than or equal to 20 percent.
   - Species with absolute percent coverage values greater than or equal to 20 percent of the total percent coverage value for that stratum.
4. Determine whether additional species must be included as dominants, as follows:

   If the sum of the absolute percent coverage values for all dominant species within a stratum is greater than 50 percent of the total percent coverage value for that stratum, then no other species are included as dominants in that stratum.

   If the sum of the absolute percent coverage values for all dominant species within a stratum is less than or equal to 50 percent of the total percent coverage value for that stratum, then additional species must be designated as dominants. Include species within that stratum in decreasing order of absolute percent coverage incrementally until the sum of the absolute percent coverage for dominant species within that stratum exceeds 50 percent of the total percent coverage value for that stratum.
5. Combine the lists of dominant species for all strata. Note that a species may be dominant in more than one stratum (e.g., a tall woody species may be dominant in both the tree and shrub strata).

Calculate the percentage of species that are categorized as FAC, FACW, or OBL. If that percentage exceeds 50 percent, then the vegetative community is hydrophytic.

Below is an example of a determination of whether a vegetation community is hydrophytic under the 50/20/20 rule (based on a table from USACE, 2007):

Stratum	Species	Wetland Indicator Status	Absolute Percent Coverage	Dominant?
Herb	*Sanguisorba stipulata*	FACW	40	Yes
	Carex nesophila	FACW	20	Yes
	Equisetum arvense	FACU	10	No
	Gymnocarpium dryopteris	FACU	10	No
	Polemonium acutiflorum	FAC	10	No
	Calamagrostis canadensis	FAC	5	No
	Dryopteris dilatata	FACU	5	No
	Epilobium angustifolium	FACU	5	No
	Lycopodium annotinum	FAC	5	No
Total Percent Cover = 110%				
50% of total cover = 55%				
20% of total cover = 22%				
Shrub	*Salix alaxensis*	FAC	80	Yes
	Populus balsamifera	FACU	10	No
	Alnus sinuata	FAC	10	No
Total Percent Cover = 100%				
50% of total cover = 50%				
20% of total cover = 20%				
Tree	*Populus balsamifera*	FACU	10	Yes
Total Percent Cover = 10%				
50% of total cover = 5%				
20% of total cover = 2%				

Three of four, or 75 percent, of the dominant species above are OBL, FACW, or FAC; therefore, this vegetation community is hydrophytic under the 50/20/20 rule.

As part of the data collection and mapping for the wetlands and waterbodies study, wetlands, other aquatic habitats, and non-wetlands were categorized by Enhanced National Wetlands Inventory (ENWI) classifications. Pebble researchers developed the ENWI classifications based on *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979) and the *Photointerpretation Conventions for the National Wetlands Inventory* (USFWS, 1995). During field data collection, ENWI classifications were applied to the vegetation communities at study plots. The ENWI classifications also were applied to every vegetation- and waterbody-mapping unit during mapping. ENWI classifications differ from NWI classifications by acknowledging non-wetland inclusions in predominantly wetland mapping units and wetland inclusions in predominantly non-wetland units.

Hydrology Data

Data collection at the Wetland Determination sites for wetland-hydrology indicators included surface observations and subsurface observations of the soil profile in the pits dug for collection of soils data (see below). At least one primary indicator or two secondary indicators are required to confirm the presence of wetland hydrology at an observation point. Examples of primary indicators of wetland hydrology are inundation, saturated soil, and surface sediment deposits. Examples of secondary indicators are water-stained leaves and oxidized root channels within 12 inches of the mineral soil surface. The primary and secondary indicators are listed in the 1987 wetlands-determination manual (USACE, 1987).

Wetlands determinations are most straightforward when direct observation of primary wetland-hydrology indicators occurs at the time of data collection. Primary indicators of wetland hydrology are most likely to be observed at the beginning of the growing season and during the summer rainy season, although in drier-than-normal years, they may not be observed even at these times. Secondary indicators of wetland hydrology may be considered in the absence of direct observation of primary wetland-hydrology indicators.

Soils Data

Soils data provide insight into the hydrology of an area and to whether a soil is sufficiently wet during the growing season to develop anaerobic conditions (that is, is a hydric soil), one of three key features used to determine wetland status. Many of the methods for sampling and documenting soils followed the *Field Book for Describing and Sampling Soils* (Shoeneberger et al., 2002). Soils at Wetland Determination sites were examined by digging a pit approximately 20” wide and 24” deep and recording the following data for each soil horizon:

- Thickness/depth.
- Horizon designation—as described in Shoeneberger et al. (2002).
- Matrix color (hue, value, chroma) of moist soil, based on Munsell color charts.
- Redoximorphic features and other mottles or inclusions.
- Texture for the fine earth fraction (2 millimeters or less).
- Coarse fragments—percentages by volume of gravels, cobbles, stones, and boulders.
- Structure—the naturally occurring arrangement of soil particles into aggregates.
- Presence of plant roots.
- Soil pH.
- Presence of ferrous iron in soils (FE++) as determined by response to alpha, alpha-dipyridyl solution.

Other soil data, listed below, were recorded based on observations from the entire pit or applicable horizons, not necessarily every soil horizon:

- Total depth of all organic horizons in the pit.
- Depth to permafrost or seasonal frost, where applicable.

- Soil temperature.
- Oxidation-reduction potential (ORP).
- Restrictive layer—such as permafrost, a layer of clay or silt, or dense glacial till.

Investigators interpreted the data collected to obtain the following additional information:

- Soil drainage class, ranging from Excessively Drained to Very Poorly Drained, was determined in the field based on guidance provided in a Natural Resources Conservation Service technical note (USDA NRCS, 2003a).
- Soil taxonomy was determined for most plots based on the interpretation of soil characteristics observed within the upper 18 to 24 inches of the soil profile, or less if there was seasonal frost in the profile. The determinations were based (retroactively) on guidance provided in the 10th edition of *Keys to Soil Taxonomy* (USDA NRCS, 2006).
- The presence and applicability of hydric-soil indicators (USACE, 1987) are subject to interpretation and best professional judgment by the investigator based on the conditions at the time of sampling and all other information available to the investigator. The following methods were used for Pebble Project:
  - The reducing-conditions indicator was considered to be met under any of three conditions observed in the upper 12 inches of mineral soil: a positive response to alpha, alpha-dipyridyl (a test to detect ferrous iron, an indicator of reduction); results from measurements of oxidation-reduction potential that indicated reduction; or sulfidic odor.
  - In 2007 the aquic moisture regime indicator was linked to reducing conditions (Wakeley, pers. comm., 2007), and the database was changed retroactively for plots sampled in prior years. In short, for the aquic moisture regime indicator to be positive, an indicator of reducing conditions must have been present.
  - Scientists interpreted the "gleyed and low-chroma" soil indicators in light of NRCS data showing that some soils in Alaska that meet the description of this indicator in the 1987 wetland-delineation manual (USACE, 1987) are not hydric. In particular, if soils had a low-chroma parent material or contained substantial organic matter, and no other soil or hydrology indicators were present, investigators did not consider the soils to be hydric.
- In each year of field study, investigators determined whether each soil profile had any hydric-soil indicators described in the then most current NRCS publication on field indicators of hydric soils (USDA NRCS, 2003b, 2004). A soil with one or more of these indicators was not considered hydric unless it also had a hydric soil indicator described in the 1987 wetland-delineation manual (USACE, 1987).

Additional Data

Additional data were collected at Wetland Determination sites. Elevation was determined with a GPS unit and also a barometric altimeter. Field investigators also collected data on slope gradient, aspect, and slope shape (linear, convex, or concave, described across slope and down slope). Major landforms,

macrotopography, and microtopography were determined on the ground at Wetland Determination plots and later in the office for photo points.

Wetland Status

Sampling points were considered to be in a wetland when criteria for all three wetland parameters—hydrophytic vegetation, wetland hydrology, and hydric soils—were clearly met. Sampling points were considered to be in a non-wetland when the criterion for at least one wetland parameter was not met. The term "transitional wetland" was used when criteria for all three wetland parameters were met, but one or more of the parameters was weak, e.g., only secondary hydrology indicators were used. The term "transitional non-wetland" generally was used when at least two of the wetland parameters were positive and the third parameter was negative or on the line between being positive and negative, e.g., a score of 50 percent for the percent dominance test for hydrophytic vegetation.

Problem-area Wetlands and Difficult Situations

Problem-area wetlands "are wetland types in which wetland indicators of one or more parameters may be periodically lacking due to normal seasonal or annual variations in environmental conditions that result from causes other than human activities or catastrophic natural events" (USACE, 1987). Some of the wetlands in the study area may be problem areas by this definition. Also, Alaska wetlands are challenging because of their diversity and the current limitations in the scientific information on these ecosystems and some of the wetland indicators. Some of the challenges are described as "difficult wetland situations" in the 2007 supplement to the wetland-delineation manual (USACE, 2007). The field investigators made their wetlands determinations based on the 1987 manual (USACE, 1987) and the best information available to them, interpreted through personal experience and knowledge of the ecology of the region.

39.6.2.5 Hydrogeomorphic Classification

During the collection of field data at wetland sites, all wetlands were classified according to the hydrogeomorphic (HGM) classification system (Brinson, 1993). HGM classification is a wetland classification system developed, in part, to characterize the primary water source, or hydrology, of wetland systems. In addition, this system is being used to classify each wetland and waterbody identified during the mapping phase. The following HGM types have been identified in the study area:

- Riverine Wetlands.
- Slope Wetlands.
- Depressional Wetlands.
- Flat Wetlands.
- Coastal Fringe Wetlands and Waters.
- Riverine Channel Waters.

The first five types are standard HGM classes that are recognized and widely used in HGM-based wetland functional assessment methods throughout the United States. In order to classify all mapped wetlands and waterbodies using a consistent system, an additional class (riverine channels) has been added for the Pebble Project.

HGM classification is based on the following characteristics of the wetland (Brinson, 1993):

- Position in the landscape or geomorphic setting.
- Dominant source of water.
- Hydrodynamics of the water in the wetland.

HGM classification groups wetlands that typically perform many of the same ecological functions because they share similar landscape positions and hydrologic characteristics. For example, riverine wetlands tend to perform a suite of functions different from those of isolated depressional wetlands. The following are definitions for the six HGM types in the Cook Inlet drainages study area.

Riverine Wetlands

Riverine wetlands occur in active floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow from the channel and subsurface hydraulic connections between the stream channel and wetlands. Additional water sources may include groundwater discharge from surficial aquifers, overland flow from adjacent uplands and small tributaries, and precipitation. Riverine wetlands lose surface water by flow into the channel after flooding and during precipitation events. They lose subsurface water by discharge to the channel, movement to deeper groundwater, and evapotranspiration.

In Alaska, riverine wetlands range from broad floodplains along large meandering river channels (such as the Yukon and Kuskokwim Rivers) to narrow, temporarily flooded zones bordering higher-gradient rivers and streams. Extremely large riverine wetland complexes can be found on deltas, such as the Yukon-Kuskokwim delta, the Copper River delta, and the Stikine River delta.

Slope Wetlands

Slope wetlands normally occur where there is a discharge of groundwater to the land surface. They usually exist on sloping land surfaces ranging from steep hill slopes to nearly level terrain. Slope wetlands are usually incapable of depressional storage. Principal water sources are groundwater flow that reaches the surface or near surface, shallow subsurface or surface flow from surrounding non-wetlands, and precipitation. Hydrodynamics are dominated by downslope unidirectional flow. Slope wetlands can occur in nearly level landscapes if groundwater discharge to the wetland surface is a dominant water source. Slope wetlands lose water by subsurface and surface flows and by evapotranspiration.

Examples of slope wetlands in Alaska include patterned fens, hillside seeps, spring-fed wetlands, and wetlands at the base of bluffs or toe slopes where groundwater is discharged near the surface.

Depressional Wetlands

Depressional wetlands occur in topographic depressions on a variety of geomorphic surfaces. Dominant water sources are precipitation, groundwater discharge, and shallow subsurface or surface flow from adjacent uplands. The direction of flow is normally from surrounding areas toward the center of the depression. Elevation contours are closed, allowing the accumulation of surface water. Depressional wetlands may have any combination of inlets and outlets or may lack them completely. Dominant

hydrodynamics are vertical fluctuations, primarily on a seasonal basis. Depressional wetlands lose water through intermittent or permanent flow from an outlet, evapotranspiration, or contribution to groundwater.

Depressional wetlands are common in glacial landscapes in Alaska, particularly in the form of kettles in moraine areas. Other common depressional wetlands include abandoned oxbows on river terraces and swales in coastal dune complexes.

Flat Wetlands

The water source of flat wetlands is dominated by precipitation. Flats are most common on land positioned between streams or rivers, extensive relic lake bottoms, and terraces above active river floodplains. They receive virtually no groundwater discharge, which distinguishes them from depressions and slopes. Dominant hydrodynamics in flat wetlands are vertical fluctuations. Flats are characterized by low lateral drainage, usually as a result of low hydraulic gradients. Flat wetlands lose water by evapotranspiration, overland flow, and seepage to underlying groundwater.

In interior Alaska, flat wetlands cover vast areas where shallow permafrost tables perch water at or near the surface. The *Picea mariana* (black spruce)-dominated forests and woodlands that are so extensive in interior and southcentral Alaska are generally considered to be flat wetlands even if they are located on hillsides. Large flat wetlands also can be found on broad glacial outwash terraces and in parts of valley bottoms where there are very broad, shallow basins that do not exhibit lateral water movement.

Coastal Fringe Wetlands and Waters

Coastal fringe wetlands occur along margins of tidal, brackish or saline waters of estuarine and marine environments. For the Pebble Project, coastal fringe wetlands (normally characterized as bearing vegetation, and called “salt marshes”) have not yet been distinguished from non-wetland waters for the purpose of HGM classification. Coastal “waters” comprise the intertidal and subtidal areas that do not support vegetation (mudflats, intertidal channels, beaches, rocky shores) or that support primarily non-vascular species (for example, marine algae) or plants that are continuously submerged (such as eelgrass).

Coastal fringe wetlands are strongly influenced by sea level, which typically sets the water table elevation, although this may be less true at upper intertidal areas with fine-grained sediments. The sea is the dominant water source, but the wetlands may also receive influxes of fresh water from groundwater discharge, overland flow (such as streams), and precipitation. Coastal fringe wetlands lose water by tidal exchange, overland flow, and evapotranspiration (Shafer and Yozzo, 1998). Coastal fringe wetlands are often classified as high or low marshes. The highest-elevation coastal fringe wetlands are flooded less often than daily. Lower-elevation wetlands and waters may be exposed and flooded daily or be continuously submerged. The primary water movement in coastal fringe wetlands and intertidal waters of the study area is horizontal and bidirectional as the tide flows and ebbs. These areas are subject to the erosive forces of tidal water flow, as well as of waves and moving ice.

In Alaska, coastal fringe wetlands and intertidal waters are extensive in Cook Inlet, where the extreme tidal range causes large areas of marshes and mudflats to be alternately flooded and exposed. They are also prominent in western Alaska, where the land and nearshore waters are so flat that large areas are influenced by tidal fluctuation.

Riverine Channel Waters

Flowing "Waters of the U.S." (i.e., waters protected under the Clean Water Act) contained within an active channel are classified as riverine channel waters in the HGM classification system for the Pebble Project. This class includes bare sand and gravel bars, bars supporting pioneer vegetation, channel areas with non-persistent vegetation or aquatic vegetation (e.g., submerged plants), and unvegetated flowing water. Riverine channel waters are bounded on the landward side by upland, by the channel bank, or by wetlands dominated by trees, shrubs, herbs, mosses, or lichens. Adjacent wetlands dominated by persistent vegetation are usually in the riverine wetlands HGM class.

39.6.3 Data Entry

Data recorded in the field either electronically or on wetland determination field forms and in field notebooks were uploaded or entered by hand into a web-based relational database and related to the plot location in the project GIS, managed by RDI. As plot locations were generated in the GIS upon uploading, some fields of the database were autopopulated by drawing from geographic information already in the database, such as quadrangle names and section numbers. Upon completion of the data entry and applicable quality-control processes, data were made available in the GIS for use in vegetation and wetland mapping.

39.6.4 Digital Mapping

Five maps were created to provide an overview of the wetlands mapping effort for the Cook Inlet drainages study or mapping area:

- Figure 39-1 shows the Field Plot Locations overview and is displayed at a 1:125,000 scale. This map shows the type of field plot and its location.
- Figure 39-2 shows the National Wetlands Inventory (NWI) Mapping and is displayed at 1:181,658 scale. The NWI mapping is described in section 39.4.
- Figure 39-3 shows the Wetlands Mapping and is displayed at 1:70,000 scale. The Wetlands Mapping coding is described in section 39.6.4.2.
- Figure 39-4 shows the Enhanced National Wetlands Inventory (ENWI) Mapping and is displayed at 1:70,000 scale. The ENWI Mapping is described in section 39.6.4.3.
- Figure 39-5 shows the Hydrogeomorphic (HGM) Classification Mapping and is displayed at 1:70,000 scale. The HGM Classification is described in section 39.6.2.5 and the HGM results in section 39.6.4.4.

Figures 39-1, 39-3, 39-4, and 39-5 are also presented in 10 additional maps as depicted on the overview figures to show the mapping detail at 1:31,680 scale. The 10 additional maps are each labeled with a C at the end of the Tile number. The C indicates the maps show features in the Cook Inlet drainages, as opposed to tiles with an A that depict the mine study area, and B that indicate the transportation-corridor, Bristol Bay drainages study area. Note that only Tiles 10C through 13C include areas within the Cook Inlet drainages. (Tiles 1 through 9, and 14, and 15 lie entirely within the Bristol Bay drainages.) Tiles 12C and 13C of the Figure 39-1 series show parts of the transportation corridor that were within the study area but not within the smaller mapping area. Tiles 10C and 11C of each map series show wetland features in the mapping area.

Interpretation of Aerial Photographs

Aerial imagery was acquired several times during collection of baseline data (see Section 39.6.1). The 2004 and 2005 orthorectified photography with 4-foot contours, derived from the aerial photography and LIDAR imagery, became the basemap for the vegetation and wetland studies. The wetland maps were drawn to a scale ranging between 1:1,200 and 1:1,500, and open water was drawn at 1:400 in ArcGIS with a minimum polygon size of approximately 0.05 acre.

Topographic clues derived from topographic contours were used to assist in determining which areas are wetlands. Topographic depressions, toe slopes, and flat areas were indications of potential wetlands, while convex slopes were indicative of potential well-drained non-wetlands. Topographic patterns also were used to assess hydrologic connectivity between wetlands and streams for assignment of HGM classes, land surface elevations relative to nearby water surfaces, and potential locations of groundwater seeps.

39.6.4.1 Vegetation-community Types

Final project vegetation codes were assigned to the mapping polygons using a combination of the draft photo signature guides (3PPI, 2006, 2007, 2008) and available field data, including site photography.

Field data were accessible via a relational database during mapping to assist in interpreting and assigning Project Vegetation Types to polygons. Scientists determined Project Vegetation Types by interpreting the aerial photographs in GIS using the project photo signature guides (3PPI, 2006, 2007, 2008), data collected from points within a given mapping polygon, and data from sampling points in nearby polygons with similar photo signatures and landscape positions. At individual sites, the data collected in the field may not always have matched the final vegetation type assigned to that area. This is the result of heterogeneity of vegetation that cannot always be reliably detected or practically mapped on aerial photographs, or the sample point was located in a small inclusion of another type of vegetation within a larger vegetation-mapping unit.

39.6.4.2 Wetland Status

Wetland status was assigned to each mapping polygon after careful review of WD field forms, site photos, and other available data for the study sites within the polygon. Clues derived from topographic contours were used to assist in determining wetlands boundaries. Topographic depressions, toe slopes, or flat areas were indications of potential wetlands, while convex slopes were indicative of potential well-drained non-wetlands. Topographic patterns also were used to assess hydrological connectivity between wetlands and streams, land surface elevations relative to nearby water surfaces, and potential locations of groundwater seeps. Data from study sites in nearby or similar polygons also were evaluated when assigning wetland status. If plot data or the best professional judgment of the investigator suggested that a particular Project Vegetation Type was consistently associated with either non-wetlands or wetlands, then this information also was considered. Wetland status assigned by investigators was based on criteria found in the 1987 wetlands-delineation manual (USACE, 1987), not on subsequent court cases pertaining to surface water connections (referred to as “jurisdictional wetlands”).

39.6.4.3 Enhanced National Wetland Inventory

ENWI classifications recommended for each Project Vegetation Type and conventions for assigning water-regime modifiers are included in the project photo signature guide (3PPI, 2008). (ENWI is described under *Vegetation Data* in Section 39.6.2.3.) Mappers coded the ENWI class of each polygon using this information as well as site-specific data collected within the polygon.

39.6.4.4 Hydrogeomorphic Classification

Each mapped polygon was assigned an HGM code based on data from the study sites within the polygon, data from nearby study sites in similar landscape settings, and interpretation of topographic contours and aerial imagery. Detailed descriptions and examples of the HGM types are presented in Section 39.6.2.4. When polygons were designated as a complex of wetlands and uplands, the HGM designation applied only to the wetland portion of the mapped polygon.

39.6.4.5 Waterbodies

Waterbodies that were mapped include unvegetated ponds, streams including gravel bars, mudflats, beaches, and estuarine and marine waters of Cook Inlet. Ponds were mapped based on interpretation of aerial photos of standing waterbodies. Perennial and intermittent streams were mapped by examining aerial photos for direct evidence of surface water and also by examining the contour data sets for topographic evidence of a channel. Shorelines and gravel bars were mapped through interpretation of aerial photos.

39.6.4.6 Disturbance

Human disturbance of soil and vegetation was noted in the mapping if there was evidence from field data or if the disturbance was visible on aerial photos.

39.7 Results and Discussion

The results presented in this wetlands chapter are based on data from the Cook Inlet drainages study area. The data-collection locations relevant to the study area are depicted on Figure Series 39-1.

During the 2004 and 2005 field seasons, investigators collected data at 227 locations in the Cook Inlet drainages study area. These locations comprised the following types of study sites:

- 139 full WD plots.
- 30 RU (non-wetland) photo points.
- 20 RW photo points.
- 25 SC photo points.
- 13 WB photo points.

The data from these study sites were used in assigning vegetation type, wetland status, and several other attributes to mapping polygons for the Cook Inlet mapping area.

39.7.1 Wetland Determinations

39.7.1.1 Data from Wetland Determination Plots

Field teams collected data at 139 wetland determination plots, where complete vegetation, hydrology, and soil data are recorded. Of those plots, 40 plots were determined to be wetlands and 99 plots were non-wetlands, based on the three wetland criteria: hydrophytic vegetation, wetland hydrology, and hydric soils.

39.7.1.2 Vegetation

Field scientists collected full vegetation data at 139 locations in the Cook Inlet drainages study area. In addition, they identified the Project Vegetation Type in the field at 50 representative wetland and non-wetland photo points. Among these study sites, field investigators documented 27 Project Vegetation Types in the transportation corridor in the Bristol Bay drainages.

39.7.2 Waterbodies

The Cook Inlet drainages study area parallels creeks as it extends eastward from the Bristol Bay/Cook Inlet drainages boundary to Cook Inlet. The study area also crosses steep and narrow drainages that descend mountain slopes directly into Cook Inlet, and it includes the tidal waters of Cook Inlet. It contains few ponds because the topography is generally steep.

Cook Inlet is the major waterbody in this study area. Investigators estimated the landward limit of Cook Inlet (i.e., the high tide line) in the field and on aerial photographs based on the presence of vegetation that typically grows at the highest extent of the tide (beach rye grass and others) and other visible lines on the shore indicating erosion, deposition of debris, or regular inundation.

39.7.3 Disturbance

Human-caused soil or vegetation disturbance in the study area is limited. Five areas (a total of 43 acres) were identified during mapping as having disturbance. Disturbance includes the Williamsport-Pile Bay road, building pads at Williamsport, and an abandoned commercial site at a small lagoon on the east side of Iliamna Bay. In addition, dredging occurs in tidal waters at Williamsport to maintain access for marine vessels at high tides.

39.7.4 Mapping

Wetland mapping is complete for the Cook Inlet drainages study area. The mapping depicts waterbodies, boundaries between wetland types, and boundaries between wetlands and non-wetlands.

39.7.4.1 Wetlands Mapping

Figure Series 39-3 shows the wetland mapping for the Cook Inlet drainages mapping area. Mapping designations and associated acreages are shown in Table 39-2. Under the protocols for determining boundaries of mapping units, areas of mixed wetlands and uplands were assigned codes that acknowledge inclusions of wetlands in primarily upland areas or of uplands in primarily wetland areas. For example, a

unit mapped as primarily upland, but with up to 20 percent of its area composed of wetlands, would be assigned a code (U_20) that reflects those wetland inclusions (see mapping unit codes in Table 39-2). All project wetlands information presented, including that in tables and on maps, is based on the criteria presented in the 1987 wetlands-delineation manual (USACE, 1987).

In the Cook Inlet mapping area, 1,293 acres, or approximately 33 percent of that mapping area, were mapped as wetlands or waters (Table 39-2). Of this acreage, most (1,261 acres) was composed of open-water habitats such as estuarine waters, marine habitats, and streams and their associated gravel bars. Thirty-two acres, less than 1 percent of the mapping area, were mapped as wetlands. In addition to wetlands and waters, 2,577 acres, or almost 67 percent of the mapping area, were mapped as uplands (i.e., non-wetlands).

39.7.4.2 Enhanced National Wetlands Inventory

Table 39-3 summarizes the ENWI wetland and waterbody groups for Pebble Project and the acreages mapped for each in the Cook Inlet drainages mapping area. Table 39-4 describes the ENWI codes for the mapping area. The ENWI mapping is shown on Figure Series 39-4. The acreages of shrub-type and herbaceous-type wetlands within the mapping area were nearly equal. The shrub class of wetlands constituted approximately 15 acres, or less than one percent of the mapping area. The herbaceous class of wetlands constituted approximately 17 acres, again less than one percent of the mapping area.

39.7.4.3 Hydrogeomorphic Mapping

The hydrogeomorphic (HGM) mapping for the Cook Inlet drainages mapping area is presented on Figure Series 39-5, and the acreage for each HGM class is listed in Table 39-5. The coastal fringe HGM class comprised 1,220 acres, or 94 percent of the total wetland and waterbody acreage in the mapping area. This class includes all estuarine and marine waters in the mapping area. The riverine channel, depressional, and riverine classes were the HGM classes with the next highest acreages, although each comprised less than 3 percent of the total wetland and waterbody acreage in the mapping area.

39.8 Summary

Scientists determined the locations of wetlands and waterbodies in a 2,000-foot-wide mapping area in the Cook Inlet drainages. Field investigators collected data at 227 sites in the Cook Inlet drainages study area: 139 Wetland Determination plots, 50 Representative Wetland or Representative Upland photo points, and 38 Waterbody or Stream Crossing photo points. Wetland determinations were made according to the 1987 wetlands-delineation manual (USACE, 1987). In addition to wetlands, investigators mapped streams, ponds, and tidal waters in the mapping area.

Within the Cook Inlet drainages mapping area, wetland scientists mapped 32 acres as wetlands and an additional 1,261 acres as waterbodies, or 1 percent and 33 percent of the Cook Inlet mapping area, respectively. The wetlands in the mapping area fall into either the shrub or herbaceous class of wetland under the ENWI classification system. The coastal fringe HGM class encompassed 94 percent of the total wetland and waterbody acreage in the mapping area. The riverine channel, depressional, and riverine HGM classes were the next most prominent HGM classes, but each comprised less than 3 percent of the total wetland and waterbody acreage in the mapping area.

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39.10 Glossary

Aquic moisture regime—"a mostly reducing soil moisture regime nearly free of dissolved oxygen due to saturation by ground water, or its capillary fringe, and occurring at periods when the soil temperature at 19.7 in. is greater than 5 degrees Celsius" (USACE, 1987).

Chroma—a measure of the purity or strength of spectral color in soil.

Evapotranspiration—the loss of water to the atmosphere through evaporation and plant transpiration.

Geomorphology—the study of landforms and the processes that shape them.

Gleyed soils—a soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles (spots or streaks) among other colors. Gleying occurs under reducing soil conditions resulting from soil saturation, by which iron is reduced predominantly to the ferrous state (USACE, 1987).

Herb (as a vegetation stratum)—a plant whose stem does not produce woody, persistent tissue and that generally dies back at the end of each growing season.

Hydric soil—"soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic [i.e., lacking oxygen] conditions in the upper part" (as defined by the U.S. Dept. of Agriculture Soil Conservation Service as cited in USACE, 2007).

Hydrophytic vegetation—vegetation that is typically adapted for life in saturated soil conditions.

Hydrogeomorphic classification—a land classification system based on the relationship between hydrology, geomorphology, and wetland function.

Lacustrine—of or related to lakes.

Macrotopography—overall shape of the land surface in the assessment area from a scale that includes more than the vegetation or cover type sampled. Macrotopography in the study area is either concave, convex, flat, hummocky, rolling, or undulating (3PPI, 2008).

Microtopography—very small-scale variations in the height and roughness of the ground surface in which a sampled vegetation or cover type is growing. Microtopography in the study area is either flat, hummocky, tussocky, or undulating (3PPI, 2008).

Mineral soils—soils that do not satisfy the criteria for classification as organic soils.

Non-wetlands—uplands and lowland areas that are neither aquatic habitats, wetlands, nor other aquatic sites. Non-wetlands are seldom or never inundated, or if frequently inundated, they have saturated soils for only brief periods during the growing season, and if vegetated, they normally support a prevalence of vegetation typically adapted for life only in aerobic soil conditions.

Organic soils—soils where either more than half of the upper 32 inches of soil is organic or organic soil material of any thickness rests on rock or on fragmental material that has interstices filled with organic materials.

Orthorectify— to rectify digital imagery by removing distortion resulting from camera angle and topography, thus equalizing the distances represented on the image.

Perennial stream (or river)—a stream or river that has continuous (permanent) surface flow in parts of its bed all year round during years of normal rainfall.

Photo signature—a unique texture, pattern, or color that vegetation has when captured in photographs taken from an airplane.

Polygon—shape drawn in the GIS and represented on maps; for purposes of this study, a polygon delineates the boundaries of areas of homogeneous vegetation types with similar hydrogeomorphology, wetlands status, ENWI designations, and other characteristics.

Project Vegetation Type—an Alaskan vegetation classification system developed specifically for the Pebble Project.

Sapling (as a vegetation stratum)—an immature or small-statured tree that is less than 3 inches in diameter at breast height. Saplings and shrubs are combined into one vegetation stratum.

Shrub (as a vegetation stratum)—a woody plant of relatively low height with several stems arising from the base and lacking a single trunk. The stems average less than 3 inches at breast height. A plant with a shrubby growth form but an average stem diameter greater than 3 inches at breast height is considered a tree in terms of vegetation strata. Saplings and shrubs are combined into one vegetation stratum.

Stratum (vegetation)—a layer of vegetation in a plant community, usually of the same or similar height. Plural is strata.

Sulfidic odor—an odor of rotten eggs that is due to the presence of hydrogen sulfide. Sulfidic odor is a primary hydric soil indicator.

Tree (as a vegetation stratum)—a tall, perennial, woody plant with a main trunk and branches that form a distinct elevated crown. In terms of strata used for wetland determination, a tree's main stem is greater than 3 inches diameter at breast height (a tree with a smaller diameter at breast height is considered a sapling). A shrub with an average diameter at breast height greater than 3 inches is classified in the tree stratum.

Wetlands—those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs, and similar areas.

TABLES

TABLE 39-1
U.S. Fish and Wildlife Service, National Wetlands Inventory Mapping Groups, Acreage in the Cook Inlet Drainages Mapping Area

NWI Group	Number of Acres [a]	Percent of Mapping Area [a]
Total Forest Types	**0.0**	**0.0**
Scrub Shrub	23.7	0.6
Scrub Shrub/Herbaceous	10.3	0.3
Total Shrub Types	**34.1**	**0.9**
Estuarine Wetlands	3.3	0.1
Total Herbaceous Types	**3.3**	**0.1**
TOTAL WETLANDS MAPPED	**37.4**	**1.0**
Estuarine Waters	819.9	21.2
Freshwater Ponds	0.4	0.0
Marine Waters	285.5	7.4
Total Waters Mapped	**1,105.9**	**28.6**
TOTAL WETLANDS/WATERS	**1,143.3**	**29.5**
Uplands (Non-wetlands)	2,726.6	70.5
TOTAL MAPPING AREA	**3,869.9**	**100**

Note:

a. Apparent inconsistencies in sums are the result of rounding.

NWI = National Wetlands Inventory (U.S. Fish and Wildlife Service). Source: U.S. Department of Interior (USDOI). Various. National Wetlands Inventory draft maps. Quadrangles Iliamna C-2 and D-2.

TABLE 39-2
Wetland Mapping Unit Summary, Cook Inlet Drainages Mapping Area, 2004-2008

Mapping Units	Mapping Unit Code	Number of Acres	Percentage of Mapped Area	Percentage That Is Wetlands or Waters	Acres of Wetlands/ Waters [a, b]
Uplands (less than 1% wetland inclusions)	U	2,576.6	66.6	0	0.0
Uplands (up to 10% wetland inclusions)	U_10	0.0	0.0	10	0.0
Uplands (up to 20% wetland inclusions)	U_20	0.0	0.0	20	0.0
Uplands (up to 40% wetland inclusions)	U_40	0.0	0.0	40	0.0
Wetlands (up to 40% upland inclusions)	W_40	0.8	0.0	60	0.5
Wetlands (up to 20% upland inclusions)	W_20	0.0	0.0	80	0.0
Wetlands (up to 10% upland inclusions)	W_10	0.0	0.0	90	0.0
Wetlands (less than 1% upland inclusions)	W	31.8	0.8	100	31.8
Total Area		**2,609.2**			**32.2**
Percent of Mapping Area		**67.4%**			**0.8%**
Waters of the U.S. [c,] Navigable	WAT1	1,222.0	31.6	100	1,222.0
Waters of the U.S. [c], Non Navigable	WAT2	38.3	1.0	100	38.3
Probable Waters of the U.S. [c]	PWAT	0.4	0.0	100	0.4
Total Waters		**1,260.7**			**1,260.7**
Percent of Mapping Area		**32.6%**			**32.6**
TOTAL MAPPING AREA		**3,869.9**	**100.0**		**1,293.0** **33.4%**

Note:

a. Apparent inconsistencies in sums are the result of rounding.

b. Calculated based on percentages in previous column.

c. “Waters of the U.S.” means waters protected under the Clean Water Act.

TABLE 39-3
Enhanced National Wetlands Inventory Classifications, Acreages in the Cook Inlet Drainages Mapping Area

ENWI Group	ENWI Code [a]	Number of Acres [b]	Percent of Mapped Area [b]
Shrubs	PSS1	5.2	0.1
Shrub/Herbaceous	PSS1/EM1	7.0	0.2
Herbaceous/Shrub	PEM1/SS1	3.0	0.1
Total Shrub Types		**15.3**	**0.4**
Freshwater Herbaceous	PEM1	6.8	0.2
	PEM1/ML1	1.8	0.0
	PEM2	0.9	0.0
Estuarine Herbaceous	E2EM	7.5	0.2
Total Herbaceous Types		**16.9**	**0.4**
TOTAL WETLANDS		**32.2**	**0.8**
Estuarine Waters	E1	678.3	17.5
	E2RS	42.6	1.1
	E2US	173.9	4.5
Marine Waters	M	316.3	8.2
Ponds	PUB	5.0	0.1
Rivers/Streams	R1	0.9	0.0
	R3UB	30.5	0.8
	R3US	11.4	0.3
	R4	1.8	0.0
Total Waters Mapped		**1,260.7**	**32.6**
TOTAL WETLAND/WATERS		**1,293.0**	**33.4**
Uplands (Non-wetlands)	U	2,576.9	66.6
TOTAL MAPPING AREA		**3,869.9**	**100.0**

Note:

a. See Table 39.4 for explanation of codes.

b. Apparent inconsistencies in sums are the result of rounding.

TABLE 39-4
Enhanced National Wetlands Inventory Codes for the Cook Inlet Drainages Mapping Area

Group	Code	Description
WETLANDS		
Shrub	PSS1	Palustrine Broad-leaved Deciduous Shrub Wetland
Shrub/Herbaceous	PSS1/EM1	Palustrine Broad-leaved Deciduous Shrub/Persistent Emergent Wetland
Herbaceous/ Shrub	PEM1/SS1	Palustrine Persistent Emergent/ Broad-leaved Deciduous Shrub Wetland
Freshwater Herbaceous	PEM1	Palustrine Persistent Emergent Wetland
	PEM1/ML1	Palustrine Persistent Emergent/Moss Wetland
	PEM2	Palustrine Non-persistent Emergent Wetland
Estuarine Herbaceous	E2EM	Estuarine Intertidal Emergent Wetland
WATERS		
Estuarine Waters	E1	Estuarine Subtidal Waters
	E2RS	Estuarine Intertidal Rocky Shore Waters
	E2US	Estuarine Intertidal Unconsolidated Shore Waters
Marine Waters	M	Marine Waters
Ponds	PUB	Palustrine Unconsolidated Bottom Waters (pond)
Riverine (Rivers/Streams)	R1	Riverine Tidal Waters
	R3UB	Riverine Unconsolidated Bottom (river channel)
	R3US	Riverine Unconsolidated Shore (river bars/flats)
	R4	Riverine Intermittent Waters
NON-WETLANDS		
Uplands (Non-wetlands)	U	Non-wetlands/Non-waters Habitat

TABLE 39-5
Hydrogeomorphic Classifications, Acreages in the Cook Inlet Drainages Mapping Area

Classification	Number of Acres [a]	Percent of Mapping Area	Percent of Wetlands/Waters
Riverine	12.7	0.3	1.0
Slope	3.5	0.1	0.3
Depressional	22.4	0.6	1.7
Flat	0.3	0.0	0.0
Riverine Channel	34.4	0.9	2.7
Coastal Fringe	1,219.5	31.5	94.3
Total Wetlands and Waters	**1,293.0**	**33.4**	
Total Non-wetland	**2,576.9**	**66.6**	
TOTAL MAPPING AREA	**3,869.9**	**100.0**	

Note:

a. Apparent inconsistencies in sums are the result of rounding.

FIGURES

153°54'0"W 153°48'0"W 153°42'0"W 153°36'0"W 153°30'0"W 153°24'0"W 153°18'0"W

59°51'0"N
59°48'0"N
59°45'0"N
59°42'0"N
59°39'0"N
59°36'0"N

Tile 13C
Tile 12C
Tile 10C
Tile 11C
Williamsport
Knoll Head
Iniskin Bay
Iliamna Bay
Bristol Bay Drainages
Cook Inlet Drainages

THE pebble PARTNERSHIP

Figure 39-1
Overview
Field Plot Locations,
Cook Inlet Drainages Study Area,
2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Grid for Detailed Mapping Tiles
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetland Determination Plot Type (Count)

- Wetland (35)
- Transitional Wetland (5)
- Non-wetland (91)
- Transitional Non-wetland (8)

Other Plot/Photo Point Type (Count)

- Stream Crossing (25)
- Waterbody (13)
- Representative Upland (30)
- Representative Wetland (20)

Note: For detailed mapping see the individual tiles in this figure series.
Tiles 1B-9B, 14B, and 15B are presented in the mapping for the Bristol Bay Drainages (EBD Chapter 14).

0 1 2 3 4 5 Miles
0 1 2 3 4 5 6 Kilometers
N

Scale 1:125,000

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

File: RDI_HDR_EBD_Fig39-1_Overview_Fldplots_11X17L_1of1_D04.mxd	Date: September 1, 2011
Version: 4	Author: RDI- LS

153°44'0"W 153°42'0"W 153°40'0"W 153°38'0"W 153°36'0"W

59°43'0"N 59°42'0"N 59°41'0"N 59°40'0"N 59°39'0"N

Williamsport

Iliamna Bay

THE pebble PARTNERSHIP

Figure 39-1
Tile 10C
Field Plot Locations, Cook Inlet Drainages Study Area, 2004 and 2005

Legend

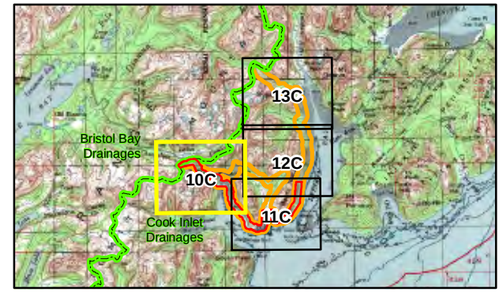
- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetland Determination Plot Type

- Wetland
- Transitional Wetland
- Non-wetland
- Transitional Non-wetland

Other Plot/Photo Point Type

- Stream Crossing
- Waterbody
- Representative Upland
- Representative Wetland



Miles
0 0.25 0.5 0.75 1 1.25

Kilometers
0 0.5 1 1.5

N

Scale 1:31,680

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

File: RDI_HDR_Fig39-1_EBD_Fldplots_Tiled_11X17L_1of4_D02.mxd	Date: July 8, 2011
Version: 2	Author: RDI- LS

153°34'0"W 153°32'0"W 153°30'0"W 153°28'0"W 153°26'0"W 153°24'0"W

59°44'0"N 59°43'0"N 59°42'0"N 59°41'0"N 59°40'0"N

Iniskin Bay

THE pebble PARTNERSHIP

Figure 39-1
Tile 12C
Field Plot Locations, Cook Inlet Drainages Study Area, 2004 and 2005

Legend

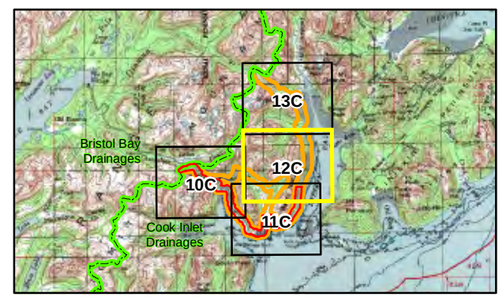
- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetland Determination Plot Type

- Wetland
- Transitional Wetland
- Non-wetland
- Transitional Non-wetland

Other Plot/Photo Point Type

- Stream Crossing
- Waterbody
- Representative Upland
- Representative Wetland



0 0.25 0.5 0.75 1 1.25 Miles

0 0.5 1 1.5 Kilometers

N

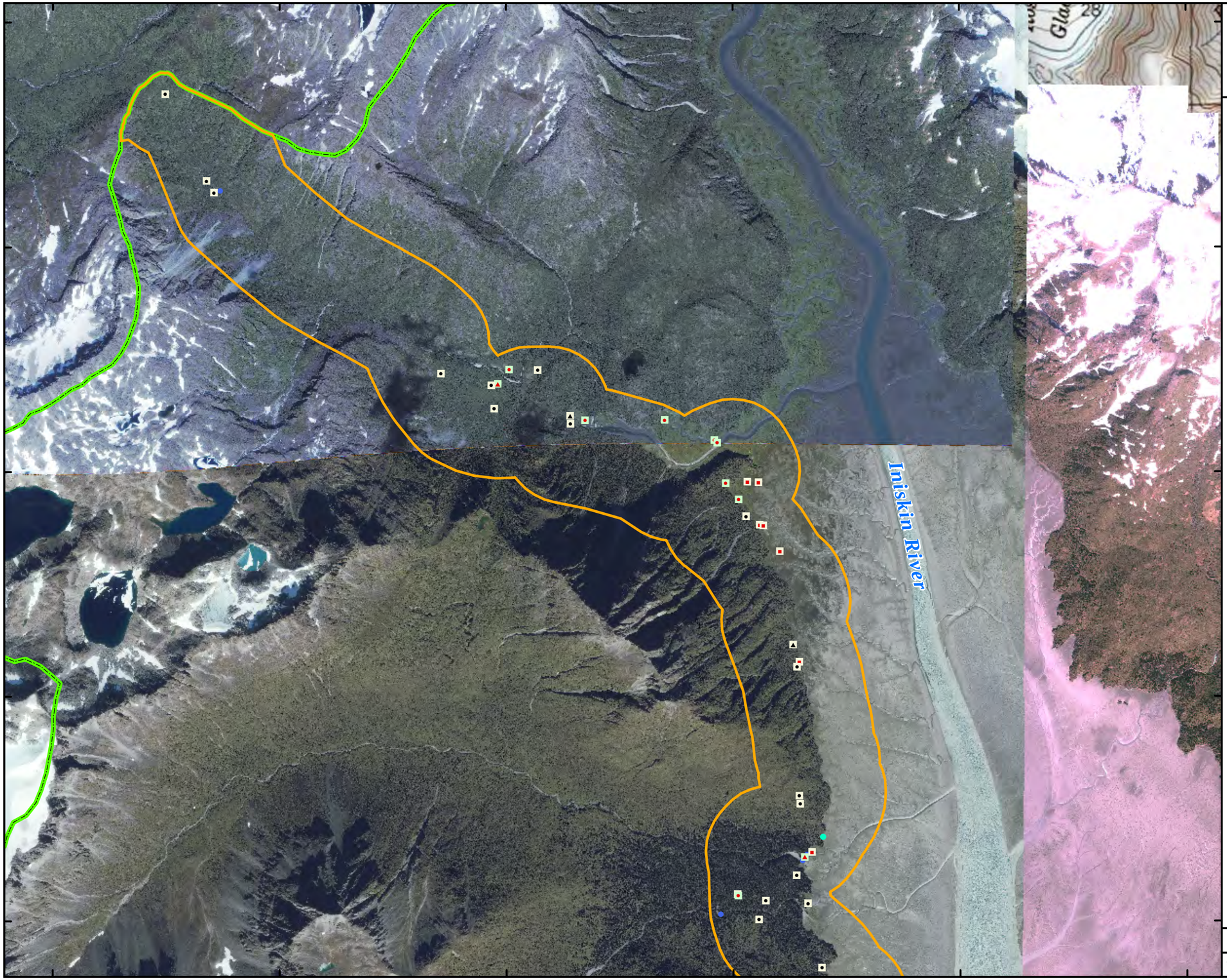
Scale 1:31,680

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

File: RDI_HDR_Fig39-1_EBD_Fldplots_Tiled_11X17L_1of4_D02.mxd	Date: July 8, 2011
Version: 2	Author: RDI- LS

153°34'0"W 153°32'0"W 153°30'0"W 153°28'0"W 153°26'0"W 153°24'0"W

59°48'0"N 59°47'0"N 59°46'0"N 59°45'0"N 59°44'0"N



THE pebble PARTNERSHIP

Figure 39-1
Tile 13C
Field Plot Locations, Cook Inlet Drainages Study Area, 2004 and 2005

Legend

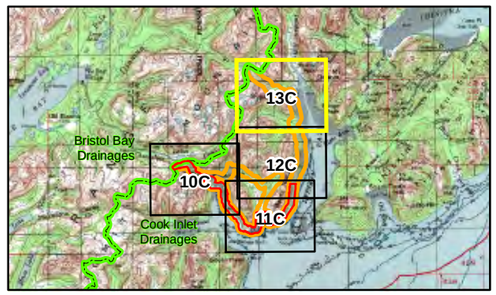
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetland Determination Plot Type

- Wetland
- Transitional Wetland
- Non-wetland
- Transitional Non-wetland

Other Plot/Photo Point Type

- Stream Crossing
- Waterbody
- Representative Upland
- Representative Wetland



Miles
0 0.25 0.5 0.75 1 1.25

Kilometers
0 0.5 1 1.5

N

Scale 1:31,680

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

File: RDI_HDR_Fig39-1_EBD_Fldplots_Tiled_11X17L_1of4_D02.mxd	Date: July 8, 2011
Version: 2	Author: RDI- LS

153°40'0"W 153°20'0"W 153°0'0"W

59°50'0"N

59°40'0"N

NATIONAL PARK

LAKE CLARK WILDERNESS

KENAI PENINSULA BOROUGH

Pile Bay

Williamsport

Knoll Head

Iliamna Bay

Iniskin Bay

Chinitna Bay

Iniskin Peninsula

Bristol Bay Drainages

Cook Inlet Drainages

THE pebble PARTNERSHIP

Figure 39-2
U. S. Fish and Wildlife Service National Wetlands Inventory Mapping for the Cook Inlet Drainages Study Area

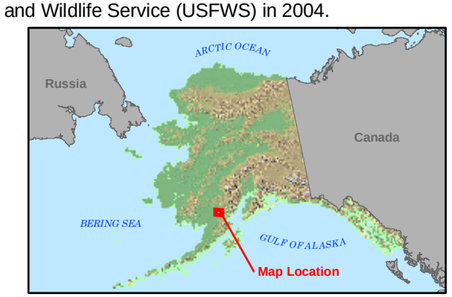
Legend

- Pebble Project Cook Inlet Drainages Mapping Area
- Pebble Project Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

USFWS National Wetlands Inventory Group

- Forested
- Forested/Scrub Shrub
- Scrub Shrub Dominated Wetlands
- Scrub Shrub/Herbaceous Dominated Wetlands
- Herbaceous Dominated Wetlands
- Emergent Herbaceous Dominated Wetlands
- Aquatic Herbaceous Dominated Wetlands
- Estuarine Wetlands
- Estuarine Waters
- Freshwater Ponds
- Lacustrine (Lakes)
- Riverine (Rivers/Streams)
- Marine Habitats
- Non-wetlands

Note: Based on non-digital National Wetlands Inventory maps (USDOI, Various) obtained from the U.S.Fish and Wildlife Service (USFWS) in 2004.



Miles 0 2 4 6

Kilometers 0 2 4 6 8

N

Scale 1:181,000

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

File: RDI_HDR_EBD_Fig39-2_NWI_11X17L_1of1_D04.mxd	Date: August 15, 2011
Version: 4	Author: RDI- LS

153°42'0"W 153°36'0"W 153°30'0"W 153°24'0"W

59°42'0"N 59°39'0"N 59°36'0"N

Bristol Bay Drainages

Williamsport

Tile 10C

Cook Inlet Drainages

Tiamna Bay

Tile 11C

Knoll Head

Turtle Reef

South Head

Iniskin Bay

THE pebble PARTNERSHIP

Figure 39-3
Overview
Wetlands Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

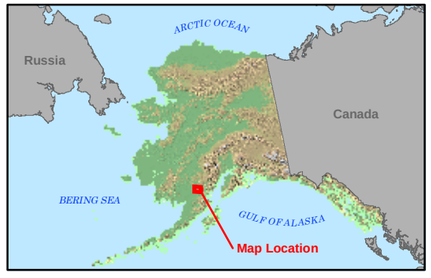
Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Grid for Detailed Mapping Tiles
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetlands Mapping Classification

- Majority Wetlands
- Majority Non-wetlands
- Waterbodies
- Gravel Bars/Seasonal Ponds

Note: For detailed mapping see the individual tiles in this figure series.
Tiles 1B-9B, 14B, and 15B are presented in the mapping for the Bristol Bay Drainages (EBD Chapter 14). Tiles 12C and 13C are not presented because mapping did not extend into those areas.



0 0.5 1 1.5 2 2.5 Miles

0 0.5 1 1.5 2 2.5 3 Kilometers

Scale 1:70,000

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

N

File: RDI_HDR_EBD_Fig39-3_Overview_JDWet_11X17L_1of1_D04.mxd	Date: September 1, 2011
Version: 4	Author: RDI- LS

153°44'0"W 153°42'0"W 153°40'0"W 153°38'0"W 153°36'0"W

59°42'0"N

59°40'0"N

Williamsport

Iliamna Bay

THE pebble PARTNERSHIP

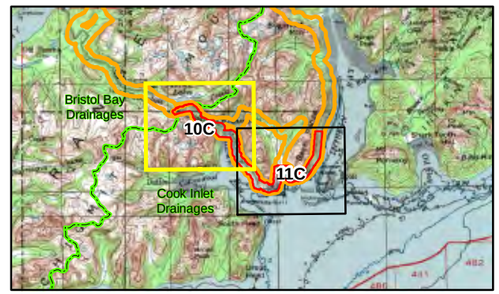
Figure 39-3
Tile 10C
Wetlands Mapping,
Cook Inlet Drainages Mapping Area,
2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetlands Mapping Classification

- Wetland (<1% Non-wetland Inclusions)
- Wetland (Up to 10% Non-wetland Inclusions)
- Wetland (Up to 20% Non-wetland Inclusions)
- Wetland (Up to 40% Non-wetland Inclusions)
- Non-wetland (Up to 40% Wetland Inclusions)
- Non-wetland (Up to 20% Wetland Inclusions)
- Non-wetland (Up to 10% Wetland Inclusions)
- Non-wetland (<1% Wetland Inclusions)
- Waterbodies
- Gravel Bars/Seasonal Ponds



Miles
0 0.25 0.5 0.75 1 1.25

Kilometers
0 0.25 0.5 0.75 1 1.25 1.5

N

Scale 1:31,680

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

File: RDI_HDR_EBD_Fig39-3_JDWet_Tiled11X17L_1of2_D02.mxd	Date: July 8, 2011
Version: 2	Author: RDI- LS

153°34'0"W 153°32'0"W 153°30'0"W 153°28'0"W 153°26'0"W

59°40'0"N

59°38'0"N

Iniskin Bay

Knoll Head

Turtle Reef

30 48 30 500

THE pebble PARTNERSHIP

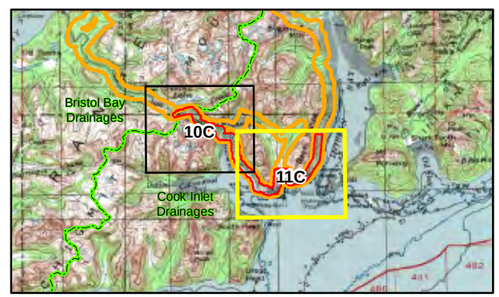
Figure 39-3
Tile 11C
Wetlands Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Wetlands Mapping Classification

- Wetland (<1% Non-wetland Inclusions)
- Wetland (Up to 10% Non-wetland Inclusions)
- Wetland (Up to 20% Non-wetland Inclusions)
- Wetland (Up to 40% Non-wetland Inclusions)
- Non-wetland (Up to 40% Wetland Inclusions)
- Non-wetland (Up to 20% Wetland Inclusions)
- Non-wetland (Up to 10% Wetland Inclusions)
- Non-wetland (<1% Wetland Inclusions)
- Waterbodies
- Gravel Bars/Seasonal Ponds



0 0.25 0.5 0.75 1 1.25 Miles

0 0.25 0.5 0.75 1 1.25 1.5 Kilometers

N

Scale 1:31,680

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

File: RDI_HDR_EBD_Fig39-3_JDWet_Tiled11X17L_1of2_D02.mxd	Date: July 8, 2011
Version: 2	Author: RDI- LS

153°42'0"W 153°36'0"W 153°30'0"W 153°24'0"W

59°42'0"N 59°39'0"N 59°36'0"N

Bristol Bay Drainages

Cook Inlet Drainages

Williamsport

Tile 10C

Tile 11C

Knoll Head

Iliamna Bay

Iniskin Bay

Turtle Reef

South Head

THE pebble PARTNERSHIP

Figure 39-4
Overview
Enhanced National Wetlands Inventory Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Grid for Detailed Mapping Tiles
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Enhanced National Wetlands Inventory (ENWI) Classification

Shrubs
- PSS1

Shrub/Herbaceous
- PSS1/EM1

Herbaceous/Shrub
- PEM1/SS1

Estuarine Wetlands
- E2EM

Herbaceous
- PEM1
- PEM1/ML1

Emergent Herbaceous
- PEM2

Estuarine Waters
- E1
- E2RS
- E2US

Marine
- M

Ponds
- PUB

River/Stream
- R3UB
- R4
- R1
- R3US

Non-wetlands
- U

Note: For detailed mapping see the individual tiles in this figure series. Tiles 1B-9B, 14B, and 15B are presented in the mapping for the Bristol Bay Drainages (EBD Chapter 14). Tiles 12C and 13C are not presented because mapping did not extend into those areas.

0 0.5 1 1.5 2 2.5 Miles

0 0.5 1 1.5 2 2.5 3 Kilometers

Scale 1:70,000

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

N

File: RDI_HDR_EBD_Fig39-4_ENWI_Overview_11X17L_1of1_D04.mxd	Date: September 1, 2011
Version: 4	Author: RDI- LS

153°44'0"W 153°42'0"W 153°40'0"W 153°38'0"W 153°36'0"W

59°42'0"N

59°40'0"N

Williamsport

Iliamna Bay

THE pebble PARTNERSHIP

Figure 39-4
Tile 10C
Enhanced National Wetlands Inventory Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Enhanced National Wetlands Inventory (ENWI) Classification

Shrubs
- PSS1

Shrub/Herbaceous
- PSS1/EM1

Herbaceous/Shrub
- PEM1/SS1

Estuarine Wetlands
- E2EM

Herbaceous
- PEM1
- PEM1/ML1

Emergent Herbaceous
- PEM2

Estuarine Waters
- E1
- E2RS
- E2US

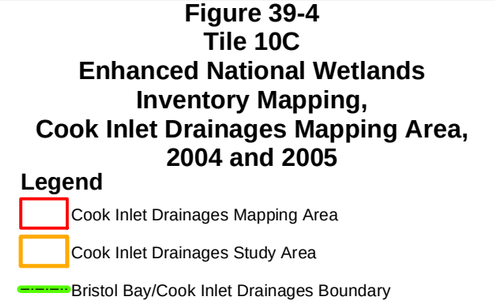
Marine
- M

Ponds
- PUB

River/Stream
- R3UB
- R4
- R1
- R3US

Non-wetlands
- U

Note: For full names of classifications and descriptions of codes, see Table 39-4.



0 0.25 0.5 0.75 1 1.25 Miles

0 0.25 0.5 0.75 1 1.25 1.5 Kilometers

N

Scale 1:31,680

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

File: RDI_HDR_EBD_Fig39-4_ENWI_Tiled11X17L_1of2_D02.mxd	**Date: August 10, 2011**
Version: 2	**Author: RDI- LS**

153°34'0"W 153°32'0"W 153°30'0"W 153°28'0"W 153°26'0"W

59°40'0"N

59°38'0"N

Iniskin Bay

Knoll Head

Turtle Reef

30 48 30 500

THE pebble PARTNERSHIP

Figure 39-4
Tile 11C
Enhanced National Wetlands Inventory Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Enhanced National Wetlands Inventory (ENWI) Classification

Shrubs
- PSS1

Shrub/Herbaceous
- PSS1/EM1

Herbaceous/Shrub
- PEM1/SS1

Estuarine Wetlands
- E2EM

Herbaceous
- PEM1
- PEM1/ML1

Emergent Herbaceous
- PEM2

Estuarine Waters
- E1
- E2RS
- E2US

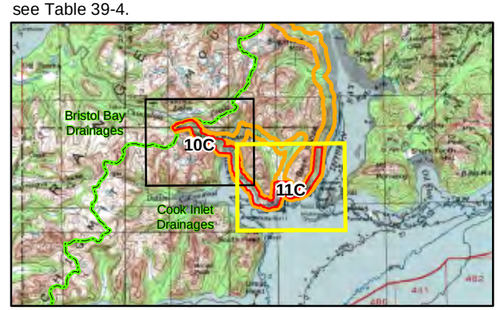
Marine
- M

Ponds
- PUB

River/Stream
- R3UB
- R4
- R1
- R3US

Non-wetlands
- U

Note: For full names of classifications and descriptions of codes, see Table 39-4.



0 0.25 0.5 0.75 1 1.25 Miles

0 0.25 0.5 0.75 1 1.25 1.5 Kilometers

N

Scale 1:31,680

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

File: RDI_HDR_EBD_Fig39-4_ENWI_Tiled11X17L_1of2_D02.mxd	**Date: August 10, 2011**
Version: 2	**Author: RDI- LS**

153°42'0"W 153°36'0"W 153°30'0"W 153°24'0"W

59°42'0"N 59°39'0"N 59°36'0"N

Bristol Bay Drainages

Williamsport

Tile 10C

Cook Inlet Drainages

Iliamna Bay

Tile 11C

Knoll Head

Turtle Reef

South Head

Iniskin Bay

THE pebble PARTNERSHIP

Figure 39-5
Overview
Hydrogeomorphic Classification Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

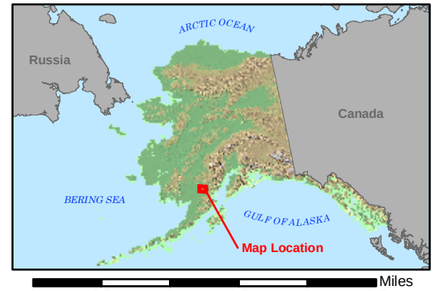
Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Grid for Detailed Mapping Tiles
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Hydrogeomorphic (HGM) Classification

- N/A - Non-wetlands
- Slope (Groundwater Driven) Wetlands
- Flat (Precipitation Driven) Wetlands
- Depressional Wetlands
- Riverine Wetlands
- Riverine Channels
- Coastal Fringe Wetlands and Waters

Note: For detailed mapping see the individual tiles in this figure series.
Tiles 1B-9B, 14B, and 15B are presented in the mapping for the Bristol Bay Drainages (EBD Chapter 14). Tiles 12C and 13C are not presented because mapping did not extend into those areas.



0 0.5 1 1.5 2 2.5 Miles

0 0.5 1 1.5 2 2.5 3 Kilometers

Scale 1:70,000

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

N

File: RDI_HDR_EBD_Fig39-5_Overview_HGM_11X17L_1of1_D04.mxd	Date: September 1, 2011
Version: 4	Author: RDI- LS

153°44'0"W 153°42'0"W 153°40'0"W 153°38'0"W 153°36'0"W

59°42'0"N

59°40'0"N

Williamsport

Iliamna Bay

THE pebble PARTNERSHIP

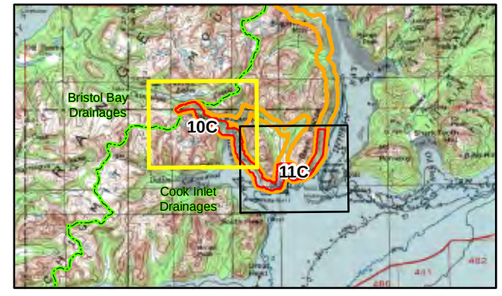
Figure 39-5
Tile 10C
Hydrogeomorphic Classification Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Hydrogeomorphic (HGM) Classification

- N/A - Non-wetlands
- Slope (Groundwater Driven) Wetlands
- Flat (Precipitation Driven) Wetlands
- Depressional Wetlands
- Riverine Wetlands
- Riverine Channels
- Coastal Fringe Wetlands and Waters



0 0.25 0.5 0.75 1 1.25 Miles

0 0.25 0.5 0.75 1 1.25 1.5 Kilometers

N

Scale 1:31,680

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

File: RDI_HDR_EBD_Fig39-5_HGM_Tiled11X17L_1of2_D02.mxd	Date: July 11, 2011
Version: 2	Author: RDI- LS

153°34'0"W 153°32'0"W 153°30'0"W 153°28'0"W 153°26'0"W

59°40'0"N

59°38'0"N

Iniskin Bay

Knoll Head

Turtle Reef

30 48 30 500

THE pebble PARTNERSHIP

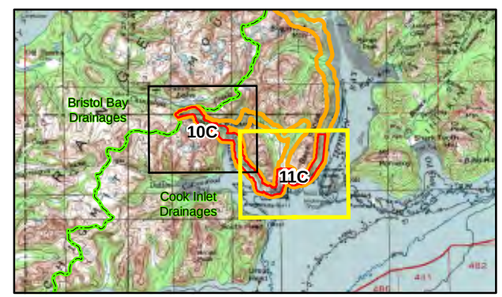
Figure 39-5
Tile 11C
Hydrogeomorphic Classification Mapping, Cook Inlet Drainages Mapping Area, 2004 and 2005

Legend

- Cook Inlet Drainages Mapping Area
- Cook Inlet Drainages Study Area
- Bristol Bay/Cook Inlet Drainages Boundary
- Communities

Hydrogeomorphic (HGM) Classification

- N/A - Non-wetlands
- Slope (Groundwater Driven) Wetlands
- Flat (Precipitation Driven) Wetlands
- Depressional Wetlands
- Riverine Wetlands
- Riverine Channels
- Coastal Fringe Wetlands and Waters



0 0.25 0.5 0.75 1 1.25 Miles

0 0.25 0.5 0.75 1 1.25 1.5 Kilometers

N

Scale 1:31,680

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

File: RDI_HDR_EBD_Fig39-5_HGM_Tiled11X17L_1of2_D02.mxd	Date: July 11, 2011
Version: 2	Author: RDI- LS