Draft Resource Report 2 – Rev 0
Water Use and Quality

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DRAFT

Notes:

Yellow highlighting is used throughout this draft Resource Report to highlight selected information that is pending or subject to change in the final report.

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
§	Section
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
AFB	Air Force Base
AMP	Alaska Mainline milepost
ANIMEDA	Arctic Nearshore Impact Monitoring in the Development Area
APDES	Alaska Pollutant Discharge Elimination System
APP	Alaska Pipeline Project
ATWS	additional temporary workspace
BLM	U.S. Bureau of Land Management
BPXA	BP Exploration Alaska
BTEX	benzene, toluene, ethylbenzene, xylenes
CANOL	Canadian-American Northern Oil Line
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
COE	U.S. Army Corps of Engineers
CSD	Contaminated Sites Database
DOI	U.S. Department of the Interior
DRO	diesel range organics
EPA	U.S. Environmental Protection Agency
FERC	U.S. Federal Energy Regulatory Commission
GIS	geographic information system
gpm	gallons per minute
GRO	gasoline range organics
GTP	Gas Treatment Plant
HDD	horizontal directional drill
L	Lacustrine
LiDAR	light detection and ranging
µg/kg	micrograms per kilogram
mg/kg	milligram per kilogram
mg/L	milligram per liter
mm	millimeter
MP	milepost
NHD	National Hydrography Dataset
NPL	National Priorities List
NWI	National Wetland Inventory
PAB	Palustrine Aquatic Bottom
PAH	polycyclic aromatic hydrocarbon
PEM	Palustrine Emergent Wetland
PFO	Palustrine Forested Wetland
PMP	Point Thomson Gas Transmission Pipeline milepost
PSS	Palustrine Scrub-Shrub Wetland
PT Pipeline	Point Thomson Gas Transmission Pipeline
PUB	Palustrine Unconsolidated Bottom
R	Riverine
SPCC	Spill Prevention, Control, and Countermeasures

SWPPP	Stormwater Pollution Prevention Plan
USGS	U.S. Geological Survey
WELTS	Well Log Tracking System

2.0 RESOURCE REPORT 2 – WATER USE AND QUALITY

The location information, facility descriptions, resource data, construction methods, and mitigation measures presented in this report are preliminary and subject to change. APP is conducting engineering studies, environmental resource surveys, agency consultations, and stakeholder outreach efforts to further refine and define the details of the Project.

The Project described in this resource report is being designed and developed based on estimated volumes of natural gas from projected shipper commitments. If final shipper commitments are significantly different from those estimated, the Project may be adjusted accordingly.

2.1 INTRODUCTION

TransCanada Alaska Company, LLC and Foothills Pipe Lines Ltd., working with ExxonMobil Alaska Midstream Gas Investments LLC, are developing a joint project to treat, transport, and deliver natural gas from the Alaska North Slope (ANS) to pipeline facilities in Alberta, Canada for markets in the contiguous United States and North America. This joint project is referred to as the Alaska Pipeline Project (APP or Project)[1].

As required by Title 18 Code of Federal Regulations (C.F.R.) Section (§) 380.12 and consistent with the Alaska Natural Gas Pipeline Act of 2004 (ANGPA), APP has prepared this draft resource report in support of its application to the U.S. Federal Energy Regulatory Commission (FERC) for a Certificate of Public Convenience and Necessity (CPCN) under Section 7(c) of the Natural Gas Act (NGA) to construct, own, and operate the portion of the Project in Alaska. This draft resource report pertains only to that portion of the Project in Alaska, and unless the context otherwise requires, references in this draft resource report to APP refer only to the Alaska portion of the Project[2].

As shown in Figure 1.1-1 of Resource Report 1, APP will comprise the following major components[3,4]:

- The Point Thomson Gas Transmission Pipeline (PT Pipeline)[5], consisting of approximately 58.4 miles of buried 32-inch-diameter pipeline from the Point Thomson Unit (PTU) to an APP Gas Treatment Plant (GTP) and associated facilities near Prudhoe Bay;

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1 Depending on the context, the term APP refers to the joint project or, collectively, to the sponsoring entities.

2 The Canadian Section refers to the portion of the Project from the Yukon border to the pipeline facilities in Alberta, Canada.

3 In previous FERC filings, the Point Thomson Gas Transmission Pipeline was referred to as Zone 1, the Gas Treatment Plant was referred to as Zone 2, and the Alaska Mainline was referred to as Zone 3 of the Alaska-Canada Pipeline.

4 As part of the Project, APP proposes to construct compressor stations, meter stations, various mainline block valves (MLBVs), pig launcher and receiver facilities, as well as associated ancillary and auxiliary infrastructure, including additional temporary workspace, access roads, helipads, construction camps, pipe storage areas, contractor yards, borrow sites, and dock modifications at Prudhoe Bay.

5 The origin of the PT Pipeline is assumed to be located at an outlet from the PTU. The final length may vary depending on the final gas development plan for the PTU.

- The GTP, which will have the capacity to process gas received from the Point Thomson Unit and the existing Central Gas Facility (CGF) on the Prudhoe Bay Unit (PBU) in order to deliver an annual average capacity up to 4.5 billion standard cubic feet per day (bscfd) (standard conditions: 14.73 pounds per square inch absolute and 60º Fahrenheit) of sales quality gas; and
- The Alaska Mainline, consisting of approximately 745.1 miles of 48-inch-diameter pipeline, all of which is buried except as otherwise described in this Resource Report. The Alaska Mainline extends from the GTP to the Alaska-Yukon border east of Tok, Alaska, and includes provisions for intermediate gas delivery points within Alaska.

Table 2.1-1 lists the FERC's filing requirements and additional information applicable to Resource Report 2 taken from FERC's Guidance Manual for Environmental Report Preparation:

TABLE 2.1-1

Alaska Pipeline Project
Resource Report 2 Filing Requirements Checklist

FERC REQUIREMENTS FROM 18 C.F.R. § 380.12	Where Found in Document
1. Identify all perennial surface waterbodies crossed by the Project and their water quality classification (§ 380.12[d][1]): • Identify by milepost (MP); and • Indicate if potable water intakes are within 3 miles downstream of the crossing.	Table 2B-1 in Appendix 2B
2. Identify all waterbody crossings that may have contaminated waters or sediments (§ 380.12[d][1]): • Identify by MP; and • Include offshore sediments.	Table 2B-1 in Appendix 2B
3. Identify watershed areas, designated surface water protection areas, and sensitive waterbodies crossed by the Project. (§ 380.12[d][1]) • Identify by MP.	Tables 2.3.2-1, 2.3.3-1, and 2.3.4-1 in Section 2.3
4. Provide a table (based on National Wetland Inventory maps if delineations have not been done) identifying all wetlands, by MP and length, crossed by the Project (including abandoned pipeline), and the total acreage and acreage of each wetland type that would be affected by construction. (§ 380.12[d][1 & 4])	Tables 2E-1 and 2E-2 in Appendix 2E
5. Discuss construction and restoration methods proposed for crossing wetlands, and compare them to staff's Wetland and Waterbody Construction and Mitigation Procedures. (§ 380.12[d][2])	Appendix 1K
6. Describe the proposed waterbody construction, impact mitigation, and restoration methods to be used to cross surface waters and compare to the FERC's Wetland and Waterbody Construction and Mitigation Procedures. (§ 380.12[d][2]) • Although the Procedures do not apply offshore, the first part of this requirement does apply. Be sure to include effects of sedimentation, etc. This information is needed on a mile-by-mile basis and will require completion of geophysical and other surveys before filing. (See also Resource Report 3.)	Section 1.6.3 in Resource Report 1; Section 2.3.5; and Appendix 1K
7. Provide original National Wetlands Inventory maps or the appropriate state wetland maps, if National Wetland Inventory maps are not available, that show all proposed facilities and include MP locations for proposed pipeline routes. (§ 380.12[d][4])	Appendix 2E
8. Identify all U.S. Environmental Protection Agency or state-designated aquifers crossed. (§ 380.12[d][9]) • Identify the location of known public and private groundwater supply wells or springs within 150 feet of construction.	Sections 2.2.3 and Table 2.2.3-1
OTHER INFORMATION OFTEN MISSING AND RESULTING IN DATA REQUESTS PER FERC'S GUIDANCE MANUAL FOR ENVIRONMENTAL REPORT PREPARATION.	
• Identify proposed mitigation for impacts on groundwater resources.	Section 2.2.5
• Discuss the potential for blasting to affect water wells, springs, and wetlands, and associated mitigation. (§ 380.12[d][8])	Section 2.2.5
• Identify all sources of hydrostatic test water, the quantity of water required, methods for withdrawal, and treatment of discharge, and any waste products generated. (§ 380.12[d][6])	Table 2.3.5-2

TABLE 2.1-1

Alaska Pipeline Project
Resource Report 2 Filing Requirements Checklist

• If underground storage of natural gas is proposed, identify how water produced from the storage field will be disposed.	N/A
• If salt caverns are proposed for storage of natural gas, identify the source locations, the quantity required, the method and rate of water withdrawal and disposal methods.	N/A
• For each waterbody greater than 100 feet wide, provide site-specific construction mitigation and restoration plans.	Section 2.3.5
• Indicate mitigation measures to be undertaken to ensure that public or private water supplies are returned to their former capacity in the event of damage resulting from construction.	Section 2.2.3
• Describe typical staging area requirements at waterbody and wetland crossings.	Section 1.6.3 in Resource Report 1
• If wetlands would be filled or permanently lost, describe proposed measures to compensate for permanent wetland losses.	Section 2.4.3
• If forested wetlands would be affected, describe proposed measures to restore forested wetlands following construction.	Section 2.4.3
• Describe techniques to be used to minimize turbidity and sedimentation impacts associated with offshore trenching, if any.	N/A

Mileposts (MPs) are commonly used markers along linear projects, such as APP. Where necessary to distinguish the PT Pipeline from the Alaska Mainline, APP has prefixed its MP identifier with a PT Pipeline MP (PMP) or an Alaska Mainline MP (AMP). This convention is used in APP's application and supporting maps and alignment sheets (refer to Appendix 1O of Resource Report 1) to identify resources and features along the respective pipeline routes.

This resource report evaluates water use and quality issues associated with the APP. In particular, this report describes how the APP facilities will be designed, constructed, operated, and maintained to reduce potential impacts to groundwater, surface water, and wetland resources.

2.2 GROUNDWATER RESOURCES

2.2.1 Existing Groundwater Resources

U.S. Geological Survey (USGS) indicates that groundwater provides over 20 percent of the total water used in Alaska (USGS 1984). About 50 percent of Alaska's overall population, and about 90 percent of rural Alaskans, rely on groundwater for drinking water. Southcentral and Interior Alaska rely to a great extent on groundwater (Alaska Department of Environmental Conservation [ADEC] 2008). Most of Alaska's groundwater meets water quality standards for domestic, agricultural, aquacultural, commercial, and industrial uses with minimal treatment required.

Depth to groundwater ranges from a few feet to over 400 feet statewide. For the majority of Alaska, bedrock is covered by unconsolidated deposits originating from glaciers and alluvium. Most of the state's aquifers are unconfined and consist of fluvial and glaciofluvial materials (ADEC 2008). In the northern part of the state, groundwater availability is generally limited due to the thickness of the permafrost. Permafrost forms a nearly impenetrable layer that restricts recharge, discharge, and movement of groundwater, and decreases the volume in which water may be stored in unconsolidated deposits and bedrock (USGS 1984). The restricted circulation imposed by permafrost boundaries may increase the concentration of dissolved solids in groundwater (USGS 1970).

The Project crosses areas of continuous permafrost (primarily north of the Brooks Range) and discontinuous permafrost (primarily south of the Brooks Range). The thickness of the permafrost is affected by the surface-air temperature and other factors, including vegetation cover type, soils, relief, snow cover and the presence of surface water or flowing groundwater. In areas of continuous permafrost, perennially frozen ground may extend to depths of up to 2,000 feet (USGS 1999). The top of the permafrost layer is referred to as the permafrost table. The active layer lies above the permafrost table, and freezes and thaws seasonally. Where the active layer is permeable and saturated, it forms a suprapermafrost aquifer. Where water quality and quantity in these aquifers is sufficient, they serve as water sources for some villages near the Arctic Ocean. The suprapermafrost aquifers are bound on the bottom by the permafrost table. Suprapermafrost groundwater plays an important role in creating distinctive geomorphic features such as wetlands, patterned mosaics formed by freeze-thaw cycles, pingos (ice-core hills in permafrost formed when hydrostatic pressure of freezing groundwater causes upheaval), and shallow lakes (Nelson and Munter 1990).

Appreciable amounts of groundwater are present in confined bedrock aquifers where glacial and alluvial deposits are thin or absent. Carbonate rocks in the northeastern portion of the Brooks Range provide extensive groundwater reservoirs, where springs in the area discharge as much as 16,000 gallons per minute (gpm) (USGS 1955). Clastic sedimentary rocks are present throughout the state, but have only been used as a groundwater resource in western Alaska, where they have generally low permeability. Groundwater obtained from fractured schist around Fairbanks probably represents the greatest development of a bedrock aquifer in the state. Wells completed in the fractured schist generally produce 10 gpm or less, which is adequate for single household needs.

The greatest groundwater use within the Project area[6] is in the vicinity of Fairbanks. In 1996, the monthly mean water withdrawal rate was approximately 6 million gallons per day (USGS 2002). In the Fairbanks area, where there is discontinuous permafrost, the depth to the base of the permafrost ranges from 155 to 265 feet (Ferrians 1965). Water is supplied to residents of the Fairbanks area by hundreds of small diameter private wells, many of which are only 15 to 30 feet in depth and take water from above permafrost or from unfrozen zones within permafrost. Other wells ranging from 100 to 250 feet in depth take water from unfrozen sediments below the frozen layer. Large yields are available both above and below the permafrost (USGS 1955). Dissolved solids concentrations in unconsolidated deposit aquifers range from 110 to 340 milligram per liter (mg/L) (USGS 1999).

In areas where the permeable material lies below the permafrost, subpermafrost aquifers serve as important water sources and include portions of the Yukon and Tanana river basins (USGS 1999). Groundwater also occurs in taliks and thaw bulbs. Taliks are unfrozen zones that occur beneath lakes and rivers and in other areas that are either underlain by permafrost or are completely open to subpermafrost groundwater. Thaw bulbs are localized regions of melted permafrost produced by a local heat source.

Although found primarily in unconsolidated deposits, groundwater also occurs in consolidated rocks including fractured metamorphic bedrock, sandstone, and carbonates. Alluvial deposits in the valleys of the Yukon and Tanana rivers, both of which are crossed by the Project, have large

6 The terms “Project area” and “Project footprint” are defined to include the project facilities and land requirements for construction and operation. The term “Project vicinity” is used to mean the area or region near or surrounding the Project area, and is subject to the context in which the term is used.

recharge potential. The maximum known thickness of alluvium in the Tanana River Valley is 2,000 feet (USGS 1984). In the Tok area of the Tanana River Valley, the depth to groundwater where frozen ground does not occur ranges from 40 to 68 feet below ground surface. In areas where frozen ground does occur, the depth of the base of frozen ground ranges from 30 to 35 feet and groundwater below the frozen layer ranges from 53 to 57 feet (USGS 1970). The quality of groundwater from unconsolidated aquifers is generally poor in the Tanana River floodplain, in the northern alluvial apron, and in valleys because much of it percolates through organic sandy silt, which adds organic matter and iron that imparts a dark color and a bad taste (USGS 1955). Dissolved solids concentrations are generally less than 250 mg/L although they are higher in many parts of the continuous permafrost zone.

2.2.2 Protected Aquifers

The APP does not cross any U.S. Environmental Protection Agency (EPA) designated-sole-source aquifers (EPA 2011a) or any state-designated protected aquifers.

2.2.3 Public and Private Water Supply Wells and Springs

The ADEC maintains a database of water well records called the Well Log Tracking System (WELTS). The well records from WELTS were searched to identify potable water supply wells in proximity to project construction areas. Well locations identified through this search were only available by township, range, and section; therefore the exact location of wells within a section is unknown. The WELTS database contained a total of 34,125 well records, of which 30,007 well records had adequate location data. A search for water wells in proximity to the Pipeline Facilities[7] was conducted by identifying any well located in a section that is intersected by the Pipeline Facilities. The resulting search identified 28 wells, which are listed in Table 2.2.3-1, along with the MP location representing the approximate midpoint of the pipeline within the section, owner, and well depth. The WELTS database does not distinguish between private and public water supply wells. No wells were identified along the PT Pipeline by this search. Field surveys will confirm the presence of public and private drinking water wells proximate to the construction area prior to the start of pipeline construction in the vicinity of the well. Figure 2.2.3-1 illustrates the locations of water wells near the Pipeline Facilities.

Because the WELTS database is incomplete, APP interviewed landowners and researched well permit records to identify an additional 21 wells within 150 feet of the construction work areas. Table 2.2.3-1 identifies the approximate locations of public and private wells near the Pipeline Facilities identified by this survey. [Note: APP will update this evaluation for Aboveground Facilities[8] and Associated Infrastructure[9] in the final report.] Section 2.2.4 describes the potential impacts of the Project on nearby wells and mitigation measures that will be taken in the event that construction activities damage a potable water source well.

[7] The Pipeline Facilities will consist of the PT Pipeline and the Alaska Mainline, as discussed in Section 1.3.1 of Resource Report 1.

[8] Aboveground Facilities include the GTP, eight compressor stations, three custody meter stations, various mainline block valves (MLBV), pig launchers, pig receivers, provisions for intermediate gas delivery points, and cathodic protection facilities as discussed in Section 1.3.2 of Resource Report 1.

[9] Associated Infrastructure and land required to construct and operate APP include additional temporary workspace (ATWS), access roads, helipads, airstrips, construction camps, pipe storage areas, contractor yards, borrow sites, and dock modifications, as discussed in Section 1.3.3 of Resource Report 1.

Prior to pipeline construction in the vicinity of the water sources and pending results of field work and agency consultations, springs within 150 feet of the Project construction areas will be identified and evaluated as to whether they are used as potable water supplies. [Note: The occurrence of any springs, seeps, or additional wells within 150 feet of the Project construction areas that are used as potable water sources will be verified during field surveys, and reported to FERC prior to construction.]

TABLE 2.2.3-1

Alaska Pipeline Project
Public and Private Water Wells Near Pipeline Facilities

Segment/Borough or Census Area	Approx. Milepost	Approximate Distance (feet) and Direction	Public or Private	Depth (feet)
ALASKA MAINLINE				
Yukon-Koyukuk Census Area	AMP 239.3	TBD[a]	Unknown[1]	49
Yukon-Koyukuk Census Area	AMP 308.9	TBD[a]	Unknown[1]	420
Yukon-Koyukuk Census Area	AMP 355.8	TBD[a]	Unknown[1]	800
Yukon-Koyukuk Census Area	AMP 355.7	TBD[a]	Public[2]	TBD
Yukon-Koyukuk Census Area	AMP 359.7	TBD[a]	Unknown[1]	240
Yukon-Koyukuk Census Area	AMP 359.8	TBD[a]	Public[2]	TBD
Yukon-Koyukuk Census Area	AMP 420.2	TBD[a]	Unknown[1]	28
Yukon-Koyukuk Census Area	AMP 420.8	TBD[a]	Unknown[1]	345
Fairbanks North Star Borough	AMP 455.2	TBD[a]	Unknown[1]	345
Fairbanks North Star Borough	AMP 455.4	TBD[a]	Public[2]	TBD
Fairbanks North Star Borough	AMP 455.9	TBD[a]	Unknown[1]	90
Fairbanks North Star Borough	AMP 455.9	TBD[a]	Private[2]	TBD
Fairbanks North Star Borough	AMP 457.3	TBD[a]	Unknown[1]	230
Fairbanks North Star Borough	AMP 468.5	TBD[a]	Unknown[1]	120
Fairbanks North Star Borough	AMP 468.5	TBD[a]	Unknown[1]	183
Fairbanks North Star Borough	AMP 469.5	TBD[a]	Unknown[1]	74
Fairbanks North Star Borough	AMP 474.7	TBD[a]	Unknown[1]	22
Fairbanks North Star Borough	AMP 486.1	TBD[a]	Unknown[1]	125
Fairbanks North Star Borough	AMP 495.7	TBD[a]	Unknown[1]	28
Southeast Fairbanks Census Area	AMP 533.9	TBD[a]	Unknown[1]	210
Southeast Fairbanks Census Area	AMP 539.5	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 540.4	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 540.4	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 540.4	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 541.4	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 547.0	TBD[a]	Unknown[1]	180
Southeast Fairbanks Census Area	AMP 550.1	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 552.7	TBD[a]	Unknown[1]	220
Southeast Fairbanks Census Area	AMP 553.9	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 554.2	TBD[a]	Unknown[1]	230
Southeast Fairbanks Census Area	AMP 554.9	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 555.2	TBD[a]	Unknown[1]	220
Southeast Fairbanks Census Area	AMP 552.2[b]	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 558.6	TBD[a]	Unknown[1]	180
Southeast Fairbanks Census Area	AMP 559.5	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 559.7	TBD[a]	Public[2]	TBD

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TABLE 2.2.3-1

Alaska Pipeline Project
Public and Private Water Wells Near Pipeline Facilities

Segment/Borough or Census Area	Approx. Milepost	Approximate Distance (feet) and Direction	Public or Private	Depth (feet)
Southeast Fairbanks Census Area	AMP 561.0	TBD[a]	Unknown[1]	200
Southeast Fairbanks Census Area	AMP 568.3	TBD[a]	Unknown[1]	140
Southeast Fairbanks Census Area	AMP 569.1	TBD[a]	Public[2]	TBD
Southeast Fairbanks Census Area	AMP 578.5	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 579.7	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 607.4	TBD[a]	Unknown[1]	48
Southeast Fairbanks Census Area	AMP 612.1	TBD[a]	Public[2]	TBD
Southeast Fairbanks Census Area	AMP 643.5	TBD[a]	Unknown[1]	17
Southeast Fairbanks Census Area	AMP 641.0	TBD[a]	Private[2]	TBD
Southeast Fairbanks Census Area	AMP 644.1	TBD[a]	Unknown[1]	17
Southeast Fairbanks Census Area	AMP 644.5	TBD[a]	Unknown[1]	18
Southeast Fairbanks Census Area	AMP 661.1	TBD[a]	Public[2]	TBD
Southeast Fairbanks Census Area	AMP 661.5	TBD[a]	Unknown[1]	108
Southeast Fairbanks Census Area	AMP 704.5	TBD[a]	Unknown[1]	275
Southeast Fairbanks Census Area	AMP 710.8	TBD[a]	Unknown[1]	250

[1] WELTS Database (ADEC 2011a)
[2] APP landowners survey and permit records search
[a] Wells are located in a section intersected by the APP workspace.

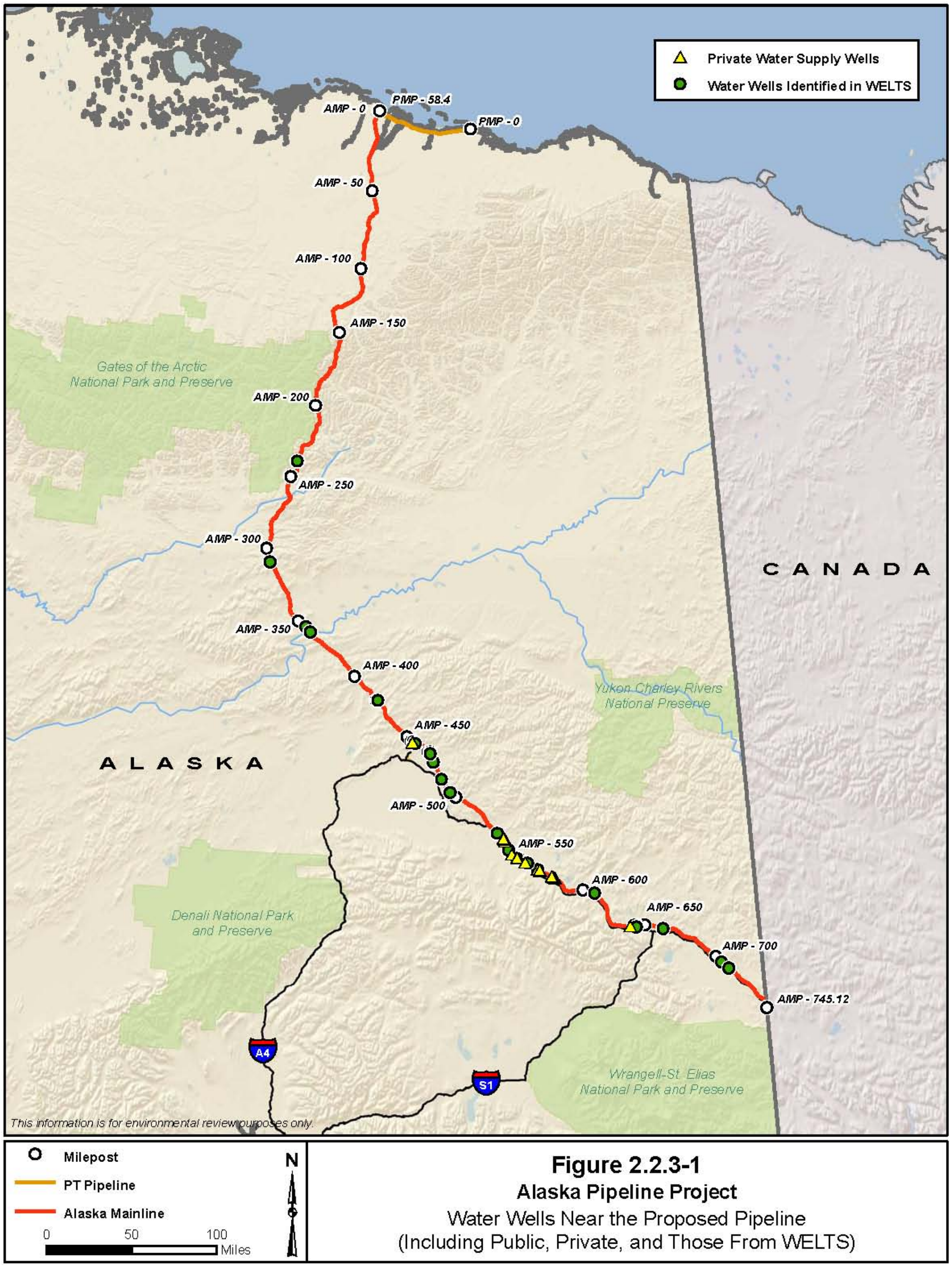

Figure 2.2.3-1
Alaska Pipeline Project
Water Wells Near the Proposed Pipeline
(Including Public, Private, and Those From WELTS)

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2.2.4 Contaminated Sites

APP conducted a desktop review of the available information concerning known or potential contamination within the Project area. This review is described in more detail in Resource Report 8, Section 8.7. The ADEC Contaminated Sites database (CSD), ADEC Leaking Underground Storage Tank (LUST) databases, and the EPA National Priority List (NPL) identified contaminated sites located within the Project area (refer to Section 2.2.4.2).

2.2.4.1 Environmental Protection Agency National Priority List

APP searched EPA's NPL to identify sites within or in proximity to the Project area. The NPL identifies those sites where contamination has been documented and where the EPA has conducted investigation and mitigation. The Project is located within or in proximity to four NPL sites (refer to Section 8.7.1 of Resource Report 8):

- Alaska Battery Enterprises
- Arctic Supplies
- Fort Wainwright
- Eielson Air Force Base (AFB)

Three of the sites are located at least five miles away and hydrogeologically downgradient from the Project area. The Project area traverses the fourth site, Eielson AFB, a 19,700-acre military installation located approximately 24 miles southeast of Fairbanks. The EPA has identified multiple groundwater contaminant source areas within Eielson AFB; however, the ADEC's CSD indicates that only two of these areas are within 0.5 mile of the Project area. APP is currently consulting with representatives of the Eielson AFB on routing of the Alaska Mainline in the AFB (refer to Resource Report 10). [Note: APP is evaluating these contaminated source areas and an update will be provided in the final report.]

2.2.4.2 Alaska Contaminated Sites Program

All reported contaminated sites, underground storage tanks, and Leaking Underground Storage Tank sites present in the State of Alaska are listed and tracked through the ADEC CSD (ADEC 2011b). APP searched the CSD to identify sites within the Project area; the results of this search are presented in Section 8.7.2 of Resource Report 8. The CSD search identified groundwater contamination at the BP Exploration Alaska (BPXA) Central Gas Facility located near the eastern boundary of the GTP, and at the Tanacross Airfield Former Fuel Facilities site near AMP 643. The ADEC Project Manager for the BPXA CGF reports that off-site migration of the contamination is limited and does not have the potential to impact the GTP.

Although groundwater contamination has been previously detected at the Alyeska Happy Valley Camp West (AMP 88), recent sampling indicates that groundwater petroleum hydrocarbon levels are now below ADEC cleanup levels. Groundwater sampling has not occurred at the Canol Pump Station J (AMP 682), Haines-Fairbanks Pipeline MP 343.9 (AMP 739), Haines-Fairbanks Pipeline MP 449.1 (AMP 630), or in the Tetlin National Wildlife Refuge between AMP 742 and AMP 745 in the proximity of the Northway Staging Field, Haines-Fairbanks Pipeline, and Canadian-American Northern Oil Line (CANOL) Pipeline; therefore, there is a the potential that groundwater contamination may be present at these sites (ADEC 2011b).

2.2.5 Construction and Operation Impacts and Mitigation

Potential temporary construction impacts to groundwater or groundwater use could result from various construction activities, such as clearing, grading, trenching, dewatering, blasting, borrow site excavation, and spills. Clearing, grading, trenching, and borrow site excavation activities could result in indirect impacts on groundwater level and quality (e.g., clarity, turbidity). Blasting, dewatering, spills, and borrow site excavation also could result in direct impacts.

These activities are not expected to have a substantial impact on groundwater resources due to the typically short-term nature of the construction activities, the limited extent of the work area (for example, cut and fill locations), the appropriate and timely implementation of reclamation measures as outlined in APP's Erosion Control, Revegetation, and Maintenance Plan (Plan) and Wetland and Waterbody Construction Mitigation Procedures (Procedures) (refer to Appendix 1J and 1K of Resource Report 1, respectively), implementation of the ADEC Construction General Permit (construction stormwater), and the management of spill response as outlined in APP's Preliminary Spill Prevention, Control, and Countermeasure (SPCC) Plan (refer to Appendix 2A for an outline of the SPCC Plan). [Note: APP is developing its SPCC Plan, which will be updated in the final report.]

Clearing and Grading

Before pipeline installation, clearing crews will clear the work area of vegetation (loose surface materials) and surface obstacles (e.g., trees, logs, brush, and rocks). Grading, including both cuts and fills, will be conducted where necessary to provide a reasonably level work surface or reasonable grades to allow equipment access and safe working conditions. Where the ground is relatively flat and does not require grading, rootstock may be left in the ground except over the ditchline. On slopes, the clearing of vegetation may result in decreased infiltration, causing higher local runoff until vegetation cover is re-established. Following construction, overland water flow and groundwater recharge and infiltration impacts will be addressed through reclamation of the disturbed areas according to the APP Plan and Procedures to stablize conditions.

Trenching and Dewatering

Since trenching associated with typical pipeline construction can extend to a depth of up to 15 feet below the graded ground surface (or more in some instances), shallow groundwater (i.e., the water table) may be encountered and in some locations trench dewatering may be required. Dewatering, depending on the rate of pumping, could cause localized, minor and temporary dewatering or drawdown of the water table. Because trenching, pipe installation, and backfilling at a given location will be completed within a short period of time, potential impacts from dewatering will be localized and short-term; the water table will quickly re-establish equilibrium.

Per APP's Plan and Procedures, the trench will be dewatered in a manner that does not cause excessive soil erosion that allows sediment-laden water to flow into adjacent wetlands or waterbodies.

Trench dewatering has the potential to temporarily and locally affect springs, seeps, wetlands, and very shallow wells. These impacts are temporary and water levels should quickly re-establish after backfilling. To reduce the potential for localized changes in groundwater flow that could affect springs and seeps, backfill generally will consist of local material and where required, trench breakers will be installed during trench backfilling per the APP Plan.

[Note: Where contaminated groundwater and/or soils are encountered in excavations, APP will follow its Construction Unanticipated Discoveries Plan (currently under development).]

Blasting

Blasting may be required where hard bedrock or numerous boulders are encountered at or near the ground surface and in certain permafrost terrain conditions where mechanized fracturing and excavating are not suitable. Section 6.5 in Resource Report 6 discusses the locations where shallow bedrock is anticipated. Blasting will also be required for the construction of the GTP water reservoir. [Note: APP's Blasting Plan will address blasting activities and measures to protect the environment. An outline of APP's Blasting Plan is included as Appendix 6B of Resource Report 6 and an updated Blasting Plan will be provided with the final report.] Where blasting is required, groundwater yield and clarity may be temporarily affected locally. No permanent impacts on groundwater resources are anticipated.

Water Wells

Groundwater supply wells located within 150 feet of construction work areas may be susceptible to impacts from proposed construction activities. Impacts, although rare, are likely to be limited to temporary increases of suspended sediments (increased turbidity) in potable water wells.

APP will mark and avoid where practicable each well up to 150 feet from construction work areas during construction. APP will work with landowners to address identified impacts to water wells.

2.3 SURFACE WATER RESOURCES

Table 2B-1 in Appendix 2B lists the waterbodies crossed by the Pipeline Facilities. [Note: Waterbodies impacted by Aboveground Facilities and Associated Infrastructure will be updated in the final report.] These crossings were identified using detailed aerial photography and maps. The initial compilation of potential waterbody crossings was based on surface water features from the National Hydrography Dataset (NHD) topographic map series at a 1:100,000 scale. The 2002 Alyeska Pipeline Service Company Environmental Atlas was used to supplement the NHD and provide additional detailed information on crossings that were in the vicinity of the Trans-Alaska Pipeline System. USGS 1:63,360 scale topographical maps were then used to confirm and compare the Trans-Alaska Pipeline System, NHD, and internal waterbody crossing data. Light detection and ranging (LiDAR) data of the pipeline route was also used to examine potential crossing sites.

Field studies of stream hydrology were initiated in 2010 to document the hydrologic characteristics of select streams and rivers at the proposed pipeline crossing locations. Each waterbody was evaluated for flow type (perennial, seasonal, or intermittent); ordinary high water width and depth; discharge; bank full width and depth; water surface width and depth; channel characteristics; and bed and bank characterization. Data collection was limited to streams and rivers that could be waded. [Note: Field surveys will be completed on additional streams in 2011 and 2012 where existing data is not available to complete waterbody crossing documentation. Results of the field surveys will be updated in the final report. APP will survey waterbodies for access roads if a new road will cross a stream and if improvements will be needed on existing access roads (a culvert, or improved bridge will be required). Field survey results will be used to further refine crossing method techniques and finalize the construction footprint, including determining locations and size of additional temporary workspace (ATWS). This information will be updated in the final report.]

The crossings are listed in Table 2B-1 of Appendix 2B. Fisheries classification information is discussed in Section 3.1 of Resource Report 3. Of the waterbodies crossed by the Pipeline Facilities, APP surveyed a total of 255, of which 15 were along the PT Pipeline right-of-way, and 240 on the Alaska Mainline right-of-way. Existing hydrology data for smaller streams was available from previous field efforts conducted in 2001. Gauging stations at larger rivers and streams provided discharge and gage height data. Sixteen major (greater than 100 feet wetted width at the point of crossing and at the time of construction), 68 intermediate (greater than 10 feet wetted width but less than 100 feet wetted width), and 420 minor (less than 10 feet wetted width) waterbodies are anticipated to be crossed by the APP. [Note: Waterbody data for Aboveground Facilities and Associated Infrastructure is will be updated in the final report].

2.3.1 Marine Environment

The principal marine environment in the Prudhoe Bay and Eastern North Slope area is a relatively shallow marine lagoon that is situated south of a barrier island complex with water depths typically ranging between 5 and 25 feet. The barrier islands parallel the coast and partially protect and stabilize much of the shoreline from exposure to waves, storm surges, and ice surges generated in the Beaufort Sea. Sea level variation due to tidal action during the open-water season is typically less than 1 foot. Storm surges in the eastern North Slope area are generally less than 3 feet, but during extreme storms can reach up to 8 feet. Positive storm surges are associated with westerly winds and negative storm surges are associated with easterly winds (ADNR 2006).

Sea ice is a dominant feature of the Arctic marine environment. Sea ice generally covers the Beaufort Sea shelf for about nine months of the year from October to June. In the Prudhoe Bay area, grounded ice typically extends to maximum depths of about 6 or 7 feet (approximately one fathom) or about half of the length of West Dock, while floating landfast ice can extend up to about 40 miles from shore in the spring (U.S. Department of the Interior [DOI] Minerals Management Service 2003) (refer to Appendix 1B of Resource Report 1). In the summer, the ice pack retreats up to 50 miles from shore, but winds can bring floes close to shore at any time during the open-water season (LGL Alaska Research Associates, Inc. et al. 1998). Seaward of the landfast ice is the stamukhi or shear zone, where the mobile pack ice covering the Arctic Ocean grinds from east to west past the landfast ice. Ice ridges and keels can cause intense ice gouging of the seafloor within this zone, which generally lies between 60 and 100 feet of water depth (ADNR 2009). The Project facilities near West Dock lie within an area of low ice gouge intensity due to the presence of landfast ice (Barnes et al. 1984).

Other sea ice hazards that occur in the project area include strudel scour and ice encroachment. Strudel scour occurs during breakup when river water overflows the sea ice, drains through holes in the ice, and erodes depressions in the seafloor sediment. Scours up to 20 feet deep and 70 feet across have been reported in the Beaufort Sea (ADNR 2009). In the vicinity of West Dock, Reimnitz et al. (1974) indicate that strudel scour density is on the order of 1 to 10 occurrences per mile of trackline survey due to overflood from both the Putuligayuk and Kuparuk rivers. Ice encroachment occurs when sea ice is forced onshore by strong wind or currents, resulting in ice rubble and sediment being shoved as much as several hundreds of feet inland (ADNR 2009; U.S. Minerals Management Service 2003). While the Prudhoe Bay area is somewhat protected from ice override hazards by barrier islands, ice pileup has been known to occur on West Dock causeway, where ice rubble up to 20 feet high was reported in the late 1970s (Kovacs 1983).

Surface sediment on the Beaufort Sea inner shelf has been sampled for a number of years as part of the Arctic Nearshore Impact Monitoring in the Development Area (ANIMEDA) project conducted by the U.S. Bureau of Ocean Energy Management. Average grain size for the ANIMEDA monitoring area, which extends for about 100 miles on either side of Prudhoe Bay, consists of mostly sand and fine-grained material with a minor amount of gravel (Neff 2010). More locally, seafloor sediment in the vicinity of the proposed dredge disposal area in Stefansson Sound consists of silty sand and sandy mud with occasional organic-rich layers (Barnes et al. 1979; McDougall et al. 1986). Sediment in the vicinity of the proposed dredge channel consists of a 0.5- to 3-foot-thick layer of sandy silt at the seafloor, underlain by gravelly to silty sand. Sediment near the base of West Dock contains relict ice-bonded permafrost, the top of which lies within a few feet of sea level near the shoreline and deepens to more than 50 feet below sea level within about 0.5 mile of shore (McClelland-EBA 1985; Osterkamp and Harrison 1976).

Marine Sediments

Marine water quality is measured by the physical and chemical characteristics of the water. Seawater contains naturally occurring constituents derived from atmospheric, terrestrial, and freshwater environments, as well as those derived from human activities. Due to limited industrial activity, most contaminants in the Beaufort Sea and on the North Slope occur in low levels (EPA 2009). Sampling results for water, sediment, and fauna collected as part of the ANIMEDA project and more locally near West Dock corroborate that conclusion (Brown et al. 2005; Kuhle 2010; Neff 2010).

Regional sediment samples collected for the ANIMEDA project were analyzed for metals and organic compounds, including polycyclic aromatic hydrocarbons (PAHs). Using older data for comparison, the concentrations of metals in the sediment samples were found to fall within the normal concentration range for Arctic marine sediments, and are considered representative of natural background conditions, with higher concentrations typically correlating with finer grained sediments. Total hydrocarbons in the sediment were measured using a saturated hydrocarbon method that quantifies carbon compounds, including C_9 through C_{40} and alkanes. Concentrations ranged from 0.24 to 38 milligram per kilogram (mg/kg), and the composition of the different hydrocarbon fractions indicated that terrigenous plant wax and river erosion of shales, coal, and peat to be the primary sources. Similarly, total PAH concentrations in the sediment samples ranged from 12 to 1,800 micrograms per kilogram (µg/kg), in assemblages indicating the primary source to be peat eroded by rivers (Neff 2010). EPA (2009) indicates that concentrations of aliphatic and aromatic hydrocarbons in sediments from the coastal Beaufort Sea are high relative to other undeveloped outer continental shelf sediments. However, it similarly notes the source to be mainly derived from natural outcrops of coal and shale on land that are drained into rivers and into the coastal Beaufort Sea. A number of sediment samples have been collected in the vicinity of West Dock as part of permitting activities for ongoing maintenance dredging (Kuhle 2010; Oasis 2006). Four of these were taken in the proposed dredged material prism proposed for the GTP channel. Chemical analyses, which included both organic compounds and metals, detected no diesel range organics (DRO), gasoline range organics (GRO), or benzene, toluene, ethylbenzene, and xylenes (BTEX) above method detection limits. Low levels of residual range organics (RRO) (28 to 92 mg/kg) are likely attributable to naturally occurring organic compounds based on gas chromatograph interpretation. Concentrations of metals are mostly within the natural variability of Beaufort Sea coastal sediment.

Concentrations of dissolved metals in sea water throughout the coastal Beaufort Sea are similar to or less than the world average values in coastal and marine areas (EPA 2009). PAHs were measured in samples of water collected from the Beaufort Sea, with concentrations ranging from 0.038 to 0.051 µg/L, falling within the range commonly reported for uncontaminated sea water. Most of the PAHs in the whole water samples are associated with the particulate fraction (Neff 2010).

PAH analysis of ANIMEDA biota tissue samples yielded annual averages of 61 to 100 nanograms per gram in amphipods, and 32 to 230 nanograms per gram in mussels. These levels are consistent with those measured elsewhere in the Beaufort Sea, and fall well below levels that pose a health risk to humans, fish or wildlife. Similarly, analysis of 18 metals in tissue samples from amphipods, isopods, clams, and mussels collected in the Beaufort Sea indicated that concentrations were in the range of those reported for the same or similar species from other locations throughout the world (Neff 2010).

Additional characterization of marine sediment, seawater, and fauna was conducted by APP in summer 2011 in the vicinity of the proposed dredge and disposal areas. [Note: 2011 field samples are currently being analyzed and the results will be summarized in the final report.]

2.3.2 Surface Water Drainage Basins

A description of major drainage basins crossed and the surface water quality characteristics of the waterbodies within the basins are presented below based on USGS (2001).

The Project crosses seven major hydrologic basins in Alaska: The East Arctic, Prudhoe Bay, Colville River, Chandalar-Christian Rivers, Koyukuk River, Upper Yukon River, and Tanana River basins. These 7 basins are in turn comprised of 19 sub-basins. Sub-basins located within the East Arctic, Prudhoe Bay, and Colville River basins drain into the Beaufort Sea, and sub-basins located within the Chandalar-Christian Rivers, Koyukuk River, Upper Yukon River, and Tanana River basins drain into the Bering Sea. Figure 2.3.2-1 depicts regional drainage basins and sub-basins crossed by the Project. Table 2.3.2-1 lists the regional basins, sub-basins, the approximate MPs of each sub-basin boundary crossing, and the number of waterbody crossings grouped according to sub-basin. Because the relatively linear APP centerline can cross the uneven meandering boundaries between sub-basins multiple times, the MPs do not always appear in sequential order when grouped by sub-basin.

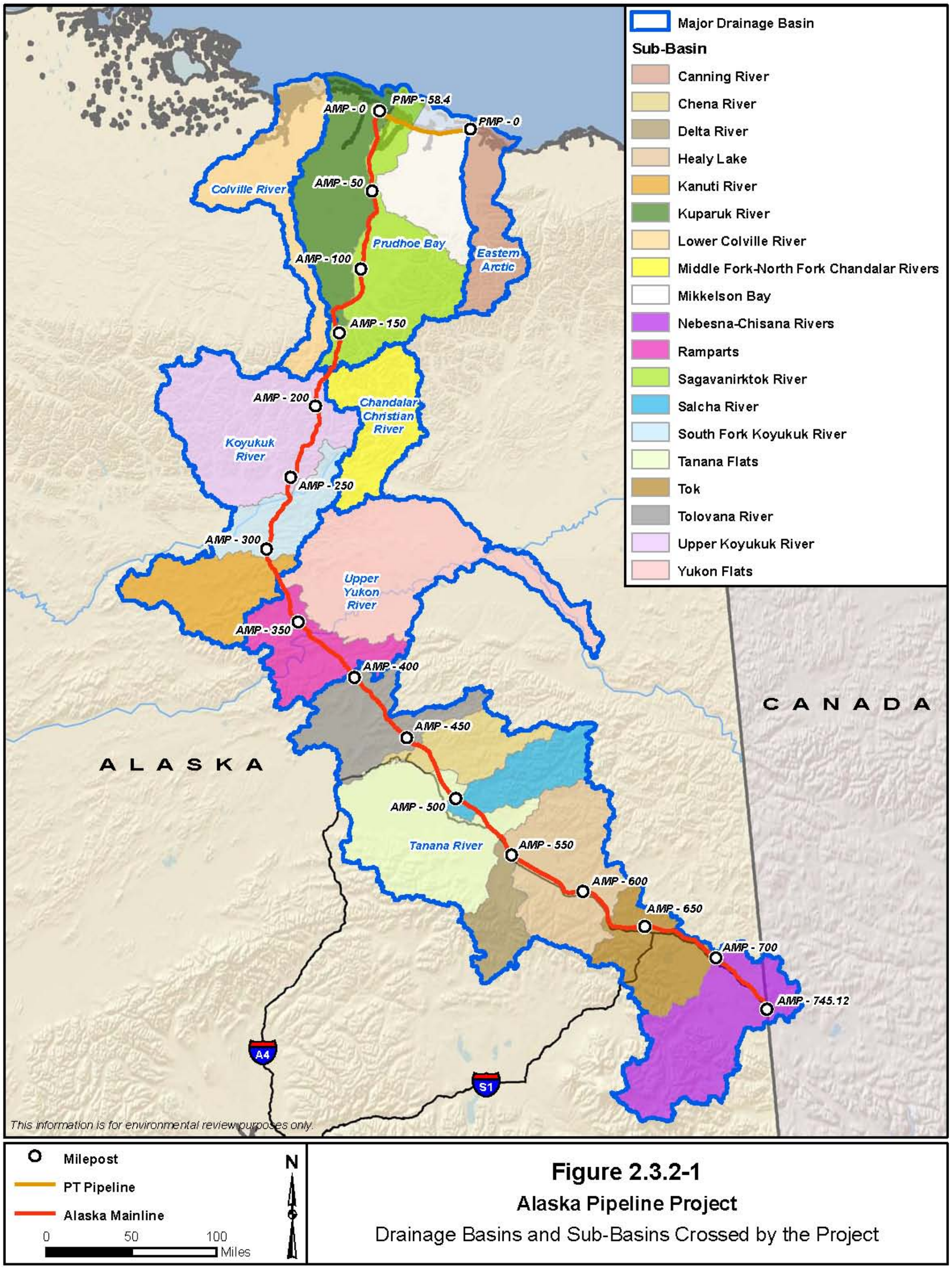

Figure 2.3.2-1
Alaska Pipeline Project
Drainage Basins and Sub-Basins Crossed by the Project

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TABLE 2.3.2-1

Alaska Pipeline Project
Drainage Basins and Sub-Basins Crossed by the Project

Hydrologic Basin/Sub-Basin [a]	Hydrologic Unit Code	Approximate Begin Milepost	Approximate End Milepost	Crossing Length (miles)	Number of Waterbody Crossings	Sub-Basin Drainage Area (square miles)
POINT THOMSON GAS TRANSMISSION PIPELINE						
Eastern Arctic Basin	190605					
Canning River Sub-Basin	19060501	PMP 0.0	PMP 1.1	1.1	1	2,757
Prudhoe Bay Basin	190604					
Mikkelson Bay Sub-Basin	19060403	PMP 1.1	PMP 35.3	34.2	74	3,115
Sagavanirktok River Sub-Basin	19060402	PMP 35.3	PMP 51.7	16.5	38	5,512
Kuparuk River Sub-Basin	19060401	PMP 51.7	PMP 58.4	6.7	8	4,672
Point Thomson Gas Transmission Pipeline Subtotal				58.4	121	
GAS TREATMENT PLANT						
Prudhoe Bay Basin	190604					
Kuparuk River Sub-Basin	19060401	AMP 0.0	AMP 0.0	n/a	0	4,672
ALASKA MAINLINE						
Prudhoe Bay Basin	190604					
Kuparuk River Sub-Basin	19060401	AMP 0.0	AMP 15.8	15.8	15	4,672
		AMP 53.6	AMP 54.5	0.9		
		AMP 55.3	AMP 55.4	0.1		
		AMP 55.6	AMP 56.1	0.5		
		AMP 64.3	AMP 65.0	0.7		
		AMP 65.2	AMP 69.9	4.7		
		AMP 125.0	AMP 126.5	1.5		
		AMP 127.8	AMP 140.3	12.5		
Sagavanirktok River Sub-Basin	19060402	AMP 15.8	AMP 53.6	37.8	66	5,512
		AMP 54.5	AMP 55.3	0.8		
		AMP 55.4	AMP 55.6	0.2		
		AMP 56.1	AMP 64.3	8.2		
		AMP 65.0	AMP 65.2	0.2		
		AMP 69.9	AMP 70.4	0.5		
		AMP 70.4	AMP 125.0	54.6		
		AMP 126.5	AMP 127.8	1.3		
		AMP 141.3	AMP 172.7	31.4		
Colville River Basin	190603					
Lower Colville River Sub-Basin	19060304	AMP 140.3	AMP 141.3	1.0	1	4,323
Chandalar-Christian Rivers Basin	190403					
Middle Fork-North Fork Chandalar Rivers Sub-Basin	19040301	AMP 172.7	AMP 180.3	7.6	8	3,457
Koyukuk River Basin	190406					
Upper Koyukuk River Sub-Basin	19040601	AMP 180	3AMP 260.9	80.6	66	6,929
South Fork Koyukuk River Sub-Basin	19040602	AMP 260.9	AMP 306.3	45.4	25	2,308
Kanuti River Sub-Basin	19040604	AMP 306.3	AMP 318.2	11.9	6	3,354
Upper Yukon River Basin	190404					
Yukon Flats Sub-Basin	19040403	AMP 318.2	AMP 327.7	9.5	9	7,688

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TABLE 2.3.2-1

Alaska Pipeline Project
Drainage Basins and Sub-Basins Crossed by the Project

Hydrologic Basin/Sub-Basin [a]	Hydrologic Unit Code	Approximate Begin Milepost	Approximate End Milepost	Crossing Length (miles)	Number of Waterbody Crossings	Sub-Basin Drainage Area (square miles)
Ramparts Sub-Basin	19040404	AMP 327.7	AMP 397.6	69.9	32	3,114
Tanana River Basin	190405					
Tolovana River Sub-Basin	19040509	AMP 397.6	AMP 458.9	61.3	28	3,446
Chena River Sub-Basin	19040506	AMP 458.9	AMP 478.5	19.6	10	2,067
Tanana Flats Sub-Basin	19040507	AMP 478.5	AMP 500.5	22.0	17	6,119
		AMP 518.1	AMP 536.5	18.4		
		AMP 536.6	AMP 536.7	0.1		
Salcha River Sub-Basin	19040505	AMP 500.5	AMP 518.1	17.6	19	2,217
Healy Lake Sub-Basin	19040503	AMP 536.5	AMP 536.6	0.1	29	4,988
		AMP 536.7	AMP 546.0	9.3		
		AMP 552.5	AMP 621.8	69.3		
Delta River Sub-Basin	19040504	AMP 546.0	AMP 552.5	6.5		1,704
Tok Sub-Basin	19040502	AMP 621.8	AMP 699.1	77.3	34	3,070
Nebesna-Chisana Rivers Sub-Basin	19040501	AMP 699.1	AMP 745.1	46.0	18	5,411
Alaska Mainline Subtotal				745.1	383	
PROJECT TOTAL				803.5	504	

[a] The USGS has established a system that divides and subdivides surface water drainage areas in the United States into hydrologic units. Each hydrologic unit is identified by a unique hydrologic unit code consisting of 2 to 12 digits based on the six levels of classification in the hydrologic unit system (region, sub-region, basin, sub-basin, watershed, and sub-watershed).

2.3.2.1 East Arctic, Prudhoe Bay, and Colville River Basins

The East Arctic, Prudhoe Bay, and Colville River Basins drain the area north of the Brooks Range, and include the Arctic Coastal Plain, Arctic Foothills, and the Brooks Range physiographic regions. The area encompassed by these basins consists of tundra and is nearly level, poorly drained, and rises to the south with an average gradient of about 10 feet per mile. South of the coastal plain, the Arctic Foothills Region is a treeless area with broad uplands and east-west trending ridges. Within the central North Slope in the area of the pipeline route, most streams flow in a northerly direction in relatively narrow valleys with few tributaries and little runoff due to very low precipitation. These tributaries discharge into the Sagavanirktok and the Kuparuk rivers, the principal river watersheds within this drainage basin. The Sagavanirktok River encompasses a watershed of approximately 5,512 square miles, has a main river length of 166 miles, and an estimated average annual flow of 2,770 cubic feet per second (cfs). The major tributary to the Sagavanirktok River along the pipeline corridor is the Atigun River, which has its headwaters in the Brooks Range near the Continental Divide. The Kuparuk River covers a drainage basin of 4,672 square miles, has a main river length of 183 miles, and an estimated average annual flow of 1,830 cfs. The Kuparuk River and its principal tributary along the pipeline corridor, the Toolik River, originate in the rolling northern foothills of the Brooks Range. The Toolik River has a drainage area of 1,181 square miles, a main-stem length of 101 miles, and an estimated average annual flow of 590 cfs. The Putiligayuk River is a short stream system less than 30 miles in length discharging directly into the Beaufort Sea west of the Sagavanirktok River.

The extreme Arctic climate, characterized by below-freezing temperatures throughout most of the year and continuous permafrost, leads to wide fluctuations in stream flow. There is little or no groundwater storage to reduce these fluctuations because unfrozen subsurface material occurs only locally near larger lakes and river channels. There is essentially no snowmelt or rain during the long Arctic winter. The Arctic summer is short and has long periods of daylight and above-freezing temperatures. A unique characteristic of spring snowmelt, or breakup, in this region is the accumulation of extensive areas of standing water and rapid runoff that can occur over a period of a few days due to the limited infiltration of water into the frozen tundra soils. At this time of the year, stream and river main channels are commonly filled with snow and ice, which can reduce the ability of the channel to contain peak flows. Mean annual runoff in this region is lowest near the Beaufort Sea coast, and increases somewhat in the foothills and Brooks Range to the south. The annual runoff peak generally occurs as a result of snowmelt runoff between late May and early June; however, late summer and fall rains in August can also produce substantial runoff events.

The concentration of total suspended solids in streams and rivers typically increases from headwaters to mouth. There is minimal glacial input to the tributaries of the major river watersheds in this basin, and consequently the stream water has high clarity in the Sagavanirktok and Kuparuk rivers. Representative surface water temperatures for the Sagavanirktok and Kuparuk rivers between early June and early September range from a low of 36 to 38ºF to a high of 60 to 62ºF.

On the flatter terrain of the North Slope much of the stream sediment originates from streambed, bank, and gully erosion of unconsolidated deposits. Tundra vegetation and permafrost in these areas inhibit erosion except near streambanks where water thaws the banks and removes material from beneath the vegetative cover. Coastal plain streams with headwaters in the Brooks Range (i.e., Atigun and Sagavanirktok rivers) contain coarser streambed sediments consisting of large gravel, cobbles, and boulders. Smaller tributary streams in the foothills and tundra generally contain sediments comprised of finer gravel, sand, and organic materials. In this region essentially all sediment transport in streams and rivers occurs between May and October. Peak sediment concentrations and discharges generally occur during spring break up, when the majority of the annual sediment discharge probably occurs.

2.3.2.2 Koyukuk River and Chandalar-Christian Rivers Basin

The Koyukuk River and Chandalar-Christian Rivers basins include the watersheds of the Dietrich River, Middle Fork Koyukuk River, South Fork Koyukuk River, Jim River, Prospect Creek, and Kanuti River. The Koyukuk River encompasses a drainage area of 32,600 square miles and a main river length of 554 miles before discharging into the Yukon River. The annual precipitation in this region ranges from 10 to 17 inches in the lowlands to more than 20 inches in the uplands. Permafrost occurs throughout the area except under the thawed zone of major rivers and streams. Surface water quality is excellent and the sediment load transported by streams and rivers is low. Peak runoff is the result of spring snowmelt and precipitation during the summer. The mean monthly runoff rate for the month with the lowest runoff of the year in the northern portion of this basin is slightly more than 0.1 cfs per square mile.

Concentrations of dissolved solids in surface waters range from less than 50 mg/L to nearly 200 mg/L, with major rivers such as the Koyukuk having the highest dissolved solids content. Glacial input to stream flows is minimal; therefore, water clarity during periods of non-peak flows is very clear. Springs are known to exist in the floodplain of large rivers such as the upper

Dietrich River, and in a number of clear-water tributaries. Intergravel flows, springs, and groundwater discharge throughout the winter provide suitable habitat for overwintering fish and incubating eggs in the stream gravel.

Streams within the Koyukuk Basin commonly carry minimal settleable (non-colloidal) solids. Non-glacier-fed tributaries have beds composed of sand, gravel, and cobbles; the coarser material is found in the upper reaches of streams within the basin, and the finer material in the lower reaches of the larger rivers and streams. Bed material is gradually sorted and rounded progressively downstream, and consists of gravel and cobbles in the main channel and gravel and sand on the bars. More than 95 percent of the suspended sediment load is discharged during the months of May through September; the rivers in this region are virtually inactive during the other seven months, October through April. Although some degree of seasonality is typical of most large rivers, this phenomenon is especially pronounced in Arctic and sub-Arctic rivers.

2.3.2.3 Upper Yukon River Basin

The Upper Yukon River Basin is crossed by the pipeline corridor in two areas: The West Fork of the North Fork Chandalar River on the immediate south side of Atigun Pass, and the area between Olsen Lake Creek and Erickson Creek including the drainages of the West Branch of the Dall River, the main-stem of the Yukon River, and the Hess Creek watershed. The West Fork of the North Fork Chandalar River watershed is crossed near its headwaters in the mountains of the Brooks Range as the stream flows east to the main-stem of the Chandalar River. This portion of the Upper Yukon Basin is situated between the East Arctic Basin and the Koyukuk Basin. The majority of the Upper Yukon Basin watershed encountered along the pipeline corridor occurs in more gently rolling topography on the north and south sides of the main-stem Yukon River crossing. The Upper Yukon Basin is rimmed by mountainous terrain from the confluence with the Tanana River upstream to the U.S.-Canada Border. The predominant physiographic feature of this region is the marshy, lake-dotted Yukon Flats. Tributaries originating in the surrounding uplands tend to have meandering reaches as they approach their Yukon River confluences. Discontinuous permafrost is present in this region, and thaw lakes are locally common in marginal terraces.

Mean annual runoff throughout much of this basin is very low, less than 0.5 cfs per square mile in the lowland areas. Along the northern periphery of the Upper Yukon Basin the runoff increases to nearly 2 cfs per square mile. Three basic patterns of runoff are exhibited in the Yukon River Basin: snowmelt runoff, rainfall runoff, and glacier meltwater runoff. From October through late April runoff is minimal and streamflow gradually decreases as the temperatures drop substantially below freezing. In most years, the greatest volume of runoff occurs between breakup in May and September. Generally, snowmelt occurs in the spring and river levels rise. River levels generally decrease after snowmelt and then rise again in response to glacier melt (where glaciers are present in the basin) and rainfall. Where glaciers are present in the basin, the rise will generally be prolonged. Where the rise is the result of rainfall, it may be prolonged or short, depending upon the storm pattern.

The dissolved solids content of streams in this region averages less than 200 mg/L. Smaller streams with meandering courses, lower gradients, and tributaries that drain wetland areas and organic soils contribute tea-colored water to some of the watersheds. The Yukon River main-stem is a very large, turbid river whose water quality varies temporally between summer and winter with the highest flows and highest turbidity from suspended sediment occuring during the summer. The observed range of water temperature is this region ranges from 32ºF to 52ºF.

At its mouth the Yukon River transports about 60 million tons of suspended sediment annually into the Bering Sea. Most of the measured suspended sediment concentrations for the main-stem of the Yukon River in the vicinity of the pipeline crossing are less than 1,000 mg/L. Virtually all sediment particles carried in suspension in the Yukon River are finer than 0.5 millimeter (mm) (0.02 inch). Streams that are tributary to the Yukon River in this portion of the basin commonly carry less than 100 mg/L of suspended sediment. Upper Yukon River watershed streams near the more mountainous borders of the basin may carry sediment loads of up to 500 mg/L.

2.3.2.4 Tanana River Basin

The Tanana River Basin covers the largest drainage area traversed by the pipeline corridor in Alaska. Over a length of approximately 347 miles, the pipeline both parallels and crosses major sub-basins (refer to Table 2.3.2-1). From the Tolovana River south to the Shaw Creek, surface waters encountered vary from clear to stained (tea-colored by tannins) with no glacial input to any of these watersheds. From the first (western) crossing of the Tanana River (AMP 538.1) near Big Delta to the U.S.-Canada Border, the influence of glacial runoff from the mountainous areas of the north side of the Alaska Range is readily apparent. In this region the Tanana River is a large, glacial stream with a high-suspended sediment load. Summer flow variability is related to precipitation and the effects of summer temperature on glacier melt. Nearly all of the south-side tributaries to the Tanana River originate in areas of high elevation, numerous glaciers, and relatively high precipitation. Glacial tributary streams and rivers are generally swift and steep, carrying large amounts of suspended sediment during the spring and summer. The channels of these tributaries are generally braided (wide unvegetated floodplain with multiple channels) in the lower reaches and formed in extensive gravel and cobble deposits. The Tanana River begins at the confluence of the Chisana and Nabesna rivers near the Village of Northway, flowing generally northwest for 531 miles where it discharges into the Yukon River. The Tanana River Basin drains 44,000 square miles. From its headwaters east to Big Delta (about 230 river miles), the Tanana River flows through a broad valley 10 to 15 miles in width. Downstream from Big Delta, this broad valley widens to 50 to 60 miles. In the non-glacial tributary portion of this basin, the major watersheds include Tolovana River, Tatalina River, Chatanika River, Chena River, Salcha River, and Shaw Creek. Along the glacial tributary section of the Tanana River Basin, the principal tributary watersheds include the Gerstle River, Johnson River, Robertson River, Tok River, and upper Tanana River.

Mean annual precipitation in the Tanana River Basin is about 12 to 13 inches a year. Permafrost is discontinuous, and extensive thaw areas are present near streams and rivers and the adjacent lowlands. Average annual runoff varies widely from year to year. Mean annual peak runoff ranges from about 10 cfs per square mile in the lowlands, to as high as 50 cfs per square mile for steep basins in the headwaters of the Alaska Range. In the Tanana River Basin, annual peak flows typically occur in summer in response to rainfall, but will occasionally occur in the spring as a result of snowmelt. Frequent channel icing and ice-jam flooding in May contribute to a high susceptibility to floods along the tributaries and main-stem of the Tanana River.

The mean monthly runoff rate for the month with the lowest runoff occurs in late winter or early spring and averages 0.1 to 0.2 cfs per square mile. Most streams in small tributary watersheds freeze completely during most winters, leaving water under large, ice covered rivers as the only substantial source of streamflow. Water storage is seasonal and limited. The snowpack retains most precipitation during the winter, and glaciers provide some year-to-year storage that helps sustain streamflow during dry years. Alluvial aquifers under the thawed beds of the larger rivers in the basin provide substantial water storage to maintain streamflow.

Within the Tanana River Basin, surface waters generally contain between 60 and 500 mg/L of dissolved solids, with most surface waters having less than 200 mg/L. Dissolved solids concentrations appear to be highest from streams draining the Alaska Range. Surface water temperatures generally range from a summer high of 66ºF to 32ºF.

The Tanana River receives its principal flows and largest sediment loads from the streams and rivers draining the glaciers of the Alaska Range. Streams derived from glacial meltwater characteristically contain higher fractions and heavier loads of silt particles that are produced from glacial processes that mechanically grind rock fragments into rock flour of that size fraction. Non-glacial stream tributaries to the Tanana River Basin north of Big Delta generally carry less than 100 mg/L of suspended sediment load; smaller streams that originate at lower elevations closer to the Tanana carry only 5 to 50 mg/L of suspended sediment since they derive most of their sediment load from bank and bed erosion.

2.3.3 Rivers and Harbors Act, Section 10 Waterbodies

In the Project area, five waterbodies are COE Rivers and Harbors Act, Section 10 designated waters (Table 2.3.3-1).

TABLE 2.3.3-1

Alaska Pipeline Project
Section 10 Waterbodies

Waterbody	Approx. Milepost	State/Federal Designation/Sensitivity
Beaufort Sea	West Dock/Dredging and Disposal Areas	River and Harbors Act, Section 10
Yukon River	AMP 360.1	River and Harbors Act, Section 10
Tolovana River	AMP 405.7	River and Harbors Act, Section 10
Chena River	AMP 474.8	River and Harbors Act, Section 10
Tanana River #1	AMP 538.1	River and Harbors Act, Section 10
Tanana River #2	AMP 666.1	River and Harbors Act, Section 10

2.3.4 Potentially Sensitive or Specially Designated Waterbodies

FERC’s Guidance Manual for Environmental Report Preparation (Section 2.2.5) identifies a number of types of waters that FERC considers potentially sensitive. [Note: APP is consulting with federal and state agencies regarding protected surface waters. Upon completion of these consultations, this section will be modified to reflect the information obtained from agencies. This information will be updated in the final report.]

2.3.4.1 Waters that Do Not Meet the Water Quality Standards

Within the Project area, no waterbodies are designated as having a Clean Water Act Section 303(d) impaired water quality (ADEC 2010b). [Note: APP is consulting with federal and state agencies regarding contaminated surface waters and sediments. This section will be modified to reflect the information obtained from agencies, and updated in the final report.]

2.3.4.2 Federal/State Endangered, State-Listed, or Special Concern Species

Waterbodies that are within the Project area and contain threatened or endangered species or designated Essential Fish Habitat are addressed in Section 3.2 of Resource Report 3. No waterbodies crossed by the Project have been determined to support federally endangered, state-listed, or special concern fish and mussel species. On U.S. Bureau of Land Management (BLM)-managed lands, the BLM has established procedures for the management of sensitive species and associated habitat (refer to Section 3.2 of Resource Report 3). Waterbodies classified by the BLM as having sensitive or critical habitat are identified in Section 3.2 of Resource Report 3.

2.3.4.3 Public Watershed Areas

[Note: APP is consulting with federal and state agencies regarding public watershed areas; this section will be updated in the final report.]

2.3.4.4 Wild and Scenic Rivers

Federal Wild and Scenic Rivers

The Wild and Scenic Rivers Act protects and manages the waters of many of the nation's most spectacular rivers and their associated natural, cultural, and recreational resources for present and future generations. None of the federally-designated Wild and Scenic Rivers in Alaska are crossed by the Project.

Alaska Wild and Scenic Rivers

None of the state-designated Wild and Scenic Rivers in Alaska are crossed by the Project.

[Note: APP is consulting with state agencies regarding state-designated wild and scenic rivers. This section will either be updated or omitted, as applicable, based on the information obtained from agencies in the final report.]

2.3.4.5 Nationwide Rivers Inventory

The Nationwide Rivers Inventory is a listing of more than 3,400 free-flowing river segments in the United States that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. There are 188 Nationwide Rivers Inventory river segments designated in Alaska, none are crossed by the Project.

2.3.4.6 Public Drinking Water Protection Areas

Information about public surface water supplies and intake locations was obtained from the state resource and regulatory agencies and the EPA [Note: APP is consulting with federal and state agencies regarding public water supplies. This section will be modified to reflect the information obtained from agencies, and updated in the final report.] In response to the 1996 Amendment to the Safe Drinking Water Act, ADEC's Drinking Water Program developed a dataset of public drinking water protection areas (ADEC 2010a).

TABLE 2.3.4-1

Alaska Pipeline Project
Public Drinking Water Protection Areas Crossed by the Project

Drinking Water Protection Area	Nearest Milepost	Drinking Water Source	Waterbody Crossed
POINT THOMSON GAS TRANSMISSION PIPELINE			
BP Exploration Well	Within one mile of PMP 21.7	Surface	Unknown
BP Exploration Well	Within 0.5 mile of PMP 48.6	Surface	Unknown
ALASKA MAINLINE			
BP Exploration Community Water Treatment Facility	Within 0.5 mile of AMP 5	Surface	Unknown
North Slope Borough SA10	Crosses watershed between AMP 15 and AMP 28	Surface	Unnamed Trib. to Sagavanirktok River
University of Alaska Fairbanks, Institute of Arctic Biology, Toolik Field Station	Crosses watershed between AMP 136 and AMP 142	Surface	Yan Creek, Moss Creek, Terry Creek, Mack Creek, Ed Creek
Slate Creek Inn	Crosses watershed between AMP 245 and AMP 246	Surface-influenced groundwater	Unknown

2.3.5 Construction and Operation Impacts and Mitigation

Potential direct construction impacts to surface water or surface water use could result from various Project construction activities such as constructing across waterbodies, blasting, and appropriating and discharging water for hydrostatic testing. Clearing, grading, and trenching could result in indirect impacts on surface water quality (e.g., clarity, turbidity). Operations will also require the appropriation of water. For discussion of impacts to fish and wildlife and their habitat refer to Resource Report 3.

These activities are not expected to have a substantial impact on surface water resources due to the typically short-term nature of the construction activities, the limited extent of the work area (for example, cut and fill locations), the appropriate and timely implementation of reclamation measures as outlined in APP's Plan and Procedures, implementation of the ADEC Construction General Permit (construction stormwater), and the management of spill response as outlined in APP's SPCC Plan (refer to Appendix 2A for an outline of the SPCC Plan). [Note: APP is developing its SPCC Plan. An updated SPCC Plan will be provided in the final report.]

2.3.5.1 Pipeline Facilities

Waterbody Crossing Methods

APP will implement its Procedures (refer to Appendix 1K of Resource Report 1) to construct waterbody crossings. APP may use any of the following stream crossing techniques as appropriate:

- Open-cut;
- Isolated crossing methods (i.e., flume, dam and pump, channel diversion);
- Horizontal directional drill (HDD); and
- Aerial-span.

A description of these crossing techniques is presented in Section 1.6.3.2 of Resource Report 1 and Appendix 1K of Resource Report 1. The proposed crossing method for each waterbody is provided in Appendix 2B. A description of major waterbody crossings is provided below.

Major Waterbody Crossings

Waterbodies are defined as major waterbodies when they are over 100 feet in width (water's edge to water's edge at the time of crossing, or cumulative water's edge to water's edge for braided channels) at the proposed crossing location. APP has identified 16 waterbodies that are greater than 100 feet wide at the crossing location (Table 2.3.5-1). [Note: The major waterbody crossings list will be updated in the final report with major lakes and ponds affected by the Project].

TABLE 2.3.5-1

Alaska Pipeline Project
Major Waterbodies Crossed by the Project

Segment/Waterbody Name	Approx. Milepost	Crossing Width (feet) [a]	Preliminary Anticipated Crossing Method [b]	Site-Specific Plan No.	Construction Window [c]
POINT THOMSON GAS TRANSMISSION PIPELINE					
Kadleroshilik River	PMP 33.5	230	OC	TBD	Winter
Sagavanirktok River – Main Channel	PMP 41.8	1,345	OC	TBD	Winter
Sagavanirktok River – West Channel	PMP 49.5	3,500	OC	TBD	Winter
ALASKA MAINLINE					
Dietrich River	AMP 211.6	105	OC	TBD	Summer
Middle Fork Koyukuk River #2	AMP 228.3	192	OC	TBD	Summer
Hammond River	AMP 228.7	143	OC	TBD	Summer
Middle Fork Koyukuk River #3	AMP 230.8	90	OC	TBD [d]	Summer
Yukon River	AMP 360.1	1,700	AERIAL/HDD	TBD	Winter/Summer
Chena River	AMP 474.8	150	HDD/OC	TBD	Winter
Salcha River	AMP 502.0	160	HDD/OC	TBD	Winter
Tanana River #1	AMP 538.1	700	HDD/AERIAL [e]	TBD	Winter/Summer
Gerstle River	AMP 576.0	450	OC	TBD	Summer
Johnson River	AMP 588.3	350	OC	TBD	Summer
Robertson River	AMP 621.4	650	OC	TBD	Summer
Tok River	AMP 660.0	120	OC	TBD	Winter
Tanana River #2	AMP 666.1	700	HDD/OC [e]	TBD [d]	Winter/Summer

[a] Crossing widths are estimated from aerial photographs, and are based on water's edge to water's edge or cumulative edge to edge for braided channels at the time when the aerial photographs were taken.
[b] Subject to change pending further engineering design and agency consultations.
OC - Open-cut conventional method, HDD – Horizontal directional drill, AERIAL – Aerial crossing.
[c] Planned summer or winter crossing. [Note: This construction schedule is preliminary and subject to change. Schedule information will be updated in the final report.]
[d] Two example plans provided in Appendix 2C. Remaining plans to be developed (see discussion in this section).
[e] Primary method is listed first followed by the secondary method of crossing.

Figure 2.3.4-1 depicts major waterbody crossings along the project corridor.

APP has prepared two conceptual crossing design drawings (refer to Appendix 2C) to illustrate the type and layout of information that may be included in the site-specific crossing plans to be filed with FERC. [Note: Draft site-specific construction plans will be provided in the final report and will be updated prior to construction. The crossing methods shown in the table are preliminary and are subject to further review.] The site-specific construction plans will address all of the factors in Section 2.2 of FERC's Guidance Manual for Environmental Report Preparation.

APP has prepared a Preliminary Inadvertent Release of Drilling Mud Plan (refer to Appendix 2D) for all HDD waterbody crossings. It establishes a 24-hour a day monitoring program for monitoring and detection. Additionally, this plan presents a contingency plan that describes monitoring and mitigation procedures for any inadvertent release of drilling mud into the waterbody or areas adjacent to the waterbody, including procedures to contain inadvertent releases. [Note: APP will provide an updated Preliminary Inadvertent Release of Drilling Mud Plan prior to construction.]

Additional Temporary Work Space within 50 feet of Waterbodies

ATWS is typically required on both sides of waterbodies to stage construction equipment and materials, and to fabricate the crossing section (refer to Table 1.4.3-2, Appendix 1F of Resource Report 1 and the alignment sheets in Appendix 1O). Wherever practicable, the ATWS typically will be located at least 50 feet from the water's edge. [Note: APP will identify a list of crossings by MP where topographic or other site-specific factors may preclude the standard 50-foot setback between the ATWS and the edges of waterbodies prior to construction.]

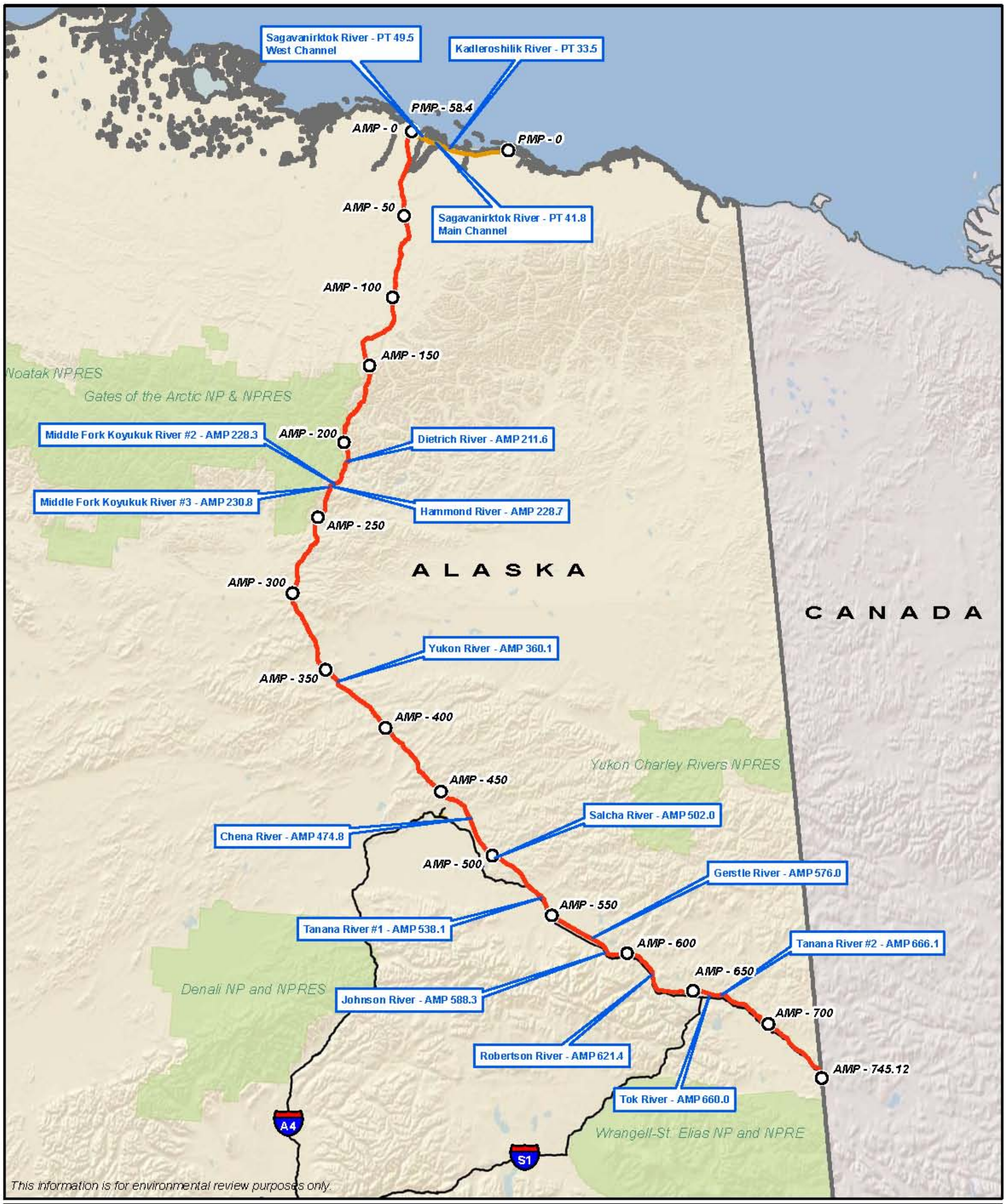

Figure 2.3.4-1
Alaska Pipeline Project
Major Waterbody Crossings

DRAFT

Construction Impacts and Mitigations

Winter Construction

Surface water quality impacts resulting from pipeline construction in winter will be short-term and minor for winter waterbody crossings. APP anticipates that two conditions will be encountered within the waterbody crossings constructed in winter: 1) waterbodies that have no flowing surface water, with or without groundwater within the excavation limits; 2) waterbodies that have surface water flow under the snow/ice cover. Each condition and the anticipated impacts are described below.

During winter construction, most waterbody crossings will not have any flowing water. Excavation through waterbodies that have no surface water or groundwater flow or no surface water flow but some groundwater flow will be accomplished with a trenching machine or conventional backhoe using upland construction techniques. Because construction equipment will generally be working off frozen ground or on the ice across the waterbody and not working "in-stream," the area of streambed disturbance during excavation and backfill will be minor. As there is no surface flow, sediment will not be transported downstream during construction at the crossing. Material excavated from the waterbody bed during construction will, in the vast majority of cases, be backfilled into the trench after pipeline installation. During the spring breakup following construction of the crossing, sediment movement and turbidity levels in the channel on the downstream side of the pipeline crossing are anticipated to be similar to upstream, natural spring breakup conditions due to the naturally higher turbidity levels during spring breakup.

As preliminarily identified in Appendix 2B, some waterbody crossings in winter may have surface water flow under a snow/ice cover. Where the flow is very low, and the watercourse is identified as not having any over-wintering fish or fish habitat, the open cut method with conventional backhoes will be employed. In the case of substantial surface flows (that exceed the practical limits of isolated methods), a wet crossing constructed by backhoes and/or draglines or a trenchless crossing technique will be used. In both the open cut crossing cases, a wet ditch may be present during the installation, with water flowing into and out of the excavation. This may result in temporary impacts to limited sections of the waterbody downstream of the crossing locations. Impacts could result in locally increased turbidity levels and sediment deposition into pools and other low flow areas. The downstream length of impact will depend on the coarseness of the excavated and backfill materials and the water velocity. Where the winter flow is sufficiently low, isolated installation methods (dam and pump, dam and flume) may be used. An isolated crossing method will keep the sediment generated during excavation and backfilling confined to the zone between the isolation dams. Turbid water will be pumped to a suitable area away from the waterbody and only clear water will be discharged back into the waterbody. Minimal downstream impacts may occur from sediment that is generated during the installation and removal of the dams. Material excavated from the waterbody bed during construction will, in the vast majority of cases, be backfilled into the trench after pipeline installation.

Streambed scour during spring flows is natural in all streams. There may be slightly higher sediment levels discharged during the first spring runoff after construction deposited within areas of normal deposition (i.e., deltas and side channels) for that waterbody. Thus, it is anticipated that the mainstream channel at the pipeline crossing will be quickly cleared of disturbed sediments following construction.

To reduce overland soil erosion and sediment discharge during and following winter construction, APP will adhere to appropriate sections of the APP Plan. Appropriate erosion control devices will be installed prior to spring thaw. Temporary extra workspace may not be required at some minor waterbody crossings constructed during the winter where typical overland construction across the frozen waterbody without the need for tie-ins can be done. [Note: Where tie-ins at specific waterbodies are required due to steep banks or flowing conditions, the need for extra workspace will be determined and submitted to the FERC prior to construction.]

Summer Construction

For streams crossed during unfrozen, summer conditions, APP will comply with timing requirements in the permits. APP will also implement the erosion control methods and bank stabilization revegetation measures outlined in the APP Plan and Procedures to reduce short- and long-term impact on the waterbodies crossed by the pipeline route. Similar to winter construction, isolated crossing methods will be used where conditions allow.

APP will adhere to the SPCC Plan (refer to Appendix 2A) during construction to reduce the potential for a release of liquid fuels, lubricants, hydraulic fluids, etc. that could impact surface waters.

A site-specific plan will be prepared for each proposed HDD waterbody crossing that accounts for the physical conditions at each site, including substrate composition and variability, and any terrain or lithological constraints that may affect drill success. APP will monitor for loss of drilling fluids during construction. Additionally, in the event of any inadvertent release of drilling mud into the waterbody or adjoining areas, APP will implement mitigation procedures as outlined in the Preliminary Inadvertent Release of Drilling Mud Plan (refer to Appendix 2D), to be prepared prior to construction. An outline of APP's Preliminary Inadvertent Release of Drilling Mud Plan is included in Appendix 2D.

Hydrostatic Test Water

Construction of the APP entails use of water for hydrostatic testing. The ADNR regulates use of Alaska water resources and issues permits for temporary and long-term appropriation of water. Withdrawals are acceptable if all water withdrawals cumulatively do not reduce the in-stream flows below the level necessary to support anadromous and resident fish. Most water withdrawals will require a Fish Habitat Permit from Alaska Department of Fish and Game and a Water Use Permit from the ADNR Division of Mining, Land and Water. Additional permits, authorizations, or reviews will be needed from EPA or ADEC if the water is being discharged into a waterbody after use. Water use at facilities in support of construction is more fully described in Section 1.6.4 of Resource Report 1.

APP intends to use hydrotesting as a basis to verify pipeline and various GTP plant piping integrity. As discussed with FERC, APP is currently identifying hydrotest water sources, water withdrawal rates, and potential discharge locations and methods. Table 2.3.5-1 lists anticipated primary water sources. [Note: APP will update water source information and include in the final report.]

TABLE 2.3.5-2

Alaska Pipeline Project
Currently Proposed Hydrostatic Test Water Volumes and Sources

Test Section	Begin Milepost	End Milepost	Volume of Water (approx. gallons)	Potential Sources [a]
POINT THOMSON GAS TRANSMISSION PIPELINE				
	PMP 0.0	PMP 58.4	1,160,000	TBD
Meter Station		PMP 0.0	58,000	TBD
PT Pipeline Subtotal			1,218,000	
GAS TREATMENT PLANT				
Associated pipelines		n/a	TBD	TBD
Prudhoe Bay Meter Station		AMP 0.0	TBD	TBD
Gas Treatment Plant Subtotal			TBD	
ALASKA MAINLINE				
	AMP 0.0	AMP 55.0		
	AMP 55.0	AMP 110.0	2,420,000	TBD
	AMP 110.0	AMP 164.5		
	AMP 164.5	AMP 180.0	2,780,000	TBD
	AMP 180.0	AMP 231.6	5,040,000	TBD
	AMP 231.6	AMP 285.7	2,420,000	TBD
	AMP 285.7	AMP 348.8	5,040,000	TBD
	AMP 348.8[b]	AMP 372.5	0	Adjacent test section
	AMP 372.5	AMP 437.7	4,290,000	TBD
	AMP 437.7	AMP 450.0	1,200,000	TBD
	AMP 450.0[b]	AMP 505.0	0	Adjacent test section
	AMP 505.0	AMP 560.0	2,420,000	TBD
	AMP 560.0	AMP 625.0	5,040,000	TBD
	AMP 625.0	AMP 690.5	5,040,000	TBD
	AMP 690.5	AMP 745.1	2,420,000	TBD
Alaska Mainline Meter Station		AMP 0.0	60,000	TBD
Happy Valley Compressor Station		AMP 79.6	200,000	TBD
Galbraith Lake Compressor Station		AMP 149.9	200,000	TBD
Chapman Creek Comp. Station		AMP 256.0	200,000	TBD
Fort Hamlin Hills Comp. Station		AMP 338.0	200,000	TBD
Tatalina River Comp. Station		AMP 419.1	200,000	TBD
Johnson Road Comp. Station		AMP 494.0	200,000	TBD
George Lake Comp. Station		AMP 579.1	200,000	TBD
Tetlin Junction Comp. Station		AMP 670.2	200,000	TBD
Alaska Mainline Subtotal			39,770,000	
PROJECT TOTAL			40,988,000	

Note: Totals shown in this table may not equal the sum of addends due to rounding.
[a] Pending water body survey study results and development of alternative plan, required.
[b] Test water may be sourced from a previously tested segment of pipeline.

All hydrostatic testing will be conducted in accordance with the APP Wetland and Waterbody Construction and Mitigation Procedures (APP's Procedures) and specifications that comply with U.S. Department of Transportation pipeline safety regulations as stated in 49 C.F.R. Part 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards." APP may use additives for hydrostatic testing during periods of subfreezing temperatures. Water containing additives may either be treated to remove the chemicals prior to discharge or may be disposed of pursuant to regulatory and/or permit requirements.

All intake hoses used for hydrostatic testing will be screened to prevent the entrainment of fish, and the hydrostatic test manifolds will be located outside wetlands and riparian areas to the maximum extent practicable.

Hydrostatic test mitigation measures typically include regulating discharge rate, using energy dissipation device(s), and installing sediment barriers as necessary to minimize erosion, streambed scour, suspension of sediments, and excessive stream flow.

After testing is complete, test water may be discharged on land into a well-vegetated area, or directly back into the waterbody in accordance with applicable federal, state, and local permits and regulations. APP will follow the Procedures to reduce erosion and sediment transport during the discharge of hydrostatic test water. The appropriate erosion control and energy dissipation devices will be used during discharge events.

Operations Impacts and Mitigation

Portions of the pipeline will be operated below 32°F on a year-round average basis. The cold pipe traverses unfrozen ground, the cold pipe may cause a frost bulb to form and grow around the pipe. Unfrozen ground within permafrost, known as a "talik," will be expected to be more prevalent at waterbody crossings that flow year-round. The chilled gas may freeze all or part of the talik depending on the volume and velocity of the water flow above and within the streambed. Natural high spring and summer flows at many waterbodies will reduce the size of the frost bulb as the water within the waterbody bed flows around the frost bulb. The formation of frost bulbs at some waterbody crossings could affect water flow within the streambed, particularly in late winter at low flow streams. Additionally, downstream water temperatures may be slightly lower for very low flow streams as a result of the chilled gas flow and frost bulb. The impacts and potential mitigation associated with the potential formation of frost bulbs on fish habitat are discussed in Section 3.2 of Resource Report 3.

2.3.5.2 Aboveground Facilities

In addition to Pipeline Facilities, Aboveground Facilities may impact waterbodies during construction. To the extent practicable, APP will avoid locating Aboveground Facilities in waterbodies. [Note: APP is refining its facility layouts and will update this information in the final report.]

The GTP will be constructed over approximately 10.0 acres of tundra lakes and 14.8 acres of tundra ponds. Construction will follow the applicable procedures outlined in the APP Procedures in Appendix 1K of Resource Report 1.

Operations Water Use

Operations of the Project will require appropriation of surface waters for personnel use at manned facilities, equipment and facility maintenance, and periodic testing. A water reservoir will be constructed on the Putuligayuk River to provide water year-round for the GTP. Intake hoses will be screened to prevent the entrainment of fish. Section 1.3.3.1 of Resource Report 1 describes the water reservoir, pump facilities, and transfer line that will be constructed to provide water to the GTP. [Note: Additional information on water use associated with Aboveground Facilities will be provided in the final report.]

2.3.5.3 Associated Infrastructure

Associated Infrastructure, such as access roads, may impact waterbodies during construction. To the extent practicable, APP will avoid crossing waterbodies or locating Associated Infrastructure in waterbodies. In the event that waterbody crossings cannot be avoided, APP will implement the APP Procedures. [Note: Waterbodies impacted by Associated Infrastructure have not been identified. This information will be updated in the final report.]

West Dock Facilities

Component modules used to construct the GTP may be transported by cargo transports using ocean tugs and barges. To facilitate barges carrying the module components, a turning basin and navigable channel will be dredged on the east side of West Dock, originating at Dock Head 2, to approximately 14 to 16 feet below mean low water. Modifications will also be required at West Dock to accommodate the offloading of barges and staging of modules. The modification of the existing West Dock facilities may include practical measures for reducing, containing, and cleaning up petroleum spills. Vessels should be operated at sufficiently low speeds to reduce wake energy, and no-wake zones should be designated near sensitive habitats. Section 1.11 of Resource Report 1 summarizes the permits and authorizations that will be required for conducting the dredging and disposal of dredged material.

Access Roads

As described in Section 1.3.3.2 of Resource Report 1, APP will use many of the existing roads to provide access to the construction right-of-way. APP will use these roads on a temporary basis to transport personnel, equipment, vehicles including high clearance vehicles and heavy trucks, and materials to the project work areas. Some of these existing temporary access roads may require improvements outside their current footprints to safely and effectively accommodate project equipment and vehicles.

APP will reduce impacts of associated access road construction and improvements on waterbodies by using its Procedures and, for example, by installing properly sized culverts and bridges, and silt fence, waterbars, straw bales, and/or other barriers to reduce erosion and sediment transport to waterbodies. Prefabricated construction mats may also be used to reduce rutting and/or compaction. Temporary access roads will be reclaimed or abandoned following the completion of construction unless otherwise negotiated with the landowner or land-managing agency. Some additional loss of habitats could result from the placement of gravel for access roads development.

[Note: Waterbodies crossed by access roads use areas have not been identified. This information will be updated in the final report.]

Construction Water Use and Discharge

Water will be needed for a variety of Associated Infrastructure during construction, including water needed at construction camps, development of ice/snow pads and roads, and water for dust suppression and control on the access roads and the construction right-of-way. Section 1.3.3 of Resource Report 1 provides a description of infrastructure development associated with the APP. Table 2.3.5-3 lists the anticipated volumes of water needed for various uses during construction. Potential sources of water for construction activities in the Project area have been identified in Resource Report 1. Appendix 1F presents a preliminary list of all access roads required for the project and indicates their designated purpose. Access roads to be used to provide access to specific waterbodies that are potential water sources are identified in

Appendix 1F by nearest MP, and are illustrated in Appendix 1A. APP will comply with applicable permit requirements for the water withdrawal.

TABLE 2.3.5-3

Alaska Pipeline Project
Anticipated Temporary Water Use for Associated Infrastructure During Construction

Facility	Start MP	End MP	Use (volume in gallons) [a] Camps	Access Rds., Ice/Snow Pads	Dust Control	Potential Sources
POINT THOMSON GAS TRANSMISSION PIPELINE						
Storage Yards						
Point Thomson East	PMP 1.3		288,000	n/a	n/a	TBD
Point Thomson Central 1	PMP 45.0		288,000	n/a	n/a	TBD
Point Thomson Central 2	PMP 45.5		288,000	n/a	n/a	TBD
Pipeline Spread						
	PMP 0.0	PMP 58.4	3,553,000	410,000,000	n/a	TBD
Stations						
PTU Meter Station	PMP 0.0		250,000	n/a	n/a	TBD
PT Pipeline Subtotal			**4,667,000**	**410,000,000**	**0**	
GAS TREATMENT PLANT						
TBD			TBD	TBD	TBD	TBD
Prudhoe Bay Meter	AMP 0.0		TBD	TBD	TBD	TBD
Gas Treatment Plant Subtotal						
ALASKA MAINLINE						
Storage Yards						
Prudhoe Bay Storage	AMP 3.1		360,000	n/a	n/a	TBD
Happy Valley	AMP 88.1		72,000	n/a	n/a	TBD
Galbraith Lake	AMP 144.3		144,000	n/a	n/a	TBD
Atigun River	AMP 169.0		48,000	n/a	n/a	TBD
Chandalar Shelf	AMP 179.9		72,000	n/a	n/a	TBD
Dietrich	AMP 210.2		72,000	n/a	n/a	TBD
Prospect Creek	AMP 281.7		96,000	n/a	n/a	TBD
Dall River	AMP 329.8		72,000	n/a	n/a	TBD
Five Miles	AMP 356.4		72,000	n/a	n/a	TBD
Hess Creek	AMP 387.5		96,000	n/a	n/a	TBD
Tatalina River	AMP 419.4		72,000	n/a	n/a	TBD
Treasure Creek	AMP 448.7		72,000	n/a	n/a	TBD
Fort Wainwright	AMP 470.4		288,000	n/a	n/a	TBD
Salcha River	AMP 503.7		72,000	n/a	n/a	TBD
Quartz Lake	AMP 532.8		72,000	n/a	n/a	TBD
Arrow Creek	AMP 563.8		72,000	n/a	n/a	TBD
Sears Creek	AMP 593.4		72,000	n/a	n/a	TBD
Cathedral Bluffs Alternate	AMP 625.7		72,000	n/a	n/a	TBD
Cathedral Bluffs	AMP 632.0		72,000	n/a	n/a	TBD
Tok River Alternate	AMP 646.3		72,000	n/a	n/a	TBD
Tok River	AMP 662.2		72,000	n/a	n/a	TBD

TABLE 2.3.5-3

Alaska Pipeline Project
Anticipated Temporary Water Use for Associated Infrastructure During Construction

Facility	Start MP	End MP	Use (volume in gallons) [a] Camps	Access Rds., Ice/Snow Pads	Dust Control	Potential Sources
Beaver Creek Camp & Storage Alternate	AMP 701.5		96,000	n/a	n/a	TBD
Northway Junction	AMP 702.8		72,000	n/a	n/a	TBD
Pipeline Spread						
	AMP 0.0	AMP 55.0	5,837,940	515,000,000	n/a	TBD
	AMP 55.0	AMP 110.0	5,033,340	290,000,000	n/a	TBD
	AMP 110.0	AMP 164.5	5,033,340	n/a	n/a	TBD
	AMP 164.5	AMP 180.0	2,866,260	n/a	139,000	TBD
	AMP 180.0	AMP 231.6	4,120,740	n/a	252,000	TBD
	AMP 231.6	AMP 285.7	5,978,640	n/a	n/a	TBD
	AMP 285.7	AMP 348.8	3,497,820	n/a	252,000	TBD
	AMP 348.8	AMP 372.5	2,495,370	n/a	n/a	TBD
	AMP 372.5	AMP 437.7	3,704,580	n/a	214,500	TBD
	AMP 437.7	AMP 450.0	2,495,370	n/a	n/a	TBD
	AMP 450.0	AMP 505.0	4,637,280	n/a	n/a	TBD
	AMP 505.0	AMP 560.0	4,530,420	n/a	n/a	TBD
	AMP 560.0	AMP 625.0	4,394,820	n/a	252,000	TBD
	AMP 625.0	AMP 690.5	4,458,120	n/a	252,000	TBD
	AMP 690.5	AMP 745.1	4,314,720	n/a	n/a	TBD
Stations						
Alaska Mainline Meter	AMP 0.0		250,000	n/a	n/a	TBD
Happy Valley Comp.	AMP 79.6		1,700,000	n/a	n/a	TBD
Galbraith Lake Comp.	AMP 149.9		1,700,000	n/a	n/a	TBD
Chapman Cr. Comp.	AMP 256.0		1,700,000	n/a	n/a	TBD
Ft. Hamlin Hills Comp.	AMP 338.0		1,700,000	n/a	n/a	TBD
Tatalina R. Comp.	AMP 419.1		1,700,000	n/a	n/a	TBD
Johnson Road Comp.	AMP 494.0		1,700,000	n/a	n/a	TBD
George Lake Comp.	AMP 579.1		1,700,000	n/a	n/a	TBD
Tetlin Junction Comp.	AMP 670.2		1,700,000	n/a	n/a	TBD
Alaska Mainline Subtotal			**79,528,760**	**805,000,000**	**1,361,500**	TBD
Project Totals			**84,195,760**	**1,215,000,000**	**1,361,500**	
Grand Total				**1,300,557,260**		

Note: Potential water sources will be updated in the final report.
[a] Volumes are per year during construction usage.

Should disposal of treated domestic wastewater from construction camps into freshwater waterbodies (including wetlands) be required, such changes will be conducted in accordance with the National Pollution Discharge Elimination System or Alaska Pollution Discharge Elimination System (APDES). Additionally, an APDES permit and approved Stormwater Pollution Prevention Plan (SWPPP) will be required for the general construction stormwater discharge for all of the construction sites (refer to the outline of SWPPP in Appendix 2G).

2.4 WETLAND RESOURCES

Wetlands are more abundant in Alaska than any other region in the United States, with over 43 percent (174 million acres) of the State classified as wetland (COE 2007). Given the linear extent of the project area and extensive number of anticipated wetland crossings, the APP Wetlands Delineation Field Study uses a wetland delineation approach that combines desktop identification and field survey verification. The iterative, three-phase wetland delineation methodology was discussed with FERC and comprises: 1) initial aerial photograph interpretation, 2) collecting ground-reference data at pre-determined field targets, and 3) revising the initial wetland map based on results of field efforts. The COE approved the APP mapping and wetland field survey protocol on July 2, 2010 (COE 2010).

Preliminary wetland maps were created using Geographic Information System (GIS) software using a “heads-up” digitizing method, the predominant wetland mapping technique employed by U.S. Fish and Wildlife Service personnel as part of the National Wetland Inventory (NWI) program (Dahl et al. 2009). This method involves viewing digital map data that overlays digital imagery on a computer monitor. Mapping resources included a combination of high-resolution (1.6-foot pixel resolution) aerial photography taken primarily in July and August of 2008, satellite imagery (minimum 1.0-m pixel resolution) in select locations where aerial photography was not available, digital NWI maps (available for 80 percent of the route), U.S. Natural Resources Conservation Service soils maps (where available), LiDAR-generated topographic contours (where available), and USGS digital raster graphics (topographic maps). Wetlands and waters were classified according to Cowardin et al. (1979) criteria within a 2,000-foot corridor along the pipeline route (i.e., 1,000 feet either side of the pipeline centerline), encompassing approximately 193,000 acres. This corridor includes the entire Project area.

Ground-reference data were collected as a subset of the mapped wetlands within a 300-foot corridor of the pipeline as well as the Aboveground Facilities and Associated Infrastructure. Field targets for ground-reference data collection were approved by the COE prior to field deployment. Wetland determination protocol followed the 2007 Alaska Regional Supplement procedures as required by the COE Alaska District (COE 2007). Ground-reference data were collected at 695 locations in 2010; and the field data was incorporated into the GIS wetland maps throughout the Project area. Field data collection at over 350 field targets and subsequent map revisions are in progress for 2011 with additional ground-reference data collection planned for 2012. At the request of the FERC staff, APP conducted a comparison study of the Alaska District of the COE required wetland mapping method described above and the traditional transect survey method typically used in the lower 48. The results of that comparison study indicated that the mapping method used for this Project accurately maps wetlands and will provide the necessary information for the EIS, as well as COE permitting. [Note: Updated wetland mapping and information on the comparison study will be provided in the final report.]

2.4.1 Wetland Types

This project used an integrated approach to wetlands classification to categorize wetlands based on both the ecological as well as physical characteristics that drive a wetland's functional capacity. Two standard classification systems were employed to classify each wetland mapped within the project vicinity: 1) Cowardin classification system (Cowardin et al. 1979), adopted by the NWI; and 2) Hydrogeomorphic Classification System (Brinson 1993). A synopsis of the codes employed for this APP from the Cowardin classification system is provided below.

2.4.1.1 National Wetland Inventory Codes

The NWI classification system is hierarchical, describing wetlands and deepwater habitats within five major systems (marine, estuarine, lacustrine, riverine, and palustrine). Further distinction at the subsystem level describes hydrologic conditions for the marine, estuarine, lacustrine, and riverine systems. The class and subclass levels describe vegetation and site hydrology. Additional modifiers are added to describe site hydrology and special conditions, such as impoundment related to development. NWI classifications assigned to the Project area wetlands and waters are described in detail below; marine wetlands are not present in the Project area.

Estuarine

The estuarine system includes deepwater tidal habitats and adjacent tidal wetlands that have partial access to the ocean. The estuarine system includes offshore areas of continuously diluted sea water. They tend to have low-energy waves, but the system is affected by oceanic tides, evaporation, wind, and freshwater runoff from land.

<u>E1: Subtidal</u> – Substrate is continuously submerged.

<u>E2: Intertidal</u> – Substrate is exposed and flooded by tides; includes the associated splash zone.

Lacustrine

The lacustrine system includes wetlands and deepwater habitats with the following characteristics: deepwater situated in a topographic depression or a dammed river channel; lacking trees, shrubs, persistent emergents, emergent mosses, or lichens with greater than 30 percent aerial coverage; and total area exceeds 8 hectares (20 acres). Basins less than 20 acres in size are included if they have either a wave-formed or bedrock feature forming all or part of the shoreline, or at low water the depth is greater than 2 meters (6.6 feet) in the deepest part of the basin.

<u>L1: Limnetic</u> – extends outward from littoral boundary and includes all deepwater habitats within the lacustrine system.

<u>L2: Littoral</u> – extends from shoreward boundary to 2 meters (6.6 feet) below annual low water or to the maximum extent of non-persistent emergents, if these grow at depths greater than 2 meters.

Riverine

The riverine system includes channelized wetlands and deepwater habitats with periodically or continuously flowing water, or that link two standing bodies of water. Upland or palustrine wetland islands may be within the channel, but are not included in the riverine system.

<u>R1: Tidal</u> – this subsystem of riverine extends from the upper boundary of the estuarine system to the extreme upper limit of tidal fluctuations. The tidal reach terminates downstream where

the concentration of ocean-derived salts in water exceeds 0.5 parts per thousand during period of annual average low flow. The gradient is low and water velocity fluctuates under tidal influence.

R2: Lower Perennial – this subsystem is characterized by a low gradient and slow water velocity. There is no tidal influence, and some water flows throughout the year. The substrate consists mainly of sand and mud. The floodplain is well developed. Oxygen deficits may sometimes occur.

R3: Upper Perennial – this subsystem is characterized by a high gradient and fast water velocity. There is no tidal influence, and some water flows throughout the year. This substrate consists of rock, cobbles, or gravel with occasional patches of sand. There is very little floodplain development.

R4: Intermittent – this subsystem includes channels that contain flowing water only part of the year, but may contain isolated pools when the flow stops.

Palustrine

The palustrine system includes all non-tidal wetlands dominated by trees, shrubs, emergents, mosses, or lichens. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

- Are less than 8 hectares (20 acres) (ponds);
- Do not have an active wave-formed or bedrock shoreline feature; and
- At low water the depth is less than 2 meters (6.6 feet) at the deepest part.

PEM: Emergent Wetland – Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. Subclasses under PEM for the APP include: Persistent and Nonpersistent.

PSS: Scrub-Shrub Wetland – Includes areas dominated by woody vegetation less than 20 feet tall (6 meters). The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Subclasses under PSS for the APP include: Broad-leaved Deciduous; Needle-leaved Evergreen; and Dead.

PFO: Forested Wetland – Characterized by woody tree species that are 6 meters tall (20 feet) or taller. Subclasses under PFO for the APP include: Broad-leaved Deciduous; Needle-leaved Evergreen; and Dead.

PUB: Unconsolidated Bottom – Includes all wetlands with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent. Ponds fall under the PUB classification.

PAB: Aquatic Bed – Includes areas dominated by plants growing principally on or below the surface of the water for most of the growing season in most years, for example duckweed (*Lemna* spp.) or pond lily (*Nuphar* spp.).

PUS: Unconsolidated Shore – Includes areas characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Beaches, bars, and flats are included in this class.

NWI Water Regime Modifiers

A: Temporarily Flooded – Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

B: Saturated – The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.

C: Seasonally Flooded – Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

D: Seasonally Flooded/Well Drained – The wetland has surface water present at some time during the growing season exhibiting flooded conditions (especially early in the growing season). When surface water is absent the substrate is well-drained.

E: Seasonally Flooded/Saturated – the wetland has surface water present at some time during the growing season exhibiting flooded conditions (especially early in the growing season). When surface water is absent the substrate remains saturated near the surface for much of the growing season.

F: Semi-Permanently Flooded – Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

H: Permanently Flooded – Water covers the land surface throughout the year in all years.

Based on NWI data and field survey data, the APP will cross PEM, PSS, and PFO wetlands as well as a small number of riverine (R), lacustrine (L), PAB, and PUB wetland types. Table 2.4.2-1 lists the most common wetland types in the project vicinity.

2.4.1 Existing Wetland Resources

2.4.1.1 General Setting

The APP will pass through seven different Level 3 ecoregions as described by Nowacki et al. (2001). Ecoregions are defined as a unit of land or water with a geographically distinct compilation of species, communities, and environmental conditions. As illustrated in Figure 2.4.2-1, APP will begin in the Beaufort Coastal Plain, turn south and pass through Brooks Foothills and the Brooks Range, briefly go through Kobuk Ridges and Valleys, then traverse in and out of the Ray Mountains, Yukon-Tanana Uplands, and Tanana-Kuskokwim Lowlands ecoregions. Unless otherwise noted, ecoregion descriptions below are from Nowacki et al. (2001) with supplemental information by Gallant et al. (1995). Further description of each ecoregion is provided in the following subsections, and typical wetland communities for each are summarized.

TABLE 2.4.2-1

Alaska Pipeline Project
Wetland Types within the Project Area

Cowardin Wetland Type	Code	Description	Example
Estuarine Subtidal	E1	Continuously submerged deepwater habitats associated with tidal habitats	Tidal Pond
Estuarine Intertidal	E2	Exposed substrates associated with tidal habitats	Beach
Lacustrine Limnetic	L1	Deepwater habitats within the lacustrine system	Lakes
Lacustrine Littoral	L2	Vegetated habitats within the lacustrine system, or shoreward bound to 2 meters (6.6 feet) below annual low water	Lake fringes
Palustrine Aquatic Bed	PAB	Dominated by plants growing on or below the water surface	Pondweeds, water lilies
Palustrine Emergent	PEM	Dominated by erect, rooted herbaceous species	Grasses, sedges, rushes
Palustrine Scrub-Shrub	PSS	Dominated by woody vegetation less than 6 meters (20 feet) tall	Willow or alder thickets, black spruce wetlands
Palustrine Forested	PFO	Dominated by woody tree species 6 meters (20 feet) tall or higher	Black spruce, tamarack wetlands
Palustrine Unconsolidated Bottom	PUB	At least 25% cover of particles smaller than stones and less than 30% vegetative cover	Ponds
Riverine Lower Perennial Unconsolidated Shoreline/Unconsolidated Bottom	R2US/UB	Low gradient rivers, streams with slow water velocity	Valley bottom streams
Riverine Upper Perennial Unconsolidated Shoreline/Unconsolidated Bottom	R3US/UB	High gradient rivers, streams with fast water velocity	Mountain streams
Riverine Intermittent Streambed	R4SB	Channels containing flowing water only part of the year	Intermittent streams
Upland	U	Lacks one or more wetland parameter(s)	Non-wetland communities ranging from cottonwood or aspen forests to dry tundra

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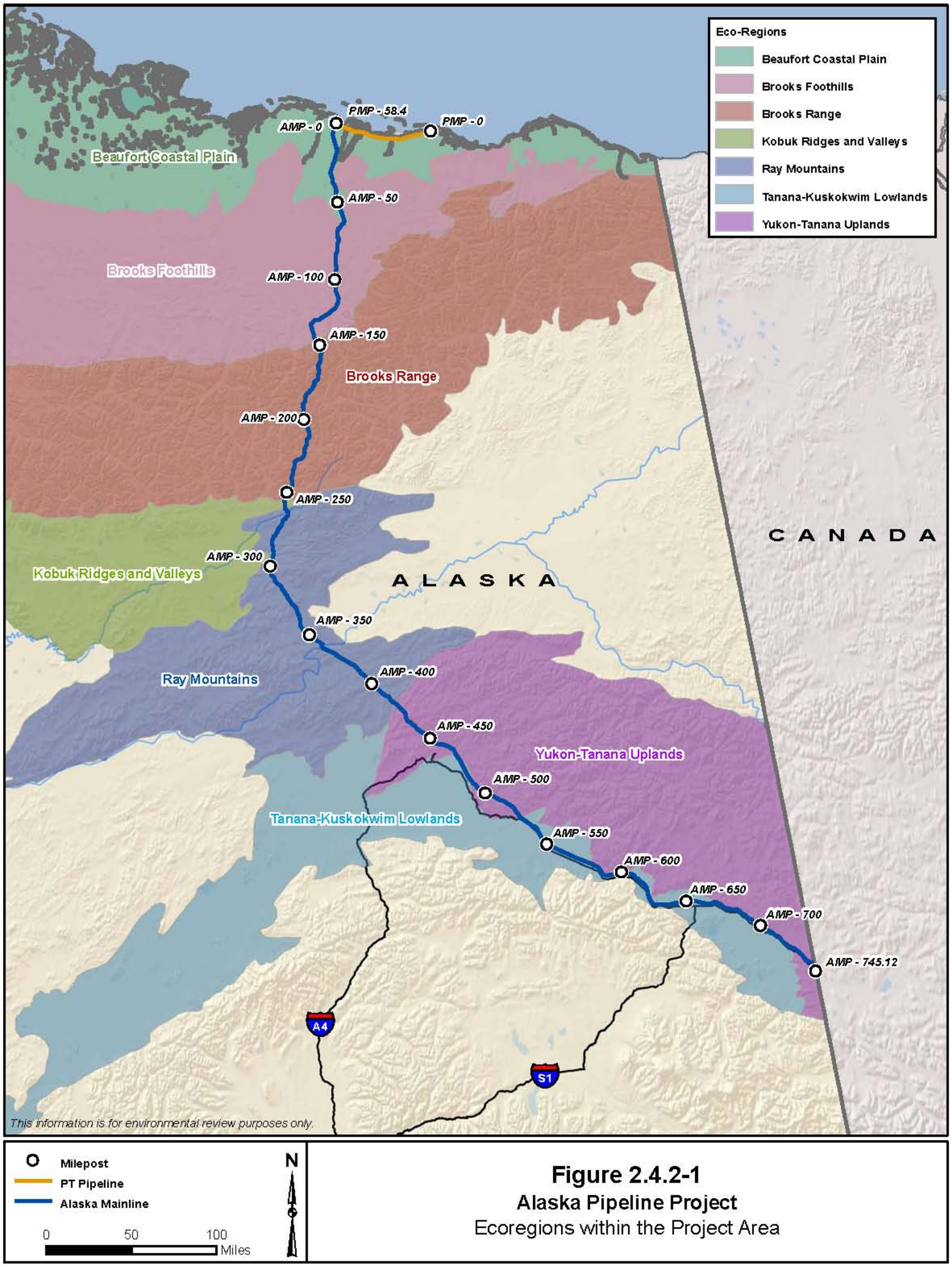

Figure 2.4.2-1
Alaska Pipeline Project
Ecoregions within the Project Area

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2.4.1.2 GTP and Point Thomson Route

Beaufort Coastal Plain Ecoregion

The GTP lies within and the PT Pipeline runs through the Beaufort Coastal Plain, the northernmost ecoregion in Alaska. It is characterized by very low temperatures and little precipitation—a true dry, polar climate (Nowacki et al. 2001). In winter, the minimum average daily temperature is -22°F, and maximum average daily temperature is -6°F. In summer, minimum average daily temperature is near freezing, and maximum average daily temperature is 46°F (Gallant et al. 1995). Annual precipitation only averages 140 mm (5.5 inches), mostly as snowfall (Gallant et al. 1995). The very flat plain rises gradually from sea level to the Brooks Foothills to the south, and there is a low probability of wildfire.

A thick layer of continuous permafrost inhibits drainage, resulting in widespread saturated soils and numerous thaw lakes. The Beaufort Coastal Plain is underlain by unconsolidated deposits of marine, fluvial, glaciofluvial, and eolian origin, and lacks bedrock control (Nowacki et al. 2001). A shallow active layer, short growing season, and extreme winters combine to keep any vegetation small and efficient. Seral herb wetlands have a substrate that is usually coarse and excessively drained, typical of overwash areas adjacent to local rivers and sand dune complexes. Emergent and dwarf shrub wetlands dominate the Beaufort Coastal Plain, including moist sedge, dwarf shrub-wet sedge-moist sedge complexes, and dwarf shrub tundra (Gallant et al. 1995; Nowacki et al. 2001; Raynolds et al. 2006). Table 2.4.2-2 presents typical wetland communities found in the Beaufort Coastal Plain, as well as characteristic flora species.

The GTP will be constructed in the Prudhoe Bay region on the North Slope, resulting in dredging and dock modifications, which could impact estuarine tidal habitat and wetlands in the area. The Arctic coastline is subject to severe erosive action and experiences tides of small fluctuation. Consequently, coastal salt marshes are smaller and less common than on southern coasts. These scattered areas along the coastline are classified as estuarine intertidal wetlands with persistent emergent vegetation, and are exposed at low tides. Coastal salt marshes consist of halophytic (salt-tolerant) sedge wet meadow communities where inundation from tides ranges from several times per month to once a summer and halophytic grass wet meadow communities where tidal inundation is regular or daily. Halophytic sedge wet meadow communities often form the main body of the coastal marsh and are characterized by a dense growth of salt-tolerant sedges (primarily *Carex ramenskii* and *C. subspathacea*), sometimes only a few centimeters (approximately 1 inch) high (DOI BLM 2002).

The dominant species of the shoreward marsh community is generally loose-flowered alpine sedge (*Carex rariflora*), 8 to 16 inches high. The seaward margin often adjoins a halophytic grass wet meadow community. Halophytic grass wet meadow communities are characterized by a sparse growth of salt-tolerant alkali grass (*Puccinellia* spp.), often associated with salt tolerant forbs. The inland portion of these marshes is often taller and denser halophytic sedge wet meadow. Halophytic herb wet meadow communities occur in early successional stages on seaward portions of beaches and coastal marshes where inundation occurs at least a few times per month. These communities are characterized by salt-tolerant forbs, such as maritime arrow grass (*Triglochin maritimum*). Brackish ponds within coastal marshes of deltas, tidal flats, and bays may support fourleaf marestail (*Hippuris tetraphylla*) communities (DOI BLM 2002).

TABLE 2.4.2-2

Alaska Pipeline Project
Typical Wetland Communities in the Beaufort Coastal Plains Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Beaufort Coastal Plain Ecoregion			
Emergent Wetlands			
Seral Herbs	Dwarf fireweed	*Chamerion latifolium*	Located on active, non-tidal floodplains. Primarily unstable sites. Biomass and cover are low but diversity is high.
	Arctic wormwood	*Artemisia senjavinensis*	
	Dwarf alpine hawk's beard	*Crepis nana*	
	Northern sweetvetch	*Hedysarum boreale*	
Sedge-Dryas Tundra	Water sedge	*Carex aquatilis*	Low-centered polygon rims, high-centered polygons, pingos.
	Bigelow sedge	*Carex bigelowii*	
	Eightpetal mountain-avens	*Dryas octopetala*	
	Entireleaf mountain-avens	*Dryas integrifolia*	
Dunegrass	Dunegrass	*Swallenia* spp.	Sand dunes.
	Dupontia	*Swallenia* spp.	
	Seaside ragwort	*Senecio pseudoarnica*	
Fresh Grass Marsh	Arctic pendant grass	*Arctophila fulva*	Thaw lakes and ponds.
	Water sedge	*Carex aquatilis*	
Wet Sedge Meadow Tundra	Tall cottongrass	*Eriophorum angustifolium*	Drained thaw lakes, non-patterned ground.
	Water sedge	*Carex aquatilis*	
	Mosses	n/a	
	Buckbean	*Menyanthes trifoliata*	
	Water knotweed	*Polygonum amphibium*	

2.4.1.3 Alaska Mainline from Prudhoe Bay to Atigun Pass

Along the Alaska Mainline route from Prudhoe Bay to Atigun Pass, the route crosses the lowland tundra areas of the Beaufort Coastal Plain as described above, and continues through upland tundra in the Brooks Foothills ecoregion. The route encompassing the Brooks Foothills ecoregion is generally upland tundra; however, they are not predominantly wetlands. While more extensive upland areas do occur on gravelly ridges and terraces, well-drained exposed slopes, and exposed till, substantial wetland areas occur within the APP right-of-way along gentle slopes, valley bottoms, and within drainageways and riparian areas.

Brooks Foothills Ecoregion

The foothills of the Brooks Range, just south of the Beaufort Coastal Plain, also have a dry, polar climate with cold temperatures (Nowacki et al. 2001). In winter, minimum and maximum average daily temperatures are -20°F and -4°F, respectively. In summer, minimum and maximum average daily temperatures are 34°F and 52-59°F, respectively (Gallant et al. 1995). The landscape comprises rolling hills, broad exposed ridges, and plateaus, and is mostly treeless and underlain by thick continuous permafrost. Highly variable streams and rivers braid through the foothills, running north from the Brooks Range to the Beaufort Sea. The average precipitation is only 140 mm (5.5 inches) per year (Gallant et al. 1995). Susceptibility for natural wildfires is very low.

The Brooks Foothills are better-drained than the Beaufort Coastal Plain, and as a result there are fewer lakes within this ecoregion. Soils within open, low willow shrub wetlands include dune sands and organic rich silts, often intermixed with sand and gravel. More windswept sites have less organic matter and more rock fragments. Organic soils (peat) typically comprise the substrate for low birch-ericaceous shrub wetlands and fens occupying lowland depressions. Typical wetland communities of the Brooks Foothills ecoregion and associated characteristic flora are summarized in Table 2.4.2-3.

TABLE 2.4.2-3

Alaska Pipeline Project
Typical Wetland Communities in the Brooks Foothills Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Brooks Foothills Ecoregion			
Scrub-Shrub Wetlands			
Open Low Mesic Birch-Ericaceous Shrub	Dwarf arctic birch	*Betula nana*	Found on silty colluvium, generally slightly sloping/rolling sites. Young wetlands in depressions.
	Bog blueberry	*Vaccinium uliginosum*	
	Mountain-cranberry	*Vaccinium vitis-idaea*	
	Labrador tea	*Ledum decumbens*	
	Feathermosses	*Hylocomium* spp.	
Open Low Willow Shrub	Willows	*Salix* spp.	Found on terraces, bluffs, dune complexes and moist upland areas.
	Alpine milkvetch	*Astragalus alpinus*	
	Dwarf fireweed	*Chamerion latifolium*	
Emergent Wetlands			
Tussock Tundra	Tussock cottongrass	*Eriophorum vaginatum*	Located on gentle slopes and silt-capped valleys.
	Diamondleaf willow	*Salix planifolia*	
	Bigelow sedge	*Carex bigelowii*	
Open Low Mixed Shrub-Sedge Tussock Tundra	Tussock cottongrass	*Eriophorum vaginatum*	Polygons and gentle sloped areas.
	Resin birch	*Betula glandulosa*	
	Dwarf arctic birch	*Betula nana*	
	Labrador Tea	*Ledum decumbens*	
	Mountain-cranberry	*Vaccinium vitis-idaea*	
	Bog blueberry	*Vaccinium uliginosum*	
Wet Sedge Meadow Tundra	Tall cottongrass	*Eriophorum angustifolium*	Drained lake basins, valley depressions and on level to gently sloping floodplains and terraces; lacustrine or fine grained silts.
	Water sedge	*Carex aquatilis*	
	Mosses	n/a	
	Buckbean	*Menyanthes trifoliata*	
	Water knotweed	*Polygonum amphibium*	

Brooks Range Ecoregion

Elevation in the steep, rugged Brooks Range varies from 2,500 feet in the Baird Mountains to 8,000 feet in the central and eastern Brooks Range (Gallant et al. 1995). These mountains traverse across the entire state of Alaska from the Chukchi Sea to the U.S.-Canada Border. Some small glaciers still exist in the highest regions. The Arctic climate here stays cold and dry throughout the year (Nowacki et al. 2001). In winter, the minimum average daily temperature is -22°F and maximum average daily temperature is -8°F. In summer, the minimum average daily temperature is 37°F and the maximum average daily temperature is 61°F (Gallant et al. 1995).

The Brooks Range receives more precipitation than its foothills, with a greater amount falling on the south-facing slopes near the summits. On average, this region receives 280 mm of precipitation a year (Gallant et al. 1995). Soils within the black/white spruce communities are typical of those within tree-line stands on cold slopes. Permafrost is usually located at various depths, but is absent in some soils. Some sites have poorly drained soils over permafrost-supporting tundra. Hummocky mats cover sites with soil or rocks. Well-drained areas of stony layers typically have dwarf shrub tundra. Fine particles and organic material are uncommon. Low-lying sites are typically flooded during summer breakup, and flooding may persist into the early part of the growing season.

Sparse vegetation comprises the dwarf shrub and graminoid herbaceous communities on the unstable hillsides and slopes. Forested communities are uncommon in this region. True shrub tundra with dense birch (*Betula* spp.), willows (*Salix* spp.), and sometimes alder (*Alnus* spp.) occur in many areas. Birch or willow thickets 80 to 200 centimeters tall (2.6 to 6.6 feet tall) occur on zonal sites in some moister areas. In some areas, toward the southern part of this region that are continuous with the boreal forest, patches of open forest penetrate into this community along riparian corridors. Emergent wetland communities are interspersed with scrub-shrub communities within the Brooks Range region. Table 2.4.2-4 presents typical wetland communities found in the Brooks Range ecoregion, as well as characteristic species of flora.

TABLE 2.4.2-4

Alaska Pipeline Project
Typical Wetland Communities in the Brooks Range Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Brooks Range Ecoregion			
Forested Wetlands			
Open and Closed Black Spruce/White Spruce Forest	Black spruce White spruce Labrador tea Willows Feathermosses	*Picea mariana* *Picea glauca* *Ledum decumbens* *Salix* spp. *Hylocomium* spp.	Located near the treeline or poorly drained silts on floodplain terraces. Observed with a deep litter/moss layer.
Open Black Spruce – Tamarack Forest	Black spruce Tamarack Resin birch Labrador tea Mosses	*Picea mariana* *Larix laricina* *Betula glandulosa* *Ledum decumbens* n/a	Wet lowlands over shallow permafrost. Generally associated with active stream terraces.
Black Spruce Woodland	Black spruce Cottongrasses Willows Sphagnum moss	*Picea mariana* *Eriophorum* spp. *Salix* spp. *Sphagnum* spp.	In areas of very poorly drained silts, generally with a more open canopy than black spruce forest.
Scrub-Shrub Wetlands			
Open Low Willow- Sedge Shrub Tundra	Willows Water sedge Bigelow sedge Arctic sweet coltsfoot	*Salix* spp. *Carex aquatilis* *Carex bigelowii* *Petasites frigidus*	Pond margins, streambanks, sites with silt loam over gravel.
Willow Dwarf Shrub Tundra	Least willow Netleaf willow Crowberry	*Salix rotundifolia* *Salix reticulata* *Empetrum nigrum*	Alpine drainages and solifluction tubes.
Open Low Alder-Willow Shrub	American green alder Diamondleaf willow Sedges	*Alnus viridis* *Salix planifolia* *Carex* spp.	Occurs on steep north slopes and along drainageways near tree line and on river terraces.
Dryas Dwarf Shrub Tundra	Entireleaf mountain-avens Arctic willow	*Dryas integrifolia* *Salix arctica*	Common on windswept alpine sites and occasionally on well-drained,

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TABLE 2.4.2-4

Alaska Pipeline Project
Typical Wetland Communities in the Brooks Range Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species		Landform/Landscape Position
	Common Name	Scientific Name	
	Bog blueberry	*Vaccinium uliginosum*	exposed arctic lowland sites.
	Alpine bearberry	*Arctostaphylos alpina*	
Emergent Wetlands			
Dryas Sedge-Dwarf Shrub Tundra	Entireleaf mountain-avens	*Dryas integrifolia*	Located on mid-slope depressions with thin, stoney soils.
	Sedges	*Carex* spp.	
Ericaceous Dwarf Shrub Tundra	Alpine bearberry	*Arctostaphylos alpina*	Rocky ridges and upper slopes.
	Mountain-cranberry	*Vaccinium vitis-idaea*	
	Bog blueberry	*Vaccinium uliginosum*	
	Bigelow sedge	*Carex bigelowii*	
	Alpine azalea	*Loiseleuria procumbens*	
Wet Sedge Meadow Tundra	Tussock cottongrass	*Eriophorum vaginatum*	Drained lake basins, valley depressions.
	Water sedge	*Carex aquatilis*	

2.4.1.4 Alaska Mainline from Atigun Pass to the Yukon River

From Atigun Pass south to the Yukon River, the Alaska Mainline route traverses the southern aspect of the Brooks Range ecoregion, dominated by upland tundra. South of the Brooks Range, the route transitions into the boreal forest zone of the Kobuk Ridges and Valleys ecoregion and the Ray Mountains ecoregion, where it is crossed by the Yukon River. The Ray Mountains ecoregion, together with the Yukon-Tanana Uplands ecoregion comprise a larger ecoregion known as the Interior Highlands, as described below. This region is underlain by discontinuous permafrost, and vegetation comprises a mix of forest, grassland, shrub, bog, and tundra communities. Both evergreen and deciduous forests are present, and both open and closed canopy black spruce forests are common wetland communities. The Interior boreal forest has an estimated fire return interval of 50 to 200 years (Dyrness et al. 1986; Heinselman 1978; Yarie 1981), and wildfire sizes can vary from less than ten to many hundreds of thousands of acres. This disturbance regime maintains early seral stages, with recently burned areas dominated by broadleaf herbaceous species, transitioning to graminoid, scrub-shrub, and eventually forested communities.

Kobuk Ridges and Valleys Ecoregion

Interior forested lowlands and uplands of Kobuk Ridges and Valleys have a continental climate with short, warm summers and long, cold winters. This ecoregion is stretched east to west across the Interior, and is intermixed with the Interior Highlands. Immense U-shaped valleys in this region run south from the Brooks Range, as a result of past continental glaciation (Nowacki et al. 2001). Wildfires occur frequently in this dry, cool continental climate. Temperatures average from -31°F to -8°F in the winter, and from 52°F to 72°F in the summer (Gallant et al. 1995).

Permafrost is not continuous in this region. There are some thaw and oxbow lakes. Multiple rivers, originating in the Brooks Range, run through the Kobuk Ridges and Valleys. Despite the rain shadow of the Alaska Range to the south, this ecoregion receives between 250 to 550 mm of precipitation annually. Elevation is highly variable in this region, encompassing both ridges and valleys.

This ecoregion has a very complex vegetation pattern owing to variation in air and soil temperatures, elevation, intermittent permafrost, and frequent wildfires. A variety of sites support needle-leaf, broad-leaf, and mixed forests. White spruce (*Picea glauca*), birch (*Betula* spp.), willow (*Salix* spp.), and alder (*Alnus* spp.) are the most commonly found trees at these sites. Typical wetland communities of the Kobuk Ridges and Valleys ecoregion and associated characteristic flora are summarized in Table 2.4.2-5.

TABLE 2.4.2-5

Alaska Pipeline Project
Typical Wetland Communities in the Kobuk Ridge and Valleys Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Kobuk Ridges and Valleys Ecoregion			
Forested Wetlands			
Needleleaf, Broadleaf, Mixed Forest	White spruce Prickly rose Alders Willows Balsam poplar Quaking aspen Paper birch Resin birch	*Picea glauca* *Rosa acicularis* *Alnus* spp. *Salix* spp. *Populus balsamifera* *Populus tremuloides* *Betula neoalaskana* *Betula glandulosa*	Dry, south-facing slopes, well-drained timberlines, floodplain terraces.
Scrub-Shrub Wetlands			
Tall and Low Scrub	Willows Alders Birches Mosses Cranberry/blueberry Labrador tea	*Salix* spp. *Alnus* spp. *Betula* spp. n/a *Vaccinium* spp. *Ledum* spp.	Ridges.
Scrub-Graminoid	Fireweed Bluejoint Willows Prickly rose	*Chamerion angustifolium* *Calamagrostis canadensis* *Salix* spp. *Rosa acicularis*	Recently burned areas.
Emergent Wetlands			
Tall Scrub Swamps	Alders Willows Leatherleaf Highbush cranberry Sweetgale Beauverd spirea Mosses	*Alnus* spp. *Salix* spp. *Chamaedaphne calyculata* *Viburnum edule* *Myrica gale* *Spiraea stevenii* n/a	Valley bottoms and riparian areas.
Low Scrub Bog	Willows Birches Labrador tea Blueberry/cranberry Shrubby cinquefoil Sweetgale Buckbean Water knotweed	*Salix* spp. *Betula* spp. *Ledum* spp. *Vaccinium* spp. *Dasiphora fruticosa* *Myrica gale* *Menyanthes trifoliata* *Polygonum amphibium*	Peatlands in low areas.

Interior Highlands: Ray Mountains and Yukon-Tanana Uplands Ecoregions

Comprised jointly of the Ray Mountains and Yukon-Tanana Uplands ecoregions, this discontinuous area is constituted by a mix of rounded, low mountains ranging from 1,500 to 5,000 feet in elevation, rugged peaks, and flat to nearly flat bottomlands along larger rivers (Gallant et al. 1995). This region lies primarily in the eastern Interior, with some branches dispersed into the western Interior. Most of the higher peaks were glaciated during the Pleistocene, and areas at upper elevations typically remain barren. The surrounding bottomlands are dotted with thaw and oxbow lakes (Raynolds et al. 2006). The climate here is continental with summers being typically moist and relatively warm, and winters that are dry and cold (Nowacki et al. 2001). Fire-affected communities are common within this region (Gallant et al. 1995).

Soil drainage is highly variable in the Interior Highlands. Permafrost is present, but often discontinuous, and tends to be thin to moderately thick (Nowacki et al. 2001). Scrub-shrub wetland areas have permafrost near the surface, and an organic layer underlain by silt loam or sandy loams. Areas without permafrost tend to be meadows with silts, loams, mucks, or peats, and may be extremely wet. The highlands primarily sustain dwarf scrub vegetation and open spruce stands, though graminoid herbaceous communities occur in poorly drained areas. Community-type and vegetation height is controlled mostly by the presence of permafrost within this region. In areas of higher permafrost and cooler soils, scrub-shrub communities dominate. Emergent communities occur in low topographic depressions and defined drainages, and are generally associated with lake or river environments that provide a consistent supply of water. More protected sites at lower elevations support denser vegetation and may have open-canopy needle-leaf forests and woodlands. Table 2.4.2-6 presents typical wetland and plant community types for the Interior Highlands, along with characteristic flora associated with each.

TABLE 2.4.2-6

Alaska Pipeline Project
Typical Wetland Communities in the Ray Mountains and Yukon-Tanana Uplands Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Interior Highlands: Ray Mountains and Yukon-Tanana Uplands Ecoregion			
Forested Wetlands			
Open and Closed Black Spruce Forest	Black spruce Prickly rose Bog blueberry Labrador tea Crowberry Willows	*Picea mariana* *Rosa acicularis* *Vaccinium uliginosum* *Ledum decumbens* *Empetrum nigrum* *Salix* spp.	Poorly drained silts on floodplain terraces or north-facing slopes. Generally located at toe-of-slope locations with a deep litter/moss layer.
Open and Closed Black Spruce/White Spruce Forest	Black spruce White spruce Labrador tea Willows Feathermosses	*Picea mariana* *Picea glauca* *Ledum decumbens* *Salix* spp. *Hylocomium* spp.	Located near the treeline or poorly drained silts on floodplain terraces. Observed with a deep litter/moss layer.
Scrub-Shrub Wetlands			
Open and Closed Black Spruce Forest	Black spruce Prickly rose Bog blueberry Labrador tea Crowberry Willows Black spruce	*Picea mariana* *Rosa acicularis* *Vaccinium uliginosum* *Ledum decumbens* *Empetrum nigrum* *Salix* spp. *Picea mariana*	Poorly drained silts on floodplain terraces or north-facing slopes. Generally located at toe-of-slope locations with a deep litter/moss layer.
Open and Closed Black Spruce/White Spruce Forest	Black spruce White spruce Labrador tea Willows Feathermosses	*Picea mariana* *Picea glauca* *Ledum decumbens* *Salix* spp. *Hylocomium* spp.	Located near the treeline or poorly drained silts on floodplain terraces. Observed with a deep litter/moss layer.
Open Black Spruce – Tamarack Forest	Black spruce Tamarack Resin birch Labrador tea	*Picea mariana* *Larix laricina* *Betula glandulosa* *Ledum decumbens*	Wet lowlands over shallow permafrost. Generally associated with active stream terraces.

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TABLE 2.4.2-6

Alaska Pipeline Project
Typical Wetland Communities in the Ray Mountains and Yukon-Tanana Uplands Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species		Landform/Landscape Position
	Common Name	Scientific Name	
Black Spruce Woodland	Mosses Black spruce Cottongrass Willows Sphagnum moss	n/a *Picea mariana* *Eriophorum* spp. *Salix* spp. *Sphagnum* spp.	In areas of very poorly drained silts, generally with a more open canopy than black spruce forest.
Closed Balsam Leaf Poplar	Balsam poplar Thinleaf alder Willows Prickly rose	*Populus balsamifera* *Alnus incana* *Salix* spp. *Rosa acicularis*	On active floodplain terraces. Willow species vary, depending on local site conditions.
Emergent Wetlands			
Bluejoint – Meadow	Bluejoint	*Calamagrostis canadensis*	Generally located on poorly drained silty lowlands. Often occur in a mosaic pattern with shrub or broadleaf forest communities.
Subarctic Lowland Sedge Wet Meadow	Water sedge Meadow horsetail Rock sedge	*Carex aquatilis* *Equisetum pratense* *Carex saxatilis*	Lake and pond margins, sloughs. These communities are quite small and widely scattered.
Subarctic Lowland Sedge-Shrub Wet Meadow	Lyngbye's sedge Buckbean Water knotweed	*Carex lyngbyei* *Menyanthes trifoliata* *Polygonum amphibium*	Wetland and bog margins, generally topographically defined areas with high seasonal water tables.
Fresh Herb Marsh	Marsh horsetail Buckbean Water knotweed	*Equisetum palustre* *Menyanthes trifoliata* *Polygonum amphibium*	Sloughs, oxbow lakes and lake margins in permanently flooded areas.

2.4.1.5 Alaska Mainline from the Yukon River to the Canadian Border

South of the Yukon River, the Alaska Mainline route continues through the Ray Mountains ecoregion and into the Yukon-Tanana Uplands ecoregion (see above), followed by the Tanasna-Kuskokwim Lowlands ecoregion, as described below. The entire route between the Yukon River and the U.S.-Canada Border is dominated by boreal forest. Within the past 10 years, there have been extensive burns between the Yukon River and Fairbanks.

Tanana-Kuskokwim Lowlands Ecoregion

The Tanana and Kuskokwim rivers are dominant landscape forces in the western Interior. Their lowlands lie primarily in the western Interior, with some fringes extending into the eastern portion of the state. Similar to the Interior Highlands, the Tanana-Kuskokwim Lowlands ecoregion comprises a mix of ecological characteristics. The mild, dry, continental climate here has an average temperature range of -27°F to 72°F (Gallant et al. 1995). The summers are cool and winters are cold. The ecoregion is primarily level with some hills, riparian areas, tall scrub thickets, and spruce and hardwood forests (Gallant et al. 1995). The Tanana-Kuskokwim Lowlands are the most fire-affected region within the survey corridor.

Precipitation in the region ranges from 280 to 400 mm (11 to 16 inches) annually. Permafrost is widespread, and both thaw and oxbow lakes are prevalent here in the shallow, poorly drained soil. Undifferentiated alluvium and slope deposits, and poorly drained shallow soils are common in this region, which was not glaciated during the Pleistocene. Eolian silts and organic soils compose the majority of the landscape (Nowacki et al. 2001). The few well-drained areas within this ecoregion have sands, gravels, and loam soils, and tend to support different vegetative communities like scrub-shrub wetlands. Table 2.4.2-7 presents typical wetland communities found in the Tanana-Kuskokwim Lowlands ecoregion, as well as characteristic flora species.

TABLE 2.4.2-7

Alaska Pipeline Project
Typical Wetland Communities in the Tanana-Kuskokwim Lowlands Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Tanana-Kuskokwim Lowlands Ecoregion			
Forested Wetlands			
Open and Closed Black Spruce Forest	Black spruce Prickly rose Bog blueberry Labrador tea Crowberry Willows	*Picea mariana* *Rosa acicularis* *Vaccinium uliginosum* *Ledum decumbens* *Empetrum nigrum* *Salix* spp.	Poorly drained silts on floodplain terraces or north-facing slopes. Generally located at toe-of-slope locations with a deep litter/moss layer.
Open and Closed Black Spruce/White Spruce Forest	Black spruce White spruce Labrador tea Willows Feathermosses	*Picea mariana* *Picea glauca* *Ledum decumbens* *Salix* spp. *Hylocomium* spp.	Located near the treeline or poorly drained silts on floodplain terraces. Observed with a deep litter/moss layer.
Open Black Spruce – Tamarack Forest	Black spruce Tamarack Resin birch Labrador tea Mosses	*Picea mariana* *Larix laricina* *Betula glandulosa* *Ledum decumbens* n/a	Wet lowlands over shallow permafrost. Generally associated with active stream terraces.
Black Spruce Woodland	Black spruce Cottongrasses Willows Sphagnum moss	*Picea mariana* *Eriophorum* spp. *Salix* spp. *Sphagnum* spp.	In areas of very poorly drained silts, generally with a more open canopy than black spruce forest.
Closed Balsam Leaf Poplar	Balsam poplar Thinleaf alder Willows Prickly rose	*Populus balsamifera* *Alnus incana* *Salix* spp. *Rosa acicularis*	On active floodplain terraces. Willow species vary, depending on local site conditions.
Scrub-Shrub Wetlands			
Open Black Spruce Dwarf Tree Scrub	Black spruce Labrador tea Tussock sedge Cottongrass Sphagnum moss	*Picea mariana* *Ledum* spp. *Carex* spp. *Eriophorum* spp. *Sphagnum* spp.	Very poorly drained soils with shallow permafrost. On some slight slopes. May occur on patterned or non-patterned ground and occur at both latitudinal and altitudinal tree line.
Open and Closed Tall Willow Shrub	Willows Dwarf fireweed Meadow horsetail	*Salix* spp. *Chamerion latifolium* *Equisetum pratense*	On active and young floodplain areas. Specific local conditions determine species of willows observed. Most common wetland type.
Open Low Shrub Birch-Ericaceous Shrub Bog	Resin birch Bog blueberry Labrador tea Sedges Sphagnum moss	*Betula glandulosa* *Vaccinium uliginosum* *Ledum decumbens* *Carex* spp. *Sphagnum* spp.	On non-patterned wetlands with a thick organic mat. Generally associated with open areas adjacent to stream corridors.
Emergent Wetlands			
Bluejoint	Bluejoint	*Calamagrostis canadensis*	Generally located on poorly drained silty lowlands. Topographically defined depressions.
Subarctic Lowland Sedge Wet Meadow	Water sedge Meadow horsetail Rock sedge	*Carex aquatilis* *Equisetum pratense* *Carex saxatilis*	Lake and pond margins, sloughs with silty, organic soils.
Subarctic Lowland Sedge-Shrub Wet	Lyngbye's sedge Buckbean	*Carex lyngbyei* *Menyanthes trifoliata*	Wetland and bog margins, generally topographically defined areas with

TABLE 2.4.2-7

Alaska Pipeline Project
Typical Wetland Communities in the Tanana-Kuskokwim Lowlands Ecoregion

Ecoregion/ Wetland Type/ Community Type	Typical Indicator Species: Common Name	Typical Indicator Species: Scientific Name	Landform/Landscape Position
Meadow	Water knotweed	*Polygonum amphibium*	high seasonal water tables.
	Marsh horsetail	*Equisetum palustre*	
Fresh Herb Marsh	Buckbean	*Menyanthes trifoliata*	Sloughs, oxbow lakes and lake margins in permanently flooded areas.
	Water knotweed	*Polygonum amphibium*	

2.4.1.6 Major Wetland Complexes and Significant Wetlands

[Note: APP is in the process of consulting with federal and state agencies regarding major wetland complexes and significant wetlands. This section will be modified to reflect the information obtained from agencies in the final report.]

2.4.2 Construction and Operation Impacts and Mitigation

APP has scheduled over half of the construction in Alaska to take place during the winter months under frozen conditions in an effort to reduce potential impacts to permafrost, tundra areas, and large saturated wetlands (refer to Section 1.6.3.1 of Resource Report 1 and discussion of winter construction below).

The construction will be unlike typical pipeline construction through wetlands that occur in the temperate regions. Due to the number, proximity, and size of wetlands in Alaska, impacts on wetlands are unavoidable. Some of these impacts include the permanent alteration of some wetland vegetation such as over the trench line area and within areas that are graded to facilitate safe construction and operations, or where gravel pads have been placed or where gravel has been used to reduce erosion or improve slope stability. Other impacts could include a change in wildlife habitat potential of the wetland; temporary soil disturbance associated with equipment traffic and the removal of stumps (where necessary); and temporary increases in turbidity and fluctuations in wetland hydrology associated with access preparation, trenching, and spoil storage.

Pipeline Facilities, Aboveground Facilities, and Associated Infrastructure are depicted on NWI maps included in Appendix 2F and include MP information. Tables 2.4.3-1 and 2E-1, 2E-2, and 2E-3 in Appendix 2E list the wetlands affected by the construction of the Pipeline Facilities, Aboveground Facilities, as well as those affected by Associated Infrastructure (e.g., yards, access roads, borrow sites, helipads, airstrips).

2.4.2.1 Pipeline Facilities

Table 2.4.3-1 summarizes by wetland classification type the acreage impacts resulting from construction of the Pipeline Facilities. [Note: Wetland acreages associated with operation of the facilities are pending further analysis and will be submitted prior to construction.]

TABLE 2.4.3-1

Alaska Pipeline Project
Summary of Wetland Types Affected by Construction of Pipeline Facilities

Segment/ NWI Classification [a]	Crossing Length [b] Feet	Miles	Acres Disturbed by Construction [c]
POINT THOMSON GAS TRANSMISSION PIPELINE			
L1UB	2,251.3	0.4	9.6
L2EM	17.9	0.0	0.1
PEM/PSS	11,342.0	2.1	48.3
PEM	203,723.1	38.6	804.9
PSS/PEM	52,974.2	10.0	238.2
PUB	1,210.0	0.2	5.6
R2UB	11,967.4	2.3	52.0
R2US	2,692.5	0.5	22.7
R2US/UB	8,730.0	1.7	108.6
R4SB	3,515.8	0.7	44.3
PT Pipeline Subtotal	298,522.1	56.5	1,334.7
ALASKA MAINLINE			
L1UB	117.5	0.0	4.5
L2EM	123.8	0.0	0.43
PAB	973.1	0.2	1.1
PEM/PSS	337,379.3	63.9	1,664.0
PEM	153,376.8	29.0	301.8
PFO	58,074.2	11.0	137.3
PFO/PSS	25,934.7	4.9	141.5
PSS	599,242.5	113.5	3,968.1
PSS/PEM	287,957.8	54.5	2,217.8
PSS/PFO	7,305.5	1.4	36.1
PSS/US	140.4	0.0	1.9
PUB	20,526.7	3.9	29.9
R2UB	33,223.4	6.3	28.7
R2UB/US	583.8	0.1	4.1
R2US	6,812.5	1.3	40.7
R2US/UB	556.9	0.1	1.7
R3UB/US	7,653.3	1.4	26.6
R3UB	966.5	0.2	0.1
R3US	499.7	0.1	0.1
R4SB	20,343.1	3.9	25.1
Alaska Mainline Subtotal	1,561,791.8	295.8	8,631.4
Project Total[d]	1,860,313.9	352.3	9,966.1

[a] Wetland types according to Cowardin et al. (1979); see also Section 2.4.1.1:
PFO - palustrine forested.
PAB - palustrine aquatic bed.
PSS - palustrine scrub-shrub.
PEM - palustrine emergent.
PUB - palustrine unconsolidated bottom.
R - Riverine: R2 - Lower Perennial; R3 - Upper Perennial; R4 - Intermittent.
L - Lacustrine: L1 - Limnetic; L2 - Littoral.

[b] Totals for crossing lengths include wetlands only.

[c] The construction corridor includes ATWS for both the PT Pipeline and the Alaska mainline pipeline. The construction corridor widths for PT Pipeline and Alaska mainline pipeline are generally 145 feet wide and 200 feet wide, respectively. The actual amount of wetland acreage affected by construction may vary with wetland type and proposed construction method (e.g., winter or summer construction) as discussed in section 2.4.3 of Resource Report 2.

[d] Totals shown in this table may not equal the sum of addends due to rounding.

Based on field and GIS data, a total of 1,335 acres of wetlands will be affected by the PT Pipeline. The combined linear crossing distance of these wetlands is approximately 56.5 miles, accounting for approximately 97 percent of the PT Pipeline route. Approximately 78 percent of the wetlands crossed are characterized as PEM. The remaining 12 percent of wetlands are composed of L, PSS, PUB, and R wetland types.

For the Alaska Mainline route, a total of 8,631 acres of wetlands will be affected. The linear crossing distance of these wetlands is approximately 295.8 miles, approximately 40 percent of the pipeline route. Approximately 23 percent of the wetlands crossed are characterized as PEM, 3 percent are classified as PFO, and 72 percent are PSS. The remaining 2 percent of wetlands comprise L, PAB, PUB, and R wetland types. No farmed wetlands are found on any portion of the Project area.

In total, approximately 9,966 acres of wetlands will be disturbed on the construction of the Pipeline Facilities. Table 2E-1 in Appendix 2E lists the specific MP location and acreage of currently expected disturbance within wetlands crossed by the pipelines.

The impact on forested and scrub-shrub wetlands is of longer duration than on emergent wetland types since woody wetland vegetation grows slower than herbaceous vegetation and will take longer to re-establish on the right-of-way after construction. Within the area of the pipeline trench, it is likely only emergent wetland will reestablish within the various classes of disturbed wetland areas. After the pipeline is constructed, APP will actively maintain the pipeline right-of-way in accordance with APP's Plan and Procedures.

As discussed below, earthen pads may be required for stabilization of the working side of the construction right-of-way during pipeline installation during summer in thaw-sensitive permafrost areas that may be present within wetland areas, and in winter in sloping terrain. As indicated below, APP proposes, subject to approval by appropriate federal and state agencies, to leave these earthen pads in place after the pipeline is constructed. These pads may constitute permanent fill within wetland areas. APP will reduce impact on wetlands during construction by following its Procedures and applicable permits. The wetland construction and mitigation procedures are summarized below and in Appendix 1K of Resource Report 1.

For wetlands that will be crossed during the summer, APP's clearing crews will cut existing woody wetland vegetation off at ground level and remove it from the wetland most likely during the winter prior to pipe installation on that specific spread. APP may also remove stumps as necessary. Following clearing, timber riprap, timber mats, and/or soil will be installed in sloping, saturated or unstable wetlands, as necessary, to create a stable surface for the operation of equipment. Temporary erosion controls will also be installed at this time, except during winter construction as noted below, as required to reduce the potential for erosion to cause soil to leave the right-or-way or enter a wetland or waterbody.

Excavated stumps will be removed from wetlands, ground and possibly used as mulch to enhance revegetation of more southerly upland sites, or burned where burning is allowed and will not negatively impact the subsurface vegetation and soils.

Where necessary, set-on weights or concrete coated-pipe will be used to provide negative buoyancy within high water table wetlands.

Following lower-in APP will backfill the ditch with the spoil excavated from the trench within the wetland. In some areas, where high ice content soils are encountered in the ditch, thaw-stable import fill may be used to supplement the local trench backfill to reduce future backfill settlement. If dewatering of the trench within the wetland is necessary, it will be conducted in a manner designed to reduce heavily sediment-laden water from entering adjacent waterbody or undisturbed portions of the wetland. Following backfilling in unsaturated wetlands, the segregated loose surface material layer will be spread over the area from which it was stripped. In wetlands with a high water table and unconsolidated soil, APP will replace and crown the soil allowing it to return to preconstruction conditions. If timber riprap or timber mats are used, APP may elect to remove the riprap or mats from the wetland after post-construction reclamation, provided removal does not result in greater impacts to the wetland than if they are left in place. In the absence of specific revegetation requirements from federal and state regulatory agencies, APP will allow revegetation of appropriate species as specified in its Procedures (refer to Appendix 1K of Resource Report 1).

Different construction and stabilization/reclamation measures from those described above may be required in some areas along the route through Alaska. The measures proposed by APP are dependent on soil conditions and topography and vary for winter construction versus summer construction (refer to Section 1.6.3.1 of Resource Report 1).

Winter Construction

Approximately two thirds of the route through Alaska is currently proposed to be constructed during the winter. Construction procedures through wetlands during the winter are described in Sections 1.6.2 and 1.6.3.1 of Resource Report 1. Due to differing construction conditions in Alaska from those found in the contiguous United States, the APP winter construction procedures are, in some cases, different from construction and mitigation requirements found in the FERC's Procedures. APP will use specific construction right-of-way widths in wetland areas in winter (refer to the APP Procedures, Appendix 1K, and Section 1.6.3.1 of Resource Report 1). Subject to approval from the FERC and other appropriate federal, state, and local agencies, APP will not install temporary erosion controls such as silt fences and staked straw bales during winter construction. Due to the stable frozen ground conditions, runoff from disturbed areas will not be an issue during periods when the ground surface is frozen. Temporary erosion controls may be installed at the end of winter construction to stabilize disturbed areas for the spring breakup and summer seasons.

In unstable wetland areas where soils are susceptible to rutting and not capable of supporting heavy construction equipment, snow/ice roads may be established over the working side of the right-of-way where the terrain is relatively level. These roads will provide a firm surface for construction equipment while minimizing potential impacts to underlying wetland soils. Where sloped terrain may result in slippery surfaces on snow/ice roads, gravel may be placed to provide a level working surface and to provide traction for construction equipment and vehicles. Subject to approval by the FERC and other appropriate federal, state, and local agencies, the gravel will be left in place, or bladed towards the trench, after construction in all areas, including wetlands, with the exception of waterbodies and drainages. Gravel roads used for wetland construction are discussed in more detail in the next section.

Following installation of the pipeline, backfilling the trench and reclamation of the right-of-way will take place. Frozen backfill will be crowned over the trench to allow for thaw and self-weight settlement.

Summer Construction

Summer construction will affect about 1,300 acres of wetlands in the areas identified by MP in Figure 1.5-1 of Resource Report 1.

In unsaturated wetlands, the uppermost organic layer is substantially different from the subsoil, and soil mixing could inhibit revegetation of the trench area and other disturbed portions of the right-of-way. Summer construction techniques may include limiting the construction right-of-way width as discussed in Section 1.6.3.1 of Resource Report 1 and the Procedures (Resource Report 1, Appendix 1K). Other techniques include using access roads to route some construction equipment around such areas, and/or using timber riprap, mats, or similar materials to distribute equipment loads on unstable soils.

Wetland construction during summer months will follow the wetland construction and mitigation measures outlined in the APP Procedures and will adhere to the provisions of the SWPPP (refer to Appendix 2G) to ensure compliance to conditions of the APDES permit for construction stormwater discharge. APP is proposing alternative wetland construction methods that differ from the FERC's Procedures. Most notably, the APP will use construction right-of-way widths in most wetland areas constructed during the summer as noted in Appendix 1H (refer to Section 1.6.3.1 of Resource Report 1). The APP needs this space due to the large diameter of the pipe, equipment operation, a larger-than-normal trench area, loose surface material segregation (if applicable), and additional spoil storage. This increased right-of-way width is necessary due to potentially unstable soil conditions at these locations. The additional workspace is required for additional trench width, storage of unconsolidated spoil that will not stack, and stabilization of the working side of the right-of-way to accommodate construction equipment.

In select wetland areas, stabilization of the construction right-of-way will be required. Soil or rock fill, timber riprap, or other means will be used over the working side of the right-of-way to provide a stable work surface. Temporary culverts may be used to facilitate cross drainage during construction. Subject to approval by the FERC, the COE, and other appropriate federal and state agencies, fill placed in these wetlands may be left in place after the pipeline is installed to avoid further disturbance to the wetlands. Leaving the fill in place may partially compensate for the long-term thaw settlement of the underlying ground and cause less impact than attempting to remove the soil fill from the wetlands. As discussed above, fill may also be placed over other disturbed areas on the right-of-way for ground stability purposes and to aid in erosion control.

2.4.2.2 Aboveground Facilities

Gas Treatment Plant

Based on field and GIS data, the footprint for the GTP will lie entirely within wetland areas, encompassing an area of approximately 235 acres. Table 2.4.3-2 summarizes the impacted wetlands by type. Construction of the GTP will impact primarily PEM wetlands (approximately 90 percent), followed by PUB wetlands (approximately 6 percent) and L wetlands (approximately 4 percent).

Construction of the GTP facility will require the permanent fill of emergent and open water wetlands. See Section 1.4.3.1 of Resource Report 1 for a description of gravel fill requirements associated with this facility. [Note: APP is still finalizing locations where permanent fill will be required and will update this information in the final report.] APP will coordinate with appropriate federal, state, and local agencies to assess wetland impacts and develop a mitigation plan for the filled wetlands.

Compressor Stations

Eight compressor stations will be constructed in Alaska. The locations of these compressor stations are shown by MP in Resource Report 1, Table 1.3.2-1. Wetlands affected by the construction of compressor stations is presented in Table 2.4.3-2 below. [Note: APP is still finalizing locations where permanent fill will be required and will update this information in the final report.]

TABLE 2.4.3-2

Alaska Pipeline Project
Wetlands Affected by Aboveground Facilities

Facility / Milepost	Site Name/Type	NWI Wetland Classification [a]	Hydrogeomorphic Classification [b]		Wetland Acreages Affected [c]
n/a	GTP	L1UBH	no data		6.4
n/a	GTP	L2EM2H	no data		3.6
n/a	GTP	PUBH	no data		8.8
n/a	GTP	PUB/EM1H	no data		6.0
n/a	GTP	PEM1F	no data		20.8
n/a	GTP	PEM1/SS1B	no data		160.7
n/a	GTP	PEM1/SS1E	no data		25.9
n/a	GTP	PEM1/UBF	no data		2.8
				Total	235.0
ALASKA MAINLINE					
Compressor Stations					
AMP-79.6	Happy Valley	PSS1/EM1B	1		11.58
		PEM1E	5		0.78
		PUBH	5		0.08
		PEM1F	2		0.87
		PEM1/SS1E	1		8.92
		PUBC	5		0.23
		PSS1/EM1C	5		2.18
				Total	24.64
AMP-149.9	Galbraith Lake	PEM1/SS1B	3		23.33
AMP-256.0	Chapman Creek	PSS1/4B	1		8.60
		PSS1/EM1B	1		2.76
		PEM1/SS1B	1		0.08
		PSS4/1B	3		13.21
				Total	24.65
AMP-338.0	Fort Hamlin Hills	PEM1/SS1C	1		1.46
		PSS1/4B	1		2.20
		PSS4/1B	3		0.15
		PSS4/3B	3		19.65
				Total	23.47
AMP-419.1	Tatalina River	PSS4/3B	3		3.89
		PFO4B	3		2.52
		PSS3/4B	3		8.31
				Total	14.72
AMP-494.0	Johnson Road	PSS4B	1		5.57
		PSS3/EM1B	1		14.36
				Total	19.93
AMP-579.1	George Lake	PSS4/3B	1		23.98
		PFO4/SS4B	1		0.66
				Total	24.64

TABLE 2.4.3-2

Alaska Pipeline Project
Wetlands Affected by Aboveground Facilities

Facility / Milepost	Site Name/Type	NWI Wetland Classification [a]	Hydrogeomorphic Classification [b]	Wetland Acreages Affected [c]
AMP-670.2	Tetlin Junction	PSS4B	3	2.46
		PSS1/4B	3	1.30
		PSS4/1B	3	0.39
		PFO4/SS1B	3	0.02
			Total	4.17

[a] NWI wetland classifications based on Cowardin et al. 1979.
[b] Hydrogeomorphic classifications based on Brinson 1993.
[c] The numbers in this table have been rounded for presentation purposes.

2.4.2.3 Associated Infrastructure

[Note: APP is still finalizing locations where permanent fill will be required and will update this information in the final report.]

Access Roads

Appendix 1F in Resource Report 1 provides a list of new and existing access roads for the APP, including information such as location, type, length, width, and affected acreages. Access roads that affect wetlands, including those that require permanent or temporary fill, are listed in Table 2E-2 of Appendix 2E.

Other Associated Infrastructure

Appendix 1F in Resource Report 1 provides a list of borrow sources, construction camps, and storage yards for the APP, including information such as location, type, length, width, and affected acreages. Other Associated Infrastructure that affect wetlands, including those that require permanent or temporary fill, are listed in Table 2E-3 of Appendix 2E.

West Dock Modifications, Dredging, and Disposal Areas

The West Dock modifications, dredging, and disposal areas will be constructed in estuarine subtidal and intertidal wetlands. [Note: APP is still finalizing locations where permanent fill will be required and will update this information in the final report.]

Bottom sediments will be dredged and then transported to the disposal or fill area. Preliminary dredged material volume can be found in Table 1.4.3-1 of Resource Report 1.

Further analysis is required to evaluate and allow comparison of the relative impacts of each dredging method and disposal option identified in Section 10.6 of Resource Report 10. Impacts at the dredge and disposal sites will be evaluated by coupling site data with sedimentation and turbidity modeling that accounts for proposed dredging, transfer, and discharge methods to estimate how far the sediment could be transported and to evaluate potential impacts.

A description of potentially viable methods for dredging and disposal options identified to-date is described in Sections 10.6.1.4 and 10.6.1.5, respectively, of Resource Report 10.

APP will conduct dredging operations and disposal of dredged materials and will comply with project-specific federal and state permit regulations and special conditions. [Note: Further consultation with COE will continue to discuss the dredging and disposal activities.]

2.5 CUMULATIVE IMPACTS

[Note: Field surveys and agency consultations are on-going. Cumulative impacts on groundwater, surface water, and wetlands will be updated in the final report.]

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