DOCKET NO. CP17-___-000
RESOURCE REPORT NO. 2
WATER USE AND QUALITY
PUBLIC

Document Number: USAI-PE-SRREG-00-000002-000

RESOURCE REPORT NO. 2
SUMMARY OF FILING INFORMATION[1]

Minimum Requirements to Avoid Rejection	Found in Section Location
Identify all perennial surface waterbodies crossed by the proposed project and their water quality classification. (§ 380.12(d)(1)) • Identify by milepost • Indicate if potable water intakes are within 3 miles downstream of the crossing.	2.3.10, Appendix H
Identify all waterbody crossings that may have contaminated waters or sediments. (§ 380.12(d)(1)) • Identify by milepost • Include offshore sediments.	2.3.6 2.3.10, Appendix H
Identify watershed areas, designated surface water protection areas, and sensitive waterbodies crossed by the proposed project. (§ 380.12(d)(1)) • Identify by milepost	2.3.4.1, 2.3.6
Provide a table (based on National Wetlands Inventory (NWI) maps if delineations have not been done) identifying all wetlands, by milepost and length, crossed by the proposed project (including abandoned pipeline), and the total acreage and acreage of each wetland type that may be affected by construction. (§ 380.12(d)(1&4))	2.4.3, Appendix E, Appendix F, Appendix G
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))	2.4.3, 2.6 Appendix N
Describe the proposed waterbody construction, impact mitigation, and restoration methods to be used to cross surface waters and compare to the staff'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.)	2.3.11, 2.4.4.3, 2.6 Appendix N
Provide original NWI maps or the appropriate state wetland maps, if NWI maps are not available, that show all proposed facilities and include milepost locations for proposed pipeline routes. (§ 380.12(d)(4))	Appendix F
Identify all U.S. Environmental Protection Agency (EPA) - 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.	2.2.2, Appendix A

[1] Guidance Manual for Environmental Report Preparation (FERC, August 2002). Available online at http://www.ferc.gov/industries/gas/enviro/erpman.pdf.

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Minimum Requirements to Avoid Rejection	**Found in Section Location**
Additional Information Often Missing and Resulting in Data Requests	
Identify proposed mitigation for impacts on groundwater resources.	2.2.7, 2.2.8
Discuss the potential for blasting to affect water wells, springs, and wetlands, and associated mitigation.	2.2.7, 2.4.3
Identify all sources of hydrostatic test water, the quantity of water required, methods for withdrawal, and treatment of discharge, and any waste products generated.	2.3.11, Appendix K
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.	Appendix I
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.	2.2.7, 2.3.11, Appendix C
Describe typical staging area requirements at waterbody and wetland crossings.	2.4.6, Appendix N
If wetlands would be filled or permanently lost, describe proposed measures to compensate for permanent wetland losses.	2.4.3, 2.4.4.3
If forested wetlands would be affected, describe proposed measures to restore forested wetlands following construction.	2.4.4, 2.4.4.3
Describe techniques to be used to minimize turbidity and sedimentation impacts associated with offshore trenching, if any.	2.3.11

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Agency	**Date**	**Comment**	**Response/Resource Report Location**
Bureau of Land Management (BLM)	9/26/2016	Please identify TAPS Oil Spill Contingency locations and resources and outline measures to ensure access during construction in case of a TAPS emergency event.	The Trans-Alaska Pipeline System (TAPS) operates with an Alaska Department of Environmental Conservation (ADEC) approved oil spill contingency plan. The plan contains comprehensive information on resources and location of response equipment. Details are located on the ADEC website at: http://dec.alaska.gov/Applications/SPAR/PublicMVC/IPP/ApprovedCPlans?page=8. This citation has been incorporated into Resource Report No. 2.
BLM	9/26/2016	Water extraction and Water-level impacted bird habitat: Nesting waterfowl and sandpipers and other species seasonally occupy lakes and ponds of various sizes as well as wetlands throughout the area proposed for development. Nest success is linked to water levels. The proposed project includes the extraction of water from waterbodies convenient to the project activities (e.g. potable water for crews, water extraction for dust mitigation). Water extraction should not occur during the nesting season. The FERC reports mentions the creation of wells for support of project related water needs. This would be a potentially less impactful approach to meeting the water needs associated with this project.	Water withdrawals would comply with permit stipulations that maintain water levels for other users and wildlife uses. Water wells are not possible in most areas of Alaska because groundwater is not a viable source on the North Slope or other areas with little to no groundwater. Water extraction would generally be in the late summer/fall for hydrotesting and throughout the year for camp use, horizontal directional drill (HDD make-up) water, and concrete coating activities.
BLM	9/26/2016	Pond/Lake Creation and Wildlife Habitat: It is inevitable that, regardless of the mitigation measures employed for the proposed action, the land-clearing activities associated with this project will lead to the creation of new lakes and ponds of variable sizes adjacent to the disturbed areas as well as some loss of suitable habitat for wildlife. To offset some of the habitat loss, the permittee should consider a measured approach to waterbody creation. Not all waterbodies adjacent to or resulting from ground disturbing development are utilized by wildlife; some studies of the requisite characteristics of wildlife suitable waterbodies are currently underway. The permittee should investigate what physical parameters are most conducive to wildlife inhabitance (e.g. depth, substrate, slope) should occur prior to project start and ensure that new waterbodies meet those criteria. It would be good to see plans for this in the project reports.	The comment is acknowledged. To address these recommendations, the Applicant has developed a Draft Restoration Plan and would develop a wetlands mitigation plan as a requirement of issuance of 404 permitting during build-up to Notice-to-Proceed. Please see Appendix P of Resource Report No. 3, Draft Restoration Plan.
U.S. Environmental Protection Agency (EPA)	9/30/2016	The DNPP route variation that crosses the Park would potentially trigger EPA' s regulatory authorities. For example, EPA retains CWA Section 402 National Pollutant Discharge Elimination System (NPDES) and Section 401 Water Quality Certification authority within the Park based on Section 11 of the Alaska	Comment acknowledged. The route through the Denali National Park and Preserve (DNPP) is not considered by the Applicant to be practicable, as noted in a letter from the Applicant to the Federal Energy Regulatory Commission (FERC) .

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		Statehood Act, and as set forth in a Memorandum of Agreement between EPA and the State of Alaska. Section 11 of the Alaska Statehood Act indicates that, apart from limited exceptions not relevant here, the United States shall exercise exclusive jurisdiction in the Park. Depending on the specific nature of project-related activities that would occur within the Park, other EPA authorities may similarly apply. As a cooperating agency, EPA will continue to work closely with FERC and the project proponent to identify applicable EPA authorities once the formal application has been filed and the environmental analysis is further developed.	
EPA	9/30/2016	We recommend that the sampling and analysis plan, and the marine dredging and disposal plan be included as an appendix to the Reports.	A Sampling and Analysis Plan would be developed and delivered to the jurisdictional agencies for review to obtain the necessary 404/10 permit and authorization to proceed with dredging. The Applicant will address this comment further after the Final Environmental Impact Statement (FEIS) but prior to construction start.
EPA	9/30/2016	Turbidity plume and water column testing/modelling should be conducted to evaluate the magnitude and distribution of sediment plumes associated with dredging, and different dredging and disposal methods. Turbidity testing/modelling should also be conducted for the placement of the subsea mainline pipeline across Cook Inlet.	Turbidity is being evaluated in association with dredging at the materials offloading facility (MOF). This information would be provided to FERC during the EIS phase of the Project.
EPA	9/30/2016	Significance: Minor effects are those that may be perceptible but are of very low intensity and may be too small to measure. Significant effects are those that, in their context, and due to their intensity, have the potential to result in a substantial adverse change in the physical environment How are effects characterized when they are between too small to measure and substantially adverse?	Comment acknowledged. The effects are addressed as one of those two exclusive categories.
EPA	9/30/2016	The Reports discuss potential impacts from ballast water discharges from marine vessels. We recommend including reference to the EPA NPDES Vessel General Permit (VGP) for discharges incidental to the normal operation of vessels, such as ballast water discharges.	See revised Section 2.3.9.1.2.2. Vessels are normally vetted (inspected) by qualified marine warranty surveyors prior to being allowed to work for the Project and repairs or upgrades are performed before construction starts.
EPA	9/30/2016	We recommend including a reference to the U.S. Coast Guard regulations 46 CFR 162.060 which require commercial vessels to have approved onboard ballast water treatment systems, etc.	See Section 2.3.9.1.2.2
EPA	9/30/2016	The Alaska Oil and Gas Conservation Commission (AOGCC). AOGCC short cited earlier on the page	See revised text in Section 2.1.3.3.4.

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EPA	9/30/2016	…and for production, injection, and disposal plan approvals for exploration and development activities in the State of Alaska. This does not include all of the description of the AOGCC activities that EPA oversees listed above on the same page	See revised text in Sections 2.1.3.3 and 2.1.3.3.4.
EPA	9/30/2016	deposits border the bedrock hills contiguous the sedimentary basin deposits border the bedrock hills contiguous with the sedimentary basin	See revised Section 2.2.2.1.
EPA	9/30/2016	Rights-of-Way (ROW) and Land Use permits. Do these permits cover any tidewater construction that would be done?	No. However, the Applicant would work with the Alaska Department of Natural Resources' (ADNR's) Division of Mining, Land & Water (DMLW) on the acquisition of Tidelands Leases or interests therein to secure construction authorization on state-owned tidelands.
EPA	9/30/2016	APDES wastewater discharge permit and mixing zone approval for wastewater disposal into all state waters under a transfer of authority from the EPA National Pollutant Discharge Elimination System (NPDES) Program. APDES only applies to that segment of state waters that are waters of the US (state waters include groundwater but except in very limited circumstances, APDES would not be the applicable permit)	Comment acknowledged. The text in Section 2.1.3.3.2 is correct as written for the context of this Project and the intended discharges.
EPA	9/30/2016	18 Alaska Administrative Code (AAC) chapters 15, and 70, and; § 72.500. Alaska administer the CWA 402 program under 18 AAC 83. As discussed in more detail below, however, EPA retains CWA 402/NPDES permitting authority in Denali National Park and Preserve. There is no mention of a plan review which is required under 18 AAC 72	This is a permitting and planning question, which would be addressed prior to Notice-to-Proceed if the DNPP alternative is determined to be the Least Environmentally Damaging Practicable Alternative (LEDPA).
EPA	9/30/2016	Certificate of Reasonable Assurance (CRA) /NPDES. This certificate is issued under CWA 401 for NPDES permit written by EPA	Comment acknowledged.
EPA	9/30/2016	Class I Underground Injection Control permit for The State does not issue Class I UIC permits, EPA does (as is stated on the previous page), but the State is required to issue a state wastewater disposal permit under 18 AAC 72. As discussed in more detail below, however, EPA retains CWA 402/NPDES permitting authority in Denali National Park and Preserve.	Section 2.1.3.3.2 has been revised.
EPA	9/30/2016	where groundwater availability for public supply is highly limited with no underground sources of drinking water but Section 2.2.8.2.1.5 (pg E112) states: No potable groundwater sources are present north of the Brooks Range. Construction of the Pipeline Associated Infrastructure in this area would have no impact to groundwater resources. And Section	See revised text in Sections 2.2.9.2.1 and 2.2.10.2.2 in defining groundwater for consistency.

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		2.2.9.2.1.2 (pg E116) says: No impacts to groundwater would occur during operation of the PTTL because groundwater does not exist on the ACP. 18 AAC 70 contains designated uses for groundwater that must be protected and does not distinguish between whether that groundwater is potable or not (drinking water is only one of the water supply categories). The document should be specific as to whether there is any groundwater in the vicinity of the project and not differentiate between potable and non-potable as if non-potable has no protections.	
EPA	9/30/2016	is this saying that there are over 400 more mgd freshwater withdrawals in other parts of AK? That seems like a lot considering that a couple of the major population centers are already accounted for here.	Aquaculture groundwater withdrawals (fresh) account for 429.29 Mgal/d in other areas not crossed by the Project.
EPA	9/30/2016	The Project area overlies one principal aquifer system: Alaska's unconsolidated-deposit aquifers. These unconsolidated alluvial (deposited by flowing water), colluvial (deposited from mass wasting), eolian (wind-blown), and glacial deposits overlie consolidated clastic and carbonate (limestone and dolomite) sedimentary rocks. Bedrock aquifers of sedimentary rock (such as shale, siltstone, sandstone or conglomerate) or sediment (such as mud, silt, sand, or pebbles) are not regionally defined as a principal aquifer but as a local aquifer source. It is unclear if the difference between a primary (regional) aquifer and a local aquifer is dependent on the type of sedimentary rock it is in proximity to.	See revised text in Section 2.2.2 to clarify local aquifers.
EPA	9/30/2016	Previous reports indicate that groundwater quality in this area is within water quality standards, with the exception of naturally-occurring elevated arsenic, iron, and manganese levels associated with gold mining district. What about mercury, which may also be at naturally elevated levels. We recommend that additional discussions regarding naturally occurring mercury levels in the project area be included in the Reports. The Reports should also discuss the potential for the methylation of mercury, which is the toxic form that is bioavailable and could bioaccumulate in the food web.	The Liquefaction Facility would not be located in a gold mining district, and naturally occurring mercury has not been detected in any historic groundwater analyses. See additional information in revised text in Section 2.2.6.1.
EPA	9/30/2016	which approaches the Alaska Water Quality Standard for drinking water of 0.05 milligrams per liter (50 micrograms per liter). The standard is 0.01 mg/L or 10 ug/L	Section 2.2.7.1 has been revised.
EPA	9/30/2016	water is obtained primarily gathered from lakes - water is obtained from lakes	Section 2.2.7.1 has been revised. In areas of continuous permafrost, water is obtained

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			primarily from lakes and stored in heated tanks for winter use.
EPA	9/30/2016	Groundwater sites under the direct influence of surface water (GUDISW), must meet the more stringent or more protective of either the Table C criteria in 18 AAC 75 or the AWQS under 18 AAC 70 to be protective for use as a drinking water source and to protect potential ecological receptors. 18 AAC75.345(b) states "Contaminated groundwater must meet (1) the cleanup levels in Table C if the current use or the reasonably expected potential future use of the groundwater, determined under 18 AAC 75.350, is a drinking water source" these are clean up levels and not criteria or standards.	See revised Section 2.2.8.1. Regulations under 18 Alaska Administrative Code (AAC) 75.345(f) state that groundwater that is closely connected hydrologically to nearby surface water may not cause a violation of water quality standards in 18 AAC 70.020 for the receiving surface water or sediment.
EPA	9/30/2016	If a DWPP area is crossed by the Project and is it is determined that construction If a DWPP area is crossed by the Project and it is determined that construction	Section 2.2.8.1 has been revised.
EPA	9/30/2016	Formerly used defense sites crossed by the Project (which may have their own requirements under compliance orders issued by EPA) are also depicted Isn't the Corps the regulatory authority for FUDS?	Yes, see Section 2.2.8.2. Section 2.2.8.2 has been revised to include the regulatory authority for Formerly Used Defense Sites (FUDS) remediation.
EPA	9/30/2016	Shallow groundwater aquifers generally recharge quickly because they are can readily recharge from precipitation and surface waters. Shallow groundwater aquifers generally recharge quickly because they readily recharge from precipitation and surface waters.	See revised text in Section 2.2.9.1.3. Shallow groundwater aquifers generally recharge quickly because they readily recharge from precipitation and surface waters.
EPA	9/30/2016	the Statewide Pipeline Construction, Operation, and Maintenance General Permit AKG3320000 – (Statewide Pipeline General Permit). Page 2-iv says this permit is AKG320000	Section 2.2.9.1.3 has been updated.
EPA	9/30/2016	Site-specific plans detailing how contaminants in areas of known contamination (see Resource Report No. 8) would either be avoided or removed, and would be provided separately following consultation with ADEC and EPA.	The comment will be addressed during the development of the Draft EIS (DEIS).
EPA	9/30/2016	Hydrostatic test water would be pumped into an onsite settling pond on site in accordance with an APDES permit. The existing APDES General Permit requirements/limits are set for discharge effluent limits of pH, settleable solids, sheen (none), TAqH, TAH, total residual chlorine, Turbidity (marine), Turbidity (fresh water), and flow. The text on page E100 indicates that there is not a statewide permit for the discharge of hydrostatic test waters so perhaps this is talking about a state wastewater disposal permit written under 18 AAC 72. But the North Slope GP (AKG331000) does contain requirements for hydrostatic test water discharges and these include that if marine	The Liquefaction Facility is not located in a gold mining district and naturally occurring mercury has not been detected in any historic groundwater analyses. See revised text in Section 2.2.6.1.

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		water is used that it be discharged back to the marine environment.	
EPA	9/30/2016	Coverage under the existing APDES Wastewater General Permit for Project domestic wastewater discharges from the operation of a domestic wastewater treatment works would specify the total amount (usually in pounds) of wastewater that could be discharged from each site. The discharge of domestic wastewater from small facilities is usually either (1) limited in gallons per day or (2) a design flow is used to calculate load requirements for BOD and TSS plus other parameters in pounds per day and then a flow limit would not necessarily be specified	The comment is acknowledged.
EPA	9/30/2016	Secondary containment capacity would be 110 percent of the volume of the container; Is this 110% of the largest container or the total storage within the secondary containment?	It refers to the total storage.
EPA	9/30/2016	Infrastructure would be the similar to those described Infrastructure would be similar to those described	See revised text in 2.2.9.2.5.1.
EPA	9/30/2016	five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), fecal coliform and possibly enterococci, total residual chlorine (if applicable), dissolved oxygen (DO), Short cites previously used on page 2-43 – they also appear on pages 2-54, 56, 115, 152, 157, 187 and 190	Revisions have been made to the following sections: 2.2.9.15 2.2.9.2.5.5 2.2.10.1.3 2.3.8.1.1.7 2.3.9.1.1.2 2.4.4.1.2 2.4.4.2.1.4
EPA	9/30/2016	Water withdrawal for facility operation would be minimal with an estimated annual requirement of approximately 15,000 gallons in total. This would include approximately 50 to 75 gallons per day per personnel and 50 gallons per month for mechanical use by the process facilities 15,000 – 50(12) = 14,400 gals; 14,400/50 gpd = 288 days. It does not specify if the pipeline above ground facilities would be manned full-time but if so, 15,000 gallons per year would not provide enough water for even one person to be there every day of the year and barely enough to be there every weekday (365 -104 = 261).	See revised the text in Section 2.2.9.2.1.6.
EPA	9/30/2016	Surface water classification is defined (18 AAC 70.050) as marine waters and fresh waters (see Sections 2.3.2, 2.3.3, and 2.3.4). Surface water resources in the Project area include marine waters at the northern and southern ends of the Project boundary to fresh water lakes, ponds, major rivers, streams and associated tributaries along the Mainline corridor. The following sections describe the surface water resources in the proposed	Wetlands are also a surface water resource protected under 18 AAC 70, and are discussed in detail in Section 2.4.

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		Project area. Surface waters also include wetlands which are protected by 18 AAC 70. It should mention here that wetlands will be discussed in a later section.	
EPA	9/30/2016	Cook Inlet is approximately 220 miles in length, ranging from 60 miles wide at the mouth, to 15–20 miles wide in Upper Cook Inlet. It separates the Kenai Peninsula from mainland Alaska. The last sentence is a strange statement since a peninsula by definition (surrounded on 3 sides by water) is connected to another land mass. The Kenai Peninsula is connected to mainland Alaska and not separated from it by Cook Inlet.	Comment acknowledged. This sentence has been removed from Section 2.3.2.1.1
EPA	9/30/2016	separating Upper and Lower Cook Inlets (there is only one Inlet)	Water depths in the center of the channel can range from 60 to more than 500 feet with some of the deepest portions at the strait between the Forelands, separating Upper and Lower Cook Inlet (NOAA, 2014a - Nautical Chart #16660).
EPA	9/30/2016	Cook Inlet – We recommend including additional figures, similar to Figure 2.3.2-1 (Bathymetry), Figure 2.3.2-4 (Max Ice Conditions) and Figure 2.3.2-5 (Mean Ice Conditions), depicting Cook inlet tides, waves, circulation and currents; salinity and temperature; sediments and sedimentation.	Comment acknowledged.
EPA	9/30/2016	The map should include labels for at least some of the places discussed in this section like the Forelands, Trading Bay and Kalgin Island similar to what is in Figure 2.3.3-1	Figure 2.3.1-1 has been revised as suggested.
EPA	9/30/2016	Twice each month, tidal ranges are a little larger than average during either a full or a new moon. In both cases, the gravitational pull from the sun and moon combine and tug a little harder at the oceans, making high tides slightly higher, and low tides slightly lower. Twice each month, tidal ranges are a little larger than average during either a full or a new moon. In both cases, the gravitational pull from the sun and moon combine making high tides slightly higher and low tides slightly lower.	Comment acknowledged. Section 2.3.1.1.1 has been revised.
EPA	9/30/2016	Salinity increases rapidly and almost uniformly down the inlet, from Point Possession to East and West Foreland. Slightly higher salinities are found on the east side of the inlet. This rapid increase can be attributed to heavily loaded glacial runoff from the Matanuska, Susitna and Knik rivers and subsequent sediment settling in Upper Cook Inlet. How does glacial runoff contribute to higher salinities? It isn't salty, is it?	Comment acknowledged. This sentence has been removed from Section 2.3.2.1.1.3.
EPA	9/30/2016	2.3.5.5 Interdependent Project Facilities Freshwater Resources this entire section is a reiteration of Section 2.3.5.2 "Interdependent	Sections 2.3.5.2 and 2.3.5.5 have been revised.

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		Project Facilities " Is there supposed to be a difference?	
EPA	9/30/2016	Baseline Suspended Sediment Concentrations for Cook Inlet? On page 2-108, the Report indicates that the sediment concentration is between 100 to 2,000 ppm and increases northward. This information should be included in Section 2.3.2.1.1.4. We recommend including a map of Cook Inlet with the sediment concentrations depicted in different colors.	The information has been reiterated in Section 2.3.1.1.4 (note the change of header numbers due to report revisions). A graphic would not be useful for an ephemeral measurement, such as turbidity, because it changes regularly.
EPA	9/30/2016	The northeastern corner of the Kalgin Island is characterized by silty shore overlaying compact clay. The storm high-tide lines on the island are marked by the presence of large logs, and the beach face is composed of mixed sand and granular material. Several shoals in the middle of the Upper Cook Inlet (e.g., Middle Ground Shoal and Moose Point Shoal consist of unstable sands prone to liquefaction. The northeastern corner of Kalgin Island is characterized by silty shore overlaying compact clay. The storm high-tide lines on the island are marked by the presence of large logs, and the beach face is composed of mixed sand and granular material. Several shoals in the middle of the Upper Cook Inlet (e.g., Middle Ground Shoal and Moose Point Shoal) consist of unstable sands prone to liquefaction.	Section 2.3.1.1.3 has been revised.
EPA	9/30/2016	Grab samples of surficial seafloor sediments were collected in the Marine Terminal area in 2015 and analyzed for physical and chemical parameters. Has a Dredge Material Sampling and Analysis Plan been developed? We recommend including this as a reference in the Reports, as well as include as an Appendix. We recommend including a summary table of the analytical results from Appendix R in the Reports.	The sediment sampling results have been included in the most recent draft of the Resource Report. A Sampling and Analysis Plan would be provided to the jurisdictional agencies and copied to FERC during development of the DEIS.
EPA	9/30/2016	Sediment grab samples were collected by the Project at nine locations near the two shore crossings (Alaska LNG, 2015). Sediment grab samples were collected at nine locations (out of 14 attempts) near the two shore crossings (Alaska LNG, 2015). Almost the exact same text appears at the end of the first paragraph and the beginning of the second.	Section 2.3.1.1.6.1 (Sediments and Sedimentation) has been revised.
EPA	9/30/2016	Prudhoe Bay – We recommend including additional figures, similar to Figure 2.3.2-7 (Bathymetry), depicting Cook inlet tides, waves, circulation and currents; salinity and temperature; sediments and sedimentation; and ice conditions in the Reports.	Comment acknowledged.
EPA	9/30/2016	Baseline Suspended Sediment Concentrations for Prudhoe Bay? We recommend including the concentration range for sediments in Prudhoe	See Section 1.4.2.4.2.3 of Resource Report No. 1. The proposed Dock Head 4 (DH 4) design does not require dredging.

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		Bay. We recommend including a map of Prudhoe Bay with the sediment concentrations depicted in different colors.	
EPA	9/30/2016	Sediment samples were collected…in 2014 from five locations in Prudhoe Bay near West Dock… We recommend including a Prudhoe Bay map depicting the locations of the five sediment samples Trench Site #1, #2A, #2B, #3A, and #3B) in Prudhoe Bay. Were any samples taken at the face of the proposed DH4 (STP)? Or at DH2 and DH3? Has a Dredge Material Sampling and Analysis Plan been developed? We recommend including this as a reference in the Reports, as well as include as an Appendix. We recommend including a summary table of the analytical results from Appendix S in the Reports.	See Section 1.4.2.4.2.3 of Resource Report No. 1. The proposed DH 4 design does not require dredging.
EPA	9/30/2016	Polycyclic aromatic hydrocarbons (PAHs) were found to be low in all samples analyzed with all concentrations; well below the DMMP screening levels and threshold effects levels and permissible exposure limits. Polycyclic aromatic hydrocarbons (PAHs) were found to be low in all samples analyzed with all concentrations well below the DMMP screening levels and threshold effects levels and permissible exposure limits.	Polycyclic aromatic hydrocarbons (PAHs) were found to be low in all samples analyzed with all concentrations well below the Dredged Material Management Plan (DMMP) screening levels and threshold effects levels and permissible exposure limits.
EPA	9/30/2016	sediment sampling in Cook Inlet and the Shelikof Straits sediment sampling in Cook Inlet and Shelikof Strait	Section 2.3.3.1.1 has been revised.
EPA	9/30/2016	increasing to 20.3 feet per year from 1979 to 2002 along	See revised text in Section 2.3.3.2.1.
EPA	9/30/2016	Section 2.3.4.1 discusses watersheds. This is the last sentence of the referenced section and it does discuss watersheds (that is its title) but the sentence seems superfluous	The sentence has been removed to address this comment in Section 2.3.4.1.
EPA	9/30/2016	Yukon-Koyukuk Census Area	Comment acknowledged. The Yukon-Koyukuk Census Area has been updated in the table in Section 2.3.4.1 (Table 2.3.4.1).
EPA	9/30/2016	The Project crosses 11 major hydrologic basins and 20 watersheds in Alaska . . . Colville River basin and Lower Colville River. The map in Figure 2.3.5-1 does not show the mainline going into the Colville basin. Are there ancillary facilities that will be there?	Approximately 1 mile of Mainline pipeline would cross Lower Colville watershed, which is depicted in the large-scale overview map. See Resource Report No. 1, Appendix A map books for further details.
EPA	9/30/2016	Beaver Creek-Yukon River basin includes Yukon Flats Ramparts watersheds Beaver Creek-Yukon River basin includes Yukon Flats Rampart watersheds	Section 2.3.2.1 has been revised.
EPA	9/30/2016	Tanana River basin includes Tolovana River, Lower Tanana River, and Nenana River watersheds and contributes to the Yukon River near Fairbanks;	See revised text in Section 2.3.2.1.

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EPA	9/30/2016	Fresh water resources near the GTP facility are limited primarily to the Putuligayuk River.	Section 2.3.2.3.4 has been revised.
EPA	9/30/2016	Freshwater Resources of the Eastern Arctic, Prudhoe Bay, and Colville River Basins each of the subsequent subsections tells what infrastructure will impact the watershed but this one doesn't so there is still no indication of how the Colville is impacted	Section 2.3.2.3.1.1 text has been updated to include the infrastructure and length crossed in the Lower Colville watershed.
EPA	9/30/2016	The study reported Sagavanirktok, Kuparuk and Colville Rivers concentrations of dissolved organic carbon (DOC) increased during peak discharge in the Sagavanirktok River and river flow increased by 250 percent. This sentence does not make sense - delete 3 river names in first part of sentence, then it makes sense with the following sentence	The text has been deleted in Section 2.3.3.2.2. The study reported that concentrations of dissolved organic carbon (DOC) increased during peak discharge in the Sagavanirktok River, and river flow increased by 250 percent.
EPA	9/30/2016	Sagavanirktok River concentrations of dissolved Cu, Pb, Zn and Fe increased at peak flow and particulate metals were more uniform for all river. What does this mean? and should it be rivers?	Section 2.3.3.2.2 has been edited for incorrectly cited information.
EPA	9/30/2016	dissolved Copper, Iron, Lead and Zinc These were all abbreviated earlier in this paragraph	See Section 2.3.3.2.2 for revised text.
EPA	9/30/2016	cobbles; the coarser material is found in the upper reaches of streams within the basin, and the finer cobbles; coarser material is found in the upper reaches of streams within the basin, and finer	Comment acknowledged.
EPA	9/30/2016	Bed material is gradually sorted and rounded progressively downstream, Gradually and progressively seem redundant	See revised text in Section 2.3.3.2.3.
EPA	9/30/2016	nearly 200 milligrams per liter, with major rivers such as the Koyukuk, which has the highest dissolved solids content nearly 200 milligrams per liter in major rivers such as the Koyukuk which has the highest dissolved solids content	Comment acknowledged. See revised text in Section 2.3.3.2.3.
EPA	9/30/2016	Streams that occur within the Susitna River basin are classified as either glacial or non-glacial streams. Water quality aspects of the glacial streams are discussed in this section but not the not-glacial steams.	Section 2.3.3.2.6 has been revised to describe non-glacial streams.
EPA	9/30/2016	Sensitive Surface Waters - that may be affected by Project include waterbodies listed in Alaska's Anadromous Waters Catalog: The Anadromous Water Catalog; The National Wild and Scenic Rivers System; The Nationwide Rivers Inventory; The Recreational Rivers Act;	The application has been updated to the current information.
EPA	9/30/2016	The Alaska Department of Fish and Game (ADF&G) maintains the Anadromous Waters Catalog (AWC), Both ADF&G and AWC were previously short cited	The mapbooks properly reference the data used in the analysis.

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EPA	9/30/2016	Rivers and Harbors Act (RHA), and require a permit for work in or affecting the waterway. The text used earlier in the document to describe RHA coverage uses “in, on, over, or under navigable waters” rather than the highlighted text	Comment noted. The text has been revised and this phrasing no longer exists.
EPA	9/30/2016	Individual bridge permits would be required for aerial pipeline crossings, permanent and/or temporary vehicle access bridges, and detour bridges on navigable waterways. We recommend including a table that identifies the bridge crossings – length and width, type of bridge, locations, the name of the waterbody, length of crossing, etc.	The U.S. Coast Guard (USCG) provided the streams and rivers that would require a bridge permit for construction and permanent bridge crossings. The text has been revised to include this information.
EPA	9/30/2016	Disposal of the MOF dredge material would be spread over about 1200 acres over two years. We recommend including a map that depicts the location of the dredge material disposal site alternatives in Cook Inlet. We recommend including a table that describes the alternatives evaluated for the methods of dredge material disposal.	A map of the proposed MOF dredge material disposal sites in Cook Inlet has been included in Resource Report No. 1 as Figure 1.5.2-1, and discussion of the alternative disposal sites is addressed in Resource Report No. 1, Section 1.5.2.2.16 – Marine Terminal - Dredging. Further discussion of the dredge material site options can also be found in Resource Report No. 10, Section 10.6.4.2.1 Marine Terminal.
EPA	9/30/2016	PLF This is not previously used so should be spelled out before it is short cited.	See Section 2.3.8.1.2.1.
EPA	9/30/2016	The preferred disposal site for dredged materials is an offshore unconfined aquatic disposal site located within 5 miles There is no mention of the Corps having to authorize an offshore disposal site. Or does one already exist?	Section 2.3.8.1.2.1 has been revised.
EPA	9/30/2016	Site-specific sediment sampling and analysis results and the potential impacts of dredging and dredge material disposal based on these results will be submitted to FERC when available. We recommend including a table that summarizes the sediment sampling and analysis results in the Reports.	This information will be provided during permitting of the proposed dredging.
EPA	9/30/2016	The marine waters at the Marine Terminal site are naturally very turbid, and the temporary, localized increase in turbidity from dock installation is not anticipated to have any significant impacts on marine waters. The turbidity standard for marine waters is a definitive standard and not a relative (to the natural condition) one as is the freshwater.	Comment acknowledged.
EPA	9/30/2016	Ocean going and vessels that deliver materials for construction of the Liquefaction Facility may use ballast water and cooling water. We recommend including in this section an inventory of all ocean going vessels into Cook Inlet that would be providing cargo, supplies,	Section 2.3.9.1.2.2 has been revised to include the USGC Ballast Water Management System (BWMS) and Notice of Intent of EPA Vessel General Permit (VGP) requirements. The Applicant will address

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		etc. to the MOF and identify the approximate volume (gallons) of ballast water that would be discharged for each vessel per year. We recommend including the total cumulative volume of ballast water that would be discharge per year into Cook Inlet. Similar to Section 2.3.12.1.2.2 for operations, include the requirements for coverage under the EPA NPDES Vessel GP and the U.S.C.G. requirements for ballast water discharges and management for commercial vessels during construction activities in Cook Inlet.	this comment further after the FEIS but prior to construction start.
EPA	9/30/2016	It is anticipated that impacts to surface water from dewatering during construction would be localized, and short-term. This section is about hydrostatic testing not construction dewatering	Section 2.3.8.1.1.4 has been revised to remove "dewatering" and replace it with "hydrostatic testing."
EPA	9/30/2016	Coverage for under the Delete either “for” or “under”	See revised text in Section 2.3.8.1.1.7.
EPA	9/30/2016	Preliminary estimates of the amount of nearshore dredging required could include up to approximately 115,000 cubic yards for the Boulder Point crossing and 355,000 cubic yards for the Shorty Creek crossing depending on the trench slope and distance selected. In previous presentations by AK LNG, the placement of the pipeline in Cook Inlet would not require dredging, but would be trenchless (HDD or DMT) and a barge would pull the pipeline offshore. Has this proposal been dropped? We recommend including a map of Cook Inlet identifying the location of the proposed dredging and the dredge material disposal area. What is the area of the proposed dredging? Has this area been sampled and tested in accordance to a Dredge Material Sampling Plan? Where would the dredged material be disposed?	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
EPA	9/30/2016	would be temporary, short-term, and minor. There seems to be a font change at the end of this sentence	See revised text in Section 2.3.8.2.1.8..
EPA	9/30/2016	All instream blasting permit requirements would be complied with blasting in sensitive streams during critical periods would be avoided. - All instream blasting permit requirements would be complied with; blasting in sensitive streams during critical periods would be avoided.	See Section 2.3.8.2.1.9. All instream blasting permit requirements would be complied with**;** blasting in sensitive streams during critical periods would be avoided.
EPA	9/30/2016	for each anadromous fish stream crossing crossed by the PTTL - for each anadromous fish stream crossed by the PTTL	Text was revised in Section 2.3.8.2.3.5. See Appendix H of Resource Report No. 3 for the season and proposed crossing method for each anadromous fish stream crossed by the Point Thomson Gas Transmission Line (PTTL).
EPA	9/30/2016	for each construction spreads - would for each construction spread would	See revised Section 2.3.8.2.4.2.

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EPA	9/30/2016	The potential effects of water withdrawals from surface waters would be minimized by adhering to measures in its Alaska LNG Project Procedures - The potential effects of water withdrawals from surface waters would be minimized by adhering to measures in Alaska LNG Project Procedures	See revised Section 2.3.8.2.5.2.
EPA	9/30/2016	Potential impacts from ATWS could cause a localized decrease in both the infiltration and groundwater recharge rate. This section is supposed to be discussing surface water impacts. Is this trying to say they were be increased in surface water runoff because infiltration and groundwater recharge would be decreased?	Sections 2.3.8.2.5.6 and 2.3.8.2.5.7 have been revised to clarify potential surface water effects from Mainline Associated Infrastructure.
EPA	9/30/2016	located at least 50 feet away from the waterbody edge - located at least 50 feet from the waterbody edge	See Section 2.3.8.2.5.6. The proposed additional temporary workspace (ATWS) would be located at least 50 feet from the waterbody edge, topographic and other site-specific conditions permitting.
EPA	9/30/2016	Alaska's Anadromous Waters Catalogue - Alaska's Anadromous Waters Catalog . Previous usage and the ADF&G website do not add the "ue"	See revised text in Section 2.3.8.2.5.10.
EPA	9/30/2016	There would be no grading, and certainly no clearing, involved in construction of the GTP. - There would be no grading and no clearing involved in construction of the GTP.	See revised text in Section 2.3.8.2.6.1.
EPA	9/30/2016	The GTP would use an adfreeze pile foundation "ad-freeze" is previously used	See revised text in Section 2.3.8.2.6.2.
EPA	9/30/2016	Even though water drawdown within that source can lower water levels for that season, spring melt/thaw in the next spring has been demonstrated to recharge these waterbodies to original levels. There is no indication of what source "that source" is referring to. Also, is this trying to say that drawdowns in summer, fall and winter would be recharged during breakup?	Section 2.3.8.2.6.2 has been revised to reflect surface water sources for Gas Treatment Plant (GTP) construction.
EPA	9/30/2016	Underground Injection Wells - Any other section that discusses the use of drilling fluids indicates there could be a potential spill but this section doesn't. Is there something special about drilling UIC wells that makes them immune from potential spills?	UIC permitted disposal wells are engineered and cased wells; therefore, these wells do not represent the same drilling fluid issues (frac-out) associated with HDD. The Applicant will address this comment further prior to the initiation of the EIS Process.
EPA	9/30/2016	Annual maintenance summer dredging is anticipated thoughout the four summer seasons of sealifts… We recommend consideration of maintenance dredging activities in the winter seasons to minimize impacts to the marine environment.	See Section 2.3.8.2.6.8. With the preferred GTP dock location now at DH 4, minimal dredging is anticipated. Section 10.6.4.1.2.1 in Resource Report No. 10 addresses West Dock maintenance dredging for all alternatives.

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EPA	9/30/2016	Based on bathymetric survey data, the sedimentation rate east of West Dock has been estimated at between 0.17 and 0.25 feet per year since the causeway was constructed through 2011. Based on these historic sedimentation rates, a sedimentation rate of 21,000 to 31,000 cubic yards of infill is expected over the course of one year. How do the two sedimentation rates discussed here (one in feet and the other in cubic yards) relate to each other?	The Applicant will address this comment prior to the initiation of the EIS process.
EPA	9/30/2016	Both the PBU MGS project and PTU Expansion project would both be located on the ACP - Change to The PBU MGS project and PTU Expansion project would both be located on the ACP	See revised text in Section 2.3.8.3.
EPA	9/30/2016	Vessel ballast water/cooling water update and/or discharge; and Is “update” supposed to be “uptake”?	See revised text in Section 2.3.9.
EPA	9/30/2016	In addition, ice roads would be needed for maintenance and repair of the associated pipelines. This section is supposed to be talking about the Liquefaction Facility in Nikiski. What pipelines would be serviced there by way of ice roads?	LNG Plant operations (Section 2.3.9.1.1.1) has been edited for inaccurate information.
EPA	9/30/2016	Surface drainage and oily water from process areas would be collected for wastewater treatment. The main discharge location of all treated wastewater containing black and gray water from Project This makes it sound as if domestic wastewater is going to be comingled with other wastewater and if that is the case, the parameters listed below may be more expansive	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
EPA	9/30/2016	Turbidity and sediment in discharge waters to Cook Inlet would be in compliance with the APDES permit and impacts are expected to minor due to the settling basins and the already high turbidity levels in Cook Inlet. The marine turbidity standard is a definitive number which is not based on whether the receiving water turbidity is high	Comment noted.
EPA	9/30/2016	the LNGCs would release the ballast water, As is indicated on the next page, coverage under EPA’s vessel general permit (VGP) would be required for any vessel (foreign or domestic) discharging ballast water (or any other discharge covered by the VGP) within 3 miles of shore	The text has been revised to include these requirements.
EPA	9/30/2016	It is estimated that approximately 2.9 – 3.2 billion gallons of ballast water would be discharged per year from LNGC’s during LNG loading operations at the Marine Terminal; We recommend that the Reports identify all marine	The Applicant will comply with conditions set forth in USCG Ballast Water Management System, EPA Vessel General Permit, and Oil Discharge Prevention and Contingency Plan requirements. Vessels

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		vessels that would require ballast water discharge and estimate the individual and total cumulative volumes of discharge during operations at the Marine Terminal. We recommend including in the Reports a commitment by AK LNG to only use commercial vessels that comply with EPA's Vessel GP, USCG's ballast water management, and the State of Alaska's ODPCP requirements, regardless of which country the vessel is registered.	and sizes would not be known until contractors are selected and final mobilization plans developed.
EPA	9/30/2016	Approximately 1.6-2.4 billion would require engine cooling water.	Section 2.3.9.1.2.3. text has been revised.
EPA	9/30/2016	Neither the uptake of seawater from Cook Inlet nor the discharged cooling water is not anticipated to have any adverse impact on Cook Inlet water quality. does the double negative make it likely to adversely impact WQ?	Section 2.3.9.1.2.3. text has been revised.
EPA	9/30/2016	PTTL: Impacts to surface water from maintenance and repair are anticipated to be long-term but intermittent and minor. PBTL: Impacts to surface water from maintenance and repair are anticipated to be intermittent and minor. Why are impacts from the PTTL expected to be long-term but impacts from the PBTL are not?	The Prudhoe Bay Gas Transmission Line (PBTL) is approximately 2,500 feet long, supported above ground on vertical support members (VSMs) with no buried sections or waterbodies crossed. PTTL is approximately 63 miles long with buried and aerial waterbody crossings.
EPA	9/30/2016	No impacts to groundwater are anticipated under normal treatment and disposal of domestic wastewater. Wastewater treatment systems designed for use in remote, Arctic environments would be used. Impacts to groundwater from domestic wastewater discharge are anticipated to be long-term but intermittent and minor. First it says there are no impacts to groundwater but then it says the impacts will be long term. Are there impacts or not?	The text has been revised in Section 2.3.9.2.1.4 to reflect surface water impacts, not groundwater.
EPA	9/30/2016	dwarf shrub tundra, barrens, and wetlands (Alaska Geobotany Center, Walker et al., 2002). Wetland types are primarily sedge/grass moss wetlands and sedge, moss, dwarf shrub wetlands. Is there a difference between dwarf shrub tundra and dwarf shrub wetlands?	Yes, dwarf scrub-shrub tundra occurs in a tundra landscape (beyond the limit of forest growth and continuous frozen subsoil), while dwarf scrub-shrub wetlands are inundated part of the growing season and have saturated soils.
EPA	9/30/2016	Wetlands are abundant in the Arctic region of the state (USACE, 2007). The Arctic region of the state includes watersheds north of the Brooks Range continuing into the Brooks Foothills. Permafrost impedes drainage in soils, creating saturated soils and associated wetlands in much of the northern region of the state. This basically says the same thing 3 times	See Section 2.4 for clarification regarding wetlands in the Arctic region of the state.
EPA	9/30/2016	A description of the wetland codes used by both systems is provided in Sections 2.4.1 and	Section numbers have been revised.

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		2.4.2 This is section 2.4.1 - the codes are in 2.4.1.1 and 2.4.1.1.2.1. Why are HGM codes listed as separate above but a subsection of Palustrine in the text that follows?	
EPA	9/30/2016	2.4.2 describes existing wetlands (e.g., marine, riverine, lacustrine, estuarine, palustrine). Some but not all are discussed further in later text. Are some not pertinent to the project?	Subsections focus on those features that are prevalent along the route.
EPA	9/30/2016	Wetland Functional Assessment - Clarification should be provided by the Corps on whether the HGM functional assessment is an acceptable functional assessment approach for the AK LNG Project. In other NEPA projects, the Corps has indicated that HGM was not an acceptable functional assessment method for Alaska.	The Applicant and the U.S. Army Corps of Engineers (USACE) are still developing the functional assessment methodology to apply to wetland impacts. This information will be provided in the upcoming permit applications with the USACE.
EPA	9/30/2016	The predominant Cowardin wetland class that would be crossed by the Project is PSS and PEM The predominant Cowardin wetland classes that would be crossed by the Project are PSS and PEM	See Section 2.4.2 regarding the predominant Cowardin wetland classes that would be crossed by the Project.
EPA	9/30/2016	If blasting is considered necessary, The BMPs listed in If blasting is considered necessary, the BMPs listed in	See revised Section 2.4.3.2.1.2.
EPA	9/30/2016	impacted is proved in Appendix E impacted is provided in Appendix E	See revised Section 2.4.3.2.1.3.
EPA	9/30/2016	A spill would potentially impair adjacent wetland functions as previously described for the Liquefaction Facility, as applicable and appropriate. How could impacting wetlands functions be considered appropriate?	Text has been revised in Section 2.4.3.2.2.4.
EPA	9/30/2016	Maintenance and repair activities as the Liquefaction - Maintenance and repair activities at the Liquefaction	See revised text in Sections 2.3.9.2.1.1 and 2.4.4.1.1.
EPA	9/30/2016	and possibly total ammonia, as nitrogen (N), total recoverable copper, and possibly total ammonia as nitrogen (N), total recoverable copper,	See revised text in Section 2.4.4.1.2.
EPA	9/30/2016	Wetland loss would be minimized for in accordance with the Project Mitigation Plan - Wetland loss would be minimized in accordance with the Project Mitigation Plan	See revised Sections 2.4.4.1, 2.4.4.2.1.4, and 2.4.4.2.2..
EPA	9/30/2016	Compensatory Mitigation – We recommend including a conceptual Compensatory Mitigation Plan in the Reports to address the unavoidable impacts to wetlands and other aquatic resources. The Draft Wetland Mitigation Plan (Appendix P) is not complete.	Appendix O of Resource Report No. 2 will be updated and progressed as the USACE permitting process evolves.
EPA	9/30/2016	Floodplains are land areas susceptible of being inundated by floodwaters -Floodplains are land	Section 2.5 has been revised.

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		areas susceptible to being inundated by floodwaters	
EPA	9/30/2016	upon a 100-year base flood (a flood that has a 1 percent probability of occurring in any given year) flooding by a 500-year (0.2 percent annual probability) flood. Once the flood probability has been defined, it shouldn't have to be redefined over and over again (the 1% is defined 3 times on this page alone)	This has been revised throughout the text.
EPA	9/30/2016	has repeatedly flooded annually since 2013 - This seems redundant	The text has been revised to remove the word "annually."
EPA	9/30/2016	Figure 2.5-1. The text spends a paragraph discussing A, V and X zones but then the map doesn't include any depiction of them.	The Applicant will address this comment prior to the initiation of the EIS process.
EPA	9/30/2016	Lower 48 states - Lower 48	See revised text.
EPA	9/30/2016	to be within a Zone VE flood hazard designation. The text on page 2-194 and 195 (E255-256) discusses V and X zones but not VE and subsequently not D or C	The Applicant will address this comment prior to the initiation of the EIS process.
EPA	9/30/2016	The PBTL would not cross any waterbodies and construction would occur during winter, when flood risk is minimal on elevated VSMs. The PBTL would not cross any waterbodies and the construction of elevated VSMs would occur during winter, when flood risk is minimal.	See revised text.
EPA	9/30/2016	Portions of the Marine Terminal would be located in a FEMA-delineated Zone VE flood hazard area…Mitigation measures would include building the facilities above the expected coastal flood elevations, using flood-proofing techniques for facilities in the coastal floodplain, and armoring the shoreline to protect from erosion. We recommend that the Reports identify the specific structural design measures that would be protective of the Marine Terminal and which would require permitting.	The basis of structural design is discussed in Section 13.4 of Resource Report No. 13.
EPA	9/30/2016	Wanty, R. B.; W. Bronwen; J. Vohden; W. C. Day.; and L. P. Gough It should be either B. Wang or Bronwen Wang	The reference text has been revised.
EPA	9/30/2016	the U.S. Environmental Protection Agency (EPA) has promulgated rules (under Section 402{p} of the CWA) for general construction permits that cover the Project. - the U.S. Environmental Protection Agency (EPA) has promulgated regulations in 122.26 to carry out the statutory requirements of 402(p) of the CWA for general construction permits that cover the Project.	See revised Appendix J, Section 1.1.
EPA	9/30/2016	The federal regulations are incorporated by reference into the state APDES regulations in 18 AAC 83.010. More specifically, the storm	Comment acknowledged.

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		water regulations are found in 18 AAC 83.010(b)(3).	
EPA	9/30/2016	in a total land disturbance equal to, or greater than, one acre in a total land disturbance equal to or greater than one acre	See Appendix J, Section 1.1. The Alaska Construction General Permit (ACGP) authorizes stormwater discharges from large and small construction activities that result in a total land disturbance equal to or greater than 1 acre, and where those discharges enter waters of the United States or a municipal separate storm sewer system discharging into waters of the United States.
EPA	9/30/2016	The purpose of a SWPPP is to identify all potential sources of pollution The purpose of a SWPPP is to identify all potential sources of pollutants	See revised Appendix J, Section 1.0.
EPA	9/30/2016	An example NOI form provided in Attachment A. - An example NOI form is provided in Attachment A.	Through revisions this sentence is no longer present.
EPA	9/30/2016	The SWPPP would be made available to ADEC for review and copying as requested and during onsite inspections In addition to being available during inspections, the ACGP requires that the SWPPP be submitted with the NOI requesting coverage under the permit.	Comment acknowledged.
EPA	9/30/2016	A Total Maximum Daily Load (TMDL) is a pollution budget A Total Maximum Daily Load (TMDL) is a pollutant budget	Comment acknowledged. See revised Appendix J, Section 3.2
EPA	9/30/2016	Conditions of the ADEC Certificate of Reasonable Assurance issued under Section 401 of the CWA and in accordance with the Alaska Water Quality Standards would also be adopted for activities associated with the placement of fill material in waters of the United States. Is this saying that some of the BMPs may result in the discharge of fill material into waters of the US that need coverage under a Corps 404 permit?	The statement only indicates that the Applicant would comply with conditions in the 401 WQ certificate (See Section 4.1 of Appendix J).
EPA	9/30/2016	approximately 300,000 gallons per day, or 250 gallons per minute. 250 gpm = 360,000 gpd (250 x 60 x 24)	At peak, onsite water demand for construction of the Liquefaction Facility would be approximately 300,000 gallons per day, or 250 gallons per minute.
EPA	9/30/2016	but is pneumatically tested with air. “pneumatically” and “with air” are redundant	Comment acknowledged. See revised Appendix K, Section 2.1
EPA	9/30/2016	Peak water demand would occur during hydrotesting of the LNG tanks (if freshwater is used for tank testing). Why would the water demand be different if marine water is used? Or is this just discussing freshwater demand?	This is just discussing freshwater demand if seawater is not used to test the tanks.
EPA	9/30/2016	In most instances, the hydrostatic test water would have similar water-quality characteristics as the source waterbody. It states earlier that hydrostatic water would be sourced from Cook	All hydrotest water will eventually be discharged back to the Cook Inlet after appropriate treatment, so if the source was from the Cook Inlet, then the composition

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		Inlet? Where else might it be discharged back to that would have similar characteristics but not be the Inlet?	will be similar. If the source was fresh water, then the composition will be different and ADEC may place some restrictions on the mixing rate under which fresh water can be disposed.
EPA	9/30/2016	North Slope (when a minimum 15 centimeters (6 inches) of snow cover is available and ground hardness reaches a minimum of 75 drops of a slide hammer to penetrate 1 foot of ground (ADNR 2004). The first opening parentheses has no corresponding closing one	See revised text.
EPA	9/30/2016	Once operations begin at the facility the camp would continue to support construction operations. What construction would continue after operations begin?	See revised text in Appendix K, Section 2.1.4.
EPA	9/30/2016	Approximately 53.35 million gallons per year when the camp is fully occupied, estimated at 1,680 people. The estimated raw water demand per person is estimated at 95 gallons of raw water per person per day. 1680 x 95 x 365 = 58.25 mgal/yr (53,350,000/95)/365 = 1538 people	These are average estimates, not fixed per person.
EPA	9/30/2016	One or more new water wells (bores) would be constructed on the Liquefaction Facility site's northeastern boundary, providing 250 gallons per minute (1.4 million gallons per day) 250 gpm only provides 360,000 gpd. Does this really mean that at least 4 wells operating at this rate would be necessary? (1.4m/360000 = 3.9)	Yes, see Section 2.3.1 of Appendix K.
FERC	10/26/16	1. The following commitments were made by AKLNG in resource report as information to be provided or pending in response to previous comments made by FERC or other agencies. If the information will not be included in the application as indicated by Alaska LNG, provide a schedule for when it will be filed with FERC or provided to the requesting agency as applicable.	Comment acknowledged.
FERC	10/26/16	a. Groundwater studies (field research) in proposed Liquefaction Facility Project area. (sec 2.2.8.1.4, pg 2-40; sec 2.2.9.1.2,pg 2-54)	See Section 2.2.3 and Appendix S - LNG Facilities Onshore Hydrogeological Report.
FERC	10/26/16	b. A wetland mitigation plan for unavoidable wetland losses (section 2.4.3.2.1.1, page 2-172)	Appendix O of Resource Report No. 2 will be updated and progressed as the USACE permitting process evolves.
FERC	10/26/16	c. A detailed revegetation and restoration plan for wetlands along the mainline. (section 2.4.3.2.1.1, page 2-173)	See Appendix P of Resource Report No. 3.
FERC	10/26/16	d. Results of the sediment grab samples taken within Cook Inlet. (section 2.3.2.2.1.3, page 2-71)	See revised text. See also Appendix Q (sediment sampling results in Cook Inlet).

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Agency	**Date**	**Comment**	**Response/Resource Report Location**
FERC	10/26/16	e. The Project Dredging Plan that describes the dredging mitigation measures that would be implemented. (section 2.3.11.1.1.1, page 2-109)	A Dredging Plan would be developed prior to permitting the proposed dredge activity. The Applicant will address this comment further prior to the issuance of the DEIS.
FERC	10/26/16	f. Results of the sediment sampling at the Liquefaction Facility MOF dredge site and confirm the absence or presence of contaminants and, if present, quantify the levels. Additionally, complete this same request for all areas of proposed dredging. Include detailed characterization data for the sediments in Cook Inlet (e.g., grain size, composition, contamination) within areas that would be dredged. Include sediment characterization for the sediments and associated containments that could be suspended as a result of Project activities. Include data characterizing the circulation (range of speeds and directions) and water column (range of salinity and temperature) within Cook Inlet and Prudhoe Bay local to any planned discharges or sediment generating activity, including dredging. (section 2.3.11.1.1.1, page 2-109)	See Appendix Q - Analytical Results of Sediment Sampling Near the Marine Terminal in Cook Inlet and Appendix R - Sediment Chemical Analytical Data for West Dock Trench Test Sites of Resource Report No. 2. The Applicant will address this comment further after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	g. New information from field research by the Project and others who are preparing a study to model the hydrogeology and water quality of the groundwater at the Liquefaction Facility site. (section 2.2.6.1, page 2-26)	Section 2.2.7.1 has been revised with new information from the 2016 summer field studies. See Appendix S - 2016 Hydrogeological Report for detailed data.
FERC	10/26/16	h. The overall Contractor Blasting Plan and a written Site-Specific Blasting Plan to be submitted to FERC for approval in its Project Implementation Plan. (section 2.2.8.2.1.1, page 2-46; section 2.3.11.2.1.1, page 2-127; appendix O; Resource Report 6 appendix B)	This would be completed once construction contractors have been selected, prior to construction.
FERC	10/26/16	i. Navigable waterbody determinations by U.S. Coast Guard, and subsequent crossing descriptions and impact analysis. (section 2.3.7.6, page 2-102)	Section 2.3.7.6 has been revised with information from the USCG Bridge Division.
FERC	10/26/16	j. Streambed sampling to support construction crossing method selection. (section 2.3.10)	Streambed sampling is planned for major waterbodies that will utilize the open cut crossing method. The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	k. Surface water withdrawal rates for all surface water withdrawals. (sec 2.3.11, page 2-107 and sec 2.3.11.2.1.1, page 2-125; app L)	Expected water usage is reported in the Water Use Plan (Resource Report No. 2, Appendix K), but the requested rates of water withdrawal will be provided to the jurisdictional state agency in permit applications filed in each year of construction. The Applicant will address this comment after the FEIS but prior to construction start.

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FERC	10/26/16	l. More specific information on water source locations and any proposed treatment. (section 2.3.11.2.1, page 2-116)	The pool of potential locations is provided in the Water Use Plan (Resource Report No. 2, Appendix K), with more specific information to be provided to the jurisdictional state agency prior to construction. No treatment is planned at this time. The Applicant will address this comment after the FEIS but prior to construction start .
FERC	10/26/16	m. Geotechnical investigations, likely success of each horizontal directional drill (HDD), and contingency crossing methods. (section 2.3.11.2.1.1, page 2-120)	The Applicant will address this comment after the FEIS but prior to construction start.
FERC	10/26/16	n. Site-specific plans for each crossing of major rivers with braided channels. (section 2.3.11.2.1.2 page 2-130; appendix J)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	o. The locations and schedules for heavy lifting vessel maintenance (including dry dock and in-water hull scraping locations and maintenance schedule). (e.g., section 2.3.12.1.2.2, page 2-154)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	p. Wetland field survey data. (section 2.4.2-1, page 2-164, appendix G)	Appendices F and G of Resource Report No. 2 will be updated with the most recent field survey data.
FERC	10/26/16	q. A final wetland report (currently appendix G), including an explanation of the timeframe and context of all data collected, and updates of older data from additional field sample points north of Livengood. (section 2.4.2, page 2-164; appendix G)	Appendix G has been updated to provide a compilation of past wetland study reports prepared for the Project. Discussion of timeframes, protocols, and updates of older data are discussed in the study reports.
FERC	10/26/16	r. Wetland functional assessment/aquatic site assessment methodology selected based on discussions with agencies, including modifications for Alaska (e.g., permafrost wetlands). (section 2.4.2.1, page 2-168)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	s. Results of the wetland functional assessment/aquatic site assessment. (section 2.4.2.1, page 2-168)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	t. A wetland mitigation plan. (section 2.4.3.2.1.1, page 2-172; appendix P)	The Applicant has prepared a Draft Wetland Mitigation Plan (Plan) to address avoidance, minimization, and introduce potential plans for offsetting mitigation (See Appendix O). The Plan would be completed following finalization of the Project footprint, additional agency consultation, and completion of the functional assessment. The final Plan would be approved by the USACE and incorporated into the individual permit by reference.

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Agency	**Date**	**Comment**	**Response/Resource Report Location**
FERC	10/26/16	u. Updated agency consultations regarding wetland mitigation, special permits required for construction within wetlands, and wetland permitting requirements with the EPA and COE. (section 2.4.3.2.1.1, page 2-172; appendix P; Resource Report 1 appendix D)	The Applicant will address this comment prior to the initiation of the EIS process.
FERC	10/26/16	v. Information regarding details for optimizing Route Revision B, including alignment relative to the railroad and wetlands. (section 2.4)	Route revision C2 incorporates changes made to avoid wetland impacts (see Resource Report No. 10, Section 10.4.4.3)
FERC	10/26/16	w. Updated wetland impact acreages based on completion of field surveys. (sections 2.4.3 and 2.4.4).	Appendices F and G of Resource Report No. 2 would be updated with the latest field survey reports and the wetland impact tables would be updated, as needed.
FERC	10/26/16	x. Additional information regarding frost bulb minimization measures at waterbody crossings. (section 2.5.5.2.1.1, page 2-229)	The Applicant will address this comment prior to the initiation of the EIS process.
FERC	10/26/16	y. Site-specific construction drawings and site-specific wetland crossing plans. (appendix I)	Site-specific wetland crossing plans are not required at this time.
FERC	10/26/16	z. Details regarding summer and winter waterbody streambed restoration methods (to re-establish native substrate). (appendix O)	See additional details in Appendix N, Section V. Waterbody Crossings, C. Restoration
FERC	10/26/16	aa. Hydrostatic testing discharge locations, with the volume of water to be discharged at each location, and a description of additives. (appendix L)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	bb. The method/procedure for documenting water chemistry of test water prior to discharge to ensure test water discharges meet Alaska Department of Environmental Conservation (ADEC) water quality standards (e.g., removal of biocides) (to be identified per the ADEC new discharge general permit requirements: expected to be issued in 2016). (appendix L)	This will be updated when the new general permit requirements are issued.
FERC	10/26/16	cc. The flow rates and designated use by source for Project water withdrawals. (appendix L)	Expected water usage and the pool of potential locations for withdrawal are reported in the Water Use Plan (Resource Report No. 2, Appendix L), and the requested rates of water withdrawal will be provided to the jurisdictional state agency in permit applications filed in each year of construction. The Applicant will address this comment further after the FEIS but prior to construction start.
FERC	10/26/16	dd. Updates to the Potential Mainline Water Sources, Potential PTTL Water Sources, and Natural Lakes that are Potential Water Sources to Support GTP Construction. (appendix L)	The Water Use Plan (Appendix K) may be refined through agency consultation and updated before permitting. The purpose of the document is to show the potential sources of water and solicit comments from permitting agencies.
FERC	10/26/16	2. Resource Report 2 discusses the preparation of groundwater studies and a model of the hydrogeology and water quality of	Sections 2.2.7.1, 2.2.9.1.4 and 2.2.10.1.2 have been revised with new information. See Appendix S for further information on

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		groundwater at the Liquefaction Facility site. (section 2.2.6.1, page 2-26; section 2.2.8.1.4, page 2-40; and section 2.2.9.1.2, page 2-54). However, we further need the information identified below:	the hydrogeological setting and conceptual hydrologic model of the proposed LNG site.
FERC	10/26/16	a. a groundwater study plan that explains in detail the elements of the study and the model objectives; and	See Appendix S - LNG Facilities Onshore Hydrogeological Report.
FERC	10/26/16	b. a description of the type of model to be used (analytical, numerical), including: i. model calibration parameters; ii. simulation scenarios of groundwater flow (pre- and post-pumping); iii. long-term water-level drawdown impacts on the aquifer and to nearby groundwater users; iv. solute transport from potential saltwater intrusion/movement of the freshwater/saltwater interface; and v. contaminant transport/groundwater plume migration from existing contaminated sites within liquefaction facility footprint and 0.25 mile of facility footprint due to Project pumping (include distance from each contaminated site to each proposed facility production well).	See Appendix S - LNG Facilities Onshore Hydrogeological Report.
FERC	10/26/16	3. Resource Report 2 states that the unconsolidated aquifer system in the Cook Inlet Basin ecoregion provides approximately 3.5 million gallons per day of groundwater for industrial use and 1 million gallons per day for public water supply. Include a map depicting the location for each major pumping center(municipal, industrial) in proximity to the Liquefaction Facility; the daily rate of pumping; the pumping cone of influence in relation to the proposed Liquefaction Facility production wells; and the combined water-level drawdown and area of influence for these pumping centers. (section 2.2.9.1.2, page 2-54)	The outdated text in Section 2.2.10.1.2 has been revised for industrial groundwater withdrawals near the Liquefaction Facility. See Table 2.2.1 in Appendix S for a summary of production wells within 2 miles of the proposed Liquefaction Facility.
FERC	10/26/16	4. Identify and discuss any existing saltwater intrusion that maybe occurring in the vicinity of the Liquefaction Facility due to existing pumping stress on the glacial aquifer system. (section 2.2.9.1.2, page 2-54)	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	5. For the Liquefaction Facility, include an analysis that shows the long-term impacts from the combined pumping of groundwater from existing pumping groundwater use along with the planned Project increase of 5 percent of demand on the aquifer system (see comment 3, above). (section 2.2.9.1.2, page 2-54)	See Appendix S - LNG Facilities Onshore Hydrogeological Report.
FERC	10/26/16	6. Resource Report 2 states that "In 2015, groundwater monitoring wells were installed at the liquefaction facility to delineate aquifers and aquitards and to provide means to develop an understanding of aquifer characteristics including artesian conditions, variations in	Section 2.2.3 has been updated with results from recent field studies. See Appendix S - LNG Facilities Onshore Hydrogeological Report for delineated aquifers occurring in the proposed LNG site.

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		hydraulic conductivity, occurrence, elevation fluctuations, tidal impacts, gradient and flow directions." Incorporate these data into the groundwater studies, groundwater impact analysis, and groundwater modeling results. (see comment 3, above). (section 2.2.3, page 2-20)	
FERC	10/26/16	7. Include a groundwater use monitoring plan or revise the existing groundwater monitoring plan to include proposed monitoring and mitigation of the glacial aquifer system during construction and operation of the Liquefaction Facility. The plan should include the equipment and procedures for monitoring groundwater levels and water-quality parameters in the aquifer to mitigate the potential effects of (appendix B): a. saltwater intrusion and/or mobilization of freshwater/saltwater interface due to 5 percent demand increase on the aquifer system; and b. groundwater contaminant plume(s) migration toward Project or other area- use groundwater production wells.	Appendix B of Resource Report No. 2 - Groundwater Monitoring Plan would be updated and available prior to construction to coincide with permitting requirements.
FERC	10/26/16	8. There appear to be discrepancies between the percentages of groundwater uses listed in section 2.2.1 and the information listed in table 2.2.1-1. Clarify these apparent discrepancies. (section 2.2.1, page 2-15).	See revised Section 2.2.1.
FERC	10/26/16	9. Update table 2.2.1-2 to include borough/census area, range in depth to the aquifer, if the aquifer is confined or unconfined, water quality characteristics, major uses, and well yield (gallons/day), per the FERC comment on page 2-xvi. The response provided on page 2-xvi references a footnote in table 2.2.1-2 that does not address the comment regarding confined/unconfined aquifers. (section 2.2.2.1, page 2-17)	Table 2.2.1 represents a generalized map of boundaries interpreted from surface location outcrop that was digitized for spatial use. This feature class does not provide attributes for aquifer characteristics.
FERC	10/26/16	10. Section 2.2.4 indicates "A similar aquifer in the upland areas of Anchorage is made of fractured slate and metagraywacke. The associated wells supply water to numerous domestic wells." Clarify whether this aquifer is in the Project area. If so, update table 2.2.1-2 to include information about this aquifer. (section 2.2.2.1, page 2-18; section 2.2.4, page 22)	These aquifers are outside of the proposed Project footprint. Section 2.2.2.
	10/26/16	10. Section 2.2.4 indicates "A similar aquifer in the upland areas of Anchorage is made of fractured slate and metagraywacke. The associated wells supply water to numerous domestic wells." Clarify whether this aquifer is in the Project area. If so, update table 2.2.1-2 to include information about this aquifer. (section 2.2.2.1, page 2-18; section 2.2.4, page 22)	The text in Section 2.2.4 has been revised to clarify that Anchorage's local aquifer is not crossed by the Project.

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FERC	10/26/16	11. Clarify the statement, "Depth to groundwater for the monitoring that differs in terms of physiography and climate, affecting groundwater movement and storage." (section 2.2.3, page 2-20)	Section 2.2.3 has been revised with new information from the 2016 Hydrology field studies. Depth to groundwater varies on the proximity of subsurface lithology, see section 2.2.9.1. The Applicant will address this comment further prior to the initiation of the EIS process.
FERC	10/26/16	12. Resource Report 2 states that wells within 150 feet from the Project footprint were identified using Alaska Department of Natural Resources' (ADNR) Well Log Tracking System and listed in appendix A. Appendix A appears to include wells within 500 feet of the Project. Confirm whether wells within 150 feet or 500 feet from the Project footprint were identified using ADNR's Well Log Tracking System or field survey. (section 2.2.7, page 2-29; appendix A)	The text has been modified to state 500 feet instead of 150 feet.
FERC	10/26/16	13. As requested in the ADEC comment on page 2-iii, describe how owners of wells within 500 feet of Project facilities would be notified regarding the planned Project. (section 2.2.7, page 2-29; appendix C)	They will be notified by letter.
FERC	10/26/16	14. Clarify that public water system contacts would be notified when working in the permitted Public Water System Drinking Water Protection Areas (regardless of whether it is determined that construction or other intrusive earth moving activity would result in impacts), as requested by ADEC. (section 2.2.7.1, page 2-33)	If any public water system protection area were to be impacted by construction, the Applicant would notify the public water system operator of the intended construction start dates and activity.
FERC	10/26/16	15. Include a copy of the guidance document from the ADEC Drinking Water Protection group as a reference to support mitigation measures developed for the Stormwater Pollution Prevention Plan. (section 2.2.8, page 2-35)	Once the document has been prepared and issued it will be provided to FERC.
FERC	10/26/16	16. Identify the depth of Marine Terminal piles in reference to geophysical or geotechnical investigation to justify the statement, "The piles [for the Marine Terminal] are not anticipated to be of sufficient depth to penetrate marine aquitard layers or influence saltwater encroachment into the groundwater table" (section 2.2.8.1.2, page 2-38), and include cross-sections orientated perpendicular to each other that:	See Resource Report No. 1, Section 1.3.1.2, Figure 1.3.1-3 and Appendix E - Typical Drawings for cross-section view of the Marine Terminal.
FERC	10/26/16	a. depict subsurface stratigraphy;	Some well logs are provided in Appendix S that depict stratigraphy in the LNG plant area.
FERC	10/26/16	b. depict depth of pilings relative to potable aquifers, semi-confining and confining units; and	Additional information is provided in Appendix S.

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FERC	10/26/16	c. identify water-quality (total dissolved solid concentrations) characteristics with depth.	The Applicant will address this comment after the FEIS but prior to construction start.
FERC	10/26/16	17. Identify the locations and depths of the proposed groundwater production wells in the Liquefaction Facility area. Include data to support the statement, "This location has been proposed because it presents high groundwater yield potential, and it is sufficiently removed from the coastal bluff to minimize the potential for saltwater intrusion."	The Applicant will address this comment after the DEIS but prior to the issuance of the Final EIS (FEIS).
FERC	10/26/16	18. Include data or a more detailed plan to support the statement, "If groundwater is used for hydrostatic testing of plant piping, the withdrawal rate of fresh water from the onsite construction [production] wells would be reduced to the extent practicable to reduce the potential for local groundwater drawdown." For example, what data or studies would Alaska LNG use to determine the threshold for local groundwater drawdown? (section 2.2.8.1.5, page 2-41)	The text was meant to imply that there is an upper limit of fresh water availability and there is a need to generate a volume of fresh water for hydrotesting with other (non-hydrotest) site/construction uses curtailed to while the volume of hydrotest water was obtained. The threshold for groundwater draw-down would most likely be set based on the pump test results and the aquifer modelling in conjunction with consultation with ADEC (or another appropriate local agency). See Appendix S, LNG Onshore Facilities Hydrogeologic report.
FERC	10/26/16	19. For water usage at the proposed Mainline construction camps, clarify/include additional detail in section 2.2.8.2.1.1 on how groundwater levels in area wells would be monitored if it is found that groundwater production exceeds natural aquifer recharge and if drawdown impacts from Mainline construction camp production wells would impact area wells. (section 2.2.8.2.1.1, page 2-45)	The Applicant will address this comment after the FEIS but prior to construction start.
FERC	10/26/16	20. Include site-specific dewatering/trenching plans around known contaminated sites. (section 2.2.8.2.1.1, page 2-46)	The Applicant has not identified any known contaminated sites within the current Mainline centerline that will require site specific plans for dewatering/trenching around contaminated soils. Unanticipated Contamination Discovery Plan in Resource Report No. 8, (Appendix I) would be implemented if previously unknown contaminated or buried waste was found during construction activities on the site.
FERC	10/26/16	21. Confirm that public water supplies are not anticipated to be used for Project. (sec 2.2.9.1.2, page 2-54; sec 2.2.9.2.1.6, page 2-56)	No public water supplies would be used for Project construction or operations.
FERC	10/26/16	22. Include details for potential blasting at the Ray River, Minto, and Honolulu compressor stations and potential impacts on local groundwater resources. (section 2.2.8.2.1.4, page 2-50)	The Applicant will address this comment after the FEIS but prior to construction start.
FERC	10/26/16	23. Include in detail a plan for the planned Project Underground Injection Control (UIC)	Requirements set forth in 40 CFR 146.12 would be provided in the permit application

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		wells; and discuss potential impacts on local aquifers from the use of new or existing UIC wells for the disposal of wastewater and other effluents generated during the construction and operation of the Project. The plan should include:	for the proposed GTP UIC well(s). A detailed underground injection control (UIC) plan would be filed prior to construction for the proposed use of an existing UIC well.
FERC	10/26/16	a. the location and EPA UIC well-class designation for each existing and/or proposed UIC well;	Existing and proposed UIC well locations would be provided during permitting and prior to construction.
FERC	10/26/16	b. subsurface stratigraphy relative to the local potable aquifer(s), UIC well(s) depth and disposal formation/horizon relative to potable aquifers;	No underground sources of drinking water would be used in accordance with 20 AAC 25.440, 40 CFR 144.7 and 146.7.
FERC	10/26/16	c. water-quality of the disposal horizon;	See above.
FERC	10/26/16	d. construction schematics for each existing or proposed new UIC well(s);	See above.
FERC	10/26/16	e. UIC well construction parameters that would be used to prevent cross contamination of potable aquifers during operation of these Project UIC wells (e.g., grouting around the well to prevent waste from migrating to and contaminating the overlying aquifer) (section 2.2.8.2.1.4, page 50; section 2.2.8.2.1.5, page 2-52); and	See above.
FERC	10/26/16	f. an analysis of the subsurface geologic structure (faults and folds) and the potential for induced seismicity during long-term operation of the Project UIC wells.	This would be provided in the UIC permit application prior to construction.
FERC	10/26/16	24. Include additional details regarding how proposed locations of domestic wastewater treatment systems would be evaluated at remote site locations associated with pipeline aboveground facilities to prevent groundwater contamination. (section 2.2.8.2.1.5, page 2-52)	These locations will be determined prior to construction, once contractors have been selected.
FERC	10/26/16	25. Include analysis to support the assertion that groundwater withdrawal for operation of pipeline aboveground facilities is not anticipated to cause a significant drawdown of the local water table. Identify the proposed locations and depths of new and/or existing groundwater wells that would be used to provide water for the Project. (section 2.2.9.2.1.6, page 2-56)	Pipeline aboveground facilities (i.e., compressor stations) are unmanned and require no groundwater to operate machinery and very little water required when personnel are there. See revised text in Section 2.2.10.2.4.2.
FERC	10/26/16	26. Address the potential for impacts of material site development, including blasting, on water wells within 500 feet of proposed material sites. For example, alternate material site 35-3-016-1 FP is located immediately adjacent to Byer's Lake campground in Denali State Park, which has a water well that may be within 500 feet of the Project. (appendix A)	Potential impacts to water wells from material site development is discussed in Section 2.2.9.2.1, Appendix C - Water Well Monitoring Plan and Resource Report 6, Appendix F - Gravel Sourcing Plan and Reclamation Measures.

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FERC	10/26/16	27. Resource Report 1 cited the potential need for maintenance dredging at the Marine Terminal (1.4.1.2.1), which includes the MOF and approaches; however, Resource Report 2 states that there would be no maintenance dredging at the MOF during operations. Clarify this apparent discrepancy. (section 2.3.12.1.2.4 , page 2-155)	Maintenance dredging is only required during the period of construction of the Liquefaction Facility (7 to 10 years).
FERC	10/26/16	28. Resource Report 1 mentions potential minor dredging needed near the sealift bulkhead at the Point Thomson facility (section 1.3.9.2.1). However, there is no mention of this activity in Resource Report 2. Include clarification in Resource Report 1 as to whether or not minor dredging is needed and if needed include details of the dredging and impacts in Resource Report 2.	Minor dredging would be required, but no additional information is available from the proponent of that facility. It is the Applicant's understanding that this dredging is less than that undertaken during the construction of that facility.
FERC	10/26/16	29. PLF is an acronym used in the text that is not included in the acronyms list for Resource Report 2. Please confirm that all acronyms are included in the Acronyms and Abbreviations table starting on page 2-1Vii. (section 2.3.11.1.1.2, page 2-111)	The Product Loading Facility (PLF) is included in Acronyms and Abbreviations.
FERC	10/26/16	30. Ensure that appendices R and S are correctly referenced in section 2.3.2.2.6. (section 2.3.2.2.6, page 2-77)	References have been corrected.
FERC	10/26/16	31. Include sediment grain size distribution for the proposed West Dock site. (section 2.3.2.2.6, page 2-77)	See revised text in Section 2.3.1.2.4 to include sediment composition at the proposed West Dock site.
FERC	10/26/16	32. The bullets of potential construction impacts do not include increased vessel traffic. Add vessel traffic as a construction impact and discuss any avoidance, minimization, or mitigation measures that would be developed. (section 2.3.11, page 2-106)	Increased vessel traffic impacts are addressed in Resource Report No. 3.
FERC	10/26/16	33. The Liquefaction Facility MOF dredging discussion indicates that increased turbidity will be localized and short-term. Include quantitative details of the meaning of short-term and localized as it pertains to this activity as well as information supporting these findings. Include quantitative metrics to describe the plume concentration, extent, and duration and an estimate of the depth of the resultant sedimentation (section 2.3.11.1.1.1, page 2-108 for Liquefaction Facility; section 2.3.11.2.1.5, page 2-134 for West Dock; section 2.3.11.2.1.5, page 2-137 for Beluga MOF). Please include similar analysis for all proposed dredging sites (e.g., Product Loading Facility, Beluga MOF, West Dock).	Quantitative modeling would be performed, if required, during permitting with the USACE and ADEC.
FERC	10/26/16	34. Include Project Dredging Plans which describe the mitigation measures that would be implemented for each of the proposed dredging	Dredging plans for Cook Inlet would be developed prior to permitting the activity. No dredging is proposed at West Dock.

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		sites (e.g., Liquefaction Facility MOF and Product Loading Facility, Beluga MOF, West Dock). (section 2.3.11.1.1.1, page 2-109)	
FERC	10/26/16	35. Include the results of the sediment sampling at proposed dredge sites (e.g., Liquefaction Facility MOF, Beluga MOF, West Dock), confirm the absence or presence of contaminants, and quantify the levels of contamination(section 2.3.11.1.1.1, page 2-109). Also, explain the use of the sampling locations illustrated on figure 2.3.2-3, page 2-66, which are not within the proposed dredging area, as data for analysis of the dredge at the Liquefaction Facility.	Sediment sampling results for proposed dredge locations would be provided during the DEIS review.
FERC	10/26/16	36. The discussion of dredging impacts presents a current scatter table and current rose diagrams for one of the two National Oceanic and Atmospheric Administration Current stations in the area, Station COI0802. Include a scatter table and rose diagrams for station COI0504, as well, and illustrate location of both observation stations. (section 2.3.11.1.1.1, page 2-109)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	37. Include details on the site-specific current measurements performed in 2015−2016 by Alaska LNG. Include the following items (section 2.3.11.1.1.1, page 2-111)	See below
FERC	10/26/16	a. a description or map illustration of measurement locations;	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	b. a description of the observations gathered;	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	c. a description of the analysis used to develop the speeds at various return periods as summarized in table 2.3.11-2; and	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	d. a scatter table and current rose of the site specific record.	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	38. The marine waters background conditions at the Marine Terminal site are characterized as very turbid. Include quantitative metrics of the existing turbidity. (section 2.3.11.1.1.2, page 2-111)	Section 2.3.1.1.4 has been revised.
FERC	10/26/16	39. Section 2.3.11.1.1.3 contains Navigation and Vessel Traffic but does not include mention of potential spills. Include an analysis of potential vessel spills and associated impacts during construction, including spills of fuels, lubricants, or solvents and any measures to avoid, minimize, or prevent potential impacts. (section 2.3.11.1.1.3, page 2-111)	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	40. Include supporting information and analysis that was performed to conclude that vessel movements during Liquefaction Facility operations will not contribute to ambient	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.

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		turbidity or shoreline erosion near the Marine Terminal during construction. (section 2.3.11.1.1.3, page 2-111)	
FERC	10/26/16	41. Include details on the potential spills that may occur during clearing and grading at the Liquefaction Facility as well as supporting information as to how the conclusions of temporary and minor impacts were drawn and any measures to avoid, minimize, or prevent potential impacts. (section 2.3.11.1.2.1, page 2-112)	Potential fluid leak sources are hydraulic fluid from hydraulic lines and connections that fail and diesel fuel during refueling activities. The volumes in both cases are relatively low and clean-up is easy, and nothing of any major consequence is permanently impaired. Mitigation methods include: a) use of environmentally friendly hydraulic fluid and lubricants, b) making sure all equipment is parked when not in use in designated areas that are designed to capture leaked fluids in the event they occur, c) performing refueling activities in designated areas designed to capture spilled diesel, d) requiring equipment providers to put new hydraulic lines and couplings on all equipment when mobilized to site and at certain intervals thereafter, e) more frequent visual inspections and f) operator training.
FERC	10/26/16	42. Identify the locations and include a map of construction stormwater runoff discharges that would be directed into Cook Inlet. (section 2.3.11.1.2.1, page 2-112)	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	43. Include details on the location and intake characteristics, including rate of withdrawal, of the hydrostatic test water intake from Cook Inlet. Assess whether impingement and entrainment would occur and any measures to avoid, minimize, or prevent potential impacts. (section 2.3.11.1.2.5, page 2-114)	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	44. Include supporting information relevant to the temporary domestic wastewater treatment plant discharge including the following. (section 2.3.11.1.2.8, page 2-115): a. a location of discharge into Cook Inlet with associated map, and b. a description of whether constituent concentrations would be met at the end of the pipe or the end of a mixing zone. If a mixing zone is required, include an analysis of the discharge that illustrates that concentrations are met at the edge of the mixing zone.	The Applicant will address this comment after the DEIS but prior to the issuance of the FEIS.
FERC	10/26/16	45. Section 2.3.11.1.2.9 pertaining to Fuel Use, Storage, Refueling, Lubrication, and Spill Control Measures during Liquefaction Facility Construction, redirects the reader to section 2.2.8.1.9, which pertains to spills from upland activities. Include an analysis of impacts and proposed mitigation for potential spills within or reaching marine waters. In addition, include an offshore/marine Spill Prevention, Control, and Countermeasure Plan (section 2.3.11.1.2.9, page 2-115). In conjunction with and as part of	The Applicant will address this comment after the FEIS but prior to construction start.

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		the development of a marine Spill Prevention, Control, and Countermeasure Plan, include an assessment of the likelihood of vessel spills and the associated impacts due to the increased vessel traffic at the Marine Terminal during operations. (section 2.3.12.1.2.3, page 2-154)	
FERC	10/26/16	46. Mainline construction methods described along the beachfront and across Cooke Inlet are noted as potentially resulting in increased turbidity and dismissed based on the background levels of turbidity in Cook Inlet. Include more detail as to how water quality standards would be monitored both nearshore and during the crossing, as well as during hydrostatic testing and potential discharge to Cook Inlet. Evaluate if parameter limits other than turbidity may be elevated during construction and best management practices that will be used to minimize these elevated parameters. Include descriptions of monitoring of water quality during construction and intended monitoring of restoration of the beachfront post- construction. (section 2.3.11.2.1.1, pages 2-122 and 2-123)	Effluent limitations and requirements for hydrostatic discharge (Discharge 005) would be per AKG320000 - Statewide Oil and Gas Pipelines General Permit conditions.
FERC	10/26/16	47. Include analysis and supporting information regarding the impacts on water quality of Cook Inlet based on the anticipated discharges of 2.9 to 3.2 billion gallons of ballast water into the inlet. include specifications and parameter limits, mitigation measures, and other relevant standards required to comply with Vessel General Permit (VGP) for vessels associated with the Project. (sec 2.3.12.1.2.2, pg 2-154)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	48. Include details of the analysis of the cooling water discharge that was performed in order to determine the extent and magnitude of the thermal plume from vessels at the Marine Terminal. Include details of the assessment parameters including discharge flow rates analyzed, location of discharge, current conditions analyzed, and initial temperature differentials analyzed. (section 2.3.12.1.2.3, page 2-154)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	49. Correct the title for appendix J (waterbody crossings not wetland crossings).	The Appendix I title has been revised.
FERC	10/26/16	50. Confirm that the relevant permit regarding the use of dredged materials from the Division of Mining, Land, and Water for the use or removal of dredged materials	Section 2.3.8.1.2.1 has been edited to include applicable ADNR authorizations for dredged materials in State waters or lands.
FERC	10/26/16	51. Specify which of the consultations in Section 2.1.4 (table 2.1.4-1) are related to the sensitive waters listed in Section 2.3.7. In Section 2.3.7, describe the mitigation measures that would be implemented for any sensitive	Table 2.3.5-1 and Appendix H identify sensitive waterbodies. A site-specific crossing plan for the Deshka River can be found in Appendix I. The preferred crossing method is DMT (directional micro-tunnel).

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		waters crossed, and identify the sensitive waters in table 2.3.10-1. (sections 2.1.4, 2.3.7,and 2.3.10)	
FERC	10/26/16	52. Discuss whether seeps are known to be present or have the potential to be present in the Project area. Include a discussion of how seeps are associated with taliks, and potential impacts related to seeps and springs. Describe the aquifer and bedrock in the area of the seep that is within 94.4 feet of the Mainline identified in Section 2.2.5. Describe the potential impact of construction activities on the seep and specific mitigation measures, as the seep is not specifically addressed in Section 2.2.8 or 2.2.9. (section 2.2.5, page 2-24)	Potential impacts of construction activities on seeps/springs and specific mitigation measures are discussed in Section 2.2.6 and identifies that such work will be done on a case-by-case basis and as needed during construction.
FERC	10/26/16	53. Clarify whether the EPA drinking water quality standard of 10 micrograms per liter (µg/L) would be applied for comparison of arsenic concentrations, or the Alaska drinking water quality standard of 50 µg/L. (sections 2.2.6.1 and 2.2.6.2.5, pages 2-25 and 2-28)	The Alaska drinking water quality standard would be applied. The text has been updated to clarify this.
FERC	10/26/16	54. Describe Alaska LNG's planned method to avoid withdrawing contaminated groundwater or surface water. (section 2.2.8.1.3, page 2-40 and/or appendix L)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	55. Describe the Cook Inlet and Prudhoe Bay ecosystems, or refer to the appropriate sections where the information is located. (section 2.3.2.1.1, page 2-59)	The sections following Section 2.3.1.1 describe the marine environments of Cook Inlet and Prudhoe Bay in detail.
FERC	10/26/16	56. Include a description of and data on historic ice scour along the pipeline route, including the depth of past scour and its potential to damage the planned pipeline. Include a discussion of how beach ice (Stamukhi) and river/estuary ice affects the marine environment. (section 2.3.2.1.1.5, page 2-65 to 70)	Sections 2.3.1.1.1 and 2.3.1.1.5 have been revised for ice events occurring in the marine environments.
FERC	10/26/16	57. Describe the rationale and criteria used to determine waterbody crossing methods presented in table 2.3.10-1 (e.g., HDD and aerial). (section 2.3.10, page 2-105; appendix J)	General rationale and criteria used to determine stream crossing modes, including major waterbodies listed in Table 2.3.7-1, are presented in Section 2.3.7.1. See also Attachment E of Appendix M of Resource Report No. 1, as well as the text in Appendix M of Resource Report No. 1.
FERC	10/26/16	58. Include the following information about aerial waterbody crossings: a. the range of sizes and disturbance areas of "bridges" and associated mid- span supports, in-channel pilings, and abutments (section 2.3.11.2.1.1, page 2-122); and b. crossing lengths and type of aerial crossings in appendix H for each aerial crossing.	The Applicant will address this comment prior to the initiation of the EIS process.
FERC	10/26/16	59. Clarify the distinction between EPA's vessel general permit for vessels over 79 feet in length and EPA's small vessel general permit	The text has been revised to stipulate both EPA and USCG ballast water discharge requirements.

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		for vessels under 79 feet in length that have a ballast water discharge. (section 2.3.12.2.2, page 2-153)	
FERC	10/26/16	60. State the ballast water treatment methodology that would be used as described in U.S. Coast Guard 33 CFR 151. (section 2.3.12.1.2.2, page 2-154)	See revised Section 2.3.9.1.2.2 to clarify USCG BWMS requirements.
FERC	10/26/16	61. Add the Fugitive Dust Plan, Stormwater Pollution Prevention Plan, and APDES permit requirements to the list of plans that Alaska LNG would implement to avoid and minimize impacts on wetlands from Project operations. (section 2.4.4, page 2-186)	See Section 2.4.4 for Fugitive Dust Plan, Stormwater Pollution Prevention Plan, and Alaska Pollutant Discharge Elimination System (APDES) permit requirements on the list of plans.
FERC	10/26/16	62. Include site-specific drawings for the following major waterbody crossings presented in table 2.3.10-1 and in appendix J (section 2.3.10.1, page 2-105; appendix J): a. Unnamed Pond (MP 468.4); b. Pinch Point Pond (MP 553.5); and c. Cook Inlet (MP 764.1).	Revision C2 of the route avoids the Unnamed Pond (MP 468.4) and reduces the crossing width at Pinch Point Pond (MP 553.5). The Site-Specific crossing plan for Cook Inlet would be developed for permitting.
FERC	10/26/16	63. Describe how any potential water discharges to frozen ground would prevent impacts on permafrost, because permafrost could be present even in summer months when hydrostatic testing is planned. (section 2.3.11.1.2.5, page 2-114 and appendix L)	The referenced section is for the LNG plant in Nikiski. There is no permafrost in the Nikiski area.
FERC	10/26/16	64. Include the height at which the pipeline would be elevated for the PBTL and PTTL waterbody crossings. (section 2.3.11.2, page 2-116)	The single aboveground waterbody crossing for PTTL is at the west channel of the Sag; the elevation will be the same as the other lines on the existing bridge. There are no waterbody crossings for the PBTL.
FERC	10/26/16	65. Describe how Alaska's prior appropriation water rights law applies to the Project, and how Alaska LNG will comply. (section 2.3.11.2.1, page 2-125, and appendix L)	See Section 2.3.11.2.1, page 2-125, and Appendix K. Most of the Project's water needs for construction would be under Temporary Water Use Authorizations. Long-term uses would be applied for and managed under traditional water rights. The Applicant would work with ADNR's Water Resources Section to obtain these authorizations and rights. The Water Resources Section would adjudicate and issue authorizations based on the applicable statutes and regulations.
FERC	10/26/16	66. Include the completed wetland validation study and a discussion of how it supports the wetland delineation methodology used for this Project. (section 2.4.2, page 2-164)	See Section 2.4.2.
FERC	10/26/16	67. Identify the acres of wetlands summarized in table 2.4.2-1 that are overlying thaw-sensitive permafrost. Describe the level of certainty to predict thaw sensitive permafrost	Please see Section 2.6 and Appendix E.

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		prior to construction. (section 2.4.2, page 2-164)	
FERC	10/26/16	68. Include a discussion and table identifying the location and types of major wetland complexes that would be affected by the Project, including regionally unique wetland types (e.g., string bogs). (section 2.4.3.2.1.1, page 2-173)	The text in Section 2.4.3.2.1.1 has been revised to include string bogs.
FERC	10/26/16	69. Include further discussion of anticipated restoration success/challenges for wetlands in the Project area based on research/past restoration efforts. (section 2.4.3.2.1.1, page 2-173)	The Project *Draft Restoration Plan* (see Resource Report No. 3, Appendix P) discusses restoration goals, methods, site responses, and lessons learned at selected sites in the Arctic and Boreal regions.
FERC	10/26/16	70. Describe the potential effects during Project construction and operation of aufeis and flooding on the Dalton Highway along the Sagavanirktok River. (section 2.5.3.2, page 2-210)	Sections 2.5.4 and 2.5.5 describe the potential construction and operational effects of aufeis and flooding that may occur within the Project footprint.
FERC	10/26/16	71. Include the North Slope stormwater management best management practices cited in the text. (section 2.5.4.2.2, page 2-221)	The text has been revised to clarify that North Slope stormwater best management practices (BMPs) are provided in the Alaska Storm Water Guide included in Appendix J.
FERC	10/26/16	72. Include a description of beaded streams and discuss the locations, Project impacts, and mitigation measures for beaded streams in the Project area. (section 2.3)	Section 2.3 has been revised to include a description of beaded streams.
FERC	10/26/16	73. Include affected floodplain acreages and more detailed discussion of specific impacts on floodplains (e.g., flood storage capacity and channel migration zones) from operations associated with the marine terminal, pipeline aboveground facilities (e.g., Coldfoot Compressor Station), bridge pilings and embankments, permanent access roads, granular pads, abandoned material sites, and any other permanent facilities or changes to the ground surface. Include additional analysis for locations with potentially vulnerable infrastructure within the 500-year floodplain. Discuss alternatives and mitigation measures concerning impacts on flood storage capacity. (section 2.5.5)	The Applicant will address this comment after the FEIS but prior to construction start.
FERC	10/26/16	74. Include a typical diagram and describe the secondary containment methods as presented in table 2.6-1 concerning sections IV.A.1.d and VI.B.1.a of FERC's Procedures. (section 2.6, pages 2-226 and 2-227)	The Applicant will address this comment prior to the initiation of the EIS process.
FERC	10/26/16	75. Include site-specific justification for additional temporary workspaces within 50 feet of wetlands or waterbodies as presented in table 2.6-1 concerning sections V.B.2.a and VI.B.1.a of FERC's Procedures. (table 2.6-1 in	Justification has been updated in Section 2.6.

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		section 2.6, pages 2-226 and 2-227; table 2.6.1-1 in section 2.6.1, pages 2-230 to 2-232)	
FERC	10/26/16	76. Identify the locations and duration of temporary equipment bridges that would remain in place as presented in table 2.6-1 concerning section V.B.5.e of FERC's Procedures. (section 2.6, page 2-226)	The Applicant will address this comment prior to the issuance of the DEIS.
FERC	10/26/16	77. Identify the locations where cross-slope grading is required in wetlands as presented in table 2.6-1 concerning section VI.B.2.g of FERC's Procedures. (section 2.6, page 2-228)	Additional information has been provided in Appendix E and Section 2.6.
FERC	10/26/16	78. Include a detailed explanation why topsoil segregation is not feasible and identify which wetlands would potentially be affected as presented in table 2.6-1 concerning section VI.B.2.h of FERC's Procedures. (section 2.6, page 2-228)	Topsoil segregation is discussed in section 2.6.3. Table 2.6.3-1 lists toilsoil segregation by construction spread and ROW mode.
FERC	10/26/16	79. Include a detailed explanation why granular fill in wetlands would be needed and identify which wetlands would potentially be permanently affected by granular fill as presented in table 2.6-1 concerning sections VI.B.2.i and VI.B.2.j of FERC's Procedures. (section 2.6, pages 2-228 and 2-229)	Please see Appendix E and Section 2.6 for revised text.
FERC	10/26/16	80. Describe measures to ensure sediment barriers remain functioning through multiple seasons of construction as presented in table 2.6-1 concerning section VI.B.3 of FERC's Procedures. (section 2.6, page 2-229)	The Applicant will conduct periodic inspections of the best management practices installed along the ROW are functioning properly, and address any corrective measures as necessary.
FERC	10/26/16	81. Include the following for each wetland in appendix E: a. length of crossing; and b. construction right-of-way mode (e.g., cross slope grading and construction right-of-way width).	See revised Appendix E, Table 2 for construction modes, seasons and underlying terrain conditions.
FERC	10/26/16	82. Clarify the use of the term "field survey corridor," which implies that a 300-foot- wide corridor was surveyed for wetlands (in its entirety), rather than the distance cited in the field verification study. (appendix G)	Field work was primarily concentrated within the field survey corridor (150 feet on each side of the proposed centerline, 300 feet wide total). Within the field survey corridor, field targets sampling a single point location were used to confirm areas where wetland subject matter experts had high confidence in their aerial interpretation, and were used to confirm or correct wetland boundary locations. Field targets were also placed in low-confidence areas to provide field data where the photo signatures or landscape features were not clearly indicative of wetland or upland. Field targets spanned the full range of Cowardin and HGM classes within the Project mapping corridor.

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FERC	10/26/16	83. Indicate whether there are any potable water intakes within 3 miles downstream of waterbody crossings. (appendix H)	No potable surface water uses occur 3 miles downstream from Mainline waterbody crossings. Appendix H has been footnoted.
FERC	10/26/16	84. Include site-specific construction mitigation and restoration plans for crossings of waterbodies greater than 100 feet. (appendix J)	See updated Appendix I.
FERC	10/26/16	85. For all major waterbodies, include a turbidity and sedimentation analysis for impacts on fish and benthic organisms. The analysis should include, for each major waterbody:	At this time, the Applicant does not plan to conduct the turbidity and sedimentation analysis for major waterbodies except if required by the Alaska Department of Fish and Game (ADF&G) for construction during any sensitive spawning periods. ADF&G will issue fish habitat permits based on their review of the crossing time period and construction method.
FERC	10/26/16	a. estimates of background (ambient) and episodic turbidity levels;	See above.
FERC	10/26/16	b. specific receptors (e.g., fish species and benthic organisms);	See above.
FERC	10/26/16	c. densities or other quantification for the aquatic biota identified;	See above.
FERC	10/26/16	d. threshold levels for turbidity or sedimentation impact on the same organisms;	See above.
FERC	10/26/16	e. quantification of the turbidity concentration, duration, and distribution during construction activities; and	See above.
FERC	10/26/16	f. depth of sedimentation downstream following construction.	See above.
National Park Service (NPS)	9/26/2016	Wetlands impacts - The AKLNG documents use both the Cowardin and HGM classifications for wetlands and the combination is appropriate for the Denali alternative. For projects that occur on NPS lands, this is only the first part of the process; we also generally use the HGM Functional Assessment methodology to directly compare the quality and function of different wetland alternatives. The AKLNG document mentions this functional assessment, but states that it is waiting for agency direction to choose which method is appropriate.	The preferred route does not cross NPS lands. If it were to the future, the Applicant would consult with the USACE and NPS on the appropriate method to use that is consistent with the remainder of the Project.
NPS	9/26/2016	NPS recommends that AK-LNG complete a functional assessment of existing wetland conditions, and evaluation of functional change resulting from the pipeline construction, of the affected wetlands within Park boundaries for each alternative alignment, using the Hydrogeomorphic Approach (HGM), Rapid Assessment Level. Alaska Interior Wetlands Functional Assessment Guidebook is available at: http://dec.alaska.gov/Water/wnpspc/wetlands/interiorhgm.htm and https://dec.alaska.gov/water/wnpspc/wetlands/i	The Applicant is consulting with the USACE and FERC on the proper functional assessment methodology to utilize across the breadth and diversity of wetlands impacted by the Project. HGM may not be the method settled on by the permitting agencies. See Section 2.4.2.1 of Resource Report No. 2 on the final agency guidance provided.

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		nterior_operational_draft_may_1999b.pdf. Provide the HGM Assessment Report as described in the Guidebook. The report must contain an evaluation of the effects of construction on the functional values of the different types of wetlands.	
NPS	9/26/2016	There was no mention of cumulative impacts. NPS would request an evaluation of wetlands along a potential Denali route include evaluation of the previous impacts of highway and railway construction, recent highway widening, and the proposed construction of the wayside north of the river near McKinley Village. Many of the mapped wetlands have already been impacted by these activities and that has likely had an effect on their function and quality. This would also help us to analyze the relative impacts of the alternative route. We would also need to know if a Denali route will involve material sites or just the gas line route and access roads.	The Denali route is not a practicable alternative at this time.
ADNR/Division of Agriculture (AG)/Plant Materials Center (PMC)	9/25/2016	V.C.7 What are the species being considered for revegetating disturbed riparian areas?	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/AG/PMC	9/25/2016	VI.C.5 The PMC is able to assist with the project-specific wetland restoration plan.	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/DMLW/ Water Resources Section	9/25/2016	The first full paragraph on page 2-40 incorrectly states the ADNR Temporary Water Use Permit application threshold for dewatering as 30,000 gallons per day(gpd). The 30,000 gpd application threshold only applies to non-consumptive water use. Dewatering activity usually constitutes a consumptive use of water because the pumped water isn't returned to the original point of pumping immediately after the need for dewatering is over. The correct dewatering application threshold is more than 5,000 gpd on any day within the first 10 days of pumping, or more than 500 gpd for pumping that continues beyond ten days. See 11 AAC 93.035(b)(1) and (b)(2).	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/DMLW/ Water Resources Section	9/25/2016	The second bullet point in this section number refers to permits under AS 46.15 for water use necessary for construction and operations. Only referencing the word use in this context implies that water has to be put to some use before a temporary water use or water right permit is required. To avoid the misperception, this sentence should state "…permits under AS 46.15 for water use, withdrawal, diversion or impoundment for construction and operations;".	The Applicant will address State of Alaska comments during required permitting activities.

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ADNR/DMLW/ Water Resources Section	9/25/2016	The last sentence in the second paragraph in this section number states that wells within 150 feet of the Project footprint are listed in Appendix A. However the title of Appendix A references wells within 500 feet of the Project, and the listing of wells in Appendix A includes many wells with separation distances between 150 and 500 feet from the Project. This appears to be a discrepancy. There were other places in Draft RR2 that mention the 150 foot buffer and then refer to Appendix A.	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/DMLW/ Water Resources Section	9/25/2016	The second paragraph under the heading (Surface Water Resource Impacts and Mitigation During Mainline Hydrostatic Testing) mentions the possibility of cascading water from test section to test section which could result in discharge to a different basin from the source. In this scenario, if the water were to be removed from a hydrologic unit (as the term hydrologic unit is defined in AS 46.15.035(e)(2)), then the application, review and permitting requirements in AS 46.15.035 would need to be complied with. I think the paragraph should acknowledge the AS 46.15.035 approval process associated with removing water out of a hydrologic unit and not returning it to the source hydrologic unit.	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	Text refers to a “narrow mountain channel” – replace with “narrow mountain valley”. “Braided sediment pattern” should be replaced with “braided stream pattern”.	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	Table 1 “Confluence of Dietrich and Ivashak Rivers. Dynamic location. The Mainline ROW would be located between the existing pipeline (TAPS) and the Dalton highway -- assumed to be armored and protected from channel migration.” (Spelling – Ivishak River, not Ivashak.) Ivishak River is on the north side of the Brooks Range; revise to reflect correct stream name (Bettles River?)	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	Table 2.2.1-2 Totals not added correctly?	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/	9/25/2016	“Ice jam floods are less predictable and potentially more destructive than open-water flooding and can produce much deeper and faster flooding.” Clarify what is meant by “faster	The Applicant will address State of Alaska comments during required permitting activities.

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Engineering Geology		flooding." Does the flooding happen more quickly, or is the floodwater velocity greater, or?	
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	"One study of fires in Russia indicated increased summer flows in some watersheds post-burn (Semenova et al., 2015) while another study suggested that melting of the permafrost can increase the water storage capacity (Ishii et al., 2006)." Reword to "thawing of the permafrost."	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	There are small amounts of groundwater in unfrozen layers called taliks. They are often associated with creeks, lakes, and rivers. These could be a major problem when operating the pipeline at below-freezing temperatures north of the Brooks Range. These aquifers are often indicated by the formation of aufeis.	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	When encountering taliks on the North Slope of Alaska with digging equipment it has to be mentioned that the trench can fill rapidly with liquid water even at air temperatures far below freezing. Taliks are often pressurized during the winter.	The Applicant will address State of Alaska comments during required permitting activities.
ADNR/Division of Geological & Geophysical Surveys (DGGS)/ Engineering Geology	9/25/2016	Aufeis also occurs on the North Slope in large quantities and on many tributaries of the Sagavanirktok River. These tributaries will need to be crossed by the main pipeline. An analysis of old imagery can point to the exact locations.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Bullet one notes that "APDES wastewater discharge permit and mixing zone approval for wastewater disposal in all state water under a transfer of authority from the EPA…." The phrase "state waters" should be replaced with "Waters of the United States within the State of Alaska".	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Bullet two notes that "Certificate of Reasonable Assurance (CRA) / NPDES and Mixing Approval for wastewater disposal into state waters under Section 402…" The phrase "state waters" should be replaced with "Waters of the United States within the State of Alaska". Please note that DEC has full authority over the APDES Program and issues CRAs on EPA permits on a limited basis. (the EPA Vessel General Permit is an exception)	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Add to bullet four the following statement "per AS 46.03.100(a) and 18 AAC 72.500 and .600, DEC issues authorizations to inject wastewater under the Class I Injection Well Disposal General Permit 2016DB0001.	The Applicant will address State of Alaska comments during required permitting activities.

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ADEC/ Environmental Health Division	9/25/2016	The first paragraph in this section notes that "Groundwater sites under the direct influence of surface waters (GUDISW), must meet the more stringent or more protective of either the Table C criteria in 18 AAC 75 or the AWQS under 18 AAC 70….." It is not clear why Table C in 18 AAC 75.345 is being cited here. The groundwater cleanup levels differ from the drinking water standards.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/ Environmental Health Division	9/25/2016	Footnote 4 in paragraph one on this page discusses the minimum separation distance for drinking water systems and refers to a "Class C" system. The department regulations at 18 AAC 80 dealing with Class C drinking water systems are currently being repealed, so this reference should be changed to read "private water systems".	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The sentence should read "No impacts to groundwater would occur during operation of the PBTL, because useable groundwater resources do not exist on the ACP." Groundwater resources do exist on the ACP, but they are saline and therefore unusable.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	In the third paragraph on this page the text reads "As required by the APDES Storm water Permit" The permit should be referred to instead as the "Construction General Permit"	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The first three paragraphs on this page discuss hydrostatic test water discharges. There should be a reference to the APDES permit requirements in these paragraphs.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The first paragraph on this page refers to hydrostatic test water discharges. The second sentence should read "Discharge would be in accordance with APDES regulatory requirements or existing UIC permit requirements."	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The last three paragraphs on this page discuss hydrostatic testing. The third sentence in the third paragraph should be changed to read: "Any proposed biocide or anti-freeze use would be coordinated with permitting agencies and discharge would be in compliance with APDES regulatory requirements and the Alaska LNG Project Procedures."	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/ Commissioner's Office	9/25/2016	In paragraph one and elsewhere the work "granular" is used instead of "gravel". It is not clear why this is being used, as it will confuse many readers.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Based on the information contained in the current Resource Report 2, the vessels transporting LNG to and from the Marine Terminal would need to comply with EPA's Large Vessel General Permit (VGP) for ballast	The Applicant will address State of Alaska comments during required permitting activities.

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		water, cooling water and other discharges while in State of Alaska marine waters. The VGP includes DEC's 401 certification of reasonable assurance that discharges comply with state water quality standards at 18 AAC 70.	
ADEC/Water Division	9/25/2016	Top Soil Segregation: The Upland Erosion Control, Revegetation, and Maintenance Plan provides a limited approach to top soil segregation and stockpiling and should be reconsidered. While it is not mandatory in Alaska, DEC recommends segregation and reuse as much as practicable, as this has been shown to be the most effective and efficient methods in Alaska.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Hay or straw bales are very expensive and seldom used on projects in Alaska. DEC recommends the use of coir logs (erosion control fiber rolls) or a similar type BMP instead.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	General comment: DEC anticipates that stormwater coverage will be covered under AKG320000, the upcoming Statewide Oil and Gas Pipeline General Permit, once it become effective rather than under the existing Construction General Permit. While it is appropriate to reference only currently effective permits in the Resource Report, DEC provides commentary to illustrate some differences between the two permits that could impact SWPPP development or project implementation.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The web address for the Notice of Intent (NOI) is www.dec.alaska.gov/water/wnpspc/stormwater/APDESeNOI.html . Please note that NOI submittal procedures are subject to change and the applicant should consult DEC at the time of submittal.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The sentence that begins with "Construction activities would be permitted…" should be revised to read as follows: "Construction activities can commence upon receiving written authorization from the Department. Authorizations are expected to be issued no sooner than seven calendar days and up to 45 days after submitting an NOI, depending on the size and complexity of the project."	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Please delete the first sentence in this section. ADEC does not grant approvals of SWPPPs. These SWPPPs are living documents that are expected to be modified as needed by the permittee in order to comply with water quality standards and permit conditions. However, DEC may review initial SWPPPs and provide	The Applicant will address State of Alaska comments during required permitting activities.

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		recommendations at DEC's discretion to provide compliance assistance to the permittee.	
ADEC/Water Division	9/25/2016	The final bullet in this section discusses Trench dewatering. Please note that in the Statewide Pipeline General Permit that the department anticipated issuing later this year, trench (excavation) dewatering will be addressed differently than in the Construction General Permit. In the new Pipeline General Permit, trench dewatering will be considered a point source discharge separate from stormwater. This difference is, in part, due to allowing a 500-foot mixing zone in freshwater streams to meet turbidity standards.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The fifteen bulleted BMPs listed after the first paragraph on this page are not described in the Project's Upland Erosion Control, Revegetation, and Maintenance Plan found in Resource Report 7, Appendix D. For the Plan to be effective and equivalent to Alaska requirements, these fifteen BMPs need to be described in the Plan. Please note that the upcoming Statewide Pipeline General Permit will refer to these as "Sediment and Erosion Control Best Management Practices (BMPs) in the BMP Toolkit. The Resource Report 7, Appendix D may be adopted as equivalent if developed to be consistent with Alaska requirements.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Paragraph two in this section discusses SWPPP development. ADEC requires a fundamentally different approach to SWPPP development and implementation than described in this paragraph. The standard practice for construction projects in Alaska is to develop Stormwater Pollution Prevention Plans (SWPPPs) to include site maps of sufficient scale to show BMPs for a particular construction site prior to the start of construction. This SWPPP approach means the Environmental Inspector has a map with BMPs specifically identified, rather than having to develop one on-site during construction. The upcoming Statewide Pipeline General Permit will require submittals, including site maps in SWPPPS prior to each construction season.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	This section discusses stormwater inspector qualifications. Please note in this section that the following training and certifications may substitute for AK-CESCL training and certification; CPESC, CESSWI, OR CPSWQ by EnviroCert International, Inc. (ECI) http://envirocertintl.org or CISEC by CISEC, Inc. http://cisecinc.org	The Applicant will address State of Alaska comments during required permitting activities.

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ADEC/Water Division	9/25/2016	Bullet one in this section provided an incorrect web address. The website for the electronic notice of intent (NOI) and notice of termination (NOT) is currently http://www.dec.alaska.gov/water/wnpspc/stormwater/APDESeNOI.html . NOI and NOT submittal procedures are subject to change and the applicant should consult DEC at the time of submittal.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Please add the following references to this section: ADEC Division of Water 2009. Alaska Stormwater Guide. Alaska Department of Environmental Conservation, Anchorage, AK. ADOT&PF 2011. Alaska Stormwater Pollution Prevention Plan Guide. Alaska Department of Transportation & Public Facilities, Juneau, AK	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	General Discussion on Clearing and Grubbing: DEC understands that Alaska LNG proposes to clear and grub in some areas years in advance of the pipeline construction. Please note that clearing is allowed to be conducted in advance of construction without triggering SWPPP requirements. However, once grubbing is initiated, SWPPP requirements become effective and continue until the end of construction.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	General Discussion on Inadvertent Release Plan: Throughout the Inadvertent Release (IR) Plan, reference is made to the Environmental Inspector taking actions “in consultation with the regulatory representative, if present”. Please delete the qualifier phrase “if present”, as in many instances an inadvertent release requires notification to regulatory agencies (e.g. DEC). Depending on where the IR occurs, immediate actions may be necessary to comply with State water quality standards or permit conditions.	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	The inadvertent release of drilling fluid in a stream would likely exceed water quality criteria for turbidity at the point of release to some distance downstream. Therefore, DEC may authorize a 500-foot mixing zone that would allow for compliance with water quality standards. However, there will be requirements to monitor turbidity in the stream as well as make visual observations. The release plan should specify that actions will be taken to the extent practicable to comply with water quality standards and any applicable APDES permit conditions	The Applicant will address State of Alaska comments during required permitting activities.
ADEC/Water Division	9/25/2016	Please add the fact that DEC must be notified when petroleum hydrocarbons and hazardous substances spill into waterbodies. Notifications are to be made to 1-800-478-9300.	The Applicant will address State of Alaska comments during required permitting activities.

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ADEC/Water Division	9/25/2016	Item A in this section needs to have an additional subsection 3 added to this page. This item should copy the Section 1 "Winter Construction Plan" in its entirety from Research Report 7, Appendix D, Part III, Preconstruction Planning here as subsection 3.	The Applicant will address State of Alaska comments during required permitting activities.
Alaska Department of Fish and Game (ADF&G)	9/25/2016	An ADF&G Special Areas Permit (5 AAC 95) would be required for project facilities sited in or activities conducted within state game refuges, critical habitats areas, or sanctuaries.	The Applicant will address State of Alaska comments during required permitting activities.
ADF&G	9/25/2016	Alaska Department of Fish and Game Title 41 fish habitat permits no longer exist. The correct Alaska Statute for these fish habitat permits is Title 16.	The Applicant will address State of Alaska comments during required permitting activities.
ADF&G	9/25/2016	The Ice Roads and Pads paragraph describes the old criteria for Alaska Department of Natural Resources (ADNR) winter cross-country travel. Contact the ADNR Division of Mining, Land, and Water – Fairbanks for the most current soil temperature and snow depth criteria for winter tundra travel.	The Applicant will address State of Alaska comments during required permitting activities.
ADF&G	9/25/2016	The Shaviovik Pit, Lake #24, Unnamed Lake 12, and Lake #10-01 are not anadromous fish waterbodies.	The Applicant will address State of Alaska comments during required permitting activities.
ADF&G	9/25/2016	A schedule identifying when trenching or blasting will occur should apply to all fish streams, not just those greater than 10 feet wide.	The Applicant will address State of Alaska comments during required permitting activities.
ADF&G	9/25/2016	The timing window for instream construction within streams supporting coldwater fisheries (June 1 through September 30) should be eliminated as it unnecessarily restricts activities within these streams at times when activities may be acceptable depending on the occupancy of streams by fish species. In other words, if fish are not present in winter, activities should be allowed to occur during these months.	The Applicant will address State of Alaska comments during required permitting activities.
ADF&G	9/25/2016	Table 1 At MP 209.2, the confluence of the Dietrich and Ivashak rivers should be corrected to read Dietrich and Bettles rivers. At MP 211.5, the river is no longer the Dietrich River but is the Middle Fork Koyukuk River.	The Applicant will address State of Alaska comments during required permitting activities.
USACE	9/26/2016	1. Additional information is requested for benthic characterization of proposed waterbottom impacts, to include, marine vegetative surveys, for the proposed project limits within intertidal areas of Cook Inlet. Please identify the specific survey or sampling techniques used for data collection and analysis as well as any limitations or assumptions associated with the survey.	The potential effects (including noise) of proposed dredging and dredge spoil disposal in Cook Inlet are addressed in Resource Report No. 3, Section 3.2.7.1.2, 3.3.6, and in Section 5.2.1 of the EFH Assessment (Resource Report No. 3, Appendix D). Effects on marine/submerged vegetation are addressed in Resource Report No. 3, Section 3.3.7.1.1; some text has been added to Resource Report No. 3,

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			Section 3.2.7.1.2.1 as well as in the EFH Assessment.
USACE	9/26/2016	2. Provide a brief description and results of thermal modeling; the Corps' interest is specific to the potential vertical and lateral extent of how thermal fluctuations could impact wetlands and streams systems.	The Applicant will address this comment prior to the initiation of the EIS process.
USACE	9/26/2016	3. Provide rationale for not segregating topsoil and subsurface soils during trenching and backfill activities, particularly, identifying challenges or benefits related to insulation and restoration potential in wetlands.	See Appendix M of Resource Report No. 1.
USACE	9/26/2016	4. "Temporary access" would be addressed by landowner agreements. The supporting statement indicates the potential for short term or long term wetland or stream impacts if the roads are abandoned and not maintained due to overland wash and erosion. What contingency or restoration consideration has been given to those situations where a landowner may wish to have the roads removed? How will the excess material be recovered and the acreage restored?	The BLM and State will dictate the process and requirements for restoring property provided for construction and operation of the pipeline.
USACE	9/26/2016	5. What is the proposed disposal method for soil, wood, rock and other organic detritus not used for backfill or mulch?	The disposal method for unsuitable soil, rock, and organic detritus is addressed in Section 6 of Appendix F of Resource Report No. 6. Section 6 of Appendix J of Resource Report No 8 addresses the disposal of vegetative waste from land clearing and the salvage of timber.
USACE	9/26/2016	6. Provide clarification on the use and duration of "temporary" versus "temporary- use" of project features particularly for those associated with wetland impacts.	Impacts are defined in the front of the Resource Report as temporary or permanent. Use is defined in Resource Report No. 8 and is related to easements or grants of right-of-way (ROWs) and is not related to the ecological impacts assessed in this Resource Report.
USACE	9/26/2016	7. Please provide a plan view and cross-section of Section 10 waterbody crossings. What contingency plans are in place to address failed HDD proposed crossings or potential frac-outs?	See the separately filed initial Clean Water Act application.
USACE	9/26/2016	8. Provide any material additions (concrete or sand bags) or anchoring systems that may be required to secure the pipeline, during installation or upon construction completion within the Cook Inlet or stream crossings. Please provide a plan view and cross-section of the bank-to-bank structure and any other support features.	The Applicant will address this comment prior to the issuance of the DEIS.
USACE	9/26/2016	9. Reclamation activities include reestablishing a static bed and bank profile for rivers and streams to ensure deposition and erosion patterns are not changed. In some cases, stream channels would be relocated to stable	The Applicant will address this comment after the FEIS but prior to construction start.

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		floodplains. What construction and profile surveys will be conducted prior to in-stream work? What variables are being recorded to ensure stream profiles are restored in a fashion unique to each stream?	
USACE	9/26/2016	10. Specific to Table 2.4.2-2, some project infrastructure has different affected or impact acreages between construction and operation phases (i.e., access roads, mainline onshore, construction camps). Are the differences due to removal of a structure, abandonment or restoration or all of the above? Please clarify.	The majority of the acreage differences in Table 2.4.2-2 are attributable to the site being used temporarily only during the construction phase (i.e., access roads, construction camps, etc.). After construction, temporary impact areas along the ROW would be managed in accordance with the Restoration Plan provided as Appendix P of Resource Report No. 3. Also The barge bridge on the West Dock causeway would be entirely removed after the construction season. Any permanent footprint impacts would occur where facilities are built or features permanently altered or filled. Some Pipeline and GTP Associated Infrastructure is shown to have a permanent impact of zero because the Applicant would return the land to landowner specifications and would no longer maintain or use that footprint during the life of operations of the Project.
U.S. Fish and Wildlife Service (USFWS)	9/26/2016	The Service is concerned regarding the number and nature of stream crossings along the pipeline route. While we have addressed these concerns in our specific comments (attached) , we make the following overarching recommendations: 1) standardize, and use more, protective buffers along all streams, rivers, and wetlands; 2) bury the pipeline across the full-width of the meaner plain at the same elevation as the pipeline under the channel thalweg to accommodate future channel migration and to avoid hardening of stream banks, river training structures and altering rive courses; 3) use natural streambank restoration techniques (e.g, avoid rip-rap or artificial erosion control material); and 4) avoid pipeline trenching through ACP rivers or streams due to thermokarst and erosion concerns (see above: ACP River Crossings).	1) The procedures outline how the buffer is implemented outside of trench portion of ROW. 2) burial depth will be determined through scour and meander analyses to comply with the U.S. Department of Transportation (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) code requirements and USACE burial depth requirements 3) restoration will follow the outline in the restoration plan that will be developed with agency input 4) pipeline trenching through Arctic Coastal Plain streams will be in compliance with permit conditions and requirements
USFWS	9/26/2016	Hydrocarbon Spills- The RRs do not contain an in-dpeth spill analysis for LNG and other petroleum products. A thorough discussion of impacts associated with accidental releases of liquefied natural gas and/or fuel spills into watercourses and the coastal and marine environments of Cook Inlet and the Beaufort Sea is warranted. Section 4.12 of the NPR-A IAP/EIS (2012) (http:www.blm.gov/ak) could be used as a template for this discussion. The	Contractor or spread-specific Spill Prevention and Response Procedures that follow the outline provided in Appendix M (see section IV. Preconstruction Planning) will be filed with the Secretary prior to construction.

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		Service would appreciate reviewing the spill analysis before the RRs are finalized.	
USFWS	9/26/2016	Ephemeral streams should be addressed in RR2. In some situations, ephemeral streams can serve as important transportation connectors for fish to move between lakes/ponds during flow events, such as during spring break-up. AKLNG should identify where the Project crosses these streams and identify if they serve as fish corridors. Project impacts to and mitigation for these valuable areas should also be addressed.	No ephemeral streams were delineated in the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) for Alaska or during Project field surveys; however, many non-perennial channels could be interpreted as ephemeral if these channels have no connection to groundwater and flow only in response to a precipitation event. See revised text in Section 2.3 for clarification on stream types. See Resource Report No. 3 for fish corridors.
USFWS	9/26/2016	We suggest using forecasted data instead of hindcasted data for predicting impacts of climate change on sea-level s, storm surges, and ice extent for the Beaufort Sea and Arctic Coastal Plain.	Section 2.3.2.2.7 and Table 2.3.2-3 have been revised using current forecasted data.
USFWS	9/26/2016	We suggest using the most recent data (beyond 2010) to predict storm surges into the future (see comment above).	See above.
USFWS	9/26/2016	We suggest editing Fig. 2.3.2-8 to reflect the most recent data (beyond 2012) as mentioned in last paragraph of section 2.3.2.2.5	The citation is a NOAA 2015 report. Additional data has not been made available.
USFWS	9/26/2016	This data is somewhat dated. We suggest using forecasted data re sea-ice regimes. More recent data is available at the UAF Geophysical Institute.	See above.
USFWS	9/26/2016	Please discuss non-tundra ponds, fens, bogs, muskegs, etc.	See Section 2.4 for a description of ponds, fens, and bogs located within the Project footprint.
USFWS	9/26/2016	Put River is saline-affected near the coast, especially during storm surges and in winter. Fall storm events in the Brooks Range can cause extensive flooding and erosion of the major rivers such as the Sagavanirktok.	Comment acknowledged; see Section 2.3.2.3.1.1.
USFWS	9/26/2016	On many maps, the Sag River is designated as having an east channel and a west channel as it runs through the Prudhoe Bay area.	Comment acknowledged.
USFWS	9/26/2016	RR2 refers to the use of straw wattles, bales and barriers, yet on pg. 2-135 it mentions that straw can be a vector for invasive weeds. App. K of RR3 addresses obtaining weed-free straw products, which is a good BMP. However, we believe straw products are less effective for erosion control and can be a source for noxious or invasive weeds, even if certified weed free. Therefore, we generally do not recommend the use of straw products for erosions control.	See Section 2.3.8.1.1. The activities may include placement of temporary erosion and sediment control products (such as jute mat) until landscaping features are fully grown or stabilized.
USFWS	9/26/2016	Streams on the north slope do not usually carry a great amount of silt during spring break-up because the stream beds are usually still	Comment acknowledged.

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		frozen. Excess sediment loads created from excavated material during winter, therefore may impact the streams unnaturally during break-up.	
USFWS	9/26/2016	Stream bed scour usually does not occur during spring break-up on the North Slope because the sides/beds of the streams are still frozen. Erosion of river banks can occur during fall flood events.	Comment acknowledged.
USFWS	9/26/2016	For streambank protection work, consider the use of natural restoration techniques, such as root wads and spruce tree revetment.	See Section 2.3.8.2.1.6 for erosion control methods considered.
USFWS	9/26/2016	What is the justification for trenching the PTTL across the 3 main river crossings (Shaviovik, Kadleroshilik and east channel of the Sag? The PT oil line is not planned to be trenched through these rivers and most of the oil lines in the Prudhoe Bay and Kuparuk oil fields are not trenched through rivers. Please provide justification for the trenching. Badami was trenched in the late 1990s only because it was thought the line may interrupt caribou movements – something which has now been proven not to be the case. The trenched section of the Badami pipeline also has been problematic because of erosion. We strongly suggest the proposed PTTL be elevated on VSMs the entire distance from Point Thomson to the proposed GTP.	See Appendix E of Resource Report No. 10 for a discussion of the design alternatives considered for PTTL river crossings.
USFWS	9/26/2016	Foundation Construction – How thick are the granular pads proposed to be? Current thickness for pads in the PBay oilfields is at least 5 ft. New construction techniques in the oil fields are being instituted to account for climate change. Wetlands – There are wetlands which contain water within the footprint of the proposed “above- ground facility sites” for the GTP and OCP.	They are proposed to be at least 5 feet. This is to be determined prior to the construction start.
USFWS	9/26/2016	We do not support leaving abandoned access roads in place, even if they have openings cut in them to allow flow through of water. Instead, we recommend reclamation of all temporary access roads to include the removal of all drainage structures, the removal of all fill (especially in wetlands and floodplains), and re-contouring of the former roadbed to the original land-surface profile. The reclaimed roadbed should be protected from initial erosion by a cover crop of non-persistent plant species of mulch, and planted with native perennial species appropriate for the adjacent plant communities. To facilitate removal of roadbed material, we recommend the use of geotextile fabric under the road, which will also help	Access roads would be restored per landowner and permit requirements.

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		prevent road materials from sinking into the ground surface during use.	
USFWS	9/26/2016	Are new pipe yards proposed for storage in Fairbanks and Anchorage? If so, are these impacts considered within the EIS or as cumulative impacts associated with the project?	A coating yard is included in the analysis of this Resource Report.
USFWS	9/26/2016	On the Arctic Coastal Plain organics will not be available for use in rehabilitation operations unless the top several inches of organic material is harvested and stored separately at the time the mine site is developed.	The Double Jointing Yards are non-jurisdictional but are included in Tables 1.4-1 and 2.4.2-2.
USFWS	9/26/2016	The depth of the granular pads should be given (a minimum of 5 ft. is necessary for oil developments on the Arctic Coastal Plain. Also, the Putuligayuk River is known to run saline at certain times of the year.	Comment acknowledged.
USFWS	9/26/2016	Material sites in the oil fields on the Arctic Coastal Plain are not usually blasted (or if they are, the top organic layer is harvested prior to blasting). The sites are usually initially developed in the summer with prep work conducted in the spring. The Service recommends the proposed mine site be cleared of snow and the top layer of organics be harvested and stored prior to the onset of the bird nesting window (June 1). Once the entire top layer of organics is harvested the footprint of the mine site is no longer an attractive nesting area for birds and work on the mine site can continue through the summer and subsequently into the winter. The mine site itself is used for sorting and storage (draining) of mined material prior to use. The mined gravel material is not placed on the tundra until winter when the tundra at the project site (pad) is sufficiently frozen and temporary ice- access roads (if necessary) can be constructed from the mine site to the pad. The saved organic material is used in site restoration at the mine site or other areas. Alternatively, the organic layer of the proposed mine site can be harvested as intact tundra sod blocks in the late summer (after the bird nesting season - July 31). Once the tundra sod blocks are harvested and stored, mining can commence at the site. The harvested sod blocks can be stacked and shrink-wrapped for at least one season (and maybe more) and utilized in tundra restoration projects in the area.	Comment acknowledged.
USFWS	9/26/2016	Gravel access roads on the north slope are constructed in winter and are usually closed to traffic over the first summer allowing for gravel thaw and drainage. The new road is worked-over (with graders and compactors) usually during the first late summer after construction.	Comment acknowledged.

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		Roads usually are not drivable until at least a year after construction.	
USFWS	9/26/2016	Pipelines: The Service strongly recommends the pipeline not be buried on the Arctic Coastal Plain. The PTTL is proposed to be elevated on VSMs except for river crossings. We suggest the PTTL pipeline be elevated on VSMs over all river crossings to avoid likely bank thawing and erosion due to trenching (which will resulting in permanent damage to rivers and associated wetlands). The associated erosion will be extremely expensive to mitigate and likely will extend for the life of the project. The expense associated with this kind of maintenance should be included in the upfront costs of construction. Burying/trenching the Mainline through the tundra from the Central Gas Facility south through the Arctic Coastal Plain also will result in subsidence over the pipeline. Once the tundra and underlying soil is disturbed via trenching the soil will become aeriated. Once the soil is placed back in the trench subsidence will occur, allowing water to pond and further infiltrate into the soil during spring/summer thaw. This will cause further subsidence. Once this process of subsidence and ponding begins it is nearly impossible to rectify. It is the disturbance of the soils above the pipeline during trenching that causes the soils to subside. Cooling the pipeline will not abate the problem as the pipeline itself is not the cause of the subsidence. Once subsidence occurs, water will pond along the trench and may cause adjacent wetlands to drain into the trench. In addition, sheetflow during spring break-up on the ACP tends to flow northward. As the pipeline is oriented in a North/South direction, the trench could become a conduit for water during breakup, potentially exacerbating erosion and drainage of adjacent wetlands. For these reasons, the Service strongly recommends the gasline be elevated on VSMs on the Arctic Coastal Plain for 60 miles). If the proposed LNG line gasline ROW runs through an area underlain by thaw-stable soils (gravel soils associated with the Sagavanirktok River historic floodplain) trenching might be possible. The TAPS line is buried in these types of soils along portions of the Sagavanirktok River corridor. However, the proposed LNG line corridor is located to the west of the TAPS line and it is not known how far to the west the Sagavanirktok River flood plain (and hence the thaw-stable soils) extends. If FERC is determined to bury the gasline through ice-rich tundra soils on the Arctic Coastal Plain, the Service suggests extensive trials be conducted to prove the efficacy of their proposed	See Section 10.4.5.1 of Resource Report No. 10 for an analysis of why the Mainline is buried across the Arctic Coastal Plain.

Resource Report No. 2 Agency Comments and Requests for Information Concerning Resource Report No. 2			
Agency	**Date**	**Comment**	**Response/Resource Report Location**
		technique. These trials should replicate the proposed methodology including sufficiently-long chilled pipelines buried through representative soils/wetlands to the same proposed depth and using the same techniques as proposed for the gasline. The trials should be conducted and monitored over a several year period. In the absence of these trials, the Service suggests elevating the gas pipeline on VSMs until thaw-stable soils are encountered south of the Arctic Coastal Plain.	
USFWS	9/26/2016	Once, disturbed wetlands on the Arctic Coastal Plain (ACP) can take upwards of 30 years or more to achieve some level of restoration. In addition, wetland restoration on the ACP does not generally result in the same type of wetland that was originally impacted. Temporal as well as functional loss should be addressed when assessing the impact of wetland loss associated with the proposed LNG pipeline. Wetland disturbance on the ACP would be best avoided by elevating the pipeline. In addition, harvesting tundra sod on the ACP where practicable, such as at mine site developments, would decrease temporal loss and increase wetland restoration success.	The text has been updated to address the potential for change in function or functional loss from burial of the Mainline. For additional considerations regarding aboveground versus belowground design, see Section 10.4.5.1 of Resource Report No. 10. The PTTL and PBTL will both be elevated pipelines, with the exception of three buried stream crossings of the PTTL (See Appendix E of Resource Report No. 10). Harvesting sod from the tundra is not practicable on the ACP. Construction will occur in winter off of ice pad to minimize impacts to the tundra and limit impacts to a more targeted area around the trench. The area will be revegetated per the Project Restoration Plan (RR 03, Appendix P).
USFWS	9/26/2016	It is very likely wetlands adjacent to the banks of rivers trenched for the PTTL will be subsequently impacted through erosion of the bank resulting in possible drainage of the wetland. Secondary impacts, due to project design, should be accounted for during the life of the project.	The Applicant has considered the potential secondary impacts from using the traditional open-cut method for the Shaviovik, Kadleroshilik, and Sagavanirktok rivers as discussed in Section 10.4.8 of Resource Report No. 10 and Appendix E of the same Resource Report. Potential erosion of the river banks or draining of water bodies and wetlands would be mitigated by incorporating learnings from the routing and restoration challenges of previous crossings on the North Slope and by implementing erosion control and restoration protection measures described in the Procedures (Appendix N) and Draft Restoration Plan (Resource Report No. 3, Appendix P).
USFWS	9/26/2016	Restoration of wetlands on the ACP after trenching likely is not possible. In this case, avoidance (elevating the pipeline on VSMs) is the best technique. Mitigation banks, and in lieu fees result in net loss of wetlands and as such should be considered after permittee-responsible restoration. Even though restoration of wetlands on the ACP is a slow process and may not result in the same type of wetland pre-disturbance, at least some level of functionality is restored.	Permittee-responsible restoration measures are described in the Draft Restoration Plan (Resource Report No. 3, Appendix 3). The primary goal of restoration in this area would be to stabilize the trench and then facilitate the restoration of wetland habitats that are integrated with the adjacent, undisturbed tundra. This goal would be achieved using a combination of fertilizing and either natural recovery or plant cultivation, as needed. Information on the restoration/revegetation techniques to be

Resource Report No. 2 Agency Comments and Requests for Information Concerning Resource Report No. 2			
Agency	**Date**	**Comment**	**Response/Resource Report Location**
			employed is described in the Plan. Additional compensatory mitigation opportunities are discussed in the Draft Mitigation Plan provided in this Resource Report, Appendix O.
USFWS	9/26/2016	Is the review of current and past mitigation strategies an internal review or a published review? A published review should be summarized and referenced. An internal review should provide sufficient detail for reviewers to assess the review's adequacy.	Development of the Resource Reports and related documents requires review of current and past mitigation practices and strategies. This review consists of an internal process involving discussions with certain regulatory agencies and subject matter experts and reviews of current and past project mitigation strategies to the extent information is publicly available. A review of published documents on the history of restoration practices in relevant Alaskan ecosystems is provided in the Draft Restoration Plan, Appendix P of Resource Report No. 3. An outline of mitigation approaches is provided in the Draft Wetland Mitigation Plan, Appendix O of this Resource Report. As the DEIS is developed, input and recommendations from resource agencies will be considered and implemented where appropriate.
USFWS	9/26/2016	There are likely to be cumulative impacts to floodplain connectivity and function with the installation of a long linear feature that will include access roads, culvert, bridges, etc. Floodplains are an important component of the aquatic ecosystem with many benefits beyond enhancing fish habitat. When considering floodplain connectivity, options for water crossings (U.S. Forest Service 2008, Figure 2.5, pg. 2-6) range from no connectivity (simple high discharge passage) to preserving full functioning of all floodplain processes (full-span crossing). The Service prefers the Project design for crossings that preserve floodplain connectivity the greatest extent possible. Stream-Simulation Group, Forest Service. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings. 0877 1801P. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. http://stream.fs.fed.us/fishxing/aop_pdfs.html	Floodplain connectivity and functionality will be maintained by removal of bridges and culverts.
USFWS	9/26/2016	The Sagavanirktok River also is known to flood during fall rain events in the Brooks Range. Flooding during fall events are unpredictable, occurring rapidly with little notice. In addition, the impacts of a fall flood event can be more severe than a spring event as the soils are thawed and more vulnerable to erosion in the fall.	Comment acknowledged.

Resource Report No. 2
Agency Comments and Requests for Information Concerning Resource Report No. 2

Agency	Date	Comment	Response/Resource Report Location
USFWS	9/26/2016	In light of the information presented here regarding the likely increase of flood flow frequency and magnitude of flood events, we would like to repeat our concern (see our 3-Apr-15 comment from RR2) about designing waterbody crossings, and recommend burying the pipeline across the full- width of the meander plain at the same elevation as the pipeline under the channel thalweg to accommodate future channel migration and to avoid hardening of stream banks, river training structures, and altering river courses. This would help prevent pipeline scour, long-term maintenance costs, the need for river training devises, and to allow Alaska's streams and rivers to behave as they naturally would, especially in the face of climate change. Unlike the lower 48, most of our streams and rivers are not confined/trained, and recommend no training devises be used in our stream and rivers. It would be prudent for the Project to address this issue up front during the design stage versus resorting to costly long-term maintenance associated with pipeline scour and the likely need to harden stream/river banks to "train" these waterways.	Comment acknowledged.
USFWS	9/26/2016	Because alluvial fans can be quite dynamic, we recommend careful consideration before placing permanent infrastructure in an alluvial fan (e.g., Galbraith Lake compressor station).	Comment acknowledged.
USFWS	9/26/2016	We do not support leaving abandoned access roads in place, even if they have openings cut in them to allow flow through of water. Instead, we recommend reclamation of all temporary access roads to include the removal of all drainage structures, the removal of all fill (especially in wetlands and floodplains), and re-contouring of the former roadbed to the original land-surface profile. The reclaimed roadbed should be protected from initial erosion by a cover crop of non-persistent plant species or mulch, and planted with native perennial species appropriate for the adjacent plant communities. To facilitate removal of roadbed material, we recommend the use of geotextile fabric under the road, which will also help prevent road materials from sinking into the ground during use.	Comment acknowledged.
USFWS	9/26/2016	The Service would appreciate the opportunity to review this App. before it is released for public review. Also, will there be a similar App. created for the Cook Inlet area?	This document was submitted to the public with Draft 2. This is one Spill, Prevention, Control, and Countermeasure (SPCC) Plan template for the entire Project, not specialized to any one location. Each contractor would use this template to prepare a SPCC Plan specific to their work

Resource Report No. 2 Agency Comments and Requests for Information Concerning Resource Report No. 2			
Agency	**Date**	**Comment**	**Response/Resource Report Location**
			area following the format and requirements listed in this overall SPCC Plan.
USFWS	9/26/2016	We appreciate the 50-foot setback from water's edge as a standard BMP, but recommend a 100- foot setback from anadromous waters or waters leading to anadromous waterbodies. Suggest making a project-wide standard buffer requirement of 50-feet for all waterbodies and wetlands and 100-feet for anadromous waterbodies and waters leading to anadromous streams/rivers.	Comment acknowledged, all ATWS (such as staging areas and additional spoil storage areas) would be located at least 50 feet away from all waterbodies. See Appendix N Section V. B.2.a.
USFWS	9/26/2016	Please refer the reader to where they can locate the Alaska LNG Plan.	See Appendix D of Resource Report No. 7 for the Applicant's Upland Erosion Control, Revegetation, and Maintenance Plan (Applicant's Plan).
USFWS	9/26/2016	Please spell-out ATWS here where it is first used.	Comment acknowledged. See revised text in Section 2.2.9.2.5.

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ACRONYMS AND ABBREVIATIONS

ABBREVIATION	DEFINITION
Abbreviations for Units of Measurement	
°C	degrees Celsius
°F	degrees Fahrenheit
psu	practical salinity unit
Mgal	million gallons
Mgal/d	million gallons per day
Mgal/yr	million gallons per year
MMTPA	million metric tons per annum
Other Abbreviations	
§	section or paragraph
AAC	Alaska Administrative Code
ACC	Alaska Conservation Corps
ACGP	Alaska Construction General Permit
ACP	Arctic Coastal Plain
ACWA	Alaska Clean Water Act
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADHSS	Alaska Department of Health and Social Services
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation and Public Facilities
AG	Division of Agriculture
AGDC	Alaska Gasline Development Corporation
Applicant's *Plan*	Applicant's Upland Erosion Control, Revegetation, and Maintenance Plan
Applicant's *Procedures*	Applicant's Wetland and Waterbody Construction, and Mitigation Procedures
ANIMIDA	Arctic Nearshore Impact Monitoring in the Development Area
AOGCC	Alaska Oil and Gas Conservation Commission
APDES	Alaska Pollutant Discharge Elimination System
APP	Alaska Pipeline Project
Applicant	The Alaska Gasline Development Corporation
ASAP	Alaska Stand Alone Pipeline
ATWS	additional temporary workspace
AWC	Anadromous Waters Catalog
AWQS	Alaska Water Quality Standards
bgs	below ground surface
BLM	United States Department of the Interior, Bureau of Land Management
BMP	best management practice
BOEM	United States Department of the Interior, Bureau of Ocean Energy Management
BWDS	ballast water discharge standard
BWMS	ballast water management system
C.F.R.	Code of Federal Regulations

ABBREVIATION	DEFINITION
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIRCAC	Cook Inlet Regional Citizens Advisory Council
CWA	Clean Water Act
DA	Department of the Army
DEIS	Draft Environmental Impact Statement
DERP	Defense Environmental Restoration Program
DGGS	ADNR Division of Geological and Geophysical Surveys
DH	dock head
DMLW	ADNR Division of Mining, Land and Water
DMMP	Dredged Material Management Plan
DNPP	Denali National Park and Preserve
DOC	dissolved organic carbon
DWPA	Drinking Water Protection Area
DWPP	Drinking Water Protection Program
EFH	Essential Fish Habitat
EH	Environmental Health
EIS	Environmental Impact Statement
EO	Executive Order
EPA	United States Environmental Protection Agency
ER	Environmental Report
ERDC	United States Army Engineer Research and Development Center
ESA	Endangered Species Act
FCI	Functional Capacity Index
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FERC	United States. Department of Energy, Federal Energy Regulatory Commission
FERC Plan	FERC Erosion Control, Revegetation, and Maintenance Plan
FERC Procedures	FERC Wetland and Waterbody Construction and Mitigation Procedures
FFRMS	Federal Flood Risk Management Standard
FIRM	flood insurance rate map
FUDS	Formerly Used Defense Sites
GHG	greenhouse gas
GIS	geographic information system
GP	General Permit
GTP	gas treatment plant
GUDISW	groundwater under the direct influence of surface water
HCD	National Marine Fisheries Service Habitat Conservation Division
HDD	horizontal directional drill
HGM	hydrogeomorphic
HLV	heavy lift vessel

ABBREVIATION	DEFINITION
HUC	hydrologic unit code
ISO	International Organization for Standardization
ITA	Individual Take Authorization
KPB	Kenai Peninsula Borough
LEDPA	Least Environmentally Damaging Practicable Alternative
Liquefaction Facility	natural gas liquefaction
LLC	Limited Liability Company
LNG	liquefied natural gas
LNGC	liquefied natural gas carrier
LP	Limited Partnership
Mainline	an approximately 807-mile-long, large-diameter, midstream intrastate gas pipeline
MGS	Major Gas Sales
MHW	mean high water
MLBV	mainline block valve
MLW	mean low water
MLLW	mean lower low water
MOF	material offloading facility
MP	milepost
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NGA	Natural Gas Act
NHD	National Hydrography Dataset
NIC	National Ice Center
NMFS	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination Systems
NPS	United States Department of the Interior, National Park Service
NRI	Nationwide Rivers Inventory
NSB	North Slope Borough
NWI	National Wetland Inventory
ODPCP	Oil Discharge Prevention and Contingency Plan
OHA	ADNR Division of Parks and Outdoor Recreation, Office of History and Archaeology
OPMP	ADNR, Office of Project Management and Permitting
ORV	Outstandingly Remarkable Value
PAH	polycyclic aromatic hydrocarbons
PBTL	Prudhoe Bay Gas Transmission Line

ABBREVIATION	DEFINITION
PBU	Prudhoe Bay Unit
PLF	Product Loading Facility
PMC	Plant Materials Center
Project	Alaska LNG Project
PTTL	Point Thomson Gas Transmission Line
PTU	Point Thomson Unit
PWS	public water supply
RCRA	Resource Conservation and Recovery Act
RHA	Rivers and Harbors Act
RM	river mile
ROW	right-of-way
SARA	Superfund Amendment and Reauthorization Act
SDWA	Safe Drinking Water Act
SFHA	Special Flood Hazard Area
SHPO	Alaska Department of Natural Resources, Department of Parks and Outdoor Recreation, Office of History and Archaeology State Historic Preservation Office
SPCC	Spill Prevention, Control, and Countermeasure Plan
SPCS	State Pipeline Coordinator's Section
SSA	sole source aquifer
SWAP	Source Water Assessment and Protection
SWPPP	Stormwater Pollution Prevention Plan
TAH	total aromatic hydrocarbon
TAPS	Trans-Alaska Pipeline System
TBD	to be determined
TDS	total dissolved solids
TMDL	total maximum daily load
TPAH	total polycyclic aromatic hydrocarbons
TSS	total suspended solids
TWUA	temporary water use authorization
UAF	University of Alaska – Fairbanks
UIC	Underground Injection Control
U.S.	United States
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDOI	United States Department of the Interior
USDW	underground source of drinking water
USFWS	United States Department of the Interior, Fish and Wildlife Service
USGS	United States Department of the Interior, United States Geological Survey
VGP	Vessel General Permit

ABBREVIATION	DEFINITION
VOC	volatile organic compound
VSM	vertical support member
WBD	watershed boundary dataset
WELTS	Well Log Tracking System
WQS	water quality standards
WSA	Waterway Suitability Assessment

2.0 RESOURCE REPORT NO. 2 – WATER USE AND QUALITY

Potential water resource impacts were assessed for both construction and operation of the proposed Project. Unless specified, impacts to water resources were assessed specific to the Project's footprint, consisting of:

- Crossing locations across all aquifers, wetlands, and waterbodies, as well as the potential impacts associated with in-water excavation, including sediment transport and deposition;
- The in-water area of disturbance in Cook Inlet and Beaufort Sea from dredging and marine facility construction and the distance sediment plumes could disperse/travel, as well as the footprint of sediment disposal; and
- The in-water potential for contamination resulting from inadvertent releases of fuel, greases and oils, solvents or other during marine and freshwater construction.

Impacts to marine waters would also include those related to construction support vessels at the Liquefaction Facility and West Dock, as well as during transit through Cook Inlet and Beaufort Sea to the outer limit of the territorial seas of the United States, including the potential for fuel spills. Operational impacts to surface waters would also include the impacts of LNG carriers (LNGCs) at the Liquefaction Facility and during transit through Cook Inlet to the outer limit of the territorial seas of the United States, including the potential for fuel spills.

2.1 PROJECT DESCRIPTION

The Alaska Gasline Development Corporation (Applicant) plans to construct one integrated liquefied natural gas (LNG) Project (Project) with interdependent facilities for the purpose of liquefying supplies of natural gas from Alaska, in particular from the Point Thomson Unit (PTU) and Prudhoe Bay Unit (PBU) production fields on the Alaska North Slope (North Slope), for export in foreign commerce and for in-state deliveries of natural gas.

The Natural Gas Act (NGA), 15 U.S.C. § 717a(11) (2006), and Federal Energy Regulatory Commission (FERC) regulations, 18 Code of Federal Regulations (C.F.R.) § 153.2(d) (2014), define "LNG terminal" to include "all natural gas facilities located onshore or in State waters that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is ... exported to a foreign country from the United States." With respect to this Project, the "LNG Terminal" includes the following: a liquefaction facility (Liquefaction Facility) in Southcentral Alaska; an approximately 807-mile gas pipeline (Mainline); a gas treatment plant (GTP) within the PBU on the North Slope; an approximately 63-mile gas transmission line connecting the GTP to the PTU gas production facility (PTU Gas Transmission Line or PTTL); and an approximately 1-mile gas transmission line connecting the GTP to the PBU gas production facility (PBU Gas Transmission Line or PBTL). All of these facilities are essential to export natural gas in foreign commerce and will have a nominal design life of 30 years.

These components are shown in Resource Report No. 1, Figure 1.1-1, as well as the maps found in Appendices A and B of Resource Report No. 1. Their proposed basis for design is described as follows.

The new Liquefaction Facility would be constructed on the eastern shore of Cook Inlet just south of the existing Agrium fertilizer plant on the Kenai Peninsula, approximately 3 miles southwest of Nikiski and

8.5 miles north of Kenai. The Liquefaction Facility would include the structures, equipment, underlying access rights, and all other associated systems for final processing and liquefaction of natural gas, as well as storage and loading of LNG, including terminal facilities and auxiliary marine vessels used to support Marine Terminal operations (excluding LNG carriers [LNGCs]). The Liquefaction Facility would include three liquefaction trains combining to process up to approximately 20 million metric tons per annum (MMTPA) of LNG. Two 240,000-cubic-meter tanks would be constructed to store the LNG. The Liquefaction Facility would be capable of accommodating two LNGCs. The size of LNGCs that the Liquefaction Facility would accommodate would range between 125,000–216,000-cubic-meter vessels.

In addition to the Liquefaction Facility, the LNG Terminal would include the following interdependent facilities:

- Mainline: A new 42-inch-diameter natural gas pipeline approximately 807 miles in length would extend from the Liquefaction Facility to the GTP in the PBU, including the structures, equipment, and all other associated systems. The proposed design anticipates up to eight compressor stations; one standalone heater station, one heater station collocated with a compressor station, and six cooling stations associated with six of the compressor stations; four meter stations; 30 Mainline block valves (MLBVs); one pig launcher facility at the GTP meter station, one pig receiver facility at the Nikiski meter station, and combined pig launcher and receiver facilities at each of the compressor stations; and associated infrastructure facilities.

  Associated infrastructure facilities would include additional temporary workspace (ATWS), access roads, helipads, construction camps, pipe storage areas, material extraction sites, and material disposal sites.

  Along the Mainline route, there would be at least five gas interconnection points to allow for future in-state deliveries of natural gas. The approximate locations of three of the gas interconnection points have been tentatively identified as follows: milepost (MP) 441 to serve Fairbanks, MP 763 to serve the Matanuska-Susitna Valley and Anchorage, and MP 807 to serve the Kenai Peninsula. The size and location of the other interconnection points are unknown at this time. None of the potential third-party facilities used to condition, if required, or move natural gas away from these gas interconnection points are part of the Project. Potential third-party facilities are addressed in the Cumulative Impacts analysis found in Appendix L of Resource Report No. 1;

- GTP: A new GTP and associated facilities in the PBU would receive natural gas from the PBU Gas Transmission Line and the PTU Gas Transmission Line. The GTP would treat/process the natural gas for delivery into the Mainline. There would be custody transfer, verification, and process metering between the GTP and PBU for fuel gas, propane makeup, and byproducts. All of these would be on the GTP or PBU pads;

- PBU Gas Transmission Line: A new 60-inch natural gas transmission line would extend approximately 1 mile from the outlet flange of the PBU gas production facility to the inlet flange of the GTP. The PBU Gas Transmission Line would include one meter station on the GTP pad; and

- PTU Gas Transmission Line: A new 32-inch natural gas transmission line would extend approximately 63 miles from the outlet flange of the PTU gas production facility to the inlet flange of the GTP. The PTU Gas Transmission Line would include one meter station on the GTP pad, four MLBVs, and pig launcher and receiver facilities—one each at the PTU and GTP pads.

Existing State of Alaska transportation infrastructure would be used during the construction of these new facilities including ports, airports, roads, railroads, and airstrips (potentially including previously abandoned airstrips). A preliminary assessment of potential new infrastructure and modifications or additions to these existing in-state facilities is provided in Resource Report No. 1, Appendix L. The Liquefaction Facility, Mainline, and GTP would require the construction of modules that may or may not take place at existing or new manufacturing facilities in the United States.

Resource Report No. 1, Appendix A, contains maps of the Project footprint. Appendices B and E of Resource Report No. 1 depict the footprint, plot plans of the aboveground facilities, and typical layout of aboveground facilities.

Outside the scope of the Project, but in support of or related to the Project, additional facilities or expansion/modification of existing facilities would be needed to be constructed. These other projects may include:

- Modifications/new facilities at the PTU (PTU Expansion project);
- Modifications/new facilities at the PBU (PBU Major Gas Sales [MGS] project); and
- Relocation of the Kenai Spur Highway.

2.1.1 Purpose of Resource Report

As required by 18 C.F.R. § 380.12, this Resource Report has been prepared in support of a FERC application under the NGA to construct and operate the Project facilities. The purpose of this Resource Report is to therefore:

- Describe the existing water resources and water quality that may be affected either directly or indirectly by the Project;

- Assess the potential effects to these resources resulting from the construction and operation of the proposed facilities; and

- Identify potential mitigation measures to avoid or minimize potential effects to groundwater, surface waterbodies, wetland resources, and floodplains.

Appendices included in this Resource Report include the following:

- Appendix A Public and Private Water Wells within 500 Feet of the Project;

- Appendix B *Groundwater Monitoring Plan*;

- Appendix C *Water Well Monitoring Plan*;

- Appendix D Hydrology Mapping (provided under separate cover);
- Appendix E Wetland Impact Tables;
- Appendix F Wetland Mapping;
- Appendix G Wetland Field Survey Report;
- Appendix H List of Waterbodies Crossed by the Project;
- Appendix I Site-specific Waterbody Crossing Plans;
- Appendix J Stormwater Pollution Prevention Plan (SWPPP);
- Appendix K *Water Use Plan*;
- Appendix L *HDD Inadvertent Release Contingency Plan* (Project-Specific HDD Contingency Plan);
- Appendix M Draft Spill Prevention, Control, and Countermeasure (SPCC) Plan;
- Appendix N Applicant's *Wetland and Waterbody Construction, and Mitigation Procedures* (Applicant's *Procedures*). Requested Project-specific modifications are outlined in tables in Section 2.6;
- Appendix O Wetland Mitigation Plan; and
- Appendix P Alaska LNG Pipeline – Floodplain Analysis Techniques;
- Appendix Q Analytical Results of Sediment Sampling Near the Marine Terminal
- Appendix R Analytical Results of Sediment Sampling Near West Dock
- Appendix S 2016 Hydrogeology Program for the Liquefaction Facility

The data for this Resource Report were compiled based on a review of:

- Feedback from FERC and other federal, state, and local agencies on Draft 1 and Draft 2 of the Environmental Report (ER);
- Discussions with agencies;
- Scoping comments;
- Recent aerial photography (2015);

- Pre-FEED and proposed construction plans;
- Scientific literature;
- Geographic Information System (GIS) data from federal and state agencies;
- Field survey data collected for the Project as well as the Alaska Pipeline Project (APP) and the Alaska Stand Alone Pipeline (ASAP);
- Agency-supplied data; and
- Review of data from adjacent projects.

2.1.2 Effect Determination Terminology

The following definitions were used when assessing the duration, significance, and outcome of potential effects related to the Project:

- Duration**:** ***Temporary*** effects are those that may occur only during a specific phase of the Project, such as during construction or installation activities. ***Short-term effects*** could continue up to five years. ***Long-term*** effects are those that would take more than five years to recover. ***Permanent*** effects could occur because of any activity that modified a resource to the extent that it would not return to preconstruction conditions during the 30-year life of the Project.
- Significance: ***Minor*** effects are those that may be perceptible but are of very low intensity and may be too small to measure. ***Significant*** effects are those that, in their context, and due to their intensity, have the potential to result in a substantial adverse change in the physical environment.
- Outcome: A ***positive*** effect may cause positive outcomes to the natural or human environment. In turn, an ***adverse*** effect may cause unfavorable or undesirable outcomes to the natural or human environment. ***Direct effects*** are "caused by the action and occur at the same time and place" (40 C.F.R. 1508.8). ***Indirect effects*** are "caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect impacts may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 C.F.R. 1508.8). Indirect impacts are caused by the Project, but do not occur at the same time or place as the direct impacts.

2.1.3 Applicable Regulations and Permits

2.1.3.1 Lead and Cooperating Agency Authorities

FERC will be the Lead Federal Agency responsible for NEPA compliance and Project certification under Section 3 of the NGA. Other cooperating agencies will review the proposed action and process permit applications for the authorizations for activities under their regulatory jurisdiction.

The following sections discuss the functions of federal and state agencies relative to their respective legislated permit granting authorities for Project water use and quality activities. Resource Report No. 1, Appendix C provides a complete list of federal, state, and local permits and authorizations that may be required to complete the Project.

2.1.3.2 Federal Agencies and Regulatory Authority

2.1.3.2.1 U.S. Army Corps of Engineers (USACE) Permits

USACE has the authority to issue or deny permits for placement of dredge or fill material in the waters of the United States, including wetlands (which incorporate the vast majority of the Project study area) and for work and/or structures in, on, over, or under navigable waters of the United States. Consequently, USACE's authority extends, and its decisions following completion of the EIS will extend to the entire Project wetlands footprint, regardless of who owns the land. USACE's regulatory authorities are set forth under:

- Section 404 of the CWA (33 USC § 1251 et seq.), USACE regulates placement of dredge and fill material in waters of the United States, including wetlands. The proposed project is located in an area that consists of wetlands that are within USACE's jurisdiction.

- In accordance with 33 C.F.R. 332.1(c)(3), *"compensatory mitigation for unavoidable impacts may be required to ensure that an activity requiring a section 404 permit complies with the Section 404(b)(1) Guidelines."* Pursuant to this authority, USACE can require compensatory mitigation calculated based on the entire functional value of each acre of the direct project footprint, plus an additional multiple of lost functional footprint.

- Section 10 of the Rivers and Harbors Act (33 USC § 401), USACE has regulatory authority for work and structures performed in, on, over, or under navigable waters of the United States.

2.1.3.2.2 U.S. Environmental Protection Agency (EPA) Review

EPA authority to regulate oil and gas development is contained in the Clean Water Act (CWA) (33 USC § 1251 et seq.) and the Safe Drinking Water Act (SDWA) (42 USC § 300f et seq.). These authorities are under:

- Section 402 of the CWA (33 USC § 1251 et seq.). The State of Alaska is delegated authority to issue permits for facilities operating within state jurisdiction of permits issued for the discharge of pollutants from a point source into waters of the United States for facilities, including oil and gas facilities Point-source discharges that require an Alaska Pollutant Discharge Elimination System (APDES) permit include, but are not limited to, sanitary and domestic wastewater, gravel pit and construction dewatering, and hydrostatic test water, stormwater discharges, etc. (40 C.F.R. 122).

- Section 404 of the CWA (33 USC § 1251 et seq.). EPA reviews and comments on Corps Section 404 permit applications for compliance with the Section 404(b)(1) guidelines and other statutes and authorities within its jurisdiction (40 C.F.R. 230).

- The SDWA (42 USC § 300f et seq.). EPA's responsibilities include the management of the Underground Injection Control (UIC) program and the direct implementation of Class I and Class V injection wells in Alaska for the disposal of non-hazardous and hazardous waste through a permitting process that regulates the disposal of fluids that are recovered from down hole, as well as municipal waste, stormwater, and other fluids that did not come up from down hole (40 C.F.R. 124A, 40 C.F.R. 144, 40 C.F.R. 146). EPA oversees the Class II program delegated to the State of Alaska that is managed by the Alaska Oil and Gas Conservation Commission (AOGCC), which includes Class II enhanced oil recovery, storage, and disposal wells that may receive non-hazardous produced fluids originating from down hole, including muds and cuttings (40 C.F.R. 147).

- Section 311 of the Federal Water Pollution Control Act of 1972, as amended (CWA, 33 USC § 1321, 40 C.F.R. Part 112) requires a *Spill Prevention Containment and Countermeasure (SPCC) Plan* for storage of over 660 gallons of fuel in a single container or over 1,320 gallons in aggregate aboveground tanks.

- The CWA as amended (Oil Pollution Act; 33 USC Chapter 40; FRP Rule; 40 C.F.R. Part 112, Subpart D, §§ 112.20 and 112.21) requires a Facility Response Plan (FRP) to identify and ensure the availability of sufficient resources to respond to the worst case discharge of oil to the maximum extent practicable, *"…generally for facilities that transfer over water to or from vessels, and maintaining a capacity greater than 42,000 gallons, or any facility with a capacity of over one million gallons."*

2.1.3.3 State Agencies and Regulatory Authority

The State of Alaska has responsibility for issuance of multiple permits (see Appendix C of Resource Report No. 1 for a listing of permits). Alaska's Department of Natural Resources (ADNR) issues temporary water use and water rights permit, and other authorizations for activities associated with oil and gas development. The Alaska Department of Fish and Game (ADF&G) issues fish habitat permits. The Alaska Department of Environmental Conservation (ADEC) is responsible for issuing several permits and plan approvals for oil and gas exploration and development activities, including the storage and transport of oil and cleanup of oil spills. The AOGCC is responsible for issuing drilling permits and for production, injection, and disposal plan approvals for exploration and development activities in the State of Alaska (BLM 2012, p. 13). AOGCC also has primacy for Alaska Class II UIC program through a Memorandum of Agreement (MOA) with the EPA. Additional state authorities are detailed the sections that follow.

2.1.3.3.1 ADNR Permits and Authorizations

ADNR issues the following permits that would be required by the Project:

- Rights-of-Way (ROWs) and Land Use permits for use of state land, off-road and tundra travel, and ice road construction on state land and state freshwater bodies under Alaska Statutes (AS) 38.35 and 38.05.850; and

- Temporary Water Use and Water Rights (adjudication) permits under AS 46.15 for water use, withdrawal, diversion or impoundment for construction and operations.

2.1.3.3.2 ADEC Permits and Authorizations

ADEC is the authority to administer the following federal and state permits and authorizations:

- APDES wastewater discharge permit and mixing zone approval for wastewater disposal into all waters of the U.S. within the State of Alaska under a transfer of authority from the EPA National Pollutant Discharge Elimination System (NPDES) Program under Section 402, Federal Water Pollution Control Act of 1972, as amended (CWA, 33 USC § 1342); AS 46.03.020, .100, .110, .120, and .710; 18 Alaska Administrative Code (AAC) chapters 15, and 70, and; § 72.500;

- Certificate of Reasonable Assurance (CRA) /NPDES and Mixing Zone Approval for wastewater disposal into all state waters under Section 402, Federal Water Pollution Control Act of 1972, as amended (CWA; 33 USC § 1342); AS 46.03.020, .100, .110, .120, and .710; 18 AAC chapters, 10, 15, and 70, and; § 72.500;

- ADEC CWA Section 401 Certificate of Reasonable Assurance for Section 404 permits issued by USACE (CWA; 33 USC 1344);

- State Wastewater Disposal Permit for Class I Underground Injection Control permit for subsurface injection of non-domestic wastewater under 18 AAC 72;

- Approves financial responsibility for cleanup of oil spills (18 AAC Chapter 75);

- Pursuant to the Oil Pollution Act of 1990 (OPA 90), ADEC reviews and approves the Oil Discharge Prevention and Contingency Plan (ODPCP) and the Certificate of Financial Responsibility for storage or transport of oil under AS 46.04.030 and 18 AAC Chapter 75. The State review applies to oil exploration and production facilities, crude oil pipelines, oil terminals, tank vessels and barges, and certain non-tank vessels; and

- Approves Public Water Systems for temporary camps.

2.1.3.3.3 ADF&G Permits and Authorizations

The ADF&G issues the following permits and authorizations that would be needed by the Project:

- Fish Habitat Permits under AS 16.05.871 and AS 16.05.841 for activities within streams used by fish that the agency determines could represent impediments to fish passage, or for travel in, excavation of, or culverting of anadromous fish streams.

- AS16.05.841 – Fishway Act deals exclusively with fish passage, applies to streams with documented resident fish use and without documented use by anadromous fish.

- AS16.05.871 – Anadromous Fish Act – applies to streams specified in the Anadromous Waters Catalog (AWC) as important for the spawning, rearing or migration of anadromous fishes – much broader authority and extends to anadromous fish habitat.

The ADF&G is also responsible for evaluating potential impacts to fish, wildlife and fish and wildlife users, and presenting any related recommendations to state land managers (ADNR) or, via the Fish and Wildlife Coordination Act, to federal permitting agencies.

2.1.3.3.4 AOGCC Permits and Authorizations

The Alaska Oil and Gas Conservation Commission (AOGCC) is responsible for issuing drilling permits (20 AAC 25.005) for all wells in Alaska, including for underground injection wells, and for production, injection, and disposal plan approvals for exploration and development activities in the State of Alaska (BLM 2012, p. 13). In addition to issuing permits to drill, AOGCC also has primacy for the Alaska Class II UIC program through an MOA with the EPA.

2.1.4 Agency and Organization Consultations

This section describes consultations that have been conducted to date with agencies and interested parties interested in the Project.

2.1.4.1 Federal Agencies

Discussions were held with multiple federal agencies regarding various Project details. Table 2.1.4-1 includes meetings and correspondence where discussions of water and wetland resources were raised.

A list of the required federal permits for the Project is provided in Resource Report No. 1, Appendix C. A preliminary summary of public, agency, and stakeholder engagement is provided in Resource Report No. 1, Appendix D.

TABLE 2.1.4-1
Summary of Consultations with Federal Agencies

Contact	Date Contacted	Summary
Bureau of Land Management (BLM)	5/16/2013	Discussion regarding 2013 summer field season activities
U.S. Army Corps of Engineers (USACE)	10/17/2013	Discussion regarding Cook Inlet metocean data gathering program and necessary approvals
U.S. Coast Guard (USCG)	10/18/2013	Discussion regarding Cook Inlet metocean data gathering program and necessary approvals
National Marine Fisheries Service (NMFS)	10/24/2013	Discussion regarding Cook Inlet metocean data gathering program and necessary approvals
USACE, USCG	11/21/2013	Discussion regarding pipeline routing sensitivities in Cook Inlet
BLM	12/10/2013	Discussion regarding 2014 field study scope and submittal of reimbursable services agreement amendment letter
USACE, USCG, BLM, National Park Service (NPS), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS)	2/26/2014	Summer field season kickoff presentation
USCG, BLM, NPS, USFWS	2/27/2014	Pipeline right-of-way (ROW) workshop with state and federal agencies

TABLE 2.1.4-1
Summary of Consultations with Federal Agencies

Contact	Date Contacted	Summary
USFWS, BLM	3/4/2014	Discussion regarding 2014 summer field season activities
NMFS, USACE	4/9/2014	Discussion regarding further metocean studies and geotechnical and geophysical studies permitting as well as GTP fieldwork.
USACE, EPA, USFWS	5/20/2014	Email to USACE, USFWS, EPA – Wetlands Determination Protocol Notification
USACE	5/28/2014	Letter to USACE - Wetlands Determination Protocol
USFWS	5/28/2014	Discussion regarding authorizations required for preliminary studies to support the GTP
USACE, EPA	5/29/2014	Discussion regarding authorizations required for preliminary studies to support the GTP
NMFS	5/30/2014	Discussion regarding authorizations required for preliminary studies to support the GTP
USACE	6/12/2014	Discussion regarding wetlands assessment protocols and data
USACE	8/13/2014	Letter to USACE - Review of Wetland Studies Data Gathered by the Alaska Pipeline Project (APP) and the Project
USACE	9/2/2014	Discussion of previously submitted wetlands data
USACE, EPA	9/9/2014	Discussion of GTP sediment sampling locations
USACE	10/1/2014	Discussion regarding permitting and Pre-File activities
USCG	10/3/2014	Discussion regarding permitting and Pre-File activities
USCG	10/7/2014	Discussion regarding permitting and Pre-File activities
USACE, EPA, NMFS	10/22/2014	Discussion regarding North Slope Test Trench permitting
USACE	12/12/2014	USACE History/Experiences – Dredging in Cook Inlet
BLM	12/16/2014	Discussion regarding agency's feedback on prior submitted field data
FERC, NMFS, NPS, USACE, USCG, U.S. Department of Energy, USFWS, U.S. Department of the Interior (USDOI), EPA	2/10/2015	Project Agency Web Mapper and SharePoint Overview
Alaska Department of Environmental Conservation (ADEC)	3/6/2015	Project Overview
EPA, FERC, USACE, NPS, BLM, USFWS, NMFS	3/16-18/15	FERC led ER review workshop
EPA, FERC, USACE, NPS, USFWS	5/12/2015	Multi-Agency Pipeline Routing Workshop – Revision B Route
USACE, EPA, USFWS	5/14/2015	USACE Aquatic Site Assessment Guidance

TABLE 2.1.4-1
Summary of Consultations with Federal Agencies

Contact	Date Contacted	Summary
USACE, EPA, USFWS	6/24/2015	Workshop to explain large-diameter natural gas pipeline construction planning and execution, including an overview of pipeline construction by season
USFWS, FERC, National Oceanic Atmospheric Administration (NOAA)	6/25/2015	Multi-Agency Waterbody Crossings Workshop
USACE	7/8/2015	Letter from USACE – Wetlands Determination Protocol
USACE	7/27/2015	Letter to USACE – Response to Wetland Delineation and Functional Assessment Protocol
NPS	7/29/2015	Letter to NPS – Visual/Aesthetics Study Work Plan
USFWS	7/29/2015	Letter to USFWS – Visual/Aesthetics Study Work Plan
BLM, USFWS, NPS	8/7/2015	Project Visual Aesthetics Study Work Plan.
EPA, FERC, NMFS, USACE, USCG, USFWS	8/12/2015	Review of GTP footprint
FERC, USACE, EPA, USFWS	8/12/2015	Cook Inlet Routing and Construction Review
FERC, NMFS, USACE, USFWS	8/19/2015	Cook Inlet Routing and Construction Review
FERC, NMFS, USACE, USCG, USFWS	9/2/2015	Workshop to review the Liquefaction Facility footprint
EPA, FERC, NMFS, USACE, USCG, USFWS	9/3/2015	Dredging workshop
FERC	9/9/2015	Review of proposed modifications to *Wetland and Waterbody Construction and Mitigation Procedures* (Applicant's *Procedures*) with FERC
FERC	9/10/2015	Review of proposed modifications to *Upland Erosion Control, Revegetation and Maintenance Plan* (Plan) with FERC
NMFS, State Historic Preservation Office (SHPO), USACE	10/13/2015	Cook Inlet 2016 test trench permitting pre-application meeting
EPA	10/22/2015	Alternative Methods for Sediment Sampling in Cook Inlet
USACE	5/2/2016	Letter from USACE (Sandy Gibson) – Review of 2015 Wetland Field Study Report
USACE	6/27/2016	Letter to USACE (Sandy Gibson) – Transmittal of 2016 Aquatic Site Assessment (ASA) Pilot Program
USACE	10/25/2016	Letter to USACE (Ryan Winn) – Transmittal of 2016 Wetland and Vegetation Field Study Report
USGS	3/14/2017	Email from USGS (Howard Reeves) – Water Will Record Databases

2.1.4.2 State Agencies

Discussions were held with multiple State of Alaska and local agencies, as well as private corporation representatives, regarding Project details. Table 2.1.4-2 includes meetings and correspondence where discussions of water and wetland resources were raised. This table will be updated in the FERC application as additional input is solicited.

A list of required state permits for the Project, as well as a summary of public, agency, and stakeholder engagement , is provided in Resource Report No. 1, Appendix D.

TABLE 2.1.4-2
Summary of Consultations with Alaska State and Local Government Agencies

Contact	Date Contacted	Summary
State Pipeline Coordinator's Section (SPCS)	5/15/2013	Discuss 2013 field studies scope and reimbursable services agreement
SPCS	10/16/2013	Review Cook Inlet metocean data gathering program and necessary approvals
SPCS	12/10/2013	Discussion regarding 2014 field study scope and submittal of reimbursable services agreement amendment letter
Alaska Department of Natural Resources (ADNR)	1/9/2014	Discussion regarding GTP siting
ADEC, SPCS	2/25/2014	Discussion regarding 2014 summer field season activities
ADNR, SPCS, Alaska Department of Fish & Game (ADF&G)	2/27/2014	Pipeline ROW workshop with state and federal agencies
ADEC, ADF&G, Alaska Department of Transportation and Public Facilities (ADOT&PF), SPCS	3/4/2014	Discussion regarding 2014 summer field season activities
SPCS	4/24/2014	Discussion regarding further metocean studies and geotechnical and geophysical studies permitting
ADNR Office of Project Management and Permitting (OPMP), SPCS, ADF&G, ADOT&PF, ADEC	5/29/2014	Discussion regarding authorizations necessary for 2014 summer field season activities
Kenai Peninsula Borough (KPB)	6/4/2014	Discussion regarding 2014 field activities
ADNR Division of Parks and Outdoor Recreation, Office of History and Archaeology (OHA), ADF&G (also BLM, USACE)	6/9/2014	Discussion regarding historical field survey data and protocols
North Slope Borough (NSB)	6/9/2014	Discuss bathymetry survey and required NSB permitting
OPMP, SPCS, ADF&G	6/11/2014	Discussion regarding fish stream and lakes investigation survey protocols and data
OPMP, SPCS	6/12/2014	Discussion regarding regulatory limitations and proposed routing
ADF&G	8/28/2014	Discussion regarding fisheries data
ADEC	10/1/2014	Discussion regarding permitting and Pre-File activities

TABLE 2.1.4-2
Summary of Consultations with Alaska State and Local Government Agencies

Contact	Date Contacted	Summary
OPMP, SPCS	10/21/2014	Discussion regarding North Slope winter 2015 field programs
ADF&G, SPCS	10/22/2014	Discussion regarding Gas Treatment Plant water reservoir design
ADEC, ADNR	10/22/2014	Discussion regarding North Slope Test Trench permitting
NSB, OPMP, SPCS	10/23/2014	Discussion regarding North Slope winter 2015 field programs
ADOT&PF, OPMP, SPCS	10/28/2014	Discussion regarding geotechnical studies along the Mainline corridor
ADEC	11/13/2014	Discuss Alaska Pollutant Discharge Elimination System (APDES) General Discharge Permit
ADEC	11/20/2014	Discussion of APDES General Discharge Permit Program
SPCS	12/12/2014	USACE history/experiences – Dredging in Cook Inlet
OPMP	12/16/2014	Discussion regarding agency's feedback on prior submitted field data
OPMP, OHA, SPCS	12/17/2014	Discussion regarding agency's feedback on prior submitted field data
Alaska Conservation Fund	1/12/2015	Compensatory Mitigation for Gas Treatment Plant Test Trench Program
ADOT&PF, North Slope Gas Commercialization Permitting Coordination Team	2/10/2015	Project Agency Web Mapper and SharePoint Overview
ADEC, ADNR, SPCS, OHA, OPMP, KPB, NSB, ADOT&PF, ADF&G, SHPO	3/16-18/15	FERC led ER review workshop
KPB	4/20/2015	2015 Permitting for Activities in the Kenai Peninsula Borough
ADEC	4/28/2015	Review of APDES Application for 2015 Cook Inlet Geotechnical Surveys
Matanuska-Susitna Borough	5/12/2015	Discussion of Liquefaction Facility siting and offshore pipeline route in Cook Inlet
ADEC, ADNR, Alaska Department of Health and Social Services (ADHSS), ADF&G, SHPO, Denali Borough, ADNR/Division of Geological and Geophysical Surveys (DGGS), ADOT&PF, KPB, SPCS	5/12/2015	Multi-Agency Pipeline Routing Workshop—Revision B route
ADF&G	5/13/2015	Review of stream crossing construction techniques. Discussion of proposed waterbody crossings along the Rev. B route
ADEC	5/21/2015	Review of Project representatives' comments to APDES Individual Discharge Permit (Cook Inlet Geotechnical Borings)
ADEC	6/22/2015	Regulatory Framework for Potential Discharge from LNG Drilling Activities on the Beach, Nikiski
ADEC, ADF&G, ADNR, ADOT&PF, NSB	6/24/2015	Workshop to explain large-diameter natural gas pipeline construction planning and execution, including an overview of pipeline construction by season

TABLE 2.1.4-2
Summary of Consultations with Alaska State and Local Government Agencies

Contact	Date Contacted	Summary
SPCS, ADHSS	6/25/2015	Multi-Agency Waterbody Crossings Workshop
SPCS	7/2/2015	Debrief of June 24 and 25 Pipeline Construction Workshops
SPCS	7/20/2015	Letter - Visual/Aesthetics Study Work Plan
ADF&G, ADNR, NSB, SPCS	8/12/2015	Review of GTP footprint
ADNR, ADF&G, ADHSS, DGGS, ADNR/Division of Mining, Land, and Water (DMLW) Southcentral Region Land Office, KPB, SPCS	8/12/2015	Cook Inlet routing and construction review
ADF&G, ADNR, KPB, Matanuska-Susitna Borough, SPCS	8/19/2015	Cook Inlet Routing and Construction Review
ADF&G, ADNR, ADOT&PF, KPB	9/2/2015	Workshop to review the Liquefaction Facility footprint
ADNR, SPCS	9/3/2015	Dredging workshop
ADEC, ADNR, KPB, SHPO	10/13/2015	Cook Inlet 2016 test trench permitting pre-application meeting
ADNR-DMLW	11/10/2015	Email from ADNR-DMLW (Henry Brooks) – Public Notice of Water Right Application LAS 29332
ADNR-DMLW	4/1/2016	Letter from ADNR-DMLW (Christine Ballard) – Water Right Certificate of Appropriation, ADL 201536, Transfer
ADEC	8/10/2016	Water Discharge Plan

2.2 GROUNDWATER RESOURCES

Alaska is divided into six hydrological regions: Arctic, Northwest, Interior, Southwest, Southcentral, and Southeast that differ in terms of physiography and climate, affecting groundwater movement and storage (USGS, 2012). The Project would cross the Southcentral, Interior, and Arctic hydrological regions. The following sections describe the existing groundwater resources including groundwater quality and uses. Adverse effects to groundwater resources from construction and operations are not expected based on proposed measures to avoid, minimize, and mitigate potential impacts as discussed in Sections 2.2.8 and 2.2.9.

2.2.1 Existing Groundwater Resources

Southcentral region is characterized by glacially derived alluvial-fill valleys delimited by the Alaska Range and Chugach-St. Elias Mountains. Between the Alaska and Brooks Ranges lies the Interior, the largest hydrological region, composed of glacial and glaciolacustrine deposits. These regions have the greatest dependence on groundwater. The largest groundwater withdrawals occur in the Anchorage, Fairbanks North Star Borough, Matanuska-Susitna Borough, and Kenai Peninsula Borough.

The Arctic region is composed of unconsolidated colluvium and alluvium deposits, confined by a thick laterally continuous low-permeability ice-rich permafrost, restricting groundwater interaction between subpermafrost and active-layer (Callegary et al., 2013). This region extends from the Brooks Range to the Beaufort Coastal Plain ecoregion (also known as the Arctic Coastal Plain Physiographic region), where groundwater availability for public supply is highly limited with no underground sources of drinking water (USDW) beneath the underlying confining permafrost.[2] In accordance with 20 AAC 25.440, the AOGCC, with concurrence from the U.S. Environmental Protection Agency (EPA), has determined that no freshwater aquifers are present in the Prudhoe Bay Unit (PBU) on the North Slope. This decision was based on no current USDW in PBU, aquifers are situated at a depth (from 2,000 to 7,000 feet below surface) that makes recovery of water for drinking water purposes economically impracticable, and groundwater at that depth is reported to have a total dissolved solids (TDS) content of 7,000 milligrams per liter (mg/L) or more (AOGCC & EPA, 1986).

The U.S. Geological Survey (USGS) has determined that approximately 177 million gallons per day (Mgal/d) of groundwater is withdrawn from areas crossed by the Project. Of the total groundwater withdrawals, 33 Mgal/d is freshwater and 144 Mgal/d is saline (Maupin et al., 2014). The Alaska Department of Environmental Conservation (ADEC) estimates that about 50 percent of Alaska's overall population, and about 90 percent of rural Alaskans, rely on groundwater for drinking water (ADEC, 2008a). Most of Alaska's groundwater meets water quality standards for domestic, agricultural, aquaculture, commercial, and industrial uses with minimal treatment required (ADEC, 2014). Groundwater uses and withdrawals are summarized in Table 2.2.1-1.

TABLE 2.2.1-1

Groundwater Uses for Areas Crossed by the Project in 2010 [a]

Type of Groundwater (GW) Withdrawals Fresh and Saline Million gallons per day (Mgal/d)	North Slope Borough [b]	Yukon-Koyukuk Census Area	Denali Borough	Fairbanks North Star Borough	Matanuska-Susitna Borough	Kenai Peninsula Borough	Total Withdrawal by Use Type
Public Supply	0.01	0.17	0.01	7.45	1.57	0.76	9.97
Domestic Self-Supply	0.00	0.02	0.12	2.60	4.22	1.96	8.92
Irrigation (Crops & Golf)	0.00	0.00	0.05	0.20	0.51	0.13	0.89
Livestock	0.00	0.00	0.00	0.02	0.02	0.01	0.05
Aquaculture (Hatcheries)	0.00	0.29	0.02	0.01	5.11	5.27	10.7
Mining-Fresh	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Mining-Saline	144.40	0.00	0.00	0.00	0.00	0.05	144.45
Industrial Self-Supply	0.03	0.00	0.00	0.45	0.19	0.00	0.67
Thermoelectric	0.00	0.00	0.60	0.70	0.00	0.45	1.75
Total Fresh GW	***0.04***	***0.48***	***0.80***	***11.43***	***11.63***	***8.58***	***32.96***
Total Saline GW	***144.40***	***0.00***	***0.00***	***0.00***	***0.00***	***0.05***	***144.45***
Total GW Withdrawals	**144.44**	**0.48**	**0.80**	**11.63**	**11.63**	**8.63**	**177.41**
Notes:							

[2] U.S. EPA, 2009: letter from E.J. Kowalski, Director of the Office of Compliance and Enforcement, to D. Pittman, ExxonMobil Production Company, date stamped Sep 25 2009; included as Exhibit 4 in ExxonMobil's Application for Area Injection Order, Point Thomson Unit, received May I, 2015.

TABLE 2.2.1-1

Groundwater Uses for Areas Crossed by the Project in 2010 [a]

Type of Groundwater (GW) Withdrawals Fresh and Saline Million gallons per day (Mgal/d)	North Slope Borough [b]	Yukon-Koyukuk Census Area	Denali Borough	Fairbanks North Star Borough	Matanuska -Susitna Borough	Kenai Peninsula Borough	Total Withdrawal by Use Type

[a] Maupin, M.A., Kenny, J. F., Hutson, S.S., Lovelace, J. K., Barber, N. L., and Linsey, K. S., 2014. Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p., http://dx.doi.org/10.3133/cir1405.

[b] Pursuant to 20 AAC 25.440 Aquifer Exemption Order (AEO) and EPA aquifer exemption (40 CFR § 144.3). Groundwater containing between 3,000 and 10,000 mg/L TDS is not suitable for human consumption. Water in excess of 10,000 mg/L would be considered saline.

2.2.2 Regional Aquifers

A principal aquifer is defined by the USGS as a regionally extensive aquifer or aquifer system that has the potential to be used as a potable water source. The Project area overlies one principal aquifer system: Alaska's unconsolidated-deposit aquifers. These unconsolidated alluvial (deposited by flowing water), colluvial (deposited from mass wasting), eolian (wind-blown), and glacial deposits overlie consolidated clastic and carbonate (limestone and dolomite) sedimentary rocks. Bedrock aquifers of sedimentary rock (such as shale, siltstone, sandstone or conglomerate) or sediment (such as mud, silt, sand, or pebbles) are not regionally defined as a principal aquifer but as a local aquifer source (Miller et al., 1999). Local aquifers and layered aquifers are often grouped into larger named regional aquifers or aquifer systems (USGS, 2011).

Well characteristics for unconsolidated alluvial and glacial deposits (confined to unconfined) have a common range depth of 50-200 feet for individual private-supply wells that yield on average 20 gallons per minute (gal/min). Major supply wells in thick alluvium, glacial deposits occur at a common range depth of 100-400 feet, yielding on average 3000 gal/min. Local unconfined bedrock aquifers are the source for private wells located (outside of the Project corridor) in upland areas of Fairbanks and Anchorage that have a common depth range of 50-500 feet, yielding 25 gal/min (USGS, 1985).

2.2.2.1 Unconsolidated-Deposit Aquifers System

The principal unconsolidated-deposit aquifers system in Southcentral underlies the gently sloping lowlands of the Cook Inlet Basin ecoregion. Deposits of sand and gravel (alluvial) are present in the upper parts of the aquifer system, while colluvial (sand and gravel) deposits border the bedrock hills contiguous with the sedimentary basin that contains the aquifer system. Poorly sorted material, that represents lacustrine (proglacial lakes) or estuarine (marine) deposits are commonly mixed with the sand and gravel having minimal permeability and confining water within the Cook Inlet Basin ecoregion. Water in the unconsolidated-deposit aquifers moves from recharge areas near the Chugach, Talkeetna, and Kenai mountains to the east, the Alaska Range in the north, and Aleutian Range to the west, down the hydraulic gradient to discharge areas beneath major streams in the Lower Susitna River, Knik Arm, Upper Kenai Peninsula, and Redoubt-Trading Bay watersheds (Miller et al., 1999; Nowacki et al., 2003).

The areal extent of unconsolidated-deposit aquifers, as shown in Figure 2.2.1-1, represents a generalized map of boundaries interpreted from surface location outcrop, or near-surface shallow subcrop of the uppermost principal aquifer system in Alaska (USGS, 2003). Sand and gravel aquifers of alluvial and glacial origin were not defined or delineated as a principal aquifer system in the *Ground Water Atlas of the United States*' (USGS HA 730), but are important sources of ground water in river valleys of Southcentral and Interior regions crossed by the Project.

The 2016 Glacial System Groundwater Availability Study added Alaska to the sand and gravel principal aquifer within the glacial aquifer system. USGS defines the sand and gravel principal aquifer as the largest source for public supply and self-supplied industrial for any principal aquifer system (USGS, 2016). Water-well drillers' records obtained from the Alaska Department of Natural Resources (ADNR) were lacking in density or detailed description of the unconsolidated geology for delineating maps or grids of hydrogeological information in glaciated areas crossed by the Project (Bayless et al., 2017).

The Liquefaction Facility, Marine Terminal, Mainline Aboveground and Mainline Pipeline facilities would cross the principal aquifer system in Southcentral and Interior regions. Table 2.2.1-2 summarizes the areas where the proposed Project would be underlain by unconsolidated-deposits of sand, silt, gravel, and glacial till. Additional information about bedrock formations in the Project area is provided in Resource Report No. 6.

TABLE 2.2.1-2

Quaternary-Age Unconsolidated-Deposit Aquifer Crossed by Project

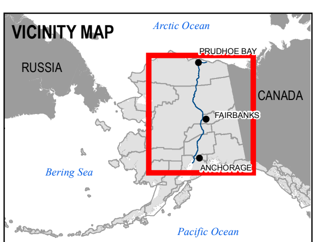
Facility Name	Approximate Milepost		Length (Miles)
	Start	End	
Liquefaction Facility			
LNG Plant	N/A		Completely Underlain
Marine Terminal	N/A		Completely Underlain
Interdependent Project Facilities			
Mainline -Pipeline	263.1	266.2	3.1
	278.6	281.8	3.2
	290.0	294.3	4.2
	354.8	359.5	4.7
	432.7	441.6	8.9
	456.3	497.3	41.0
	629.7	637.6	7.9
	642.2	645.8	3.6
	656.3	670.0	13.7
	674.9	739.9	65.0
	745.4	766.0	20.6
	766.0	766.3	0.3
	792.9	793.3	0.4

TABLE 2.2.1-2

Quaternary-Age Unconsolidated-Deposit Aquifer Crossed by Project

Facility Name	**Approximate Milepost**		**Length (Miles)**
	Start	**End**	
	793.3	806.6	13.3
PBTL-Pipeline	N/A		None Identified - Continuous Permafrost [a]
PTTL-Pipeline	N/A		None Identified - Continuous Permafrost [a]
Gas Treatment Plant			
GTP	N/A		None Identified - Continuous Permafrost [a]

[a] An aquifer exemption order (AEO) has previously been determined by the EPA and AOGCC that “No USDWs” occur within GTP, PBTL and PTTL.



X:\AKLNG\Resource Reports\RR02\Figure 2_2_1-1 Quaternary Deposits.mxd

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Major Highways
- Major Rivers
- Coarse-Grained Quaternary Deposit Aquifer
- State & Federal Conservation Lands

0 25 50 100 Miles

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QUATERNARY ALLUVIUM AND GLACIAL OUTWASH DEPOSITS WHICH COMMONLY SERVE AS AQUIFERS IN ALASKA

FIGURE 2.2.1-1

ALASKA LNG

2.2.3 Liquefaction Facility

Unconsolidated sediments that make up the regional aquifer system consist of discontinuous clay, silt, sand, gravel and boulders deposited primarily by glaciers, but also by alluvial and colluvial processes. The sediments are complexly interbedded, with lenses and thin beds of sand and gravel interfingering with beds of clay, silt, and till. This complexity and the high variability in grain size distribution of the sediments causes discontinuity and variability in their hydraulic characteristics (*USGS Ground Water Atlas of the United States, Publication HA 730-N*).

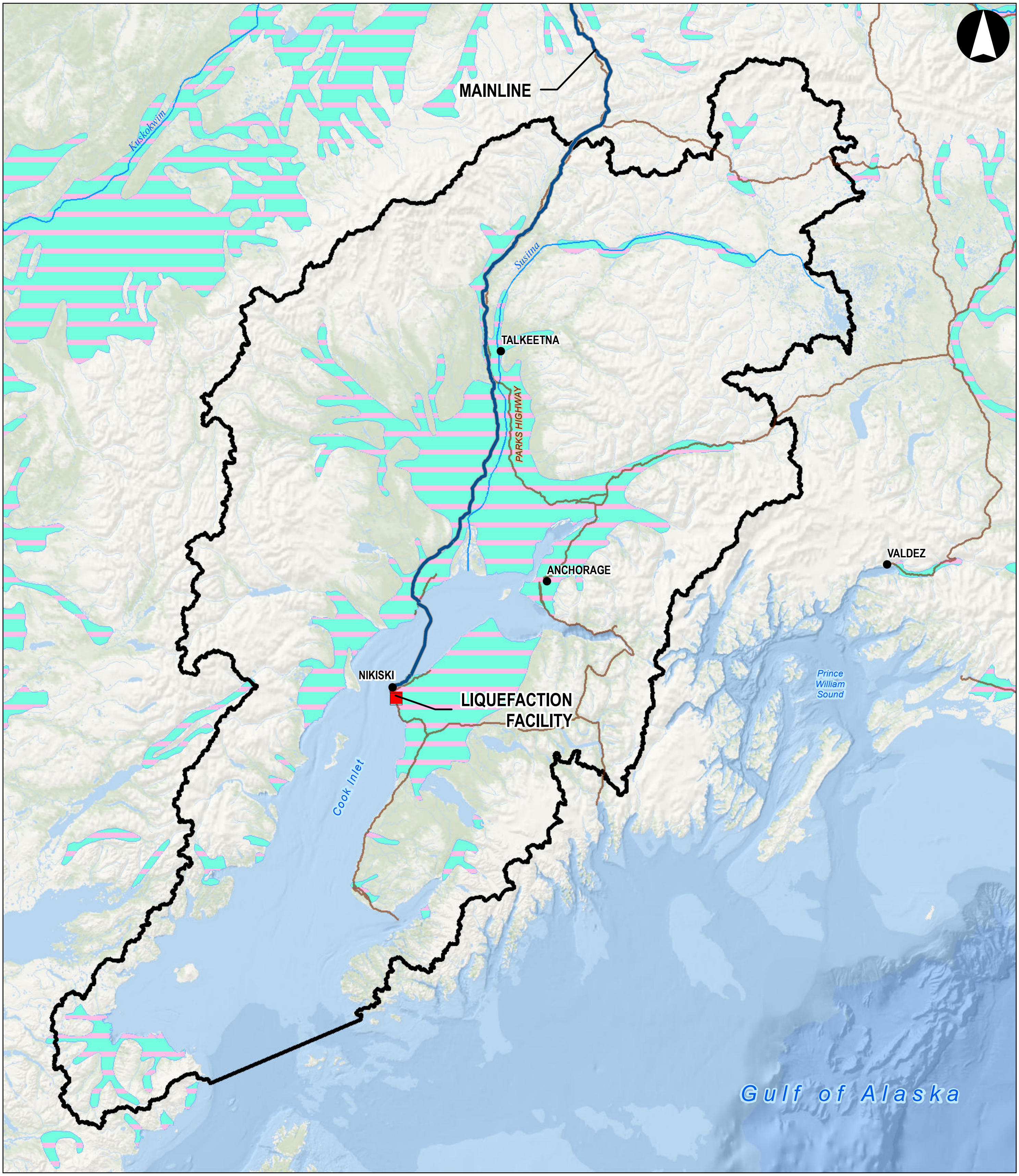
The two main rock formations at the Liquefaction Facility include the stratigraphically higher Killey Unit and the stratigraphically lower Moosehorn Unit. The transition zone between the Killey Unit outwash deposits and the late Moosehorn Unit subestuarine deposits are generally marked by rust discoloration of the underlying late Moosehorn deposits. The finer-grained and more compact (i.e., lower permeability) upper Moosehorn deposits act as a leaky aquitard for iron-rich groundwater descending through the Killey sands, which leaves behind a characteristic iron staining.

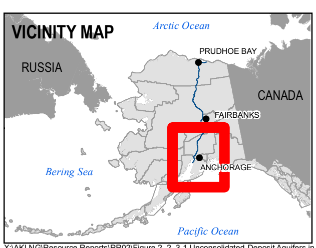
There are three regional aquifers noted by researchers in the Nikiski area. The uppermost aquifer, referred to herein as Water Bearing Unit 1 is unconfined. The next encountered aquifer (Water Bearing Unit 2) is confined or semi-confined, and the last encountered aquifer (Water Bearing Unit 3) is confined. Reportedly, the unconfined aquifer (Water Bearing Unit 1) is hydraulically connected to Beaver and Bishop Creeks and other lakes in the area (USGS, 1972).

The base of the unconfined aquifer (Water Bearing Unit 1) is comprised of discontinuous layers of silt and clay within the Killey-Moosehorn transition zone. Water Bearing Units 2 and 3 receive recharge from upland sources to the east and to a lesser extent from water percolating through the Killey-Moosehorn transition zone from the overlying Water Bearing Unit 1. A lower confined aquifer is separated from Water Bearing Units 2 and 3 by a silt and clay unit, and reportedly consists of many interconnected lenses and layers of sand, gravel, silt and clay at depths greater than 400 feet below ground surface (bgs) (USGS, 1981).

The interactions between precipitation, surface waterbodies, and water percolation through the diverse identified glacial and glaciofluvial formations have created unconfined, semi-confined and confined aquifers at the Site. The three aquifers are separated by discontinuous aquitards (typically between Water Bearing Units 1 and 2), and a generally more continuous aquitard (between Water Bearing Units 2 and 3). There appears to be significant hydraulic communication between surface water bodies and Water Bearing Unit 1, and a lesser degree of hydraulic communication between Water Bearing Units 1 and 2. This is likely attributable to the discontinuous nature of the aquitard separating these units.

Groundwater-monitoring wells were installed at the Liquefaction Facility site to delineate aquifers and aquitards and to provide means to develop an understanding of aquifer characteristics including artesian conditions, variations in hydraulic conductivity, occurrence, elevation fluctuation, tidal impacts, gradient, and flow direction. The results of the *2016 Hydrogeology Program* are included in Appendix S, groundwater quality is discussed in section 2.2.7 . An overview map of the Quaternary deposits in the Cook Inlet region is provided in Figure 2.2.3-1.





X:\AKLNG\Resource Reports\RR02\Figure 2_2_3-1 Unconsolidated-Deposit Aquifers in Cook Inlet.mxd

LEGEND

- Project Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Major Highways
- Major Rivers
- Cook Inlet Basin Study Unit
- Coarse-grained Quaternary deposits-Locally comprise aquifers

0 15 30 60 Miles

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UNCONSOLIDATED-DEPOSIT AQUIFERS IN COOK INLET

FIGURE 2.2.3-1

ALASKA LNG

2.2.4 Interdependent Project Facilities

The Interdependent Project facilities (i.e., Mainline, PBTL, and PTTL) traverse several physiographic regions, each having different surface and groundwater resource characteristics. Mapping of the facilities in Appendices D and F have mileposts on the pipeline according to convention to reflect natural gas flow (i.e., from north to south in the case of the Mainline and from east to west in the case of the PTTL). A description of the different physiographic regions and the groundwater resources found is generally described here and in the subsections below.

On the Arctic Coastal Plain, unconsolidated colluvium and alluvium deposits are confined laterally by continuous permafrost, restricting interaction between subpermafrost and active layer, therefore, do not produce potable groundwater (USGS, 1999a). Along the Brooks Range and to the south, the Mainline would cross three principal areas that may contain groundwater in unconsolidated surficial deposits —the aquifers in the Tanana River basin, unnamed bedrock and river-valley alluvial aquifers, and aquifers in the Cook Inlet Basin ecoregion.

Aquifers in the Tanana River basin are located along the banks of the Tanana River and its tributaries southeast of Fairbanks. Water from the aquifer discharges locally to springs and lower reaches of the Tanana River tributaries and regionally to the Tanana River. Though aquifers in the Tanana River basin contain naturally-occurring higher concentrations of iron and manganese than is typically recommended by the EPA for drinking, the aquifer supplies Fairbanks and surrounding communities with drinking water (USGS, 1998).

Groundwater may be found in metamorphic bedrock aquifers north of the Tanana River basin. Metamorphic rocks yield substantial quantities of water where they have been fractured (USGS, 1998). Northeast of Fairbanks, wells in fractured schist supply water for approximately one-half of the population of the city. A similar aquifer in the upland areas of Anchorage is made of fractured slate and metagraywacke. [3] The associated wells supply water to numerous domestic wells (USGS, 1998).

Unconsolidated-deposit aquifers in the Cook Inlet Basin ecoregion (described in Section 2.2.2.1), are located just beyond the Matanuska-Susitna Borough in the Alaska Range ecoregion (USGS, 1999a). The Matanuska-Susitna Borough operates and maintains the public water systems for the community of Talkeetna and the Palmer Garden Terrace Subdivision (ADNR, 2009). The system provides part of the water supply for Anchorage and for smaller cities and towns including Soldotna, Kenai, and Palmer. Many domestic wells also obtain water from the Cook Inlet system (USGS, 1998).

Demographic information related to groundwater uses is discussed in Section 2.2 and summarized in Table 2.2.1-1 for the boroughs crossed by the Project.

[3] A hard dark sandstone with poorly sorted angular grains of quartz, feldspar, and small rock fragments in a compact, clay-fine matrix that has undergone some degree of metamorphism.

2.2.4.1 Arctic Coastal Plain

As summarized by the USACE (2012a), shallow seasonal interstitial water is present along the Arctic Coastal Plain. Subsurface water in the active layer is limited to soil zones above the permafrost (suprapermafrost soils), taliks (thawed zones) beneath relatively deep lakes, and hyporheic zones (thin zones of mixing of surface water and shallow groundwater) present in thawed sediments below major rivers and streams (USGS, 2009; USACE, 2012a). Above the permafrost table is the active layer, which is a zone that freezes in winter and thaws in summer. Ice-rich permafrost prevents recharge of subpermafrost groundwater, resulting in snowmelt or surface run-off, often maintaining a shallow semi-saturated to saturated active layer.

Suprapermafrost water is inadequate as a freshwater source, resulting in an unreliable source of water supply. Most of this highly organic subsurface water in the active layer freeze during the winter, and are hydraulically separated from subpermafrost groundwater systems (Sloan and van Everdingen, 1988; Kane et al., 2012). This is manifested by the great number of lakes and poorly drained areas present throughout the Arctic Coastal Plain. As discussed in Section 2.2, no potable groundwater is present north of the Brooks Range. Continuous permafrost exists in this area and there are no known Quaternary alluvium or glacial outwash deposits (hence formations to hold groundwater resources) north of Coldfoot. A detailed summary of permafrost conditions along the Project corridor in the Arctic Coastal Plain and the rest of Alaska can be found in Resource Report No. 7.

2.2.4.2 Brooks Range

From the Brooks Range through the southern Alaska Range, permafrost is discontinuous. Where there is discontinuous permafrost, the depth to the base of the permafrost ranges from 155 to 265 feet (Ferrians, 1965). Large groundwater yields are available both above and below the permafrost (USGS, 1955). Depth to the top of the permafrost table varies widely depending on elevation and proximity to a seasonally open waterbody.

Where the Mainline would pass through the Brooks Range, extensive areas of carbonate bedrock are present, with locally high porosity. This porous limestone serves as a high capacity aquifer in some areas. Springs present in the eastern Brooks Range have demonstrated discharge rates of up to 16,000 gallons per minute (USGS, 1999a). However, the porosity and potential groundwater storage of the bedrock in the Project area is unknown.

2.2.4.3 Yukon-Tanana Region

Quaternary alluvium serves as shallow aquifers along the floodplains of the Tanana and Yukon rivers in Interior Alaska (USGS, 1999a). The maximum known thickness of alluvium in the Tanana River Valley is 2,000 feet (USGS, 1984); however, lenses of finer-grained glacial sediments may serve as aquitards at depth. Where the Mainline would cross these rivers, there is a large groundwater recharge potential.

Groundwater in the area also occurs in taliks and thaw bulbs. Taliks are bodies of unfrozen ground that completely penetrate permafrost, connecting suprapermafrost and subpermafrost water that are found below large rivers and lakes (van Everdingen, 1998). Thaw bulbs are localized regions of thawed permafrost produced by a local heat source (USGS, 1999a).

2.2.4.4 Alaska Range

The Alaska Range contains many glaciers and permafrost that affects the quantity of groundwater (USACE, 2012). Aquifers and potential aquifers are not well defined within the Alaska Range. Unconsolidated alluvium and glacial deposits may yield water in some areas along the Susitna drainage.

2.2.5 Non-Jurisdictional Facilities

The PBU Major Gas Sales (MGS) project and Point Thomson Gas (PTU) Expansion project are located on the Arctic Coastal Plain, where Quaternary deposits contain continuous permafrost and, therefore, are not drinking water aquifers (USGS, 1999). A discussion of the area is provided in Section 2.2.4.1.

The Kenai Spur Highway relocation project would be located above the unconsolidated-deposit aquifers system in the Cook Inlet Basin ecoregion. A discussion of this system is provided in Section 2.2.2.1.

2.2.6 Seeps and Springs

One Alaska Department of Natural Resources (ADNR)-identified spring is located within 150 feet of the Project footprint. At approximately milepost 537.2 of the Mainline, temporary workspace would be located within 94.4 feet of a spring (Case file 1821433). No other springs have been identified near the Project footprint. In the event seeps and/or springs are identified during Project construction, they would be evaluated on a case by case basis to identify potential impacts and any mitigative actions that may be required.

2.2.6.1 Non-Jurisdictional Facilities

None of the Non-Jurisdictional Facilities would be located within 150 feet of any ADNR-identified springs.

2.2.7 Groundwater Quality

Groundwater across most of Alaska is considered to be of generally good quality and suitable for domestic, agriculture, aquaculture, commercial, and industrial use with only moderate or minimal treatment. However, hard water and naturally high iron concentrations are common.

On a localized basis, some water quality problems exist due to various natural and synthetic causes. These include natural geologic conditions, such as aquifers in marine sedimentary rocks, that produce brackish water; natural biologic processes and contamination from domestic wastewater discharges that can cause high nitrate concentrations; and intensive pumping in aquifers near the coasts that can mix sea water with fresh water, making it unfit for most uses (USGS, 1999). Additionally, contaminated sites associated with military, industrial, mining, and other human activities have been identified as described in Resource Report No. 8.

ADEC has the authority to enforce the Alaska Water Quality Standards (AWQS) criteria (ADEC, 2008b and 2012) to both ensure that waters are safe to use for various human consumptive purposes and to protect these natural resources from potential negative effects of human use. Criteria maintained by ADEC include drinking water primary maximum contaminant levels, stock water and irrigation water criteria, aquatic life criteria for fresh and marine waters, and several other criteria lists.

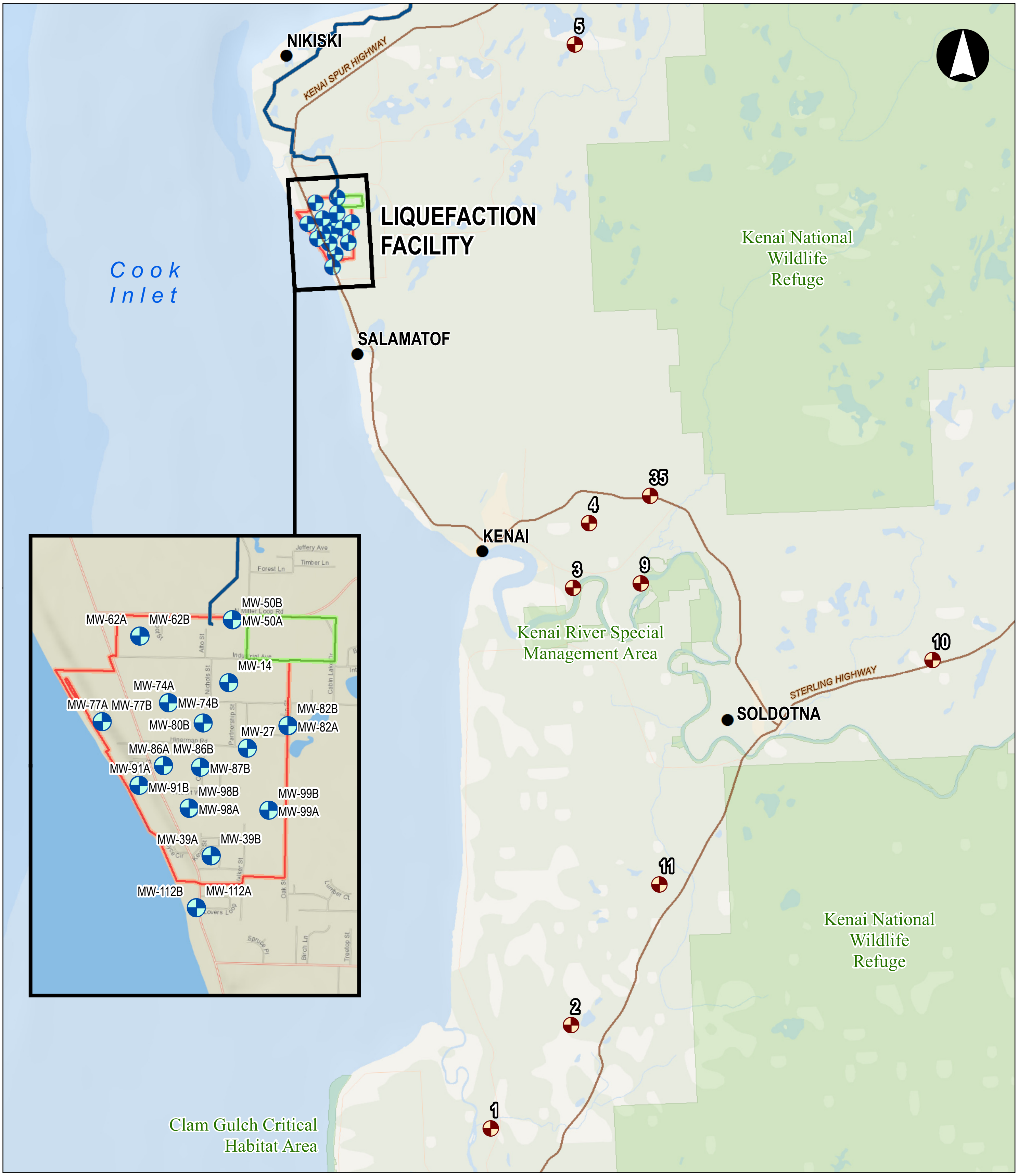
2.2.7.1 Liquefaction Facility

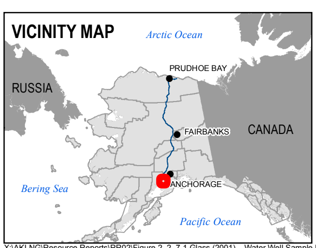
Previous reports indicate that groundwater quality in this area is within water quality standards, with the exception of naturally-occurring elevated arsenic, iron, and manganese levels associated with gold mining districts. Groundwater quality in the Liquefaction Facility area was studied by Glass (2001). Nutrients and dissolved organic carbon, pesticides, and volatile organic compound (VOC) levels have all been found to be low, well within Environmental Protection Agency (EPA) drinking water standards (Glass, 2001). Total dissolved solids are also generally low, mostly in the 100–200 milligrams per liter range, with the highest value reported in recent studies being 986 milligrams per liter in southeastern Cook Inlet.

The pH of water sampled in the Glass (2001) study was 6.7 and the temperature was 6.5 °C (Glass, 2001). All major ions that were tested (e.g., calcium, magnesium, sodium, potassium, sulfate, chloride, fluoride, bromide, and silica) showed low concentrations well within EPA drinking water standards. Nutrients and dissolved organic carbon levels were low, as would be expected in an area with no significant agricultural activity. Likewise, there were no significant levels of pesticides or VOCs detected. Environmental isotopes of hydrogen and oxygen were within expected ranges for local precipitation-derived waters. Elevated Radon-222 levels are common within the Cook Inlet Basin, but in Nikiski the radon was measured at 260 picocuries per liter, well below the national median concentration of 450 (Glass, 2001).

Water sampled in 1999 at a well in Nikiski showed elevated iron levels of 7,300 micrograms per liter (Glass, 2001). Other data, however, suggests that whereas iron levels can be higher than desired, this particular data point is an anomaly. The well is number five depicted on Figure 2.2.6-1. The preferred level for public water supply is less than 300 micrograms per liter, and the average iron levels in the Cook Inlet region groundwater are less than 10 micrograms per liter. Iron is naturally present in groundwater from dissolution of common minerals in rocks and soils and does not pose human health risks. High levels of iron, however, can impart a reddish-brown color and a slightly bitter taste to drinking water which can be evident at <1 mg/L. Increased iron levels can also cause the precipitation of sediment that can leave stains on laundry and plumbing fixtures, and in serious cases can promote growth of iron bacteria in pipes (Glass, 2001). Water sampled in Nikiski also showed elevated levels of manganese, measured at 290 and 295 micrograms per liter (by two different testing methods). The preferred level for public water supply is less than 50 micrograms per liter. Elevated manganese, like iron, can impart a bitter taste to drinking water and can produce black staining (Glass, 2001).

Elevated levels of arsenic, iron, and manganese are common throughout the region. In 1999, arsenic levels up to 29 micrograms per liter were found in Cook Inlet groundwater (Glass, 2001), which exceeded the EPA's revised maximum containment level of 10 micrograms per liter in 2001 that was withdrawn pending additional review. A 2001 review of 220 USGS groundwater samples collected in the Cook Inlet Basin (39,325 square miles) showed that 65 had arsenic concentrations of 10 micrograms per liter or greater and 10 had arsenic levels greater than the 50 micrograms per liter maximum contaminant level for drinking water. Of the 220 samples, 109 sampling locations were located within the Kenai Peninsula Borough, and of these 9 percent of the wells had greater than 50 micrograms per liter and 40 percent had greater than 10 micrograms per liter. The study did not specify which exact ground water sample locations had the elevated arsenic levels, but many were located in the Nikiski region.





LEGEND

- Alaska Place Names
- Water Well - Glass (2001)
- AKLNG 2015 Groundwater Sampling Wells
- Alaska LNG Rev C2 Route
- Major Highways
- LNG Operations Area
- LNG Construction Camp
- State and Federal Conservation Lands

0 1 2 4 Miles

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GLASS (2001) – WATER WELL SAMPLE LOCATIONS (COLLECTED 1999) NEAR NIKISKI

FIGURE 2.2.7-1

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_2_7-1 Glass (2001) – Water Well Sample Locations (Collected 1999) Near Nikiski.mxd

In addition to the studies listed, USGS groundwater quality samples from around the Liquefaction Facility were reviewed. Other than arsenic, iron, and manganese, levels above the maximum contaminant level for drinking water were not identified in these samples that were taken from the 1960s through 1990s at various depths and analyzed for varied parameters (USGS, 2015). Preliminary Project data collected from field investigations of existing groundwater resources in the proposed Liquefaction Facility footprint suggest that iron oxide-rich seeps are present, emerging from the side of beach bluffs within the Killey-Moosehorn transition zone (see Section 2.2.3). The presence of the iron oxide may indicate elevated levels of iron and total dissolved solids, especially in the upper aquifer (Fugro, 2015).

Two groundwater quality sampling events (Figure 2.2.7-2) were conducted in 2016 to evaluate groundwater quality in the proposed LNG Plant wells. Water quality found within the three (3) water bearing units varies by unit and laterally within the unit. Total arsenic concentrations within Water Bearing Unit 2 and Water Bearing Unit 3 are greater than concentrations within Water Bearing Unit 1. Trichloroethene has been detected in Water Bearing Unit 2 and Water Bearing Unit 3 groundwater samples, but not in Water Bearing Unit 1 groundwater samples. Measured pH values in Water Bearing Unit 1 groundwater are slightly acidic to neutral; pH values in Water Bearing Unit 2 and Water Bearing Unit 3 groundwater are neutral to alkaline.

The groundwater sampling program activities and aquifer pump test (APT) results are documented in Appendix S (see *LNG Facilities Groundwater Sampling and Testing Report – Event 1 Report, and LNG Facilities Groundwater Sampling and Testing Report – Event 2 Report*). Groundwater details for observation wells and APT wells are listed in Table 2.2.7-1.

TABLE 2.2.7-1
Observation Well and Aquifer Pump Test Well Groundwater Details

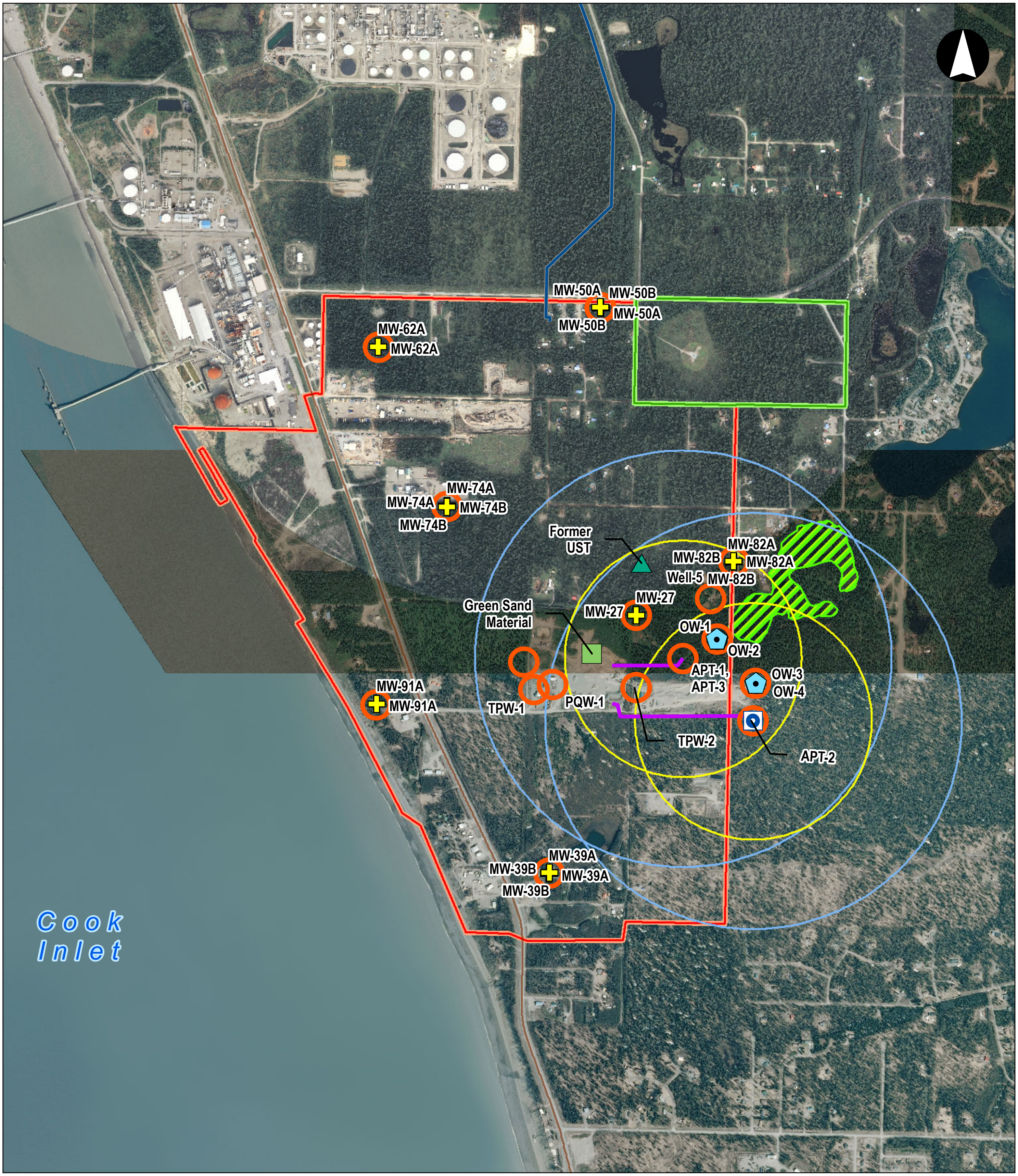
Water Bearing Unit	Well ID	Static Groundwater (GW) Depth (feet bgs) [a,b,c]	GW Elevation (feet)[b,c]
1	OW-1	15.29	96.94
2	OW-2	37.48	74.61
1	OW-3	34.26	97.00
2	OW-4	55.70	75.09
2	APT-1	47.87	72.22
2	APT-2	55.64	74.35
3	APT-3	72.97	45.86

Notes:

[a] bgs = below ground surface

[b] Groundwater depths measured at 18:00 hrs. on 9/22/16; corresponding elevations are referenced to NAVD88.

[c] To convert NAVD88 to MLLW add 7.32 feet.



X:\AKLNG\Resource Reports\RR02\Figure 2_2_7-2 Aquifer Pump Test Program.mxd

LEGEND

- Water Quality Well Testing
- Installed Monitoring Well
- 3rd Party Well with Access to Aquifer Pump Testing (APT) Well
- APT Well
- Observation Well
- Former UST
- Former Quarry Area, Green Sand Material, Inert Solid Waste
- APT Discharge Pipe
- Alaska LNG Rev C2 Route
- Major Highways
- APT Study Area (1500 Feet Radius)
- APT Vicinity (0.5 Mile Radius)
- Approximate Wetland Boundary

Liquefaction Facility

- Operations Area
- Construction Camp

No ADEC contaminated sites present within 0.5 mile radius of APT Vicinity.

0 0.1 0.2 0.4 Miles

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2016 AQUIFER PUMP TEST PROGRAM

FIGURE 2.2.7-2

ALASKA LNG

2.2.7.2 Interdependent Project Facilities

As noted previously, there is a general lack of data concerning groundwater aquifers in Alaska. In fact, very few of Alaska's groundwater aquifers have been studied or even located (ADEC, 2008a). The following paragraphs summarize overall groundwater quality information that is known by general regions from the Arctic Coastal Plain through the Alaska Range. Cook Inlet is discussed in Section 2.2.6.2.5.

2.2.7.2.1 Arctic Coastal Plain

In areas of continuous permafrost, no potable groundwater resources are present north of the Brooks Range. In areas of continuous permafrost, water is obtained primarily from lakes and stored in heated tanks for winter use.

2.2.7.2.2 Brooks Range

Within the Brooks Range, water that stems from carbonate rock springs or limestone aquifers would likely have basic (pH > 7) properties, given the dissolution of calcite in the groundwater.

2.2.7.2.3 Yukon-Tanana Region

Groundwater in Yukon-Tanana Region aquifers may contain calcium bicarbonate or calcium magnesium bicarbonate but is generally suitable for most uses. Locally, concentrations of iron and manganese may also be high (USGS, 1999).

2.2.7.2.4 Alaska Range

In the Alaska Range, dissolved solids concentrations in unconsolidated-deposit aquifers range from 110 to 340 milligrams per liter (USGS, 1999). For reference, Alaska's Water Quality Standard for drinking water is that total dissolved solids from all sources may not exceed 500 milligrams per liter. Neither chlorides nor sulfates may exceed 250 milligrams per liter (18 AAC 70.020(b) (4)).

2.2.7.2.5 Cook Inlet

Groundwater quality in the unconsolidated-deposit aquifers system in the Cook Inlet Basin ecoregion is generally quite high. Most major ion concentrations are low, with only occasional elevated levels of chloride up to 500 milligrams per liter. Total dissolved solids are also generally low, mostly in the 100–200 milligrams per liter range, with the highest value reported in recent studies being 986 milligrams per liter in southeastern Cook Inlet. Nutrients, dissolved organic carbon, pesticides, and volatile organic compounds levels are all low, well within EPA drinking water standards (Glass, 2001). Groundwater quality for Cook Inlet Basin is previously discussed in Section 2.2.7.1.

2.2.7.3 Non-Jurisdictional Facilities

The PBU MGS project and PTU Expansion project are located in areas of continuous permafrost, and no potable groundwater sources exist. Water sources are primarily gathered from lakes.

The Kenai Spur Highway relocation project would be located above the Cook Inlet Basin. A discussion of water quality within the basin is provided in Section 2.2.6.2.5.

2.2.8 Groundwater and Wellhead Protection Programs

Sections 1453 and 1454 of the Safe Drinking Water Act (SDWA) require states to develop and implement a Source Water Assessment and Protection Program (SWAP) that delineates boundaries of public water systems (PWS), identify the origins of contaminants in PWS areas to determine susceptibility to contamination, and establish protection zones for PWS. In Alaska, the Drinking Water Protection Program (DWPP) was implemented in compliance with SDWA establishing one program that includes source water assessments, groundwater protection, and wellhead protection.

Wells within 500 feet from the Project footprint were identified using ADNR's Well Log Tracking System (WELTS). Although the database may not be complete prior to construction, field surveys would also be conducted along the Project's footprint to confirm the presence of public and private drinking water wells in proximity to the construction area. Public and private water wells that have been identified within 500 feet of the Project footprint are listed in Appendix A and depicted in Appendix C of Resource Report No. 8.

Wellhead protection measures are implemented to protect groundwater zones of influence from pollutants that may reduce the uses of a well. Identified groundwater and wellhead protection areas are depicted in Resource Report No. 8, Appendix C. Additionally, there may be local ordinances established to protect watershed areas and larger groundwater basins (ADEC, 2014). The following sections describe various programs developed to protect groundwater sources.

2.2.8.1 State Well Head Protection and Drinking Water Programs

Regulations under 18 AAC 75.345(f) state that groundwater that is closely connected hydrologically to nearby surface water may not cause a violation of water quality standards in 18 AAC 70.020 for the receiving surface water or sediment. Groundwater sites under the direct influence of surface water (GUDISW), must meet the more stringent or more protective of either the Table C criteria in 18 AAC 75 or the AWQS under 18 AAC 70 to be protective for use as a drinking water source and to protect potential ecological receptors. Groundwater is protected (18 AAC 70.050) for Class (1) (A) uses (freshwater water supply).

ADEC has specified minimum separation distances between wellheads and potential sources of contamination (18 AAC 80.020(a)). These setbacks range from 75 to 200 feet depending on the potential source of contamination (this can also be modified, if necessary, to protect public health). The separation distance from a petroleum line (e.g., natural gas pipeline) is typically 75 to 100 feet depending on how the water system at the wellhead is defined.[4] Additionally, the separation distance from a wastewater disposal

[4] For community water systems, non-transient non-community water systems, and transient non-community water systems, the separation distance minimum is 100 feet, but for a Class C, non-public, non-federally regulated system the separation distance minimum is 75 feet.

system (e.g., leach field), which might be needed for the Project's associated facilities depending on the final engineering design, is 150 to 200 feet.[5]

ADEC Division of Environmental Health performs source water assessments funded by the EPA under SWAP (ADEC, 2015a). Source water assessments determine the susceptibility of a drinking water system, including groundwater wells, to contamination (Miller, 2009). Source water assessments also determine where drinking water originates and defines the protection area around the USDW. The protection area is categorized into zones depending on the distance from the USDW, and the time of travel (TOT) is the time it takes for the contaminant to reach a well or source water intake.

USDW zones crossed by the Project are: (1) "Zone A" several months TOT or less to the well; and (2) "Zone B" two years TOT or less to the well. This creates two areas around a wellhead showing the distance groundwater can move within the TOT time frame. These areas are usually generalized as a representative polygon. To the extent Project facilities cross drinking water zones, the zones crossed are summarized in Table 2.2.7-1 and depicted in Resource Report No. 8, Appendix C (labeled concurrent with the ADNR as subsurface and surface water rights). The zones are further identified on the map's legend in Appendix C of Resource Report No. 8.

TABLE 2.2.8-1

Public Water System Zones Crossed by the Project

Segment/ Borough or Census Area	Milepost	Project Feature	Public Water System (PWS) Name	PWS ID Crossed	Travel Timeframe (Zone Type)	Distance of PWS Crossed (feet)	Distance to Footprint and Direction (feet)
Mainline Pipeline							
North Slope Borough	109.45	Construction Access Road	Alyeska MCCF #2 Camp - PS3 Well PW-3	320751.001	A	-	318/S
Denali Borough	547.36	Construction ROW	DENALI CABINS SOUTH/ MILE 229	390358.001	A	-	38/SE
Matanuska-Susitna Borough	657.78	Construction ROW	Chulitna Campground	226923.001	A	-	80/W
Mainline Associated Infrastructure							
Denali Borough	522.59	Material Site	Denali North Star Inn	391524.001	A	-	229/N
	525.74	Material Site	MCKINLY RV & CAMPGROUND	391786.001	A	-	244 / E
	525.74	Material Site	MCKINLEY RV & CHEVRON	390536.001	A	-	246 / E
	525.89	Material Site	STAMPEDE LODGE	391118.001	B	-	322 / E

[5] Wastewater disposal systems follow the same categorizations for water systems as previous footnote.

TABLE 2.2.8-1

Public Water System Zones Crossed by the Project

Segment/ Borough or Census Area	Milepost	Project Feature	Public Water System (PWS) Name	PWS ID Crossed	Travel Timeframe (Zone Type)	Distance of PWS Crossed (feet)	Distance to Footprint and Direction (feet)
	526.05	Material Site	MCKINLEY RV & CAMPGROUND	391786.001	B	-	245 / E
	526.05	Material Site	MCKINLEY RV & CHEVRON	390536.001	B	-	246 / E
	528.55	Construction Access Road	Park Hotel	391820.001	A	-	91 / E
	566.13	Material Site	Denali B SD Cantwell	390146.001	A	-	397 / E
Matanuska-Susitna Borough	663.71	Construction Access Road	Trapper Creek Pizza Pub	225376.001	A	-	120 / W
	663.96	Construction Access Road	Trapper Creek Trading Post	221680.001	B	-	86 / NW
	709.76	Double Joint Yard	Alaskan Trails RV Park	220160.001	A	-	383 / N
	709.76	Double Joint Yard	Alaskan Trails RV Park	220160.001	B	-	383 / N
	709.76	Double Joint Yard	B& J Rainbow Center	224557.001	B	-	327 / E
Kenai Peninsula Borough	764.79	ATWS	Veco Beluga Lodge	249387.001	B	-	488 / SW
	798.41	ATWS	Offshore Systems Kenai	244997.001	A	-	367 / SE
	798.41	ATWS	Offshore Systems Kenai	244997.002	A	-	367 / SE
	805.09	ATWS	Tesoro Refinery	241745.001	A	-	244 / N

ADEC reviews ADNR's water rights issuances to determine if there are contaminated sites within the groundwater travel polygon and thus potentially affecting the source water. For instance, several temporary water use authorizations from ADNR would be needed for water use during construction and operations; ADEC would review these. ADEC also reviews permits for other permitted sites (e.g., material extraction sites) with the potential to affect groundwater. Additionally, certain ADEC permits (e.g., AKG320000 – Statewide Oil and Gas Pipelines) require additional monitoring when dewatering or discharging a permitted source near a contaminated site. Specifically, dewatering within 1,500 feet of a contaminated site requires an additional permit application and the submittal of a best management practices (BMP) plan. Potential contamination sources are identified in Resource Report No. 8; they may include contamination sources identified by ADEC's Contaminated Sites Program, Leaking Underground Storage Tanks Program, Spill

Prevention and Emergency Response, and/or Solid Waste Program. Sites within 1,500 feet of the Project corridor are listed in Resource Report No. 8.

ADEC has also implemented a community -based effort to protect groundwater sources for public drinking water under the voluntary DWPP. The DWPP includes a source water assessment, as described previously, and voluntary efforts may assist in the development or enforcement of local protection ordinances. Some local entities may also have Alaska Clean Water Action (ACWA) grants from ADEC to perform certain actions like developing a DWPP; however, for state fiscal year 2015 there are no ACWA grants within or adjacent to the Project area. There is one Clean Water Action grant in the Susitna Valley that addresses clean boating and outreach recreational boating users of the Deshka River (ADEC, 2014).

If a DWPP area is crossed by the Project and it is determined that construction or other intrusive earth moving activities would possibly result in contamination or disturbance to surface water or groundwater, the public water drinking system contact would be notified for the area in accordance the Project *SWPPP* and associated general APDES permit. An outline for a Project *SWPPP* is provided in Appendix J and the Applicant's *Wetland and Waterbody Construction, and Mitigation Procedures* (Applicant's *Procedures*) are provided in Appendix M. The *SWPPP* outline would be used by construction contractors to develop and implement a plan specific to their area of responsibility before the start of any soil disturbing activity.

2.2.8.2 Federal Programs

Sensitive groundwater resources are designated by the EPA through the Sole Source Aquifer (SSA) Protection Program authorized by Section 1424(e) of the SDWA. SSA is an aquifer that provides a sole or principle source (greater than 50 percent) of drinking water for an area, where contamination of the aquifer could create a public health hazard, and where no alternative drinking water sources are available to replace the water supply. There are no EPA designated Sole Source Aquifers in Alaska (EPA, 2014).

A number of other important EPA programs, such as its Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), protects groundwater quality in Alaska. Section 211 of SARA established the Defense Environmental Restoration Program (DERP), executed through Department of Defense (DoD), and delegated to the USACE for environmental restoration of DoD-generated contamination at Formerly Used Defense Sites (FUDS). Remediation of FUDS properties is performed in consultation with EPA and ADEC. Sites covered by these programs are depicted in Resource Report No. 8, Appendix C. In addition, the EPA implements the UIC program for Class I injection wells pursuant to Section 40 C.F.R. Part 144. AOGCC has primacy for the Alaska Class II UIC program in accordance with 20 AAC 25.005.

2.2.8.3 Non-Jurisdictional Facilities

The PBU MGS project and PTU Expansion project are located in areas of continuous permafrost, and no potable groundwater sources exist. Water sources are primarily gathered from lakes.

The Kenai Spur Highway relocation project would cross several drinking water zones (Table 2.2.8-2).

TABLE 2.2.8-2

Public Water System Zones Crossed by Non-Jurisdictional Facilities

Segment / Borough or Census Area	Public Water System (PWS) Name	PWS ID Crossed	Travel Timeframe (Zone Type)	Distance to Footprint and Direction (feet)
Kenai Spur Highway Relocation project				
Kenai Peninsula Borough	Phillips Petroleum	240969.001	A	139 / S
	Agrium Well No. 10	240919.002	A	101 / SW
	Agrium Well No. 12	240919.003	A	101 / SW
	Forelands	240634.001	A	359 / E
	Kassik Kenai Brew Stop	249080.001	A	340 / W
	Phillips Petroleum	240969.001	B	139 / S
	Tesoro 201 Northstore	243362.001	B	439 / N
	Kassik Kenai Brew Stop	249080.001	B	340 / W
PBU MSG project—N/A				
PTU Expansion project—N/A				

2.2.9 Potential Construction Impacts and Mitigation Measures for Groundwater

The use of groundwater resources would be relied upon to support construction activities. Without the implementation of Best Management Practices, unregulated withdrawal of excessive water volumes from aquifers could have the potential to affect groundwater supply, while construction activities and spill events have the potential to affect groundwater quality. Groundwater would be relied upon for a wide range of Project uses (e.g., potable water, concrete preparation, hydrostatic testing, dust suppression). Anticipated groundwater use during Project construction is summarized in the Project *Water Use Plan* included as Appendix K.

Construction activities that could potentially impact groundwater resources (i.e. water yield and/or water quality) would include, but are not limited to, the following:

- Blasting;
- Clearing, grading, and site preparation;
- Dewatering and trenching;
- Domestic sewage and greywater disposal from construction camps;
- Facility, work pad, and helipad/airstrip construction;
- Groundwater withdrawal;
- Hydrostatic test water discharge;
- Material extraction sites and excavation dewatering;
- Potential of drilling mud release during trenchless construction;
- Potential of encountering contaminated soils or groundwater;
- Restoration or reclamation of construction areas;

- Spills or leaks of petroleum liquids or hazardous materials;
- Stormwater management and runoff;
- Underground injection; and
- Water well construction or disturbance.

Construction practices designed to minimize or mitigate potential impacts on groundwater during construction would be implemented. This includes the proposed measures, BMPs, and guidance provided in the following Project-specific plans:

- *Blasting Plan* (Resource Report No. 6, Appendix B);
- *Gravel Sourcing Plan and Reclamation Measures* (Appendix F of Resource Report No. 6);
- *Groundwater Monitoring Plan* (Appendix B);
- *HDD Inadvertent Release Contingency Plan* (Appendix L);
- Project *Waste Management Plan* (Resource Report No. 8, Appendix J);
- *Spill Prevention, Control, and Countermeasure (SPCC) Plan* (Appendix M);
- *Stormwater Pollution Prevention Plan (SWPPP)* (Appendix J);
- *Unanticipated Contamination Discovery Plan* (Appendix J of Resource Report No. 8);
- Applicant's *Upland Erosion Control, Revegetation, and Maintenance Plan* (Applicant's *Plan*) (Appendix D of Resource Report No. 7);
- *Water Well Monitoring Plan* (Appendix C);
- *Water Use Plan* (Appendix K);
- Applicant's *Wetland and Waterbody Construction and Mitigation Measures* (Applicant's *Procedures*) (Appendix N); and
- *Fugitive Dust Control Plan* (Appendix J of Resource Report No. 9).

Table 2.2.9-1 shows the prominent water resource impacts of concern and the corresponding measures that each plan addresses.

TABLE 2.2.9-1

Water Resource Impact Locations of Concern and Corresponding Project-specific Mitigation Plans Options Presented in Resource Report No. 2 Appendices

Appendix	Potential Impacts	Plan Provisions
Appendix B Groundwater Monitoring Plan	• Spread of contamination associated with dewatering	Provides measures to comply with special permit conditions for the following regulations:

TABLE 2.2.9-1

Water Resource Impact Locations of Concern and Corresponding Project-specific Mitigation Plans Options Presented in Resource Report No. 2 Appendices

Appendix	**Potential Impacts**	**Plan Provisions**
	contaminated groundwater in the vicinity of known hazardous waste sites.[1]	• 18 ACC 72 Wastewater Disposal Regulations; and • 18 AAC 83 APDES Regulations. The special conditions would provide assurance that the dewatering activities would not pull contamination from known contaminated sites. Monitoring would also ensure compliance and allows early detection of potential contamination for remedial action.
Appendix C Water Well Monitoring Plan	• Potential impairment of groundwater quality from construction activities from spills or sediment introduction; • Reduction in aquifer yields by certain construction activities; • Intersection and migration of existing groundwater contaminant plumes during trenching;	Provides measures to protect water quality and aquifer yield with measures to minimize or mitigate potential sources of construction impacts (e.g., blasting and vibrations from heavy equipment operation, contamination of the local aquifer from spills or sediment introduction, or effects from Horizontal Directional Drilling operations Provides monitoring parameters for groundwater quality in the vicinity of known contaminant groundwater plumes
Appendix I Site-Specific Construction Drawings: Site-specific Waterbody Crossing Plans	• Disturbance of riparian vegetative buffer; • Runoff and downstream transport of sediment-laden water from the construction site; • Generation of elevated turbidity levels; Streambank/channel instability following construction.	Provides site-specific BMPs, and construction and restoration methods to be employed at large and/or sensitive waterbody crossings
Appendix J *Stormwater Pollution Prevention Plan* (*SWPPP*)	• Migration of sediments, oils, and greases from the disturbed work area following precipitation or snowmelt events; • Also provides measures incorporated into permanent impervious facility design to control stormwater discharges during the Project operations phase.	Provides measures to prevent migration of sediments and potential disturbance from construction sites. Also provides measures incorporated into permanent impervious facility design to control stormwater discharges during the Project operations phase.
Appendix K Water Use Plan	• Consumptive use of Alaska waters for construction and operations; • Potential impacts associated with water withdrawals and discharges; • Assurance of water rights and maintained volumes for existing users.	This Water Use Plan addresses the consumptive and non-consumptive uses of state water resources during construction of the Project. Water use and water rights permitting would be undertaken to provide water necessary to construct the Project.
Appendix L HDD Inadvertent Release Contingency Plan (Project-Specific HDD Contingency Plan)	• Unintentional discharge of bentonite-based drilling fluids via subsurface hydraulic communication	Provides contingency measures for control and cleanup of inadvertent releases of drilling fluids during HDD operations.

TABLE 2.2.9-1

Water Resource Impact Locations of Concern and Corresponding Project-specific Mitigation Plans Options Presented in Resource Report No. 2 Appendices

Appendix	Potential Impacts	Plan Provisions
Appendix M Draft Spill Prevention, Control, and Countermeasure (SPCC) Plan	• Introduction of potential contaminants to soil and water resources during construction and operations resulting from spills or other unintended discharges	Provides emphasis on measures that would be implemented to avoid spills of potential contaminants. In the event that a spill occurs, specific procedures would be provided for spill control, clean up, and final disposition.
Appendix N Wetland and Waterbody Construction, and Mitigation Procedures (Applicant's *Procedures*) with Requested Project-Specific Modifications	• Disturbance of riparian vegetative buffers; • Runoff and downstream transport of sediment-laden water from the construction site into adjacent wetland areas; • Generation of elevated turbidity levels; • Conversion of wetland cover types; Effective wetland restoration.	Provides Project-requested alternative wetland construction and mitigation measures for locations where strict adherence to the FERC's Procedures is not practicable. These alternative measures are intended to provide equal or better environmental resource protection.
Appendix O Wetland Mitigation Plan	• Permanent unavoidable losses or conversion of wetland functions and values	Provides long-term wetland restoration and mitigation (including compensatory) designed to reduce or offset permanent unavoidable losses of wetland functions

[1]If contaminated groundwater would be discovered during construction, the *Unanticipated Contamination Discovery Plan* (Resource Report No. 8, Appendix J) would be implemented to prevent the spread to uncontaminated areas.

2.2.9.1 Liquefaction Facility

Depth to groundwater at the Liquefaction Facility site varies depending on proximity to the subsurface geologic feature (i.e., stratigraphically higher Killey Unit and the stratigraphically lower Moosehorn Unit). Water Bearing Unit 1 was found within the Killey Unit, and is unconfined with water elevation ranging between 100 feet (NAVD88) and 73 feet (NAVD88). Water Bearing 2 is present within the Moosehorn geologic unit, is semi-confined, and lies immediately beneath the Killey-Moosehorn transition zone. Observed water elevations ranged from 96 feet (NAVD88) and 17 feet (NAVD88), which is reflective of upgradient and downgradient locations, respectively. No sole-source aquifers or springs would be impacted by construction of the Liquefaction Facility. The following sections discuss potential construction impacts and mitigation measures.

2.2.9.1.1 Clearing, Grading, and Site Development

Clearing and grading of the LNG Plant on the Liquefaction Facility site would likely cause a minor decrease in localized groundwater infiltration (i.e., absorption of rainfall into soils) and recharge (i.e., the process by which water moves downward from surface water to groundwater). Site development with the construction of roads, parking areas, laydown areas, and other areas with impermeable concrete and asphalt would also result in a minor reduction in infiltration and recharge. The impacts to groundwater recharge from clearing, grading, and site development would be long-term as the site would remain developed following construction. Natural vegetation buffers would be left intact and maintained around the LNG Plant site.

Impact from dust would be mitigated by following BMPs listed in the Project *Fugitive Dust Control Plan* (Resource Report No. 9, Appendix J) and *SWPPP* (Appendix J).

2.2.9.1.2 Foundation Construction

Foundation construction would include installation of granular pads, pile driving for support structures, and concrete work. The foundation for the LNG Plant and associated aboveground structures would be excavated and replaced by structural fill. Depending on the depth of excavation, shallow groundwater could be encountered during foundation construction, exposing it to potential surface water runoff, dust, and spills. In addition, piles could potentially be conduits for contaminants to impact groundwater if a spill of hazardous material occurs at the pile location. Implementation of the BMPs provided in the Applicant's *Plan* (Resource Report No. 7, Appendix D) and the *SPCC Plan* (Appendix M), as well as adherence to ADEC requirements, would minimize the risk of potential impacts to groundwater. Potential spill-related impacts and mitigation measures are further discussed in the following sections. Impacts to groundwater from foundation construction would be anticipated to be short-term and minor.

The Marine Terminal would also require pile installation. The piles are not anticipated to be of sufficient depth to penetrate marine aquitard layers or influence saltwater encroachment into the groundwater table. No impacts to the groundwater table are anticipated from Marine Terminal construction.

2.2.9.1.3 Dewatering

Shallow groundwater may be encountered during foundation construction or pipe laying, and dewatering may be required. Without appropriate controls, dewatering of shallow groundwater aquifers result in a localized lowering (i.e., drawdown) of the aquifer and potential changes in groundwater quality, such as increases in turbidity. It is anticipated that these changes would be minor and temporary. The amount of water table drawdown and the area influenced are dependent upon the hydraulic conductivity of the soil, the depth of the excavation relative to the water table, and the volume of the excavation that requires dewatering. Shallow groundwater aquifers generally recharge quickly because they are easily recharged from precipitation and surface waters.

Extracted water would likely be pumped into an onsite settling pond in accordance with an APDES General Permit AKG320000 – Statewide Oil and Gas Pipelines. The permit sets conditions on pollutants and authorizes discharges into waters of the United States and disposals to State lands resulting from construction, operation, and maintenance activities for pipelines and related facilities. This wastewater disposal general permit authorizes the following discharges from pipeline facilities:

- Drilling Fluids and Drill Cuttings;
- Domestic Wastewater;
- Gravel Pit Dewatering;
- Excavation Dewatering;
- Hydrostatic Test Water;
- Storm Water;
- Mobile Spill Response; and
- Secondary Containment.

Effluent limitations and requirements for excavation dewatering (Discharge 004) include parameters such as flow volume, pH, settleable solids (SS), turbidity oil and grease visual (no discharge), Total Aqueous Hydrocarbons (TAqH), and Total Aromatic Hydrocarbons (TAH). The Applicant may be required to apply for individual permits for locations where the Project wastewater discharges would be unable to comply with permit eligibility criteria.

Any discharges to the ground would be first directed through an energy-dissipating device to reduce the potential for erosion and encourage infiltration back into the soil. If dewatering requires pumping of more than 30,000 gallons per day, an ADNR Temporary Water Use Permit would be obtained. With the use of the appropriate BMPs, it is anticipated that impacts to groundwater from dewatering would be mitigated according to the Temporary Water Use Permit conditions.

Excavation and dewatering in contaminated areas can expose contaminants in groundwater or cause them to migrate to previously unaffected adjacent areas by altering the local groundwater flow regime. To reduce or eliminate the potential for such impacts, construction in known/predetermined contaminated sites would be avoided to the extent practicable. Visual monitoring for sheen and odor would also be performed daily in all locations where dewatering occurs. Site-specific plans detailing how contaminants in areas of known contamination (see Resource Report No. 8) would either be avoided or removed, and would be provided separately following consultation with ADEC and EPA. In addition, for sites located within 1,500 feet of an identified contaminated site, dewatering would be performed in accordance with the BMPs provided in the Project *Groundwater Monitoring Plan* (Appendix B). If unanticipated contamination is discovered during construction, the Project *Unanticipated Contamination Discovery Plan* (Resource Report No. 8, Appendix J) would be followed to protect groundwater resources.

2.2.9.1.4 Proposed Water Supply Wells

Groundwater would be used for site preparation, dust suppression, potable water, concrete mixing, back-up fire water supply, and hydrostatic testing. New 200- to 250-foot-deep groundwater wells would be located on the site to supply water for construction of the Liquefaction Facility. This location has been proposed because it presents high groundwater yield potential, and it is sufficiently removed from the coastal bluff to minimize the potential for saltwater intrusion into the aquifer. During peak construction activities, onsite water demand for the Liquefaction Facility would be approximately 300,000 gallons per day, or 250 gallons per minute, depending on whether hydrostatic testing of the LNG Tanks would be using freshwater or seawater from Cook Inlet. This includes water for construction uses and for potable water at the camp. A breakdown of the proposed water use is provided in the *Water Use Plan* (Appendix K).

Potential impacts to groundwater from construction water use are anticipated to be short-term and minor. Construction activities may impact groundwater through impacts to existing water wells during the drilling or casing of new wells. By following permitting requirements to ensure the wells are properly built and subsurface formations are sealed off by the well casing and cement, impacts to drinking water aquifers can be avoided. The interaction between surface water and groundwater would be prevented by sealing any settling or retention ponds on-site and putting a buffer around existing wells during construction until they can be sealed and capped. The existing water wells may be used during the pioneering phase of construction as the new construction wells are installed. However, the wells would be sealed/capped during site preparation. They are not intended to be used for operations.

Construction activities could also impact water supply wells in the vicinity of the Liquefaction Facility site by altering aquifer porosity/permeability (i.e., infiltration rates) and/or the recharge area (e.g., compaction from heavy equipment operation). In addition, spills could contact shallow groundwater. Impacts would be unlikely, but if they occurred, would result in temporary and localized impacts. For water supply wells located within 150 feet and up to 500 feet of the construction footprint, routine monitoring of the groundwater quality and yield would be performed on a case-by case basis, as required by FERC regulations and ADEC APDES permits. Monitoring of wells in the vicinity of the construction footprint would depend on construction activity and potential to impact water source as detailed in the Project *Water Well Monitoring Plan* (Appendix C).

Water quantity and quality testing would be implemented prior to, during, and after construction completion, as needed. Water quantity parameters would be monitored, including water column height, flow rate of existing equipment, water column drawdown, and rebound time. Water would also be tested for compounds of concern including arsenic, manganese, iron, total dissolved solids, nitrates, pathogens, and radon. In addition, the BMPs listed in the Project *SWPPP* and *SPCC Plan* (Appendix J and Appendix M) would be followed. In the unlikely event that damage to a water supply were to occur during construction, affected parties would be provided with temporary sources of potable water and a new, comparable well or an alternative water source.

2.2.9.1.5 Hydrostatic Testing

Hydrostatic testing would occur directly after the LNG tanks and other Liquefaction Facility piping is installed to determine that they are leak-free and meet design strength criteria. Details of the required water volumes and testing procedures are provided in the Project *Water Use Plan* (Appendix K). Hydrostatic test water would be sourced from Cook Inlet. Hydrostatic testing of the LNG tanks would occur over a 14-21 day period, with an average fill rate of 1,400 – 2,000 gallons per minute of Cook Inlet seawater. Hydrostatic testing of the 240,000 cubic meter tanks would require roughly 42,000,000 gallons of water. If groundwater is used for hydrostatic testing of plant piping, the withdrawal rate of fresh water from the onsite construction wells would be reduced to the extent practicable to reduce the potential for local groundwater drawdown. Impacts on groundwater availability could be significant but would be localized and temporary. Potential impacts from the use of Cook Inlet water for hydrostatic testing are discussed in Section 2.3.8.1.1.4.

Hydrostatic test water would be pumped into an onsite settling pond in accordance with an APDES Statewide Oil and Gas Pipeline. The existing APDES General Permit requirements/limits are set for discharge effluent limits of pH, settleable solids, sheen (none), TAqH, TAH, total residual chlorine, Turbidity (marine), Turbidity (fresh water), and flow. With adherence to permit requirements, it is anticipated that any impacts to groundwater from test water discharge would be localized, short-term, and minor.

2.2.9.1.6 Material Sites

As detailed in the Project *Gravel Sourcing Plan and Reclamation Measures* (Resource Report No. 6, Appendix F), onsite quarries would be developed at the Liquefaction Facility to serve the primary fill needs for construction of the Liquefaction Facility. However, the impact to any confined aquifers is unlikely since they are well over 90 feet deep. Surficial groundwater may be present, depending on rainfall events and season of initial ground disturbance. However, this surficial groundwater would be removed through dewatering for the mining of granular material from the site.

To protect groundwater resources the Project's Gravel Sourcing Plan and Reclamation Measures included in Resource Report No. 6, Appendix F, will be implemented. With implementation of this Plan, it is anticipated that impacts to groundwater from material extraction would be short-term and minor.

2.2.9.1.7 Blasting

Blasting is not anticipated to be required for construction of the Liquefaction Facility.

2.2.9.1.8 Domestic Wastewater

A temporary domestic wastewater treatment plant would be located east of the construction camps. Discharge from the temporary wastewater plant would be to a sediment basin on site that would ultimately discharge to Cook Inlet through an outfall in accordance with APDES permit requirements. Coverage under the newly implemented APDES Wastewater Disposal Authorization General Permit (*AKG320000 – Statewide Oil and Gas Pipelines*) for Project domestic wastewater discharges from the operation of a domestic wastewater treatment works would specify the total amount (usually in pounds) of wastewater that could be discharged from each site. APDES permit would include limits on the following pollutants: five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform and escherichia coli bacteria, total residual chlorine, pH, and flow rate.

To reduce fecal coliform count, disinfection such as ultraviolet (UV) or chlorine would be used. In the unlikely event of a sewage spill, immediate clean-up procedures would be implemented and impacts to groundwater would be temporary and minor.

2.2.9.1.9 Fuel Use, Storage, Refueling, Lubrication, and Spill Prevention

Construction equipment would generally be refueled on the site by fuel trucks. There would be temporary fuel storage tanks placed on-site within temporary bermed secondary containment.

All fuel handling necessary for construction would be in accordance with ADEC requirements and the Project draft *SPCC Plan* (Appendix M) for the construction phase of the Project to minimize the potential for accidental releases and to establish proper protocol concerning minimization of, containment of, remediation of, and reporting of any releases that might occur. The proposed measures to reduce the risk of spills and minimize impacts should a release occur include, but are not limited to:

- Inspections of tanks, vehicles, equipment, and automatic shut-offs for leaks would be conducted daily;
- Secondary containment would be used for all single-walled containers, portable (e.g., skid-mounted) fuel tanks, aboveground tanks, and containers in excess of 55 gallons. Secondary containment capacity would be 110 percent of the volume of the largest container;
- Impermeable plastic lining materials would be used for temporarily stored contaminated soils and materials;

- Supervisors would oversee major fuel transfers (e.g., filling storage tanks), and other personnel would be trained on how to conduct transfers. Personnel would be trained on the components of the *SPCC Plan*;

- Sorbent, boom, and clean up materials would be available on all construction sites. All fueling vehicles would carry spill response materials such as absorbent pads, plastic bags, and shovels;

- The storage of petroleum products and refueling and lubricating activity during construction would take place at least 150 feet from water supply wells to the extent practicable. If within 150 feet, locations would be approved by the Environmental Inspector, spill response materials would be available at the site, and secondary containment structures would be used;

- Cook Inlet-specific SPCC practices would be followed; and

- If a spill were to occur in an upland area, activity associated with that spill would cease until the release was contained at the source. Small spills would be cleaned up with absorbent materials to reduce penetrations into soils, and large spills would be immediately pumped into tank trucks. Contaminated clean-up materials, excavated soil, and water would be disposed of in accordance with all applicable state, local, and federal laws and regulations.

All petroleum, oil, and lubricant handling needed for construction would be dictated by the SPCC Plans. Environmental Inspectors would also oversee contractor compliance with the plan. To further protect groundwater, petroleum product storage and handling would have appropriate secondary containment to prevent spills.

While any release has the potential for significant adverse environmental impacts, adherence to the *SPCC Plan* would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur.

2.2.9.1.10 Waste Management

Waste management activities would be performed in accordance with the waste management hierarchy. In order of preference, the aim would be:

1. Avoidance – Avoid the generation of waste, and particularly hazardous waste, through applicable methods, practices or materials substitution.

2. Minimization – Minimize the amount of generated waste where waste generation cannot be avoided or prevented.

3. Reuse – Reuse materials that would otherwise be relegated to a waste stream.

4. Recycle – Recycle wastes by delivering them to accessible and practicable recycling programs.

5. Recover – Recover energy from waste.

6. Disposal – Dispose of wastes responsibly at only properly licensed waste disposal facilities.

All waste generated from construction would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal. The generation and storage of hazardous wastes during construction would be minimal. Volumes and types would be determined when construction contractors are selected and construction plans finalized. At that time, each contractor would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during construction. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to groundwater due to waste management during construction of the Liquefaction Facility are not anticipated.

2.2.9.2 Interdependent Project Facilities

The various Interdependent Project Facilities, including the Mainline, PBTL, PTTL, and GTP are predominantly located in remote areas, away from other water resource users. No sole source aquifers would be impacted by construction of the Interdependent Project Facilities.

2.2.9.2.1 Mainline

No potable groundwater sources are present north of the Brooks Range. Construction of the Mainline in this area would have no impact to groundwater resources. The following discussion describes potential impacts to groundwater from construction of the Mainline south of the Brooks Range.

Extensive use of groundwater is not expected to be required for Mainline construction, with the exception of supplying the temporary construction camps as described in the Pipeline Associated Infrastructure section. However, Mainline construction activities have the potential to impact groundwater resources and are expected to be minimal, localized, and temporary. Water quantity and quality testing would be implemented prior to, during, and after construction completion, as needed.

Potential impacts of the Mainline's temporary camps water wells to community drinking water supplies would be minimized by:

- Siting water supply wells outside drinking water protection zones as required by State water use regulations;
- Monitoring camp water supply wells for groundwater quality and yielding, as required by permits and detailed in Project *Water Well Monitoring Plan* (Appendix C);
- Reducing the withdrawal rate to the extent practicable if local groundwater drawdown is determined; and
- Using alternate water supply source for camps depending on location and feasibility.

2.2.9.2.1.1 Clearing and Grading

The Mainline construction ROW consists predominantly of forested land and open space, which would be cleared and graded throughout the southern half of the route (see Resource Report No. 1). Clearing and grading would not occur north of the Brooks Range. South of the Brooks Range, clearing and grading could cause a localized decrease in both the infiltration and groundwater recharge rate. Potential impacts from clearing and grading would be reduced or eliminated with adherence to the BMPs provided in the Applicant's *Plan* (Resource Report No. 7, Appendix D). Following construction, the pipeline ROW would be contoured to maintain surface water flow and restored in accordance with the *Project Restoration Plan* (Resource Report No. 3, Appendix P). The vegetative cover would serve to slow water runoff, return groundwater infiltration, and recharge rates that may have been diminished during ROW clearing. Impacts to groundwater from clearing and grading of the Mainline construction ROW are anticipated to be short-term and minor.

Depending on granular material source quality and water content, particularly north of Atigun Pass, a full summer of "seasoning" may be required to allow the water from the frozen granular materials to drain sufficiently to support summer construction. In areas with groundwater, runoff or seepage from piled cut material would be controlled by silt fences, vegetative buffers, and other control measures as specified by the *SWPPP* (Appendix J) and the Applicant's *Plan* (Resource Report No. 7, Appendix D).

2.2.9.2.1.2 Trenching and Dewatering

Trenching would occur over the length of the Mainline and may extend to a depth of up to 15 feet or more below the ground surface. Aside from wetland, crossing shallow groundwater may be encountered at these depths in some areas, and dewatering may be required, depending on such variables as season, antecedent soil moisture conditions and elevation of the water table at the time of open trench in any given location. Other potential impacts from dewatering are similar to those discussed previously for the Liquefaction Facility. North of the Brooks Range in areas of continuous permafrost, pipeline trenching would occur during the winter, and no impacts to groundwater resources would be expected.

Sedimentation basins are not planned along the Mainline. South of the Brooks Range, dewatering discharge would be to the ground or nearby surface waters in accordance with ADEC requirements and the Applicant'*Procedures*. Where construction occurs during the summer, and the dewatering discharge causes ponding due to permafrost, discharges may be routed to a nearby drainage path or surface water body to minimize the ponding. Local trench dewatering discharges to the ground would be directed into established vegetation cover, typically through a small dewatering structure adjacent to the pipeline ROW to reduce the potential for erosion and encourage infiltration. It is anticipated that impacts to groundwater from construction dewatering would be localized, short-term, and minor.

As noted previously, spoil piles would be contained by silt fences, where required, and other control measures as specified by the *SWPPP* (Appendix J) and the Applicant's *Plan* (Resource Report No. 7, Appendix D) to prevent runoff into adjacent waterbodies.

Trenching and dewatering in unknown contaminated areas can expose contaminants in groundwater or cause them to migrate to previously unaffected areas by altering the groundwater flow regime. Constructing in known/predetermined contaminated sites without consulting ADEC would be avoided. In areas of known contamination (see Resource Report No. 8), site-specific plans detailing how contaminants at these sites would either be avoided or minimized would be provided separately. In addition, for sites located within 1,500 feet of an identified contaminated site, dewatering would be performed in accordance with the BMPs provided in the Project *Groundwater Monitoring Plan* (Appendix B). If unanticipated contamination is discovered during construction, the Project *Unanticipated Contamination Discovery Plan* (Resource Report No. 8, Appendix J) would be followed to protect groundwater resources.

2.2.9.2.1.3 Hydrostatic Testing

The proposed testing plan calls for hydrostatic testing to take place in the summer for the pipelines and would not require use of antifreeze. The use of other additives, including biocides, is not anticipated for the Mainline with the exception of Cook Inlet shore crossings and on the North Slope. As discussed previously, there is no drinking water groundwater on the Arctic Coastal Plain and groundwater would not be used for hydrostatic testing along the Mainline south of the Brooks Range. Water for hydrostatic testing would be sourced from surface water resources adjacent to the Project area and water would be discharged into the same watershed from which it was drawn. Surface discharge would be in accordance with permit requirements and released to the ground through an energy-dissipating device to reduce the potential for erosion and encourage infiltration. Water for hydrostatic testing may also be injected to approved UIC wells if they are nearby and permitted to receive hydrostatic test water.

2.2.9.2.1.4 Water Supply Wells and Springs

The construction footprint of the Mainline crosses drinking water protection areas and would be located within 150 feet of water supply wells (see Appendix A) and one spring. For the spring and water supply wells located within 150 feet, routine monitoring of groundwater quality and yield would be performed as detailed in the Project *Water Well Monitoring Plan* (Appendix C). In addition, the BMPs listed in the Project *SPCC Plan* (Appendix M) and *Blasting Plan* (Resource Report No. 6, Appendix B) would be followed to reduce potential impacts to nearby wells. In the unlikely event that damage to a water supply occurs during construction, affected parties would be provided with temporary sources of potable water and a new, comparable well or an alternative water source.

2.2.9.2.1.5 Waterbody Construction Methods

The Mainline would use bridged, elevated waterbody crossings for aerial span crossing of rivers as discussed in Section 2.3. The few number of pilings and limited extent of any foundation required to support the aerial span is unlikely to contribute to groundwater recharge rates or groundwater movement. These effects are expected to be minor and localized to the immediate areas where the pile driving occurs. Implementation of the BMPs provided in the Applicant's *Plan* (Resource Report No. 7, Appendix D) and the *SPCC Plan* (Appendix M), as well as adherence to regulatory requirements, would minimize the risk of potential impacts to groundwater in the unlikely event of a spill near a piling or foundation.

Open-cut waterbody crossings would only have minor impacts to groundwater when fine sediments and clays fill in waterbody crossing cuts and create a minor width of the low permeable nature of the streambed. However, over several seasons of spring break-up flows, this material would be carried into the watershed with the high and rapid flows experienced in the spring. Therefore, it is anticipated that any movement of surface water into groundwater, or an increased groundwater recharge rate, resulting from construction would be temporary and minor.

Where a buried trenchless method is required for waterbody crossings, the pipe would be placed well below scour depths to prevent disturbance to streambeds, based on detailed geotechnical information that would be developed during a later stage of the Project. Trenchless waterbody crossings using the HDD method would require slurry containment pits and sumps to prevent mixed-in groundwater from discharging back into the environment. Drilling mud may inadvertently discharge through previously unidentified fractures in subsurface strata ("frac-out") along the drill path due to unfavorable ground conditions. Although drilling mud consists of nontoxic materials, the release of drilling mud in large quantities could cause localized turbidity within the groundwater. Direct Micro-Tunneling would not have any risk of mud release. A Project-specific *HDD Inadvertent Release Contingency Plan*, following the outlined provided in Appendix L would minimize the risk of trenchless crossing complications and the potential for inadvertent releases of drilling fluid. It is anticipated that any impacts to groundwater from trenchless construction would be localized and minor.

2.2.9.2.1.6 Blasting

Blasting may be required where bedrock or 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 of Resource Report No. 6 discusses the locations where shallow bedrock is anticipated.

Blasting explosives and detonators commonly contain perchlorate or ammonium nitrate fuel oil, which may leave residues after blasting reach groundwater during infiltration. However, with the shallow nature of the blasting it is not anticipated that blasting residue would concentrate in quantities able to reach drinking groundwater aquifers. With adherence to the procedures detailed in the *Blasting Plan* (Resource Report No. 6, Appendix B), any potential impacts to groundwater from blasting are anticipated to be localized, short-term, and minor based on the spatial extent of the impact, the duration and frequency, and localized nature of the work.

2.2.9.2.1.7 Fuel Use, Storage, Refueling, Lubrication, and Spill Prevention

During development of the construction infrastructure, temporary fuel storage tanks would be set up at pioneer camps, civil construction spreads, pipeline construction camps, and each spread's active contractor yard. Interim storage tanks would be located at the Coldfoot and Happy Valley camps along the Dalton Highway to provide fuel for transport trucks. Tanks would be double-walled and/or include secondary spill containment in accordance with applicable regulations. Construction equipment working along the Mainline ROW would generally be refueled by fuel/maintenance trucks that visit each crew on a daily basis.

All fuel handling necessary for construction of the Mainline would be in accordance with regulatory requirements and the Project *SPCC Plan* (Appendix M). The Plan would be managed by the Environmental Inspectors during construction. Adherence to the protective measures outlined previously in Section 2.2.8.1.9 would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur.

2.2.9.2.1.8 Waste Management

All waste generated from construction would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would ensure compliance with all regulations for transportation, treatment, storage, and disposal.

The generation and storage of hazardous wastes during construction would be minimal. Volumes and types would be determined when construction contractors are selected and construction plans finalized. At that time, each contractor would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during construction. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to groundwater due to waste management during construction of the Mainline are not anticipated.

2.2.9.2.2 Prudhoe Bay Transmission Line (PBTL)

The PBTL would be constructed aboveground on VSMs and surface water would be used to hydrostatic test the pipeline. Because there are no potable groundwater resources present on the Arctic Coastal Plain, there would be no impacts to groundwater from pipeline construction.

2.2.9.2.3 Point Thomson Transmission Line (PTTL)

The PTTL would be constructed aboveground on VSMs and surface water would be used to hydrostatic test the pipeline. Because there are no potable groundwater resources present on the Arctic Coastal Plain, there would be no impacts to groundwater from pipeline construction.

2.2.9.2.4 Pipeline Aboveground Facilities

Because there are no potable groundwater resources present on the Arctic Coastal Plain, there would be no impact to groundwater resources from the construction of aboveground facilities. Construction practices, potential impacts and mitigation measures, waste management practices, and water use would follow existing practices used on the North Slope and described in Section 2.2.8.2.2 (GTP). The following discussions describe potential impacts to groundwater resources from construction of the Mainline Aboveground Facilities (compressor stations, meter stations, MLBVs, etc.) south of the Brooks Range.

Water for aboveground facilities would be sourced from permitted nearby surface water for use by construction personnel. All other water used during construction (e.g., construction of ice pads, water for dust control, concrete preparation, hydrostatic testing) would be taken from permitted surface water sources. Details on the anticipated water use are provided in the Project *Water Use Plan* (Appendix K). Impacts to groundwater would be short-term and minor with the withdrawals from surface water sources in compliance with permit conditions. Water use from wells is discussed under operations impacts.

2.2.9.2.4.1 Clearing, Grading, and Site Development

Potential impacts to groundwater and mitigation measures for clearing, grading, and site development for the Pipeline Aboveground Facilities would be similar to those described for the Mainline above. Granular pads and access roads installed during facility construction would remain in place. This would provide a semipermeable surface to allow for infiltration of water. Though the compacted surface would retard infiltration, however, it would not cause significant increased runoff due to the relatively small footprint of the pad surface. It is anticipated that impacts to groundwater from these ground-disturbing activities would be long-term but minor.

2.2.9.2.4.2 Foundation Construction

The Pipeline Aboveground Facilities would be constructed on granular pads or foundations built on-site. In areas south of the Brooks Range, impacts to groundwater infiltration and movement would be minor and temporary, occurring where a compacted granular pad replaces a vegetated area. Maintaining vegetative buffers and natural features at the perimeter of the pad would allow runoff to infiltrate at the perimeter. Impacts to groundwater from pad construction are anticipated to be long-term and minor based on the small footprint within the region.

Shallow groundwater could be encountered during construction of the support piles in areas south of the Brooks Range. Potential impacts to groundwater and the proposed mitigation measures would be similar to those described for the Mainline above.

2.2.9.2.4.3 Dewatering and Trenching

The amount of dewatering would vary depending on all geographic locations and seasons. If any does occur, it would be for construction and discharged in compliance with regulatory requirement.

2.2.9.2.4.4 Hydrostatic Testing

Due to the limited volumes required, approximately 80 percent of hydrostatic testing for aboveground facility modules or skids would be done at manufacturing facilities. What little hydrostatic testing is required during aboveground facility construction would be small water volumes taken from nearby surface water sources and be withdrawn and discharged according to required permits or otherwise injected or disposed at an approved facility. Impacts would be similar as those for Mainline hydrostatic testing.

2.2.9.2.4.5 Water Wells

No water supply wells have been identified within 150 feet of the aboveground facilities.

2.2.9.2.4.6 Blasting

It is not anticipated that blasting would be required for construction of most of the aboveground facilities. There is some possibility that blasting to level the sites for the Ray River, Minto, and Honolulu compressor stations may be required. This would be determined during a later stage of the Project and information provided prior to construction.

2.2.9.2.4.7 Fuel Use, Storage, Refueling, Lubrication, and Spill Prevention

All fuel handling necessary for construction of the Pipeline Aboveground Facilities would be in accordance with applicable regulatory requirements and the Project *SPCC Plan* (Appendix M). The *SPCC Plan* would be managed by the Environmental Inspectors during construction. Adherence to the protective measures outlined previously in Section 2.2.8.1.9 and the Project *SPCC Plan* would greatly reduce the likelihood of fuel spill impacts, as well as minimize the resulting impacts should a spill occur.

2.2.9.2.4.8 Wastewater Management

All industrial wastewater generated during construction would be collected in sumps, pits, drip collection devices (e.g., built-in drip pans), or storage tanks and removed for final disposal at an approved facility in accordance with its constituent chemical properties. Domestic wastewater would be treated onsite and the treated effluent would be discharged according to required permits or into an existing permitted UIC well if present. Package wastewater systems specially designed for use in remote, Arctic environments would be used. All effluents would meet applicable regulatory standards prior to discharge or be discharged into an existing UIC well approved for sewage injection. With effective collection and treatment, impacts to groundwater resources are expected to be short-term for the period of construction and minor in effect because of the relatively small camp sizes and short durations of camp use at aboveground facilities proposed.

2.2.9.2.4.9 Waste Management

All waste generated from construction would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal.

The generation and storage of hazardous wastes during construction would be minimal. Volumes and types would be determined when construction contractors are selected and construction plans finalized. At that time, each contractor would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during construction. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to groundwater due to waste management during construction of the Pipeline Aboveground Facilities are not anticipated.

2.2.9.2.5 Pipeline Associated Infrastructure

The Pipeline Associated Infrastructure includes construction camps, material sites, ice roads/access roads, additional temporary workspaces (ATWS), contractor yards, pipe storage yards, rail spurs, temporary disposal sites, and material extraction sites used for construction of the pipelines. Impacts and mitigation measures described above for pipeline construction and aboveground facility construction would be similar to the impacts anticipated for the associated infrastructure facilities.

No potable groundwater sources are present north of the Brooks Range. Construction of the Pipeline Associated Infrastructure in this area would have no impact to groundwater resources. The following discussion describes potential impacts to groundwater from construction of the Pipeline-Associated Infrastructure south of the Brooks Range.

2.2.9.2.5.1 Clearing, Grading, and Site Preparation

South of the Brooks Range, potential impacts to groundwater and mitigation measures for clearing, grading, and site preparation for the Pipeline Associated Infrastructure would be similar to those described for the Mainline and Liquefaction Facility above.

If unanticipated contamination is discovered during construction, the Project *Unanticipated Contamination Discovery Plan* (Resource Report No. 8, Appendix J) would be followed to protect groundwater resources.

2.2.9.2.5.2 Access Roads

Use of properly designed culverts and siting of access roads would reduce changes to surface runoff patterns and subsequent recharge to surficial aquifers. Granular material placement and soil compaction from granular material access road construction may increase local runoff and alter normal groundwater infiltration patterns. Impacts to groundwater from road construction would be long-term and minor based on the road footprint in related to the surface area of the watersheds crossed.

2.2.9.2.5.3 Water Wells

There is no planned groundwater use from existing or new wells at aboveground facilities during construction. There is no anticipated impact to existing water wells from construction of the facilities.

2.2.9.2.5.4 Material Sites

As detailed in the Project *Gravel Sourcing Plan and Reclamation Measures* (Resource Report No. 6, Appendix F), existing mine sites would be used or new mine sites would be developed to support construction of the Mainline. Potential impacts to groundwater, where present, and mitigation measures from any required blasting and dewatering, would be the similar to those described for the Mainline above.

2.2.9.2.5.5 Domestic Wastewater

At all remote site locations, wastewater would be treated using systems designed for cold climate conditions. The systems would be designed to meet AWQS at the point of discharge. Treated Wastewater from camps and living areas would then be directed to the ground in the vicinity of the camps or living areas, in accordance with the applicable permits. Permits granted from the State of Alaska under the APDES permit would specify the total volume of wastewater that could be discharged from each site. APDES permits limit the following parameters: BOD_5, TSS, fecal coliform and escherichia coli bacteria, total residual chlorine, dissolved oxygen (DO), pH, and flow rate.

To reduce fecal coliform count, disinfection such as UV or chlorine would be used. Where it exists, no impacts to groundwater are anticipated with treatment and disposal of domestic wastewater in accordance with regulatory requirements. In the unlikely event that a release of sewage was to occur, immediate clean-up procedures would be implemented. During winter, sewage spills would be collected and put through a snow-melter and sent to a package plant or downhole into a UIC well. During summer, soils would be removed and sewage infrastructure will be steam cleaned and the run off will be collected for treatment. Impacts to groundwater would be anticipated to be temporary and minor.

2.2.9.2.5.6 Fuel Use, Storage, Refueling, Lubrication, and Spill Prevention

All fuel handling necessary for construction of the Pipeline Associated Infrastructure would be in accordance with all regulations and the Project *SPCC Plan* (Appendix M). The Plan would be managed by the Environmental Inspectors during construction. Adherence to the protective measures outlined previously in Section 2.2.8.1.9 and the Project *SPCC Plan* would greatly reduce the likelihood of fuel spill impacts, as well as minimize the resulting impacts should a spill occur.

2.2.9.2.5.7 Waste Management

All waste generated from construction would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal. The generation and storage of hazardous wastes during construction would be minimal. Volumes and types would be determined when construction contractors are selected and construction plans finalized. At that time, each contractor would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during construction. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to groundwater due to waste management during construction of the Pipeline Associated Infrastructure are not anticipated.

2.2.9.2.6 Gas Treatment Plant (GTP)

The GTP would be located on the Arctic Coastal Plain, which is an area of continuous permafrost. Aquifers do not exist in this area due to the extensive permafrost layer. No impacts to groundwater would occur from construction of the GTP.

2.2.9.2.6.1 GTP Associated Infrastructure

The GTP Associated Infrastructure would include a construction camp, pipelines, new Dock Head 4 at West Dock, granular material mine, reservoir, laydown/staging areas, and access roads. The GTP Associated Infrastructure would be located on the Arctic Coastal Plain, which is an area of continuous permafrost. Aquifers do not exist in this area due to the extensive permafrost layer. Surface water sources would be used for construction of the GTP Associated Infrastructure. No impacts to groundwater would occur from construction of the GTP Associated Infrastructure.

2.2.9.3 Non-Jurisdictional Facilities

The PTU Expansion project and PBU MGS project are located close to the PBTL, PTTL, and GTP. They would both be located within the Arctic Coastal Plain, which is an area of continuous permafrost. Potable aquifers do not exist in this area, therefore no impacts to groundwater resources would occur during non-jurisdictional facility construction and operation.

The Kenai Spur Highway relocation project would result in site clearing and grading and the relocation of an impervious highway surface further inland. These activities would likely cause a minor decrease in localized groundwater infiltration and recharge. The impacts to groundwater would be long-term because the roadway would remain following construction and add impervious surface area within the recharge zones. However, the acreage anticipated (<150 acres) would only slightly increase the footprint of the existing road being relocated.

2.2.10 Potential Operational Impacts and Mitigation Measures for Groundwater

Groundwater would be required to support operational activities at the Liquefaction Facility and some of the Pipeline Aboveground Facilities. It is not anticipated that groundwater would be used for operation of the Mainline, PBTL, PTTL, or GTP and are therefore not discussed further.

Groundwater withdrawal to support operations would have the potential to affect groundwater supply, while maintenance/repair activities, wastewater discharge, and spill events have the potential to affect groundwater quality. The discussion in the following section addresses potential impacts to both groundwater quantity and quality and provides proposed mitigation measures and BMPs to avoid and minimize potential adverse effects.

2.2.10.1 Liquefaction Facility

Site development would result in an increased amount of impermeable surface present. This would result in a long-term, minor reduction in groundwater infiltration and recharge. Natural buffers would be maintained around the Liquefaction Facility site to preserve as much recharge area as possible and all run-off and water used would be routed through on-site treatment facilities prior to discharge, reducing the likelihood of impact to groundwater resources.

2.2.10.1.1 Maintenance and Repair

Maintenance and repair activities during operation at the Liquefaction Facility are anticipated to require minimal site preparation (e.g., excavation) and hydrostatic testing. Potential impacts to groundwater from maintenance activities are anticipated to be of a lower magnitude than those described for construction due to the use of drip collection devices and collection sumps to handle lubricants and the limited fueling of vehicles to only those used by operations personnel when at the Liquefaction Facility. Impacts to groundwater from maintenance and repair are anticipated to be intermittent and minor. Essentially all maintenance and repair activities during operations would occur in confined space, on hard surfaces, and with catch-basins in place to prevent the loss of process fluids to the environment.

2.2.10.1.2 Water Wells

Project operations would use groundwater from new water wells for process water, potable water, and the firewater system. The wells would be located near the liquefaction trains. Similar to the construction wells, the operation wells would access the unconsolidated-deposit aquifers system in the Cook Inlet ecoregion and would likely be of the same depth. Normal water consumption during operations is less than 150 gallons per minute. In the unlikely event of a fire, the volume would increase to 1,000 gallons per minute for no more than 4 hours duration.

The proposed withdrawal could represent an approximate increase of 5 percent demand on the aquifer system during normal operations and up to 30 percent for the short-term emergency use. It is anticipated that the aquifer system would be able to meet this demand, however impacts would be long-term, and the increased demand may enhance the possibility for saltwater intrusion. Hydrogeology evaluations to assess potential groundwater yield at the Liquefaction Facility site are continuing with preliminary results from the *2016 Hydrogeology Program* summarized in Appendix S.

2.2.10.1.3 Wastewater

The main discharge location of all treated wastewater containing black and gray water from Project operations would be an outfall to Cook Inlet following appropriate treatment per regulatory requirements. The outfall would be operated according to an APDES individual permit. APDES permits limit the following pollutants: BOD_5, TSS, fecal coliform and possibly total ammonia, nitrogen (N), total recoverable copper, total recoverable zinc, whole effluent toxicity (WET), enterococci, total residual chlorine (if applicable), DO, oil and grease, pH, and flow.

One of the three onsite lined ponds would serve as the receiving area prior to discharge. No effects to groundwater are anticipated from wastewater disposal.

2.2.10.1.4 Waste Handling

Operation of the Liquefaction Facility would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, there would be no expected groundwater quality impacts from operation of the Liquefaction Facility.

2.2.10.1.5 Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of fuels and lubricants could occur in any area where these compounds are used or stored and have the potential to damage groundwater resources. Personnel would be trained for proper handling, storage, disposal, and timely spill response of hazardous fluids, and an *SPCC Plan* would be developed for operations. All petroleum, oil, and lubricant handling required during Project operations would be dictated by the SPCC Plans and managed by the Environmental Managers. Storage tanks and containers for fuels and hazardous liquids would be stored in tanks with secondary spill containment, and oil-filled operational equipment would be addressed in a manner consistent with the requirements of 40 C.F.R. 112 and ADEC requirements. Potential impacts to groundwater from fuel spills during operation of the Liquefaction Facility and mitigation measures would be similar to those described for construction.

During operations everything containing lube oil or grease would have self-contained drip collection devices and reservoirs with overflow sumps, and all repairs would take place on concreted surfaces which feed to the closed drain and effluent treatment system. Stormwater and all surface waters collected would be checked prior to release and contaminated fluids sent to the oily water treatment system.

During operation, there is the potential for an LNG spill. However, LNG vaporizes rapidly when exposed to ambient conditions such that no effects to groundwater resources are anticipated from an LNG spill.

2.2.10.2 Interdependent Project Facilities

2.2.10.2.1 Mainline

Maintenance and repair activities for the Mainline are anticipated to require minimal site preparation (e.g., excavation) and hydrostatic testing. Potential impacts to groundwater in areas south of the Brooks Range from maintenance activities are anticipated to be similar but of a lower magnitude than those described for construction. Impacts to groundwater from maintenance and repair are anticipated to be long-term but intermittent and minor.

2.2.10.2.2 Point Thomson Transmission Line

No impacts to groundwater would occur during operation of the PTTL since groundwater (highly saline and nonpotable) is present at a depth greater than 1,800 feet below the permafrost layer that affects groundwater recharge.

2.2.10.2.3 Prudhoe Bay Transmission Line

No impacts to groundwater would occur during operation of the PBTL because groundwater resources do not exist on the Arctic Coastal Plain.

2.2.10.2.4 Pipeline Aboveground Facilities

Granular pads installed during facility construction and for access roads would remain in place. They allow for infiltration of water, but the compressed surface slows infiltration and increases surface runoff. Maintaining vegetative buffers and natural features along the perimeters of the pads would encourage infiltration of runoff. It is anticipated that impacts to groundwater, where applicable, would be long-term but minor since the footprint of the granular pads and roads is small and surface flow would not be impeded by design and placement of the granular material.

2.2.10.2.4.1 Maintenance and Repair

Maintenance and repair activities at the Pipeline Aboveground Facilities are anticipated to require minimal activities such as site preparation (e.g., excavation) and hydrostatic testing. Potential impacts to groundwater from maintenance and repair activities are anticipated to be similar but of a lower magnitude than those described for construction. Impacts to groundwater from maintenance and repair are anticipated to be long-term but intermittent and minor.

2.2.10.2.4.2 Water Wells

South of the Brooks Range, water for operations may come from a nearby surface water source, trucked and stored on site, or acquired through a water well installed at the site. Water withdrawal for the unmanned facility operation would be minimal with an estimated annual requirement of approximately 15,000 gallons in total. This would include approximately 50 to 75 gallons per day per personnel and 50 gallons per month for mechanical use by the process facilities (make-up water for the heating units). It is not anticipated that this would cause a significant drawdown of the local water table. Impacts to groundwater from use of water wells during operation of the Pipeline Aboveground Facilities are anticipated to be long-term but minor.

2.2.10.2.4.3 Wastewater

All industrial wastewater would be collected in sumps, pits, drip collection devices, or storage tanks and vacuum trucks for disposal at an approved wastewater treatment or disposal facility. Domestic wastewater would be treated onsite, and the effluent would be discharged to the ground per regulatory requirements.

Effluent would meet ADEC regulatory standards prior to discharge. APDES permits limit the following pollutants: BOD_5, TSS, fecal coliform and possibly enterococci, total residual chlorine (if applicable), DO, oil and grease, pH, and flow. To reduce fecal coliform count, disinfection, such as UV or chlorine, would be used. No impacts to groundwater are anticipated under normal treatment and disposal of domestic wastewater.

2.2.10.2.4.4 Waste Handling

Operation of the Pipeline Aboveground Facilities would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal. The generation and storage of hazardous wastes during operations would be minimal. Volumes and types would be determined once operation plans are finalized. At that time, each facility operator would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during operation. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, there would be no expected groundwater quality impacts from operation of the Pipeline Aboveground Facilities south of the Brooks Range.

2.2.10.2.4.5 Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of fuels and lubricants could occur where these compounds are used or stored and have the potential to impact groundwater resources if not cleaned up immediately. *SPCC Plans* would be developed for each facility prior to operation. In addition, operations would meet regulatory requirements. Potential impacts to groundwater from fuel spills and mitigation measures during operation of Pipeline Aboveground Facilities would be similar to those described for construction of these facilities.

2.2.10.2.5 Gas Treatment Plant

No impacts to groundwater would occur during operation of the GTP since groundwater (highly saline and nonpotable) is present at a depth greater than 1,800 feet below the permafrost layer that affects groundwater recharge.

2.2.10.2.6 Non-Jurisdictional Facilities

The PTU Expansion project and PBU MGS project are located close to the PBTL, PTTL, and GTP. Both projects would be located within the Arctic Coastal Plain, which is an area of continuous permafrost. Aquifers do not exist in these areas. No impacts to groundwater would occur from operation of either project.

The Kenai Spur Highway relocation project could result in an increased amount of impervious surface depending on the final route selected. This would likely cause a minor decrease in localized groundwater infiltration and recharge. It is anticipated that impacts to groundwater would be long-term and minor, but consistent with the current impacts of the highway.

2.3 SURFACE WATER RESOURCES

Surface water resources within the proposed Project area were initially identified through desktop analysis using USGS Nationally Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD), best available imagery, and LiDAR (Light Detection and Ranging). Subsequent hydrology field investigations were conducted to document hydrologic characteristics and representative reaches (upstream and downstream) at select waterbodies for developing site-specific mitigation measures to avoid and minimize adverse impacts to surface water resources. Waterbodies that would be crossed by the Project pipeline facilities, including milepost, proposed crossing method and construction season, crossing width, flow regime, and fishery classification are listed in Appendix H. Fisheries that would be crossed by the Project are discussed in Resource Report No. 3.

2.3.1 Marine Resources

The Project infrastructure would be located in two distinct ecoregions, with the Liquefaction Facility located in Cook Inlet Basin ecoregion (which opens into the Gulf of Alaska), and the GTP facility located in the Beaufort Coastal Plain ecoregion adjacent to Prudhoe Bay and the Beaufort Sea coast. Cook Inlet Basin is a mix of continental and maritime climates with moderate seasonal temperature fluctuations and abundant precipitation, while the Beaufort Coastal Plain ecoregion is regulated by a dry, polar climate producing short, cool summers and long, cold winters (Nowacki et al., 2003). The following section describes the marine environments of Cook Inlet and Prudhoe Bay in detail.

2.3.1.1 Cook Inlet Marine Environment

The Liquefaction Facility would be located on the eastern shore of Cook Inlet near Nikiski in the Upper Kenai Peninsula watershed. The Mainline is addressed in Section 2.3.1.1.6. Cook Inlet is a tidal estuary extending from the Anchorage area that opens into the Gulf of Alaska with a basin area of approximately 12,000 square miles (Figure 2.3.1-1). At the northern end of Cook Inlet are two extensions, the Turnagain Arm (an easterly extension) and the Knik Arm (a northerly extension). Cook Inlet is approximately 220 miles in length, ranging from 60 miles wide at the mouth, to 15–20 miles wide in Upper Cook Inlet.

2.3.1.1.1 Water Depths

The bottom of Cook Inlet is rugged with deep pockets and shallow shoals. The depths in the upper inlet north of the Forelands are generally less than 115 feet, with the deepest portion located in Trading Bay, east of the mouth of the McArthur River. South of the Forelands, two channels extend southward on either side of Kalgin Island and join in an area west of Cape Ninilchik. South of the cape, this channel gradually deepens to approximately 475 feet and widens to extend across the mouth of Cook Inlet from Cape Douglas to Cape Elizabeth.

Water depths in the center of the channel can range from 60 to more than 500 feet with some of the deepest portions at the strait between the Forelands (opposing peninsulas), constricting the Inlet into two distinct regions, Upper Cook Inlet and Lower Cook Inlet (NOAA, 2014a - Nautical Chart #16660). From the shoreline at the Liquefaction Facility, the depth extends to 60 feet by the berthing piers. Bathymetry is provided in Figure 2.3.1-1.

2.3.1.1.2 Tides, Waves, Circulation, and Currents

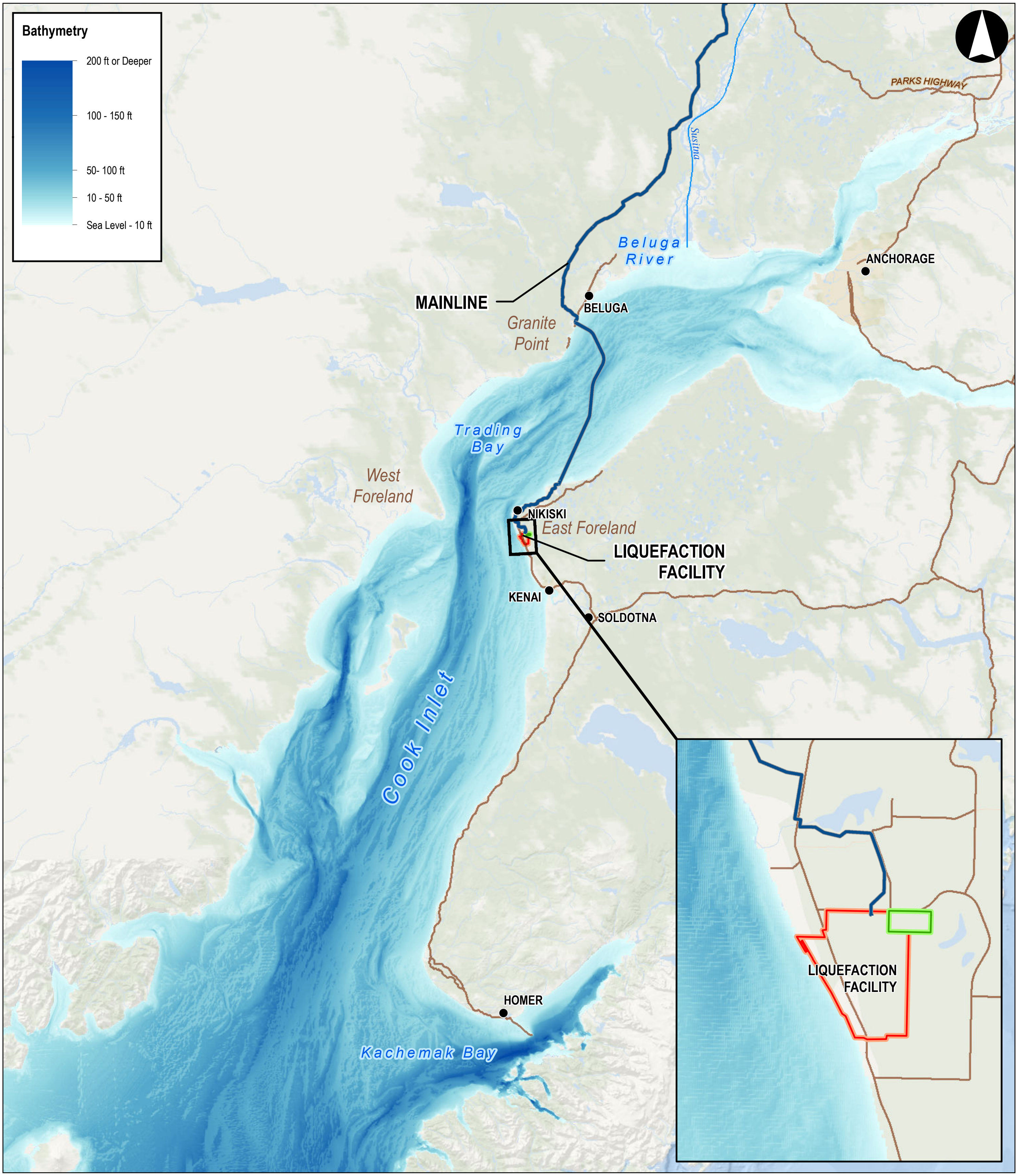
The tide range in Cook Inlet is among the largest in the United States (ADEC, 2010a). Tides are semi-diurnal (two unequal high and two low tides occur per tidal day [24 hours, 50 minutes long]) with the mean tidal range increasing northward. Mean daily tide range varies from approximately 15 feet at the inlet mouth to approximately 30 feet at Anchorage (ADEC, 2010a). At Kenai, the mean tidal range is 20 feet. Twice each month, tidal ranges are a little larger than average during either a full or a new moon. In both cases, the gravitational pull from the sun and moon combine making high tides slightly higher and low tides slightly lower

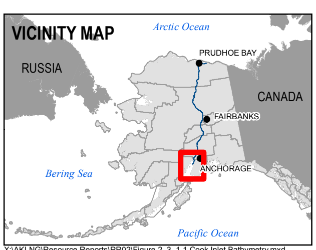
During spring tides, the highest and lowest tides may exceed the mean high and mean low tides by more than 6.5 feet, producing tidal ranges of more than 30 feet at Kenai and 39 feet at Anchorage. Tidal ranges in Cook Inlet are higher on the east side of the inlet due to the Coriolis Effect (rotation of the Earth) on the advancing tidal wave.

At Nikiski (NOAA Station ID 9455760), the average tide ranges from approximately 2.1 feet mean low water (MLW) to 19.9 feet mean high water (MHW) based on local mean lower low water (MLLW) datum, with a highest observed astronomical tide of 25.6 feet (NOAA, 2015a). Overall, Cook Inlet has a maximum tidal range of 13 to 39 feet, depending on location, which produces rapid tidal flows and strong riptides. In addition, tidal bores of up to 10 feet sometimes occur in the Turnagain Arm (Kenai Peninsula Borough, 1990).

Storm surges (storm-induced wave run-up) in Cook Inlet are small compared to tidal fluctuations. Wave heights are generally less than 10 feet in central Cook Inlet, although they can reach up to 15 feet in Upper Cook Inlet near the Beluga Point area (EPA, 2002).

At the entrance to Cook Inlet the tidal currents have an estimated velocity of 2 to 3 knots, and in general increase toward the head of the inlet, with very large velocities in the vicinities of Harriet Point, East and West Forelands, and the entrances to Knik and Turnagain Arms, where they are reported to be strongest (NOAA, 2015b). NOAA estimated that the velocity of the current during a large tide is as much as 8 to 9 knots between East and West Forelands and probably more between Harriet Point and the south end of Kalgin Island (NOAA, 2015b). Current speeds of up to 12 knots have been reported, though not verified, in the vicinity of Kalgin Island and Drift River (ADEC, 2010a). The tidal currents near the Project area average 5.3 knots at the Forelands (NOAA, 2014b).





X:\AKLNG\Resource Reports\RR02\Figure 2_3_1-1 Cook Inlet Bathymetry.mxd

LEGEND

- Alaska Place Names
- Alaska LNG Rev C2 Route
- Major Highways
- Major Rivers

Liquefaction
- LNG Operations
- LNG Construction Camp

0 5 10 20 Miles

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COOK INLET BATHYMETRY

FIGURE 2.3.1-1

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Many factors influence the circulation of water in Cook Inlet: the shape of the inlet, bathymetry, fresh water input from rivers, the Coriolis Effect, the Alaska Coastal Current, and semidiurnal tides. Marine water enters the inlet on the southeast during flood tide, progresses northward along the east shore with minor lateral mixing. This water is colder and has fewer suspended sediments than Cook Inlet waters. South of the Forelands, mixing with turbid inlet water becomes extensive. The major fresh water inputs come from rivers discharging into Upper Cook Inlet and along the west shore. Turbid water moves south primarily along the north shore during the ebb tide and a shear zone between the two water masses forms mid-inlet, south of Kalgin Island. Local shore configuration, bottom contour, and possibly wind effects in some shallow areas also influence current velocities.

Currents in Upper Cook Inlet are classified as reversing currents; as the flow changes to the opposite direction it is briefly near zero velocity at each high and low tide. The Upper Inlet, therefore, experiences strong turbulence and vertical mixing during each tidal cycle, resulting in fairly uniform water properties throughout the water column. Strong tidal currents in Upper Cook Inlet can oppose wind-generated waves, making the waves steeper and more chaotic (NOAA, 2012).

Upwelling occurs along the outer Kenai Peninsula coast northwest of the Chugach Islands. Fronts occur as Gulf of Alaska water encounters fresh water outflow from Upper Cook Inlet. These convergent zones are termed “tide rips.” Tide rips are concentrations of longitudinal tidal currents in Cook Inlet that result in residual vertical circulation that forms lines of slicks and flotsam at laterally convergent zones and erratic steep wave motion in divergent zones (Haley et al., 2000). Three main rips are often evident in central Cook Inlet, extending from the vicinity of the Forelands to beyond the southern tip of Kalgin Island. The surface expressions of the rips can change position and strength considerably during the tidal cycle. These rips have the ability to accumulate debris, ice, and other sediments.

Fresh water input is important in determining the circulation within Cook Inlet. However, only a few of the rivers are gauged for measuring discharge, and those measurements are not possible when the river is covered with ice. Through the summer, there is considerable variability in the discharge associated with rainfall within the drainage basin, but in general, the flow decreases from June through August. In September, it is dramatically reduced as snowmelt ceases and precipitation starts to be snow once again (Okkonen, Pegau, and Saupe, 2009).

2.3.1.1.3 Salinity and Temperatures

Salinity increases rapidly and almost uniformly down the inlet, from Point Possession to East and West Foreland(s). Slightly higher salinities are found on the east side of the inlet. This rapid increase can be attributed to heavily loaded glacial runoff from the Matanuska, Susitna and Knik rivers and subsequent sediment settling in Upper Cook Inlet. Local areas of depressed salinity occur off the mouth of large glacially fed streams, such as the Tuxedni, Kenai, and Kasilof rivers (ADEC, 2010a). Spring and fall mean salinities near the Project area (i.e., West and East Forelands) range from 22.6 parts per thousand (in the fall) to 25.7 parts per thousand (in the spring) (Okkonen and Howell, 2003).

NOAA has maintained a weather and water data buoy at Nikiski and records are available online from 2005–present. Figure 2.3.1-2 shows the monthly mean and standard deviation of temperatures in Celsius from the data gathered from April 2005 to November 2012 (NOAA, 2015c).

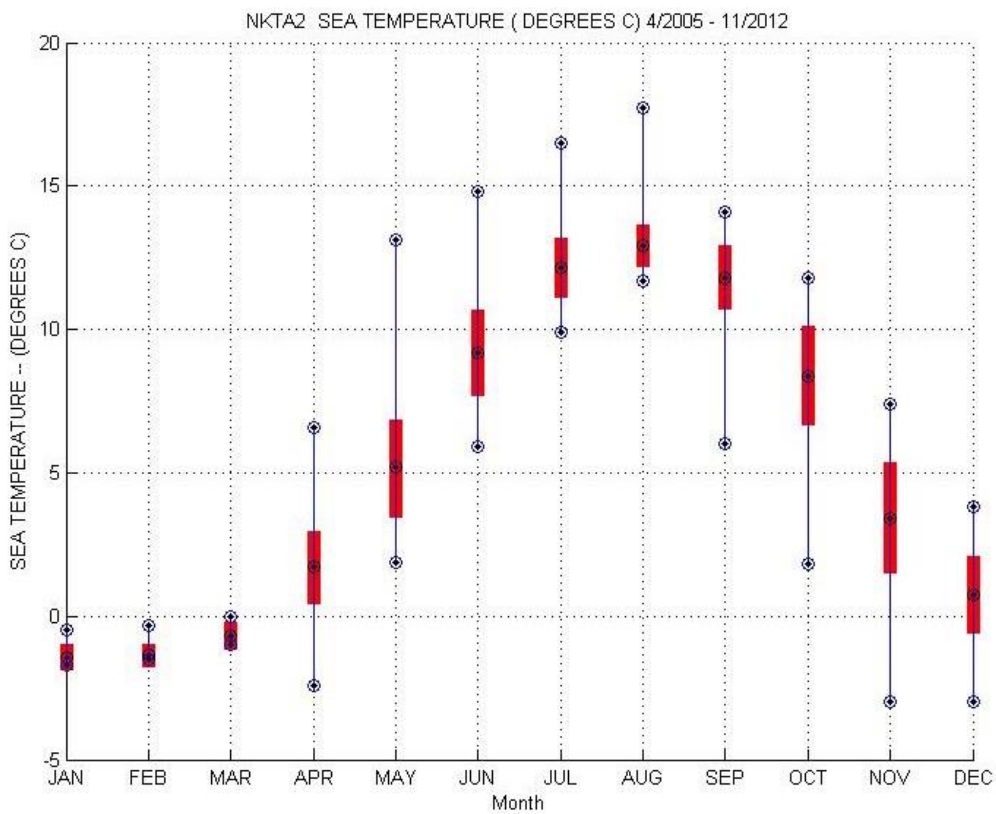


Figure 2.3.1-2 Mean Monthly Sea Temperatures Recorded at Nikiski (NOAA, 2015c)

2.3.1.1.4 Sediments and Sedimentation

Seabed sediments for the upper Cook Inlet are dominated by sand, granular material, and large stones with isolated areas of higher silt concentration. The rivers entering Knik Arm annually discharge 13–19 million tons of sediment, primarily in the summer (Gatto, 1976). Bluffs that are up to 100 feet high along both shores of Cook Inlet are composed of glacially deposited till, a widely graded mix of clay, silt, sand, granular material, and intermittent larger rocks. Bottom and subsurface soil conditions vary greatly, ranging from soft unconsolidated clays on the west side of the inlet to boulder-covered, extremely stiff clays on the middle and the east side (Visser, 1989).

Coastal bluffs, ranging from 20 feet to 120 feet in height along Cook Inlet, are receding in response to natural processes: wave action, precipitation, and wind. Eroding bluffs are a major source of sediment supply to Knik Arm and the rest of Cook Inlet (Smith et al., 2005). The steep slopes, loose nature of the bedrock, and the tendency for the soils to become saturated with water make the Cook Inlet bluffs very vulnerable to landslides. Intense tidal currents then redistribute this sediment. The Kenai Lowlands of the Cook Inlet Basin are made up of two formations that include several thousand feet of layered sand, silt, clay, conglomerate, coal seams, and volcanic ash. Most of this sediment is deposited on the extensive tidal flats or is carried offshore through Shelikof Strait. Longshore transport of sediment within Cook Inlet is generally up the Inlet, although Kamishak, Tuxedni, and Kachemak bays are areas where this trend is reversed. Homer Spit is maintained by longshore sediment transport from the north (Kenai Peninsula

Borough, 1990). Rain and snow events and glacial dam flooding also deposit significant amounts of sediment into Cook Inlet.

The average particle grain sizes of sediments at sites in the middle of the inlet are coarser, while those on the west side of the inlet are finer. The predominance of coarser grains that occur in the middle of the inlet is influenced by the degree of exposure to wave action and currents at Kalgin Island and by the number of highly exposed shoals. In contrast, the west side of the inlet, especially toward the north, receives heavy loads of fine-grained, suspended sediments from the many river systems feeding from glaciers.

The east side of Middle and Upper Cook Inlet is characterized by relatively wide (approximately 100–1,000 feet) subtidal beaches composed of pebbles and wide silt flats or poorly sorted sands. The shoreline is backed by a highly erosional vegetated bluff about 20 to 100 feet high. The bluffs are composed mostly of fine granular material and well-sorted sand with lenses of clay and layers of glacial till. Boulders up to 10 feet in diameter are scattered sparsely on the mud flats. Usually a narrow band of cobbles and boulders are located in a transition zone between bluffs and mud flats. Sand is deposited on the outer portion of the tidal flat where wave energy is highest and tidal currents are strongest, and at the high-tide area where wave energy is strong. Typically, silt/clay is found in the wave-energy shadow between the outer sand flats, where wave energy is focused at low tide, and the high-tide beach, where the waves break during high tide (CIRCAS, 2001).

The west, southeast, and northern shores of Kalgin Island in the middle of Cook Inlet are mostly characterized by high steep eroding bluffs (approximately 20 to 150 feet high) and migrating sand waves in the intertidal zone. Sand waves are composed of medium and fine well-sorted sand. Boulders up to 10 feet in diameter are scattered sparsely around Kalgin Island. The extent to which the sand wave features are stationary relict features, or evolve and migrate slowly over time (like sand dunes in a desert) is uncertain (CIRCAS, 2001).

The northeastern corner of the Kalgin Island is characterized by silty shore overlaying compact clay. The storm high-tide lines on the island are marked by the presence of large logs, and the beach face is composed of mixed sand and granular material. Several shoals in the middle of the Upper Cook Inlet (e.g., Middle Ground Shoal and Moose Point Shoal) consist of unstable sands prone to liquefaction.

Turbidity and sedimentation rates are naturally high in the Upper Cook Inlet due to the abundance of glacial sediments and strong currents. Suspended sediment concentrations in Upper Cook Inlet range from 100 to 2,000 parts per million, increasing northward. Shore-based field measurements in the Project area in September indicate TSS estimates ranging from 220 mg/L to 1,113 mg/L depending on the day measured and tidal cycle (CH2M, 2016).

The west side of Upper Cook Inlet north of West Foreland appears to be exposed to strong physical forces (e.g. wave action, currents, and ice forces). The northern side of the West Foreland is characterized by gradually sloped beaches backed by vegetated bluff about 20 to 100 feet high. The western side of Cook Inlet shows signs of mass wasting (slumping) of the bluff into the inlet in the past, as well as minor sediment accretion offshore. The upper portion of the beach slope is primary pebbles and flattened boulders, and the lower intertidal zone consists of sand and mud or compacted clay (CIRCAS, 2001).

Geophysical surveys (Alaska LNG, 2014a) were conducted in the nearshore area around the proposed Liquefaction Facility (see Appendix C of Resource Report No. 6). Sand waves were mapped throughout the facility area and in the approach channel where they occur in narrow strips all oriented in a north-south direction, paralleling the tidal currents. Rock ridges were observed paralleling the coastline extending out from the north edge of the nearshore Marine Terminal area. The parallel rock ridges generally display a relief of only a few feet rising up to 5 feet in height. The western section of the Marine Terminal area is generally smooth with scattered seafloor depressions and a few isolated boulders.

Existing information on sediments in the Marine Terminal area was summarized in a Soil Stratigraphy Report (CH2MHill, 2015), which includes data from a 1967 exploration by McClelland Engineers, a 1975 report prepared by Fugro Gulf, Inc. for the Western LNG Project, and onshore borings conducted by Fugro for this Project in 2014. The Soil Stratigraphy Report indicates that within the limits of the Material Offloading Facility (MOF), the sediments consist of medium dense sandy silt and sand overlying hard sandy clay. Cobbles and boulders of varying sizes up to 10 feet to 15 feet in diameter are also present throughout the site.

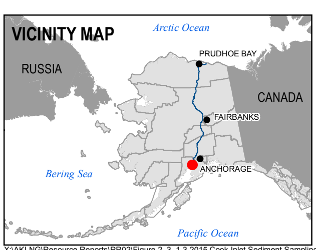
Grab samples of surficial seafloor sediments were collected in the Marine Terminal area in 2015 and analyzed for physical and chemical parameters. Figure 2.3.1-3 shows the locations of those sites sampled in 2015. The sediments were generally found to contain metal concentrations at or near regional background concentrations (see Appendix Q). All samples were well below screening level guidelines established for USACE Seattle District's Dredged Material Management Program (DMMP), which is used by the EPA and USACE to evaluate dredged material in Alaska in lieu of an Alaska-specific program (USACE, 2014). Most were also below ADEC's recommended sediment quality guidelines consisting of marine threshold effects levels developed by MacDonald et al. (2000) and NOAA Screening Quick Reference Table values (SQIRTS). Several metals (nickel, copper, chromium, arsenic) exceeded threshold effects levels but were below permissible exposure limits and within the range of background concentrations. Threshold effects levels are concentrations at which toxic effects can be rarely expected, while permissible exposure limits are concentrations where toxic effects can be expected. Total petroleum hydrocarbons concentrations were low in the samples indicating no evidence of contamination with petroleum.

2.3.1.1.5 Ice Conditions

Sea ice (first year ice only) occurs in the central and northern Cook Inlet from late fall to early spring. During winter, the Cook Inlet water body can have significant ice coverage, especially in the northern inlet. Marine Ice Atlas for Cook Inlet, Alaska prepared by USACE (Mulherin et al., 2001) contains ice coverage data in terms of ice thickness and concentration in the form of biweekly maps for the months from December through March, based on 13-year record between Jan 1986 and April 1999.

Sea ice can exist in Cook Inlet as first-year medium stage, up to 3 feet thick, and in the form of medium floes to 1,000 feet wide. In late March or early April, the only ice remaining in the inlet are the large chunks of beach ice and grounded pieces of pressure ridges formed offshore (Smith et al., 2003). The examples of ice coverage maps (produced on the basis of the above 2001 Atlas) are shown in Figure 2.3.1-4 for the maximum ice coverage as well as in Figure 2.3.1-5 for the mean severity ice conditions. The probability of occurrence for sea ice at least 5/10ths concentration from December to March of any given year is depicted in Figure 2.3.1-6 and 2.3.1-6a.

VICINITY MAP



LEGEND

Sediment Sample Locations (2015)

Major Highways

Liquefaction Facility

0 0.05 0.1 0.2 Miles

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2015 COOK INLET SEDIMENT SAMPLING LOCATIONS

FIGURE 2.3.1-3

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X:\AKLNG\Resource Reports\RR02\Figure 2_3_1-3 2015 Cook Inlet Sediment Sampling Locations.mxd

Ice conditions specific to the Marine Terminal area are significantly less severe than those for the upper Cook Inlet. The mean ice condition maps show that new ice (0–3.94 inches) typically encroaches the Nikiski terminal area mid- to late-December, and lasts to through the end of March and later. Table 2.3.1-1 shows the ice thickness and concentration at Nikiski from December through March for the maximum, mean and minimum ice conditions. As shown, the mean ice thickness at Nikiski is approximately 3.94 inches in January with 30–40 percent surface area coverage, and increases up to 11.81 inches with approximately 50 percent surface area coverage in February and first half of March.

TABLE 2.3.1-1

Ice Thickness and Concentration from December through March with Bimonthly Interval for Nikiski

Date	Ice thickness (in.)			Ice concentration (1/10)		
	Maximun	Mean	Minimum	Maximum	Mean	Minimum
Dec 01-15	0-3.94	0	0	6	0	0
Dec 16-31	0-3.94	0	0	5	0	0
Jan 01-15	>11.81	3.94	0	7	3	0
Jan 16-31	11.81-27.56	3.94	0-3.94	8	4	1
Feb 01-15	11.81-27.56	3.94-11.81	0-3.94	9	5	1
Feb 16-28	>11.81	3.94-11.81	0-3.94	8	5	1
Mar 01-15	11.81-27.56	11.81	0-3.94	8	5	2
Mar 16-31	>11.81	0-3.94	0	7	3	0

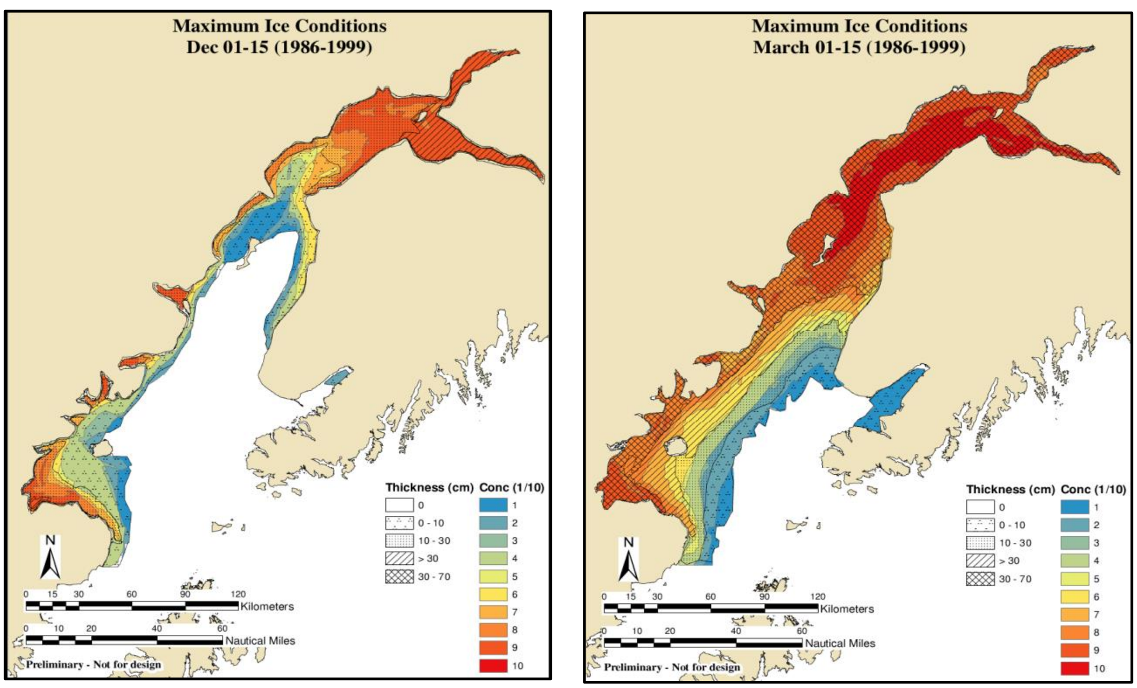


Figure 2.3.1-4 Maximum Ice Conditions

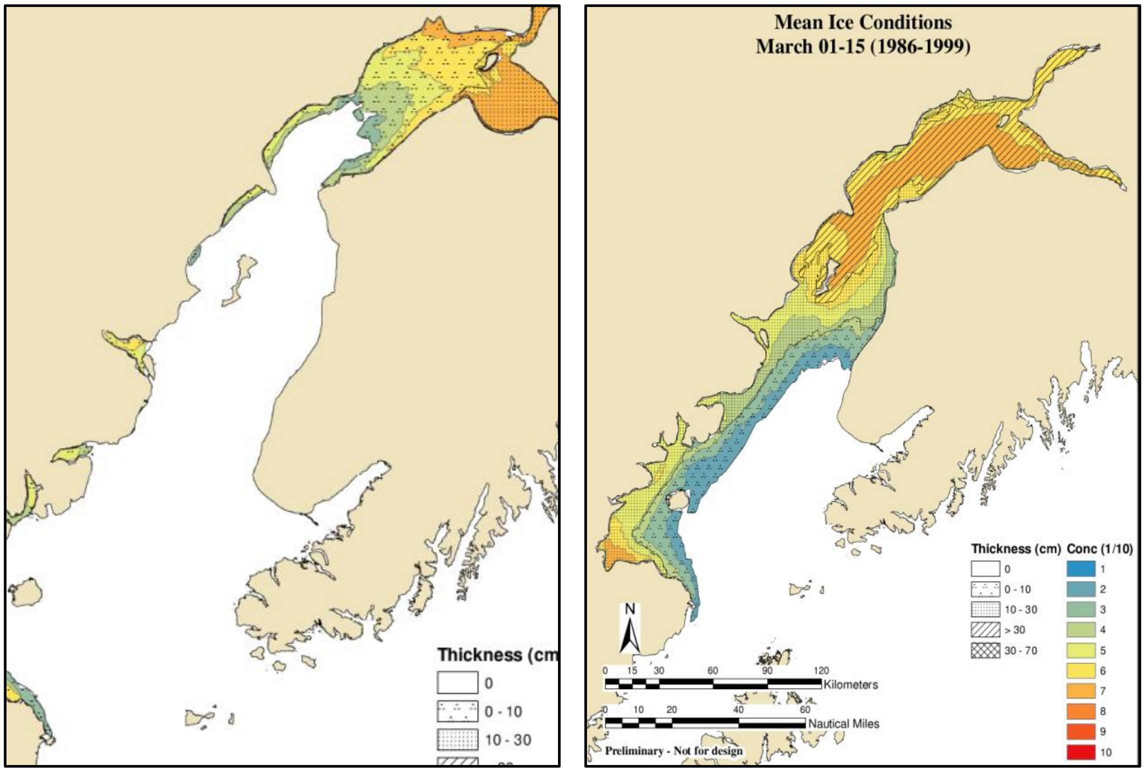


Figure 2.3.1-5 Mean Ice Conditions

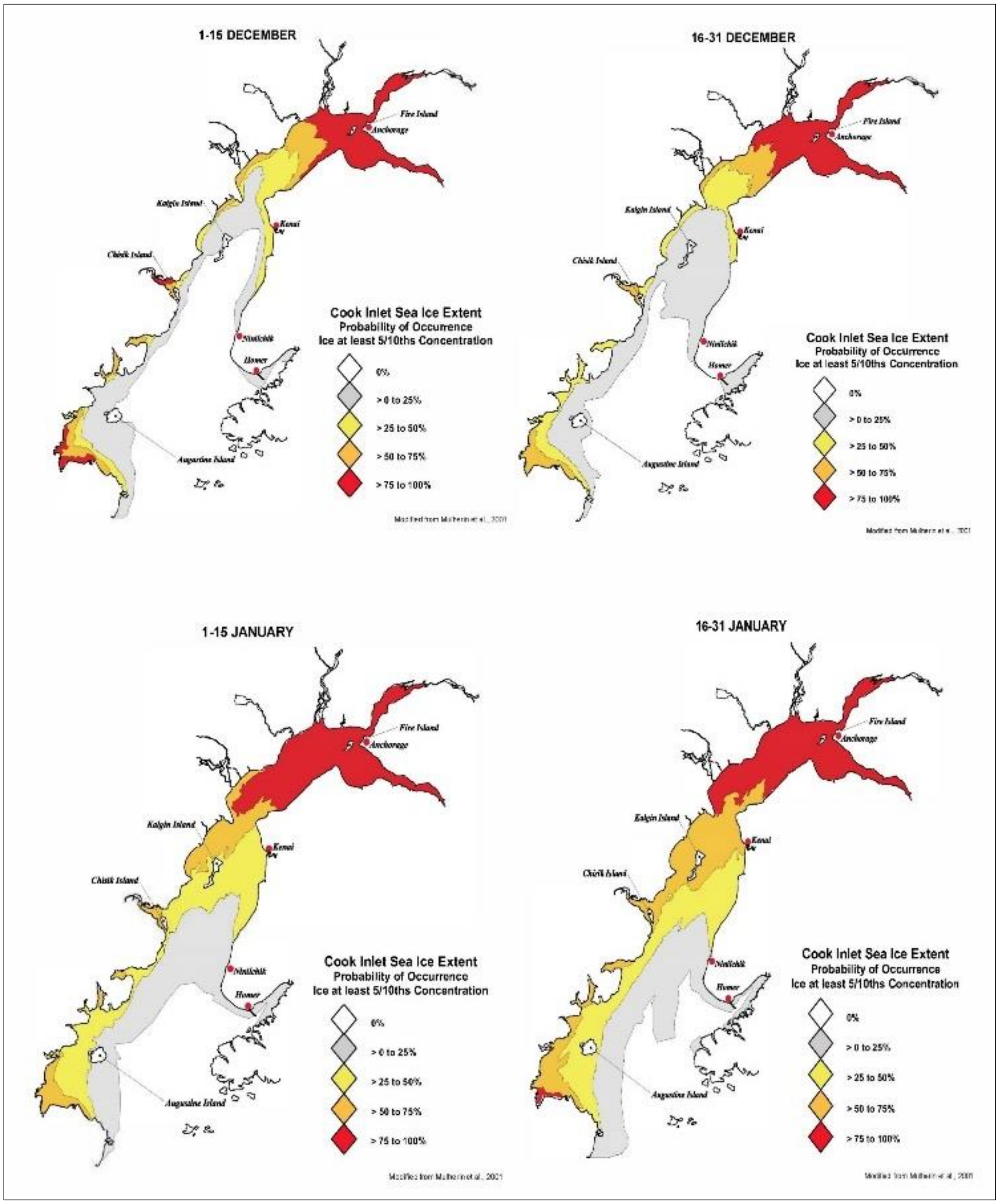


Figure 2.3.1-6 Probability of Occurrence 5/10ths Ice Concentration for December and January

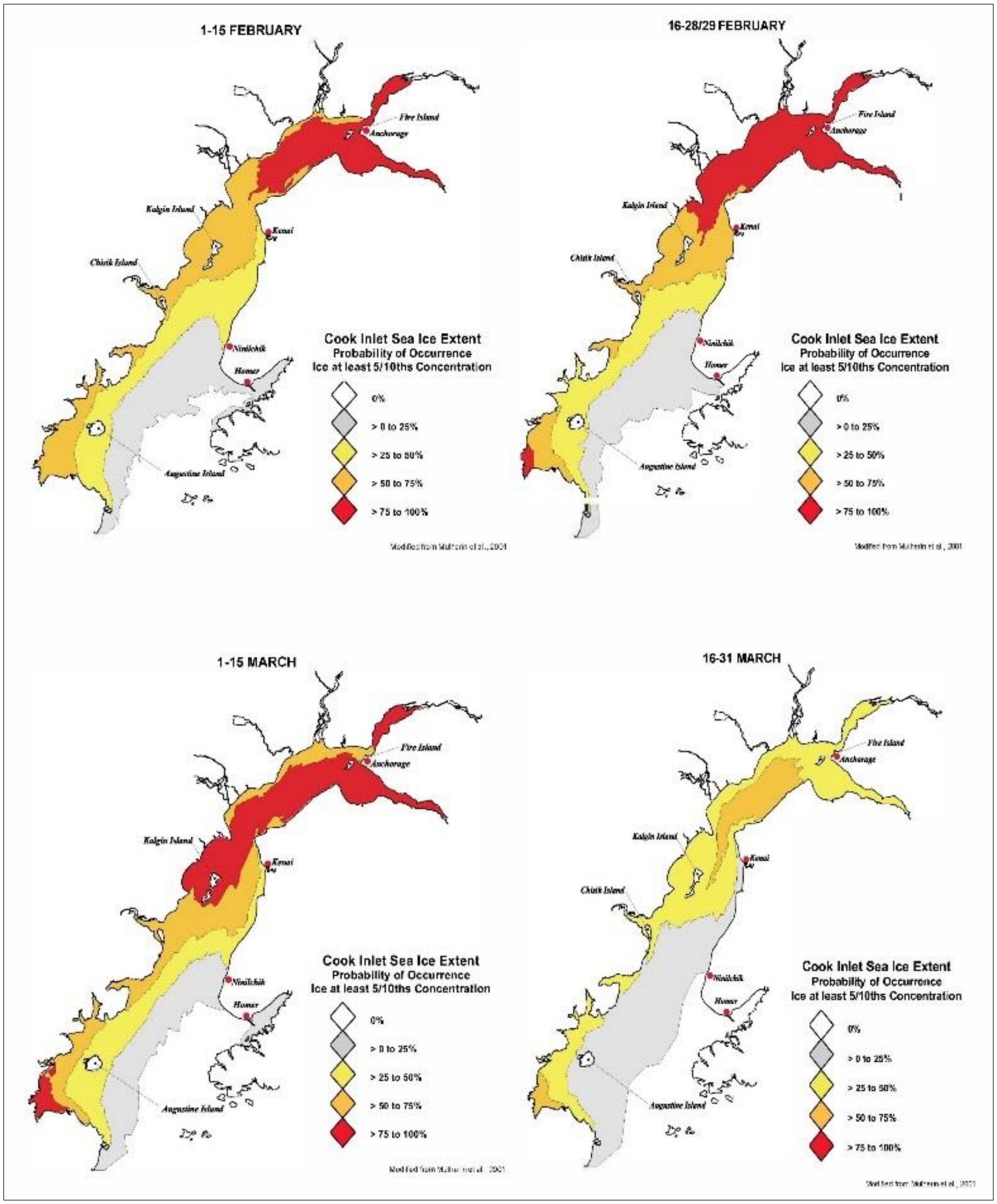


Figure 2.3.1-6a Probability of Occurrence 5/10ths Ice Concentration for February and March

For the purpose of the terminal site and approach area ice conditions analysis, the long-term (1985-2014) ice data were extracted at three locations (see Figure 2.3.1-7, Site: N60°39/ W151°25, S1: N60°30/ W151°30, S2: N60°15/ W151°30) from the Canatec ice database. Source data of the Canatec ice database is primarily based on National Ice Center (NIC) charts.

The database is in sea-ice gridded (SIGRID) format with 0.15 nautical mile grid size and at weekly intervals. Ice data extracted from the Canatec database includes ice concentration value (tenths) associated with each ice type as well as the total ice concentration. Ice types (different stage of ice development) include multi-year ice, second-year ice, and first-year ice (further categorized into five sub-types). Only the first-year ice is present in Cook Inlet.

Extreme ice thicknesses were assessed by carrying out an Extreme Value Analysis of the weekly high-end and the middle of the range of ice categories thicknesses at the site using the Canatec data. The analysis used Peaks-over-Threshold method and the Weibull probability distribution. Table 2.3.1-2 summarizes the estimated extreme ice thicknesses associated with return periods for the middle and high-end extreme ice thicknesses range. The 10-year and 100-year return period extreme ice thicknesses based on medium ice statistics were estimated to be approximately 27.4 inches and 35.4 inches, respectively. The high-end ice thickness, the 10-year and 100-year return period extreme ice thicknesses were estimated to be approximately 27.4 inches and 43.0 inches, respectively.

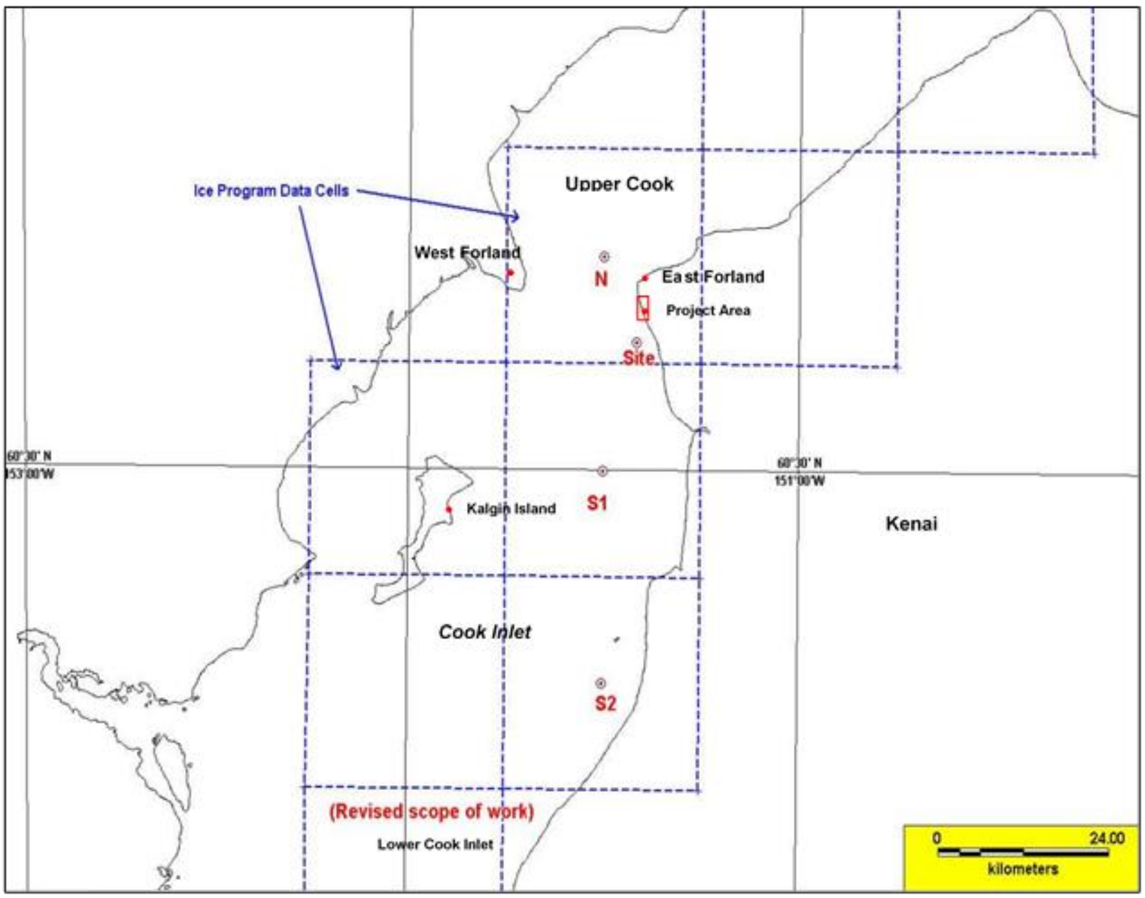


Figure 2.3.1-7 Canatec Ice Program DATA Cells and Extraction Locations Used

TABLE 2.3.1-2

Extreme Ice Thickness (Canatec, 1985–2014)

Return Period (years)	Medium Extreme Ice Thickness (inches)	High-End Extreme Ice Thickness (inches)
1	12.2	26.0
5	24.7	33.0
10	27.4	36.0
30	31.3	39.0
60	33.7	42.0
100	35.4	43.0

Other types of ice that form in Cook Inlet are beach, estuarine and river ice. Beach ice (also known as shorefast ice) starts forming when frozen mud is exposed to the air by the ebbing tide. At flood tide, water in contact with the frozen mud also freezes. It can float away during extreme high tides and circulate throughout the inlet. Beach ice conglomerates are generally dark and therefore can be more difficult to see than other forms of ice. Relatively thick beach ice is the last to melt in Cook Inlet in spring. Although blocks of floe ice generally reach a thickness of less than 3 feet in Cook Inlet, grounding of these blocks can form large piles (called Stamukhi). In the past, a single Stamukha was reported exceeding 40 feet in thickness (Combellick et al., 1995; Hutcheon, 1972b). Floating Stamukhi can represent the danger for the ships passing the inlet but have not been reported near terminal site in the last two decades.

Freshwater ice that forms in estuaries and rivers also occurs in Cook Inlet near Knik and Turnagain Arms. Estuarine ice has similar characteristics as pack ice (sea ice), but is considerably stronger and tends to remain firmly attached to the surrounding shoreline (Mulherin et al., 2001). Wind-driven turbulence that occurs in the upper Inlet (north of the Forelands) can entrained estuarine ice with moving pack ice, increasing the ice floe strength. River ice is significantly harder than sea ice and is unaffected by tidal action or wind until spring breakup. At that time, a considerable amount of river ice, with pieces up to 6 feet thick, may be discharged into the inlet (Hutcheon, 1972a).

2.3.1.2 Interdependent Project Facilities

2.3.1.2.1 Mainline

The Mainline is proposed to cross Cook Inlet between a location south of Shorty Creek (also referred to as Beluga Landing South Shore Approach, see Section 10.4.3.2 of Resource Report No. 10) near Tyonek and a location near Boulder Point (also referred to as Suneva Lake Shore Approach, see Section 10.4.3.2 of Resource Report No. 10) near Nikiski. A description of Cook Inlet is provided in Section 2.3.1.1. A description of conditions along the Mainline follows.

2.3.1.2.1.1 Water Depths

Water depths along the pipeline route range from 0.0 at each shore crossing to a maximum depth of approximately -139 feet at MLLW. Average water depth along the route is -80 feet MLLW. Most of the route is in water depths of -70 to -90 feet MLLW with the exceptions of the shore approaches and two locations where tidal channels have been incised into the seafloor to depths of approximately -140 feet and -130 feet respectively (Alaska LNG, 2015, 2016).

2.3.1.2.1.2 Tides, Waves, Circulation, and Currents

Numerous features have been mapped along the route that are indicative of the inlet's significant tidal currents, including sand waves, scour depressions, channeling, lag deposits, and boulder fields. The seafloor can generally be described as worn flat and current swept, interspersed with areas of sand waves, boulder fields, and channels. Several sand wave areas of 0.2 mile to more than 3.0 miles in length are traversed by the route. The sand waves are all oriented in a northeast-southwest dip direction paralleling the tidal currents. Wavelengths in the sand wave fields typically measure 40 to 50 feet, with some approaching 100 feet. Sand wave height is typically about 5 feet or more (Alaska LNG, 2016). Three distinct buried channels have also been mapped along the route centerline (Alaska LNG, 2016).

2.3.1.2.1.3 Sediments and Sedimentation

Boulders are found as isolated boulders or in boulder fields with shallow depressions in the seafloor that are apparently scoured by currents moving around the boulders (Alaska LNG, 2015). A number of erosional scarps have been mapped along the route corridor; the route crosses one scarp with a height of approximately 8 feet above the surrounding seafloor.

Sediment grab samples were collected at nine locations (out of 14 attempts) near the two shore crossings (Alaska LNG, 2015). With two exceptions, the preponderance of the samples consisted of rock, rock fragments, and coarse sand. The rocks were predominantly cobble and pebble in size and well rounded, suggestive of the high-energy environment. Two samples collected in relatively shallow water (16 to 22 feet) near the Shorty Creek landfall, were the only samples that consisted of fine sand and mud. Results of the sampling will be provided in the FERC application.

Nine magnetic anomalies were observed along the route during the geophysical surveys (Alaska LNG, 2016). All the anomalies are believed to represent debris that is either buried below the mudline, geologic in origin, and/or probably associated with construction, fishing, or industrial activities. Two unidentified sonar contacts were also observed along the route. One is approximately 2 feet wide and 15 feet long, and is exposed 1.5 feet above the seafloor. This contact is linear and could represent debris such as cable or pipe associated with modern industrial human activities in the area. The other contact is also linear and roughly 5 feet wide and 18 feet long with no visible relief above the seafloor. This object may also be cable or pipe debris.

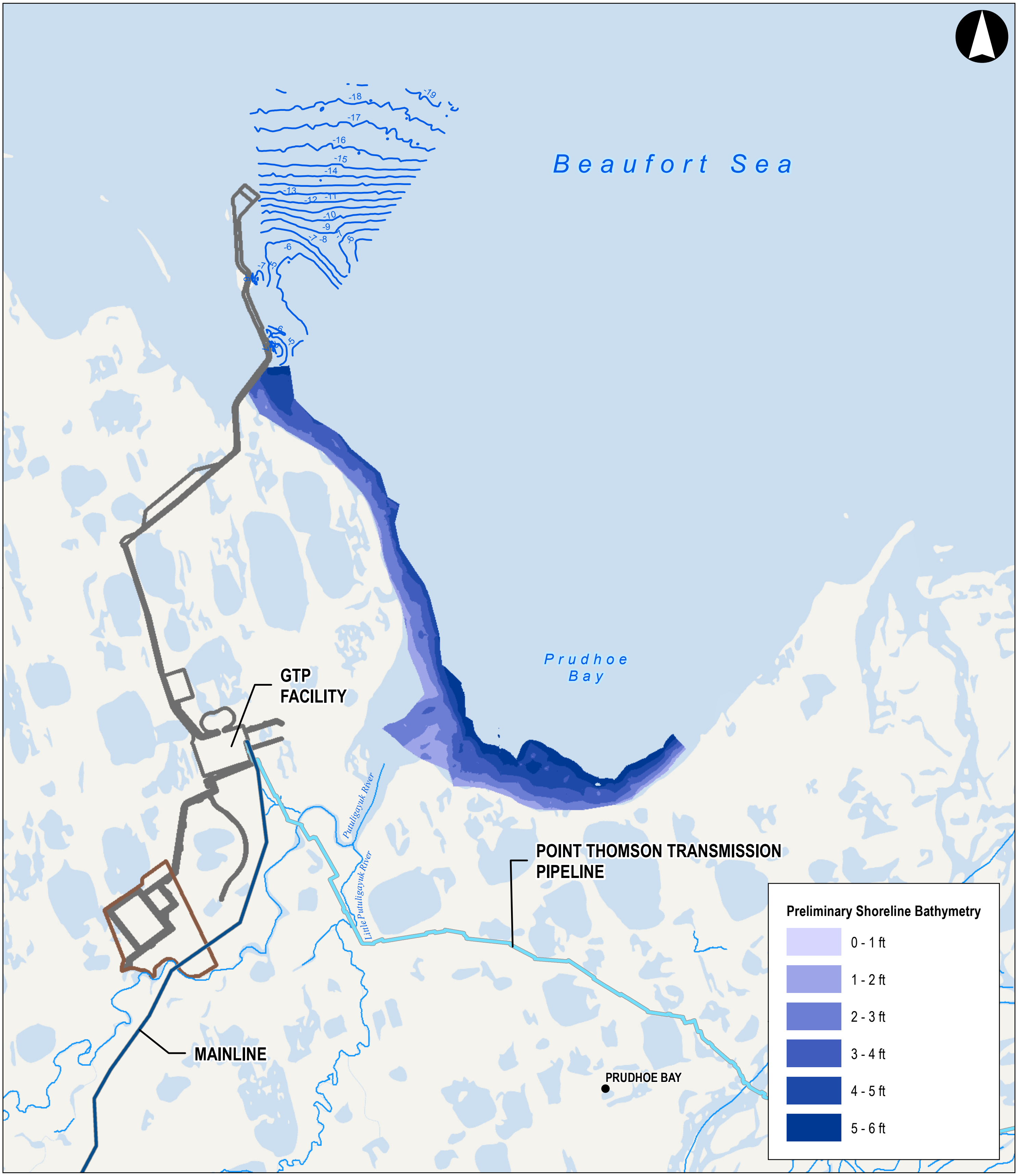
2.3.1.3 Prudhoe Bay Marine Environment

The proposed GTP would be located on the North Slope along the Beaufort Sea coast in the Kuparuk River watershed. The GTP Facilities and infrastructure would include upgrading and making use of the West Dock causeway located on the northwest corner of Prudhoe Bay, which is part of Stefansson Sound and the Beaufort Sea. Prudhoe Bay is a relatively shallow marine lagoon, situated south of a barrier island complex, although West Dock extends slightly past these barrier islands (NOAA, 2015d - Nautical Chart #16061).

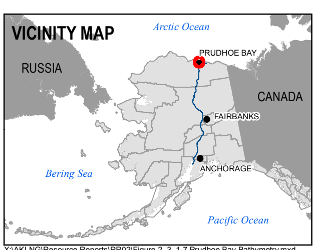
2.3.1.3.1 Water Depths

Water depths typically range between 1 and 10 feet in Prudhoe Bay, with West Dock extending into deeper water ranging from 10–15 feet deep (Figure 2.3.1-8). Barometric water level variation in this region often exceeds the local tidal range, even during quiescent periods with no storm activity. A 2008 NOAA technical report stated barometric pressure changes and wind stress significantly affect daily water levels (Sprenke et. al., 2011)

According to a study of North Slope sea level time series from 1993 to 2010 revealed no statistically significant trends in relative sea level, storm frequency, intensity and duration. The study reported that, glacial rebound is typical and an important factor in Arctic regions and seasonal trends in weather and currents, and decadal cycles are significant factors (Sultan et. al., 2010)



VICINITY MAP



X:\AKLNG\Resource Reports\RR02\Figure 2_3_1-7 Prudhoe Bay Bathymetry.mxd

LEGEND

- Alaska Place Names
- Alaska LNG Rev C2 Route
- West Dock Contours
- Major Highways
- Major Rivers
- GTP Facility
- Study Area

0 0.5 1 2 Miles

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PRUDHOE BAY BATHYMETRY

FIGURE 2.3.1-8

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2.3.1.3.2 Tides, Waves, Circulation, and Currents

At Prudhoe Bay (NOAA Station ID 9497645), the average tide ranges from 0.08 feet MLW to 0.59 feet MHW based on local MLLW datum, with a highest observed astronomical tide of 1.50 feet (NOAA, 2015e).

Storm surges (storm-induced wave run-up) in the Prudhoe Bay area can be large compared to the small tidal fluctuations. The 100-year return period water storm surge is estimated to be at +4.9 feet and the 100-year storm set-down is estimated to be -3.6 feet (both elevations relative to MLLW) (Sultan, et al., 2010). Positive storm surges are associated with westerly winds and negative storm surges are associated with easterly winds (ADNR, 2006). Wind-generated wave information is not well documented in Prudhoe Bay, although it would be depth-limited in the shallow waters around West Dock.

The circulation of water in Prudhoe Bay is not as well studied as that in Cook Inlet. However, in general the circulation patterns of the inner shelf of the Beaufort Sea are driven by wind, particularly in the summer (Aagaard, 1984, cited in Aagaard, et. al, 1989). Winter circulation is not as energetic but still has a wind component. The currents under ice are typically slow moving (about 0.16 feet/second) and weakly sheared and have no effect from the wind (Weingartner et al., 2005). The Beaufort undercurrent drives subsurface circulation eastward on the outer shelf, but the surface flow regime moves westward. There are frequent reversals in current direction (Aagaard et al., 1989).

2.3.1.3.3 Salinity and Temperatures

Salinity and temperatures were measured in the Prudhoe Bay vicinity from 1999–2007 as part of a larger study of the marine environment of the Alaskan Beaufort Sea (Weingartner et al., 2009). It was determined that these properties vary seasonally in response to annual events (ice formation and melting, spring breakup, and wind mixing during the open-water season). Both salinity and temperature were found in this study to follow an annual cyclic pattern.

Salinity generally increases from approximately 26 to 28 parts per thousand in September of each year to a maximum of approximately 33 to 34 parts per thousand in January due to ice formation forcing a concentration of salt into the remaining liquid water column. From January to May, salinity remains fairly consistent and then it begins to decrease in June due to the large amount of fresh water flowing offshore during spring break up. Salinity quickly drops to approximately 15 parts per thousand in August as wind is able to mix the fresh water into the full water column. It then recovers back to its September values to repeat the cycle.

Temperature generally remains at or below the freezing point from October through mid-July. As the open-water season begins, water temperatures increase to approximately 40 to 45 °F in July or August and fluctuate with weather patterns before returning to freezing conditions when the ice cover returns.

NOAA has maintained a weather and water data buoy at Prudhoe Bay and records are available online from 2005–present. Figure 2.3.1-9 shows the monthly mean and standard deviation of temperatures in Celsius from the data gathered from April 2005 to November 2012 (NOAA, 2015f).

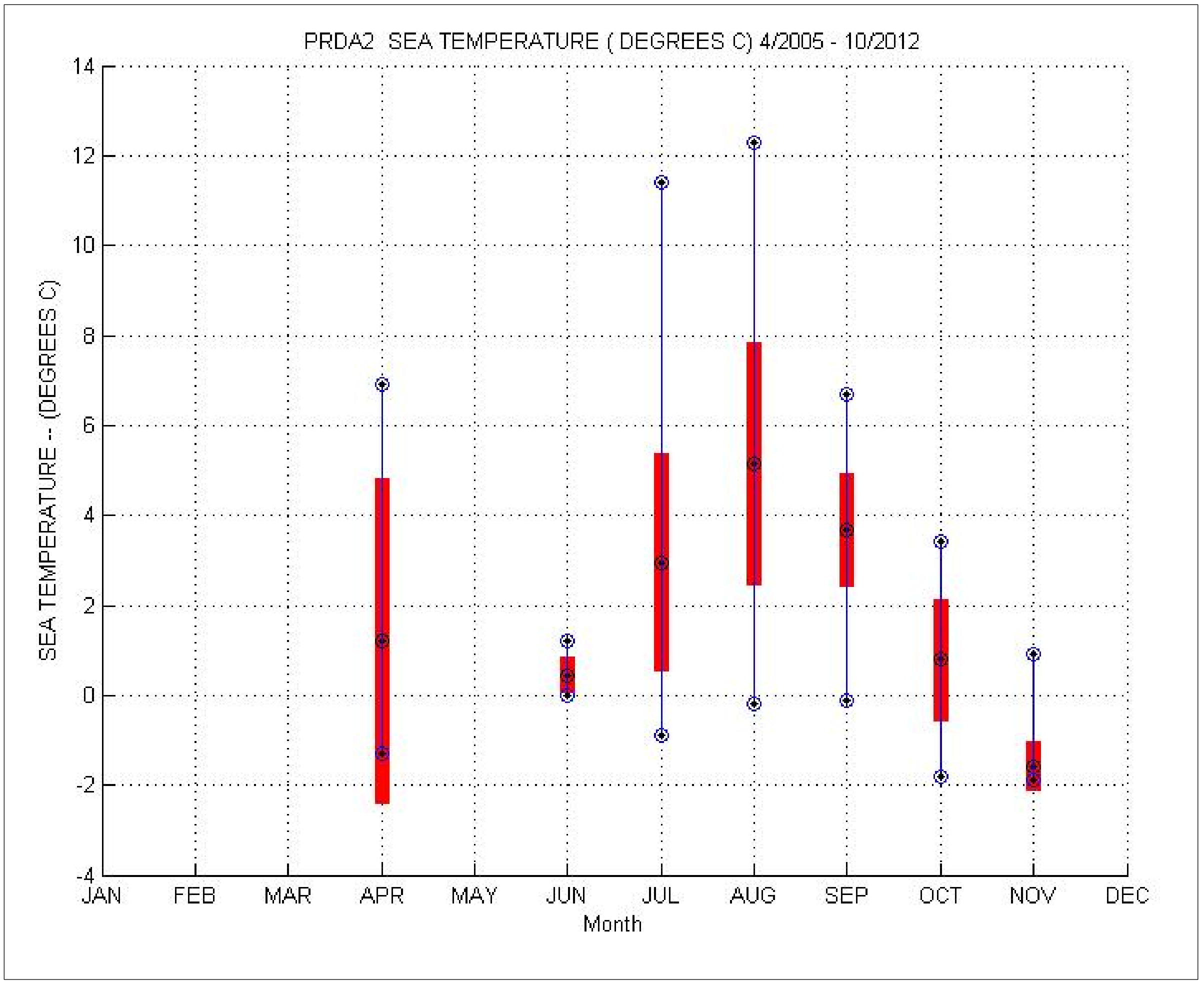


Figure 2.3.1-9 Mean Monthly Sea Temperatures Recorded at Prudhoe Bay (NOAA, 2015f)

2.3.1.3.4 Sediments and Sedimentation

A large contributor to the sediment cycle in the Beaufort Sea is the annual deposition of river-borne (e.g., Mackenzie and Sagavanirktok rivers) sediments during the spring breakup flood (Weingartner et al., 2009). This sediment is deposited beneath the floating ice cover during breakup, then re-suspended and transported during open-water storms due to wind-generated waves and longshore currents. In addition, when land-fast ice forms it contains large amounts of sediment, which then can be transported with this ice or returned to the local area as the ice melts in place the following summer.

The shoreline of the region is characterized by a chain of barrier islands fronting a low to moderately high tundra mainland coast. The mainland coast is predominantly low to moderately high bluffs (less than 10 feet high) and low-lying landscape (less than 6 feet high) associated with tapped thermokarst lakes and adjacent rivers, creeks, and drainages. Relatively higher bluffs (up to 15 feet high) are found only near Heald Point on the eastern coast of Prudhoe Bay. Narrow beaches are composed of fine-to-coarse sand and fine granular material. The beaches are frozen most of the year, thawing during the summer months but maintaining permafrost underneath the thawed active layer. Occasional erratic boulders up to 3 feet have been reported.

The barrier island coastal region includes Cross Island and the Midway Islands (Argo and Reindeer) located approximately 10 miles north of Prudhoe Bay and an approximately 40 miles long, nearly continuous barrier island chain that stretches between Stump Island and Thetis Island. The island chain trends southeast-northwest and increases in distance from the mainland from east to west, from about 0.6 mile near Stump Island to more than 5 miles at Thetis Island. Most of the islands are low-lying and unvegetated to sparsely vegetated. Coastal currents generated by the predominant northeasterly winds drive sediment westward while occasional northwesterly autumn storms drive sediment in the opposite direction, although westerly sediment transport prevails (Gibbs et al., 2015).

The coast of Prudhoe Bay, between Heald Point and Point McIntyre, is somewhat exposed to open-ocean energy conditions, although Cross and Reindeer-Midway Islands, located about 10 miles offshore, and the West Dock causeway, may dampen some incident wave energy. Between Point McIntyre and the Colville River, the mainland coast is separated from the barrier island chain by Gwydyr Bay and Simpson Lagoon (Gibbs et al., 2015).

There are a number of hypotheses that describe the origin and construction of barrier islands in the Arctic. Low-lying non-vegetated to vegetated barrier islands can form as emergent depositional shoals linked to the outer fringes of river deltas, or by recent (less than 1,000 years) deposition of longshore or cross-shore transported sediment including the breaching of spits connected to the mainland or other islands. Reimnitz and others (1990) describe an ice-shove process where sand and granular material is excavated by ice from the seabed in nearshore water depths and reformed into ridges along the shoreline.

Shoreline change rates along the mainland coast of Prudhoe Bay, between Heald Point and Point McIntyre, are predominantly erosional with rates averaging -2.6 feet per year and ranging from -8.2 to +3.6 feet per year. The only significant accretion (greater than +1.0 feet per year) was measured at Heald Point and is associated with the artificially hardened shoreline associated with oil and gas development (Gibbs et al., 2015). High turbidity and sediment movement would result in annual maintenance dredging for the Project during the summer to remove the infill of the channel.

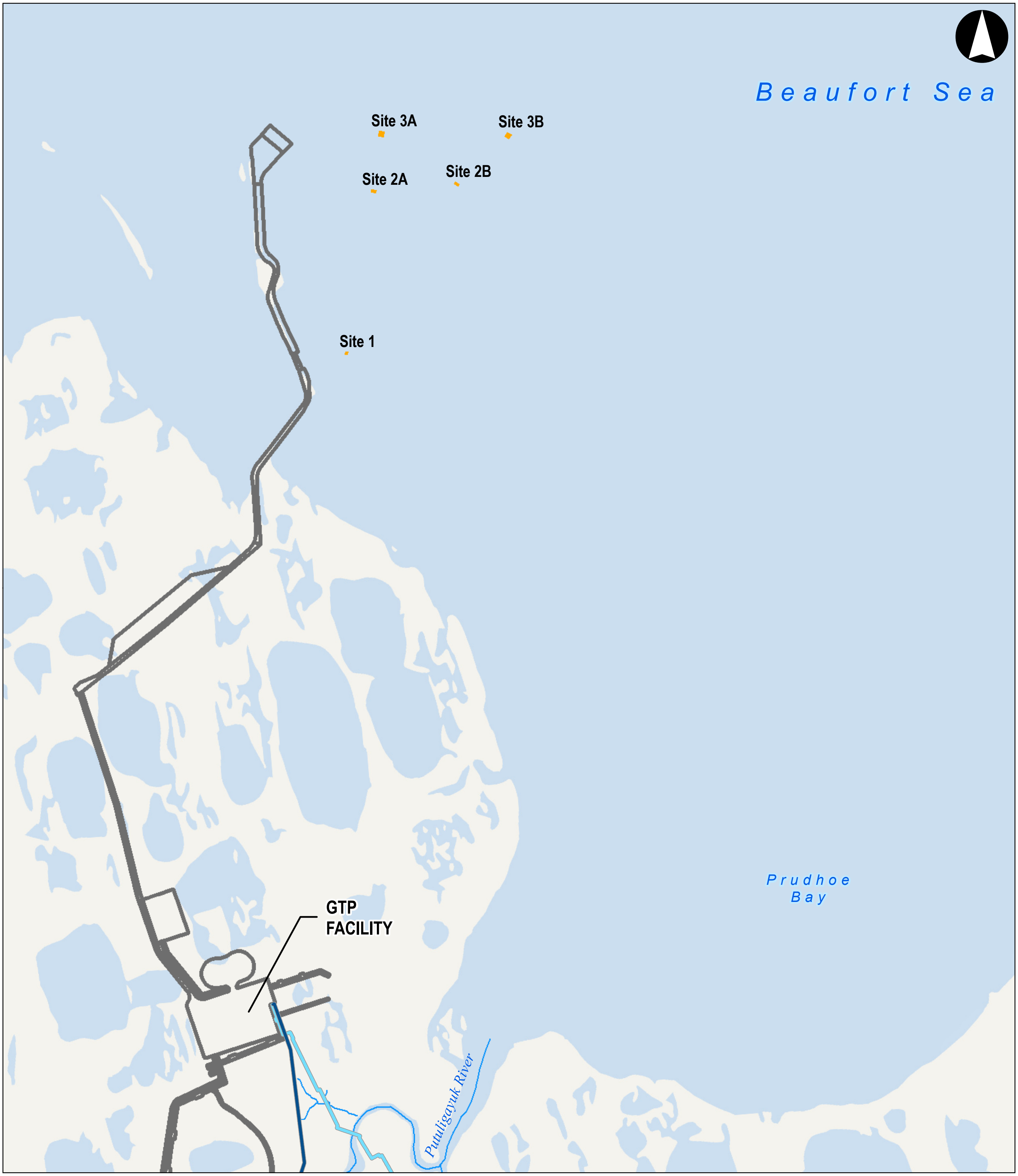
Sediment samples were collected (Alaska LNG, 2014b) in 2014 from five locations in Prudhoe Bay near West Dock where dredging would take place and analyzed them for physical and chemical parameters. Figure 2.3.1-9 depicts the sediment sampling locations near West Dock. The analytical results are presented in Appendix R. Metal concentrations were found to be below both the DMMP (USACE, 2014) screening levels and ADEC's recommended permissible exposure limits, and within the range of background sediments for the Beaufort Sea coastal area. Arsenic, copper, and nickel concentrations in some samples, exceeded their marine threshold effects levels; however, Beaufort Sea sediments are naturally high in these three metals, and the observed concentrations were well within the established range for background.

No evidence of petroleum contamination was observed in the samples; concentrations of both diesel range organics and residual range organics in all samples were found to be below ADEC-recommended soil cleanup levels for the Arctic. Polycyclic aromatic hydrocarbons (PAHs) were found to be low in all samples analyzed with all concentrations well below the DMMP screening levels and threshold effects levels and permissible exposure limits. Overall, concentrations of petroleum hydrocarbons in the sediment samples were found to be low and well within the range of natural background levels. Petroleum hydrocarbons concentrations were well below DMMP guidance and sediment quality guideline levels, and showed no evidence of anthropogenic inputs or contamination. Very low levels of pesticides were observed in some samples; however, generally, there was no indication of any contamination from chlorinated pesticides or polychlorinated biphenyls of the test trench sediments. These data support other recent findings that the West Dock area of Prudhoe Bay is generally free of contamination with metals or hydrocarbons (Oasis 2006, 2008).

2.3.1.3.5 Ice Conditions

Sea ice, a dominant feature of the Arctic marine environment, generally covers the Beaufort Sea shelf for about nine months of the year (October to June). Ice encroachments, referred to as "Ivu" in the local Inupiat language, occur when sea ice is forced onshore by strong wind or currents. The wind can push a sheet of ice or pile of debris forward (ride-up), or cause it to form a pile of ice near the shore (pile-up). Ivu events usually consist of a combination of pile-up and ride-up. Ice pile-up occurs when the incoming ice floe encroaches upon the shoreline and breaks into pieces forming a rubble pile. The ice floe then tends to continue failing at the same location causing a rubble pile to grow vertically and horizontally as rubble falls down the pile slopes. In contrast, ice ride-up occurs when the ice deforms plastically, or becomes broken without overturning, overrunning the land while remaining basically an intact ice sheet sometimes resulting in ice rubble and sediment being shoved as much as several hundred feet inland in extreme conditions (ADNR, 2009; USDOI, 2003a).

While the Prudhoe Bay area is somewhat protected by barrier islands, ice pileup has been known to occur on the West Dock causeway, where ice rubble up to 20 feet high was reported in the late 1970s (Kovacs, 1983). Generally, landfast sea ice protects the coastline from Ivu events and limits coastal erosion. However, Arctic coastal communities recognize that sea ice conditions are not what they once were; the ocean is freezing later in the fall and the ice is melting earlier in the spring; landfast ice is less stable; there is far less of the thicker multiyear ice than in the past; and environmental conditions overall are less predictable. The formation and breakup of the landfast ice appears to be a complex interaction of several forces in any number of combinations. These forces may include wind vectors, currents, storm surges, pieces of moving ice floes acting like a chisel ("tuuq" in Inupiat) on the landfast ice, a sudden drop in sea level, tides, ice-surface melt and bottom melt, and the weak points in shorefast ice where new sections of ice were most recently added. Figures 2.3.1-11 and Figure 2.3.12 depicts ice conditions for Prudhoe Bay for the years of 2015 and 2016.



LEGEND

- Sediment Sample Location (AKLNG 2014b)
- Alaska LNG Rev C2 Route
- Point Thomson Transmission Line (PTTL)
- Major Rivers
- GTP Facility

0 0.5 1 Miles

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SEDIMENT SAMPLE LOCATIONS IN PRUDHOE BAY NEAR WEST DOCK

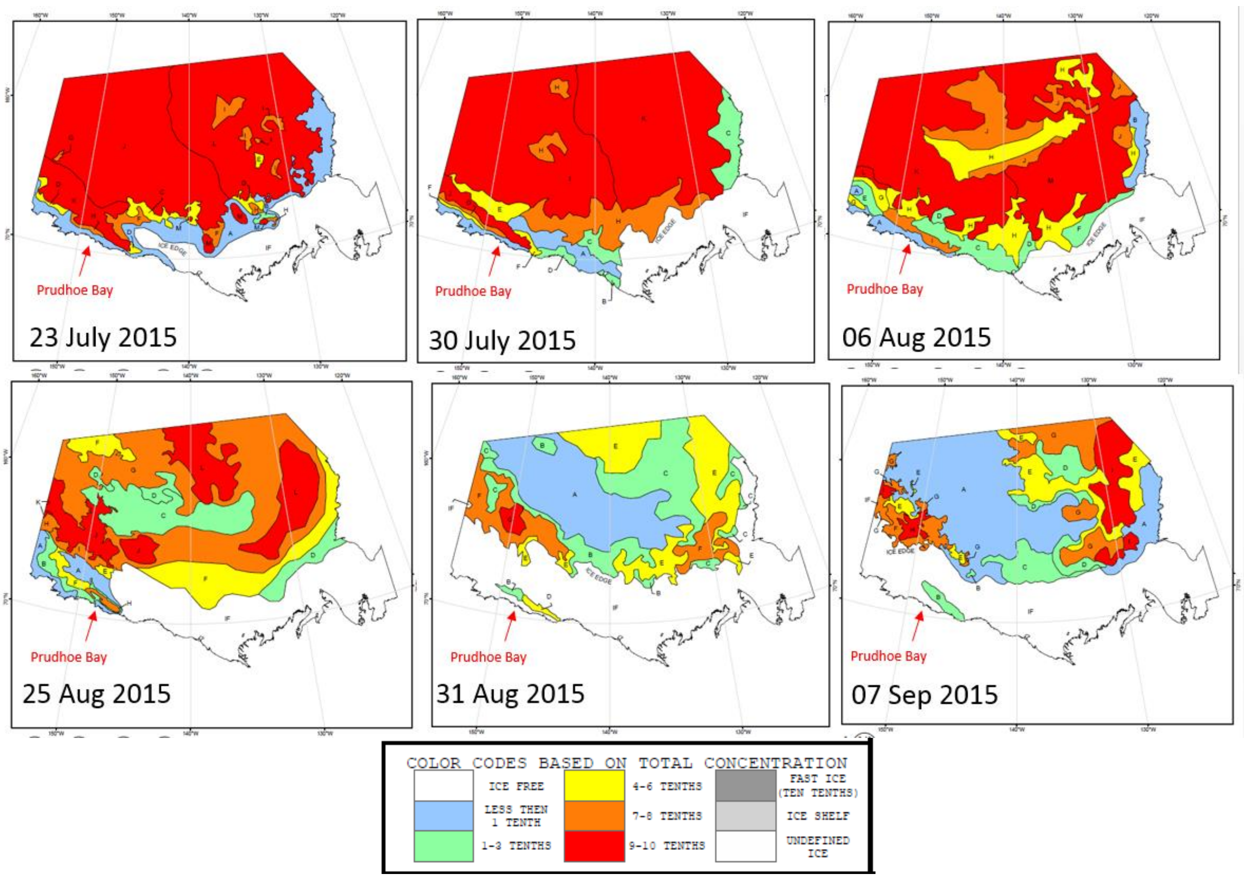
FIGURE 2.3.1-10

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_3_1-9 Sediment Sample Locations in Prudhoe Bay Near West Dock.mxd

Typically, grounded ice only extends to depths of 6 or 7 feet. In the spring, floating landfast ice can extend up to about 40 miles from the shore (USDOI, 2003a). In the summer, the ice pack retreats up to 50 miles from shore, but winds can bring floes back at any time (LGL Alaska Research Associates, Inc. et al., 1998). Seaward of the landfast ice is the Stamukhi zone, or shear zone, where the mobile pack ice covering the Arctic Ocean grinds from east to west past the landfast ice. Generally lying within 60 and 100 feet of water depth, intense ice gouging of the seafloor can occur from ice ridges and keels moved by the mobile pack (ADNR, 2009).

Figure 2.3.1-11 Selected NIC Weekly Ice Charts, Summer 2015



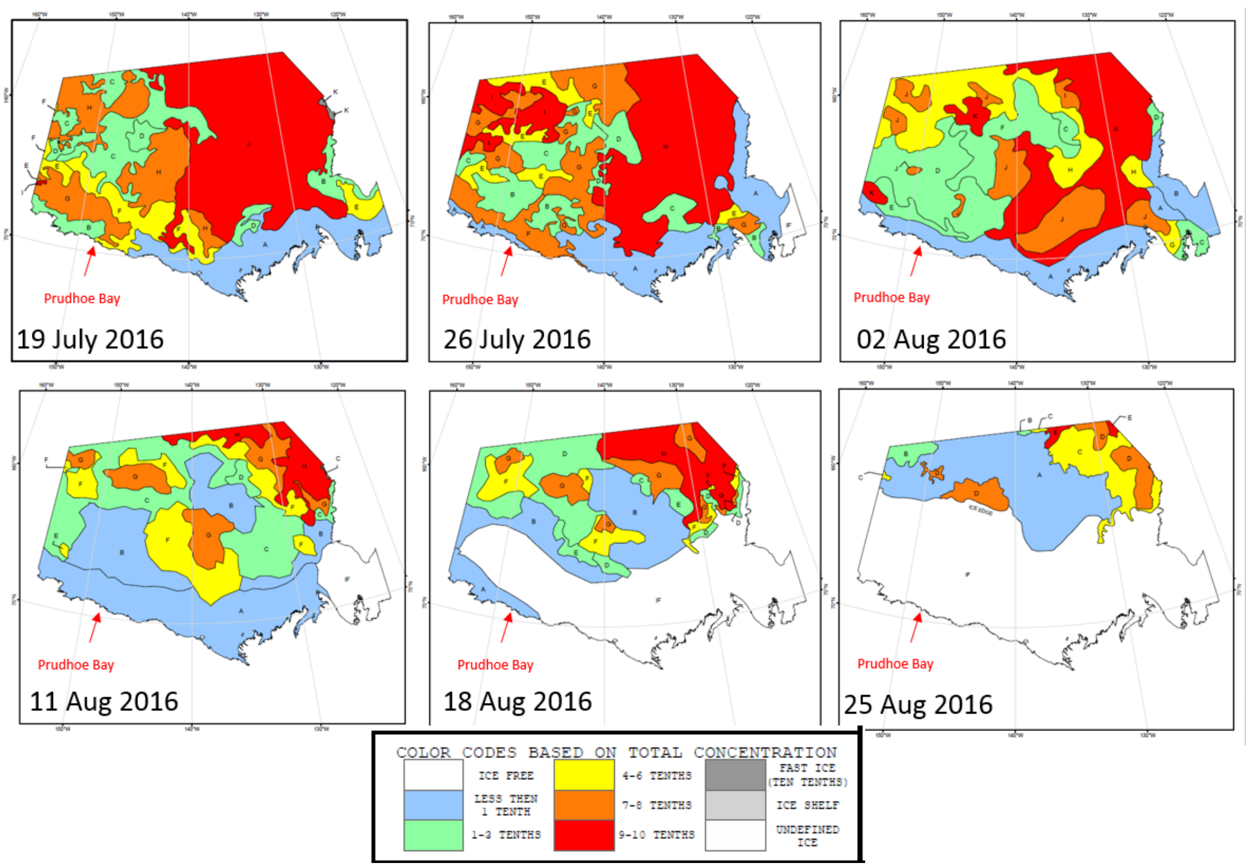


Figure 2.3.1-12 Selected NIC Weekly Ice Charts, Summer 2016

2.3.2 Fresh Water Resources

2.3.2.1 Watersheds

Watersheds in Alaska are delineated by USGS using a hierarchal system that defines drainage areas for surface water. Hydrologic Unit Code (HUC) is a unique numeric identifier that describes the level of drainage subdivision (i.e., first-level [region] is a two-digit HUC; second-level [subregion] is a 4-digit HUC; etc.) and geographic location of a watershed. A hydrologic unit can accept water directly from upstream drainages and indirectly from associated surface areas with a single or multiple outlet points (NRCS, 2007).

Watersheds crossed by the proposed Project facilities were identified by using a third-level (basin) 6-digit HUC and a fourth-level (subbasin) 8-digit HUC. Project facilities would be located within 12 third-level basins (HUC6) and 21 watersheds defined at a fourth-level subbasin (HUC8). State and Federal agencies use an 8-digit HUC for watershed management, assessment, and planning (AS 46.15.035). Table 2.3.2-1 lists the HUC6 and HUC8 watersheds that would be crossed by the Project.

TABLE 2.3.2-1

Basins and Subbasins Cross by the Project

Facility Name	Borough/Census Area	Basin Name	Subbasin Name	Milepost of Drainage Area Crossed
Liquefaction Facility and Associated Infrastructure				
LNG Plant	Kenai Peninsula Borough	Kenai Peninsula	Upper Kenai Peninsula	806.6
Marine Terminal	Kenai Peninsula Borough	Kenai Peninsula	Upper Kenai Peninsula	-
Pipelines and Associated Infrastructure				
Mainline Associated Infrastructure	North Slope Borough	Prudhoe Bay	Sagavanirktok River	11.4
			Kuparuk River	0-0
		Koyukuk River	Upper Koyukuk River	177.3
		Colville River	Lower Colville River	137.7
		Chandalar-Christian River	Middle Fork-North Fork Chandalar Rivers	169.9
	Yukon-Koyukuk Census Area	Koyukuk River	Upper Koyukuk River	182.6
			South Fork Koyukuk River	257.8
			Kanuti River	303.6
		Beaver Creek-Yukon River	Yukon Flats-Yukon River	315.5
			Ramparts-Yukon River	324.7
		Tanana River	Tolovana River	394.0
			Lower Tanana River	466.6
			Nenana River	473.2
	Fairbanks North Star Borough	Tanana River	Tolovana River	421.9
			Chena River	445.2
	Denali Borough	Tanana River	Nenana River	488.9
	Matanuska-Susitna Borough	Tanana River	Nenana River	575.1
		Susitna River	Chulitna River	579.2
			Lower Susitna River	661.0
			Yentna River	720.6
		Knik Arm	Anchorage	709.8
		Western Cook Inlet	Redoubt-Trading Bays	745.6
	Kenai Peninsula Borough	Western Cook Inlet	Redoubt-Trading Bays	752.6
		Kenai Peninsula	Upper Kenai Peninsula	793.2
Mainline ROW	North Slope Borough	Prudhoe Bay	Sagavanirktok River	20.4 -169.9
			Kuparuk River	0 -137.4
		Koyukuk River	Upper Koyukuk River	177.3 -182.4
		Colville River	Lower Colville River	137.4 -138.4
		Chandalar-Christian River	Middle Fork-North Fork Chandalar Rivers	169.9 -177.3
	Yukon-Koyukuk Census Area	Koyukuk River	Upper Koyukuk River	182.4 - 257.8
			South Fork Koyukuk River	257.8 - 303.6
			Kanuti River	303.6 - 315.3
		Beaver Creek-Yukon River	Yukon Flats-Yukon River	315.3 - 324.7
			Ramparts-Yukon River	324.7- 394
		Tanana River	Tolovana River	394 - 466.6
			Lower Tanana River	466.6 - 473.2
			Nenana River	473.2 - 488.6

TABLE 2.3.2-1

Basins and Subbasins Cross by the Project

Facility Name	Borough/Census Area	Basin Name	Subbasin Name	Milepost of Drainage Area Crossed
	Fairbanks North Star Borough	Tanana River	Tolovana River	421.9 - 424.3
	Denali Borough	Tanana River	Nenana River	488.6 - 575.4
	Matanuska-Susitna Borough	Tanana River	Nenana River	575.4 - 579.6
		Susitna River	Chulitna River	579.6 - 660.9
			Lower Susitna River	660.9 - 748.1
			Yentna River	720.6 - 721.9
		Western Cook Inlet	Redoubt-Trading Bays	748.1 - 755.3
	Kenai Peninsula Borough	Cook Inlet	Cook Inlet	767 - 791.2
		Western Cook Inlet	Redoubt-Trading Bays	755.3 - 767
		Kenai Peninsula	Upper Kenai Peninsula	791.2 - 806.6
PBTL	North Slope Borough	Prudhoe Bay	Kuparuk River	0-0
PTTL Associated Infrastructure	North Slope Borough	Eastern Arctic	Canning River	0-0
		Prudhoe Bay	Mikkelson Bay	1.8
			Sagavanirktok River	38.9
			Kuparuk River	56.8
PTTL ROW	North Slope Borough	Eastern Arctic	Canning River	0 - 1
		Prudhoe Bay	Mikkelson Bay	1-37
			Sagavanirktok River	37-56
			Kuparuk River	56 - 62.5
GTP and GTP Associated Infrastructure				
GTP	North Slope Borough	Prudhoe Bay	Kuparuk River	-

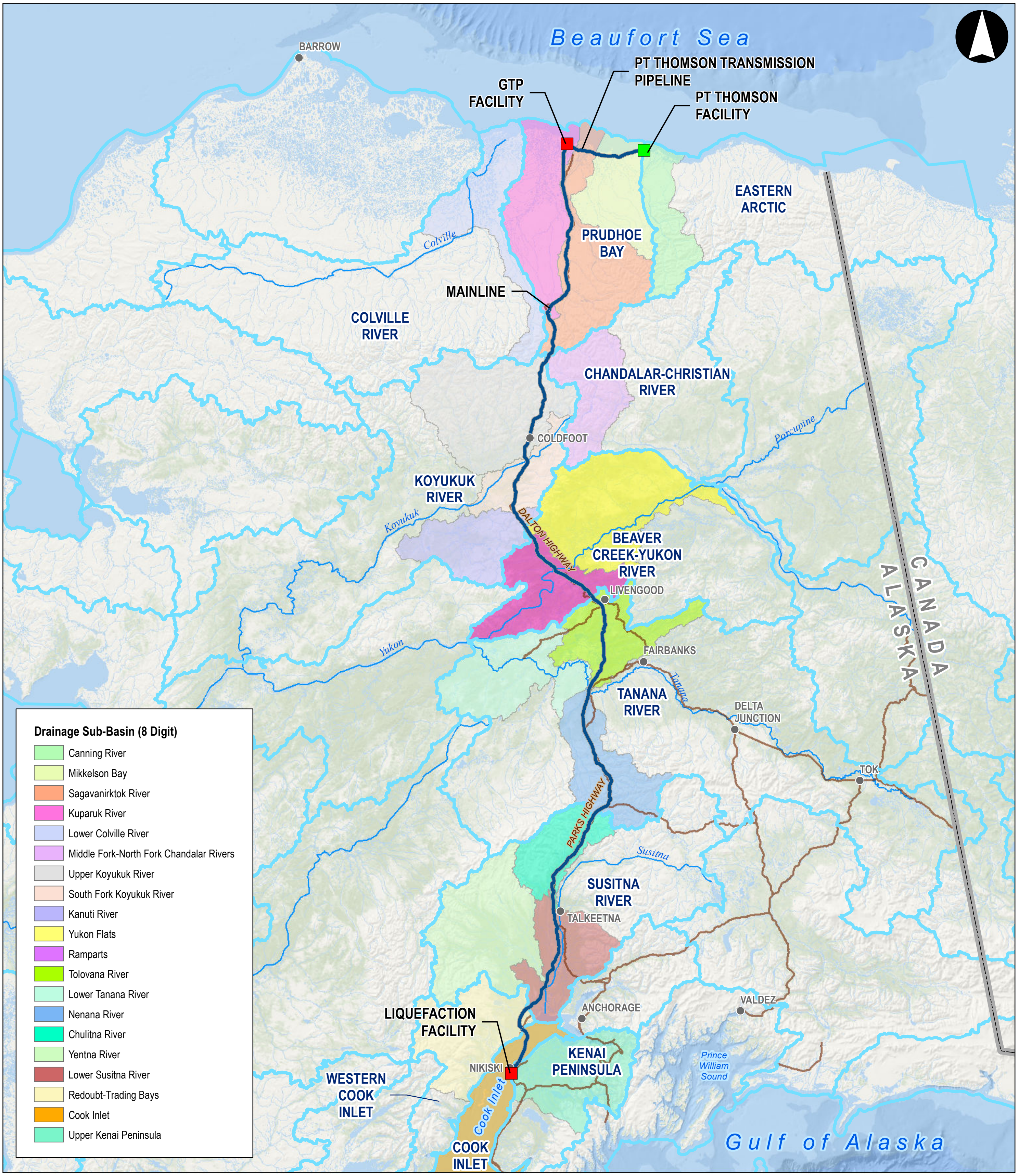
The Project crosses 12 major hydrologic basins and 21 watersheds in Alaska (Figure 2.3.2-1). These basins are identified based on the primary river, waterbody or physiographic area within the basin, as described subsequently from north to south:

- Eastern Arctic basin includes the Canning River watershed that carries runoff from the Beaufort Coastal Plain ecoregion to the (Alaskan) Beaufort Sea;
- Prudhoe Bay basin includes the Kuparuk River, Sagavanirktok River and Mikkelson Bay watersheds that drain into the Beaufort Sea;
- Colville River basin and Lower Colville River watershed is within the Brooks Foothills and drains to the Beaufort Sea;
- Chandalar-Christian River basin includes the Middle Fork-North Fork Chandalar Rivers watershed that flows downstream into the Yukon River northeast of Fairbanks;
- Koyukuk River basin includes watersheds of Upper Koyukuk River, South Fork Koyukuk River and Kanuti River north of Fairbanks;

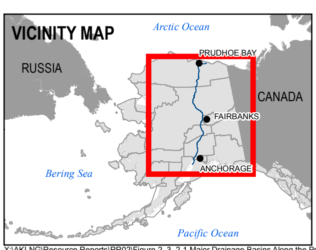
- Beaver Creek-Yukon River basin includes Yukon Flats and Ramparts watersheds that drains an area north of Fairbanks and terminates in the Bering Sea far to the west of the Project;
- Tanana River basin includes Tolovana River, Lower Tanana River, Chena River and Nenana River watersheds drain into the Yukon River near Fairbanks;
- Susitna River basin drains to upper Cook Inlet and contains the Chulitna River, Lower Susitna River, and Yentna River watersheds;
- Knik Arm basin drains into upper Cook Inlet and includes the Anchorage watershed;
- West Cook Inlet basin includes the Redoubt-Trading Bays watershed that drains into upper Cook Inlet;
- Cook Inlet basin includes Cook Inlet watershed; and
- Kenai Peninsula basin includes the Upper Kenai Peninsula watershed that drains directly to Cook Inlet.

Watersheds have diverse physical landscape geomorphic features that can affect the amount of suspended material in the water that can then cause the water to be cloudy or turbid. Natural sources of material include sediment from the weathering of rocks and mass wasting (e.g., glacial outwash), dead plant material, and phytoplankton. Human-caused sources include substances in stormwater from urban areas (e.g. roads, parking lots), upland industrial activities, construction and land clearing, and activities occurring directly in water bodies such as powerboat use and vehicle use. Turbidity may vary over time, seasonally, or on a geographic basis depending on differences in precipitation, gradient (slope), geology, flow, and disturbances such as landslides (ADEC, 2016).

A description of the major drainage basins crossed by the Project and the surface water quality characteristics of the waterbodies within the basins are discussed in the following sections based on USGS information. The regional basins and subbasins that would be crossed by the Project are listed in Table 2.3.2-1 along with the approximate pipeline feature mileposts and depicted in Figure 2.3.2-1.



VICINITY MAP



LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Major Highways
- Major Rivers
- Drainage Basin Boundary (6 Digit)

0 25 50 100 Miles

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MAJOR DRAINAGE BASINS ALONG THE PROJECT ALIGNMENT

FIGURE 2.3.2-1

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_3_2-1 Major Drainage Basins Along the Project Alignment.mxd

2.3.2.2 Liquefaction Facility

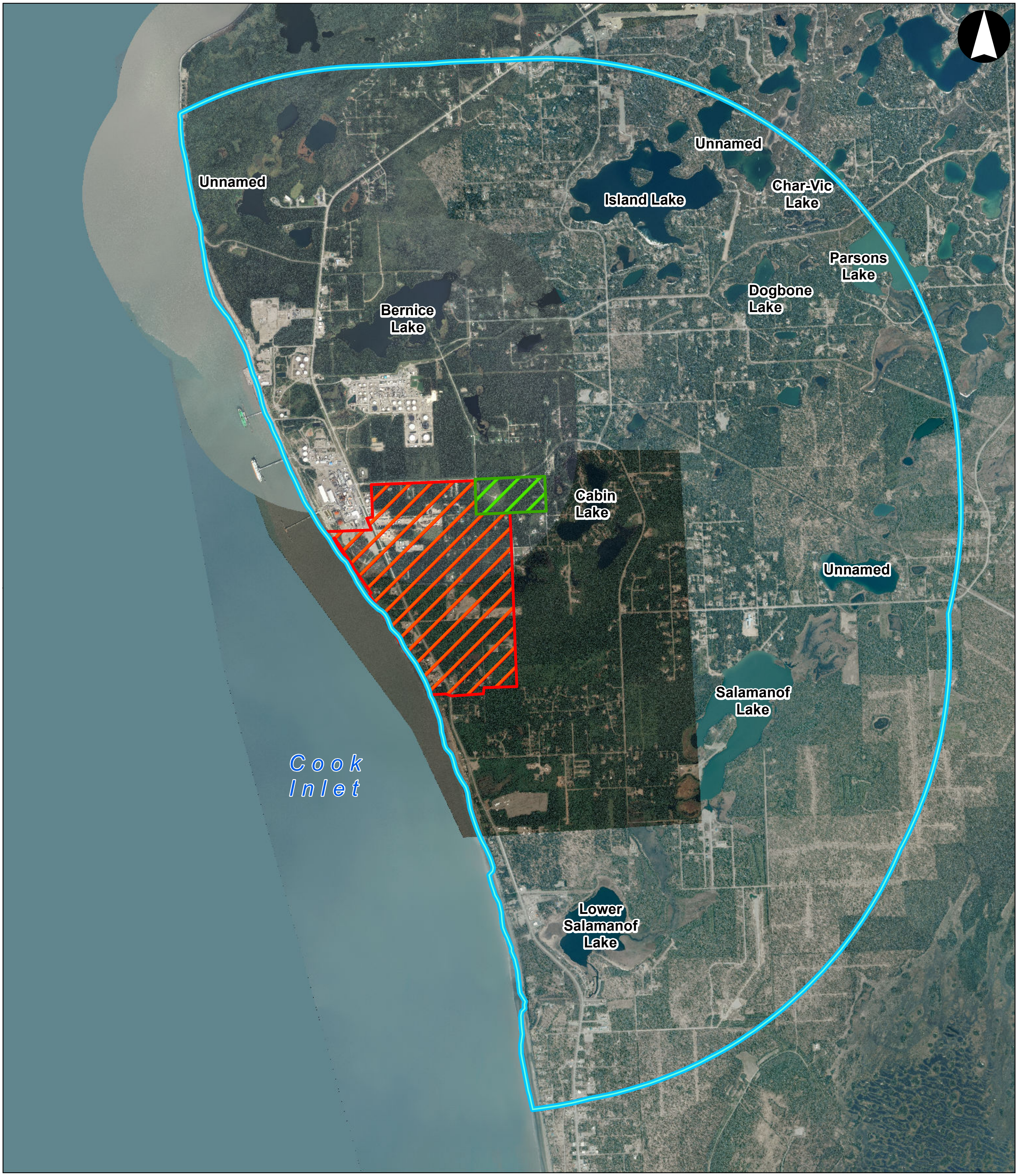
2.3.2.2.1 LNG Plant

The LNG Plant would be located on the upland area in the Upper Kenai Peninsula subbasin near Nikiski, within the Kenai Peninsula basin. Glacial rivers and non-glacial streams, along with numerous ponds, lakes, and wetlands, contribute to the hydrology of the Kenai Peninsula basin. The Kenai Peninsula basin receives approximately 15–30 inches of precipitation annually (KPB, 2008).

No freshwater resources are identified within the actual LNG Plant footprint. Figure 2.3.2-2 depicts the small lakes in the Nikiski area within approximately 3 miles of the Liquefaction Facility. The closest lake, Cabin Lake, is located approximately 0.5 mile east of the proposed LNG Plant.

2.3.2.2.2 Marine Terminal

The Marine Terminal would be positioned within the Upper Kenai Peninsula watershed. This subbasin includes the tidal zones with the low-lying uplands adjacent to the beaches and rocky intertidal areas are intermixed with mudflats, beaches, and benthic environments. The watershed drains into the Cook Inlet basin. Cook Inlet watershed is a confluence of fresh water from surrounding basins and seawater. The Marine Terminal is located approximately 10 miles north of the Kenai River—the only major river in the area—but the most popular sport fishing destination in Alaska (ADF&G, 2015a).



LEGEND

3 Mile Facility Radius - Onshore

Liquefaction Facility Area

LNG Operations Area

LNG Construction Camp

0 1,500 3,000 6,000 Feet

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LAKES WITHIN 3 MILES OF LIQUEFACTION FACILITY

FIGURE 2.3.2-2

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_3_2-3 Lakes within 3 miles of Liquefaction Facility.mxd

2.3.2.3 Interdependent Project Facilities

2.3.2.3.1 Mainline

The Mainline would cross 10 basins starting in the Arctic with Prudhoe Bay, Colville River, Chandalar-Christian River, continuing south into the Interior crossing the Koyukuk River, Beaver Creek-Yukon River, Tanana River, continuing through Southcentral crossing Susitna River, Western Cook Inlet, Cook Inlet, and terminating at the Liquefaction Facility in the Kenai Peninsula drainage basin. The following sections discuss surface water resources crossed by Mainline, Pipeline Aboveground Facilities, and Associated Infrastructure.

2.3.2.3.1.1 Prudhoe Bay and Colville River Basins

Prudhoe Bay and Colville River drainage basins originate in the Brooks Range, flowing north through the Brooks Foothills and Beaufort Coastal Plain ecoregions into the Beaufort Sea. The landscape of the Beaufort Coastal Plain ecoregion is dominated by wetlands, lakes, tundra ponds, and streams. The terrain consists of nearly flat and poorly drained low-lying tundra that gradually rises to the south with an average gradient of about 10 feet per mile.

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 Brooks Foothills and Brooks Range ecoregions. 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 major tributary to the Sagavanirktok River along the Mainline corridor is the Atigun River, which has its headwaters in the Brooks Range. Fall storm events in the Brooks Range can cause extensive flooding and erosion of the major rivers such as the Sagavanirktok. One other river along the corridor, the Putuligayuk River, is a short stream system less than 30 miles in length, discharging directly into the Beaufort Sea west of the Sagavanirktok. The Putuligayuk River is saline-affected near the coast, especially during storm surges and in winter.

The Kuparuk River has a main river length of 183 miles and a drainage basin covering 4,672 square miles. The river's estimated annual flow is 1,830 cubic feet per second on average. The Kuparuk River and its principal tributary along the Mainline corridor, the Toolik River, originate in the rolling northern foothills of the Brooks Range. The Toolik River drains 1,181 square miles, has a mainstream length of 101 miles, and an estimated average annual flow of 590 cubic feet per second.

Mainline would cross approximately 170-miles through the Sagavanirktok River and Kuparuk River watersheds located in the Prudhoe Bay basin. A small portion (1 mile) of the pipeline would cross the Lower Colville watershed in the Colville River basin.

2.3.2.3.1.2 Koyukuk and Chandalar-Christian River Basins

The Koyukuk River and Chandalar-Christian River basins would be crossed by the Mainline corridor. Watersheds of the Upper Koyukuk River, South Fork Koyukuk River, Kanuti River, and Middle Fork-North Fork Chandalar Rivers would be crossed by the Project. 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 zones of major rivers and streams. Peak runoff is the result of spring snowmelt and precipitation during the summer. The rivers in this region are virtually inactive from October to April. Although some degree of seasonality is typical of most large rivers, this phenomenon is especially pronounced in Arctic and Subarctic rivers.

The Middle Fork-North Fork Chandalar Rivers watershed would be 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 Yukon Basin is situated between the Eastern Arctic Basin and the Koyukuk Basin in more gently rolling topography on the north and south sides of the mainstream of the Yukon River. The Yukon Basin is rimmed by mountainous terrain from the confluence with the Tanana River upstream all the way 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.

2.3.2.3.1.3 Beaver Creek-Yukon River Basin

Beaver Creek-Yukon River basin would be crossed by the Mainline corridor in the watersheds of Yukon Flats and Rampart.

Mean annual runoff throughout much of this basin is very low, less than 0.5 cubic feet per second per square mile in the lowland areas. Along the northern periphery of the Yukon Basin, the runoff increases to nearly 2 cubic feet per second 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 May and September. Generally, snowmelt occurs earlier in this time frame and river levels rise. River levels generally decrease after snowmelt and then rise again in response to glacier melt (where it is present) and seasonal rainfall. In locations where glaciers are present in the basin, the rise is generally prolonged. Where the rise is the result of rainfall, it may be prolonged or short, depending upon storm patterns.

2.3.2.3.1.4 Tanana River Basin

The Tanana River basin consists of: the Tolovana River, Lower Tanana River, and Chena River; Salcha, Kantishna, and Nenana Rivers; the Tanana Flats, Delta River, Healy Lake, Tok, and Nebesna-Chisana Rivers subbasins. Approximately 186 miles of the Mainline corridor intersects the Tanana River basin via the Tolovana River, Lower Tanana River and Nenana River watersheds.

2.3.2.3.1.5 Susitna River Basin

The Susitna River basin is composed of the Upper Susitna River, Yentna River, Lower Susitna River, Chulitna River, and Talkeetna River subbasins. Approximately 170 miles of the Mainline corridor would run through the Susitna River basin via the Chulitna River, Yentna River, and Lower Susitna River watersheds.

2.3.2.3.1.6 West Cook Inlet Basin

The West Cook Inlet basin is composed of the Redoubt-Trading Bays and Tuxedni-Kamishak Bays subbasins. A small portion (19 miles) of the Mainline corridor would run through the Western Cook Inlet basin via the Redoubt-Trading Bay watershed.

2.3.2.3.1.7 Cook Inlet and Kenai Peninsula Basins

A small portion of the Mainline corridor would also run through this basin via the Cook Inlet watershed terminating at the Liquefaction Facility within the Kenai Peninsula Basin. The hydraulic characteristics of these basins and subbasin were described previously (see Section 2.3.2).

2.3.2.3.2 Prudhoe Bay Transmission Line

Surface water recourses located near the PBTL consists of small tundra ponds and shallow lakes within the Kuparuk River watershed as previously discussed in Section 2.3.2.3.1. The nearest waterbody is the Putuligayuk River, a short stream system less than 30 miles in length, discharging directly into the Beaufort Sea west of the Sagavanirktok River.

2.3.2.3.3 Point Thomson Transmission Line

Surface water resources along the PTTL corridor occur in the Eastern Arctic and Prudhoe Bay drainage basins, which includes the Canning River, Mikkelson Bay, and Sagavanirktok River subbasins. Two main waterbodies that would be crossed by the proposed Project are the Shaviovik and Kadleroshilik rivers within the Mikkelson Bay watershed, along with a number of unnamed surface water features.

The Shaviovik River is a braided stream system with headwaters flowing from the eastern Brooks Range, north through the Beaufort Coastal Plain ecoregion discharging into the Beaufort Sea. The Kadleroshilik River is a coastal stream system that originates in the Brooks Foothills flowing north through the Beaufort Coastal Plain ecoregion, discharging into Foggy Island Bay located in the Beaufort Sea.

2.3.2.3.4 Gas Treatment Plant

Surface water resources near the GTP facility are limited primarily to the Putuligayuk River. Lakes and tundra ponds located near the GTP facility are generally too small and shallow to provide significant volumes of water. During winter construction activities, these lakes may be used as a source of ice chips. Figure 2.3.2-3 depicts the lakes within approximately 3 miles of the GTP facility.

As previously stated (see Section 2.2.4.1), the Arctic region is underlain by continuous permafrost that limits groundwater-surface water (GW-SW) hydraulic connectivity to interactions between the shallow active layer and suprapermafrost water via open taliks (unfrozen zones), or restricted to permeable zones such faults or springs (Kane et al., 2012).

2.3.2.4 Non-Jurisdictional Facilities

The Kenai Spur Highway relocation project would be located within the Upper Kenai Peninsula watershed. Water quality characteristics are the same as those described for the Liquefaction Facility. The PBU MGS project and PTU Expansion project would be located within the Prudhoe Bay and Eastern Arctic watersheds, respectively, as described above.

VICINITY MAP

LEGEND

GTP Facility

3 Mile Facility Radius - Onshore

0 2,500 5,000 10,000 Feet

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LAKES WITHIN 3 MILES OF GAS TREATMENT PLANT

FIGURE 2.3.2-3

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_3_2-4 Lakes within 3 Miles of the Gas Treatment Plant.mxd

2.3.3 Surface Water Quality

Surface water quality standards are promulgated at the state and federal level to protect marine waterbodies from degradation because of discharges of pollutants or other materials. The standards protect such beneficial uses of the waterbody as water supply, recreation, and fisheries. Standards are sometimes based on a variance from the natural (or background) condition of a waterbody.

In general, Alaska's natural surface water resources are considered to be of high quality due to the remote character of Alaska and sparse population (hence few anthropogenic pollutants). ADEC maintains Water Quality Standards criteria (ADEC, 2008b and 2012) to both ensure that waters are safe to use for various human consumptive purposes and to protect these natural resources from potential negative effects of human use. Criteria maintained by ADEC include drinking water primary maximum contaminant levels, stock water and irrigation water criteria, aquatic life criteria for fresh and marine waters, and several other criteria lists. Alaska Water Quality Standards designate seven uses for fresh waters (drinking water, agriculture, aquaculture, industrial, contact recreation, non-contact recreation, and growth and propagation of fish, shellfish, other aquatic life, and wildlife) (ADEC, 2012).

2.3.3.1 Liquefaction Facility

2.3.3.1.1 Cook Inlet Marine Waters

Water quality describes the chemical and physical characteristics of water, usually in respect to its suitability for a particular purpose such as enabling fish and wildlife to carry on biological cycles of life. Glass et al. (2004) in the National Water-Quality Assessment Program for 1997–2001 reported:

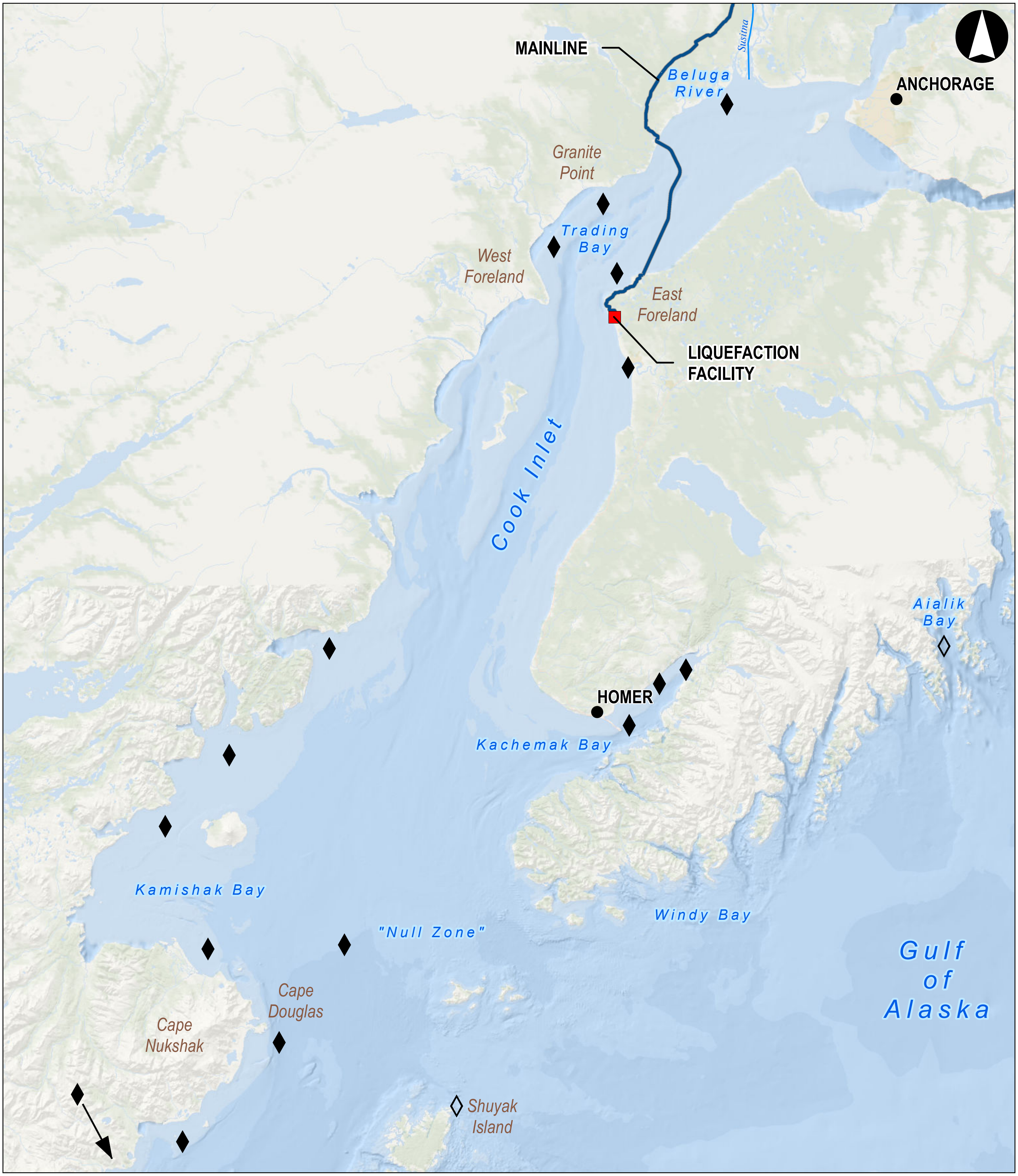
> Water quality is generally good in the Cook Inlet Basin, supporting most beneficial uses of water most of the time, including drinking, recreation, and protection of fish, other aquatic life, and wildlife. Much of the water originates in the mountainous headwaters from melting snow and glaciers, and because the snow is relatively pure, much of the water is either free of, or contains only low concentrations of, contaminants. Although water quality generally is good, natural geologic and climatic features, including the presence or absence of glaciers, affect this quality. In the northwestern and southwestern regions of the [upper Cook Inlet] basin, naturally occurring trace elements, such as arsenic, chromium, nickel, and zinc, frequently are found in streambed sediments at concentrations that exceed guidelines for the protection of sediment-dwelling organisms. Human activities also affect water quality in the basin, particularly in urban areas on lowlands along the northern and eastern shores of Cook Inlet.

High suspended sediment concentrations characterize the entire Upper Cook Inlet, with sediment loads increasing between the Forelands, at approximately 100–200 parts per million, to the Anchorage area at the head of the inlet, at levels greater than 2,000 parts per million. Annual suspended-sediment load to Cook Inlet is more than 44 million tons (USGS, 1999a). High local tidal currents tend to keep this sediment suspended. Soils within Cook Inlet consist of silts, sands, granular material, cobbles, and boulders—all can be moved by the tidal fluctuations (EPA, 2002). Silicate concentrations range from 9 to 90 parts per billion and are likely related to the overall sediment load. Sediment is carried into the Upper Inlet from several glacial rivers, including the Matanuska, Knik, and Susitna rivers, among others.

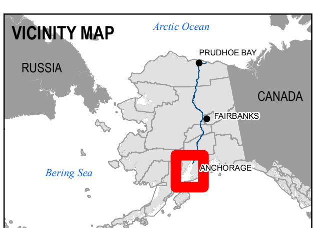
Some water quality sampling has been done as a result of the oil and gas activity in Cook Inlet. This sampling has indicated that suspended and bottom sediments are relatively free of anthropogenic hydrocarbon contaminants (EPA, 2002; Lees et al., 1999). Total polycyclic aromatic hydrocarbon (TPAH) levels ranged from 6 to 469 parts per billion during sediment sampling in Cook Inlet and Shelikof Strait from 1993 to 1997 (see Figure 2.3.3-1; Lees et al., 1999). TPAH levels tested did not appear to follow any predictable patterns, but were lowest in areas with oil production activities. Total aliphatic hydrocarbon levels varied from approximately 50 to 2,816 parts per billion and did not follow any predictable patterns.

2.3.3.1.2 Kenai Peninsula Basin

Waters within the Kenai Peninsula basin consist of glacial and non-glacial streams and numerous ponds and lakes. Snowmelt and rainfall often cause the isolated lakes and ponds to combine through surface water flow. In general, surface water quality in the Kenai Peninsula basin is good, with the exception of localized areas or seasonal periods where high concentrations of iron, silica, color and dissolved organic material may be present (USDOI, 2003; Kenai Peninsula Fish Habitat Partnership, 2008). Most of the surface water contains calcium magnesium bicarbonate type and is generally low in dissolved solids, chloride, and hardness. Most surface waters meet all known drinking water standards except for iron and color (Kenai Peninsula Fish Habitat Partnership, 2008).



VICINITY MAP



LEGEND

- Project Facility
- Cook Inlet Regional Citizens Advisory Council Sites
- Prince William Sound Cook Inlet Regional Citizens Advisory Council Sites
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Major Rivers

0 10 20 40 Miles

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WATER QUALITY SAMPLING IN THE COOK INLET (LEES et al., 1999)

FIGURE 2.3.3-1

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_3_3-1 Water Quality Sampling in Cook Inlet (Lees et al).mxd

2.3.3.2 Interdependent Project Facilities

2.3.3.2.1 Prudhoe Bay Marine Waters

The U.S. Bureau of Ocean Energy Management (BOEM) has conducted surface sediment sampling on the Beaufort Sea inner shelf for a number of years as part of the Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) Project. Average grain size for the ANIMIDA 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 granular material (Neff, 2010).

Seawater in Prudhoe Bay contains naturally occurring constituents derived from atmospheric, terrestrial, and fresh water environments, as well as those derived from human activities. Most contaminants in the Beaufort Sea and on the Beaufort Coastal Plain ecoregion occur in low levels (EPA, 2009). Sampling results for water, sediment, and fauna collected as part of the ANIMIDA Project corroborate that conclusion (Brown et al., 2005; Neff, 2010). Dissolved metals concentrations in seawater throughout the coastal Beaufort Sea are similar to, or less than, world average values in coastal and marine areas (EPA, 2009). Regional sediment samples collected for the ANIMIDA Project in 1999 were analyzed for metals, PAHs, and other organic compounds. Using older data for comparison, the concentrations of metals in the sediment samples were found to be representative of natural background conditions.

Concentrations of total PAH in the sediment samples ranged from 12 to 1,800 micrograms per kilogram in assemblages indicating the primary source to be peat eroded by rivers (Neff, 2010). The EPA 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, EPA similarly notes the source to be mainly derived from natural outcrops of coal and shale on land that has drained into rivers and into the coastal Beaufort Sea (EPA, 2009).

PAH analysis of ANIMIDA biota tissue samples yielded annual averages of 61–100 nanograms per gram in amphipods and 32–230 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, concentrations of 18 metals in tissue samples collected in the Beaufort Sea from amphipods, isopods, clams, and mussels indicate that metals analyzed were in the range of those reported for the same or similar species from other locations throughout the world (Neff, 2010).

Possible sources of hydrocarbons in marine waters are natural occurrences such as exposed coal seams, natural outcrops, and peat erosion that are transferred by streams and along the coast to the ocean (Steinhauer and Boehm, 1992; MMS, 1996). Two marine water samples were collected in Lion Bay near the Project area in 2002 as part of the Point Thomson Project and analyzed for total aromatic hydrocarbons, polynuclear aromatic hydrocarbons, and total aqueous hydrocarbons. None of these parameters was detected (USACE, 2012a).

Trace metals naturally occur in the Beaufort Sea and are introduced from coastal erosion, fresh water inputs, and atmospheric deposition. The background concentrations of trace metals in Lion Bay are relatively low or below detection limits. During 1998, trace metals were analyzed in water samples from Lion Bay as part of the Point Thomson Project. Of the metals analyzed (arsenic, barium, chromium, lead, and mercury), only barium was detected. Barium concentrations ranged from 0.015 to 0.020 milligrams per liter. There are no aquatic life water quality standards in a marine environment for barium. Arsenic, barium, cadmium, chromium, lead, magnesium, nickel, and zinc were analyzed in two marine water samples collected from Lion Bay near the Project area in 2002. Arsenic and nickel were not detected. The other metals were detected in at least one of the samples at concentrations that were in compliance with water quality standards (USACE, 2012a).

The Beaufort Sea coastline in the Prudhoe Bay area is subject to high coastal retreat due to erosion, and rates have increased in recent years. Reimnitz et a. (1985) reported an average rate of coastal retreat of 6.9 feet per year along a 186-mile stretch of the Beaufort Sea coast that included Prudhoe Bay. Jones et al. (2008) reported annual rates of 18.4 feet per year in 1955-1979 increasing to 20.3 feet per year from 1979 to 2002 along a 62-mile segment of the coastline farther west.

2.3.3.2.2 Eastern Arctic, Prudhoe Bay, and Colville River Basins

Beaufort Coastal Plain ecoregion streams with headwaters in the Brooks Range (e.g., the Atigun and Sagavanirktok rivers) contain coarser streambed sediments consisting of large granular materials, cobbles, and boulders. On the flatter terrain of the Beaufort Coastal Plain ecoregion, 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. Smaller tributary streams in the foothills and tundra generally contain sediments composed of finer granular materials, 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 normally occurs.

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 (Rember and Trefy, 2004).

A 2002 study of dissolved and suspended matter transported by the Sagavanirktok, Kuparuk and Colville rivers reported that Arctic rivers typically transport 40 to 80 percent of their annual volume of water during spring floods in May, June and July. The study reported concentrations of dissolved Cu, Pb, Zn and Fe and dissolved organic carbon (DOC) increased 30 to 250 percent at peak discharge than off-peak flow in the Sagavanirktok River. The Kuparuk and Colville rivers average concentrations of dissolved metals and DOC were higher than the Sagavaqnirktok River during spring floods is related to regional differences in lithology and soil pH (Rember and Trefy, 2004). The Kuparuk and Sagavanirktok rivers peak discharge transported more than 80 percent of suspended sediment and more than 33 percent of annual inputs of dissolved Cu, Fe, Pb, Zn and DOC were discharged to the coastal Beaufort Sea (Rember and Trefy, 2004).

Representative surface water temperatures for the Sagavanirktok and Kuparuk rivers between early June and early September range from a low of approximately 35º F to a high of approximately 60 ºF (USGS, 2015a and 2015b).

2.3.3.2.3 Koyukuk and Chandalar-Christian Rivers Basin

Streams within the Koyukuk basin commonly carry minimal settleable (non-colloidal) solids. Glacial input to stream flows is minimal; therefore, water clarity during periods of non-peak flows is high. Non-glacier-fed tributaries have beds composed of sand, granular material, 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 sorted and rounded progressively downstream, and consists of granular material and cobbles in the main channel and granular material and sand on the bars.

The sediment load transported by streams and rivers is low. Concentrations of dissolved solids in surface waters range from less than 50 milligrams per liter to nearly 200 milligrams per liter in major rivers such as the Koyukuk, which has the highest dissolved solids content.. More than 95 percent of the suspended sediment load is discharged during the months of May through September (USGS, 2001a).

2.3.3.2.4 Beaver Creek-Yukon River Basin

The dissolved solids content of streams in the region south of the Brooks Range averages less than 200 milligrams per liter. 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's mainstream is a very large, turbid river whose water quality varies temporally between summer and winter with highest flows and highest turbidity from suspended sediment occurring during the summer. The observed range of water temperature in this region ranges from 32 ºF to 52 ºF (NOAA, 2014).

At its mouth, the Yukon River transports about 60 million tons of suspended sediment annually into the Bering Sea. Measured suspended sediment concentrations for the mainstream of the Yukon River were recorded 35 times between 2000–2005 approximately 3,500 feet upstream of the Project crossing at USGS station 15453500 (Yukon River near Stevens Village). The measured values ranged from 4 to 985 milligrams per liter, with an average value of about 365 milligrams per liter and a standard deviation of approximately 230 milligrams per liter (USGS, 2015c). Virtually all sediment particles carried in suspension in the Yukon River are finer than 0.02 inch. Streams that are tributaries to the Yukon River in this portion of the basin commonly carry less than 100 milligrams per liter of suspended sediment. Yukon River watershed streams near the more mountainous borders of the basin may carry sediment loads of up to 500 milligrams per liter (USGS, 2001a).

2.3.3.2.5 Tanana River Basin

Within the Tanana River basin, the Tolovana River, Lower Tanana River and Nenana River watersheds are crossed by the Project, and these rivers have a high-suspended sediment load. However, the non-glacial tributaries from the north carry lower amounts of sediment. Within the basin, surface waters generally contain between 60 and 500 milligrams per liter of dissolved solids, with most surface waters having less than 200 milligrams per liter. Dissolved solids concentrations appear to be highest from streams draining the Alaska Range (USGS, 2001a). Logging, mining, increased land development, DOD sites and contaminated sites in the Fairbanks area contribute to decreased water quality and sedimentation in the basin (USGS, 2000).

2.3.3.2.6 Susitna River Basin

Streams that occur within the Susitna River basin are classified as either glacial or non-glacial streams. Glacial streams have high turbidity from fine sediment during the meltwater season from May through September, but are typically lower in turbidity during winter months. Streams in this basin are either completely frozen or generally remain at a temperature of 32 ºF during the winter. During the open-water period, which is typically mid-May to mid-October, glacially fed streams remain at 32 ºF at their headwaters, while lowland stream temperatures can reach as high as approximately 70 ºF during July. Non-glacial fed streams are characterized by having lower turbidity and higher water temperatures than glacial fed streams particularly during the summer meltwater periods. Discharge rates are low during the winter for both glacial and non-glacial fed streams due to ice formation. Discharge declines in non-glacial streams during the warm summer months compared to glacial fed streams because of the continuous melting of snow and ice upstream. The unit discharge for streams in basins with glacial ice coverage is generally larger than for streams in basins without glacial ice (USGS, 2001b).

2.3.3.2.7 West Cook Inlet Basin

West Cook Inlet drainage basin is sparsely populated and accessible by boat and aircraft only and constitutes 18 percent of the total area of Cook Inlet and contributes about 22 percent of the total discharge attributed to the presence of many glaciers in western Cook Inlet and high precipitation (USGS, 1999a). The Chuitna River is a non-glacial stream located near the Native Village of Tyonek. The basin has large coal deposits and is the site of the Chuitna Coal Project currently undergoing the state and federal permitting process for mineral developments. If these developments are approved, it would most likely result in an increase in suspended sediments and reduced water quality from pre-development levels (USGS, 1999b). Water quality could be affected by mining through sedimentation and alteration of the water chemistry resulting in increased acidity and elevated trace-element concentrations detrimental to aquatic organisms and water unfit for human consumption (USGS, 1997).

2.3.3.2.8 Cook Inlet Basin

Cook Inlet Basin receives freshwater from adjacent drainage basins, which include the Susitna River, Knik Arm, Kenai Peninsula, and West Cook Inlet basins. Urban runoff, discharges from municipal wastewater treatment systems, and discharges from various industrial activities flow into Cook Inlet from those basins (USDOI, 2003b). Large amounts of suspended sediments are found within this basin within the Susitna and Knik rivers because of glacial melt runoff. Streams in this basin are either completely frozen or generally remain at a temperature of 32 ºF during the winter. During the open-water period, which is typically mid-May to mid-October, glacially fed streams still remain at 32 ºF at their headwaters, while lowland stream temperatures can reach as high as approximately 70 ºF during July (USGS, 2001b).

2.3.3.3 Non-Jurisdictional Facilities

Associated non-jurisdictional facilities in the Kenai Peninsula basin include the Kenai Spur Highway relocation project.

Associated non-jurisdictional facilities within the Eastern Arctic and Prudhoe Bay basins include the PTU Expansion project and PBU MGS project, respectively.

2.3.4 Navigable Waterways

2.3.4.1 Rivers and Harbors Act, Section 10 Waterbodies

Waterbodies that are of sufficient size and use may be designated as navigable under the authority Section 10 Rivers and Harbors Act (RHA), and require a permit for work in or affecting the waterway. The Project facilities would cross several of these waters as shown in Table 2.3.4-1.

TABLE 2.3.4-1

Section 10 Navigable Waterbodies Crossed by the Project

Facility	Milepost	Waterbody	Watershed [a]
Liquefaction Facility	-	Cook Inlet	Cook Inlet
Interdependent Project Facilities - Mainline Pipeline	211.2	Middle Fork Koyukuk River	Upper Koyukuk River
	260.8	South Fork Koyukuk River	South Fork Koyukuk River
	356.5	Yukon River	Ramparts-Yukon River
	402.2	Tolovana River	Tolovana River
	439.1	Chatanika River	Tolovana River
	473.0	Tanana River	Lower Tanana River
	476.0	Nenana River	Nenana River
	489.2	Nenana River	Nenana River
	766.3 – 793.0	Cook Inlet	Cook Inlet
Interdependent Project Facilities - PTTL Pipeline	43.7	Sagavanirktok River	Sagavanirktok River
Gas Treatment Plant	-	Beaufort Sea	Kuparuk River

Note:

[a] Based on USGS Watershed Boundary Dataset (WBD) 8-digit hydrologic unit (HUC8).

2.3.4.2 Section 9 of the RHA

In accordance with Section 9, RHA (33 U.S.C. 401) and the General Bridge Act of 1946 (33 U.S.C .525 et seq.), the United States Coast Guard (USCG) authorizes and issues permits for the construction of causeways and bridges across navigable waterways as defined in 33 C.F.R. Part 2.05-25. Navigable waterways include any internal waterways of the United States that are subject to tidal influence, and internal waterways of the United States not subject to tidal influence which are found susceptible for use for substantial interstate or foreign commerce by the USCG. Table 2.3.4-2 lists Section 9 waterways crossed by the Project.

TABLE 2.3.4-2

Section 9 Navigable Waterbodies Crossed by the Project

Facility	Milepost	Waterbody	Watershed [a]
Interdependent Project Facilities - Mainline Pipeline	179.16	Dietrich River	Upper Koyukuk River
	288.48	North Fork Bonanza Creek	South Fork Koyukuk River
	290.13	South Fork Bonanza Creek	South Fork Koyukuk River
	356.47	Yukon River	Ramparts
	402.21	Tolovana River	Tolovana River
	439.11	Chatanika River	Tolovana River
	472.98	Tanana River	Tanana River
	476.04	Nenana River	Nenana River
	586.34	Middle Fork Chulitna River	Chulitna River
	589.77	East Fork Chulitna River	Chulitna River
	598.50	Honolulu Creek	Chulitna River
	641.79	Chulitna River	Chulitna River
	704.72	Deshka River	Lower Susitna
	720.94	Yentna River	Lower Susitna
	727.82	Alexander Creek	Lower Susitna
Interdependent Project Facilities - PTTL Pipeline	43.7	Sagavanirktok River	Sagavanirktok River

Note:

[a] Based on USGS Watershed Boundary Dataset (WBD) 8-digit hydrologic unit (HUC8).

Individual bridge permits would be required for aerial pipeline crossings, permanent and/or temporary vehicle access bridges, and detour bridges on navigable waterways. Buried trenchless waterbody crossings under navigable waterways require no permit, but would be reviewed by USCG to ensure construction does not impact navigation.

2.3.5 Sensitive Surface Waters

Sensitive surface waters that may be affected by the Project include waterbodies listed in:

- The Anadromous Water Catalog;
- The National Wild and Scenic Rivers System;
- The Nationwide Rivers Inventory;
- The Recreational Rivers Act;
- The Alaska Impaired Waterbodies list; and
- Waterbodies that contain threatened and/or endangered species or critical habitat(s).

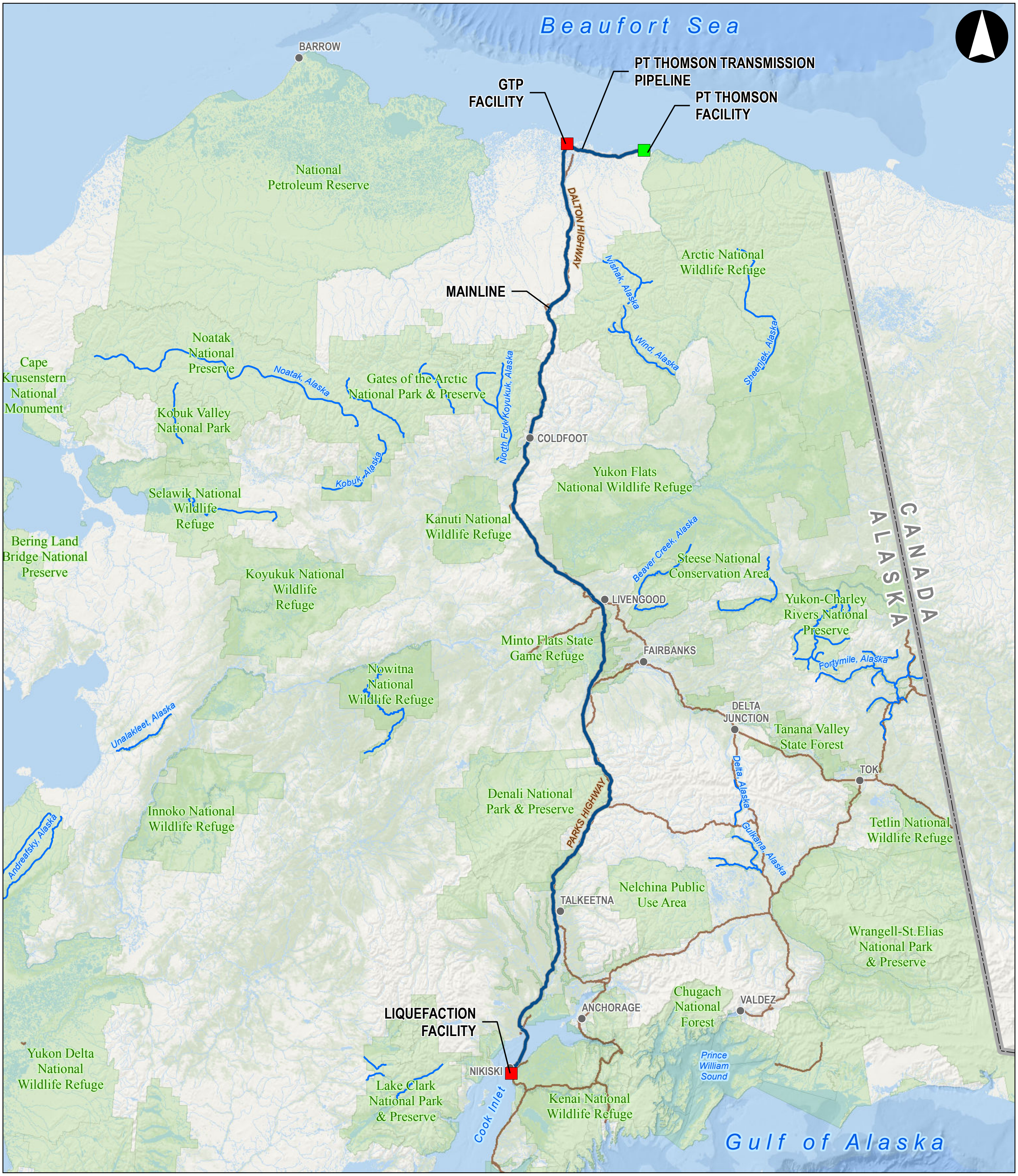
Each of these designated waterbodies requires special consideration along with careful construction planning execution to ensure that adverse effects are avoided or minimized.

2.3.5.1 Anadromous Waters Catalog

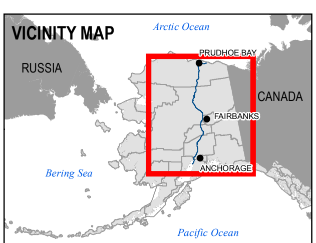
The *Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes* and associated Atlas specifies which rivers, streams, associated tributaries and lakes that are important to anadromous fish species and protected pursuant to AS 16.05.871. The Alaska Department of Fish and Game (ADF&G) maintains the Anadromous Waters Catalog (AWC), where waterbodies are documented by a qualified observer to support some aspect of an anadromous fish species life function (i.e., rearing, spawning, present, or migration). These sensitive surface waters have been identified that would be crossed by Interdependent Project Facilities through the Southcentral, Interior, and Arctic regions listed in the catalog (ADF&G, 2015b, 2015c, and 2015d). Anadromous waters and species are further discussed in Resource Report No. 3, and listed in Resource Report No. 3, Appendix H.

2.3.5.2 Wild and Scenic Rivers

The National Wild and Scenic Rivers System was created to preserve certain rivers with outstanding natural, cultural, and recreational values. There are no federal or state wild and scenic rivers that are crossed by the Project. The North Fork of the Koyukuk River is the closest wild and scenic river to the Project. This waterbody is 10.5 miles to the west at its nearest point from the Project corridor. Figure 2.3.5-1 shows the Project footprint in relation to Wild and Scenic Rivers in Alaska.



VICINITY MAP



X:\AKLNG\Resource Reports\RR02\Figure 2_3_5-1 Wild and Scenic Rivers in Alaska.mxd

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Wild Scenic Rivers
- Major Highways
- State & Federal Conservation Lands

0 25 50 100 Miles

DISCLAIMER

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WILD AND SCENIC RIVERS IN ALASKA

FIGURE 2.3.5-1

ALASKA LNG

2.3.5.3 Nationwide Rivers Inventory

Rivers listed on the Nationwide Rivers Inventory (NRI) must be free flowing and possess one or more Outstandingly Remarkable Values (ORVs) based on the river's hydrology and inventory of its natural, cultural, and recreational resources (16 U.S.C. § 1271). The following NRI-listed Rivers would be crossed by the Project:

- Deshka River - Primary habitat for king salmon and also supports sockeye, coho, pink, and chum salmon. Valuable winter moose habitat. Popular recreational area for fishing, snowmachines, dog mushing, and cross-country skiing. Lower section of river supports many archaeological sites; and

- Alexander Creek – popular fishing river for king and coho salmon. The upper reaches have scenic views of the Alaska Range. Class I waters encourage beginning floaters. Lower reaches contain archaeological sites of Native sites, historic roadhouses, and the Iditarod Trail.

- No other NRI-listed Rivers occur within the Project area (NPS, 2009). Crossings of these rivers are identified in Table 2.3.5-1.

TABLE 2.3.5-1

Nationwide Rivers Inventory and Recreation Rivers Act Waterbodies Crossed by the Project

Facility	Waterbody	Milepost	Watershed
Mainline Pipeline	Deshka River	704.7	Lower Susitna River
	Alexander Creek	727.8	Lower Susitna River

2.3.5.4 Recreation Rivers Act

The Recreation Rivers Act of 1988 (AS 41.23.400) established a mile-wide recreation river corridor on state-owned lands and waters acquired by the state in the future, including shore and submerged lands that lies within the following areas of the Little Susitna, Deshka, Talkeetna, and Talchulitna rivers and Lake, Moose, Kroto, and Alexander creeks. Waterbodies that would be crossed by the Project are listed in Table 2.3.5-1.

2.3.5.5 Waterbody Categories

Alaska is required under CWA Section 106 and 305(b) to assess and report (every two years) on the status of state's waters. The Integrated Water Quality Monitoring and Assessment Report (Integrated Report) is a comprehensive statewide evaluation that characterizes the quality of all waterbodies (ADEC, 2013). Waterbody categories are assigned by water quality as follows:

- **Category 1.** All AWQS for all designated uses are attained.
- **Category 2**. Some AWQS for the designated uses are attained, but data and information to determine whether the AWQS for the remaining uses are attained are insufficient or absent.
- **Category 3.** Data or information is insufficient to determine whether the AWQS for any designated uses are attained.
- **Category 4.** The waterbody is determined to be impaired but does not need a total maximum daily load (TMDL).

  - **Category 4a.** An established and EPA–approved TMDL exists for the impaired water.
  - **Category 4b.** Requirements from other pollution controls have been identified to meet AWQS for the impaired water.
  - **Category 4c.** Failure to meet a water quality standard for the impaired water not caused by a pollutant; instead the impairment is caused by a source of pollution such as nuisance aquatic plant, degraded habitat, or a dam that affects flow.
- **Category 5.** AWQS for one or more designated uses are not attained and the waterbody requires a TMDL or recovery plan. Category 5 waters are identified on the Section 303(d) list of impaired waters.

In the 2012 Integrated Report, the majority of Alaskan waterbodies were classified as a Category 1 maintaining the seven designated AWQS uses for fresh waters and marine waters (ADEC, 2013). The proposed Project would cross one Category 2 and five Category 3 waterbodies that are listed in Appendix H (List of Waterbodies Crossed by the Project).

Surface water classification is defined (18 AAC 70.050) as marine waters and fresh waters (see Sections 2.3.1 and 2.3.2). Surface water resources in the Project area include marine waters at the northern and southern ends of the Project boundary to fresh water lakes, ponds, major rivers, streams and associated tributaries along the Mainline corridor. Surface water resources in wetlands are discussed in Section 2.4. The following sections describe the surface water resources in the proposed Project area.

2.3.5.6 Impaired Waterbodies

Under section 303(d) of the 1972 Clean Water Act (CWA), states, territories, and authorized tribes are required to develop lists of impaired waterbodies that do not meet water quality standards that these entities have set for them. Impaired waterbodies are listed in Alaska's Integrated Water Quality Monitoring and Assessment Report (Integrated Report) published by ADEC approximately every two years.

There are no waterbodies within the Project area that are designated as CWA Section 303(d) impaired for water quality based on the 2010 approved Integrated Report (ADEC, 2010b). Additionally, no new waterbodies are included in the 2012 Integrated Report still pending final EPA approval (ADEC, 2013). According to its website, ADEC recently closed the solicitation for water quality data and information for the 2014–2016 Integrated Report (ADEC, 2016).

2.3.5.7 Aufeis

Aufeis is the term used to describe sheet-like ice that forms when pressurized ground or river water upwells above the existing ground or river ice surface to flow during subfreezing ambient air temperature conditions. This can occur due to the previously existing ice surface preventing liquid water from reaching the surface, causing it to become pressurized. Eventually, the pressure causes the local water table to rise sufficiently to allow groundwater to release from riverbanks and other high-gradient features to rupture through and flow over top of the existing ice layers. Over the course of a winter season, successive overflow events can add multiple layers of ice, which in some areas can create very massive ice forms.

Aufeis distribution in the Arctic occurs along the northeast slope of the Brooks Range (Callegary et al., 2013). Aufeis is an important surface storage component in arctic watersheds. The source of winter discharge is mainly spring water from intra and subpermafrost aquifers. Aufeis accumulates during the winter, reaching a peak in late spring, and discharging aufeis meltwater in earlier summer.

There are no statewide maps of documented locations where aufeis occurs or can occur on an annual basis. However typical environments include high-gradient terrain that has the potential of a high groundwater table right next to a lower ground or stream surface, such that once the surface is frozen, the only release for the higher water table is above the existing lower surface. Mountainous areas, cut banks created during road construction, and rivers that cut through steep valleys or past bluffs all are potential areas for aufeis formation. The Brooks and Alaska Mountain ranges, and the streams and surface groundwater aquifers that flow through and have their headwaters in these ranges, are likely to exhibit seasonal aufeis in various locations.

2.3.6 Existing Surface Water Uses

Tables 2.3.6-1 and 2.3.6-2 provides surface water uses and volumes used near or within the Project footprint. This list also includes downstream uses that could be impacted by a Project crossing of that waterbody. In addition to the uses listed in this table, it is likely that any waterbody that is deep enough could be used by various hunters, fishers, rafters, or other recreational users in some form or another during the open-water period, even if the stream appears to be fairly remote. Likewise, streams are often used as snow machine and dog sled corridors during winter. Generally, except for very accessible streams near population centers, these types of usages are not tracked. Personal drinking water intakes associated with remote or off-the-grid cabins also are not well tracked. Therefore, none of these uses is included in Table 2.3.6-1 except for potentially unusual or well-documented instances.

TABLE 2.3.6-1

Surface Water Uses for Areas Crossed by the Project

Type of Surface Water (SW) Withdrawals Fresh and Saline Million gallons daily (Mgal/d) [a]	North Slope Borough	Yukon-Koyukuk Census Area	Denali Borough	Fairbanks North Star Borough	Matanuska-Susitna Borough	Kenai Peninsula Borough	Total Withdrawal by Use
Public Supply	0.45	0.04	0.00	0.00	0.00	2.73	3.22
Domestic Self-Supply	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Irrigation	0.00	0.00	0.00	0.00	0.02	0.00	0.02
Livestock	0.00	0.00	0.00	0.02	0.04	0.02	0.08
Aquaculture (Hatcheries)	0.00	0.88	0.07	0.04	20.43	15.81	37.23
Mining-Fresh	0.70	0.37	0.10	10.43	1.63	0.02	13.25
Mining-Saline	75.56	0.00	0.00	0.00	0.00	0.80	76.36
Thermoelectric	0.00	0.00	23.2	31.7	0.00	0.00	54.90
Total Fresh SW	***1.16***	***1.29***	***23.37***	***42.19***	***22.12***	***18.58***	***108.71***
Total Saline SW	***75.56***	***0.00***	***0.00***	***0.00***	***0.00***	***0.8***	***76.36***
Total SW Withdrawals	**76.72**	**1.29**	**23.37**	**42.19**	**22.12**	**19.38**	**185.07**

TABLE 2.3.6-1

Surface Water Uses for Areas Crossed by the Project

Type of Surface Water (SW) Withdrawals Fresh and Saline Million gallons daily (Mgal/d) [a]	North Slope Borough	Yukon-Koyukuk Census Area	Denali Borough	Fairbanks North Star Borough	Matanuska-Susitna Borough	Kenai Peninsula Borough	Total Withdrawal by Use

Note:

[a] Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014, Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p., http://dx.doi.org/10.3133/cir1405

Finally, in Alaska all waters are protected for all water use classes (ADEC, 2012) and therefore specific waterbodies are not listed in Tables 2.3.6-1 and 2.3.6-2 for these seven designated uses: drinking, culinary, and food processing; agriculture, including irrigation and stock watering; aquaculture; industrial; contact recreation; secondary recreation; and growth and propagation of fish, shellfish, other aquatic life, and wildlife.

TABLE 2.3.6-2

Surface Water Use by Others in the Project Area

Waterbody Name	Surface Water Use	Details
Cook Inlet	Shipping	Shipping traffic to and from Ports of Anchorage, Knik, Nikiski, Kenai, Homer, Seldovia, and Drift River; local industrial shipping traffic at existing Nikiski port docks
	Oil and Gas Platforms	Osprey, Dolly Varden, Steelhead, Grayling, King Salmon, Monopod, Dillon, “C,” “A,” Baker, Spurr, Spark, Granite Point, Anna, Bruce, and Tyonek A platforms (2013)
	Tourism	Cruise ship traffic to/from Ports of Anchorage and Homer
	Municipal Discharges	Wastewater effluent discharged from all communities in Cook Inlet drainage basin, whether discharged directly into Cook Inlet or one of the many tributary streams
Yukon River	Shipping	Barge Traffic to and from various communities lining the Yukon River
Tanana River	Shipping	Barge Traffic to and from Port of Nenana
Beaufort Sea/ Prudhoe Bay	Shipping	Shipping traffic for commercial shipping, subsistence hunting and fishing, and shipping to supply remote communities.

Sources: Cook Inlet Oil and Gas Platforms and Infrastructure Map: ADNR, 2013; ADNR Surface Water Rights information,

2.3.7 Waterbody Crossings

The FERC’s *Wetland and Waterbody Construction and Mitigation Procedures* (2013) defines “waterbody” as any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing, including lakes and ponds, which differs from the USACE definition of “Waters of the United States.” FERC’s Procedures further classifies waterbodies by the width of the water’s edge at the time of crossing as minor (less than or equal to 10 feet wide), intermediate (10 feet but less than or equal to 100 feet wide), and major (greater than 100 feet wide). Waterbodies that are crossed by the proposed Project facilities are listed in Appendix H. Some waterbodies may be frozen or dry at the time of construction, and therefore would not be treated as an open waterbody at the time of construction.

The Project pipeline facilities waterbody crossings would be installed using a variety of techniques depending on season, weather, and size of the crossing, typical flow and flood conditions, sediment loading, stream hydraulics, and fishery. Resource Report No. 1 provides a summary of the construction methods for crossing waterbodies. The seasonal conditions for the Project vary from the northernmost point of the Project to the southernmost reaches, and were considered in developing the construction methods. However, in general, the Project can expect to see freezing in the waterbodies six to eight months per year. Freezing begins in the smaller waterbodies and ponds and marshes, and then progresses to the large bodies of water. In the southern Project areas, the largest rivers do not always freeze over.

The Project pipeline facilities would cross a total of 12 major waterbodies. Proposed construction methods and crossing widths are identified in Table 2.3.7-1. Resource Report No. 1 provides a summary of the construction methods for crossing waterbodies and Resource Report No. 3 provides detailed information concerning fish habitat (i.e., spawning or rearing habitat for resident or anadromous fish) and fish resources near the buried trenchless crossing locations. A site-specific crossing plan will be prepared for each proposed major waterbody crossing, including offshore construction, and will be provided prior to construction. Preliminary draft crossing plans are provided in Appendix I.

TABLE 2.3.7-1

Major Waterbodies Crossed by the Project

Facility Name	Approx. Milepost	Waterbody Name [a]	Crossing Width (feet)	Proposed Crossing Method [b]	Construction Season	Watershed
Interdependent Project Facility-Mainline Pipeline	211.1	Middle Fork Koyukuk River	2,099	Trenchless (DMT)	Summer	Upper Koyukuk River
	356.5	Yukon River	2,300	Trenchless (DMT)	Summer	Ramparts-Yukon River
	473.6	Tanana River	2,755	Trenchless (DMT)	Summer	Lower Tanana River
	476.6	Nenana River (#1)	280	Open Cut	Winter	Nenana River
	561.2	Nenana River (#4)	300	Open Cut	Summer	Nenana River
	641.9	Chulitna River	1,830	Trenchless (DMT)	Summer	Chulitna River
	704.9	Deshka River	220	Trenchless (DMT)	Summer	Lower Susitna River
	721.1	Yentna River	1,400	Open Cut	Winter	Lower Susitna River
	757.3	Beluga River	1,310	Open Cut	Winter	Redoubt-Trading Bays
Mainline Pipeline-Offshore	766.3	Cook Inlet	141,253	Open Cut/Direct Pipe Lay	Summer	Cook Inlet
Interdependent Project Facility-PTTL Pipeline	44.2	Sagavanirktok River Main Channel	700	Open Cut	Winter	Sagavanirktok River
	53.5	Sagavanirktok River West Channel	700	Aerial Span	Winter	Sagavanirktok River

Notes:

TABLE 2.3.7-1

Major Waterbodies Crossed by the Project

Facility Name	Approx. Milepost	Waterbody Name [a]	Crossing Width (feet)	Proposed Crossing Method [b]	Construction Season	Watershed

[a] Major Waterbody is greater than 100 feet wide at the water's edge at the time of crossing.
[b] Trenchless Directional Micro-Tunnelling (DMT).

2.3.8 Potential Construction Impacts and Mitigation Measures for Surface Water

Construction activities that could impact surface water resources include but are not limited to the following:

- Blasting;
- Clearing and grading;
- Dewatering and trenching;
- Discharges of ballast and cooling water;
- Dock installation and dredging;
- Domestic sewage and greywater disposals from construction camps;
- Facility, ice/access road, work pad, and helipad/airstrip construction;
- Fueling and use of hazardous materials;
- Hydrostatic test water discharges;
- Ice roads/access road construction;
- Material extraction sites and excavation dewatering;
- Pipeline waterbody crossings;
- Inadvertent releases of drilling fluids; and
- Stormwater management and runoff.

In addition, surface water would be used to support construction activities (e.g., dust suppression and road maintenance, ice road and work pad construction, buried trenchless method fluid makeup, and potable water). Sources for water during construction would include lakes, rivers, and streams where Temporary Water Use Authorizations (TWUA) have been granted. Estimated surface water use during the construction of each Project component is summarized in the Project *Water Use Plan* included in Appendix K. Preliminary sources and volumes of water are identified in this Plan and would be finalized prior to construction, considering agency input received on the source waters and their applicability for use.

This section addresses potential impacts to surface water quantity and quality from Project construction and provides proposed mitigation measures and BMPs to avoid and minimize potential effects. In general, impacts to surface waterbodies from Project construction may include the following:

- Changes in surface water flows from withdrawals or discharges;
- Physical disturbance or alteration of waterbodies from construction activities;
- Releases of sediment and increases in turbidity (e.g., from dredging, construction, material sites);
- Temperature change (e.g., from cooling water);

- Changes in BOD_5, fecal coliform bacteria count, pH, TSS (e.g., from domestic sewage discharges);
- Inadvertent spills of hazardous compounds including fuels, lubricants, and solvents; and
- Contamination of runoff during concrete batching, causing increased pH, TSS, and TDS levels.

BMPs designed to minimize or mitigate potential impacts on surface water during construction would be implemented, including:

- Applicant's *Plan* (Resource Report No. 7, Appendix D);
- Applicant's *Procedures* (Appendix M);
- *Blasting Plan* (Resource Report No. 6, Appendix B);
- *Fugitive Dust Control Plan* (Resource Report No. 9, Appendix J);
- *Gravel Sourcing Plan and Reclamation Measures* (Resource Report No. 6, Appendix F);
- *HDD Inadvertent Release Plan* (Appendix L);
- *Waste Management Plan* (Resource Report No. 8, Appendix K);
- *Site-Specific Waterbody Crossing Plans* (Appendix I);
- *Spill Prevention, Control, and Countermeasure* (*SPCC*) *Plan* (Appendix M);
- *SWPPP* (Appendix J); and
- *Water Use Plan* (Appendix K).

2.3.8.1 Liquefaction Facility

The Liquefaction Facility would be located in Nikiski and include an LNG Plant and Marine Terminal. The LNG Plant would be located in an upland area (at an elevation between 100 and 140 feet above sea level) on the eastern shore of Cook Inlet in the Kenai Peninsula basin. There are no major fresh water waterbodies or streams on the Liquefaction Facility site; however, several lakes are within a mile of the Liquefaction Facility site. The Marine Terminal would be located within Cook Inlet and along the shoreline.

2.3.8.1.1 LNG Plant

2.3.8.1.1.1 Clearing, Grading, and Site Development

A summary of the acreage affected during construction and operation of the LNG Plant is shown in Resource Report No. 1, Table 1.4-1. Approximately 900 acres of land would be cleared and graded for construction of the LNG Plant.

The initial site work would concentrate on the site improvements necessary for installing all three trains. The proposed site would be cleared and graded to the extent necessary to install the facility and provide a level platform and sufficient space to execute the work safely, as well as provide for site drainage. Changes in infiltration rates, soil water storage, and surface runoff amounts and pathways would result from soil compaction, changes in site topography, and stripping of surface vegetation.

Potential impacts from clearing and grading may be reduced or eliminated through mitigation measures included in the Applicant's *Plan* and *SWPPP*. These measures include installing stormwater runoff control measures prior to construction and stabilizing (both temporarily and permanently) construction areas as soon as practicable.

During construction, the LNG Plant would be susceptible to erosion and sedimentation as a result of storm events and construction activities. The Applicant has prepared a draft construction *SWPPP* (Appendix J), which includes BMPs (e.g., silt fencing, sediment barriers, and washdown areas to remove soil from vehicles before they exit the site) to reduce erosion during construction and to capture sediment that does become mobilized and entrained in stormwater during rain events.

During construction, stormwater runoff would be directed to designated graded temporary sediment catch basins that would flow via one of three outfalls into Cook Inlet. Undisturbed areas of the site would retain their existing natural drainage. The Applicant's *Plan* (Appendix D, Resource Report No. 7) would implement BMPs, including silt fencing, sediment barriers, and wash-down areas to remove soil from vehicles before they exit the site. Turbidity and sediment in discharge waters to Cook Inlet would be in compliance with the APDES permit and impacts are expected to be minor due to the settling basins and the already high turbidity levels in Cook Inlet as described previously in the dredging section. Prior to discharge, sampling and analysis of discharges would be done as specified by applicable permit requirements.

Other than the vegetative buffer left along the southern and eastern sides of the property, vegetative cover would be reestablished as soon as construction has been completed. The activities may include placement of temporary erosion and sediment control products (such as jute mat) until landscaping features are fully grown or stabilized. Periodic inspections of landscaping features would help assure that runoff is controlled and infiltration measures that aid in groundwater recharge are working. At the termination of the construction period, all temporary measures would be replaced with permanent measures. Restoration and revegetation activities would tend to have temporary and long-term positive impacts on water quality and runoff rates.

Equipment used for clearing and grading would be regularly inspected for drips and leaks according to the *SPCC Plan*. Mitigation measures contained in the *SPCC Plan* are further summarized under the Fuel Use, Storage, Refueling, Lubrication, and Spills section. Routine inspections would also cover control measures used for encouraging infiltration and ensure proper maintenance of sedimentation basins, silt fence, and other controls. With the *SWPPP* and *SPCC Plan* mitigation measures in place, the Applicant expects that impacts to surface water are expected to be temporary and minor.

2.3.8.1.1.2 Foundation Construction

Foundation construction includes installation of granular pads, pile driving to support structures, and concrete work. The foundation for the LNG Plant and associated aboveground structures would be excavated and replaced by structural fill.

During construction, stormwater runoff could be exposed to fill material or concrete, possibly from metal fabrication and welding. Foundations at the Liquefaction Facility would be composed of concrete or granular material (including temporary granular pads for construction facilities). Because there are no waterbodies on the site, precipitation would infiltrate into the ground or be managed as stormwater as discussed in the previous section. Concrete poured into footings and foundations would be contained using forms (solid barriers that hold concrete in place), and batching and washout areas would be controlled.

Construction of foundations, paved roads, parking areas, and other areas with impermeable concrete and asphalt would reduce infiltration and increase surface water runoff, which would be managed as stormwater and discharged to Cook Inlet or infiltrated into the ground near the impermeable surface. Impacts to Cook Inlet from construction activities are expected to be temporary and minor due to compliance with the *SWPPP*, *SPCC Plan*, and the APDES permit.

2.3.8.1.1.3 Dewatering

Dewatering involves pumping water from the shallow groundwater aquifer during excavation and trenching activities and transferring it to the surface where it is discharged to lower the local water table level to expose the trench. A description of groundwater dewatering impacts for the Liquefaction Facility is provided in Section 2.2.6.1.

Typically, the pumped water would be discharged into a dewatering structure or directed into stable, vegetated areas. Impacts during construction dewatering would be similar to those described under the Clearing and Grading section and would be managed according to the *SWPPP, SPCC Plan,* and in compliance with the APDES permit. All dewatering activities would be done under the supervision of the Environmental Inspectors. It is anticipated that impacts to surface water from dewatering during construction would be localized, short-term, and minor.

2.3.8.1.1.4 Hydrostatic Testing

Hydrostatic testing would occur after the LNG tanks and other Liquefaction Facility piping is installed to determine that all are leak-free and meet design strength criteria. Details of the required water volumes are provided in the Project *Water Use Plan* (Appendix K). Hydrostatic test water would be sourced from either onsite groundwater wells (see Section 2.2.6.1) or salt water from Cook Inlet. In advance of filling each tank, the hydrotest water source would be tested to ensure that the water would meet all applicable permit requirements. In most instances, the hydrostatic test water would have similar water-quality characteristics as the source waterbody.

Hydrostatic testing of the LNG tanks would occur over a 14- 21 day period, with an average fill rate of 1,400 – 2,000 gallons per minute. It is estimated that the testing would be sequenced such that test water from the first tank could also be used as test water for the second tank. Hydrostatic testing of the 240,000-cubic-meter tanks would require roughly 42,000,000 gallons of Cook Inlet seawater (see *Water Use Plan*, Appendix K). It is anticipated that impacts to surface water use from Cook Inlet would be localized, short-term, and minor.

It is not planned to use additives in the hydrostatic test water. Biocides and/or anti-freeze agents during pipeline testing would only be used during shoulder season work or where test water sources contain bacteria. Any proposed biocide or anti-freeze use would be coordinated with permitting agencies. Following testing, the test water would contain particulate dust and mill scale (rust) that would settle out in the sediment basins onsite in compliance with applicable permits. The water would then be tested prior to discharge via outfall to Cook Inlet. If treatment is needed, procedures would be developed for removal of additives prior to discharge. It is anticipated that impacts to surface water from hydrostatic testing during construction would be localized, and short-term.

2.3.8.1.1.5 Material Sites

As detailed in the Project *Gravel Sourcing Plan and Reclamation Measures* (Resource Report No. 6, Appendix F), onsite quarries would be developed at the Liquefaction Facility to serve the primary fill needs for construction of the Liquefaction Facility. Surface water impacts for the extraction sites are similar to those described in the clearing and grading section, with the additional possibility of pumping water out of the extraction pits to nearby retention basins. Sediment from pit water would be retained in the retention ponds. The construction *SWPPP* would be used to manage surface water during pit operation, and the *SPCC Plan* would address potential spills and leaks from equipment. With the *SWPPP* and *SPCC Plan* mitigation measures in place, impacts to surface water due to disturbance to ground cover are expected to be temporary and minor.

2.3.8.1.1.6 Blasting

Blasting is not anticipated during construction of the LNG Plant or Marine Terminal.

2.3.8.1.1.7 Domestic Wastewater

A temporary domestic wastewater treatment plant would be located east of the construction camp. Discharge from the temporary wastewater plant would be to a sediment basin on site that would discharge to Cook Inlet through an outfall in accordance with APDES permit requirements. Coverage under the new APDES Statewide Oil and Gas Pipeline (AKG320000) specifies effluent limitations for Project domestic wastewater discharges from the operation of a domestic wastewater treatment works. APDES permits limit the following: BOD_5, TSS, fecal coliform and possibly enterococci, total residual chlorine, DO, oil and grease, pH, and flow.

To reduce fecal coliform count, disinfection such as UV or chlorine would be used. In the unlikely event of a sewage spill, immediate clean-up procedures would be implemented and impacts to groundwater would be temporary and minor.

2.3.8.1.1.8 Fuel Use, Storage, Refueling, Lubrication, and Spill Control Measures

Spills, leaks, or other accidental releases of substances during construction of the Liquefaction Facility could adversely affect surface water quality. Practices and procedures outlined in Section 2.2.8.1.9 would be implemented to reduce potential impacts to surface water near the Liquefaction Facility and Cook Inlet.

2.3.8.1.1.9 Access Roads

Access roads would connect the Liquefaction Facility infrastructure to the existing road system in Nikiski and to the temporary MOF (see Resource Report No. 1), to allow access during the construction phase of those facilities.

Soil compaction and road construction may increase runoff, reduce infiltration and recharge, and alter surface water flows. Increased rates of erosion could contribute sediment to low-lying areas within the facility and to Cook Inlet. The Applicant's *Plan* would implement BMPs, including silt fencing, sediment barriers, and ECBs to minimize erosion.

As required by the APDES Stormwater Permit, construction stormwater BMPs described in the *SWPPP* would be employed, as would the provisions of the Applicant's Project *Plan*. Roads on the upland portion of the Project would be mostly level and incorporated into the site's grading plan. Surface water runoff would be managed site-wide and routed to appropriately sized retention basins as described in the engineering typical designs. The haul road, which descends from the upland area to the MOF, would be steeper and would require additional runoff management structures appropriate for the grade and proximity to Cook Inlet. Because access roads comprise a comparatively small impervious surface area relative to the area available for infiltration, construction impacts to water quality and runoff are expected to be temporary and minor.

A washdown facility would be located onsite to wash vehicles and equipment. The washdown pad wastewater would be contained in a washdown pad sump, which would be sized to hold 2,000 gallons. This would be a closed loop system and water would be recycled into the washdown area; thus, this closed system would have no impact on surface water.

2.3.8.1.2 Marine Terminal

2.3.8.1.2.1 Dredging/Dredge Disposal

Planned dredging for construction of the temporary MOF is described in Resource Report No. 1. A summary of the acreage affected during construction and operation of the Marine Terminal is shown in Resource Report No. 1, Table 1.4-1. The initial design of the facilities indicates that the Marine Terminal footprint would impact approximately 19 acres for the Product Loading Facility (PLF) and dredge 52 acres for the temporary MOF.

Capital dredging would be carried out with a combination of mechanical dredging and hydraulic cutterhead dredging. The total preliminary estimated volume that would be dredged at these locations is approximately 800,000 cubic yards, with maintenance dredging during the period of construction potentially required. The dredged material is anticipated to be a combination of sandy silt and sand with hard packed clay. Disposal of the MOF dredge would be spread over about 1,200 acres over two years.

It is anticipated that maintenance dredging would be required to maintain the berths for the temporary MOF and approach at required depths. A detailed discussion of the initial sedimentation modeling sedimentation rates is provided in Resource Report No. 1, Section 1.4.1.2 (Marine Terminal Dredging).

Dredging operations during construction of the temporary MOF would cause a temporary, localized increase in turbidity and sedimentation in the marine waters of Cook Inlet. Turbidity and sedimentation rates are naturally high in the Upper Cook Inlet due to the abundance of glacial sediments and strong currents. Suspended sediment concentrations in Upper Cook Inlet range from 100 to 2,000 parts per million, increasing northward (see Section 2.3.1.1). Additional mobilization of sediment is not anticipated to have significant impacts.

Several disposal and/or reuse options are under consideration and will be submitted in the USACE application and applicable ADNR, Division of Land, Mining and Water authorizations. The preferred disposal site for dredged materials is an offshore unconfined aquatic disposal site located in state waters within 5 miles of the dredged area at water depths greater than 80 feet and dispersive currents. The method of dredge disposal would be a split hull barge over the disposal site. The strong tidal currents of Cook Inlet would naturally disperse the sediment from the disposal site.

Disposal of dredged sediments would cause a localized, short-term increase in turbidity and sedimentation in the vicinity of the disposal site for the duration of disposal activities. Currents would be expected to rapidly entrain and remobilize any sediments deposited. The method of disposal selected is intended to minimize impacts on turbidity and sedimentation. Disposal of sediments via pipeline allows for a slower discharge rate than barge disposal. Additionally, the discharge pipeline can be submerged below the water surface, so that the sediment is not exposed to the entire water column. This further minimizes the plume of turbidity, and reduces the volume of water subject to the increased turbidity. Having a disposal site in close proximity (within 5 miles) to dredging operations allows for this direct pumping disposal method. Furthermore, dredging operations would be conducted during the months of April through October, when sea ice is not anticipated to be present at significant levels. Sea ice is therefore not anticipated to cause an impact on dredging operations. Mitigation measures would be implemented as outlined in the Project *Dredging Plan*, which will be submitted with the USACE permit application. The months proposed for dredging coincide with the recreational and commercial fishing seasons. Potential impacts and mitigation for these activities are discussed in Resource Reports Nos. 3 and 8.

Based on sediment samples from other Cook Inlet sites, dredged sediments are not anticipated to contain significant levels of contaminants. Suspended and bottom sediments from Cook Inlet have previously been sampled and have been shown to contain low levels of anthropogenic hydrocarbon contaminants (see Section 2.3.2.1). At the temporary MOF dredge site, sediments are relatively high density and contain hard clay, suggesting that they are not recent deposits that may contain anthropogenic contaminants. It is likely that the sediments contain low levels of contaminants and would be suitable for unconfined, open water disposal. Site-specific sediment sampling and analysis results and the potential impacts of dredging and dredge disposal based on these results will be submitted to FERC when available.

The data from NOAA, Current Station COI0802, which is the closest NOAA ADCP station near the Project site, shows that near the Marine Terminal site, the Depth-Averaged Current maximum velocity is 5 feet/second (3 knots) with a probability of exceedance 10 percent or 7 feet/second (4.1 knot) with probability of exceedance 2%. Further offshore, at NOAA Station CO10504 (approximately one nautical mile towards the center of the Cook Inlet) the current speed slightly increases to 6.5 and 7.99 feet/second (3.5 and 4.7 knots). The current direction and velocity are illustrated in Table 2.3.8-1 and Figures 2.3.8-1 and 2.3.8-2.

TABLE 2.3.8-1

Scatter Table of Mean Current Direction vs Depth-Averaged Current Speed at Station COI0504

Mean Cur. Dir (°N)	Current Speed (ft/s)										Sum
	0.0-0.99	1.00-1.99	2.00-2.99	3.00-3.99	4.00-4.99	5.00-5.99	6.00-6.99	7.00-7.99	8.00-8.99	9.0-9.99	
0.0	1.62%	3.77%	3.04%	2.44%	2.76%	2.34%	0.15%	0.00%	0.00%	0.00%	16.12%
22.5	1.15%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.17%
45.0	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.54%
67.5	0.41%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.41%
90.0	0.41%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.41%
112.5	0.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.65%
135.0	0.82%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.85%
157.5	2.05%	3.53%	2.83%	2.99%	3.51%	2.05%	0.49%	0.00%	0.00%	0.00%	17.46%
180.0	0.19%	1.04%	2.51%	3.96%	5.91%	9.35%	6.12%	0.14%	0.00%	0.00%	29.22%
202.5	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%
225.0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
247.5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
270.0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
292.5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
315.0	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
337.5	0.20%	0.68%	2.04%	3.44%	4.65%	8.27%	9.88%	3.51%	0.47%	0.00%	33.15%
Sum	8.10%	9.08%	10.42%	12.83%	16.84%	22.01%	16.64%	3.65%	0.47%	0.00%	100.00%

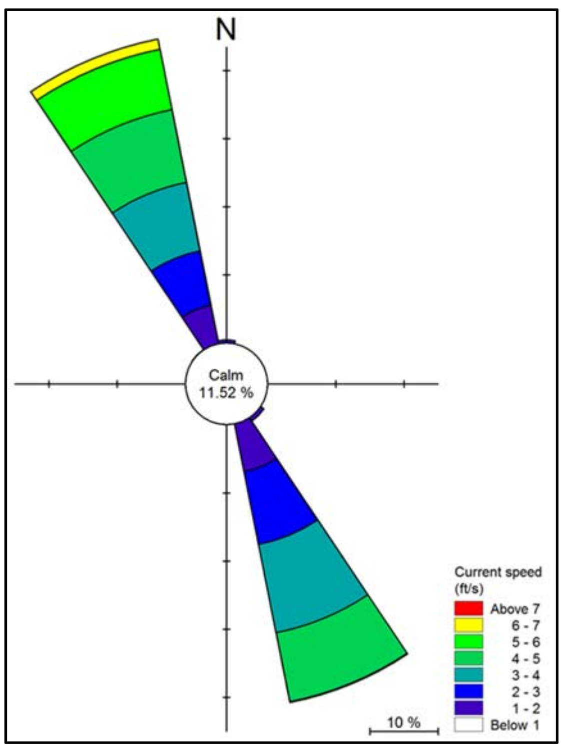


Figure 2.3.8-1 Averaged Current Rose at Station COI0802

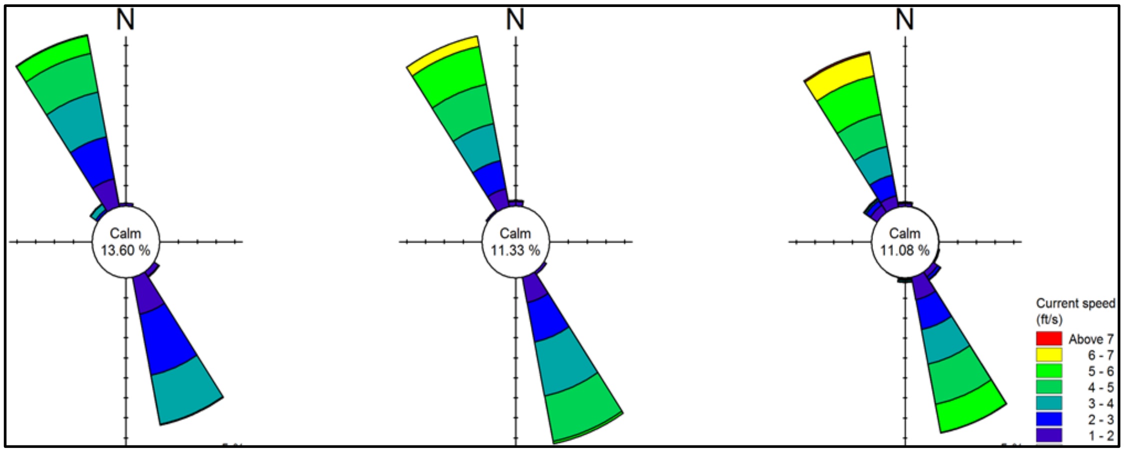


Figure 2.3.8-2 Current Roses at Station COI0802 (left to right, Near-Bottom, Mid-Depth, Near-Surface)

The Site-Specific Current measurement performed in 2015–2016 by Alaska LNG and subsequent Extreme Value Analysis shown that Depth-Averaged Current Speed can reach 6.85 feet/second (4.1 knot) for 1 year return period and 7.38 feet/second (4.4 knot) for 100 year return period (see Table 2.3.8-2).

TABLE 2.3.8-2

Estimated Extreme Depth-Averaged Current from Site Measurement Data (11-Dec-13 to 13-Oct-15)

Return Period (years)	Depth-Averaged Current Speed (ft/s)
1	6.85
5	7.03
10	7.11
20	7.19
30	7.24
60	7.32
100	7.38

At these current speeds, suspended sediment plumes quickly disperse. Predominant current directions indicate little opportunity for plumes to reach more coastal waters.

2.3.8.1.2.2 Marine Facility Construction

Installation of the PLF and temporary MOF dock would cause a minor, temporary, localized increase in turbidity. Installation of structural supports on the seafloor would disturb loose sediments, introducing them into the water column and thereby increasing the turbidity of the marine water at the work site. The plumes of elevated suspended sediment concentrations are not anticipated to extend significant distances from the work sites. The marine waters at the Marine Terminal site are naturally very turbid, and the temporary, localized increase in turbidity from dock installation is not anticipated to have any significant impacts on marine waters. The additional small volume of disturbed sediment would be distributed by currents and redeposited on the surrounding seafloor.

Following the Project *SPCC Plan* and regulatory requirements would reduce the potential impact of a spill if it were to occur during construction.

2.3.8.1.2.3 Navigation and Vessel Traffic

Vessel movements are not expected to contribute to ambient turbidity or to shoreline erosion, due to the necessarily low speeds mandated for operational safety in and near the Marine Terminal.

Oceangoing vessels that deliver materials for construction of the Liquefaction Facility may use ballast water and cooling water. Section 2.3.9.1.2.2 addresses the protocol for ballast and cooling water discharge and applicable permitting requirements.

2.3.8.2 Interdependent Project Facilities

Waterbodies that would be affected by the proposed Interdependent Project Facilities are listed in Appendix H. No waterbodies would be crossed by the PBTL and GTP facility. Mainline routing has avoided numerous waterbodies within the Project corridor. Potential construction impacts on surface waterbodies could result from various Project activities such as clearing, grading, trenching, constructing across waterbodies, blasting, and surface water withdrawals (e.g., for hydrostatic test water, dust suppression and road maintenance, ice road and work pad construction, buried trenchless method fluid makeup, and potable water). A discussion of the potential construction impacts and avoidance/minimization measures is provided as follows.

2.3.8.2.1 Mainline

Waterbodies would be crossed using a number of different crossing methods, which are summarized in Section 1.5.2.3 of Resource Report No. 1, Waterbody Crossing Methods and in the Applicant's *Procedures*. The Mainline design would be a belowground pipeline and the PBTL and PTTL would be aboveground on VSMs.

Crossing installations would be performed in accordance with construction specifications and all terms and conditions included in each crossing permit. If local conditions at the time of the planned installation dictate that the planned installation method is not feasible, a site-specific crossing plan will be prepared for review and approval by the corresponding authorities.

Pipeline construction could affect surface waters in several ways. Clearing and grading of stream banks, in-stream trenching, trench dewatering, and backfilling could result in modification of aquatic habitat, increased sedimentation, turbidity, decreased dissolved oxygen concentrations, releases of chemicals and nutrients from sediments, inadvertent release of drilling mud during the buried trenchless method operations, and introduction of chemical contaminants such as fuel and lubricants. The use of surface waters and groundwater for hydrostatic testing, dust abatement, and vehicle washing could directly or indirectly affect surface water volumes.

Most water use during construction would be temporary and would need to be discharged when no longer needed for construction activities. Fresh water for use during construction would be sourced from rivers and lakes adjacent to the Project area. Details of the required water volumes, sources, and testing procedures are provided in the Project *Water Use Plan* (Appendix K). Tundra ice roads and work pads would be built using water from rivers, lakes, and/or mine sites. Seawater would not be used at any terrestrial locations.

As discussed in the following sections, no long-term, significant impacts on surface waters are anticipated as a result of the Project because designated water uses would not be permanently affected, erosion controls would be implemented, and the streambanks and streambed contours would be restored as close as practical to preconstruction conditions. A variety of measures would be implemented to minimize impacts on aquatic habitats and water quality, including: 1) the use of dry-ditch methods to ensure that aquatic species are not directly affected by construction, 2) aerial and buried trenchless crossings to avoid disruption of habitat; restoration of disturbed habitat to preconstruction conditions to the extent practicable, 3) minimization of vegetation clearing along waterbodies, 4) setbacks from waterbodies for storage and use of potentially hazardous materials, 5) implementation of erosion and sediment control to avoid sedimentation, and 6) direct lay for Cook Inlet pipeline crossing. Further, the measures in the buried trenchless method contingency plans would be implemented to avoid or minimize the risk of drilling mud release, as well as procedures that would be followed if an inadvertent release does occur. Through implementation of these measures, it is anticipated that the impacts on aquatic and riparian habitats and water quality would be short-term and minimized to the extent practicable.

2.3.8.2.1.1 Waterbody Crossings

The Mainline would be constructed in four spreads (or sections), over a period of two years during winter and summer (see Resource Report No. 1, Section 1.5.2.3 for more detail). Several factors were considered when defining sections of the Mainline as winter or summer construction, including climate, geologic conditions, and the local terrain's ability to support construction equipment during summer. Generally, the selection of winter construction was based on the presence of permafrost and/or swampy terrain and relatively flat terrain. Proposed crossing methods based on each waterbody's characteristics and site-specific conditions would be identified as follows:

- If the waterbody is dry or frozen to the bed, cross the waterbody using standard upland construction techniques in accordance with the Applicant's *Plan* and *Procedures* (labeled as open cut or frozen cut in Table 2.3.8-3, depending on season);
- If the waterbody is flowing, assess the type of fish and fish habitat present within the affected reach and determine whether an open-cut timing window is available;
- If the potential fisheries impact is rated as acceptable, and if an open-cut timing window is available such that instream work can be completed within the timing window, proceed with the installation using the open-cut crossing method;
- If an open-cut timing window is not available or is too short to complete the instream work, consider use of isolated (dry ditch) crossing methods (labeled as isolation cut in Table 2.3.8-3); and

- If the potential fisheries impact is rated as not acceptable, and if isolated crossing methods or alternate crossing locations are not feasible or appropriate, consider using a buried trenchless crossing method such as HDD (a minimum practical length of 1,700 to 1,900 feet on level terrain is required for using the HDD method with large-diameter pipe), Direct Micro-tunneling (DMT), boring, or aerial span crossing (labeled as buried trenchless or aerial span in the Table 2.3.8-4).

The Mainline would be collocated with existing ROWs for more than three quarters of its length and would be buried for almost the entire length with the exception of four aboveground river crossings. The Mainline and PTTL would cross 612 waterbodies using a combination of crossing methods including open cut, dry ditching, aerial span, and buried trenchless. Approximately half of the crossings would be constructed in the winter using frozen-cut construction methods for most of those crossings.

Table 2.3.8-3 lists the number of waterbody crossings that would be constructed during summer or winter, the classification of the waterbody, and the proposed crossing methods. Crossing installations would be performed in accordance with the Applicant's *Procedures* construction specifications and all terms and conditions included in each crossing permit. If local conditions at the time of the planned installation dictate that the planned installation method is not feasible, a site-specific crossing plan would be prepared for review and approval by the corresponding authorities.

TABLE 2.3.8-3

Waterbody Crossings by FERC Classification and Crossing Method Along the Right-of-Way

FERC Class [a]	Proposed Crossing Method [b]	Summer Construction	Winter Construction
Mainline Pipeline			
Minor	Aerial Span	1	--
	Dry Ditch	42	54
	Frozen Cut	1	99
	Open Cut	166	49
	Minor Total	***210***	***210***
Intermediate	Dry Ditch	30	26
	Frozen Cut	--	3
	Open Cut	21	11
	Intermediate Total	***69***	***51***
Major	Aerial Span	1	--
	Open Cut	1	3
	Trenchless	1	--
	Open Cut /Direct Pipe lay	5	--
	Major Total	***7***	***8***
	Mainline Pipeline Total	**271**	**269**
PTTL Pipeline			
Minor	Aerial Span	-	94
	Open Cut	-	1
	Minor Total	***-***	***95***
Intermediate	Open Cut	-	1
	Intermediate Total	-	***1***
Major	Aerial Span	-	1
	Open Cut	-	1

TABLE 2.3.8-3

Waterbody Crossings by FERC Classification and Crossing Method Along the Right-of-Way

FERC Class [a]	Proposed Crossing Method [b]	Summer Construction	Winter Construction
	Major Total	**-**	***2***
	PTTL Pipeline Total	**-**	**98**
		Total Waterbodies Crossed by the Project	**612**

Notes:

[a] Based on FERC's *Wetland and Waterbody Construction and Mitigation Procedures* (2013) the definition of waterbodies includes any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing, and other permanent waterbodies such as ponds and lakes. Minor Waterbody is less than or equal to 10-feet-wide at the water's edge at the time of crossing; Intermediate Waterbody is greater than 10 feet wide but less than or equal to 100-feet-wide; and Major Waterbody is greater than 100-feet-wide at the water's edge at the time of crossing.

[b] Proposed crossing method is based on Rev C route for Mainline and Rev B route for PTTL.

[c] Waterbodies that are dry or frozen to the bed would be crossed using standard upland construction techniques in accordance with the Applicant's *Plan*. Crossing methods defined as (buried) Trenchless - HDD or Direct Micro-tunneling (DMT); dry-ditching methods (i.e., dam and pump, flume, and channel diversion); and Aerial Span – aboveground supported by VSMs or a plate girder bridge. Aerial Span crossings are aboveground with no impact to waterbodies.

2.3.8.2.1.2 Winter Construction

Two conditions could be encountered within the waterbody crossings constructed in winter: (1) waterbodies have no flowing surface water, with or without groundwater within the excavation limits; or (2) waterbodies have surface water flow under the snow/ice cover. During winter construction, most waterbody crossings would not have flowing water and would use the frozen cut method (Table 2.3.8-3). Excavation through waterbodies that have no surface water or groundwater flow, or no surface water flow but some groundwater flow, would be accomplished with a trenching machine or conventional backhoe using upland construction techniques. Because construction equipment would generally be working off frozen ground or on the ice across the waterbody and not working instream, the area of streambed disturbance during excavation and backfill would be minor. Because there is no surface flow, sediment would not be transported downstream during construction at the crossing. Material excavated from the waterbody bed during construction, in the vast majority of cases, would be backfilled into the trench after pipeline installation. During spring break up 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 those upstream because higher turbidity levels naturally occur during spring break up and flows.

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 would be employed. In the case of substantial surface flows (flows that exceed the practical limits of isolated methods), a wet crossing constructed by backhoes and/or draglines would be used. In both the open-cut crossing cases, a wet ditch may be present during installation, with water flowing into and out of the excavation. This may result in temporary impacts on 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 would depend on the coarseness of the excavated and backfill materials and the water velocity. Where the winter conditions are appropriate, dry-ditching methods (dam and pump, dam and flume) may be used. A dry-ditch method would be designed to keep the sediment generated during excavation and backfilling confined to the zone between the isolation dams. Turbid water would be pumped to an upland area away from the waterbody and only clear water would be discharged back into the waterbody. Minimal downstream impacts may occur from sediment that is generated during installation and removal of the dams. Material excavated from the waterbody bed during construction, in the vast majority of cases, would be backfilled into the trench after pipeline installation.

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

To reduce overland soil erosion and sediment discharge during and following winter construction, the appropriate sections of the Applicant's *Plan* and *Procedures* would be followed. Appropriate erosion control measures would be installed prior to spring thaw. Appropriate erosion control measures would be installed prior to spring thaw. ATWS areas may not be required at some waterbody crossings constructed during winter where typical overland construction across the frozen waterbody without the need for tie-ins can be done. Surface water quality impacts resulting from pipeline construction in winter would be temporary and minor for winter waterbody crossings.

2.3.8.2.1.3 Summer Construction

For streams crossed during unfrozen, summer conditions, the timing requirements in the permits and implement the erosion control methods and bank stabilization revegetation measures outlined in the Applicant's *Plan* and *Procedures* would be followed to reduce short- and long-term impacts on the waterbodies crossed by the pipeline route. As indicated in Table 2.3.8-3, about half of the crossings would use the open-cut method, and most of the rest would use the isolation cut method.

The open-cut method would use heavy equipment such as backhoes to cut a trench through minor- or intermediate-sized streams. For the larger and deeper crossings, barge-mounted equipment or a dragline would be used to cut the trench through the stream. In-water work would proceed quickly to minimize instream impacts. The pipe would be installed by walking the pipe in or the pipe would be pulled across. Impacts from the open-cut method include disturbance of the stream banks and streambed for the width of the ROW, increased downstream turbidity from sediments disturbed during construction, increased bank erosion of exposed soils from stream flows or precipitation, and disturbance of instream biota and geomorphic features.

Isolation cut, also referred to as open cut with flow isolation or dry ditch, uses flow barriers up- and downstream of the crossing to block flows through the ROW and divert them either around or through the active construction area. For streams with low flows, blocked water can be pumped around the construction area, or, for streams with higher flows, water can be diverted using a pipe, flume, side channels, or the other portions of the floodplain. Flows can be blocked using several types of flow isolation structures including aquadams, super sandbags, ecology blocks, or steel plating, depending on the riverbed composition, flows, and season of construction. For larger rivers with a mid-channel island or bar, flow may be diverted down one side and then the other while construction occurs on the dry side. Each crossing would be evaluated for the most appropriate method to be used. Due to variable flows during summer, flow isolation techniques would also be used in the fall and winter when flows are lower and more predictable. Impacts of the dry-ditching crossing method include bank and streambed disturbance, temporary modification of flows, and potential fish mortality during dewatering. Advantages over the open-cut method include reduced turbidity and sedimentation during crossing construction, although there would still be some sediment released downstream once flows are restored.

Mitigation for open-cut, frozen-cut, and dry-ditch crossings would include backfilling trenches with natural bed material at the natural grade, stabilization of banks within 24 to 48 hours of completing instream work, completing channel restoration prior to returning flows to the channel (isolation cut), removing equipment bridges as soon as practical, restoring riparian vegetation with native species where practical, using native bank stabilization materials such as root wads and boulders, and real-time adaptations to local conditions (see Applicant's *Procedures*). Streams with anadromous fish species have been identified, and construction would occur during the appropriate time of the year in compliance with permit requirements (described in more detail under the subsequent Potentially Sensitive or Specially Designated Waterbodies section and in Resource Report No. 3). Where necessary and for all major crossings, site-specific crossing plans would be developed.

2.3.8.2.1.4 Buried Trenchless and Aerial Span Crossings

Buried trenchless crossings would be used at about half of the major crossings and HDD technology is the likely method for those crossings. HDD technology has advanced over the past decade and has higher success rates due to better preplanning and geotechnical data. A specially designed drill rig is used to drill a hole that curves gradually downward below the river channel and back up to the other side. Table 2.3.8-4 lists the proposed crossings that would use HDD based on preliminary design.

TABLE 2.3.8-4

Proposed Buried Trenchless Crossings

Waterbody Name	Milepost	Entry and Exit Length (feet) [a]	Drill Direction	Season
Middle Fork of the Koyukuk River	211.5	2,629	North	Summer
Yukon River	356.8	2,691	North	Summer
Tanana River	472.6	3,129	South	Summer
Chulitna River	642.1	2,653	North	Summer
Deshka River	704.8	1,302	North	Summer

Note:

[a] HDD or Direct Micro-tunneling (DMT)

The main advantage to using HDD is that no construction occurs within the river channel and therefore impacts on water quality and the river channel are effectively eliminated. Impacts include larger ATWS areas set back from the channel to support the drilling rig, drilling pad, support equipment, drilling mud, and the need to fabricate the length of pipe to be placed in the hole. Drilling mud must also be prepared and has the potential to leak at the preparation site or from the drill hole itself, depending on the pressures and substrate encountered. Drilling mud is composed of approximately 80 percent water and 20 percent bentonite clay. In the event of a release to a stream, the amount of change in turbidity levels would depend on the stream size and background turbidity levels. There is a potential for bentonite clay to be carried downstream and settle on the stream bottom and affect fish eggs (if present).

A site-specific plan would be prepared for each proposed buried trenchless method 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. The drill would be monitored for loss of drilling fluids during construction and the upland containment area, the ground surface, and the waterbody being crossed would all be visually inspected continuously. Prior to the commencement of buried trenchless method operations, containment structures would be installed at the entrance and exit points of the drill. Sand bags, silt fencing, hay bales, earthen berms, vacuum pumps, and/or other materials determined necessary by the Contractor and Environmental Inspector would be staged on-site before drilling begins. Additionally, in the event of any inadvertent release of drilling mud into the waterbody or adjoining areas, the construction crew would implement mitigation procedures as outlined in the *HDD Inadvertent Release Contingency Plan* (Appendix L).

Aerial span crossings would be used for two primary reasons along the Mainline: difficult terrain or geologic fault lines. The proposed plan is to use aerial crossings at two locations as listed in Table 2.3.8-5.

TABLE 2.3.8-5

Proposed Aerial Crossings

Waterbody Name	Milepost	Aerial Length (feet)	Reason	Type of Aerial Crossing	Season
Nenana River #3	532.0	1,102	Terrain	Triple Span; Plate Girder Bridge	Summer
Lynx Creek	537.9	534	Terrain & Seismic	Suspension bridge	Summer

The proposed aerial span crossings are essentially bridges installed across the waterbody for the pipe. Single-span bridges cross the entire waterbody with no in-channel pilings; multiple span aerial crossings have one or more mid-span supports. All of the proposed crossings use the plate girder bridge design with pilings and abutments outside of the high water channel. Impacts from aerial crossings include construction work at the edges of river channels and the possibility of some instream work for bridge and pier construction. Mitigation includes site-specific crossing designs, adherence to the Applicant's *Procedures* (Appendix M) and *SWPPP* (Appendix J), and minimal to no instream disturbance or work. Construction would adhere to the *SPCC Plan* (Appendix M) to reduce potential for a release of liquid fuels, lubricants, hydraulic fluids, etc. that could impact surface waters.

The buried trenchless and aerial crossing techniques, when properly implemented, would have temporary and minor water-quality impacts. There is potential for buried trenchless method drilling mud releases, but the site-specific plan and the *HDD Inadvertent Release Contingency Plan* (Appendix L) would minimize impacts so that they would be temporary and minor.

2.3.8.2.1.5 Nearshore and Offshore Trenching

The Mainline would be laid on the seafloor via conventional pipe lay for the majority of its 28.1-miles of the offshore crossing of Cook Inlet. The pipeline would need to be buried from the shoreline out to a depth such that the top of the pipe is sufficiently protected from major hazards. This depth is expected to be between -12 to -41 feet (MLLW). Future studies will be performed to support the selection of a burial distance and depth that best minimizes the prevailing risks.

Offshore trenching would be conducted during the months of April through October, when sea ice is not anticipated to impact offshore trenching activities. The trench for each shoreline is expected to be constructed using amphibious or barge-based excavators to trench to a transition water depth where a dredge vessel can be employed. A backhoe dredge may also be required to work in the nearshore region. Geotechnical investigations and future studies will be performed to support the excavation method selection. Alternative excavation methods such as plowing or jetting will also be considered.

It is unlikely that sheet piles would be necessary along the trench sides prior to excavation and the presence of boulders could potentially prevent driving of sheet piles. Similarly, the use of pilings in the high currents of Cook Inlet is not considered practical. Therefore, the trench basis is to excavate a shallow slope trench that would not retain sediments (i.e., a self-cleaning trench).

Resource Report No. 1, Table 1.5.2-8, provides a summary of offshore trenching requirements. Based on the bathymetry of Cook Inlet and for a burial distance out to -45 feet (MLLW), the buried shore approaches could extend up to approximately 6,600 feet at Suneva Lake Shore Approach to 8,800 feet at Beluga Landing South Shore Approach. The shoreline approaches would be installed using an open-cut method, similar to the majority of the pipelines previously installed in Cook Inlet. Preliminary estimates of the amount of nearshore dredging required could include up to approximately 123,000 cubic yards for the Suneva Lake Shore Approach crossing and 163,000 cubic yards for the Beluga Landing South Shore Approach crossing depending on the trench slope and distance selected. As previously noted, the depth and extent of pipeline burial would be finalized in later stages of the Project, so the estimates provided in Resource Report No. 1, Figure 1.5.2-8, are subject to change.

Following pipeline installation, the trench is expected to naturally backfill. Backfilling is anticipated to occur rapidly, within a matter of several days. If manual backfilling is required, the trench would be placed by reversing the flow of the trailing suction hopper dredger used offshore (see Resource Report No. 1) or mechanically with the use of excavators.

Increased turbidity and sedimentation as a result of offshore trenching in Cook Inlet are anticipated to be temporary, minor, and localized. Turbidity and sedimentation rates are naturally high in the Upper Cook Inlet due to the abundance of glacial sediments and strong currents. Suspended sediment concentrations in Upper Cook Inlet range from 100 to 2,000 parts per million, increasing northward (see Section 2.3.1.1). Any sediments mobilized by trenching operations would be rapidly redistributed by strong currents and tides. Additional mobilization of sediment in the vicinity of trenching operations is not anticipated to have significant impacts on water quality.

2.3.8.2.1.6 ROW Preparation and Trenching

Construction activities for the ROW would include clearing vegetation, grading over the centerline, and excavating a trench for pipeline installation across streams. The primary construction impacts to surface waters would be from excavation in waterbodies at stream crossings (discussed in prior sections).

Vegetation would be removed using heavy equipment. Clearing of vegetation reduces shading in the stream and may result in decreased infiltration due to soil compaction and reduced interception, causing an increase in local runoff until vegetative cover is reestablished. Work sites would be stabilized during construction to reduce surface erosion and siltation. Stabilization work would be done using BMPs outlined in the Applicant's *Plan* and the *SWPPP*. Installation and maintenance of temporary and permanent environmental mitigation measures would depend on site-specific conditions and needs. Erosion control techniques include slope drainage (diversion berms, rock flumes, control structures), revegetation (seeding, hydroseeding, live staking), rolled and layered erosion control (jute mats, wattles), barriers and fencing (silt fences, straw bales, filter berms, brush barriers), mulching and blanket erosion control (mulching, wood chips, granular blankets), streambank protection (live staking, vegetation plugs, vegetative strips), and other techniques such as roughening and terracing, outlet energy dissipation, and sediment ponds. Impacts would be greatest during construction and until the surface contour and vegetation is reestablished.

Erosion control measures would be installed after initial disturbance of the soil, and would be left in place and repaired, replaced, and supplemented as required through the end of the construction period to minimize surface soil erosion that could occur as a result of the spring thaw and snowmelt or summer precipitation events. Erosion and sedimentation control measures would be monitored and maintained to ensure function according to the Applicant's *Plan*, *Procedures*, and *SWPPP*.

Winter construction generally has fewer impacts than summer season construction due to the frozen conditions and lack of flowing water. More vegetation can be preserved under packed snow and ice work surfaces. Impacts of winter clearing and grading include compaction of underlying soils and emplacement of ice pads and roads to facilitate construction that may not melt until adjacent snow has melted, which could temporarily block or disrupt surface flow patterns. Ice-rich soils on sloping terrain can melt during warm summer months causing slumping and erosion of the soil-water mixture. Proposed mitigation approaches include constructing a granular berm on the downslope side to allow water drainage and to trap soil particles.

Summer construction would have greater impacts than winter construction, as a result of the larger construction footprint, muddy soils, direct contact with surface vegetation and soils, and exposure to streamflows, precipitation, and runoff. Impacts from summer clearing and grading include soil compaction, reduced infiltration, removal of soil-retaining vegetation and organic matter, exposure of soil to splash, rill, and gully erosion, interception of surface and subsurface flows, and increased chance of erosion and sedimentation. During summer construction periods, crossing wet or unstable soils containing high-moisture content may require the use of construction mats, log corduroy, geotextile products, or combinations thereof to condition the work surface to support heavy construction equipment and reduce rutting.

During clearing activities, temporary bridges would be installed where necessary across waterbodies to allow construction equipment and personnel to proceed and to reduce waterbody impacts. Temporary bridges would be removed when construction and reclamation activities are complete. Unless specifically designed to withstand flood flows, bridges would also be removed prior to snowmelt. A number of bridging methods would be used for access during construction to cross waterbodies, depending on season of use and waterbody flow and width (see Onshore Pipeline Construction Procedures in Resource Report No. 1).

Potential impacts due to clearing and grading would be reduced or eliminated with adherence to the BMPs provided in the Applicant's *Plan* and *SWPPP*. Environmental Inspectors would be present to oversee contractor compliance with Project BMPs included in these plans. Following construction, the pipeline ROW would be returned to approximate preconstruction contours (at stable repose) and restored as per the Project *Restoration Plan* (Resource Report No. 3, Appendix P). The vegetative cover would serve to slow water runoff rates that may have been diminished during ROW clearing. Given the transient nature of the construction and adherence to the BMPs provided in the Applicant's *Plan* and *SWPPP,* impacts to surface water due to disturbance to ground cover are expected to be temporary and minor.

2.3.8.2.1.7 Restoration/Revegetation

Following construction, waterbody crossings would be restored to preconstruction contours and drainage patterns in accordance to the Applicant's *Procedures*. Maintenance of the pipeline ROW would be conducted according to the measures outlined in the Applicant's *Plan* and *Procedures*. The Appl would be responsible for ensuring successful revegetation of soils disturbed by Project-related activities, or in other areas where application of thermal stabilization measures precludes revegetation (such as where a permanent mulch or other ground cover has been installed) as outlined in the Project *Restoration Plan* (see Appendix P, Resource Report No. 3) will be provided during permitting. Restoration and revegetation activities would have temporary and long-term positive impacts on water quality and runoff rates.

2.3.8.2.1.8 Hydrostatic Testing

Hydrostatic testing is the process used to pressure test the pipeline and other piping with water to identify potential leaks. Hydrostatic testing of the Mainline and Aboveground Facilities is estimated to require approximately 298 million gallons of water (see Table 2.3.11-6) over the three-year period.

The proposed hydrostatic test approach is based on testing of up to 20-mile long sections of the Mainline mainly in the summer. This involves filling the test section of pipe, bringing the water up to pressure, holding for the test period, and dewatering. It is currently not planned to transfer water between test sections, but this flexibility would need to be maintained to implement a plan that reduces water use and impacts to water bodies and therefore cascading water from test section to test section may be necessary and would result in discharge to a different basin from the source water. A preliminary identification of potential water sources, current permitted users and their volumes and the Project's needs are provided in the Project *Water Use Plan* (Appendix K). These quantities and the final sources would be provided prior to permitting.

The withdrawal of large volumes of water from the surface water sources could temporarily affect the recreational and biological uses of the resource if the diversions constitute a large percentage of the source's total flow or volume. Water withdrawals could also result in temporary loss of habitat, change in water temperature and dissolved oxygen levels, and entrainment or impingement of fish or other aquatic organisms. The intake line would be screened to prevent entrainment of debris and fish. The screen around the intake would be fabricated to provide an adequate surface area of fine-meshed screen to reduce the approach velocity and reduce the risk of impingement or entrainment of small fish, larvae, and eggs. The intake hose and screen would be kept off the bottom of the waterbody to avoid sediment uptake. Resource Report No. 3 further discusses potential impacts on aquatic resources due to water withdrawals.

The necessary permits and approvals from state and federal agencies would be acquired and water rights would be complied with or obtained before appropriating surface waters including a Fish Habitat Permit from ADF&G and a Temporary Water Use Authorization from ADNR. The potential effects of water withdrawals from surface waters would be reduced by adhering to measures in Applicant's *Procedures* (Appendix N) and permit limits. Adequate flow rates to protect aquatic life, provide for all waterbody uses, and provide for downstream withdrawals of water by existing users would be maintained during intake from fresh water sources. Water withdrawal rates would be monitored to avoid significant impacts on stream flow or downstream water users and resources.

TABLE 2.3.8-6

Estimated Water Requirements for Hydrostatic Testing of the Mainline and Aboveground Facilities

Construction Spread / Facility Group	**Estimated Volume (Mgal)**
Mainline (ML) Spread 1	74.34
ML Spread 2	68.29
ML Spread 3	73.58
ML Spread 4	61.21
Offshore Pipeline	9.70
Aboveground Facilities	10.46
Preliminary Water Requirements Total	**297.57**

The proposed testing plan calls for Mainline Hydrostatic testing to take place in the summer. Biocides and/or anti-freeze agents during pipeline testing would only be used during shoulder season work or where test water sources contain bacteria or on the North Slope. Any proposed biocide or anti-freeze use would be coordinated with permitting agencies.

Hydrostatic test water discharges would be performed in accordance with all applicable state water regulations and federal and state discharge requirements. On the Arctic Coastal Plain, hydrotest water would be discharged to permitted UIC wells. Outside of the Arctic Coastal Plain, hydrostatic test water would be discharged into erosion control devices in upland areas to minimize the potential for scour, erosion, and sedimentation into nearby wetlands and waterbodies in accordance with the Applicant's *Procedures* (Appendix N) and would comply with applicable regulatory requirements.

In most instances, the hydrostatic test water discharge would have similar water quality characteristics as the source waterbody. Following testing of long pipeline segments, the test water would contain particulate mill scale (rust) which would settle out in the dewatering structure during dewatering. Hydrostatic test water for marine crossing hydrostatic testing would be discharged in Cook Inlet in accordance with applicable regulatory requirements. All hydrostatic test water discharges would be done under the supervision of the Environmental Inspectors. Based on compliance with state and federal permit conditions and implementation of BMPs in the Applicant's *Procedures*, it is anticipated that impacts from hydrostatic testing would be temporary, short-term, and minor.

2.3.8.2.1.9 Blasting

Blasting would be required during construction for excavation at material sites and where boulders, bedrock, or certain permafrost terrain conditions are encountered near the ground surface and mechanized fracturing and excavation are not practicable. In-stream blasting has the potential to injure or kill aquatic organisms, displace organisms during blast-hole drilling operations, and temporarily increase stream turbidity. Blasting explosives and detonators commonly contain perchlorate or ammonium nitrate fuel oil that may leave residues after blasting and contaminate water resources. However, specialized trench-blasting explosives lacking these components would be used. To minimize or avoid these impacts, the BMPs listed in the *Blasting Plan* (Resource Report No. 6, Appendix B) would be followed. All instream blasting permit requirements would be complied with; blasting in sensitive streams during critical periods would be avoided. Any potential impacts to waterbodies from blasting are anticipated to be localized, short-term, and minor.

2.3.8.2.1.10 Dust Suppression and Freeze Down

Dust generated from vehicular and equipment traffic could increase sedimentation of adjacent waterbodies. To minimize this effect, it is proposed to use water from surface water sources for dust control and freeze-down during construction of the Mainline, which would minimize the movement of soil due to wind (see *Fugitive Dust Control Plan*, Resource Report No. 9, Appendix J). The estimated quantity of water required for dust control and freeze-down of the construction ROW of the Mainline is provided in Table 2.38-7. It is estimated that there would be approximately two trucks (15,000 gallons each) running 360 days per year to freeze the ROW or manage dust control on each spread; the actual quantities used would depend on weather patterns each year.

Similar to hydrostatic testing, dust abatement water would not be withdrawn at a rate that would impact the waterbody. The necessary permits and approvals from state and federal agencies would be acquired and water rights would be complied with or obtained before appropriating surface waters, which would include a Fish Habitat Permit from ADF&G, and a Temporary Water Use Authorization from ADNR. Watering rates would be controlled to minimize the amount of water needed and to minimize the chance of sediment runoff. Erosion control measures from road construction would still be in place as described in the *SWPPP*. It is anticipated that impacts from dust suppression and freeze-down would be temporary, short-term, and minor.

TABLE 2.3.8-7

Estimated Water Requirements Dust Control, Freeze-down, and Ice Road/Pad Construction and Maintenance of the Mainline ROW

Activity/Project Facility	Million Gallons per Year (Mgal/yr)	Estimated Volume (Mgal)
Ice Roads and Ice Pads		
Mainline (ML)	-	556.92
Dust Suppression		
ML Spread 1	31.51	126.03
ML Spread 2	31.51	126.03
ML Spread 3	31.51	126.03
ML Spread 4	31.51	126.03

TABLE 2.3.8-7

Estimated Water Requirements Dust Control, Freeze-down, and Ice Road/Pad Construction and Maintenance of the Mainline ROW

Activity/Project Facility	Million Gallons per Year (Mgal/yr)	Estimated Volume (Mgal)
Estimated Water Requirements Total	126.03	1,061.04

2.3.8.2.1.11 Fuel Use, Storage, Refueling, Lubrication, and Spill

Any large construction project presents the potential for spills of fuel or other hazardous liquids from storage containers, equipment working in or near streams, and fuel transfers. Any spill of fuel or other potential contaminant that reaches a waterbody would negatively impact water quality. Impacts to fisheries are further discussed in Resource Report No. 3.

The *SPCC Plan* (Appendix M) would be implemented to minimize impacts related to spills. The *SPCC Plan* specifies preventive measures such as personnel training, equipment inspection, and refueling procedures to reduce the likelihood of spills, as well as mitigation measures such as containment and cleanup to minimize potential impacts should a spill occur. Adherence to the *SPCC Plan* would prevent a large spill from occurring near surface waters because construction equipment fueling would be prohibited within 100 feet of the waterbody banks, and hazardous material storage would be prohibited within 100 feet of waterbodies unless approved through the FERC Order.

During development of the construction infrastructure, temporary fuel storage tanks would be set up at pioneer camps, civil construction spreads, pipeline construction camps, and each spread’s active contractor yard. Interim storage tanks would be located along Dalton Highway and provide fuel for transport trucks. Tanks would have 110 percent secondary spill containment.

All fuel and hazardous material handling needed for construction of the Mainline would be in accordance with ADEC requirements and the *SPCC Plan* (Appendix M) and managed by the Environmental Inspectors. This includes that secondary containment would be used for single-walled containers; storage and construction equipment would be maintained and inspected daily for leaks; and all equipment would be parked overnight or refueled at least 100 feet from waterbody boundaries unless specifically approved by FERC. For some long wetland crossings, it may not be practicable to remove equipment to an upland parking location on a daily basis. In these instances, the Environmental Inspectors would have the contractors take appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined above for the Mainline (Section 2.2.8.2.1.1) would greatly reduce the likelihood of such impacts, as well minimize the resulting impacts should a spill occur. As such, significant adverse impacts to surface waterbodies due to contamination from spills or releases are unlikely.

2.3.8.2.1.12 Sensitive Surface Waters

Special waterbody types determined to be important include those streams listed under Alaska's Anadromous Waters Catalog, the National Wild and Scenic Rivers System, the Nationwide Rivers Inventory, the Rivers Act, the Alaska Impaired Waterbodies list, and waterbodies that contain threatened or endangered species or critical habitats. Each of these stream types requires special consideration and potential additional permitting requirements, and careful planning to ensure that adverse effects are avoided or minimized.

No National Wild and Scenic designated rivers are crossed by the Project. Impacts and mitigation measures to anadromous waters are discussed in Resource Report No. 3. Appendix H to Resource Report No. 3 lists the season and proposed crossing method for each anadromous fish stream crossing. Most of the crossings would be constructed in the winter when flows are reduced or the stream is frozen, which would reduce likelihood of disturbing habitat and would minimize water quality impacts.

The Deshka River (MP 704.7) and Alexander Creek (MP 727.8) are on the National Rivers Inventory for having ORVs. These rivers all have popular recreational and sport fisheries (Section 2.3.5.3). The proposed crossing method for the Deshka River would be the buried trenchless in the summer and Alexander Creek would be crossed in winter using the dry-ditch method to reduce turbidity and habitat impacts as described in prior sections. Additional information can be found in Appendix I, *Site-Specific Construction Drawing; Site-Specific Waterbody Crossing Plans* for crossing details for the Deshka River.

There are no waterbodies within the Project area that are designated as CWA Section 303(d) impaired for water quality based on the 2010 approved integrated report (ADEC, 2010b). Additionally, no new waterbodies are included in the 2012 Integrated Report that is pending final EPA approval (ADEC, 2013). According to its website, ADEC is currently soliciting water quality information for the 2014–2016 Integrated Report.

2.3.8.2.2 Prudhoe Bay Transmission Line

2.3.8.2.2.1 Waterbody Crossings

The PBTL would not cross any waterbodies. The approximate 1-mile-long, aboveground PBTL would be constructed aboveground on VSMs using ice roads and pads to minimize impacts on the tundra and surrounding habitat during winter, when surface water and the permafrost active layer are frozen. Water use for construction (i.e., hydrostatic test water and ice road/pad) would be sourced from surface water/mine site resources. Water used for ice road and pad construction is further discussed under Pipeline Associated Infrastructure. Because the pipeline would be aboveground, dewatering and trenching would not occur.

2.3.8.2.2.2 Hydrostatic Testing

PBTL would be hydrostatically tested in conjunction with the GTP facility pipelines and is discussed in the Gas Treatment Plant section.

2.3.8.2.2.3 Fuel Use, Storage, Refueling, Lubrication, and Spills

Potential surface water impacts and mitigation measures for the use and storage of hazardous materials (including fuel spills or leaks) during construction of the PBTL would be the same as those discussed in the PTTL section under Fuel Use, Storage, Refueling, Lubrication, and Spills. All fuel and hazardous material handling needed for construction of the PBTL would be in accordance with ADEC requirements and the Project *SPCC Plan* (Appendix M), the Project *Waste Management Plan* (Resource Report No. 8, Appendix K), and managed by the Environmental Inspectors. This includes a secondary containment that would be used for single-walled containers; storage and construction equipment that would be maintained and inspected daily for leaks; and all equipment that would be parked overnight or refueled at least 100 feet from waterbody boundaries where practicable. Hazardous waste would be stored temporarily and transported by licensed carriers to an out-of-state EPA-registered treatment, storage, and disposal facility. For detailed procedures on managing hazardous and non-hazardous solid and liquid wastes generated for the proposed Project, refer to the Project *Waste Management Plan.*

2.3.8.2.3 Point Thomson Transmission Line

2.3.8.2.3.1 Waterbody Crossings

The PTTL would cross 98 waterbodies (see List of Waterbodies Crossed by the Project in Appendix H). Three named waterbodies (i.e., Shaviovik River, Kadleroshilik River, and Sagavanirktok River Main Channel) would be buried with conventional open-cut methods in the winter. Alternate crossing methods for the above-mentioned named crossings are discussed Resource Report No. 10, Appendix E. The remaining crossings would be installed with aboveground pipeline crossings (i.e., aerial span). The West Channel of the Sagavanirktok would be crossed by adding structural extensions to an existing pipeline bridge, while the Putuligayuk and its unnamed tributary would be crossed using standard VSMs.

As most of the waterbody crossings would use the aboveground pipeline crossing technique and would be constructed during winter when surface water is frozen, water quality impacts would be temporary and minor. The open-cut crossings would also be constructed during winter, however, trenching and dewatering activities may contribute some additional sediment from the disturbed streambed when the spring melt and flows resume, but this is expected to be minor compared to the background level of sediment transport in these braided river channels. Open-cut crossings of these Arctic Coastal Plain rivers could also potentially destabilize the bank at the crossing point, leading to bank erosion and habitat degradation. Site-specific crossing plans and reclamation measures would be developed for these crossings.

The use of surface waters for hydrostatic testing could directly or indirectly affect water volumes. Surface water impacts due to an inadvertent release of drilling mud during buried trenchless burial operations would be minor and easily contained due to frozen water and ground conditions. Because of the recharge of surface water bodies with every spring melt, the temporary use for construction would be short-term.

To reduce overland soil erosion, sediment discharge, and bank erosion during and following winter construction, appropriate sections of the Applicant's *Plan* and *Procedures* would be followed, along with permitting requirements and site-specific crossing plans at the major river crossings developed in consultation with the agencies. Appropriate erosion control measures would be installed prior to spring thaw. In general, it is anticipated that surface water quality impacts resulting from pipeline construction in winter would be temporary and minor.

Ice roads would be allowed to melt following construction, which would cause minimal impact to surface waters. Prior to spring break-up, cuts across the roads would be made to facilitate sheet flow and break-up.

2.3.8.2.3.2 Blasting

It is not anticipated that blasting would be required for construction of the PTTL. However, if blasting is required at river crossings or a mineral site, adherence to regulatory requirements and the Project *Blasting Plan* would reduce potential impacts. Working in the winter time would also reduce the potential impacts to fisheries and wildlife, but would require coordinating with the U.S. Fish and Wildlife Service (USFWS) on potential polar bear den surveys and mitigation measures.

2.3.8.2.3.3 Hydrostatic Testing

Hydrostatic testing of the PTTL is estimated to require approximately 14 million gallons of water (see Table 2.3.11-9). Anticipated water volumes and potential sources are discussed in the Project *Water Use Plan* (Appendix K). Once final water sources are identified, pressure test plans for each construction spread would list all permitted water sources, the associated pipeline milepost, and the permitted water volume and conditions for water withdrawals and discharge received from the regulatory authorities.

The proposed basis for PTTL Hydrostatic testing is for it to take place in the summer. Biocides and/or anti-freeze agents during pipeline testing would only be used during shoulder season work or where test water sources contain bacteria. Any proposed biocide or anti-freeze use would be coordinated with permitting agencies.

Water would be discharged into the same watershed from which it was drawn where possible or into existing permitted UIC wells. Discharge would be in accordance with regulatory requirements or existing UIC permit requirements.

Impacts and mitigation measures for withdrawal and discharge of hydrostatic test water during construction of the PTTL would be similar to the Mainline discussed above. Based on compliance with state and federal permit conditions and implementation of BMPs in the Applicant's *Procedures*, it is anticipated that impacts from hydrostatic testing would be temporary, short-term, and minor or there would be no impacts to use of an existing permitted UIC well.

TABLE 2.3.8-9

Estimated Water Requirements Summary for PTTL Construction (M/gal) [a]

Construction Camp	Construction	Ice Road and Work Pad Construction	Hydrostatic Testing	Estimated Total
6.22	31.51	180.77	14.22	232.72

Note:
[a] All water use for PTTL construction would occur in a one-year timeframe.

2.3.8.2.3.4 Fuel Use, Storage, Refueling, Lubrication, and Spills

All fuel and hazardous material handling needed for construction of the PTTL would be in accordance with ADEC requirements and the Project *SPCC Plan* (Appendix M) and managed by the Environmental Inspectors. This includes that secondary containment would be used for single-walled containers; storage and construction equipment would be maintained and inspected daily for leaks; equipment not placed on granular pads in the winter would be parked overnight or refueled within 100 feet from waterbody boundaries with proper secondary containment per the Applicant's *Procedures*. As previously described, modifications to this requirement would be overseen by the Environmental Inspectors and approved by FERC.

All waste would be handled in accordance with the *Waste Management Plan* (Resource Report No. 8, Appendix K). While a spill has the potential for significant adverse environmental impacts, construction during the winter and the ability to contain and clean-up any spill would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to surface waterbodies due to contamination from spills or releases are unlikely.

2.3.8.2.3.5 Sensitive Surface Waters

There are no National Wild and Scenic Rivers, Nationwide Rivers Inventory rivers, Alaska Impaired Waterbodies, or waterbodies contain threatened or endangered species and/or critical habitats affected by the PTTL.

Impacts and mitigation measures to anadromous waters are discussed in Resource Report No. 3. Appendix H to Resource Report No. 3 lists the season and proposed crossing method for each anadromous fish stream crossed by the PTTL. As previously described, anadromous fish stream crossings would be constructed during winter when the rivers are frozen. Most of the crossings would be aboveground (aerial) pipeline crossings with little or no in-water (or ice) work. Locations deep enough to maintain unfrozen water with adequate dissolved oxygen levels for fish overwintering are most sensitive to perturbation. The open-cut crossings may have minor and temporary increases in sedimentation when flows resume in the spring. Habitat modification would also be limited and confined to the narrow ROW strip across the river if overwintering locations are avoided as specified (see Resource Report No. 3 for more detail on potential impacts to anadromous fisheries).

Impacts and mitigation measures for crossing waterbodies (including potentially sensitive or specially designated waterbodies) along the PTTL route for the conventional open cut and aerial methods would be similar to those previously described for the Mainline.

2.3.8.2.4 Pipeline Aboveground Facilities

No waterbodies (although some wetlands would be impacted, see next section) would be located within the proposed Pipeline Aboveground Facilities' footprint. There are no anadromous fish streams, National Wild and Scenic Rivers, Nationwide Rivers Inventory rivers, Alaska Impaired Waterbodies, or waterbodies contain threatened or endangered species or critical habitats that would be affected by Pipeline Aboveground Facilities.

A discussion of the potential construction impacts and avoidance/minimization measures is provided in the following sections.

2.3.8.2.4.1 Foundation Construction

Aboveground Facilities would be constructed on pilings over granular pads, on foundations, and/or a combination, depending on the location. Modules on skids would be used for many components. There are no surface water bodies at aboveground facility sites. Some streams are crossed by access roads to sites and are discussed below under pipeline associated infrastructure.

Impacts to surface water from construction runoff from the aboveground facility site are expected to be temporary and minor because stormwater would be managed in accordance with the Applicant's *Plan* and Project *SWPPP* and adhering to permit requirements.

2.3.8.2.4.2 Hydrostatic Testing

Hydrostatic testing of the Pipeline Aboveground Facilities is estimated to require approximately 10 million gallons of water (see Table 2.3.11-6). Anticipated water volumes and potential sources are discussed in the Project *Water Use Plan* (Appendix K).

Once water sources are finalized with the agencies, pressure test plans for each construction spread would list all permitted water sources with the associated pipeline milepost, as well as the permitted water volume and conditions for water withdrawals and discharge received from the regulatory authorities. Impacts and mitigation measures for withdrawal and discharge of hydrostatic test water from surface waters during construction of the Pipeline Aboveground Facilities would be similar to the Mainline or PTTL discussed previously (depending on location of aboveground facility and season of construction). Adherence with temporary water use regulatory requirements and agency input would reduce the potential for impacts to surface water users and fisheries.

The proposed testing plan calls for Mainline hydrostatic testing to take place in the summer with some potential for testing in the fall. Biocides and/or anti-freeze agents during pipeline testing would only be used during shoulder season work, where test water sources contain bacteria, or on the North Slope. Any proposed biocide or anti-freeze use would be coordinated with permitting agencies and discharge would be in compliance with regulatory requirements and the Applicant's *Procedures*. If possible, water would be returned to the basin it was removed from, to the extent practicable, and if on the North Slope, injected into an existing UIC disposal well.

2.3.8.2.4.3 Blasting

Any potential blasting at Pipeline Aboveground Facilities would not impact surface water since there are no streams or ponds at aboveground facility sites.

2.3.8.2.4.4 Fuel Use, Storage, Refueling, Lubrication, and Spills

All fuel and hazardous material handling needed for construction of the Pipeline Aboveground Facilities would be in accordance with ADEC requirements and the Project *SPCC Plan* (Appendix M) and managed by the Environmental Inspectors. This includes that secondary containment would be used for single-walled containers; storage and construction equipment would be maintained and inspected daily for leaks; and all equipment would be parked overnight or refueled at least 100 feet from waterbody boundaries to the extent practicable. In addition, all waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined in Section 2.2.8.1.9, as applicable and appropriate would greatly reduce the likelihood of such impacts, as well minimize the resulting impacts should a spill occur. As such, significant adverse impacts to surface waterbodies due to contamination from spills or releases are unlikely.

2.3.8.2.5 Pipeline Associated Infrastructure

Pipeline Associated Infrastructure includes construction camps, material sites, ice roads/access roads, helipads/airstrips, ATWS, contractor yards, pipe storage yards, rail spurs, temporary disposal sites, and material extraction sites used for construction of the pipelines. Impacts and mitigation specific to constructing the Pipeline Associated Infrastructure are described in more detail in the following sections.

2.3.8.2.5.1 Access Roads

Access roads would be required during construction of the Mainline and Aboveground Facilities to transport equipment, material, pipe, and personnel to the ROW, compressor stations, material sites, and other locations. These access roads include existing public and nonpublic roads, newly built access roads, and shoo-fly roads. Shoo-fly roads are required where traffic access is not possible along the ROW due to severe slopes or other impediments. The shoo-flies allow traffic to detour around the severe slope sections and maintain access along the ROW. A list and description of access roads that would be used by the Project is included in Resource Report No. 1, Appendix F. A list of the waterbodies crossed by access roads is provided in the waterbody crossing table (see Resource Report No. 1, Appendix H).

Impacts to surface waterbodies from clearing, grading, and construction of access roads would be similar to the impacts described in the Mainline section, although with placement of granular material instead of trenching and may include the following:

- Changes in surface water flows from withdrawals or discharges;
- Physical disturbance or alteration of waterbodies from construction activities;
- Releases of sediment and increases in turbidity; and
- Inadvertent spills of hazardous compounds including fuels, lubricants, and solvents.

Erosion and sedimentation would be the primary impacts, particularly on steeper ground and in close proximity to waterbodies. Roads cut along slopes could intercept surface and subsurface flows, increasing runoff and erosion from the roadbed. Fill placed along slopes could trigger mass wasting events if saturated and not maintained properly. Roads constructed in areas with more gentle slopes could disrupt surface water flows (particularly in wetland areas) and could contribute sediment to adjacent waterbodies. Granular roads could cause a variety of local impacts on floodplain processes including disruption of flow paths, increases in local flood elevations due to backwater effects and reduced floodplain volume, diversion or deflection of flows, input of sediment to streams, creation of backwaters or ponds, and channel constrictions. The magnitude of the impact would be dependent on the relative size of the floodplain.

It is likely that some erosion and sedimentation could occur during construction of access roads, particularly during storm events. The weather would be monitored and work plans adjusted accordingly. Given the transient nature of the construction, impacts would be temporary. Mitigation measures include following site-specific BMPs and engineering practices appropriate for the slopes, soils, geology, and hydrology of the area, as well as including appropriately sized and spaced drainage (see Applicant's *Procedures*). Types of erosion and sediment control measures could include revegetation, rolled, and layered erosion control, straw barriers and silt fencing, mulching and blanket erosion control, vegetative streambank protection, streambank roughening and terracing, outlet energy dissipation, and sediment ponds. Environmental Inspectors would be present to oversee contractor compliance and erosion and sedimentation control measures would be monitored and maintained to ensure function according to the Project *SWPPP*, and the Applicant's *Procedures*, and any applicable Project permits and ROW lease stipulations.

Temporary access roads would be addressed per landowner agreements, and if required to be left in place, no longer maintained by the Project. Potential long-term impacts of access roads built in the floodplain include accelerated channel erosion if flows are deflected by the roadbed, flow blockage at stream crossings, and erosion from the roadbed surface and from lateral scour. Impacts from road abandonment could be short to long-term and minor to significant at the local scale if a road blocks or restricts flows and leads to a washout or mass-wasting event. Abandoned roads near smaller streams could lead to increased bank erosion by deflecting flows, or mass wasting if the roadbed is washed away.

Mitigation measures include minimizing the number of access roads constructed in floodplains; avoiding sensitive areas in floodplains; avoiding, to the extent practicable, access road construction near smaller streams and confined valleys; placing permanent, appropriately-sized culverts to maintain surface drainage and stream crossings; and/or making the road corridor as hydrologically permeable as possible prior to abandonment by cutting openings through the roadbed at locations of likely flow paths.

2.3.8.2.5.2 Ice Roads and Work Pads

Winter roads and work pads constructed of snow and ice would be used in tundra and wetland areas for the northern segments of the pipeline in areas of continuous permafrost (e.g., north of the Brooks Range). They may be constructed of compacted snow, ice aggregate, granular material, mixtures of snow and water, manufactured snow, or ice created by flooding the tundra surface to achieve a design thickness and width. Access roads would be developed for access to approved sources of water and ice for manufacturing ice roads, developing the winter work pad on the ROW, acquiring ice aggregate from the frozen surfaces of approved waterbodies, and for filling depressions on the ROW and on more conventional winter access roads. In many cases, these access roads would also be constructed of snow or ice.

Ice roads and work pads share similar construction methodologies. Prior to construction, the locations for work pads and ice road routes would be surveyed and staked. The ice roads would be routed to avoid deep holes in streams, steep riverbanks, cultural resources, stands of willow, and any prior year's work pad locations and road routes wherever possible. Construction would begin once the ground temperature and snow cover on the tundra meet the ADNR criteria for general cross-country traveling on wet sedge tundra on the Beaufort Coastal Plain ecoregion: "When a minimum 15 centimeters (6 inches) of snow cover is available and ground hardness reaches a minimum of 75 drops of a slide hammer to penetrate 1 foot of ground" (ADNR, 2004). Work crews would decommission winter snow and ice work pads and roads at the end of each winter season in accordance with land use permits.

Estimated water use during ice road/work pad construction for the Mainline is approximately 557 million gallons. Anticipated water volumes and potential sources are discussed in the Project *Water Use Plan* (Appendix K). Water would be sourced from local surface waterbodies as described in the *Water Use Plan*. Impacts on local waterbodies could include drawdown of local water supplies, entrainment of waterborne biota, and localized impacts at water intakes.

Withdrawal of large volumes of water from the surface water sources could temporarily affect the recreational and biological uses of the resource if the diversions constitute a large percentage of the source's total flow or volume. Water withdrawals could also result in temporary loss of habitat, change in water temperature and dissolved oxygen levels, and entrainment or impingement of fish or other aquatic organisms. The intake line would be screened to prevent entrainment of debris and fish. The screen around the intake would be fabricated to provide an adequate surface area of fine-meshed screen to reduce the approach velocity and reduce the risk of impingement or entrainment of small fish, larvae, and eggs. The intake hose and screen would be kept off the bottom of the waterbody to avoid sediment uptake. Resource Report No. 3 further discusses potential impacts on aquatic resources due to water withdrawals.

The necessary permits and approvals from state and federal agencies would be acquired and water rights would be complied with or obtained before appropriating surface waters, including a Fish Habitat Permit from ADF&G and a Temporary Water Use Authorization from ADNR. The potential effects of water withdrawals from surface waters would be minimized by adhering to measures in the Applicant's *Procedures* (Appendix N). Adequate flow rates to protect aquatic life, provide for all waterbody uses, and provide for downstream withdrawals of water by existing users would be maintained during intake from fresh water sources. Water withdrawal rates would be monitored to avoid significant impacts on stream flow or downstream water users and resources.

Impacts from ice road construction and use include compression of the tundra surface under the ice road or pad, potential contamination from drips or leaks, potential tundra disturbance from activities that accidently leave the iced area, and slower melt times for the ice roads and work pads relative to surrounding areas. During the spring melt, the denser and slower melting roads and work pads could impede water flows, causing local ponding. Impacts on tundra ecosystems would be reduced by using ice road and work pad construction techniques instead of summer road construction and use. Impacts to tundra habitat and the water underlying the construction zones would be temporary to short-term and minor to significant, depending on the nature of a deviation from the Applicant's *Plan* and the Project *SPCC Plan*.

2.3.8.2.5.3 Helipads and Airstrips

Permanent helipads would be installed at the compressor station sites, the heater station site, and all mainline block valve (MLBV) sites as part of the facility footprint. Temporary helipads would be installed at construction camps for the duration of the construction phase and would be part of the camp footprint. A list of proposed temporary and permanent helipads is provided in Table 1.3.2-11 in Resource Report No. 1. Because helipads would be constructed as part of other facilities, potential impacts are described in the sections related to those facilities.

Existing airports and airfields (collectively termed airstrips) would be used to transport personnel and freight to and from the Project area. At this time, there are no potential upgrades that would be required for existing public airports or private airfields.

2.3.8.2.5.4 Mainline MOF

A MOF on the northwest side of Cook Inlet may be required to support the transportation of pipe, construction equipment, and other materials to the remote Cook Inlet area of the Mainline during the construction phase. There is an existing Beluga barge landing facility, which is not suitable to accommodate Project construction. However, due to the limited infrastructure in this area, this existing barge landing is planned to be used as an offloading and backhaul point during initial MOF construction. No dredging at this existing landing is planned to enhance barge-docking capabilities, however, adequate fill from onshore would be added at the facility to enable the barge to ground itself and provide offloading capability.

No dredging is planned at the Mainline MOF site. Access roads would be constructed that lead from the MOF to a planned material laydown area that connects to the local road system. Impacts and mitigations would be similar to those described for the Marine Terminal. Sediments from onshore fill would cause a localized, temporary increase in turbidity and sedimentation at the barge grounding site. Currents would be expected to rapidly entrain and remobilize any sediments deposited.

2.3.8.2.5.5 Spurs and Work Pads

The approximate location and size of the rail spurs is included in Resource Report No. 1, Appendix I. Mitigation measures and impacts for rail spurs and work pads would be similar to those discussed in the prior Access Roads section.

2.3.8.2.5.6 Additional Temporary Workspaces

ATWS would be located outside of, but adjacent to and contiguous with, the pipeline construction ROW where construction activities could not be executed as safely within the ROW or where more equipment may be necessary (e.g., waterbody, road, or utility crossings; at bends and timber storage locations). ATWSs would typically be required on both sides of waterbodies to stage construction equipment and materials; store excavated soils, and to fabricate the crossing section (see Table 1.4.2-2 in Resource Report No. 1 for dimensions and Table 2.6.1-1). Each individual location requiring ATWS would be assessed and sized appropriately to account for terrain, soil conditions, site configuration, site-specific construction method, and construction season. Proposed ATWS would be located at least 50 feet from the waterbody edge, topographic and other site-specific conditions permitting. If conditions do not permit a 50-foot setback, a modification to the FERC Procedures would be required (see Section 2.6.1).

Potential impacts to surface water resources from ATWS would be temporary and minor. These impacts would be reduced or eliminated by adherence to BMPs provided in the Project *SWPPP* and elements of the Applicant's *Plans* and *Procedures* that require the ATWS areas be returned to preconstruction contours and allowed to revegetate, slowing water runoff and returning groundwater infiltration and recharge rates diminished by clearing. Environmental Inspectors would be present to oversee contractor compliance with Project BMPs included in these plans. With these BMPs in place, impacts to surface water due to disturbance to ground cover at ATWS areas are expected to be temporary and minor.

2.3.8.2.5.7 Pipe Storage and Contractor Yards

The approximate location and size of Pipe Storage and Contractor Yards is included in Resource Report No. 1, Appendix I. Potential impacts to surface water from pipe storage and contractor yards would include a localized decrease in both the infiltration and groundwater recharge rate due to clearing and grading. These impacts would be reduced or eliminated by adherence to BMPs provided in the Project *SWPPP* with areas being returned to preconstruction contours and allowed to revegetate, slowing water runoff and returning groundwater infiltration and recharge rates diminished by clearing. Environmental Inspectors would be present to oversee contractor compliance with Project BMPs included in these plans. With these BMPs in place, impacts to surface water due to disturbance to ground cover at Pipe Storage and Contractor Yard areas would be expected to be temporary and minor.

2.3.8.2.5.8 Construction Camps

The approximate location and size of the Construction Camps is included in Resource Report No. 1, Appendix I. No waterbodies would be located within the proposed Construction Camps. To the extent practical, Camps would be established at previously disturbed sites to the extent practical or compressor station sites. Where new sites are established or existing sites expanded, the sites would be cleared of vegetation and then leveled and stabilized as necessary prior to installation of the site facilities. All camps would need a granular pad of varying thickness, depending on the presence of permafrost. Mitigation measures and impacts from clearing and grading would be similar to those described for the Mainline under the Groundwater discussion, as appropriate and applicable.

Water for camps would be from wells drilled on site; no surface water sources would be used. A temporary drinking water plant and sewage treatment plant would be installed at each construction camp. Domestic wastewater at the Construction Camps would be treated through an Arctic package plant, designed to meet AWQS at the point of discharge. Treated discharge water would be released into an onsite lagoon for large volumes or onto the ground near the camps areas for small discharge volumes. Sludge would be stored onsite for subsequent incineration or transport to an approved disposal facility. No impacts on surface water are anticipated under normal treatment and disposal of domestic wastewater.

In the unlikely event that a sewage spill (e.g., from lines from bunkhouses) were to occur, immediate cleanup procedures would be implemented. During winter, sewage spills would be allowed to freeze and would then be chipped, bagged, and landfilled. During summer, soils would be removed and sewage infrastructure will be steam cleaned and the run off will be collected for treatment. Depending on the size of a sewage spill, impacts on surface water from fecal or nutrient contamination would be temporary, but could be minor or significant depending on the extent and duration of the spill.

Nonhazardous solid waste would be segregated into specific reuse, recycling, and disposal waste streams at the point of origin to the extent practicable or at least before reuse on site or shipping off site. Nonhazardous wastes would be stored in separate, designated storage areas and incompatible wastes would be segregated so as to prevent inadvertent contact in the event of leakage from a container. Wastes would be transferred only to appropriately permitted or licensed facilities with capacity to accept the waste, and only by appropriately trained and licensed transporters. The *SPCC Plan* would be followed to contain and clean up any spill or inadvertent release of hazardous wastes at the camps.

With the mitigation measures and procedures implemented as described in prior sections, water quality impacts are expected to be temporary and minor.

2.3.8.2.5.9 Material Sites

As detailed in the *Gravel Sourcing Plan and Reclamation Measures*, Resource Report No. 6, Appendix F, various materials (e.g., sand, granular material, and stone) would be required for construction of the Mainline and Aboveground Facilities, including base material for the ROW work pad, compressor station sites, temporary construction facilities, access roads and other uses. Material may also be used during construction for concrete production, temporary laydown, equipment staging, and other uses. The material required for these facilities would be obtained from material sites that either exist or would be developed for the Project. A list of potential sources for these various materials is included in Resource Report No. 6 (Geologic Resources, Section 6.3.1).

New material sites would be surveyed and staked, any trees and brush would be cleared, and an access road into the site would be constructed if necessary. The material sites would be developed in accordance with any permit requirements related to site preparation. Existing material sites may be expanded and/or improved to facilitate use for the Project in accordance with landowner agreements and any permit amendments.

Granular operations typically occur near streams and rivers where sorted granular material is likely to be found. Mining and processing the granular material involves separating out fine sediment from the appropriately sized aggregate, which increases the chance that the finer sediment could be entrained in storm or floodwater and be transported to nearby waterbodies. Surface water runoff would be managed site-wide and routed to retention basins. The material sites located near streams could pose a greater water quality risk to rivers and floodplains from sedimentation and spills. Potential impacts on nearby waterbodies could be significant if mitigations are not implemented correctly or flooding were to occur (see Floodplains in Section 2.5.4.2) for more details on potential flooding and floodplain impacts from material sites located in floodplains.

Potential impacts to surface water at material sites may include the following: changes in surface water flows from withdrawals or discharges; physical disturbance or alteration of waterbodies from construction activities; releases of sediment and increases in turbidity; and inadvertent spills of hazardous compounds including fuels, lubricants, and solvents. Mitigation measures to minimize and reduce impacts to surface water and any nearby waterbodies from inadvertent spills and extraction activities at material sites would include implementation of various prevention and control measures in the *SPCC Plan a*s directed by the Environmental Inspectors and include:

- Secondary containment for fuels and hazardous materials;
- Use of portable secondary containment; and
- Ample supply of spill adsorbent pads during fueling.

Other control measures for granular material extraction included in ADEC's Gravel BMP Manual and the Project *SWPPP* that prescribe the use of silt fences, retention ponds, sediment barriers, and vegetative buffers to prevent increased sedimentation and turbidity levels in affected surface waters; and conducting restoration and revegetation activities after material site is no longer in use.

Reclamation is required of all mining operations, including sand, granular material, and aggregate extraction (AS 27.19). A reclamation plan and reclamation surety bond is also required for operations extracting more than 50,000 cubic yards or a cumulative disturbed area of five or more acres. The plan would include mitigation measures to ensure successful restoration. The following measures would be considered in developing and implementing a material site reclamation plan:

- The area would be backfilled, graded, and recontoured using strippings, overburden, and topsoil to a condition that allows for the reestablishment of renewable resources on the site within a reasonable period of time;

- Brush piles, vegetation, topsoil, and other organics would be spread on the backfilled surface to inhibit erosion and promote natural revegetation;

- The site would be stabilized to a condition that would allow sufficient moisture to be retained for natural revegetation;

- If extraction occurs within a flood plain, the reclamation activity should reestablish a stable bed and bank profile such that river currents would not be altered and erosion and deposition patterns would not change;

- Stream channel diversions would be relocated to a stable location in the flood plain; and

- Any roads, helipads, airstrips or other proposed facilities constructed to provide access to the mining operation should be reclaimed (unless otherwise authorized) and included in the reclamation plan.

The reclamation plan for state or federal lands may include, after consultation with ADEC, ADF&G, and concurrence of the landowner, alternative land uses such as fish and wildlife enhancement, wetland and stream enhancement, trails, or recreational sites as mitigation measures for restored material sites.

With implementation of the Project *SPCC Plan*, *SWPPP*, *Restoration Plan*, and ADEC Gravel BMP Manual control measures, it is anticipated that impacts to surface water from material extraction sites would be short-term and minor. Referenced plans are available in Appendix J (*SWPPP*), Appendix M (*SPCC Plan*), and Appendix P (*Alaska LNG Floodplain Analysis Techniques*). The Project *Restoration Plan* is provided in Resource Report No. 3, Appendix P. Mining would be conducted according to applicable local, state, and federal requirements.

2.3.8.2.5.10 Sensitive Surface Waters

There are no National Wild and Scenic Rivers, Nationwide Rivers Inventory rivers, or Alaska Impaired Waterbodies affected by Pipeline Associated Infrastructure. Anadromous watercources and waterbodies that contain threatened or endangered species and/or critical habitats are discussed in Resource Report No. 3. Pipeline construction activities that are conducted below the ordinary high water mark of an anadromous waterbody will require an ADF&G *Fish Habitat Permit* with stipulations for maintaining instream flow and not impeding fish passage. Impacts and mitigation measures to anadromous waters and fisheries of special concern crossed by the Project are discussed in Resource Report No. 3 and listed in Appendix H.

2.3.8.2.6 Gas Treatment Plant

GTP facilities would be constructed on a granular pad designed to insulate the permafrost. After the site has been prepared, ad-freeze piles would be installed to support modules, buildings, equipment, and structures. Preparation work includes road widening, pipeline crossings, GTP pad construction, support pipeline construction, and reservoir construction. The majority of the GTP facility would consist of modules transported to the site via seagoing vessel and Self-Propelled Module Transporters. It is expected that the modules would be delivered during four summer sealift seasons. The remaining facility components would be trucked or constructed on site. A reservoir created from the nearby Putuligayuk River would be the source of fresh water for the GTP and its associated facilities during construction and operation.

Potential impacts on surface waterbodies could result from various GTP facility construction activities such as earthmoving, trenching, inadvertent spills from refueling of vehicles, and surface water withdrawals and discharge (e.g., for hydrostatic test water, dust suppression and road maintenance). Impacts to adjacent waterbodies from construction activities are expected to be short-term and minor due to compliance with the Applicant's *Plan* and *Procedures*, Project *SWPPP*, *SPCC Plan*, *Fugitive Dust Plan*, and USACE and ADEC permit requirements. A discussion of the potential construction impacts and minimization measures is provided in the following sections.

2.3.8.2.6.1 Clearing and Grading

Due to the pervasiveness of wetlands and waterbodies across the tundra at the GTP site, installation of work pads and road construction to support the GTP would primarily be completed in winter to avoid tundra degradation. Summer construction would mainly occur on the roads and granular pads that were constructed during the previous winter season. There would be no grading and no clearing involved in construction of the GTP.

2.3.8.2.6.2 Pad Construction

The GTP Pad would be built up using granular material to protect the underlying permafrost and prevent tundra from becoming thermokarst. Installation would primarily be completed in winter to avoid tundra degradation during access. The GTP would use an ad-freeze pile foundation system to prevent thaw bulbs in the permafrost. The granular pads would be of sufficient thickness to adequately minimize potential thaw in the active layers and protect the permafrost from thermal degradation. The Project *SWPPP* would be followed to address erosion and sedimentation impacts related to the pad construction. Granular pad construction would cause minor localized, long-term alterations in surface water runoff patterns.

2.3.8.2.6.3 GTP Construction

The GTP would source its process water and camp water from the Putuligayuk River, which would be stored in the reservoir (discussed in Section 2.3.8.2.6). Even though water drawdown within that source can lower water levels for that season, spring melt/thaw in the next spring has been demonstrated to recharge these waterbodies to original levels. The raw water would flow into the plant at a rate of approximately 190 gallons per minute. This water would be split to the Process Water system and the Potable Water Treatment system. It is expected that 60 gallons per minute of process water would be used at the GTP and 130 gallons per minute of potable water would be used between the GTP area and the GTP Operations

Center. The flow of water from the reservoir to the GTP is expected to be a year-round activity, versus the reservoir fill operation, which is expected to only occur for a short duration during the flood season. Filling of the water reservoir would cause a minor and temporary drawdown of the Putuligayuk River, removing less than 20 percent of flow summer months.

2.3.8.2.6.4 Waste Management Practices

Waste material would be disposed of as required by federal, state, and local environmental regulations and in accordance with Project *Waste Management Plan* (Resource Report No. 8, Appendix K). Wastewater would be disposed of in UIC wells, described in the subsequent GTP Associated Infrastructure section.

Nonhazardous solid wastes would be transported to other approved facilities for disposal. Recyclables would be segregated from other waste streams and sent to a recycling facility. Hazardous wastes would be collected and temporarily stored until transport to a hazardous waste disposal facility in the Lower 48. No impacts on surface water are expected.

2.3.8.2.6.5 Hydrostatic Testing

Some hydrostatic testing activities would be required on the Beaufort Coastal Plain ecoregion. Module piping and vessels would be hydrostatically tested in the fabrication facilities. Information on anticipated test water volumes and potential sources is provided in the *Water Use Plan* (Appendix K). Approximately 1.8 million gallons of water are anticipated to be required to hydrostatically test the GTP pipelines.

Water for hydrostatic testing would be sourced from nearby rivers and lakes until the GTP reservoir is operational (see Appendix K). Impacts and mitigations would be to the same as those described for the Mainline. The necessary permits and approvals from state and federal agencies would be acquired and water rights would be complied with or obtained before appropriating surface waters including a Fish Habitat Permit from ADF&G and a Temporary Water Use Authorization from ADNR. The potential effects of water withdrawals from surface waters would be minimized by adhering to permit requirements and measures in the Applicant's *Procedures* (Appendix N). Adequate flow rates to protect aquatic life, provide for all waterbody uses, and provide for downstream withdrawals of water by existing users would be maintained during intake from fresh water sources. Water withdrawal rates would be monitored to avoid significant impacts on stream flow or downstream water users and resources.

Hydrostatic test water discharges would be performed in accordance with all applicable state water regulations and federal and state discharge requirements. Because the majority of testing would occur during the summer, using test-water additives is not currently anticipated. However, based on site conditions, biocides and/or anti-freeze agents may be used. Any proposed biocide or anti-freeze use would be coordinated with permitting agencies. Water would be discharged into an existing permitted UIC well. Discharge would be in accordance with UIC permit requirements. Based on compliance with state and federal permit conditions and implementation of BMPs in the Applicant's *Procedures*, it is anticipated that impacts from hydrostatic testing would be temporary, short-term, and minor.

2.3.8.2.6.6 Blasting Operations

It is not anticipated that blasting would be required for construction of the GTP. However, permafrost blasting may be necessary to excavate the mineral site and water supply reservoir. Blasting would be done in accordance with the Project *Blasting Plan* and impacts would be similar to those discussed for Mainline blasting.

2.3.8.2.6.7 Fuel Use, Storage, Refueling, Lubrication, and Spill Prevention

Consistent with current practices, ultra- low sulfur diesel ("Arctic diesel") would be trucked to the GTP plant and stored for use on the Integrated Operations center pad. Tanks would be double-walled with 110 percent secondary spill containment.

All fuel and hazardous material handling needed for construction of the GTP would be in accordance with ADEC requirements and the Project *SPCC Plan* (Appendix M) and managed by the Environmental Inspectors. While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures described previously for GTP groundwater impacts would greatly reduce the likelihood of such impacts, as well minimize the resulting impacts should a spill occur. In addition, all waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). As such, significant adverse impacts to surface water due to contamination from spills or releases are unlikely.

2.3.8.2.6.8 GTP Associated Infrastructure

The GTP Associated Infrastructure would include a construction camp, pipelines, West Dock's Dock Head 4, granular material mine, reservoir, laydown/staging areas, and access roads.

Module Staging Area

A new module staging area (approximately 86 acres) would be constructed for placement of the modules immediately following offload (see Section 1.3.2.2 of Resource Report No. 1). Impacts and mitigation measures from the module staging area would be the same as those previously described for granular pads.

Construction Camps

The approximate location and size of the Construction Camp is included in Resource Report No. 1, Appendix I. A pioneer camp would be established to support development of construction infrastructure during GTP construction. The camp would continue to support the Project after the onsite construction/operations camp becomes available. The Pioneer camp would be located at previously disturbed site to the extent practical. A new granular pad would be constructed for the Integrated Construction and Operations Camp. Granular material thickness would be sufficient to protect the permafrost from thermal degradation. No waterbodies would be located within the proposed pioneer camp or Construction Camp footprints. All camps would need a granular pad to maintain stability on the tundra. Mitigation measures and impacts from clearing and grading are similar to those described in Section 2.2.8.

The GTP construction camp is estimated to require up to approximately 175,000 gallons of raw water per day during peak work periods (160,000 potable water), assuming approximately 95 gallons of water per day for up to 1,680 workers. Water would be brought in via trucks until the reservoir is completed. Estimated surface water use during the construction of the GTP is summarized in the Project *Water Use Plan* included in Appendix K. Impacts from water withdrawal from the reservoir are discussed in the following sections. Impacts from construction of the GTP temporary and permanent camps would be the same as those previously described for GTP in the groundwater section. Wastewater generated at the camps would be injected into the underground injection wells or at an approved facility and would not impact surface water resources. Solid waste would be managed as described in the prior Waste Management section.

Material Sites

As detailed in the Project *Gravel Sourcing Plan and Reclamation Measures* (Resource Report No. 6, Appendix F), a reservoir and mine site would be developed to supply granular material for construction of the GTP. Approximately 11.4 million cubic yards of granular material would be required during construction of the GTP and the GTP Associated Infrastructure. Both the material and reservoir sites would be located 700 feet from the existing Putuligayuk Mine Site. The mining operations at both the GTP mine site and reservoir would require removal of overburden, estimated to be 10 feet thick. This would be done during the winter and would entail blasting. Stemming and blasting mats would be used to control flyrock, as well as other proper safety, security, and alarms to comply with mine safety requirements. See Project *Blasting Plan* in Resource Report No. 6 for measures to reduce impacts of blasting.

The sites are estimated to produce close to 1.3 million cubic yards of overburden. This material would initially be stockpiled at selected locations along the perimeter of each site for either subsequent filling of nearby material site areas as a restoration measure, or stored at a location yet to be determined for future use. To prevent overburden from entering surface water and impacted sedimentation and turbidity, erosion control measures would be used as outlined in the Applicant's *Plan* and the Project *SWPPP*.

During summer excavation activity, there may be increased sediment, particulate matter, and metals present in gravel pit dewatering discharge to remove accumulated groundwater. Discharge would be according to applicable federal and state requirements. Following regulatory requirements, nearby surface waters would be monitored at least one year prior to mining, during mining, and at least one year after reclamation is complete (ADEC, 2012). Construction of material extraction sites and active granular material mining and blasting would be conducted in compliance with applicable federal and state requirements to reduce impacts to surface water. Compliance with permitting requirements would mitigate for minor to significant long-term increases in sediment loading, turbidity, and contamination levels in nearby surface water resources.

Water Reservoir

Water supply for process makeup requirements, firewater, and potable water at the GTP and associated camp would originate from the Putuligayuk River. Due to the Arctic conditions of the area, this river is generally not available for water uptake for the majority of the year. Therefore, to ensure year-round water supply for the facility, water from the river would be used to fill the reservoir during spring break-up when there is sufficient water run-off. It would require several seasons to complete the initial fill of the reservoir to its design capacity due to the short fill window. The water reservoir is expected to cover 45 acres, with a depth of approximately 27 to 47 feet under an anticipated 8-foot-deep ice pack. The proposed design assumes this ice pack would be unavailable for use, but during summer months, some portion of this ice pack would become available for use from melting. While it may be used if needed in the summer, this volume would need to be restored during the following spring season from the Putuligayuk River (Resource Report No. 1).

An approximately 1-mile long pipeline would draw water out of the Putuligayuk River. Pumps would contain suction screens to prevent biota entrainment and filters at the uptake pipe would remove silt and sand. The river intake structures would comply with ADF&G regulations to protect fish and existing water rights. An approximately 5-mile-long, 6-inch-diameter supply water pipeline would then draw water from the reservoir to the GTP and operations camp. Both pipes would be constructed on aboveground VSMs. Withdrawal rates would be in accordance with permitted volumes and regulatory requirements to reduce impacts to the Putuligayuk River.

Access Roads

Three new roads would be required to support GTP infrastructure (see Section 1.3.2.2 of Resource Report No. 1). The roads that are proposed to be constructed of granular material would require use year-round. Ground compaction caused by expansion of existing roads and new access roads would generate increased runoff as compared to undisturbed sites and could disrupt surface flows. Access road construction could also transfer sediments and pollutants (e.g., diesel particulates) into surface water resources. Erosion and sediment control measures would be implemented as outlined by the Applicant's *Plans* and *Procedures* and Project *SWPPP* so that access road expansion, construction, and use would cause minor but long-term impacts on surface water sedimentation and flow.

Ice Roads

Onshore and offshore ice roads are planned for construction of GTP infrastructure, including pipelines/transfer lines. Anticipated water volumes and potential sources are provided in the Project *Water Use Plan* (Appendix K). During construction, water consumption for ice roads would range from approximately 6 to 3574 million gallons of water per season would be required to create 110- to 120-foot-wide ROW ice roads for the GTP and associated pipeline infrastructure. Minor and temporary depletions of local waterbodies could occur during water withdrawals for ice road construction.

Other general access ice roads would be needed during the initial phases of construction. The number, routing, length, and duration of use of general access ice roads have not yet been determined. In general, ice road width is assumed to be 50 feet for most applications and general water usage is assumed to be approximately 1.2 million gallons of water per mile; however, this is highly weather dependent. Ice chips would be used as potential mitigation.

Ice road corridors would be reused to the extent practicable to reduce impacts on the surrounding tundra. The primary concern associated with ice bridging across streams would include flooding during spring break up resulting in increased sedimentation loads. At each ice bridge stream crossing, slots would be cut into the ice to avoid flooding impacts. It is expected that, with the appropriate mitigation measures, ice road construction and use would have a temporary and local impact on water resources.

Fuel Use, Storage, Refueling, Lubrication, and Spills

Impacts on surface water from fuel or spills and leaks during construction of GTP Associated Infrastructure and associated mitigation measures would be the same as those described for the GTP facility.

Underground Injection Wells

The GTP would develop two industrial Class I wells under the UIC program. There would be no impact on surface water from wastewater disposal in underground injection wells due to their depth and lack of contact with surface water. Drill cuttings would be disposed of at an approved facility. Spent drilling fluids would be disposed of in the appropriate manner in accordance with the *Waste Management Plan*.

West Dock Modifications and Dredging

Major components of the GTP would be built as modules off site and delivered in a series of sealifts, requiring offloading of barges and other large oceangoing vessels. Improvements at West Dock would include creating DH 4. The West Dock DH 4 addition would include installing sheet piling and fill material behind the sheet piling and dredging a new channel to a design navigable depth of -16 feet MLLW.

During Project construction, the existing 650-foot breach would be spanned with a temporary barge bridge that would allow modules to travel to the onshore roads. The barge bridge would include gaps at each bow and/or stern connection point to allow for fish passage. The barge bridges would be installed annually at the beginning of the open-water season, and they would be removed in the fall prior to freeze-up. With incorporation of these procedures, it is believed that construction impacts would be minor and the duration of impact would be generally concentrated during construction use of the facility and mostly limited to the immediate vicinity of each causeway.

Installation of new sheet piling at West Dock would cause a minor, temporary, localized increase in turbidity. Installation of sheet piling on the seafloor would disturb loose sediments, introducing them into the water column and thereby increasing the turbidity of the marine water at the work site. The plumes of elevated suspended sediment concentrations are not anticipated to extend significant distances from the work sites.

Due to the extremely shallow waters of Prudhoe Bay, dredging would be required to accommodate the larger vessels for module offloading. The previous design entailed dredging a navigation channel that is 400 feet wide out to the 16-foot depth contour (-16 feet MLLW). In addition, a 1,200-foot by 1,400-foot maneuvering basin would be dredged at the landward end of the channel.

With the preferred GTP dock location now at DH 4, no maintenance dredging is anticipated. However, Section 10.6.4.1.2.1 in Resource Report No. 10 addresses West Dock maintenance dredging for all alternatives.

Navigation and Vessel Traffic

Vessel movements are not expected to contribute materially to ambient turbidity or to shoreline erosion, due to the necessarily low speeds mandated for operational safety in and near Prudhoe Bay. Project vessels utilizing West Dock during GTP construction would require ballast and cooling water.

2.3.8.3 Non-Jurisdictional Facilities

The PBU MGS project and PTU Expansion project would both be located on the Arctic Coastal Plain, which is an area of continuous permafrost. Surface water is anticipated to be used as a source of water for supplying potable water for construction camps, water for hydrostatic testing, and water for ice roads. Water requirements for construction of the PTU Expansion project would be up to approximately 2 million gallons per year which would be withdrawn from permitted water sources according to ADNR & ADF&G requirements.

Construction of the PTU Expansion project (e.g., West Gathering line) would cross four waterbodies. None of these waterbodies are classified as anadromous fish streams. Construction of the PBU MGS project proposed pipeline infrastructure would cross 35 waterbodies (seven of which are classified as anadromous fish streams). Potential impacts to surface water from construction of both the PTU Expansion project and PBU MGS project are anticipated to be similar to those described for above for Project facilities on the Arctic Coastal Plain, that is, minor and short-term. The pipelines would be built on VSMs in the winter and avoid impacts to surface water bodies, but would require water sources for use in ice road construction and hydrostatic testing that would be controlled with regulatory requirements in permitting to reduce surface water impacts.

It is not known at this time if any surface water is required or would be crossed by the Kenai Spur Highway relocation. Construction stormwater runoff would be in accordance with regulatory requirements to reduce potential impacts of sedimentation into surface waters. Additional information will be provided in the FERC application as it becomes available.

2.3.9 Potential Operational Impacts and Mitigation Measures for Surface Water

Surface water resources would be relied upon to support operational activities. Withdrawal from rivers, lakes, and streams would have the potential to affect surface water quantity, and potential wastewater discharges and releases of hazardous materials could affect surface water quality. The subsequent discussion addresses potential impacts to surface water quantity and quality and provides proposed mitigation measures and BMPs to abate potential adverse effects.

Operational activities that could potentially impact surface water resources include the following:

- Discharges of wastewater;
- Fueling and use of hazardous materials;
- Maintenance and repair activities, including continued material extraction;
- Surface water withdrawals;
- Spills;
- Stormwater management and runoff;
- Vessel ballast water/cooling water uptake and/or discharge; and
- Waste disposal.

It is proposed to implement practices designed to minimize or mitigate potential impacts on surface water during operation and maintenance as informed by the following Project-specific plans and guidance:

- Applicant's *Plan* (Appendix D of Resource Report No. 7);
- Applicant's *Procedures* (Appendix N);

- Facility-specific SPCC plans to be developed prior to operations, as required;
- Facility-specific SWPPPs to be developed prior to operations, as required;
- *Noxious/Invasive Plant and Animal Control Plan* (Appendix K of Resource Report No. 3);
- *Project Waste Management Plan* (Resource Report No. 8, Appendix K);
- *Project Restoration Plan* (Resource Report No, 3, Appendix P);
- *Unanticipated Contamination Discovery Plan* (Appendix J of Resource Report No. 8); and,
- The Project facilities would be operated and maintained following all applicable federal, state, and local requirements.

Estimated surface water use during operation of each project component is preliminarily identified and discussed below.

2.3.9.1 Liquefaction Facility

2.3.9.1.1 LNG Plant Operations

During LNG Plant operation, fresh water would be used to supply the firewater system, potable and demineralized water needs, and steam. It is likely that groundwater from new or existing wells would be used for these purposes during operation. Normal water consumption during operations is less than 150 gallons per minute. In the unlikely event of a fire, the use would increase to 1,000 gallons per minute for the duration of use. There are no major fresh surface water sources on or near the Liquefaction Facility. Groundwater use would have minor impacts to groundwater sources (<5% of water used), thereby having minor or negligible impacts to nearby surface water sources.

2.3.9.1.1.1 Maintenance and Repair

Maintenance and repair activities at the Liquefaction Facility are anticipated to require minimal site disturbance and hydrostatic testing. Potential impacts to waterbodies from maintenance and repair activities are anticipated to be similar, but of a lower magnitude than those described for construction because of the smaller-disturbance footprint and infrequent need for maintenance and repair. It is anticipated that impacts to waterbodies from maintenance and repair would be long-term, but intermittent and minor.

Hydrostatic testing of Liquefaction Facility lines may be required for maintenance activities. Periodic hydrostatic testing water use needs are not yet determined, and would be permitted separately during operations.

2.3.9.1.1.2 Wastewater

Surface drainage and oily water from process areas would be collected for wastewater treatment. The main discharge location of all treated wastewater containing black and gray water from Project operations would be an outfall to Cook Inlet. APDES permits limit the following pollutants: BOD_5, TSS, fecal coliform and possibly total ammonia, (N, total recoverable copper, total recoverable zinc, WET, enterococci, total residual chlorine (if applicable), DO, oil and grease, pH, and flow. One of the three onsite ponds would serve as the receiving area prior to discharge. No effects to groundwater are anticipated from wastewater disposal. As there are no fresh water sources around the Liquefaction Facility, wastewater discharges would not impact fresh water sources around the Liquefaction Facility. Because wastewater would be treated prior to discharge to Cook Inlet in compliance with the APDES discharge permit, impacts to water quality (e.g., increased coliform count) would be minor.

2.3.9.1.1.3 Stormwater Management and Runoff

All paved and non-paved surfaces outside of the operational areas would drain into stormwater ponds. A *SWPPP* for operations would be developed before the facilities are placed in service. Water from these ponds would be discharged in accordance with APDES requirements via outfalls into Cook Inlet. Turbidity and sediment in discharge waters to Cook Inlet would be in compliance with the APDES permit and impacts are expected to minor due to the settling basins and the already high turbidity levels in Cook Inlet.

2.3.9.1.1.4 Waste Handling

Operation of the Liquefaction Facility would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This *Plan* addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The *Plan* would reflect compliance with all regulations for transportation, treatment, storage, and disposal. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, no impacts to surface water would be anticipated from waste handling.

2.3.9.1.1.5 Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of hazardous liquids, including fuels and lubricants, could occur in any area where these compounds are used or stored and have the potential to damage surface water resources. However, storage of these materials would comply with current regulatory requirements and personnel would be trained for proper handling, storage, disposal, and spill response of potential contaminants, and an *SPCC Plan* would be developed for operations. All petroleum, oil, and lubricant handling required during Project operations would be dictated by the *SPCC Plan* and managed by the Environmental Inspectors. Storage tanks and containers for fuels and hazardous liquids would be stored secondary spill containment, and oil-filled operational equipment would be managed consistent with the requirements of 40 C.F.R. 112.

Operational waste materials would be disposed of as required by federal, state, and local regulations. A description of the proposed waste characterization procedures, estimated waste quantities, and waste handling/disposal procedures is provided in the draft *Waste Management Plan* (see Resource Report No. 8, Appendix K). Potential impacts to groundwater from releases of fuel or other substances during operation of the Liquefaction Facility and mitigation measures would be similar to those during construction. While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the Liquefaction Facility would greatly reduce the likelihood of such impacts, as well minimize the resulting impacts should a spill occur. As such, significant adverse impacts to surface waterbodies due to contamination from spills or releases are unlikely.

In addition, during operation, the potential for a leak or spill of LNG from the Liquefaction Facility would exist. Once natural gas is liquefied, its principal hazards result from its cryogenic temperature (-260 °F), flammability, and vapor dispersion characteristics. As a liquid, LNG would neither burn nor explode. LNG vaporizes rapidly when exposed to ambient heat sources such as water or soil. In the event of a loss of containment of LNG, which consists of ethylene, methane, propane, and other natural gas liquids, the LNG would vaporize on release from any storage or process facilities. Due to this rapid vaporization, an LNG tank leak would not impact surface water or Cook Inlet marine waters. Because LNG would vaporize upon an inadvertent release from a pipe or storage tank, there is little potential for infiltrating surface waters to become contaminated from a LNG release and therefore, effects to surface water would be minor and short term.

2.3.9.1.1.6 Water Supply

Fresh water would be supplied by several 200–250-foot-deep groundwater wells located by the liquefaction trains. The low volume required (<5% of the current groundwater usage in the area) of these groundwater wells would not impact surface water resources.

2.3.9.1.2 Marine Terminal

2.3.9.1.2.1 Navigation and Vessel Traffic

Vessel movements are not expected to contribute to ambient turbidity or to shoreline erosion due to the necessarily low speeds mandated for operational safety in and near the Marine Terminal.

2.3.9.1.2.2 Ballast Water

Empty LNGCs would dock and load at the Marine Terminal (see Section 1.6.1.2 of Resource Report No. 1). These oceangoing vessels generally use ballast water (seawater) that would be exchanged in international waters in accordance with international convention. As LNG is loaded onto the LNGCs at the Marine Terminal, the LNGCs would release the ballast water, thereby replacing the seawater with LNG product as ballast to maintain stability of the LNGC in the water.

It is estimated that approximately 2.9–3.2 billion gallons of ballast water would be discharged per year from LNGCs during LNG loading operations at the Marine Terminal; with the range in annual discharge volume due to varying LNGC sizes and number of LNGCs that may call at the Marine Terminal (estimated at 204 to 360 LNGCs annually). The water discharged would be approximately 0-25 degrees Fahrenheit warmer than ambient water temperature in Cook Inlet. Ballast water discharged in Cook Inlet would be treated according to US regulations.

All vessels brought into the State of Alaska or federal waters would be subject to USCG 33 C.F.R. 151.2000-2080 regulations, which are intended to reduce the transfer of aquatic invasive organisms. Management of ballast water discharge is regulated by federal regulations (33 C.F.R. 151.2025) that prohibit discharge of untreated ballast water into the waters of the United States unless the ballast water has been subject to a mid-ocean ballast water exchange (at least 200 nautical miles offshore). Vessel operators are also required to remove "*fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state, and federal regulations*" (33 C.F.R. 151.2050(f)). Adherence to the USCG 33 C.F.R. 151 regulations would minimize the likelihood of Project-related vessel traffic introducing aquatic invasive species.

Any discharge of a pollutant into the navigable waters of the United States requires authorization under the CWA. Although discharges of ballast waters were historically excluded from the CWA, the EPA has promulgated a National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels. The revised VGP, effective December 19, 2013, sets for the first time numeric effluent limits for ballast water discharges from certain large commercial vessels under a staggered implementation schedule. The standard is expressed as the maximum concentrations of living organisms in ballast water. The permit also includes maximum discharge limitations for biocides and residues.

USCG regulations (46 C.F.R. 162.060) were enacted in June 2012, in an effort to phase out ballast water exchange practices. Ballast water discharge standard (BWDS) (33 C.F.R. 151.2030(a)) requires vessels calling at all U.S. ports must be equipped with a USCG-approved ballast water management system (BWMS). This applies to all new ships constructed in or after December 2013. All vessels over 300 gross tons or that have the capacity to discharge 8 cubic meters (2113 gallons) of ballast water must submit a Notice of Intent (NOI) to the EPA for the 2013 VGP. In addition to these federal requirements, vessels calling on Alaska ports must also comply with all state ballast water exchange rules and laws.

Ballast water discharge is regulated under AS 46.03.750(a) (b), where (a) person may not cause or permit the discharge of ballast water from a cargo tank of a tank vessel into the waters of the state. A tank vessel may not take on petroleum or a petroleum product or by-product as cargo unless it arrives in ports in the state without having discharged ballast from cargo tanks into the waters of the state and the master of the vessel certifies that fact on forms provided by the department. Unless (b), the master of a tank vessel may discharge ballast water from a cargo tank of a tank vessel if it is necessary for the safety of the tank vessel and no alternative action is feasible to ensure the safety of the tank vessel.

The water discharged would be approximately 0–25 degrees Fahrenheit warmer than ambient water temperature in Cook Inlet depending on the season of discharge. With the current flows at the proposed Marine Terminal, and the range of temperatures at the surface of Cook Inlet, it is not expected that this discharge would affect water quality in Cook Inlet.

Adherence to these rules and regulations would minimize the likelihood of water quality impacts due to discharges of ballast water during Project operation.

Carriers are required to have oil discharge prevention and contingency plans in place to protect against spills and measures to address any spills that occur. The Applicant would comply with conditions set forth in USCG BWMS, EPA VGP, and ODPCP requirements.

2.3.9.1.2.3 Cooling Water

LNGCs that dock at the Marine Terminal would require engine cooling water. Approximately 1.6-2.4 billion gallons of sea water per year may be taken in and discharged by LNGCs as cooling water while at the Marine Terminal (for the 204 to 360 LNGCs per year). The water would undergo minimal filtration upon intake and supports a heat exchange process to provide cool water needed for the LNGC integrated cooling systems for equipment onboard such as main engines and diesel generators. Modern cooling water systems are designed as non-contact systems to avoid contact with fuels, oils, or other potential contaminants.

The range in intake/discharge volumes account for the varying LNGC sizes and estimates of the number of LNGC calls at the Marine Terminal. The water discharged could be approximately 5 degrees Fahrenheit warmer than ambient water temperature in Cook Inlet. The discharged waters within the plume would be expected to cool to within 1-2 degree °F of ambient temperature within 328 feet of the discharge point. The cooling water discharge is not expected to reach the seafloor.

The source of cooling water would be Cook Inlet. If Cook Inlet waters are determined to be too high in suspended sediment, filtration systems could be employed. Seawater intake or cooling water discharged is not anticipated to adversely impact Cook Inlet water quality. Thermal impacts from the discharge of heated waters would be ameliorated by natural mixing in the high current regime of Cook Inlet.

2.3.9.1.2.4 Maintenance Dredging

There would be no maintenance dredging at the MOF during operations.

2.3.9.2 Interdependent Project Facilities

2.3.9.2.1 Pipelines

Surface water impacts from operations and maintenance of the Project pipelines would be mostly associated with frost bulb formation induced by chilled gas. 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. On the other hand, natural high spring and summer flows at many waterbodies would reduce the size of the frost bulb as the water within the waterbody bed flows around the frost bulb. The impacts and potential mitigation associated with the potential formation of frost bulbs on fish habitat are discussed in Resource Report No. 3.

The permanent ROW of the pipelines would be kept free of obstructions and maintenance would be performed according to measures outlined in the Applicant’s *Plan* and *Procedures*.

2.3.9.2.1.1 Mainline

Maintenance and repair activities for the Mainline are anticipated to require minimal site preparation (e.g., excavation) and hydrostatic testing. Maintenance of the pipeline ROW would be conducted according to the measures outlined in the Applicant’s *Plan* and *Procedures*. Potential impacts to surface water from maintenance activities are anticipated to be similar but of a lower magnitude than those described for construction because they would have a smaller footprint, be of shorter duration, and occur infrequently. Impacts to surface water from maintenance and repair are anticipated to be long-term, but intermittent and minor.

2.3.9.2.1.2 Point Thomson Transmission Line

Ice roads could be needed for maintenance and repair of the PTTL, with some remote work potentially performed with the use of ADNR Division of Mining, Land and Water (DMLW)-approved vehicles or helicopters in the summer. Ice roads would be constructed from snow, ice chips, and surface water sources. Ice or access road construction needed to complete PTTL maintenance would be similar to construction and is previously discussed in the Pipeline Associated Infrastructure section. Potential impacts to surface water from maintenance and repair activities are anticipated to be similar to, but of a lower magnitude than, those described for construction. Impacts to surface water from maintenance and repair are anticipated to be long-term but intermittent and minor.

2.3.9.2.1.3 Prudhoe Bay Transmission Line

Ice roads could be needed for maintenance and repair of the PBTL, with some off-road work conducted in the winter on an ice road or in the summer using DMLW-approved vehicles. Ice roads would be constructed from snow, ice chips, and surface water sources, not groundwater. Ice or access road construction needed to complete PBTL maintenance is discussed in the following Pipeline Associated Infrastructure section. Potential impacts to surface water from maintenance and repair activities are anticipated to be similar but of a lower magnitude than those described for construction. Impacts to surface water from maintenance and repair are anticipated to be intermittent and minor.

2.3.9.2.1.4 Pipeline Aboveground Facilities

Pipeline Aboveground Facilities would be operated and maintained following all applicable federal, state, and local requirements. Site development would result in an increased amount of impermeable surface present. This would result in a long-term, minor increase in surface runoff. Indirect effects to waterbodies would be similar to those previously described for surface water and are anticipated to be long-term and minor.

Maintenance and Repair

Planned maintenance activities at compressor stations and meter stations would include routine checks, calibration of equipment and instrumentation, inspection of critical components, and servicing and overhauls of equipment. Unplanned maintenance activities would include investigating problems identified by the natural gas control center and station monitoring systems and the implementation of corrective actions.

Pipeline Aboveground Facilities are anticipated to require minimal site preparation (e.g., excavation) and hydrostatic testing. Potential impacts to surface water from maintenance and repair activities are anticipated to be similar but of a lower magnitude than those described for construction. Impacts to surface water from maintenance and repair are anticipated to be long-term but intermittent and minor.

Wastewater

It is anticipated that there would be no process wastewater from the pipeline aboveground facilities. However, drains within compressor sites, sumps, pits, drip collection devices, or storage tanks would be used to collect and store any water that contacts the machinery or wash down waste at the facility. Periodic collection and disposal at approved disposal facility would occur, or a UIC well could be installed at the site. Domestic wastewater would be treated onsite, and the effluent would be discharged according to ADEC regulatory requirements. APDES permits limit the following pollutants: BOD_5, TSS, fecal coliform and possibly enterococci, total residual chlorine (if applicable), (DO, oil and grease, pH, and flow. To reduce fecal coliform count, disinfection, such as UV or chlorine, would be used. No impacts to groundwater are anticipated under normal treatment and disposal of domestic wastewater. Wastewater treatment systems designed for use in remote, Arctic environments would be used. Impacts to surface water from domestic wastewater discharge are anticipated to be long-term but intermittent and minor. Where it exists, no impacts to surface water are anticipated with treatment and disposal of domestic wastewater in accordance with regulatory requirements.

Waste Handling

Operation of the Pipeline Aboveground Facilities would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would ensure compliance with all regulations for transportation, treatment, storage, and disposal. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, there would be no expected impacts to surface water from waste handling operations.

Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of hazardous materials, including fuels and lubricants, could occur where these compounds are used or stored and have the potential to impact groundwater resources. SPCC Plans would be developed for each facility prior to operation. Potential impacts to surface water from fuel spills and mitigation measures during operation of Pipeline Aboveground Facilities would be similar to those described for these facilities during construction.

Compressor and Heater Stations

Water use during operation of compressor and heater stations would not be significant because they would normally be unmanned. Water use would be shared between the maintenance personnel’s personal hygiene requirements and general maintenance and engine wash. Compressor and heater station facilities would include potable and domestic wastewater (including black and gray water) storage, each having approximately 3,000 gallons of capacity.

The potable water would be trucked in to ensure adequate supply and grey water would be pumped out as required and trucked to a pre-designated approved disposal location. General maintenance and engine wash water would be collected in designated separate drain tanks, pumped out, and trucked to a pre-designated disposal location. Bottled drinking water would be trucked in as required. Therefore, no impacts to surface water are anticipated.

2.3.9.2.2 Gas Treatment Plant

GTP would be operated and maintained following all applicable federal, state, and local requirements. A discussion of operations impacts and mitigation measures is provided in the following sections.

2.3.9.2.2.1 Maintenance and Repair

Maintenance and repair activities at the GTP are anticipated to require minimal site disturbance and hydrostatic testing. Use of DMLW-approved vehicles may be required to access areas on the tundra in the summer. In addition, ice roads could be needed for maintenance and repair of the associated pipelines (discussed above). Ice roads would be constructed from snow, ice chips, and surface water sources, not groundwater. Potential impacts to waterbodies from maintenance and repair activities are anticipated to be similar but of a lower magnitude to those described for construction. It is anticipated that impacts to waterbodies from maintenance and repair would be long-term but intermittent and minor.

Hydrostatic testing of GTP lines may be required for maintenance activities and emergency repairs. Periodic hydrostatic testing water use needs are not yet determined but would likely be provided by the reservoir created during the construction phase. The reservoir would be fed by the Putuligayuk River. Hydrotest discharge would be through one of the onsite UIC wells.

2.3.9.2.2.2 Water Supply

GTP would source its process water and camp water from the Putuligayuk River, which would be stored in the reservoir (discussed in Section 2.3.11.2.2). The raw water would flow into the plant at a rate of approximately 190 gallons per minute. This water would be split to the Process Water system and the Potable Water Treatment system. It is expected that 60 gallons per minute of process water would be used at the GTP and 130 gallons per minute of potable water would be used between the GTP area and the GTP Operations Center. The flow of water from the reservoir to the GTP is expected to be a year-round activity, versus the reservoir fill operation, which is expected to occur only for a short duration during the flood season. Filling of the water reservoir would cause a minor and temporary drawdown of the Putuligayuk River, removing less than 20 percent of flow for about 20 days during periods of extreme high flow (spring breakup).

2.3.9.2.2.3 Waste Management

Operation of the GTP would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This *Plan* addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The *Plan* would reflect compliance with all regulations for transportation, treatment, storage, and disposal.

As previously noted, the GTP would drill and complete two industrial Class I wells that would be used to dispose of RCRA exempt liquid waste streams, wastewater, and nonhazardous wastes. The wells would be approximately 6,000 to 7,000 feet deep and thus would extend below the depth of permafrost. It is not anticipated that waterbodies would be impacted from use of the wells.

2.3.9.2.2.4 Stormwater Management and Runoff

Stormwater management and runoff would be discharged in accordance with APDES requirements. No effects to waterbodies are anticipated from stormwater runoff since most would move through the granular pad, or in impervious areas to be pumped into the UIC wells. A *SWPPP* for operations would be developed before the facilities are placed in-service.

2.3.9.2.2.5 Fuel Use, Storage, Refueling, Lubrication, and Spill

Spills of hazardous materials, including fuels and lubricants, could occur where these compounds are used or stored and have the potential to impact surface water resources. SPCC Plans would be developed for the GTP prior to operations. Potential impacts to surface water from fuel spills and mitigation measures during operation of the GTP would be similar to those described for the Liquefaction Facility.

2.3.9.2.2.6 GTP Associated Infrastructure

Operations Camp

The onsite construction camp would be located entirely within the construction camp pad acreage and would remain as a permanent operations camp. As discussed previously, water would be sourced from the reservoir and camp waste would be injected into underground injection wells and should therefore have no effect on surface waters. These camp wastes include nonhazardous wastewaters; however, the domestic wastewaters such as black water and gray water would be disposed through permitted UIC wells.

Fuel Use, Storage, Refueling, Lubrication, and Spill Prevention

Impacts on surface water from fuel or spills and leaks during operation of GTP Associated Infrastructure and associated mitigation measures would be the same as those described for the GTP construction.

GTP would operate fuel gas and propane pipelines (see Resource Report No. 1). During operations, a spill or leak from the propane pipelines would result in volatilized gases that would not impact surface water.

2.3.9.3 Non-Jurisdictional Facilities

The PTU Expansion project process facilities would not require use of freshwater; rather, process facilities would separate produced water from the hydrocarbons and inject this produced water back into the subsurface using a UIC disposal well. As a result, no impacts on surface water resources associated with operations of the proposed PTU Expansion project are anticipated.

Water for the PBU MGS project would be obtained from sources that have been permitted with ADNR and ADF&G, and water withdrawals would be conducted in accordance with all permit stipulations, conditions, and requirements. Facilities at the Prudhoe Bay field would not appear significantly different with the addition of the PBU MGS project. It is anticipated that indirect impacts to waterbodies from Project operation would be similar to ongoing oil production operations and would be intermittent, short-term, and minor.

It is not known what impact the Kenai Spur Highway relocation would have to surface water. Routing may cross streams and would do so with approved bridges. Stormwater runoff would be designed to reduce direct flow into any surface water bodies.

2.4 WETLANDS

Wetlands are areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (Environmental Laboratory, 1987). Wetlands can be a source of substantial biodiversity and serve a variety of functions that include providing wildlife habitat, flood control, and naturally improving water quality. More than 43 percent of Alaska's surface area is composed of wetlands (Hall et al., 1994). This amounts to more than 174 million acres of land. Nearly all of the wetlands found in Alaska are classified as palustrine meaning that they are inland wetlands, which lack flowing water, contain ocean-derived salts in concentrations of less than 0.5 parts per thousand, and are non-tidal.

Wetlands are abundant in the Arctic region of the state (USACE, 2007). This region includes watersheds north of the Brooks Range continuing into the coastal plain. Permafrost impedes drainage, creating saturated soils and associated wetlands in much of the northern region of the state. Lakes, tundra ponds and rivers are abundant within this region. Arctic vegetation consists mainly of various types of tundra species including graminoid (dominated by grasses, sedges, rushes) tundra, dwarf shrub tundra, barrens, and wetlands (Alaska Geobotany Center, Walker et al., 2002). Wetland types are primarily sedge/grass moss wetlands and sedge, moss, dwarf shrub wetlands. Riparian areas and some hillsides in the southern portion of the Arctic Coastal Plain (BLM, 2012) are dominated by shrubs consisting of willows (*Salix* spp.), birches (*Betula* spp.), and alders (*Alnus* spp.). Wetlands occupy approximately 83 percent of the Arctic Coastal Plain and Brooks Foothills regions (Hall et al., 1994).

The Brooks Range acts as a divide between the Arctic and Interior regions. Valleys and lower slopes along the northern portion of the Brooks Range are covered by mixed shrub-sedge tussock tundra. Lower mountain slopes and valleys of the southern portion of the mountain are covered by sedge tussocks and shrubs. Large valleys contain sparse conifer-birch forests and tall shrubs. Wetlands occupy 22.2 percent of the Brooks Range region (Hall et al., 1994).

The Interior region, consisting of the Koyukuk River, Chandalar-Christian River, Beaver Creek-Yukon River, and Tanana River drainage basins, contains almost half of Alaska's wetlands. Permafrost occurs throughout the region with the northern portion of the Interior having thicker, more continuous permafrost compared to the southern region. Black spruce is common in bogs and other areas where soils are poorly drained. Dryas-lichen tundra is common in the northern alpine areas, but little vegetation grows at the uppermost portions of all mountain ranges throughout the Interior region. Wetlands are more common in low-lying areas within this region.

Wetlands are less abundant in the Southcentral region, which includes the Western Cook Inlet, Susitna River, and Kenai Peninsula drainage basins. Permafrost occurs sporadically throughout these areas. Spruce and hardwood forests are considered the dominant vegetation, but black spruce (*Picea mariana*) and ericaceous shrubs do occur within lowlands and bogs. Wetlands in the Southcentral region include scrub bogs and marshes dominated by grasses. Upper Cook Inlet contains a large amount of tidally influenced mud flats.

The results of the assessment of wetland resources within the Project footprint are described in in Appendix E (*Wetland Impact Tables*) and Appendix G (*Wetland Field Survey Report*s), and wetland mapping is provided in Appendix F. The following sections provide a summary of this information.

2.4.1 Wetland Classification System

Two classification systems have been used for the characterization of wetlands within the Project area:

- Cowardin classification system – The Cowardin classification system is hierarchical, describing wetlands and deepwater habitats within five major systems (marine, estuarine, lacustrine, riverine, and palustrine) and further distinguishing by hydrologic conditions and modifiers that describe site hydrology and special conditions; and

- Hydrogeomorphic (HGM) classification system – The HGM classification system, as introduced by Brinson (1993) describes the wetland's position in the landscape and its function using geomorphic and hydrologic characteristics.

Using both systems provides a comprehensive assessment of wetlands within the Project area. A description of the wetland codes used by both systems is provided in Sections 2.4.1 and 2.4.2 and the *Wetland Field Survey Reports* (Appendix G).

2.4.1.1 Cowardin Classification Codes

Wetlands and other Waters of the United States in the Project area were identified using standard Cowardin classification codes as described in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979). Cowardin classification codes classify wetlands and aquatic habitats by system, subsystem, class, subclass, and water regime and are based on hydrologic setting (e.g., marine, riverine, lacustrine, estuarine, palustrine), vegetation structure (e.g., forested, scrub-shrub, emergent, aquatic bed), and water regime (e.g., saturated, seasonally flooded, semi-permanently flooded, etc.) (Cowardin et al., 1979). A summary of the systems and associated wetland codes is outlined in the following sections. Additional details can be found in Cowardin et al. (1979).

One deviation from standard Cowardin classification codes identified for this Project is the use of two non-wetland categories. One category includes all vegetated uplands and is labeled "Uplands." The other is labeled "Disturbed" and includes areas that have been previously impacted by human development, including all roads, granular pads, buildings, and farmland.

2.4.1.1.1 Estuarine System

The Estuarine System includes deepwater tidal habitats and adjacent tidal wetlands that have partial access to the ocean, including offshore areas of continuously diluted seawater. The system tends to have low-energy waves, but is affected by oceanic tides, evaporation, wind, and fresh water runoff from land. The NWI classes crossed by the Project include:

- E1UB: Subtidal Wetlands – Permanently flooded deepwater brackish or saline tidal habitats with unconsolidated bottom, less than 30 percent vegetative/substrate visible (e.g., Cook Inlet and Beaufort Sea coast).

- E2US: Intertidal Wetlands – Aquatic habitats with unconsolidated substrates that are exposed at low tide and flooded at high tide with less than 30 percent vegetative cover, not permanently inundated with water (e.g., Cook Inlet mud flats).

2.4.1.1.2 Palustrine System

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 20 acres, do not have an active wave-formed or bedrock shoreline feature, and at low water the depth is less than 6.6 feet at the deepest part. The Palustrine System wetland codes include:

- PEM: Emergent Wetland – This class is 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, and may be temporarily, seasonally or semi-permanently flooded or saturated;

- PSS: Scrub-Shrub Wetland – This class includes areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions that may be temporarily, seasonally or semi-permanently flooded or saturated; and

- PFO: Forested Wetland – This class is characterized by woody tree species that are 20 feet or taller. PFO4B is a palustrine forested needle-leaved wetland complex that is semi-permanently flooded or saturated and usually dominated by (white or black spruce) woody vegetation 20 feet or taller with an undergrowth of scrub-shrub (less than 20 feet) and an herbaceous layer.

2.4.1.2 Hydrogeomorphic Wetland Classes

The HGM classification system describes the wetland's position in the landscape and its function using geomorphic and hydrologic characteristics. This system focuses on water as the foundation of all wetlands and the abundance of water is what drives habitat. Landscape (i.e., geomorphic setting), water source and its transport (i.e., precipitation, surface flow, ground water discharge), and hydrodynamics (i.e., the direction and strength of flow) are largely responsible for determining a wetland's ecosystem function. The HGM classes include:

- MINERAL SOIL FLATS – These wetlands do not receive groundwater discharge, rather they receive water from precipitation and overland flow. Flat wetlands lose water by evapotranspiration and saturation by overland flow. Flat wetlands are very common in permafrost soils, but can also form from an accumulation of organic material and primarily function to store surface water and provide wildlife habitat, notably for waterfowl;

- DEPRESSIONAL – These wetlands occur in topographic depressions. Their water source is precipitation, groundwater discharge, and both interflow and overland flow from adjacent wetlands. These wetlands store surface water and provide groundwater recharge and wildlife habitat;

- SLOPE – These wetlands occur where there is groundwater discharge to the surface. They are normally found along elevation gradients. They do not store surface water, or recharge groundwater. Instead, they mediate surface flow to other wetlands and waterbodies;

- RIVERINE – These wetlands occur in floodplains and riparian corridors. Their water source is primarily overbank flow, supplemented by overland flow and precipitation. Riverine wetlands can moderate stream flow, store floodwaters, and facilitate nutrient export;

- LACUSTRINE FRINGE – These wetlands occur adjacent to ponds and lakes where the water elevation of the pond or lake maintains the water table in the wetland. They function to store floodwater and detritus (organic material) and provide habitat for wading birds and juvenile fish;

- ORGANIC SOIL FLATS, or extensive peatlands – These wetlands are created by the vertical accretion of organic matter. The water source for extensive peatlands is typically precipitation with water loss due to saturation and seepage to groundwater. Bogs or muskegs are common examples; and

- ESTUARINE FRINGE – These wetlands occur along coasts and estuaries that are influenced by sea level. They intergrade with riverine wetlands where tidal current declines and river flow is the dominant source. These wetlands frequently flood from tidal exchange. Organic matter accumulates in higher elevated marsh areas. Salt marshes are an example of an estuarine fringe wetland.

2.4.2 Existing Wetland Resources

The Cowardin classifications are used as the standard codes in the National Wetland Inventory (NWI). NWI maps in Alaska are based on 1:63,360 scale USGS Topographic (TOPO) series, interpreted from high-altitude B/W (black and white) imagery, taken during the Alaska High-Altitude Photography Program (1978–1986). The 1:63,360 USGS TOPO series does not meet the National Mapping Standard of 1:24,000 scale. Where field surveys were not completed due to lack of access to properties (no right-of-entry or remoteness of location), a desktop assessment was completed to delineate wetland and waterbody boundaries.

All wetland mapping was created in a GIS platform, using a “heads-up” digitizing effort. This “heads-up” process applies aerial image interpretation to delineate vector polygons of ground features. This is the generally accepted wetland and deepwater habitat mapping technique employed by the USFWS personnel as part of the NWI program (Dahl et al., 2009). Data sources were overlaid on aerial photography and wetland, non-wetland, and areas of uncertain wetland status were identified by interpreting color, texture, and landscape position, among other elements. Aerial photography clues can include dwarf or stunted trees, topography characteristics (such as swales, toe slopes and depressions), and obvious signs of inundation.

Standard methods were used to delineate wetlands for large linear projects in Alaska. The protocols included a three-phased iterative approach, including: 1) wetland pre-mapping relying primarily on aerial photo interpretation; 2) collection of ground reference data at predetermined field targets; and 3) revision of wetland pre-mapping based on the results of field efforts. Due to conditions unique to Alaska (e.g., remote, rugged or inaccessible sections of the pipeline corridor, large contiguous wetland expanses, terrain constraints, etc.), this was an iterative process consisting of multiple cycles of aerial photo interpretation, collecting ground reference data at predetermined field locations to verify the photo interpretation and ground-truthing areas of uncertainty. Following each iteration, the wetland maps were revised accordingly as the engineering design proceeded. FERC requested that the Applicant prepare a Wetland Delineation Method Validation Study Report that compares the method used by the Applicant called the Field Target Method and the Routine/Transect Method used in the contiguous 48 states for FERC-regulated projects. Upon completion, the report will be provided to FERC.

Wetland boundaries for the mapping corridor were delineated on digital ortho-rectified and geo-referenced true color aerial imagery with 1.6-foot pixel resolution. All wetlands were mapped at a scale of 1:2,400 (1 inch to 200 feet) or finer. Lakes, ponds and rivers were mapped at a scale of 1:1,200 (1 inch to 100 feet). The amount of field survey coverage to date is listed in Table 2.4.2-1.

TABLE 2.4.2-1

Wetland Evaluation of the Project Area

Facility	Unsurveyed (acres)	Surveyed (acres)	Foot Print Total (acres)	Percent Complete
Liquefaction Facility	0.00	1,065.14	1,065.14	100.00%
Mainline ROW	67.76	50,548.34	50,616.10	99.87%
Mainline	235.31	12,257.12	12,492.44	98.12%
PBTL	0.00	7.31	7.31	100.00%
PTTL ROW	0.01	1,725.98	1,725.99	100.00%
PTTL	0.00	349.70	349.70	100.00%
GTP	0.00	925.88	925.88	100.00%
Total	**270.81**	**66,911.74**	**67,182.55**	**99.60%**

On February 2, 2015, USACE confirmed that the wetland boundaries within the Project area north of Livengood have been established in accordance with its 1987 Wetland Delineation Manual and its 2007 Regional Supplement for Alaska. The agency's conclusion was based on data submitted from the 2014 field surveys. Additional Wetland Field Surveys for 2016 have been submitted.

Wetland communities that have been identified in the Project area are listed by basin in Appendix E (*Wetland Impact Tables*) and summarized in Table 2.4.2-2. Detailed information of the wetlands within the Project footprint is provided in the *Project Wetland Field Study Report*s (Appendix G). Mapping of wetlands within the Project area is provided in Appendix F.

TABLE 2.4.2-2

Preliminary Summary of Wetland and Estuarine Habitats Crossed by Facility Type

Project Facility [a, b]	NWI Class [c]	Acreage Affected During Construction [d]	Acreage Affected During Operations [d]
Liquefaction Facilities			
LNG Plant	E2US	9.74	9.74
	PEM	6.01	6.01
	PSS	0.20	0.20
Marine Terminal			
MOF (Temporary) [i]	E2US	11.42	0.00[h]
MOF Dredge Area	E1UB	30.75	0.00
	E2US	19.50	0.00
PLF	E1UB	17.71	17.71
	E2US	0.96	0.96
Shoreline Protection	E2US	1.17	-
Liquefaction Facilities Total		***97.46***	***34.61***
Interdependent Project Facilities			
Pipelines ROW			
Mainline Onshore	PEM	2,101.88	821.50
	PFO	616.17	242.25
	PSS	3,268.38	1,340.28
Mainline Offshore	E1UB	36.36	13.67 [f]

TABLE 2.4.2-2

Preliminary Summary of Wetland and Estuarine Habitats Crossed by Facility Type

Project Facility [a, b]	**NWI Class [c]**	**Acreage Affected During Construction [d]**	**Acreage Affected During Operations [d]**
	E2US	27.75	0.00 [f]
PBTL	PEM	0.00 [e]	0.00
PTTL	PEM	0.26 [e]	0.26
	PSS	0.01 [e]	0.01
Pipelines Total		***6,050.55***	***2,417.71***
Pipeline Aboveground Facilities			
PTTL Meter Station	PEM	0.00	0.00
	PSS	0.00	0.00
PTTL Mainline Block Valves (MLBV)	PEM	0.14	0.14
GTP Mainline Meter Station	PEM	0.00[d]	0.00 [d]
Coldfoot Compressor Station	PEM	1.60	1.60
	PFO	4.82	4.82
	PSS	22.29	22.29
Sagwon Compressor Station	PEM	19.86	19.86
	PSS	10.05	10.05
Galbraith Lake Compressor Station	PEM	0.27	0.27
	PSS	7.27	7.27
Ray River Compressor Station	PSS	0.18	0.18
Healy Compressor Station	PSS	30.30	30.30
Honolulu Creek Compressor Station	PFO	1.31	1.31
	PSS	3.65	3.65
Rabideux Creek Compressor Station	PFO	0.98	0.98
	PSS	0.52	0.52
Theodore River Heater Station	PSS	0.12	0.12
Pipeline Aboveground Facilities Total		***103.36***	***103.36***
Pipeline Associated Infrastructure			
Access Roads	PEM	202.39	10.47
	PFO	110.95	41.35
	PSS	334.87	56.92
Additional Temporary Workspace (ATWS)	E2US	1.22	0.00
	PEM	114.42	0.00
	PFO	62.81	0.00
	PSS	321.72	0.00
ATWS (PTTL)	PEM	5.65	0.00
	PSS	0.74	0.00
Construction Camps	PEM	46.24	0.00 [i]
	PFO	30.03	0.00 [i]
	PSS	49.47	0.00 [i]
Disposal Sites	PEM	17.58	0.00 [i]
	PFO	7.96	0.00 [i]
	PSS	81.20	0.00 [i]
Double Joint / Coating Yards	PEM	6.47	0.00 [i]

TABLE 2.4.2-2

Preliminary Summary of Wetland and Estuarine Habitats Crossed by Facility Type

Project Facility [a, b]	NWI Class [c]	Acreage Affected During Construction [d]	Acreage Affected During Operations [d]
	PFO	5.07	0.00 [i]
	PSS	31.06	0.00 [i]
Helipads (Mainline)	PEM	0.32	0.32
	PFO	0.00	0.00
	PSS	0.39	0.39
Helipad (PTTL)	PEM	0.57	0.57
Material Sites	PEM	311.47	0.00 [i]
	PFO	296.01	0.00 [i]
	PSS	892.23	0.00 [i]
Pipe Storage Yards	PEM	38.61	0.00 [i]
	PFO	12.82	0.00 [i]
	PSS	55.31	0.00 [i]
Pipe Storage Yards (PTTL)	PEM	22.16	0.00
Railroad Spurs	PEM	0.01	0.00 [i]
	PSS	0.67	0.00
Railroad Work Pads	PEM	2.06	0.00
	PFO	0.41	0.00
	PSS	5.14	0.00
Pipeline Associated Infrastructure Total		***3,068.09***	***110.02***
GTP Aboveground Facilities			
GTP Pad	PEM	211.97	211.97
Operations Center Pad	PEM	50.64	50.64
GTP Aboveground Facilities Total		***262.61***	***262.61***
GTP Associated Infrastructure			
Associated Transfer Pipes	PEM	0.02[e]	0.02
Access Roads	E1UB	16.05	16.05
	E2US	3.90	3.90
	PEM	104.89	104.89
Barge Bridge	E1UB	2.57	0.00
Material (Mine) Site	PEM	135.39	135.39
Module Staging Pad	PEM	78.80	0.00 [i]
Water Reservoir and Pump Facilities	PEM	27.19	27.19
GTP Associated Infrastructure Total		***368.81***	***287.44***
Preliminary Total Wetland Impacts		**9,951.15**	**3,216.03** [a b d f g]

Notes:

Impacts do not include ice roads or ice workpads for construction, since ice roads were determined to be a non-intrusive means to construct across the tundra.

[a] Preliminary estimate of Wetland Impacts by Facility is for the Rev C route. ROW widths vary by construction method across the proposed route; a 50-foot-wide permanent easement was used to determine preliminary wetland impacts. Forested wetlands within the operational maintenance corridor would be permanently converted to scrub-shrub and/or emergent wetlands.

TABLE 2.4.2-2

Preliminary Summary of Wetland and Estuarine Habitats Crossed by Facility Type

Project Facility [a, b]	NWI Class [c]	Acreage Affected During Construction [d]	Acreage Affected During Operations [d]

[b] Compressor Station footprint includes block valves and construction camps. PTTL MLBV footprint includes Helipad, and GTP Operations Center footprint includes the construction camp. MLBV and helipads footprints are included within Mainline ROW acreage.

[c] NWI Wetland Classification System as defined in Cowardin et al. (1979): PEM - Palustrine Emergent; PSS - Palustrine Scrub-Shrub; and PFO - Palustrine Forested, may be Temporarily, Seasonally or Semi-Permanently Flooded or Saturated. E1UB – Estuarine Subtidal Unconsolidated Bottom; E2US – Estuarine Intertidal Unconsolidated Shore, may be Irregularly Exposed, Regularly or Irregularly Flooded.

[d] Acreage used for the construction and operation of a facility is 0.00 when it occurs within the construction or operation footprint of another facility. Additional acreage is included if the facility is placed outside of these areas.

[e] PTTL, PBTL and GTP pipelines would be aboveground on Vertical Support Members (VSMs), ice roads and ice work pads would be used for construction and operations. Construction/Operations camp is located on a pad connected to the GTP Pad. The flare pad is contained within the footprint for the GTP Pad.

[f] Cook Inlet crossing includes nearshore service berms, offshore and subsea trenchlines. The majority of the construction ROW would not be disturbed during construction with 10 to 14 anchor points for pipe lay barge moves. The operational ROW is the 42-inch pipe on seafloor plus concrete coating (assumed 6-inch).

[g] ROW maintenance practices specified in the Applicant's Procedures, a 10-foot-wide strip over the pipeline would be maintained in an herbaceous condition. Trees within 15 feet of the pipeline (centerline) with roots that could compromise the integrity of the pipeline coating may be selectively cut. For buried trenchless crossings, the permanent ROW would not be maintained between the buried trenchless entry and exit points. Values rounded to nearest hundredth of an acre.

[h] Until it is removed during LNG Plant operations.

[i] Although the permanent impact is shown as 0.00, the facility would be left in place and could be maintained and used by other parties, but not the Project.

2.4.2.1 Estuarine Tidal Wetlands

Salt marshes and mud flats occur along the unconsolidated shores of the Beaufort Sea coast and Cook Inlet tidal estuary. Tidal wetlands in Cook Inlet are influenced by an extreme tidal range mixing large amounts of freshwater discharging from glacial sediments into already diluted saltwater. The Project crosses Estuarine (non-vegetative, subtidal and intertidal) wetlands near the Beaufort Sea coast and Upper Cook Inlet marine environments. Preliminary estuarine wetlands affected during construction and operations is approximately 180 and 62 acres, respectively. Table 2.4.3-2 summarizes wetland impacts by facility type and NWI Classification.

2.4.2.2 Palustrine Emergent Wetlands

Most regions of Alaska include extensive areas of wetlands. Palustrine emergent (grasses and sedges) wetlands are abundant in the Project corridor, occurring mainly in the Prudhoe Bay drainage basin within the watersheds of Mikkelson Bay, Sagavanirktok and Kuparuk rivers. North of the Brooks Range, PEM wetlands are underlain by wet (ice-rich) continuous permafrost soils that are poorly-drained and impervious to water infiltration. Emergent wetlands affected during construction and operations is 3,591 and 1,391 acres, respectively. Additional information on wetlands crossed by the Project is provided in Appendix E, *Wetland Impact Tables*.

2.4.2.3 Palustrine Scrub-Shrub Wetlands

The most prominent wetland type crossed by the Project is palustrine scrub–shrub. PSS wetlands are extensive in the Project area, especially in the watersheds of Sagavanirktok, Upper Koyukuk and South Fork Koyukuk rivers. Scrub-shrub wetlands with dwarf alder or willow, mixed shrub-tussock tundra, and ericaceous bogs are common in the Project corridor. PSS wetlands are abundant in the valleys and basins associated with large perennial systems within the Beaver Creek-Yukon River, Tanana River, and Koyukuk River drainage basins. Preliminary estimate of potential PSS wetlands affected during construction and operations is 5,116 and 1,472 acres, respectively. Wetland field reports and delineations forms (2014-2016) are provided in Appendix G.

2.4.2.4 Palustrine Forested Wetlands

Forested wetlands within the Project footprint consist of Palustrine Forested (PFO) wetlands (Table 2.4.2-2 and Appendix E, *Wetland Impact Tables*). A preliminary estimate of PFO wetlands would be located within the construction footprint of the Mainline, Mainline's Aboveground Facilities and associated infrastructure is approximately 616, 7, and 526 acres, respectively. No other facilities would cross forested wetlands. Approximately 242 acres of forested wetlands within the operational maintenance corridor would be permanently converted to scrub-shrub and/or emergent wetlands.

2.4.2.5 Major Wetland Complexes

Large wetland complexes that would be crossed by the Project are PSS, PEM or mixed classes (e.g., PSS/PEM). The predominant HGM class that would be crossed is Flat - Organic, with Slope and Depressional features also abundant. Due to the abundance of water in Alaska and the corresponding abundance of wetlands, numerous wetlands complexes would be crossed by the Project. General wetland construction methods are provided in the ROW Mode descriptions discussed in Section 2.6.2 and depicted in the draft *Restoration Plan* (see Resource Report No. 3., Appendix P). Anticipated impacts and mitigation strategies are discussed in Sections 2.4.3 and 2.4.4.

2.4.3 Potential Construction Impacts and Mitigation Measures for Wetlands

The abundance of wetlands and aquatic resources in Alaska makes complete avoidance of wetland impacts technically infeasible (see also Resource Report No. 10) due to site-specific conditions along the proposed corridor. The Project footprint would cross approximately 51,000 acres of Waters of the United States, including wetlands, during construction. Approximately 41,000 acres of these contain the anticipated workspace required for the pipe lay barge to use anchors during Mainline construction across Cook Inlet. Further details on wetland impacts from Project construction are provided in Table 2.4.2-2 and Appendix E (*Wetland Impact Tables*). An assessment of potential impacts to surface water (e.g., waterbodies), including Marine, Riverine and Lacustrine Systems, from Project construction is provided in Sections 2.3 and 2.6, and Appendix N (Applicant's *Procedures*).

Examples of construction activities that could impact wetlands include, but are not limited to, the following:

- Blasting;
- Clearing, grading, and filling;

- Dewatering and trenching;
- Domestic sewage and greywater disposal from construction camps;
- Fueling and use of hazardous materials;
- Hydrostatic test water discharges;
- Ice roads/access road construction;
- Material extraction and excavation dewatering;
- Potential of drilling mud release during buried trenchless method construction;
- Restoration or reclamation of construction areas;
- Surface water and groundwater withdrawals (e.g., hydrostatic test water);
- Stormwater management and runoff; and
- Fugitive dust.

Additional wetland impacts may occur from the introduction of invasive species, erosion, fugitive dust, permafrost thaw, thermokarst, and changes to hydrology. Construction practices designed to avoid, minimize, or mitigate potential impacts on wetlands during construction would be implemented. This includes the measures and guidance provided in the following Project-specific plans:

- Applicant's *Plan* (Resource Report No. 7, Appendix D);
- Applicant's *Procedures* (Appendix N);
- *Blasting Plan* (Resource Report No. 6, Appendix B);
- *Fugitive Dust Control Plan* (Resource Report No. 9, Appendix J);
- *HDD Inadvertent Release Contingency Plan* (Appendix L);
- *Noxious/Invasive Plant and Animal Control Plan* (Resource Report No. 3);
- *Project Waste Management Plan* (Resource Report No. 8, Appendix K);
- *SPCC Plan* (Appendix M);
- *SWPPP* (Appendix J); and
- *Unanticipated Contamination Discovery Plan* (Resource Report No. 8, Appendix J).

For impacts to wetlands that cannot be avoided or minimized, the appropriate form of mitigation offsets for wetland net loss and permanent cover type modifications would be determined in conjunction with USACE and other resource management agencies.

2.4.3.1 Liquefaction Facility Potential Wetland Construction Impacts and Mitigation Measures

A summary of the acreage of wetlands within the footprint of the Liquefaction Facility that would be directly affected during construction of the Liquefaction Facility is provided in Table 2.4.2-2. A detailed list of the individual wetland impacts is provided in Appendix E (*Wetland Impact Tables*).

Wetlands within the proposed footprint would be permanently converted to industrial or open land during site clearing, grading, and development. Based on the extent of wetlands in Alaska, impacts are anticipated to be long-term but minor. Of the estimated approximate 2.6 million acres of fresh water wetlands in the Cook Inlet area (Hall et al., 1994) construction of the Liquefaction Facility would impact less than 0.01 percent.

Wetlands adjacent to the Liquefaction Facility construction footprint could be indirectly impacted during construction due to:

- Alterations of recharge areas (e.g., contours) and infiltration rates (e.g., compaction);
- Runoff of stormwater;
- Dewatering from excavation/trenching and material extraction areas;
- Fugitive dust; and
- Discharges of hydrostatic test water and domestic wastewater.

Potential impacts to wetlands from construction of the LNG Plant and the proposed mitigation measures would be similar to those previously described for surface water resources. Stormwater runoff, hydrostatic test water, and domestic wastewater would be directed to designated, graded sediment catch basins that would outflow via one of three outfalls into Cook Inlet. Extracted water from dewatering activities would also either be pumped into an onsite sediment basin or discharged to the ground on site. Impacts to adjacent wetlands from construction activities are expected to be short-term and minor due to compliance with the Project *SWPPP*, the Applicant's *Plan* and *Procedures*, Project *Fugitive Dust Plan*, and permit requirements.

Construction of the Marine Terminal would also impact intertidal wetland habitat along the shoreline for the length of the Liquefaction Facility boundary. Impacts would include wetland fill, loss or alteration of vegetation communities, shoreline erosion, and increased sedimentation from vessel wake. The Liquefaction Facility has been sited in an area of existing industrial development, which includes marine transport activities. It is anticipated that impacts to intertidal wetlands would be long-term but minor.

2.4.3.1.1 Water Supply Wells

As previously noted, groundwater would be used for site preparation, dust suppression, potable water, concrete mixing, and hydrostatic testing. Withdrawal of groundwater could result in a drawdown of the aquifer impacting wetlands in proximity to the Liquefaction Facility site. Groundwater studies are planned to further assess potential groundwater yield at the Liquefaction Facility site. The results of these studies will be provided in the FERC application as they relate to the potential for impacts to the surrounding groundwater levels due to the proposed withdrawal.

2.4.3.1.2 Blasting

Blasting is not anticipated to be required for construction of the Liquefaction Facility.

2.4.3.1.3 Invasive Species

Noxious/invasive plant species tend to thrive in disturbed areas (e.g., construction areas, roadsides). They then spread into and dominant native vegetative communities reducing plant biodiversity and wildlife habitat. Vectors include materials (e.g., straw, machinery, footwear, clothing, hand tools, and tires) and equipment brought in from outside of the local area, non-native seeds inadvertently included with seed mixtures, and existing ROWs that are already infested. Disturbance related to construction of the Liquefaction Facility could increase the potential for noxious/invasive plants to invade adjacent, natural wetland areas. Protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Appendix K of Resource Report No. 3) would be followed. This plan includes preventative measures and treatment methods. Additional details on the prevention of noxious/invasive plant species is provided in Resource Report No. 3.

2.4.3.1.4 Fuel Use, Storage, Refueling, Lubrication, and Spills

A spill would potentially impair wetland functions from water contamination restricting oxygen exchange between the water surface and air; coating of wetland vegetation that reduces photosynthesis, transpiration, and carbon assimilation; and the coating/contamination of hydric soils that would persist until removal of soils or biodegradation by microbes. All fuel handling necessary for construction of the Liquefaction Facility would be in accordance with ADEC requirements and the Project *SPCC Plan* (Appendix M). The *SPCC Plan* would be managed by the Environmental Inspectors during construction. This includes that secondary containment for fuel storage tanks would be used for single-walled containers; storage and construction equipment would be maintained and inspected daily for leaks; and all equipment would be parked overnight or refueled at least 100 feet from wetland boundaries to the extent practicable, or use portable secondary containment or other means to contain drips and potential fuel leaks.

While a spill has the potential for significant adverse environmental impacts, adherence to the proposed protective measures previously outlined for the Liquefaction Facility (see the Groundwater section), would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to a release are unlikely.

2.4.3.1.5 Waste Management

All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This *Plan* addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal of waste. The generation and storage of hazardous wastes during construction would be minimal. Volumes and types of waste would be determined when construction contractors are selected and construction plans finalized. At that time, each contractor would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during construction. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to wetlands due to waste management during construction of the Liquefaction Facility would not be anticipated.

2.4.3.2 Interdependent Project Facilities

Potential impacts to wetlands from construction of the Interdependent Project Facilities would include loss or alteration of vegetation and wetland types, habitat fragmentation, soil compaction, erosion and sediment deposition, loss of natural buffers and filters, and changes to hydrology.

2.4.3.2.1 Pipelines

The Mainline design would be a belowground pipeline, except at fault crossings and some waterbody crossings. The PBTL and PTTL would be aboveground on VSMs. Wetland crossing methods would vary between aboveground/aerial crossings, buried trenchless, and traditional trenching (i.e., open cut). As practicable, the pipeline routes would be sited to avoid wetland areas and construction timing would be planned to limit impacts.

2.4.3.2.1.1 Mainline

The Mainline construction schedule would be planned with consideration to weather, geologic conditions, permafrost, hydrology, and the terrain's ability to support summertime construction activities. The winter construction schedule would primarily be dependent on authorization from ADNR to allow winter access to tundra; other factors required for winter construction include the presence of permafrost and/or swampy and relatively flat terrain where water sources are available for frost packing and construction of ice pads and ice roads. At the onset of freezing weather, snow would be removed from the site then wheeled or tracked equipment would be repeatedly driven over the site to compact soils to increase frost depth penetration. Winter construction (ROW preparation) would begin when the ground surface is frozen deep enough to support construction equipment. This would minimize potential impacts to wetlands. Typical winter construction would begin with survey of the ROW, followed by frost packing and ice pad construction, then pipe laying and welding. Rehabilitation and revegetation would take place starting the following spring

Sites would be selected for summer work based on several factors including construction cost, schedule, safety, thaw-stable and unfrozen soils or difficult terrain (hills with steep slopes). Additional details on the proposed construction schedule and rationale are provided in Resource Report No. 1.

A summary of the acreage of wetlands within the construction footprint of the Mainline that would be directly affected during construction is provided in Table 2.4.2-2. A detailed list of individual wetland impacts is provided in Appendix E (*Wetland Impact Tables*). For unavoidable impacts (losses), some form of mitigation would be required. As previously noted, the Project *Wetland Mitigation Plan* (Appendix O) provides an outline of mitigation options and will continue to be updated (see Section 2.4.4).

ROW Preparation and Trenching

Impacts on wetlands would include alteration or loss of wetland vegetation and potential changes to wetland soils characteristics, hydrology, and water quality from clearing, grading, and trench construction. The technique for crossing wetlands would depend on site-specific conditions at the time of construction including season, weather, soil, presence and extent of permafrost, slope and soil stability, and wetland type. Prior to construction, BMPs would be put in place and maintained. BMPs would be specific to wetland crossing methods and time of year. In areas where trenching could drain wetlands, trench breakers would be constructed to maintain wetland hydrology. All wetland boundaries and buffers would be clearly marked with signs or flagging. Boundary markings would remain in place and maintained until construction activities and restoration efforts in these areas are complete.

Wetlands within the construction ROW would be restored following construction (see the following Restoration/Reclamation section) in compliance with regulatory requirements and the Project *Restoration Plan* (Resource Report No. 3, Appendix P).

Major Wetland Complexes

Due to the abundance of water in Alaska and the corresponding abundance of wetlands, there are numerous wetlands complexes that would be crossed by the Project.

Forested Wetlands

All vegetation would be cleared from the ROW prior to any construction activities during the winter preceding earth-moving activities. Vegetation would be cut at ground level and BMPs installed prior to spring breakup and managed until construction activities start at that location. Construction of the 807-mile pipeline would impact a preliminary estimate of approximately 1,233 acres of forested wetlands. Forested areas would take decades to recover to preexisting conditions, and forested areas within the permanent ROW would be maintained in an herbaceous state for the lifetime of the pipeline. Impacts to forested wetlands could also lead to habitat fragmentation. The potential for fragmentation would be minimized by following existing linear corridors (e.g., pipelines, roads) to the extent practicable. Additional details on efforts to collocate the Mainline with existing corridors are provided in Resource Report No 10.

Impacts to forested wetlands from Mainline construction are anticipated to be long-term and minor based on the extent of forested wetlands in Alaska and the use of existing corridors to the extent practicable.

Restoration

Temporarily disturbed wetland areas would be restored in accordance with the Project *Restoration Plan* (Resource Report No. 3, Appendix P). Trees would not be allowed to reestablish within the permanent ROW as tree roots may damage pipeline coating. Post-construction monitoring, maintenance, and reporting would be conducted in accordance with the Applicant's *Plan* and *Procedures*. The effects on wetland vegetation would be greatest during and immediately following construction. In general, wetland vegetation would eventually transition back into a community with a function similar to that of the wetland before construction. It is expected that herbaceous wetlands would recover to their preexisting vegetative conditions in a relatively short period (i.e., several growing seasons) post-construction, depending on location. Where the length of the growing season is shorter (e.g., Beaufort Coastal Plain ecoregion), it is anticipated that recovery could take longer. Despite their harsh environment, Arctic plants have adapted well to the low temperatures. Research suggests that hydrology, low nutrients, and short growing seasons are key factors limiting plant growth and reproduction (Jorgenson and Joyce, 1993; NSSI, 2013). It is anticipated that impacts would be minor based on the extent of wetlands in Alaska. Of the estimated approximate 92.6 million acres of palustrine fresh water wetlands in Polar (Arctic Tundra) and Boreal (Intermontane Boreal and Alaska Range Transitional) ecosystems in Alaska (Hall et al., 1994), construction of the Mainline would temporarily impact approximately 0.005 percent.

Hydrostatic Testing

Hydrostatic testing of up to 20-mile-long sections of the Mainline would be performed in the summer, when temperatures would be above freezing. It is not anticipated that hydrostatic testing of the Mainline would negatively impact wetlands. Water for hydrostatic testing would be sourced from surface water resources adjacent to the Project area. Water would be discharged into the same watershed from which it was withdrawn and would adhere to APDES permit discharge requirements for water quality. Because testing would occur during the summer, no test water additives would be necessary, unless hydrostatic test-water discharge requires treatment prior to discharge.

Blasting

Blasting would be required during trenching, stream crossings, and for excavation at material sites and where boulders, bedrock, or certain permafrost terrain conditions are encountered near the ground surface and mechanized fracturing and excavation are not practicable. Potential impacts to wetlands and mitigation measures during construction of the Mainline would be similar to those previously described for the Mainline impacts to surface and groundwaters. The BMPs listed in the Project *Blasting Plan* (Resource Report No. 6, Appendix B) would be followed. Any potential impacts to wetlands adjacent to the Mainline from blasting are anticipated to be localized, short-term, and minor based on the spatial extent of the impact, the duration and frequency, and localized nature of the work

Invasive Species

Wetlands could be impacted by the introduction of noxious/invasive plant species during Mainline construction. Potential vectors and impacts during construction of the Mainline would be similar to those previously described for the Liquefaction Facility. A list of potential species of concern is provided in Resource Report No. 3 and the *Noxious/Invasive Plant and Animal Control Plan* (Appendix K of Resource Report No. 3). The *Plan* includes preventative measures and treatment methods.

Fuel Use, Storage, Refueling, Lubrication, and Spills

During development of the construction infrastructure, temporary fuel storage tanks would be set up at pioneer camps, civil construction spreads, pipeline construction camps, and each spread's active contractor yard. Interim storage tanks would be located along Dalton Highway and provide fuel for transport trucks. Tanks would have 110 percent secondary spill containment.

All fuel handling necessary for construction of the Mainline would be in accordance with regulatory requirements and the Project *SPCC Plan* (Appendix M). The *SPCC Plan* would be managed by the Environmental Inspectors during construction. This includes that secondary containment would be used for single-walled containers; storage and construction equipment would be maintained and inspected daily for leaks; and all equipment would be parked overnight or refueled at least 100 feet from wetland boundaries unless approved by the Environmental Inspector. Given the pervasiveness of wetlands of varying types along the route, there are hundreds of locations where there would be no reasonable alternative to refueling (within the construction ROW) within 100 feet of a waterbody or wetland. These activities can occur closer only if the Applicant and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the Liquefaction Facility (see the Groundwater section), would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to a release would be unlikely.

Waste Management

All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This *Plan* addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The *Plan* would reflect compliance with all regulations for transportation, treatment, storage, and disposal of waste. The generation and storage of hazardous wastes during construction would be minimal. Volumes and types of waste would be determined when construction contractors are selected and construction plans finalized. At that time, each contractor would be required to develop a waste management plan that follows the guidance in the Project *Waste Management Plan* and outlines the types, volumes, and disposition of wastes anticipated during construction. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to wetlands due to waste management during construction of the Mainline are not anticipated.

HDD Inadvertent Release

Effective steps that would limit potential impacts on wetlands from buried trenchless method construction include placing entry and exit drill points in uplands (to the extent practicable) and installing containment structures (e.g., pits, self-containment system) at these points prior to drilling. Drilling mud may leak through previously unidentified fractures in the material under the surface (frac-out) along the drill path due to unfavorable ground conditions. Although drilling mud consists of nontoxic materials, the release of drilling mud in large quantities could cause coating of wetland vegetation resulting in reduced food availability; displacement or smothering of macroinvertebrates; and changes in hydrology from modified soil saturation, water levels, and circulation (Crowell, 2014). These impacts would vary depending on wetland size, how much fluid is released, and time of year.

Measures outlined in the Project-specific *HDD Inadvertent Release Contingency Plan* (Appendix L) would be implemented to minimize the risk of the buried trenchless method complications and the potential for inadvertent releases of drilling fluid. With adherence to the BMPs in this plan, it is anticipated that any impacts to wetlands would be localized and minor.

2.4.3.2.1.2 Point Thomson Transmission Line

A summary of the acreage of wetlands within the footprint of the PTTL that would be directly affected during construction is provided in Table 2.4.2-2. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (*Wetland Impact Tables*).

Aboveground Pipeline and VSM Construction

Standard industry practice would be followed by constructing the PTTL aboveground on VSMs using ice roads and pads to minimize impacts on the tundra, wetlands, and surrounding habitat. Other than permanent wetland loss where VSMs would be embedded into the ground, impacts to wetlands from construction of the PTTL on VSMs would be anticipated to be short-term and minor.

Special Use Wetlands

No special use wetlands have been identified that would be crossed by the PTTL.

Restoration

Temporarily disturbed wetland areas (e.g., ice road along the construction ROW) would be restored in accordance with the Project *Restoration Plan*. The Project *Restoration Plan* is included as Appendix P of

Resource Report No 3. Post-construction monitoring, maintenance, and reporting would be conducted in accordance with the Project *Restoration Plan*, Applicant's *Plan* and *Procedures*.

Blasting

It is not anticipated that blasting would be required for construction of the PTTL. Blasting would be required where boulders, bedrock, or certain permafrost terrain conditions are encountered near the ground surface at any of the PTTL buried river crossings and mechanized fracturing and excavation are not practicable. If blasting is considered necessary, BMPs listed in the *Blasting Plan* (Resource Report No. 6, Appendix B) would be followed. Any potential impacts to wetlands adjacent to the Pipeline Facilities from blasting are anticipated to be localized, short-term, and minor based on the spatial extent of the impact, the duration and frequency, and localized nature of the work.

Hydrostatic Testing

It is not anticipated that hydrostatic testing of the PTTL would impact wetlands. Water for hydrostatic testing would be sourced from surface water resources adjacent to the Project area and water would be discharged into an existing permitted UIC well, or, to the same watershed from which it was drawn. If discharge cannot be through a permitted UIC well, surface discharges would be released to ground through an energy-dissipating device to reduce the potential for erosion and encourage infiltration. Additives may be necessary, and if used, their use would be coordinated with permitting agencies.

Invasive Species

Wetlands could be impacted by the introduction of noxious/invasive plant species during PTTL construction. Potential vectors and impacts during PTTL construction would be from construction equipment handling of water, ice chips, ice road work, and drilling of VSM holes. The protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Resource Report No. 3, Appendix K) would be followed. The Plan includes preventative measures and treatment methods.

Fuel Use, Storage, Refueling, Lubrication, and Spills

See discussion of fuel use under Mainline above. While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the Mainline (see the Groundwater section), would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to a release would be unlikely.

Waste Management

See discussion of waste management under Mainline above. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to wetlands due to waste management during construction of the PTTL would not be anticipated.

2.4.3.2.1.3 Prudhoe Bay Transmission Line

A summary of the acreage of wetlands within the footprint of the PBTL that would be directly affected during construction is provided in Table 2.4.2-2. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (*Wetland Impact Tables*). Similar to the PTTL, standard industry practice would be followed by constructing the PBTL aboveground on VSMs using ice roads and pads to minimize impacts on the tundra and surrounding habitat. Potential wetland impacts and mitigation measures would be similar to those previously discussed for the PTTL.

2.4.3.2.1.4 Pipeline Aboveground Facilities

A summary of the acreage of wetlands within the footprint of the Pipeline Aboveground Facilities that would be directly affected during construction is provided in Table 2.4.2-2. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (*Wetland Impact Tables*).

The Pipeline Aboveground Facilities would be built on granular pads and the wetlands on site would be permanently converted to industrial or open land during site clearing, grading, and development (e.g., fill). Based on the extent of wetlands in Alaska, impacts are anticipated to be long-term but minor. Of the estimated approximate 92.6 million acres of palustrine fresh water wetlands in ecoregions Polar (Arctic Tundra) and Boreal (Intermontane Boreal and Alaska Range Transitional) in Alaska (Hall et al., 1994), construction of the Pipeline Aboveground Facilities would impact approximately 0.0001 percent.

Wetlands adjacent to a Pipeline Aboveground Facility's construction footprint could be indirectly impacted during construction due to:

- Alterations of recharge areas (e.g., contours) and infiltration rates (e.g., compaction);
- Blasting;
- Runoff of stormwater;
- Dewatering from excavation/trenching;
- Fugitive dust; and
- Discharges of hydrostatic test water.

Potential impacts to wetlands from construction of the Pipeline Aboveground Facilities and the proposed mitigation measures would be similar to those described previously for surface water resources. Impacts to adjacent wetlands from construction activities are expected to be short-term and minor due to compliance with the Project *SWPPP*, the Applicant's *Plan* and *Procedures*, Project *Fugitive Dust Plan*, and permit requirements.

Water Supply Wells

Other than potable water, water used during construction (e.g., construction of ice pads, water for dust control, concrete preparation, hydrostatic testing) would be taken from permitted surface water sources. Details on the anticipated water use are provided in the Project *Water Use Plan* (Appendix K). Withdrawal of groundwater could result in a local drawdown of the aquifer, impacting wetlands in proximity to the Pipeline Aboveground Facilities. However, it is not anticipated that the limited amount of proposed groundwater withdrawal would result in a significant drawdown of the aquifer. Effects to adjacent wetlands would be short-term and minor.

Blasting

Blasting may be required for construction of compressor stations to create a level surface for locations with bedrock overlain with wetlands. Adherence to the *Blasting Plan* (Resource Report No. 6, Appendix B) would help minimize impacts to the compressor station site. Any potential impacts to wetlands adjacent to the Pipeline Associated Infrastructure from blasting are anticipated to be localized, short-term, and minor based on the spatial extent of the impact, the duration and frequency, and localized nature of the work.

Invasive Species

Adjacent wetlands could be impacted by the introduction of noxious/invasive plant species during construction of the Pipeline Aboveground Facilities. Potential vectors and impacts during construction of the Pipeline Aboveground Facilities would be similar to those described previously for the Liquefaction Facility. The protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Resource Report No. 3, Appendix K) would be followed. The Plan includes preventative measures and treatment methods.

Fuel Use, Storage, Refueling, Lubrication, and Spills

See discussion above under Mainline for fuel use. While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the Liquefaction Facility (see the Groundwater section), would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to a release are unlikely.

Waste Management

See discussion above under Mainline for waste management. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to wetlands due to waste management during construction of the Pipeline Aboveground Facilities would not be anticipated.

2.4.3.2.1.5 Pipeline Associated Infrastructure

A summary of the acreage of wetlands within the footprint of the Pipeline Associated Infrastructure that would be directly affected during construction is provided in Table 2.4.2-2. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (*Wetland Impact Tables*).

Wetlands onsite at the facilities (e.g., access roads, material sites) would be impacted during site clearing, grading, and development (e.g., fill). Undisturbed areas of the site would retain their existing natural drainage. Following construction, infrastructure would be left in place or removed per landowner requirements. If removed, restoration would be according to the Project *Restoration Plan*. Based on the extent of wetlands in Alaska, impacts are anticipated to be minor. Of the estimated approximate 92.6 million acres of palustrine fresh water wetlands in ecoregions Polar (Arctic Tundra) and Boreal

(Intermontane Boreal and Alaska Range Transitional) in Alaska (Hall, 1994), construction of the Pipeline Associated Infrastructure would temporarily impact approximately 0.008 percent.

Wetlands adjacent to the Pipeline Associated Infrastructure construction footprint could also be indirectly impacted during construction due to:

- Alterations of recharge areas (e.g., contours) and infiltration rates (e.g., compaction);
- Dewatering from excavation/trenching and material extraction areas;
- Blasting at material sites;
- Discharges of domestic wastewater;
- Fugitive dust; and
- Runoff of stormwater.

Potential impacts to wetlands from construction of the Pipeline Associated Infrastructure and the proposed mitigation measures would be similar to those previously described for surface water resources. Impacts to adjacent wetlands from construction activities are expected to be short-term and minor due to compliance with the Project *SWPPP*, the Applicant's *Plan* and *Procedures*, Project *Fugitive Dust Plan*, and permit requirements.

Restoration

Wetlands affected during construction activities would be restored in accordance with the Project *Restoration Plan* (Appendix P of Resource Report No. 3). Post-construction monitoring, maintenance, and reporting would be conducted in accordance with the Applicant's *Plan* and *Procedures*.

Water Supply Wells

Where possible, water for the construction camps would be sourced from new wells located on site. Details on the anticipated water use are provided in the Project *Water Use Plan* (Appendix K). Withdrawal of groundwater could result in a local drawdown of the aquifer, impacting wetlands in proximity to the Pipeline Aboveground Infrastructure. However, it is not anticipated that the limited amount of proposed groundwater withdrawal would result in a significant drawdown of the aquifer. Effects to adjacent wetlands would be short-term and minor.

Ice Road Construction

Current permitting regime allows the use of ice pads and ice roads over the tundra during winter months. This permitting process is closely monitored by ADNR and is used extensively as a means to reduce potential impacts to tundra. The greatest impacts generally occur in low snow areas on dry upland tussock tundra sites. However, wetlands are usually already frozen during construction of ice roads and typically show little to no impact. Overall, impacts on vegetation on ice roads typically require no restoration treatments and recover naturally (North Slope Science Initiative Alaska, 2013).

Blasting

Blasting would be required during construction for excavation at material sites and where boulders, bedrock, or certain permafrost terrain conditions are encountered near the ground surface and mechanized fracturing and excavation are not practicable. Potential impacts to wetlands and mitigation measures during construction of the Pipeline Associated Infrastructure would be similar to those previously described for the Mainline. The BMPs listed in the *Blasting Plan* (Resource Report No. 6, Appendix B) would be followed. Any potential impacts to wetlands adjacent to the pipeline associated infrastructure from blasting are anticipated to be localized, short-term, and minor based on the spatial extent of the impact, the duration and frequency, and localized nature of the work.

Invasive Species

Wetlands could be impacted by the introduction of noxious/invasive plant species during construction of the Pipeline Associated Infrastructure. Potential vectors and impacts during construction of the Pipeline Associated Infrastructure would be similar to those previously described for the Liquefaction Facility. The protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Resource Report No. 3, Appendix K) would be followed. The plan includes preventative measures and treatment methods.

Fuel Use, Storage, Refueling, Lubrication, and Spills

See discussion above under Mainline for fuel use. While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the Liquefaction Facility (see the Groundwater section) would greatly reduce the likelihood of such impacts, as well minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to a release are unlikely.

Waste Management

See discussion above under Mainline for waste management. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, adverse impacts to wetlands due to waste management during construction of the Pipeline Associated Infrastructure would not be anticipated.

2.4.3.2.2 GTP

A summary of the acreage of wetlands within the footprint of the GTP that would be directly affected during construction is provided in Table 2.4.2-2. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (*Wetland Impact Tables*). Wetland impacts include approximately 263 acres of herbaceous vegetation.

The GTP would be built on granular pads and wetlands onsite would be permanently converted to industrial or open land. Based on the extent of wetlands in Alaska, impacts are anticipated to be long-term but minor. Of the estimated approximate 16.6 million acres of fresh water wetlands in the Arctic Coastal Plain (Hall et al., 1994); construction of the GTP would impact approximately 0.0016 percent.

Wetlands adjacent to a GTP construction footprint could be indirectly impacted during construction due to:

- Alterations of recharge areas (e.g., contours) and infiltration rates (e.g., compaction);
- Runoff of stormwater; and,
- Fugitive dust.

Potential impacts to wetlands from construction of the GTP and the proposed mitigation measures would be similar to those previously described for surface water resources, as applicable and feasible. Impacts to adjacent wetlands from construction activities are expected to be short-term and minor due to compliance with the Project *SWPPP*, the Applicant's *Plan* and *Procedures*, Project *Fugitive Dust Plan*, and permit requirements.

2.4.3.2.2.1 Water Supply

Water for construction of the GTP would be brought in via trucks and stored onsite until the new water reservoir and pumping stations necessary to support permanent operations are established. Potential water sources would be an existing water system or nearby rivers or lakes. Details on the anticipated water use are provided in the Project *Water Use Plan* (Appendix K). No impacts to wetlands would be anticipated based on the GTP's construction water source.

2.4.3.2.2.2 Blasting

It is not anticipated that blasting would be required for construction of the GTP.

2.4.3.2.2.3 Invasive Species

Adjacent wetlands could be impacted by the introduction of noxious/invasive plant species during construction of the GTP. Potential vectors and impacts during construction of the GTP would be similar to those previously described for the Liquefaction Facility as applicable and appropriate. The protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Resource Report No. 3, Appendix K) would be followed. The *Noxious/Invasive Plant and Animal Control Plan* includes preventative measures and treatment methods.

2.4.3.2.2.4 Spills

A spill would potentially impair adjacent wetland functions as previously described for the Liquefaction Facility. All fuel handling necessary for construction of the GTP would be in accordance with regulatory requirements and the Project *SPCC Plan* (Appendix M). The *SPCC Plan* would be managed by the Environmental Inspectors during construction. Secondary containment would be used for all single-walled containers 55 gallons and above; storage and construction equipment would be maintained and inspected daily for leaks; and all equipment would be parked overnight or refueled at least 100 feet from wetland boundaries except in large areas of contiguous wetlands. Given the pervasiveness of wetlands of varying types along the route, there are hundreds of locations where there would be no reasonable alternative to refueling (within the construction ROW) within 100 feet of a waterbody or wetland. These activities can occur closer only if the Applicant and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the Liquefaction Facility as applicable and appropriate would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to contamination from a release would be unlikely.

2.4.3.2.2.5 Underground Injection

All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). During construction, wastewater and other select liquid wastes would initially be disposed of at an approved, existing facility until the onsite UIC industrial wells are completed. Once installed, the GTP's industrial UIC wells would be approximately 6,000- to 7,000-feet deep and thus would extend below the depth of permafrost. It is not anticipated that use of the wells would impact wetlands.

2.4.3.2.2.6 GTP Associated Infrastructure

Approximately 446 acres of wetlands would be directly impacted during construction of the GTP associated infrastructure (see Table 2.4.2-2). Wetlands dominate the area, comprising over 80 percent of the Arctic Coastal Plain according to the USFWS (Hall et al., 1994). Jurisdictional wetlands cannot be avoided. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (Wetland Impact Tables).

Undisturbed areas of the site would retain their existing natural drainage. Following construction, infrastructure would be left in place or removed per landowner requirements. Leaving the infrastructure in place would result in a permanent impact. Based on the extent of wetlands in Alaska, impacts are anticipated to be long-term but minor. Of the estimated approximate 16.6 million acres of fresh water wetlands on the Arctic Coastal Plain (Hall et al., 1994); construction of the GTP Associated Infrastructure would impact approximately 0.0032 percent.

Wetlands adjacent to the GTP Associated Facilities construction footprint could be indirectly impacted during construction due to:

- Alterations of recharge areas (e.g., contours) and infiltration rates (e.g., compaction);
- Blasting;
- Fugitive dust; and
- Runoff of stormwater.

Potential impacts to wetlands from construction of the GTP Associated Facilities and the proposed mitigation measures would be similar to those previously described for surface water resources. Impacts to adjacent wetlands from construction activities are expected to be long term since most impacts involve placing granular pads over the tundra or excavating a reservoir and mine site. Impacts are within a designated area for oil and gas development (PBU) and minor due to the extent of the impacts within the Beaufort Coastal Plain ecoregion. By complying with the *SWPPP*, Applicant's *Plan*, *Procedures*, Project *Fugitive Dust Plan*, and applicable regulatory requirements, it is expected that impacts to adjacent wetlands would be negligible.

Restoration

Temporarily disturbed wetland areas would be restored in accordance with the Project *Restoration Plan* (Appendix P of Resource Report No. 3). Post-construction monitoring, maintenance, and reporting would be conducted in accordance with the Applicant's *Plan* and *Procedures*.

Ice Road Construction

As previously described for the Pipeline Associated Infrastructure, wetlands are usually already frozen during construction of ice roads and typically show little to no impact in the next summer season after the ice road melts.

Construction Camps

The construction camp would be placed on the pad built during construction specifically for the camp. This would become a permanent wetland impact since the construction camp would be converted to an operations center for the life of the Project.

Blasting

Blasting would be required during excavation of material from the proposed reservoir and mine sites. Potential impacts to wetlands and mitigation measures during construction of the GTP Associated Infrastructure would be similar to those previously described for the GTP surface water impacts section. The BMPs listed in the *Blasting Plan* (Resource Report No. 6, Appendix B) would be followed. Any potential impacts to wetlands adjacent to the GTP Associated Infrastructure from blasting are anticipated to be localized, short-term, and minor based on the spatial extent of the impact, the duration and frequency, and localized nature of the work.

Invasive Species

Wetlands could be impacted by the introduction of noxious/invasive plant species during construction of the GTP Associated Infrastructure. Potential vectors and impacts during construction of the GTP Associated Infrastructure would be similar to those previously described for the Liquefaction Facility. The protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Appendix K of Resource Report No. 3) would be followed. The *Plan* includes preventative measures and treatment methods.

Fuel Use, Storage, Refueling, Lubrication, and Spills

See discussion of fuel use under GTP above. While a spill has the potential for significant adverse environmental impacts, adherence to the protective measures previously outlined for the GTP (see the Groundwater section), would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts to wetlands due to a release would be unlikely.

Waste Management

See discussion of waste management under GTP above. With adherence to the *Waste Management Plan* procedures and mitigation measures, adverse impacts to wetlands due to waste management during construction of the GTP Associated Infrastructure would not be anticipated.

2.4.3.2.3 Non-Jurisdictional Facilities

The PTU Expansion project and PBU MGS project are located in proximity to the PBTL, PTTL, and GTP, although the PTU Expansion project and PBU MGS project are located at opposite ends of the 63.6-mile PTTL from the GTP and PBTL. They would both be located within the Beaufort Coastal Plain ecoregion, which is an area of continuous permafrost. Impacts to wetlands from project construction would be similar to those described for the GTP, PBTL, and PTTL. Wetland impacts associated with the proposed alternatives to the Kenai Spur Highway and PBU MGS and PTU Expansion projects footprint for VSMs, pads, and access roads are provided in Appendix E, Table 3.

2.4.4 Potential Operational Impacts and Mitigation Measures for Wetlands

Based on preliminary estimates, post-construction, approximately 5,350 acres of wetlands would be permanently converted to industrial or open land. Approximately 4,570 of these acres would remain as a wetland within the permanent ROW of the Mainline, but there would be a conversion of the wetland type until restoration is complete. For forested (i.e., PFO) wetlands, the conversion would be permanent. Further details on wetland impacts from Project operations are provided in Table 2.4.2-2 and Appendix E (Wetland Impact Tables). An assessment of potential impacts to surface water (e.g., waterbodies), including Marine, Estuarine, Riverine and Lacustrine Systems, from Project operations is provided in Section 2.3.

Loss of wetlands would be due to granular pad construction, access roads, and other paved and graveled areas. Granular pads generally support little vegetation and there is an absence of natural colonization of native plant species (Jorgenson and Joyce, 1994). For impacts to wetlands that cannot be avoided or minimized, some form of mitigation, whether it is restoration, establishment, enhancement, or preservation would be required. In consultation with the appropriate stakeholder agencies, a determination would be made regarding the appropriate form and amount of mitigation needed to offset the proposed wetland impacts. The *Wetland Mitigation Plan* (Appendix O) provides an outline of mitigation options and will continue to be updated upon further agency consultation (see Section 2.4.4). For restoration and rehabilitation of impacted wetlands, a draft *Restoration Plan* in Resource Report No. 3, Appendix P

Operational activities that could also impact adjacent wetlands without proper mitigation measures include:

- Discharges of wastewater;
- Fueling and use of hazardous materials;
- Maintenance and repair activities;
- Surface water and groundwater withdrawals;
- Spills;
- Stormwater management and runoff; and
- Waste disposal.

Additional wetland impacts may occur from the introduction of invasive species, erosion, fugitive dust, permafrost thaw and associated thermokarst, and long-term changes to hydrology. Indirect impacts of granular fill also include impoundments (Jorgenson and Joyce, 1994).

A UIC well(s) would be used to avoid discharges to the tundra. Ice roads or low-pressure equipment would be used to conduct routine maintenance of the facilities. Local hydrology data and reports would be used to design all pads and granular roads to accommodate natural sheet flow patterns in the Beaufort Coastal Plain ecoregion to the extent practical in minimizing any significant or long-terms impacts to hydrology. In addition, the following plans would be implemented to avoid and minimize impacts to wetlands from Project operations:

- Applicant's *Plan* (Appendix D of Resource Report No. 7);
- Applicant's *Procedures* (Appendix N);
- Facility-specific SPCC plans to be developed prior to operations, as required;
- APDES permit requirements;
- *Noxious/Invasive Plant and Animal Control Plan* (Appendix K of Resource Report No. 3);
- *Project Waste Management Plan* (Resource Report No. 8, Appendix K);
- *Stormwater Pollution Prevention Plan (SWPPP)* (Appendix J);
- *Fugitive Dust Control Plan* (Appendix J of Resource Report No. 9).
- *Project Restoration Plan* (Resource Report No. 3, Appendix P); and
- *Unanticipated Contamination Discovery Plan* (Appendix J of Resource Report No. 8).

2.4.4.1 Liquefaction Facility

A summary of the acreage of wetlands within the footprint of the Liquefaction Facility that would be directly affected during operation of the Liquefaction Facility is provided in Table 2.4.2-2. Wetland loss within the operational footprint would be approximately 6 acres of PEM wetlands. A detailed list of the individual wetland impacts is provided in Appendix E (*Wetland Impact Tables*). Wetland loss would be minimized in accordance with the Project *Mitigation Plan* (Appendix O).

The Liquefaction Facility would be operated and maintained following all applicable federal, state, and local requirements. Site development would result in an increased amount of impermeable surface present but also stormwater ponds to collect and manage surface run off from impervious surface areas. This would result in a long-term, minor increase in surface runoff and minor reduction in groundwater infiltration and recharge. Natural buffers would be maintained around the Liquefaction Facility site. Indirect effects to wetlands would be similar to those previously described for surface and groundwater and are anticipated to be long-term and minor.

2.4.4.1.1 Maintenance and Repair

Maintenance and repair activities at the Liquefaction Facility are anticipated to require minimal site preparation (e.g., excavation) and hydrostatic testing. Potential impacts to wetlands from maintenance activities are anticipated to be similar but of a lower magnitude (approximately one-tenth) than those described for construction. Impacts to wetlands from maintenance and repair are anticipated to be long-term but intermittent and minor.

2.4.4.1.2 Wastewater

Surface drainage from process areas would be collected for wastewater treatment. The main discharge location of all treated wastewater containing black and gray water from Project operations would be an outfall to Cook Inlet. The outfall would be operated according to an APDES individual permit. APDES permit limits typically would include concentration limits on the following pollutants: BOD_5, TSS, fecal coliform and possibly total ammonia as N, total recoverable copper, total recoverable zinc, WET, enterococci, total residual chlorine (if applicable), DO, pH, and flow. One of the three onsite ponds would serve as the receiving area prior to discharge. With containment and treatment of wastewater, no effects to wetlands would be anticipated from wastewater disposal.

2.4.4.1.3 Stormwater Management and Runoff

All paved and non-paved surfaces outside of the operational areas would drain into stormwater ponds. A *SWPPP* for operations would be developed before the facilities are placed in service. Water from these ponds would be discharged in accordance with APDES requirements via an outfall into Cook Inlet. No effects to wetlands are anticipated from stormwater runoff.

2.4.4.1.4 Waste Handling

Operation of the Liquefaction Facility would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This Plan addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would reflect compliance with all regulations for transportation, treatment, storage, and disposal. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, there would be no expected impacts to wetlands from operation of the Liquefaction Facility.

2.4.4.1.5 Invasive Species

During operations of the Liquefaction Facility, any ground disturbing activities could introduce noxious/invasive plants to invade adjacent, natural wetland areas. The protective measures provided in the *Noxious/Invasive Plant and Animal Control Plan* (Resource Report No. 3, Appendix K) would be followed. This plan includes preventative measures and treatment methods. Additional details on the prevention of noxious/invasive plant species are provided in Resource Report No. 3.

2.4.4.1.6 Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of hazardous materials, including fuels and lubricants, could occur in any area where these compounds are used or stored and have the potential to damage wetland resources. Personnel would be trained for proper handling, storage, disposal, and spill response of hazardous fluids, and an *SPCC Plan* would be developed for operations. All petroleum, oil, and lubricant handling required during Project operations would be dictated by the *SPCC Plan* and managed by the Environmental Managers. Storage tanks and containers for fuels and hazardous liquids would be stored in secondary spill containment, and oil-filled operational equipment would be addressed in a manner consistent with the requirements of 40

C.F.R. 112. Potential impacts to estuarine (tidal) fringe wetlands from fuel spills during operation of the Liquefaction Facility and mitigation measures would be similar to those described for construction.

During operation, there is the potential for an LNG spill. However, LNG vaporizes rapidly when exposed to ambient conditions. Any impacts to estuarine (tidal) fringe wetlands would be anticipated to be localized and minor. Impacted wetland areas would be expected to recover.

2.4.4.2 Interdependent Project Facilities

A summary of the acreage of wetlands within the operational footprint of the Interdependent Project Facilities is provided in Table 2.4.2-2. Preliminary estimates of wetland loss within the operational footprint would be approximately 10,623 acres (not inclusive of Cook Inlet seabed). As previously noted, approximately 5,230 of these acres would remain as a wetland within the permanent ROW of the Mainline, but there would be a conversion of the wetland type until restoration is complete. For PFO wetlands, and wetlands covered with granular material, the conversion would be permanent. A detailed list of individual wetland impacts is provided in Appendix E (*Wetland Impact Tables*).

2.4.4.2.1 Pipelines

The permanent ROW of the pipelines would be kept free of obstructions and maintenance would be performed according to measures outlined in the Applicant's *Plan* and *Procedures*.

2.4.4.2.1.1 Mainline

A 100-foot permanent ROW would be maintained during Mainline operation. Temporarily disturbed wetland areas would be restored in accordance with the Project *Restoration Plan*. Restoration and rehabilitation of wetlands in Alaska can be challenging due to terrain, permafrost, recovery time, soil, available nutrients, limited growing season, and low temperatures and precipitation (Jorgenson and Joyce, 1993; NSSI, 2013).

On the North Slope of Alaska, industry and agencies currently monitor over a hundred rehabilitation sites, with about 5 to 10 new sites added each year. Sites include removal of abandoned granular material, excavation and burial of reserve and flare pits, cleanups involving spills, trenching, off-road travel, and mining. Depending on severity and type of impact, recovery of disturbed tundra typically takes 3 to 10+ years and involves seeding, fertilization, and monitoring of sites once every two to three years. Where activities would not damage the vegetative mat and shallow permafrost, restoration may take less than 10 years. A Project *Restoration Plan* is provided in Resource Report No. 3, Appendix P. Post construction monitoring, maintenance, and reporting would be conducted after the first and second growing season to determine successful revegetation of the ROW. With successful restoration and revegetation post-construction, impacts to herbaceous wetlands would be short-term.

Trees would not be allowed within the boundaries of the permanent ROW, except over buried trenchless crossings (e.g., buried trenchless method crossings), because tree roots have the potential to damage the pipeline coating, which may contribute to the loss of integrity of the pipeline. Forested wetlands would be permanently converted to herbaceous wetlands within the permanent ROW. Shrubs may be permitted within the ROW, provided they do not interfere with the maintenance, inspection, and operation of the pipeline and related facilities.

2.4.4.2.1.2 PTTL

The PTTL would be aboveground on VSMs. Wetlands within the footprint of the VSMs would be permanently lost. Any maintenance of the pipeline would be via an ice road or low-pressure equipment per permitting requirements.

2.4.4.2.1.3 PBTL

The PBTL would be aboveground on VSMs. Wetlands within the footprint of the VSMs would be permanently lost. Any maintenance of the pipeline would be via an ice road or low-pressure equipment per permitting requirements.

2.4.4.2.1.4 Pipeline Aboveground Facilities

The Pipeline Aboveground Facilities would be operated and maintained following all applicable federal, state, and local requirements. A fire buffer zone would be required for all compressor and heater stations. This would be a 130-foot cleared area from the station fence on all three sides, with the Mainline ROW as the fourth maintained side. This buffer is already included in the acreages for each compressor station. The amount of wetlands that would be permanently converted to industrial and open land as a result of operation of the Pipeline Aboveground Facilities is provided in Table 2.4.3-1. Wetland loss would be minimized in accordance with the Project *Mitigation Plan* (Appendix O).

Site development would result in an increased amount of impermeable surface present. This would result in a long-term, minor increase in surface runoff and minor reduction in groundwater infiltration and recharge. Indirect effects to wetlands would be similar to those previously described for surface water and groundwater and would be anticipated to be long-term and minor.

Water Supply Wells

Water withdrawal for facility operation would be minimal with an estimated annual requirement of approximately 15,000 gallons. This would include approximately 50-75 gallons per day per personnel and 50 gallons per month for mechanical use by the process facilities (make-up water for the heating units). It is not anticipated that this would cause a significant drawdown of the water table. Impacts to wetlands from use of water wells during operation of the Pipeline Aboveground Facilities would be anticipated to be long-term but minor.

Wastewater

There are no anticipated process water discharges required at aboveground facilities for the Mainline. All wastewater discharges from facilities such as stormwater runoff from operation areas, material storage areas, steam cleaning or equipment wash down, heavy equipment, equipment parts, trucks, or machinery would be collected in sumps, pits, drip collection devices, or storage tanks and transported for disposal at an approved disposal facility. Domestic wastewater would be treated onsite, and the effluent would be discharged to the ground according to ADEC permit conditions. Effluent would meet ADEC regulatory standards prior to discharge.

APDES permit limits include concentration limits on the following pollutants: BOD_5, TSS, fecal coliform bacteria, escherichia coli bacteria, total residual chlorine, DO, pH, and flow rate. To reduce fecal coliform count, disinfection, such as UV or chlorine, would be used. No impacts to wetlands are anticipated under normal treatment and disposal of domestic wastewater in accordance with regulatory requirements. Wastewater treatment systems designed for use in remote, Arctic environments would be used.

Waste Handling

Operation of the Pipeline Aboveground Facilities would generate onsite waste. All waste would be handled in accordance with the Project *Waste Management Plan* (Resource Report No. 8, Appendix K). This *Plan* addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The *Plan* would ensure compliance with all regulations for transportation, treatment, storage, and disposal. With adherence to the Project *Waste Management Plan* procedures and mitigation measures, there would be no expected impacts to wetlands from operation of the Pipeline Aboveground Facilities.

Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of hazardous materials, including fuels and lubricants, could occur where these compounds are used or stored and have the potential to impact wetland resources. SPCC Plans would be developed for each facility prior to operation. Potential impacts to wetlands from fuel spills and mitigation measures during operation of Pipeline Aboveground Facilities would be similar to those described for the Liquefaction Facility.

2.4.4.2.2 GTP

Granular pads installed during GTP construction would remain in place. A summary of the acreage of wetlands within the footprint of the GTP that would be directly affected during operations is provided in Table 2.4.2-2. Wetland loss within the operational footprint would be approximately 263 acres. A detailed list of the individual wetlands that would be impacted is provided in Appendix E (*Wetland Impact Tables*). Wetland loss would be minimized in accordance with the Project *Mitigation Plan* (Appendix O).

The GTP would be operated and maintained following all applicable federal, state, and local requirements. Granular pads allow for infiltration of water if they are not frozen, but the highly compacted material slows infiltration and increases runoff. This could result in a long-term decrease in infiltration beneath the pad footprint. Indirect effects to wetlands would be similar to those previously described for surface and groundwater and are anticipated to be long-term; however, the amount of water runoff from the pad would be minor and seasonal. Impact to adjacent wetlands from granular pad installation can be reduced by use of BMPs listed in the Applicant's *Plan* and *Procedures*, Project *SWPPP*, *Fugitive Dust Plan*, and APDES permit requirements.

2.4.4.2.2.1 Maintenance and Repair

Maintenance and repair activities at the GTP are anticipated to require minimal site preparation (e.g. clearing or excavation) and hydrostatic testing and would occur mostly within the pad built for the facilities. Summer maintenance may require use of DMLW-approved vehicles to access the tundra for routine activities. In addition, ice roads could be needed for maintenance and repair of the associated pipelines. Ice roads would be constructed from snow, ice chips, and surface water sources, not groundwater. It is anticipated that impacts to wetlands from maintenance and repair would be short-term but intermittent and minor.

2.4.4.2.2.2 Water Supply

The GTP would source water from the reservoir created during construction, which would be supplied by surface water from the Putuligayuk River. It is not anticipated that additional wetlands would be impacted from use of the GTP's water supply.

2.4.4.2.2.3 Waste Management

Operation of the GTP would generate onsite waste. All waste would be handled in accordance with the *Waste Management Plan* (Resource Report No. 8, Appendix K). This *Plan* addresses hazardous and nonhazardous waste materials and volumes, handling, and disposal in detail. The plan would ensure compliance with all regulations for transportation, treatment, storage, and disposal.

As previously noted, GTP would develop two industrial Class I wells that would be used to dispose of RCRA exempt liquid waste streams, wastewater, and nonhazardous wastes. The wells would be approximately 6,000- to 7,000-feet deep and thus would extend below the depth of permafrost. It is not anticipated that wetlands would be impacted from use of the wells.

2.4.4.2.2.4 Fuel Use, Storage, Refueling, Lubrication, and Spills

Spills of hazardous materials, including fuels and lubricants, could occur where these compounds are used or stored and have the potential to impact wetland resources. An *SPCC Plan* would be developed for the GTP prior to operations. Potential impacts to wetlands from fuel spills and mitigation measures during operation of GTP would be similar to those described for the Liquefaction Facility.

2.4.4.3 Mitigation

In accordance with Section 404(b)(1) Guidelines, joint 2008 ruling *Compensatory Mitigation for Losses of Aquatic Resources: Final Rule* (Mitigation Rule), and the *1990 Memorandum of Agreement* (MOA) *Between the Army and the Environmental Protection Agency*, for any unavoidable impacts to wetlands or aquatic resources, compensatory mitigation would be required to replace (offset) the loss of wetland and aquatic resource functions. Methods of providing compensatory mitigation include restoration, establishment, enhancement, or preservation to offset unavoidable impacts to Waters of the U.S. (40 CFR 230.3) authorized through the issuance of Department of the Army (DA) permits pursuant to CWA Section 404 and/or RHA Section 10.

Assessment of wetland functions in Alaska is complex because of the number of ecoregions impacted. The Applicant has consulted with USACE to receive guidance based on lessons learned from other projects, but no current functional assessment method has been approved for all of Alaska. Eight functional assessments/aquatic site assessments are being compared, including the Wetland Ecosystem Services Protocol for Southeast Alaska by Paul Adamus, ADOT&PF Alaska Wetlands Assessment Method (AKWAM), A Rapid Procedure for Assessing Wetland Functional Capacity (Magee-Hollands), the HGM Operational Draft Guidebook for Interior Alaska, Interim HGM (iHGM), the Wetland Functional Assessment for Point Thomson Project, the MatSu Wetland Functions and Values Assessment, and ABR's

Arctic Coastal Plain Aquatic Site Assessment Ranking Protocol. A draft comparison matrix was developed and recommended methodology was be submitted for agency approval in July 2016. USACE asked that we include the new method developed by its Engineer Research and Development Center (ERDC) for the North Slope and recommended that it be used in the two northern-most ecoregion(s). USACE also agreed with the Applicant's recommendation to use AKWAM for portions of the Project south of the area covered by ERDC's new method.

Impacts on wetlands and waterbodies that cannot be avoided may require some form of mitigation, such as restoration, establishment, enhancement, and/or preservation. A requirement for compensatory mitigation has been established under Section 404 of the CWA to offset environmental losses from unavoidable impacts on wetlands and aquatic resources. A review of current and past mitigation strategies from existing studies, literature, and agency comments has identified issues dealing with large-scale mitigation. Several actions have been identified that need to be taken to minimize unavoidable impacts on wetlands and waterbodies:

1. Identify measures the Applicant has taken to avoid and minimize impacts to wetlands.
2. Identify wetlands restoration measures that would be undertaken after pipeline trenching and backfill.
3. Identify any other short- and long-term restoration measures.
4. Identify possible offset mitigation.
5. Identify mitigation banks and in-lieu fee sponsors appropriate for the Project.
6. Identify areas available for mitigation.
7. Identify alternative mitigation opportunities.
8. Determine functional assessment methods.

The hierarchy described in the Final Compensatory Mitigation Rule (33 C.F.R. 332) to identify potential mitigation projects would be followed:

1. Mitigation Banks – Purchase credits from an established bank that covers the watershed impacts realized by the Project.
2. In-Lieu Fee Sponsors – Purchase credits in service area/ecoregion from an approved provider.
3. Permittee Responsible – Restoration, enhancement, establishment, and/or preservation of aquatic resources performed by the permittee.

Approaches for any required offsetting mitigation will be provided during permitting, based on more-detailed analyses of potential wetlands impacts and mitigation opportunities, as well as agency consultation. An outline of mitigation approaches is provided in the Draft *Wetland Mitigation Plan* (Appendix P).

2.4.4.4 Non-Jurisdictional Facilities

The PTU Expansion project and PBU MGS project would avoid and minimize impacts to wetlands to the extent practicable. Preliminary estimates of wetland disturbance from the PTU Expansion project and PBU MGS project are discussed above in Section 2.4.3.2.3. An updated assessment of the amount of anticipated wetland disturbance and estimated permanent wetland loss as a result of the projects will be provided once that information is available. It is anticipated that indirect impacts to wetlands from Project operation would be similar to those of existing North Slope long-term oilfield operations and those described for the GTP, PBTL, and PTTL. Impacts to wetlands from Project operation would be long-term and minor. Of the estimated approximate 16.6 million acres of fresh water wetlands in the Arctic Coastal Plain (Hall et al., 1994), operation of the PTU Expansion project and PBU MGS project would impact approximately 0.0005 and 0.001 percent, respectively.

2.5 FLOODPLAINS

Floodplains are land areas susceptible to being inundated by floodwaters from any source. They are generally low-lying areas adjacent to streams or coastlines. Floodplains are valuable hydrological and ecological resources. They serve many functions, including the storing of stormwater, providing erosion and sediment control, and providing wildlife habitat.

Floods occur when runoff from rain or snowmelt exceeds the capacity of rivers, stream channels, or lakes and overflows onto adjacent land. Floods can also be caused by ice jams in rivers, or storm surges and waves that inundate areas along coastlines. Ice jams occur when ice chunks in a river are blocked by still-frozen sections of the river or structures in the river, such as bridge piers or footings. Ice jams on rivers usually occur in the springtime as the river ice begins to break up, but may also occur in early winter during freeze-up. Ice jam floods are less predictable and potentially more destructive than open-water flooding because they can produce much deeper and faster flooding with the ice jam forming over a very short time. This causes an almost immediate blockage of the flow and therefor a faster and higher rise in water levels than spring meltwater entering the stream.

Storm surge is a coastal phenomenon associated with low-pressure weather systems. The surge of the ocean water inland above the high tide mark is a result of low barometric pressure combined with high winds pushing on the ocean surface causing the water to “pile up” higher than ordinary sea level. The storm surge effect is enhanced if it occurs at high tide. The high water level that exists during coastal floods is not of primary concern. What makes coastal floods one of the leading causes of property damage is the powerful and destructive surf that occurs in conjunction with the high water. Damage during large coastal floods is not limited to the effects of high water and surf. If sea ice is present, the moving blocks of ice carried by high water and driven by waves and wind can have considerable destructive effect on structures.

Executive Order (EO) 11988 (Floodplain Management) was issued on May 24, 1977, and requires federal agencies to avoid to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The EO established a process for flood hazard evaluation based upon a 100-year base flood (a flood that has a 1 percent probability of occurring in any given year).

1. On January 30, 2015, EO 11988 was amended by EO 13690 to include a new Federal Flood Risk Management Standard (FFRMS). EO 13690 emphasized using natural systems, ecosystem processes, and nature-based approaches when developing alternatives to floodplain development. The new EO changes the definition of a floodplain from the 100-year base flood to any of the following:

    2. The elevation and flood hazard area resulting from a climate-informed science approach that uses the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding. This approach includes emphasis on whether the action is a critical action when conducting the analysis.

    3. The elevation and flood hazard area that results from using the freeboard value, reached by adding an additional 2 feet to the base flood elevation for noncritical actions and by adding an additional 3 feet to the base flood elevation for critical actions.

    4. The area subject to flooding by a 500-year (0.2 percent annual probability) flood.

The Federal Emergency Management Agency (FEMA) has delineated numerous floodplains throughout the United States as part of the National Flood Insurance Program (NFIP) and published the results on Flood Insurance Rate Maps (FIRMs). Floodplain management ordinances are promulgated and enforced by local communities if they wish to participate in the NFIP. In Alaska, FEMA has delineated only a small portion of the state's floodplains. The NFIP requirements apply to areas mapped as Special Flood Hazard Areas (SFHAs). The SFHA is the area that would be flooded by a 100-year base flood. Because the NFIP is primarily a federally managed flood insurance program, the focus of FEMA mapping and local requirements for construction in a floodplain are habitable structures (homes). Habitable structures are typically required to have the first habitable floor above flood elevation. Non-habitable structures are allowed to use flood-proofing measures (building on fill or piles, use of watertight seals, berms, etc.) to protect against flooding. An important task in facility siting is to conduct an engineering-level analysis of the flood levels and proposed structures that are located in floodplains.

FIRMs designate the SFHA (100-year base flood) as either A Zones or V Zones. A 500-year flood area is designated as shaded X Zones and low risk areas (above the 500-year flood) are designated as unshaded X Zones (FEMA, 2015a). Most maps also designate the floodway, which is an area of the floodplain that is wide enough to carry the 100-year flood without causing an increase in flood elevation. Development within the floodway is severely restricted and must show that no additional increases in flood heights would occur.

Currently, the site of the Liquefaction Facility in the Kenai Peninsula Borough and portions of the Mainline in the Matanuska-Susitna Borough and Kenai Peninsula Borough are the only Project areas where FEMA has delineated floodplains (Figure 2.5-1) (FEMA, 2015b; Matanuska-Susitna Borough, 2011).

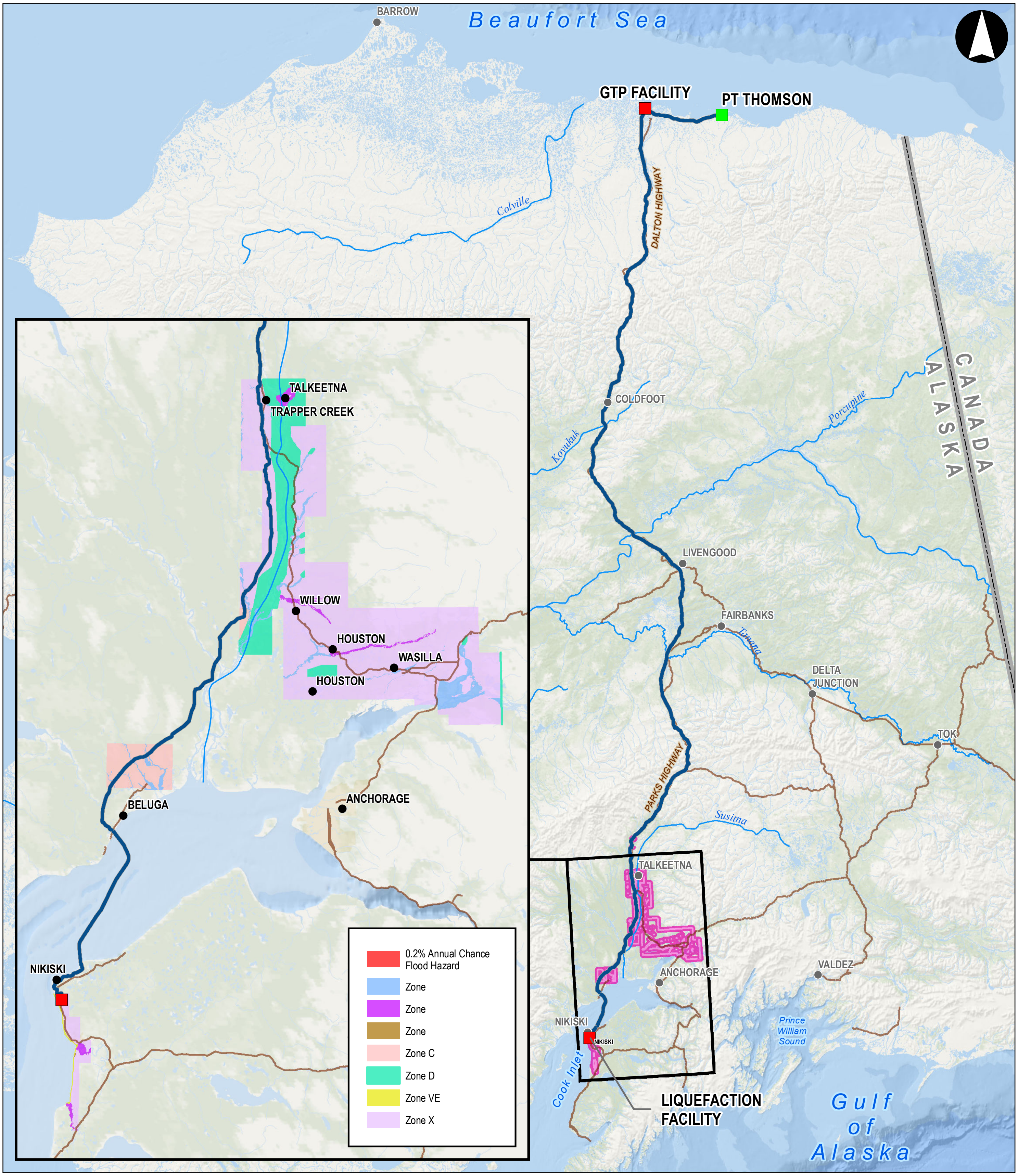
The Sagavanirktok River has not currently been delineated by FEMA for flood risks; however, a section of the river approximately 25 to 30 miles south of Deadhorse along the Mainline between MP 28 and 32 (Mile 390 to 415 of the Dalton Highway) has repeatedly flooded since 2013 due to ice dams created during spring break-up. The State of Alaska declared the area a Declaration of Disaster Emergency on March 13, 2015. A total of 4 miles of the proposed pipeline may be exposed to future flooding from the river.

Project areas that are not delineated by FEMA have not had flood risks determined. Thus, a historic peak flow analysis was conducted using available data to provide preliminary information on areas susceptible to riverine and coastal flooding. The analysis used available USGS stream gauge data (for riverine areas), NOAA tidal data (for coastal areas), and interpretation of topographic maps to estimate potential areas of flood risks. Because the peak flow analysis does not identify the 500-year floodplain (see the following sections), additional analyses would be conducted at locations with potentially vulnerable infrastructure to meet the requirements of EO 13690 for the FERC application.

2.5.1 Peak Flow and Floodplain Analysis

Causes of peak annual flood flows vary by region in Alaska. In much of the central and northern part of the Project area, flow is limited in winter due to below-freezing conditions. Ice on rivers typically breaks up in May and the streams have high flows through the summer until freezing conditions prevail in the fall. Peak flows typically result from snowmelt, rainstorms on melting snow, or widespread summer rains or thunderstorms. Along the southern coastal area, peak flows can also occur in the fall and winter in association with fall storm events. Peak flows can be caused by dam-bursts or glacial outbursts in the mountainous areas with glacial-fed streams (Jones and Fahl, 1993; USGS, 2003).

Information on potential changes to peak flows in Alaska is limited. In September 2015, USACE released a literature synthesis for the Alaska region that summarizes available climate change studies and data with a focus on the best available and actionable climate science and climate change information as it relates to hydrology (USACE, 2015).



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LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Major Roads
- Major Rivers
- Areas that Contain Flood Hazard Areas

0 25 50 100 Miles

DISCLAIMER

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DATE:	2017-03-16	SHEET:	1 of 1

FEMA FLOOD ZONE AREAS

FIGURE 2.5.1-1

ALASKA LNG

2.5.1.1 Temperature

In general, a warming trend has been observed and is predicted for Alaska as a whole, with the greatest change occurring in the Beaufort Coastal Plain ecoregion and Interior areas. Warmer average temperatures and annual average temperatures, and longer growing seasons have been observed. Extreme cold temperatures are less frequent, and extreme warm temperatures are more frequent. Loss of Arctic sea ice may be affecting temperature regimes due to greater heat storage in open water during summer months (USACE, 2015). Temperatures are predicted to increase by 3 to 15 degrees Fahrenheit (°F) by the end of the century with the greatest increases occurring during winter months, depending on the greenhouse gas (GHG) emissions scenario used.

2.5.1.2 Precipitation

There is a general lack of consensus on changes in precipitation patterns in Alaska, although more studies indicate increasing precipitation in the southern part of the state, and decreasing precipitation in the Arctic regions. One study indicates that precipitation is likely increasing in the winter, but not in the summer. Extreme events may be increasing in intensity in most areas; however, insufficient data exist to determine a trend in the Arctic region. Based on simulation models, precipitation is predicted to increase across Alaska including the Arctic regions with the greatest increases occurring toward the end of the century. Large precipitation events and precipitation during the winter months are also projected to increase (USACE, 2015). Precipitation is projected to increase from 15 to 35 percent by 2099 when compared to the reference period of 1971 through 1999 under a high GHG emissions scenario, and between 10 to 20 percent for a low GHG emissions scenario.

2.5.1.3 Hydrology

There are few studies reporting changes in hydrology in Alaska. One study reported that spring snowmelt events were occurring 5 to 20 days earlier in the year and another showed an increase in winter flows without significant changes in annual flows (USACE, 2015). Model projections for the end of the century predict increases in annual runoff with the increase in flows occurring during the fall and winter along the southern coastline and during the spring in the Interior. Peak flows from spring snowmelt would continue to occur earlier in the spring as warmer winter temperatures decrease the period of snow cover. A recent study of the Cook Inlet watershed (southern coast) predicted increases in stream flows and a “considerable increase in the 100-year peak flow” (USACE, 2015).

A recent study modeled projected hydrology changes in the Chuitna watershed, which drains into Cook Inlet immediately south of the Mainline ROW crossing near Beluga (Prucha et al., 2011). Much of the predicted change was driven by evapotranspiration and snowpack estimates. Snowpack is predicted to decrease by 62 percent across the basin with snow accumulating one to two weeks later in the season and melting one to three months earlier. Winter streamflow is estimated to increase by 43 to 640 percent and summer streamflow to decrease by 7 to 73 percent. The study did not discuss extreme events such as changes in magnitudes of flood flows or precipitation events.

Spring breakup monitoring has been conducted to determine the extent and magnitude of the annual flooding that occurs within the Colville River Delta. The Colville River is the largest river in the Beaufort Coastal Plain ecoregion. The annual flooding typically occurs during a three-week period and the Colville River Delta breakup is generally considered the largest flooding event in the region. In 2012, the peak flood stage was 5.67 feet lower than the historic maximum peak stage, which was recorded in 2011 (Baker, 2012). The data recorded during the spring breakup monitoring shows that the peak flow discharge in 2012 was generally higher than the peak discharges recorded in the previous 20 years. Overall, summer conditions are expected to get drier with increases in evapotranspiration outweighing projected increases in precipitation. The period of above-freezing temperature is expected to lengthen resulting in longer growing seasons (increased transpiration) and higher evaporation for a longer portion of the year. One study predicts the month of June will be 10 to 30 percent drier overall by the end of the century (Brendan and Loya, ND).

Increased summer temperatures and drier conditions have already increased the prevalence of wildfire across Alaska, with rapid changes in vegetation and fire regimes predicted over the next 20 to 30 years in boreal forests (Springsteen and Rupp, 2009). Large fires are predicted to increase, resulting in patchy stands of deciduous vegetation and less mature spruce forest. The impact of boreal forest fires on the hydrologic regime is not well studied. One study of fires in Russia indicated increased summer flows in some watersheds post-burn (Semenova et al., 2015) while another study suggested that thawing of the permafrost can increase the water storage capacity (Ishii et al., 2006). Hydrologic response to fires in the Lower 48 is complex and depends on variables such as burn intensity and frequency, topography, geology, and ecology. Boreal forests have additional variables of permafrost and greater temperature extremes. In general, studies have shown that severe fires in mountainous areas can lead to short-term increases in sediment loads and runoff, but applicability to boreal forests is uncertain.

2.5.1.4 Summary

Regarding flood events and peak flows, current research suggests that snowmelt-driven peak flows would be likely to occur earlier in the year due to warmer predicted temperatures. Changes in the magnitude of peak annual flows and extreme events are much less certain. One study in southern Alaska predicted considerable increases in the 100-year peak flow, and another predicted that the 20-year precipitation event is expected to occur two to seven times more frequently when compared to historic conditions (USACE, 2015). Increases in the observed frequency of flood or precipitation events of similar magnitudes and increases in the magnitude of flows for a given probability event are both indicators that floods are becoming more frequent.

Increased frequency and magnitude of peak flow events are likely to increase the rate of channel migration, streambank erosion, and scour. Many Alaskan streams have high sediment loads and are prone to active channel migration already. These events may increase the size of existing floodplains or the rate of channel migration. Streams in confined valleys tend to move back and forth across their entire valley bottom, and would continue to do so in the absence of development that tends to confine river movement.

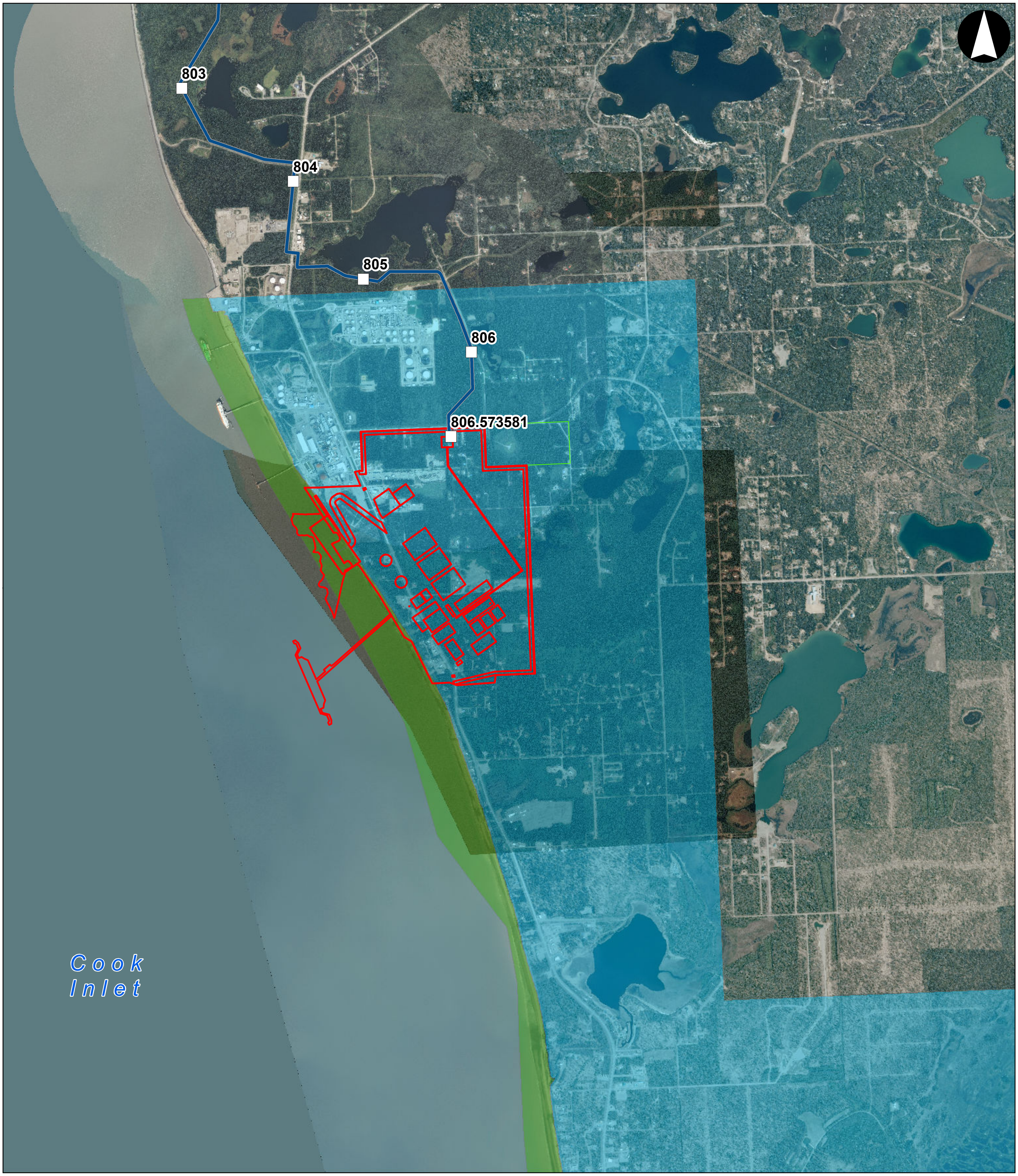
2.5.2 Liquefaction Facility

The Liquefaction Facility would be located in Nikiski in an upland area (at an elevation between 100 and 140 feet above sea level) on the eastern shore of Cook Inlet in the Kenai Peninsula basin. The Marine Terminal would be located within Cook Inlet and along the shoreline. The Cook Inlet basin is a confluence of fresh water from surrounding basins and seawater. The site of the proposed Marine Terminal is exposed to south-northeast swells but is sheltered from storms from the north and east (ADEC, 2008). There are no major fresh water watercourses near the Liquefaction Facility although there are some ponds and lakes within 1 mile of the proposed facility (Cabin Lake and some smaller ponds). The closest major stream or river to the site is the Kenai River, approximately 10 miles to the south. However, the ice formed from fresh water flowing out from the Kenai River can move as far north as the Marine Terminal (Alaska Ocean Observing System, 2015).

The Marine Terminal may be susceptible to coastal flooding. Cook Inlet has a maximum tidal range of 13 to 36 feet, depending on location, which produces rapid tidal flows and strong riptides. In addition, tidal bores (i.e., when the incoming tide forms a wave of water that travels against the direction of the current) of up to 10 feet sometimes occur in the Turnagain Arm (Kenai Peninsula Borough, 1990). Storm surges (storm-induced wave run-up) in Cook Inlet are small compared to tidal fluctuations. Wave heights are generally less than 10 feet in central Cook Inlet, although they can reach up to 15 feet in Upper Cook Inlet near the Beluga Point area (EPA, 2002). Mitigation measures would include building the facilities above the expected coastal flood elevations, using flood-proofing techniques for facilities in the coastal floodplain, and armoring the shoreline to protect from erosion.

FEMA produced FIRMs for the Kenai Peninsula Borough, including the proposed Liquefaction Facility, in 1981. Draft updates to the maps were released in 2014, but have not yet been approved (Figure 2.5.2-1). The updated map shows the location of the LNG Plant to be in the unshaded Zone X flood hazard designation (an area determined to be outside the 500-year floodplain) and portions of the Marine Terminal to be within a Zone VE flood hazard designation (coastal areas with velocity hazards [wave action], with a 1 percent annual probability of flooding) with a base flood elevation of 23 to 31 feet (NAVD 88). The 1981 FEMA maps showed the MOF to be in Zone VE flood hazard designation with a base flood elevation of 17 feet (NGVD 29) and all other areas to be in a Zone D flood hazard designation (areas of undetermined but possible flood hazards).

In addition, an updated FEMA flood insurance study (FEMA 2014) indicates that there are additional flood hazards associated with tsunamis along Cook Inlet. Based on the FEMA flood insurance study, local tsunamis can be generated in Cook Inlet by massive earth or rockslides that can occur above or below the water, which may not be triggered by earthquakes. There is insufficient data to estimate risks and frequencies associated with these slide events. According to FEMA, the second type of tsunami that may occur in Cook Inlet is caused by earthquakes and fault-releases below the water surface. The magnitude of tsunami events has been estimated for Homer, Alaska, which lies approximately 72 miles to the south of the Liquefaction Facility on the Kenai Peninsula. The tsunami from the 1964 earthquake, which was the largest on record worldwide, was estimated to exceed the 500-year coastal flood event. However, the flood elevation of a 500-year tsunami was estimated to be below a 100-year flood associated with a storm event. Additional details concerning tsunamis and impacts to the Project are provided in Resource Report No. 6.



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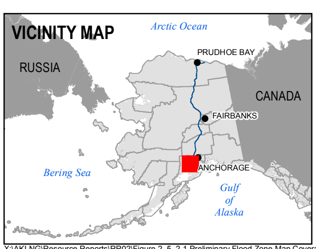

LEGEND

- Mile Post
- Alaska LNG Rev C2 Route
- LNG Operations Area
- LNG Construction Camp

Flood Zone

- VE
- X

0 1,450 2,900 5,800 Feet

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PRELIMINARY FLOOD ZONE MAP COVERAGE NEAR THE LIQUEFACTION FACILITY

FIGURE 2.5.2-1

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_5_2-1 Preliminary Flood Zone Map Coverage near the Liquefaction Facility.mxd

2.5.3 Interdependent Project Facilities

2.5.3.1 Pipelines

2.5.3.1.1 Mainline

The Mainline would be buried with exception of geologic fault crossings and four aerial river crossings, and therefore would not be subject to flood hazards for most of its length. The Mainline would cross 11 major drainage basins in Alaska, as well as 20 smaller drainage sub-basins (Figure 2.3.5-1). The main rivers and tributaries in each basin and their characteristics are summarized Section 2.3.5.

Only a portion of the Mainline route is covered by FEMA-delineated floodplain maps (Figure 2.5.3-1). FEMA has delineated the Mainline section along the Susitna River drainage from MP 660 to MP 710. The delineation shows this section of the Mainline to be in an unshaded Zone X or Zone C flood hazard designation (outside the 500-year floodplain), except for three stream crossings:

- Trapper Creek crossing between MP 663 and MP 664;
- Tributary to the Rabideux Creek crossing between MP 666 and MP 667; and
- Deshka River crossing between MP 704 and MP 705.

These crossings are located in an area of Zone A flood hazard designation (areas with 1 percent annual probability of flooding, with no base flood elevation determined).

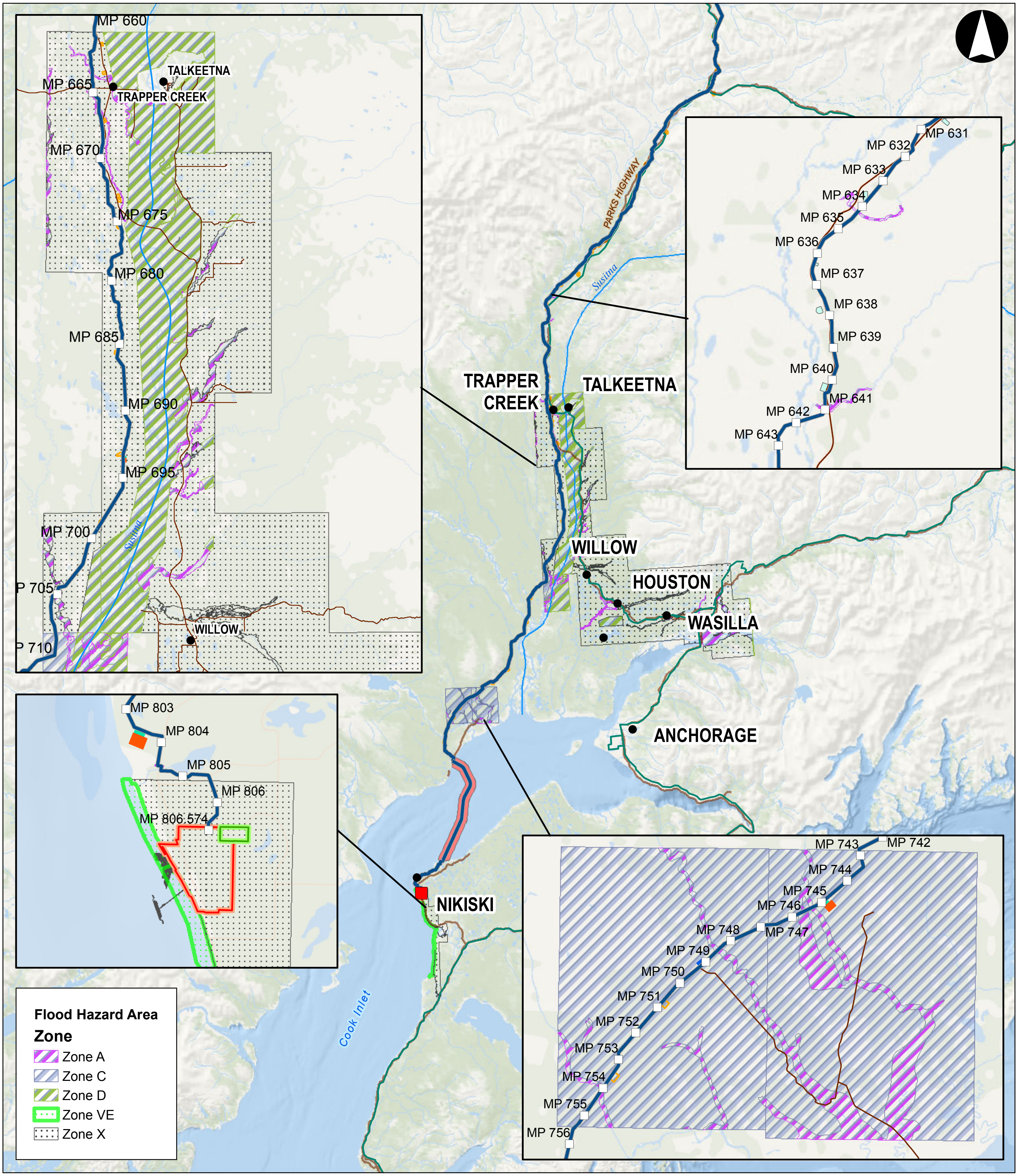
FEMA has also delineated three other sections along the Mainline route from MP 630 to MP 641, MP 741 to MP 754, and MP 801 to MP 804. The delineations show these sections of the Mainline to be in an unshaded Zone X or Zone C flood hazard designation (outside the 500-year floodplain), except for seven stream crossings:

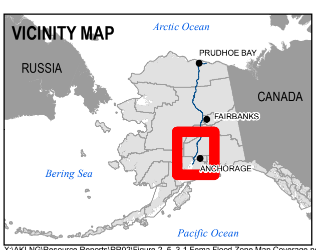
- Byers Creek crossing between MP 633 and MP 634;
- Troublesome Creek crossing between MP 640 and MP 641;
- Lewis River and two tributaries to the Lewis River crossings between MP 744 and MP 745;
- Theodore River crossing between MP 747 and MP 748; and
- Olson Creek crossing between MP 752 and MP 753

These crossings are located in a Zone A flood hazard designation (100-year floodplain, with no base flood elevation determined).

2.5.3.1.1.1 Historical Flood of Record

For a few areas without FEMA floodplain mapping, peak flows were analyzed using available USGS stream gauge sites and the interpretation of topographic maps to estimate areas that have flooded within the period of record for each gauge. Eight USGS gauge locations were selected based on availability of flood frequency analyses, location, and sufficient periods of record to analyze (Figure 2.5.3-2).





X:\AKLNG\Resource Reports\RR02\Figure 2_5_3-1 Fema Flood Zone Map Coverage near the Mainline.mxd

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Pipeline Mile Post
- Alaska LNG Rev C2 Route
- Major Roads
- Major Rivers
- LNG Operations Area
- LNG Construction Camp
- Borrow Source
- Compressor / Heater Station 42"
- Offshore Operational Construction Area
- Pipe Storage Yard
- RR Spur
- RR Workpad
- ATWS
- Camp
- Marine Facility

0 10 20 40 Miles

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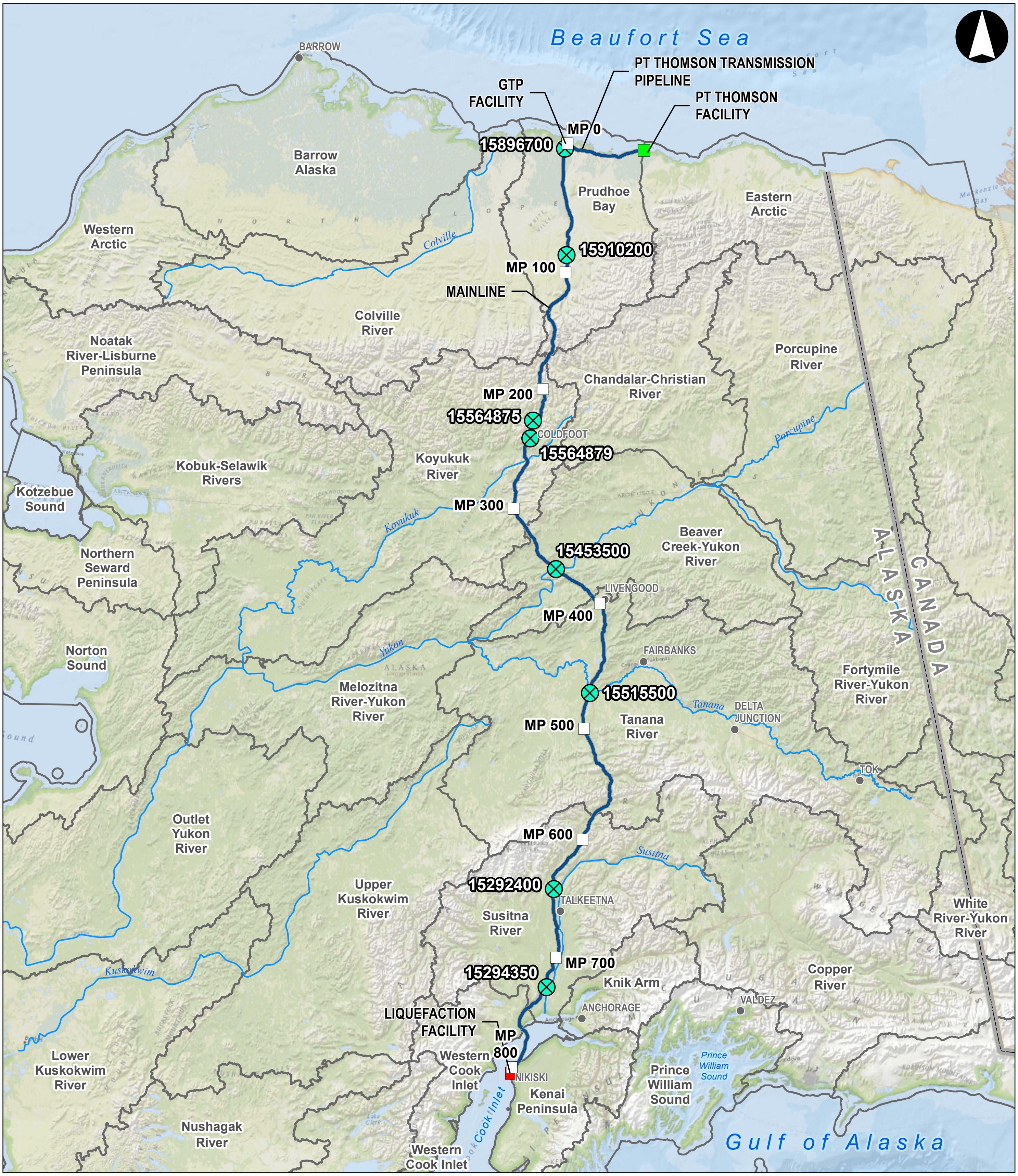
FEMA FLOOD ZONE MAP COVERAGE NEAR THE MAINLINE

FIGURE 2.5.3-1

ALASKA LNG



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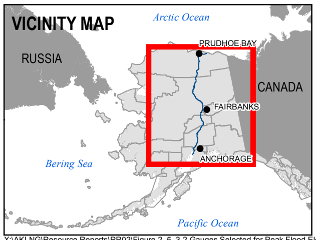

LEGEND

Mile Post	Alaska Place Names
Project Facility	Alaska LNG Rev C2 Route
Existing Facility	Major Rivers
Stream Gauges	Watershed Basin

0 25 50 100 Miles

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GAUGES SELECTED FOR PEAK FLOOD ELEVATION ANALYSIS

FIGURE 2.5.3-2

ALASKA LNG

X:\AKLNG\Resource Reports\RR02\Figure 2_5_3-2 Gauges Selected for Peak Flood Elevation Analysis.mxd

Details concerning the stream gauges are provided in Table 2.5.3-1. Peak elevations were plotted on topographic maps to simulate the extent of peak riverine flooding during the period of record for each gauge. Stream peak elevation maps (Figures 2.5.3-3 and 2.5.3-4) demonstrate that some sections of the Mainline could be inundated during a flood event, including:

- MP 3.4;
- MP 85.5;
- MP 228.5;
- MP 240.8 to MP 240.9;
- MP 356.9 to MP 357.3;
- MP 473.3 to MP 473.9;
- MP 648; and
- MP 724.1 to MP 725.1.

TABLE 2.5.3-1

Stream Gauge Records used in the Peak Elevation Analysis

USGS Site ID	Description	Period of Record	Peak Stream Elevation (feet above sea level)[a]	Peak Stream Flow (cubic feet per second)	Peak Year of Record	Distance of Site to Mainline (feet)	Near Milepost (MP)	Estimated Return Interval (Years)
Prudhoe Bay Basin, Sagavanirktok River Sub-basin								
15896700	Putuligayuk River near Deadhorse	1970-1995	48.5[b]	5800	1980	1221	4	Between 10 and 25
15910200	Happy Creek at Happy Valley Camp near Sagwon	1972-2002	968.6	1400	2002	4116	86	Near 10
Koyukuk River Basin, Upper Koyukuk River Sub-basin								
15564875	Middle Fork of the Koyukuk River near Wiseman	1968-1994	1209[b]	42700	1979	942	228	Near 500
15564879	Slate Creek at Coldfoot	1981-2014	1069	4320[b]	1989	1346	242	1076
Yukon River Basin, Ramparts Sub-basin								
1543500	Yukon River near Stevens Village	1964-2014	303	827000	1992	3381	357	Between 25 and 50
Tanana River Basin, Tanana Flats Sub-basin								
15515500	Tanana River at Nenana	1948-2014	357	186000	1967	3771	474	Near 500
Susitna River Basin, Chulitna River Sub-basin								
15292400	Chulitna River near Talkeetna	1958-2014	546	100000	2006	5163	647	Near 500
15294350	Susitna River at Susitna Station	1975-2014	63	312000	1986	4383	724	Between 50 and 100

TABLE 2.5.3-1

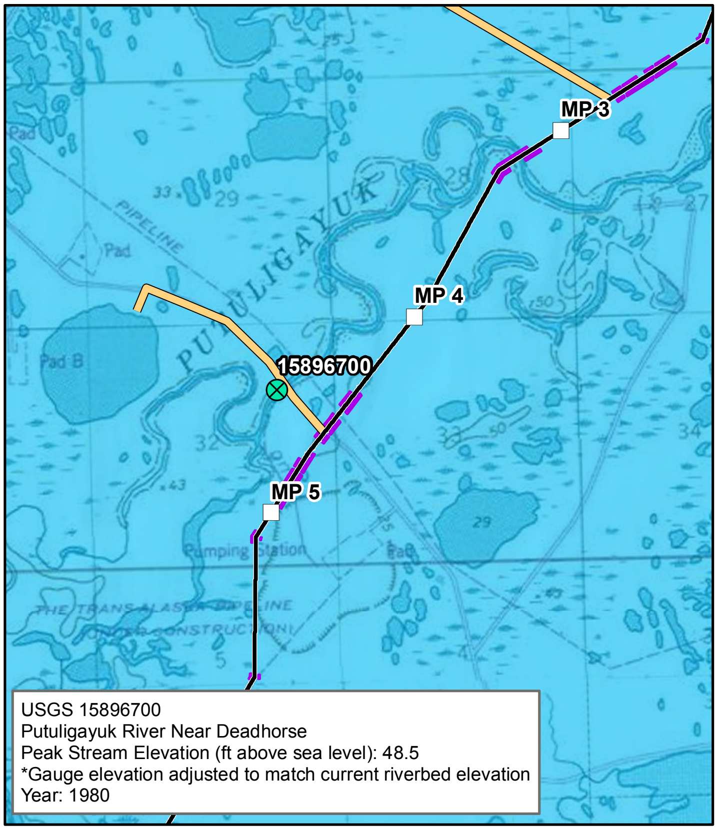
Stream Gauge Records used in the Peak Elevation Analysis

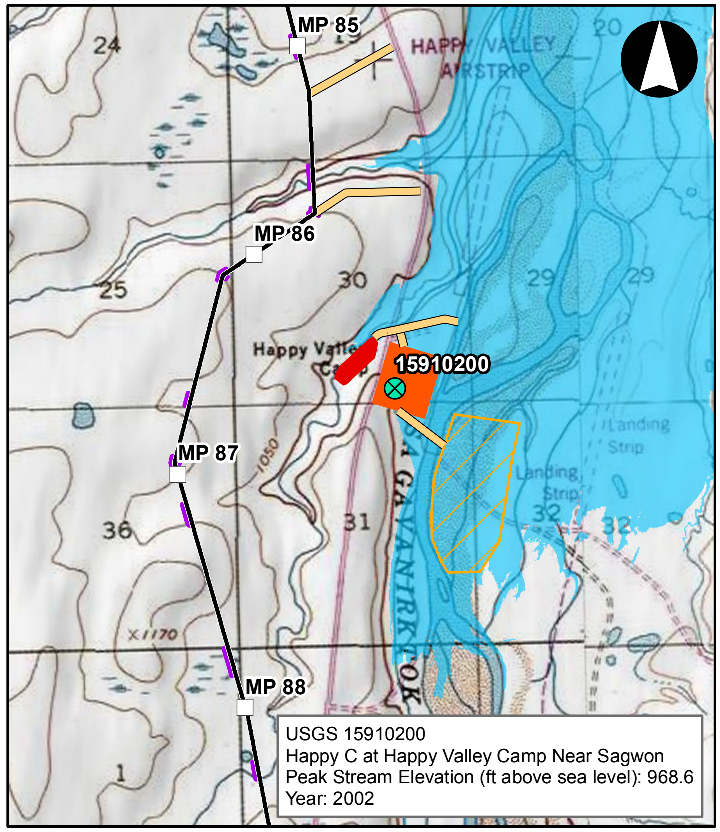
USGS Site ID	Description	Period of Record	Peak Stream Elevation (feet above sea level)[a]	Peak Stream Flow (cubic feet per second)	Peak Year of Record	Distance of Site to Mainline (feet)	Near Milepost (MP)	Estimated Return Interval (Years)

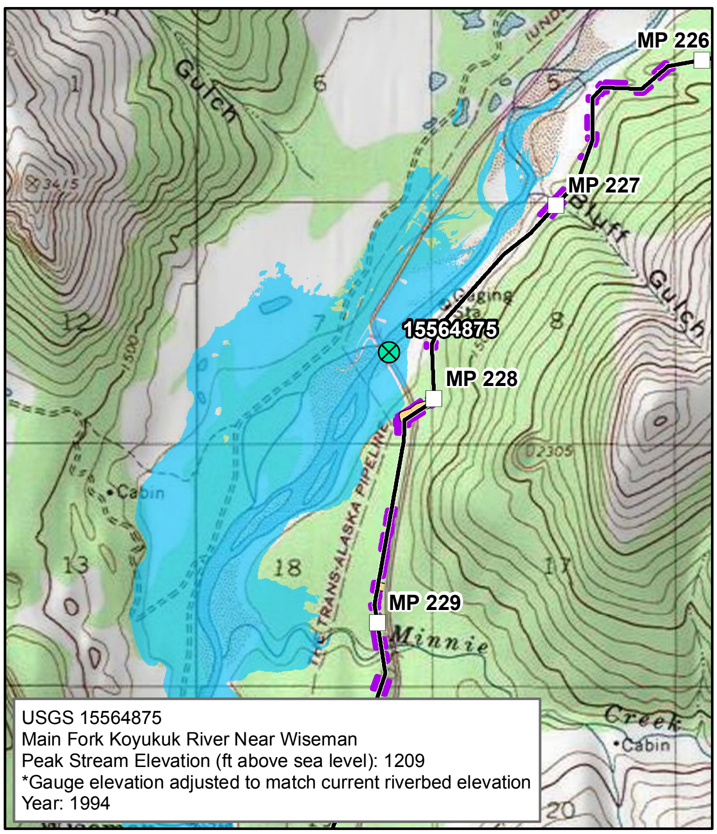
Source: USGS 2015

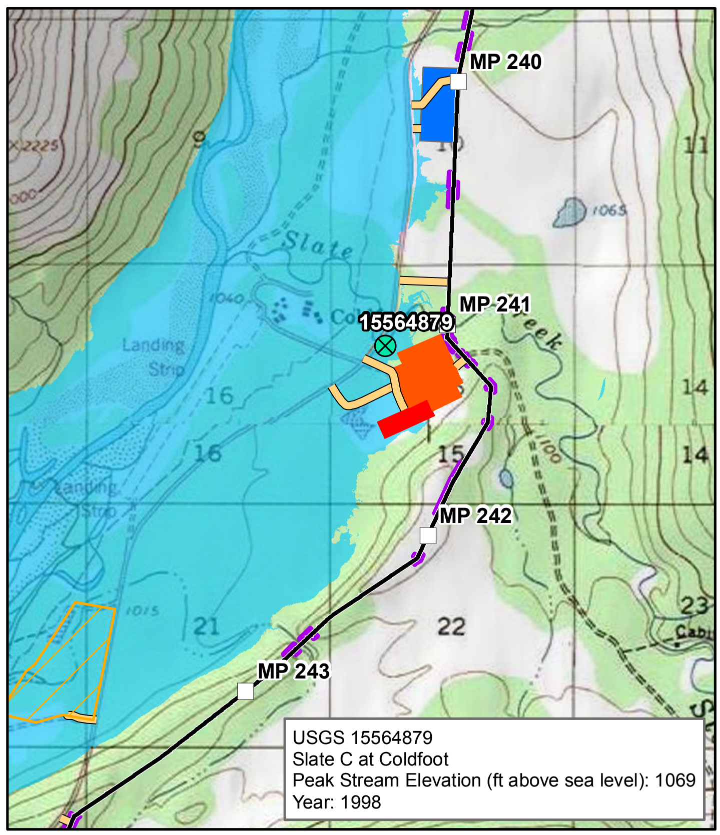
a Peak stream elevation accounts for the USGS gauge height—the height of the water surface above the gauge datum (zero point).

b Gauge datum does not match local elevation— the local land elevation substituted as base gauge elevation.









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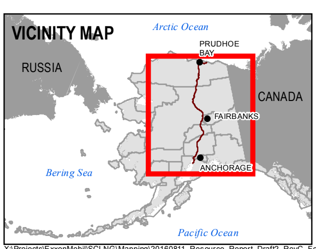

LEGEND

- Stream Gauge
- Mile Post
- Rev C2 Route
- Access Roads
- Borrow Source
- RR Spur
- RR Workpad
- Compressor Station 42"
- Camp
- Meter Station
- Pipe Storage Yard
- ATWS

0 0.25 0.5 1 Miles

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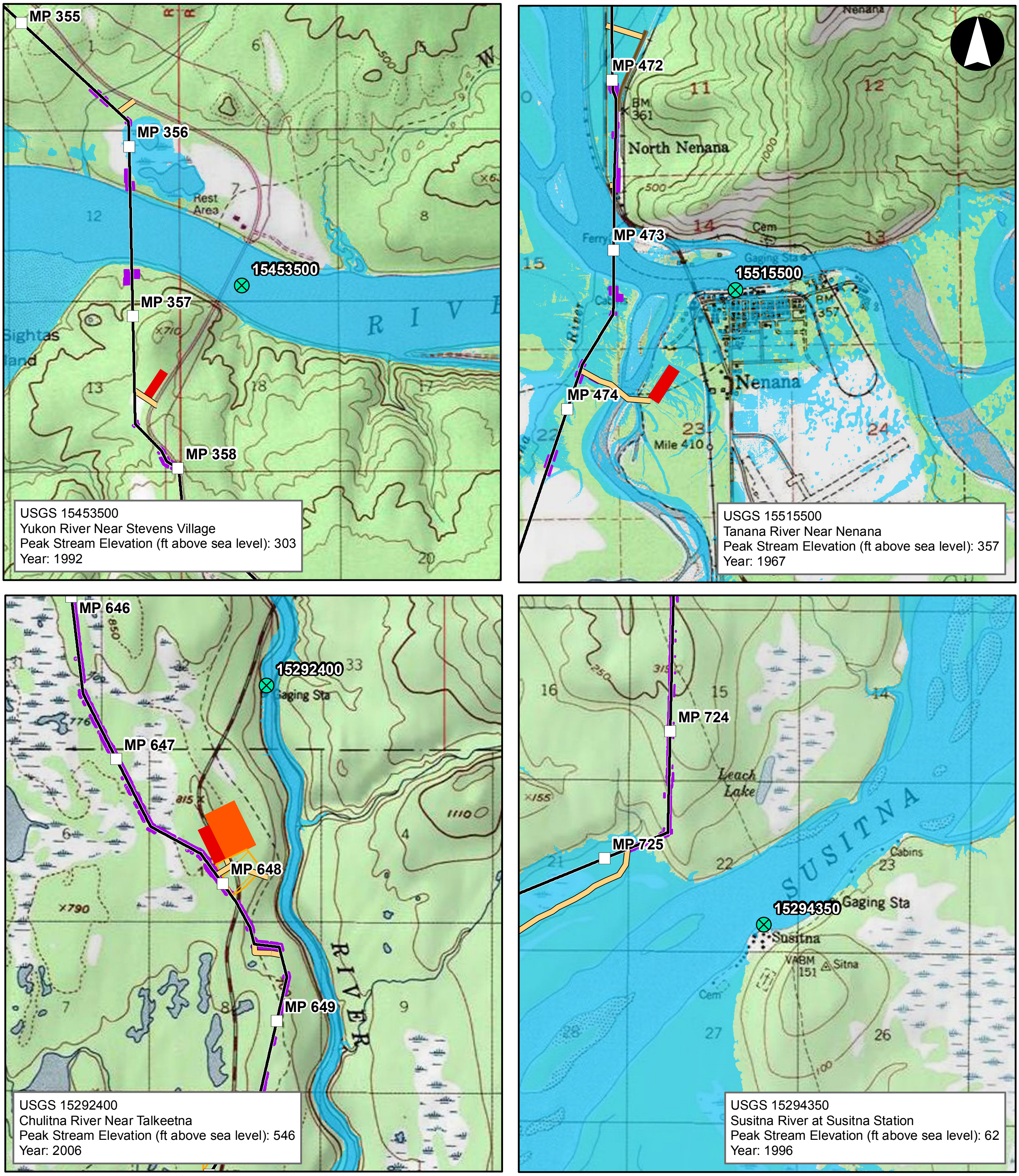
POTENTIAL EXTENT OF FLOODING BASED ON PEAK HISTORIC FLOOD ELEVATIONS FOR GAUGES LOCATED NEAR THE MAINLINE ROW IN THE PRUDHOE BAY AND KOYUKUK RIVER BASINS

FIGURE 2.5.3-3

ALASKA LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20160811_Resource_Report_Draft2_RevC_Footprint\RR2\Figure 2_5_3-3 Potential Extent of Flooding near the Mainline ROW in the Prudhoe Bay and Koyukuk River Basins.mxd



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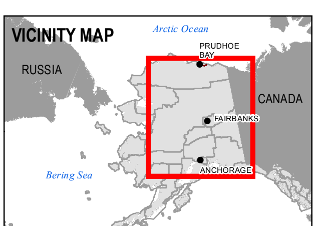

LEGEND

- Stream Gauge
- Mile Post
- Rev C2 Route
- Access Roads
- Borrow Source
- RR Spur
- RR Workpad
- Compressor Station 42"
- Camp
- Pipe Storage Yard
- ATWS
- Meter Station
- Peak Flood

0 0.25 0.5 1 Miles

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POTENTIAL EXTENT OF FLOODING BASED ON PEAK HISTORIC FLOOD ELEVATIONS FOR GAUGES LOCATED NEAR THE MAINLINE ROW IN THE YUKON, TANANA AND SUSITNA RIVER BASINS

FIGURE 2.5.3-4

ALASKA LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20160811_Resource_Report_Draft2_RevC_Footprint\RR2\Figure 2_5_3-4 Potential Extent of Flooding near the Mainline ROW in the Yukon Tanana and Susitna River Basins.mxd

Due to the limited availability of peak flood elevation data, this analysis only presents the potential extent of flooding associated with the highest flow recorded during the period when a particular gauge was active rather than floods of a specific return interval. The maps represent a simplified approach to mapping flood elevations. The maps show the area adjacent to the gauge at the same elevation as the flood peak rather than using a model to estimate changes in water surface elevation with changes in topography, and should be interpreted accordingly. Because most of the Mainline would be buried and not subject to flood hazards, additional floodplain analyses were not conducted for the Mainline. However, detailed flood frequency analyses, floodplain mapping, determinations of potential scour were conducted for permanent aboveground facilities as described below and in Appendix P (*Alaska LNG Pipeline – Floodplain Analysis Techniques*). The floodplain analysis description in Appendix P further describes the techniques and analyses used to assess potentially impacted locations. The results of the floodplain analysis would be incorporated into the Mainline design to prevent exposure of the pipeline following construction.

2.5.3.1.2 PBTL and PTTL

The PTTL and PBTL would be constructed aboveground on VSMs. No portion of the PTTL or PBTL route has been delineated for floodplains. The closest gauge analyzed for peak flow is on the Putuligayuk River, approximately 5 miles to the southwest of the GTP. Due to its proximity to the GTP, the PBTL area was analyzed for historic peak flood elevations using the methods described for the GTP in Section 2.5.3.2, which describes the historic peak flood elevation for the Putuligayuk River and the 100-year coastal flooding event that could affect the GTP and PBTL area. Based on the limited information available, the PBTL is unlikely to be inundated during most flood events.

The same 100-year coastal flooding elevation was used to depict the potential flood extent for the PTTL (Figure 2.5.3-5). Some sections of the PTTL could be inundated during a flood event, including:

- MP 0 to MP 0.3;
- MP 1.4 to MP 1.7;
- MP 2.3 to MP 2.5;
- MP 25.6 to MP 25.7;
- MP 35.4;
- MP 42.3; and
- MP 61.1 to MP 61.3.

None of the six stream crossings along the PTTL is gauged, so no historic riverine flooding information is available.

POTENTIAL EXTENT OF FLOODING FOR THE PTTL

FIGURE 2.5.3-5

ALASKA LNG

LEGEND

- Mile Post
- NOAA Tidal Station
- Project Facility
- Existing Facility
- Alaska LNG Rev C2 Route
- Point Thomson Transmission Line (PPTL)
- River
- Coastal Flood

NOAA 9497645
Mean Sea Level (MSL): 0.3 feet
Mean Lower Low Water (MLLW): 0 feet
Estimated 100-year return interval event (above MML): 5.3 feet

0 2.5 5 10 Miles

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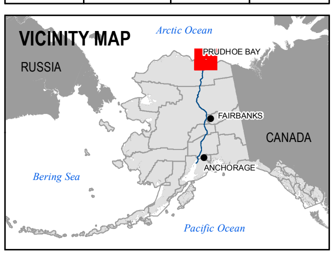


X:\AKLNG\Resource Reports\RR02\Figure 2_5_3-5 Potential Extent of Flooding for the PTTL.mxd

2.5.3.1.3 Pipeline Aboveground Facilities

As previously described for the Mainline, very little of the Mainline route has been delineated for floodplains. None of the permanent aboveground facilities is located within the available delineations. The Coldfoot Compressor Station (MP 240) is located near one of the gauges analyzed for peak flows and may be subject to flooding (Figure 2.5.3-3). The Coldfoot Compressor Station and other aboveground facilities that could be impacted by flooding were screened based on their proximity to waterbodies and geomorphic features as described in Appendix P (*Alaska LNG Pipeline – Floodplain Analysis Techniques*).

2.5.3.1.4 Pipeline Associated Infrastructure

With the exception of permanent access roads to the Pipeline Facilities, all Pipeline Associated Infrastructure would be temporary and only used during construction. Some Pipeline Associated Infrastructure would be located within areas of available FEMA delineation (Figure 2.5.3-1), including:

- Access roads near MP 641, MP 663, MP 704, and MP 744;
- ATWS near MP 634, 641, 663, 664, 666, 667, 704, 744, and 745; and
- Potential material sites near MP 634, MP 668, MP 669, and MP 674.

In addition, some infrastructure is located near the gauges analyzed for peak flows and may be subject to flooding (Figures 2.5.3-3 and 2.5.3-4), including:

- Access roads near MP 86, MP 240, MP 241, MP 242, and MP 474;
- ATWS near MP 3, MP 241, MP 474, and MP 725;
- Construction camps near MP 86, MP 241, and MP 242;
- Pipe storage yards near MP 86, MP 242 and MP 474; and
- Potential material site near MP 87.

No additional analyses were conducted specifically for the Pipeline Associated Infrastructure.

2.5.3.2 GTP

The GTP would be located on the North Slope in the Beaufort Coastal Plain ecoregion. The Beaufort Coastal Plain ecoregion fringes the Beaufort Sea and consists of low tundra-covered coastal plains with numerous deltas allowing storm surges to inundate extensive areas. Storm surges (storm-induced wave run-up) in the Beaufort Sea can be large compared to small tidal fluctuations (average range of 0.5 feet) (Reimnitz and Maurer, 1979). The dominant easterly wind causes low water levels and offshore movements of ice, whereas the westerly wind causes a rise in water level and onshore movement of ice. The most severe storms have westerly winds and generally occur during September or October.

During the first part of freeze-up, nearshore ice in the Beaufort Sea is susceptible to movement and deformation by modest winds and currents. Ice ride-up occurs when the ice deforms plastically, or becomes broken without overturning, overrunning the land while remaining basically an intact ice sheet, sometimes resulting in ice rubble and sediment being shoved as much as several hundred feet inland during extreme conditions (ADNR, 2009; USDOI, 2003b). While the Prudhoe Bay area is somewhat protected by barrier islands from ice override hazards, ice pileup has been known to occur on the West Dock causeway, where ice rubble up to 20 feet high was reported in the late 1970s (Kovacs, 1983).

River ice begins to melt before the sea ice. During early stages of ice breakup, water from rivers may temporarily flood ice that has formed on deltas.

The GTP would be located within the Prudhoe Bay basin and Kuparuk River Sub-basin. The location of the GTP may be susceptible to coastal flooding of the Beaufort Sea and riverine flooding of the Sagavanirktok River. There are numerous small streams and lakes that would be in proximity of the GTP. Local lakes tend to increase in surface area during extreme rainfall or ice breakup events and flood adjacent land, and may present a source of potential flooding.

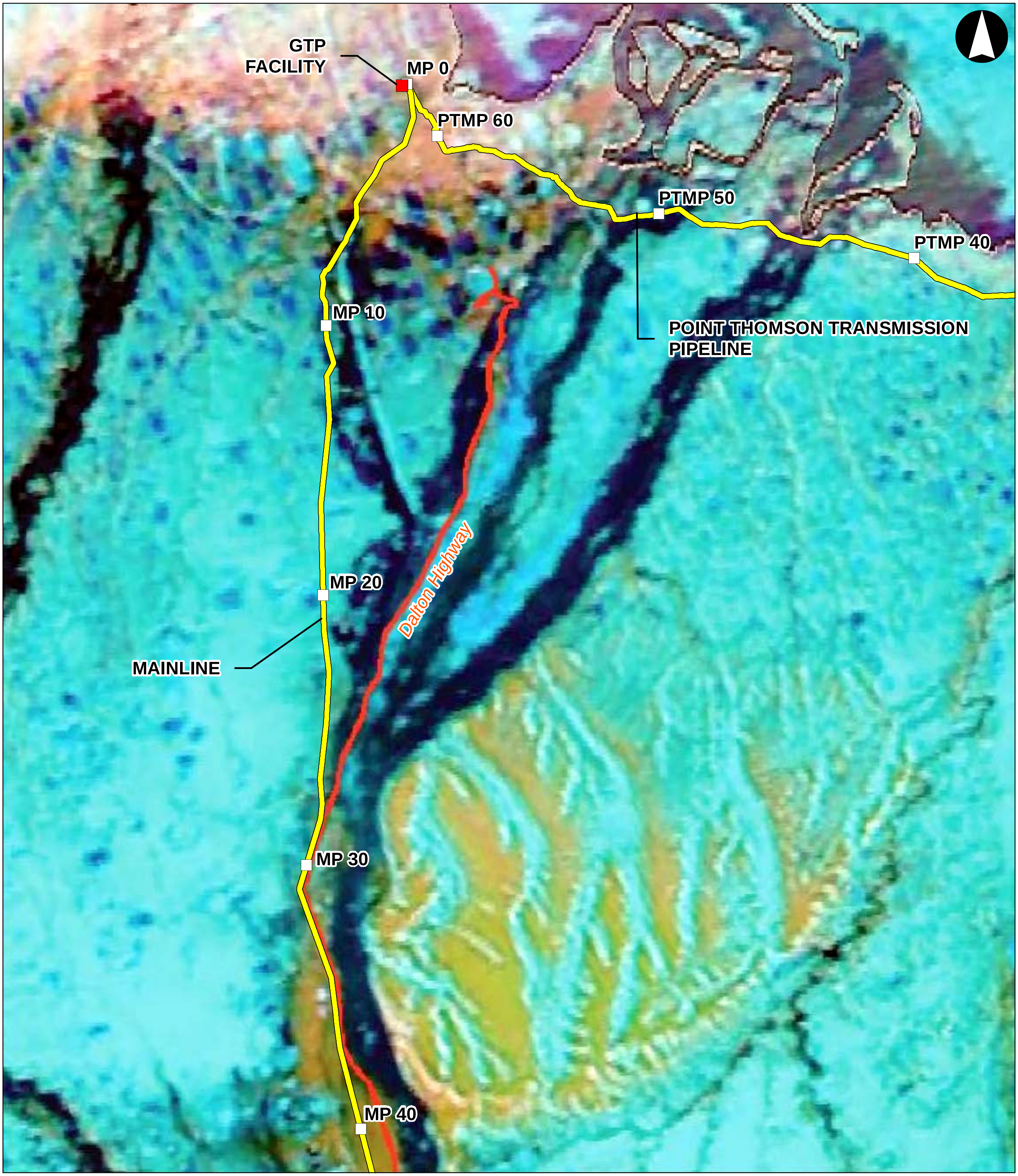
In late spring of 2015, the Dalton Highway, located approximately 7 miles southeast of the proposed GTP, was closed twice due to historic flooding of the Sagavanirktok River (Alaska Dispatch News, 2015). The first event occurred during March and early April and flooded an almost 60-mile stretch of the Dalton Highway, which was constructed approximately 3 feet above the surrounding terrain. The second flooding event occurred during spring break up with record warmth in May. The Sagavanirktok River, unlike many other central Alaskan rivers, does not typically experience large ice breakup-related flooding, and the spring floods were not caused by typical spring breakup flooding. Unusually wet conditions in 2014 contributed to unusually large spring river ice formations called aufeis. Aufeis is an ice jam formed by frozen groundwater welling up and flowing higher and higher on the surface of the ice jam and freezing, forming a channel wide blockage. Aufeis-related flooding is not unusual on the Beaufort Coastal Plain ecoregion and is very difficult to predict since the resulting floods are not caused by precipitation or high-flow events.

The first road closure in March–April occurred when frozen slush overflowed the Sagavanirktok River banks and onto the Dalton Highway. The second event occurred when the normal spring snowmelt runoff was blocked by the ice jam and flowed across the Dalton Highway to the west, and then followed the roadbed north to Deadhorse and surrounding areas (Alaska Center for Climate Assessment and Policy, 2015). The flooded areas are shown as black and darker blue areas in Figure 2.5.3-6, and it does not appear that the flooding event would have impacted the GTP and associated facilities. The GTP could be impacted by similar aufeis-related flooding on the smaller Kuparuk River, which runs about 1.1 miles south of the proposed GTP.

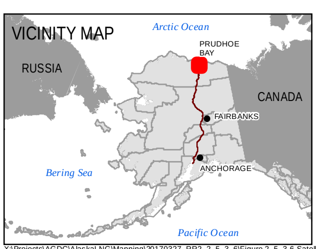
No FEMA floodplain delineation exists for the site of the GTP, and other sources of information on site-specific flooding are limited.

2.5.3.2.1 Historical Flood of Record

There is one USGS stream gauge 3.7 miles from the GTP site that has recorded annual peak discharges and flood elevations (Table 2.5.3-2). Flood frequency analysis for this gauge, based on the available period of record (25 years), indicates that the highest recorded peak flow would have a return interval of between 10 and 25 years. The available historic peak elevation was plotted on a topographic map to estimate the areas that have experienced riverine flooding during the period of record for the gauge (Figure 2.5.3-7). The flood elevations associated with each return interval discharge were not determined by the USGS and are therefore not presented.



VICINITY MAP



LEGEND

- Project Facility
- Mile Post
- Rev C2 Route
- Major Highway

0 1.5 3 6 Miles

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DATE: 2017-03-27	SHEET: 1 of 1

SATELLITE IMAGE SHOWING THE EXTENT OF THE 2015 FLOODING

FIGURE 2.5.3-6

ALASKA LNG

X:\Projects\AGDC\AlaskaLNG\Mapping\20170327_RR2_2_5_3_6\Figure 2_5_3-6 Satellite Image showing the extent of the 2015 Flooding.mxd

TABLE 2.5.3-2

Stream Gauge Records near the GTP

USGS Site ID	Description	Period of Record	Peak Stream Elevation (feet above sea level)[a]	Peak Stream Flow (cubic feet per second)	Peak Year of Record	Distance of Site to GTP (feet)	Near Milepost (MP)	Baseline Land Elevation (feet above sea level)
Gauge Information								
15896700	Putuligayuk River near Deadhorse	1970-1995	48.5[b]	5,800	1,980	19,517	5	25.9
Peak Streamflow Estimates								
USGS Site ID	**Description**	**Period of Record**	**Length of Record (years)**	**10-Year Return Interval Flood (cubic feet per second)**	**25-Year Return Interval Flood (cubic feet per second)**	**50-Year Return Interval Flood (cubic feet per second)**	**100-Year Return Interval Flood (cubic feet per second)**	**500-Year Return Interval Flood (cubic feet per second)**
15896700	Putuligayuk River near Deadhorse	1970-1995	25	5,350	6,310	6,960	7,570	8,840

Source: USGS 2015, USGS 2003

[a] Peak stream elevation accounts for the USGS gauge height—the height of the water surface above the gauge datum (zero point).

[b] Gauge datum does not match local elevation—the local land elevation substituted as base gauge elevation.

Available NOAA tidal data were reviewed to estimate areas of potential coastal flood risk near the GTP. Table 2.5.3-3 lists tidal elevations relative to MLLW measured at a NOAA buoy located east of the nearby West Dock causeway (NOAA, 2011). Analysis of the 16-year sea level dataset indicates that the highest observed water level represents an approximate 25-year return interval extreme sea level event, which includes storm surge, astronomic tide, and seasonal cycle. Although extreme sea level estimates may not be reliable beyond the 25-year return period due to the limited data, it is estimated that the 50-year and 100-year return interval events would be 5.1 feet and 5.3 feet, respectively (Sultan et al., 2010). Driftwood measurements from the extreme event in 1970 indicated potential surge elevations ranging from 4.9 feet to 8.2 feet, and that the storm surge elevation was not likely equaled in the past 90 to 100 years (Sultan et al., 2010).

TABLE 2.5.3-3

Tidal Datum Relative to MLLW at Prudhoe Bay, Beaufort Sea (NOAA Station ID 9497645)

Tidal Datum	Meters	Feet
Highest Observed Water Level (08/11/2000)	1.464	4.8
Mean Higher High Water (MHHW)	0.214	0.7
Mean High Water (MHW)	0.181	0.6
Mean Sea Level (MSL)	0.106	0.3
Mean Tide Level (MTL)	0.103	0.3

TABLE 2.5.3-3

Tidal Datum Relative to MLLW at Prudhoe Bay, Beaufort Sea (NOAA Station ID 9497645)

Tidal Datum	Meters	Feet
Mean Low Water (MLW)	0.025	0.1
Mean Lower Low Water (MLLW)	0.000	0.0
Lowest Observed Water Level (10/10/2006)	-0.927	-3.0

Source: NOAA 2011
Notes:
Length of series: 16 years
Time Period: 12/1993–11/2004, 03/2006–02/2008, and 07/2008–06/2011
Tidal Epoch: 1983–2001

Based on the information available, the GTP would not be in an area that would be inundated during a flood event. Figure 2.5.3-7 depicts estimated flood elevations near the GTP using estimated 100-year coastal flooding elevation as well as the peak historic flood elevation for the Putuligayuk River (between a 10- and 25-year return interval flood).

2.5.3.2.2 GTP Associated Infrastructure

The GTP Associated Infrastructure was analyzed for historic peak flood elevations using the methods described for the GTP in Section 2.5.3.2. The West Dock causeway could be affected by the 100-year coastal flooding event (Figure 2.5.3-7). No additional analyses were conducted specifically for the GTP Associated infrastructure.

LEGEND

- Mile Post
- NOAA Tidal Station
- Stream Gauge
- Rev C2 Route
- PTTL Pipeline
- Peak Stream Flood
- Coastal Flood
- GTP Facility
- PBTL ROW

0 0.75 1.5 3 Miles

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POTENTIAL EXTENT OF FLOODING FOR THE GTP AREA

FIGURE 2.5.3-7

ALASKA LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20160811_Resource_Report_Draft2_RevC_Footprint\RR2\Figure 2_5_3-7 Potential Extent of Flooding for the GTP Area.mxd

2.5.4 Potential Construction Impacts and Mitigation Measures for Floodplains

Project construction within floodplain areas would result in both:

1. Potential impacts of Project construction on floodplain processes; and
2. Potential impacts to Project activities/components by floodplain processes.

The potential impacts of Project construction on floodplain processes could include, but are not limited to:

- Alteration of natural vegetation;
- Changes in water flow pathways and/or magnitude through the floodplain;
- Changes in subsurface flows;
- Changes in sediment deposition;
- Changes in sediment load or type;
- Changes in waterbody channel geometry, including the creation of channel restrictions;
- Enhancement of flooding upstream or downstream;
- Increased erosion;
- Reduced flood storage capacity; and/or
- Reduced surface area for the infiltration of floodwaters.

The primary impact of Project activities/components on floodplain processes would likely be due to floodplain encroachment. The potential impacts of encroachment would differ between riverine and coastal floodplains. Floodplain encroachment could result in a reduction in flood storage capacity and the displacement of floodwater, which could intensify flooding either upstream or downstream of the encroachment. Encroachment of a stream or river's floodplain (e.g., placement of a bridge pier or footing) could also result in a restriction of the channel, causing erosion or scour, and increasing flood elevations upstream. Coastal encroachment could result from wave action during a storm surge or storm tide (storm surge and the astronomical tide), undercutting bluff shorelines, weakened by bluff top development.

Floodplain encroachment during Project construction would occur during installation of aboveground facilities, access roads, pipe storage areas, additional temporary work areas, and work camps; as well as the use of material extraction, staging, and storage areas within the floodplain. Alteration of natural floodplain processes would occur from access road and ROW construction; land clearing, grading, trenching, blasting, and excavating activities; extracting granular material from material sites; and staging/storing materials within the floodplain.

The potential for these impacts would vary greatly across the Project area. Construction impacts on floodplains would generally be temporary and minor, occurring only during the construction phase, before removal of the temporary Project components. Longer-term floodplain impacts would result from encroachment and disruption of floodplain processes from those Project components that remain in place post-construction. Potential impacts related to permanent infrastructure (e.g., compressor stations, bridge pilings and embankments, shoreline facilities) are discussed in Section 2.5.5.

Although permanent structures within the floodplain are at greater risk over the lifetime of the Project, temporary construction infrastructure and equipment could also be impacted by floodplain processes. The potential impacts include, but are not limited to:

- Burial from increased sedimentation (e.g., channel migration, storm events);
- Damage from aufeis/ice dams;
- Damage from shoreline ice;
- Inundation and flooding; and
- Scour and undercutting.

Inundation by riverine floodwaters can be intensified by the presence of aufeis or ice dams, particularly in the northern areas. Streams that have high sediment loads and active floodplains can migrate during floods or overflow into secondary channels, thereby increasing the potential for damage.

The following general mitigation measures would be used to reduce the potential for temporary impacts to floodplains from Project construction, as well as to protect the construction infrastructure and equipment:

- Install appropriate temporary and permanent erosion control (e.g., trench breakers, permanent slope breakers, mulch) in accordance with the Applicant's *Plan* and *Procedures*;

- Minimize the placement of construction infrastructure and equipment within floodplains and channel migration zones, as practicable;

- Sequence construction to limit the amount of open excavation/trenched areas and the duration these areas are left open, as practicable;

- Minimize the time between backfilling and completing final restoration and installation of permanent erosion control structures, as practicable; and,

- Prevent debris from entering sensitive areas of the floodplain (e.g., use of blasting mats), as practicable.

2.5.4.1 Liquefaction Facility

The LNG Plant would not be located in a 500-year floodplain, and there are no waterbodies located on the site. It is not anticipated that floodplain processes would be affected by construction or that the construction footprint would be prone to flooding. Stormwater from surfaces located outside operational areas would be drained to stormwater ponds and then discharged to Cook Inlet. Stormwater from operations areas would be treated and held in one of three onsite ponds prior to discharge to Cook Inlet.

Construction of the temporary MOF would involve cutting and filling along the Cook Inlet shoreline and dredging within the Inlet. These activities would not affect flood levels, but the area could be prone to flooding, as portions of the Marine Terminal and MOF would be constructed within the 100-year coastal flooding zone. It is anticipated that impacts to the coastal floodplain would be limited. The shoreline consists of unconsolidated sediments composed of alluvium, moraine, glacioestuarine, and modified glacial deposits. Potential mitigation measures would include flood-proofing and placing geo-tubes and other shoreline protection, such as riprap or armor stone blankets, to reduce erosion and protect construction areas. Flood-proofing would include incorporating measures such as constructing, where practicable, utilities and supporting infrastructure of the Marine Terminal (i.e., trestle(s) and piping) above the floodplain, using waterproof compounds or other flood damage resistant techniques into the design and construction of the Marine Terminal. The geo-tubes, which are buried, sediment-filled sleeves of geotextile fabric, would be buried parallel to the shoreline to reduce the potential for erosion of the shore.

2.5.4.2 Interdependent Project Facilities

Without existing floodplain data for the majority of the Project area, a simplified approach was used to estimate the Project footprint near waterbodies. A 1,000-foot buffer was placed around waterbodies to provide estimates of potential floodplain encroachment. The actual floodplain area is dependent on the size of the waterbody, the size of the associated valleys, and/or the slopes of the waterbody and associated banks.

2.5.4.2.1 Pipelines

2.5.4.2.1.1 Mainline

With the exception of four proposed aerial crossings and five buried trenchless crossings, the Mainline would be buried in a trench constructed through waterbodies and their associated floodplains using an open-cut crossing. Temporary impacts on floodplains from the open-cut crossing would include the clearing of native vegetation, soil disturbance, potential surface and subsurface flow disruption, and potential changes in flow pathways. Backfilled trenches may be more easily eroded and have a higher potential for scour than surrounding soils and could capture overland flow. Compacted soils could also disrupt subsurface flows and cause water to pool behind the trench line.

The buried trenchless crossings would be expected to have less of an impact to floodplains than open-cut crossings since the pipeline would be tunneled under all, or a portion, of the floodplain. Aerial crossings would also be expected to have less of an impact as compared to open-cut crossings. However, in some cases, it may be necessary to construct support pilings within the floodplain.

Almost half of the Mainline waterbody crossings would be constructed during the winter, which would minimize impacts to vegetation and reduce soil disturbance and erosion. In many cases, the Mainline would also cross nearly perpendicular to the waterbody and floodplain, representing a relatively small linear disturbance. With properly implemented mitigation measures, including adherence to the Applicant's *Plan* and *Procedures*, it is anticipated that floodplain impacts from construction would be short-term and minor. Surface floodplain processes would be expected to return quickly to previous conditions post-construction. Subsurface flow would likely take longer to return to previous levels.

Most of the waterbodies and their associated floodplain that are crossed by the Mainline are relatively undisturbed. Floods, ranging from annual peak flows associated with spring melt or summer storm events are not uncommon and could impact construction sites. Inundation by riverine floodwaters can be intensified by the presence of aufeis or ice dams, particularly in the northern areas. Waterbodies that have high sediment loads and active floodplains can migrate during floods or overflow into secondary channels, thereby increasing the potential for damage. However, the probability of a major flood event occurring in any particular drainage during the short period of time that construction would occur is anticipated to be low.

2.5.4.2.1.2 PTTL

The PTTL would be constructed during the winter, which would minimize impacts to floodplain vegetation and reduce the potential for soil disturbance and erosion. The PTTL would be elevated on VSMs and all but three of the proposed waterbody crossings would be aerial crossings. The three non-aerial crossings would be of major rivers and the open-cut method would be used. With properly implemented mitigation measures, including adherence to the Applicant's *Plan* and *Procedures*, it is anticipated that floodplain impacts from construction of the PTTL would be short-term and minor.

2.5.4.2.1.3 PBTL

The PBTL is not within a NOAA-mapped floodplain. It was analyzed for historic peak flood elevations using the methods described for the GTP in Section 2.5.3.2. Based on the limited information available, the PBTL is unlikely to be inundated during most flood events. The PBTL would not cross any waterbodies and the construction of elevated VSMs would occur during winter, when flood risk is minimal. Floodplain impacts from construction would not be anticipated.

2.5.4.2.1.4 Pipeline Aboveground Facilities

The Pipeline Aboveground Facilities would be constructed on granular pads located adjacent to the pipeline ROW. Pad thickness would vary and depend on soil and permafrost conditions at each site. None of these permanent facilities would be located within areas delineated by FEMA. However, several facilities would likely be located in floodplain areas based on a review of aerial imagery:

- The Sagwon Compressor Station (MP 76) would be located within the 500-year floodplain of the Sagavanirktok River (see Appendix Q, Alaska LNG Pipeline – Floodplain Analysis Techniques). Approximately 24 acres of the construction footprint would be located within 1,000 feet of a waterbody:

- The Galbraith Lake Compressor Station (MP 147) would be located on an alluvial fan with two branches of a small stream running through the site. Approximately 23 acres of the construction footprint would be within 1,000 feet of a waterbody.

- Ten MLBVs would be located within 1,000 feet of a waterbody with a total area of approximately 3 acres of the construction footprint. Of those ten MLBVs, only two are located within the 500-year event floodplain (see Appendix P).

Potential long-term impacts of the site's location in the floodplain are discussed in the Section 2.5.5.

It is anticipated that construction related impacts would be similar to those previously described for the Mainline and would be short-term and minor. Spring and summer construction would occur during times of peak flow, which typically occurs due to spring snowmelt or summer storms. Construction BMPs would be implemented to minimize erosion and sedimentation from the site, including adherence to the Applicant's *Plan* and *Procedures*.

2.5.4.2.1.5 Pipeline Associated Infrastructure

Construction of access roads and material extraction sites is the only Pipeline Associated Infrastructure that would require the addition/removal of potentially significant amounts of fill within the floodplain. Although a portion of the Pipeline Associated Infrastructure would be located within areas with FEMA floodplain delineations, none of it would be located within the 500-year floodplain.

Some infrastructure would be located near the gauges analyzed for historic peak flows and may be within the floodplain. The approximate acreage of Pipeline Associated Infrastructure that would be located within 1,000 feet of a waterbody is provided in Table 2.5.4-1.

TABLE 2.5.4-1

Approximate Acres of Pipeline Associated Infrastructure Located within 1,000 feet of a Waterbody

Interdependent Project Facilities	Acreage within Waterbody Boundary
Mainline Pipeline, Aboveground Facilities and Associated Infrastructure	
Construction Access Roads	770.70
Ice Roads	221.18
Permanent Access Roads	150.72
Additional Temporary Workspaces (ATWS)	1,122.57
Material Sources	2,506.40
Off ROW Construction Camps	236.32
Compressor/Heater Stations	116.86
Facility Camps	11.51
Disposal Sites	160.05
Helipads	2.98
MLBV Pads	4.56
Pipe Storage Yards	192.95
Railroad Spurs	0.22
Railroad Workpads	0.84
Mainline Associated Infrastructure Total	***5,497.86***
PTTL Pipeline, Aboveground Facilities and Associated Infrastructure	
Ice Roads	107.02
Additional Temporary Workspaces (ATWS)	17.15
Construction Camps	0.27
Helipads	0.57
MLBV Pads	0.41
PTTL Associated Infrastructure Total	***125.42***

It is anticipated that the majority of the related impacts from construction of the Pipeline Associated Infrastructure would be similar to those previously described for the Mainline and would be short-term and minor. Spring and summer construction would occur during times of peak flow, which typically occurs due to spring snowmelt or summer storms. Construction BMPs would be implemented to minimize erosion and sedimentation from the site, including adherence to the Applicant's *Plan* and *Procedures*.

Potential long-term impacts from construction of the Pipeline Associated Infrastructure would be anticipated from abandoned access roads and material sites. Material sites are often located in floodplains to access granular material that has been sorted and washed by the river; however, a number of these sites may be in abandoned floodplains. It is anticipated that there could be significant local effects to floodplain processes, including disruption of local surface and subsurface flow patterns, ponding, increased erosion, diversion or capture of stream channels, and increased local erosion. Additional impacts could include local decreases in flood elevations due to reduced volume in the floodplain and creation of pond habitats if excavation sites refill with water.

The magnitude of the impact would be dependent on the relative size of the floodplain. Mitigation measures that would be implemented to minimize impacts would include minimizing the number of access roads constructed in floodplains, avoiding sensitive areas in floodplains, avoiding to the extent practicable access road construction near smaller streams and confined valleys, removing culverts, and making the road corridor as hydrologically permeable as possible prior to abandonment by cutting openings through the roadbed at locations of likely flow paths. To minimize potential floodplain impacts, a *Gravel Sourcing Plan and Reclamation Measures* (Resource Report No. 6, Appendix F) has been developed, which has incorporated these mitigation measures.

Winter ice roads would only result in a temporary impact and are not likely to impact floodplain processes unless they disrupt spring snowmelt flows before they melt. Granular roads could cause a variety of local impacts on floodplain processes including disruption of flow paths, increases in local flood elevations due to backwater effects and reduced floodplain volume, diversion or deflection of flows, input of sediment to streams, creation of backwaters or ponds, and channel constrictions. As with material sites, the magnitude of the impact would be dependent on the relative size of the floodplain. Possible mitigation measures include minimizing the number of access roads constructed in floodplains, avoiding sensitive areas in floodplains, avoiding to the extent practicable access road construction near smaller streams and confined valleys, removing culverts, notching ice roads, and making the road corridor as hydrologically permeable as possible prior to abandonment by cutting openings through the roadbed at locations of likely flow paths.

2.5.4.2.2 GTP

The GTP would not be located in a 500-year floodplain, a lake is adjacent to the GTP pad; however, it is not part of the floodplain and it is not anticipated that floodplain processes would be affected by construction or that the construction footprint would be prone to flooding. Stormwater would be managed according to North Slope stormwater management BMPs. Stormwater would not discharge directly into the nearby Putuligayuk River and would not be anticipated to affect peak flows.

2.5.4.2.2.1 GTP Associated Infrastructure

FEMA has not delineated any areas where the GTP Associated Infrastructure would be located. However, the West Dock causeway could be affected by a 100-year coastal flooding event. Construction of the GTP Associated Infrastructure would occur primarily during winter months to avoid impacts to tundra. With the exception of the West Dock facilities and the pump for the water reservoir, none of the GTP Associated Infrastructure would be located in floodplains. It is anticipated that potential impacts to the coastal and

Putuligayuk River floodplains would be minor and long-term, because these facilities would remain post-construction. Potential mitigation measures would include measures to reduce erosion and protect construction areas, including adherence to the Applicant's *Plan* and *Procedures*. Since West Dock is an existing marine facility, it is designed to withstand expected peak coastal flood events.

2.5.4.3 Non-Jurisdictional Facilities

The PTU Expansion project and PBU MGS project are located on Alaska North Slope CP within close proximity to the PBTL, PTTL, and GTP. The GTP and PBTL are located adjacent to the PBU MGS project, and the PTTL connects the area of the PTU Expansion project with the GTP. As described for the PBTL (Section 2.5.5.2.1.3) and PTTL (Section 2.5.5.2.1.2.), construction of these facilities would be in the winter time and therefore it is anticipated that any potential long-term floodplain impacts from construction of the PTU Expansion project and PBU MGS project would be minor. The majority of construction would occur during the winter when flood events do not typically occur. Stormwater would be managed according to North Slope stormwater management BMPs and permanent granular pads and roads would be designed to accommodate natural drainage patterns on the North Slope.

It is not anticipated that there would be any long-term impacts from floods or on floodplains as a result of construction of the Kenai Spur Highway relocation project. Stormwater be would discharged directly to Cook Inlet, it would not affect peak flows of nearby streams or rivers.

2.5.5 Potential Operational Impacts and Mitigation Measures for Floodplains

The presence of permanent, aboveground facilities could have similar impacts to floodplain processes as those described in Section 2.5.4 for Project construction (e.g., reduced flood storage capacity, reduced surface area for the infiltration of floodwaters, increased erosion). Naturally occurring floodplain processes could also have similar impacts to Project infrastructure (e.g., inundation and flooding of structures, damage to structures from aufeis/ice dams or shoreline ice), but the likelihood of occurrence would be higher over the operational lifetime (i.e., longer time period) of the Project.

Permanent infrastructure would be located outside of the 500-year floodplain, as practicable. In addition, the following general mitigation measures would be used to reduce the potential for impacts to floodplains from Project operations, as well as to protect the operational infrastructure and equipment:

- Account for floodplain processes (e.g., channel migration) in the design of waterbody crossings and facility locations;
- Permanent Pipeline Facilities have been located away from known floodplains. Site specific hydrogeological assessments will be conducted in further stages of project design; and
- If required, flood mitigations would be incorporated for facilities located in flood zones.

2.5.5.1 Liquefaction Facility

the site. It is not anticipated that there would be any long-term impacts from floods or on floodplains. Stormwater be would discharged directly to Cook Inlet, it would not affect peak flows of nearby streams or rivers.

Portions of the Marine Terminal would be located in a FEMA-delineated Zone VE flood hazard area with a base flood elevation of 23 to 31 feet (NAVD 88). Shallow surface sloughing along the slope faces should be expected for each slope configuration due to natural processes, and some form of mitigation or maintenance would be required over the life of the structures to arrest the natural processes. Near the Liquefaction Facility site, existing protection measures are in service and appear to be effective in reducing erosion. Exposed slopes could be protected from erosion by diverting surface runoff using berms or channels.

Mitigation measures would include building the facilities above the expected coastal flood elevations, using flood-proofing techniques for facilities in the coastal floodplain, and armoring the shoreline to protect from erosion. Where erosion due to wind or water is a concern, the slopes could be protected with shotcrete, asphalt, soil cement slurry, geocells, gabions, Reno mattresses, sheetpile, riprap or a layer of geomat in addition to diverting the surface water. It is not anticipated that the Marine Terminal would increase flooding and impacts to the coastal floodplain would be long-term but minor.

2.5.5.2 Interdependent Project Facilities

2.5.5.2.1 Pipelines

2.5.5.2.1.1 Mainline

It is anticipated that any potential, long-term floodplain impacts from operation of the Mainline would be minor, since the Mainline would primarily be buried underneath the floodplain. Flood elevations and floodplain extents would not be affected by operation of the buried pipeline. In very limited situations, frost bulbs could occur where groundwater or a stream flowing over the chilled pipeline could freeze, creating a raised obstruction to surface flow in an area along the pipeline. This is addressed more fully in Resource Report No. 7, but would also be minimized through investigations along the pipeline route to determine areas susceptible to frost bulb formation and design pipeline burial depths to address the potential risk.

Although the Mainline would be buried, waterbodies tend to move over time, particularly in high sediment load systems. An initial geomorphic assessment identified some of the areas along the Mainline ROW that could be affected by channel migration, erosion, or scour, potentially exposing the buried pipeline (Appendix P, *Alaska LNG Pipeline – Floodplain Analysis Techniques*). Proposed mitigation measures would include adjusting crossing plans to accommodate channel migration and potentially burying the pipe at a deeper depth in areas of possible channel migration. In addition, routine inspections of the ROW would be conducted to identify any areas of exposed pipe during operations.

2.5.5.2.1.2 PTTL

It is anticipated that any potential long-term floodplain impacts from operation of the PTTL would be minor. With the exception of three open-cut river crossings, the PTTL would be elevated above the floodplain. Flood elevations and floodplain extents would not be affected by the suspended pipeline and the VSMs would not be of enough volume to materially affect flood elevations or extent. The buried portion of the PTTL could be subject to channel migration, similar to the Mainline. In addition, channel migration or scour over the lifetime of the Project could expose and erode VSM foundations, destabilizing the VSM at that location. Proposed mitigation measures would include placing the VSMs outside of channel migration zones to the extent practicable and monitoring for potential scour around VSMs foundations during operations.

2.5.5.2.1.3 PBTL

The PBTL is not located within a NOAA-mapped floodplain, therefore, it is not anticipated that there would be any long-term impacts from floods or on floodplains in the PBTL operational area. The PBTL would be unlikely to be inundated during most flood events. The PBTL would be elevated above the ground surface. Flood elevations and floodplain extents (if found present) would not be affected by the suspended pipeline and the VSMs would not be of enough volume to affect flood elevations or extent.

2.5.5.2.1.4 Pipeline Aboveground Facilities

None of the permanent Pipeline Aboveground Facilities would be located within areas delineated by FEMA. As indicated in Section 2.5.4.2, the Sagwon Compressor Station (MP 76), and Galbraith Lake Compressor Station (MP 147)could be located in floodplains. Of the stations potentially located in floodplains:

- The Sagwon Compressor Station is located along the dynamic Sagavanirktok River, and could be subject to both channel migration and flooding over the lifespan of the Project;
- The Galbraith Lake Compressor Station would be located on an alluvial fan and could be subject to minor flooding or debris flows; and

The remaining compressor and heater station are not likely to be in the 500-year floodplain based on a review of aerial photography. Of the 30 total MLBVs, 2 would be potential located within 500-year floodplain. In total, approximately 50 acres of the operational footprint of the Pipeline Aboveground Facilities would be located within 500-year event floodplain.

Potential mitigation measures for facilities that could be impacted by flooding would include elevating the station, providing flood proofing, installing culverts, and/or placement of berms or flow deflecting structures. Additional fieldwork and/or studies would be conducted to determine appropriate flood protection.

It is anticipated that any potential long-term impacts from Pipeline Aboveground Facilities on floodplains would be minor due to the small footprint of the facilities relative to the floodplain. In addition, the facilities would be located in remote areas where there has been little development or impacts on floodplains. None of the facilities would be expected to significantly impact flood elevations or extents.

2.5.5.2.2 GTP

As described in Section 2.5.4.2, the GTP would not be located in a floodplain and no streams cross the site. It is not anticipated that there would be any long-term impacts from floods or on floodplains. Stormwater would be managed according to North Slope stormwater management BMPs. Stormwater runoff from the GTP pad would not flow directly into the nearby Putuligayuk River and is not anticipated to affect the peak flows of the river.

2.5.5.3 Non-Jurisdictional Facilities

The civil design of the PTU Expansion project and PBU MGS project would incorporate the drainage patterns present on the North Slope and the hydrologic requirements of spring break-up. Stormwater would be managed according to North Slope stormwater management BMPs.

It is not anticipated that there would be any long-term impacts from floods or on floodplains as a result of the Kenai Spur Highway relocation project. Stormwater be would discharged directly to Cook Inlet, it would not affect peak flows of nearby streams or rivers.

2.6 REQUESTED MODIFICATIONS TO FERC'S PROCEDURES

The following tables outline the requested modification to accommodate the Alaska-specific conditions that would be encountered during construction of this Project.

TABLE 2.6-1

Requested Alternative Measures from the 2013 FERC Procedures for Construction and Operation of the Independent Facilities

Section No.	FERC Procedures (May 2013)	Alaska LNG's Proposed Measure	Justification
IV.A.1. d	All equipment is parked overnight and/or fueled at least 100 feet from a waterbody or in an upland area at least 100 feet from a wetland boundary. These activities can occur closer only if the Environmental Inspector determines that there is no reasonable alternative, and the Project sponsor and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.	All equipment is parked overnight and/or fueled at least 100 feet from a waterbody or in an upland area at least 100 feet from a wetland boundary. These activities can occur closer only if the Applicant and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.	Given the pervasiveness of wetlands of varying types along the route, there will be hundreds of locations where there will be no reasonable alternative to refueling (within the construction ROW) within 100 feet of a waterbody or wetlands.
V	WATERBODY CROSSINGS		
V.B.2.a	Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land.	Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. In areas where it is determined that no reasonable alternative exists, additional temporary work space may be located in or within 50 feet of a waterbody.	Refer to justifications provided in Table 2 Proposed Modification to the FERC Staff's Procedures Section V.B.2.a and VI.B.1.a.
V.B.5.e	Remove temporary equipment bridges as soon as practicable after permanent seeding.	Remove temporary equipment bridges as soon as practicable after restoration is complete.	Provides improved clarity and flexibility to address potential delays in the removal of temporary bridges due to limited existing infrastructure, weather conditions, or impassible terrain. The revised wording reflects the remoteness of many of the water crossing sites, the difficulty in accessing these sites and right-of-way areas beyond the water crossing and other issues. For example, the need to maintain a crossing structure may be controlled by construction and/or restoration activities taking place on a pipeline section at some distance from the crossing structure.

TABLE 2.6-1

Requested Alternative Measures from the 2013 FERC Procedures for Construction and Operation of the Independent Facilities

Section No.	FERC Procedures (May 2013)	Alaska LNG's Proposed Measure	Justification
VI	WETLAND CROSSINGS		
VI A.3	Limit the width of the construction right-of-way to 75 feet or less. Prior written approval of the Director is required where topographic conditions or soil limitations require that the construction right-of-way width within the boundaries of a federally delineated wetland be expanded beyond 75 feet. Early in the planning process the Project sponsor is encouraged to identify site-specific areas where excessively wide trenches could occur and/or where spoil piles could be difficult to maintain because existing soils lack adequate unconfined compressive strength.	Limit the width of the construction right-of-way to 110 feet or less. Prior written approval of the Director is required where topographic conditions or soil limitations, safety, construction efficiency, and logistics practicability require that the construction right-of-way width within the boundaries of a federally delineated wetland be expanded beyond 110 feet. Early in the planning process the Project is encouraged to identify site-specific areas where excessively wide trenches could occur and/or where spoil piles could be difficult to maintain because existing soils lack adequate unconfined compressive strength.	Refer to justifications provided in Section 2.6.1
VI.B.1. a	Locate all ATWS' (such as staging areas and additional spoil storage areas) at least 50 feet away from wetland boundaries, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land	Locate all ATWSs (such as staging areas and additional spoil storage areas) at least 50 feet away from wetland boundaries, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. In areas with long stretches of contiguous wetlands where it is determined that no reasonable alternative exists, ATWS may be located in or within 50 feet of a wetland.	Refer to justifications provided in Section 2.6.2
VI.B.1.c	The construction right-of-way may be used for access when the wetland soil is firm enough to avoid rutting or the construction right- of-way has been appropriately stabilized to avoid rutting (e.g., with timber riprap, prefabricated equipment mats, or terra mats). In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall use access roads located in upland areas. Where access roads in upland areas do not provide reasonable access, limit all other construction equipment to one pass through the wetland using the construction right-of-way.	The construction right-of-way may be used for access when the wetland soil is firm enough to avoid rutting or the construction right- of-way has been appropriately stabilized to avoid rutting (e.g., with timber riprap, prefabricated equipment mats, or terra mats). In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall use access roads located in wetland soils that are stable (i.e., can support equipment without soil mixing) or upland areas. Where access roads in stable wetlands or upland areas do not provide reasonable access, limit all other construction equipment to one pass through	Revised wording provided to reflect logistical and operational constraints of working in a predominantly wetland environment.

TABLE 2.6-1

Requested Alternative Measures from the 2013 FERC Procedures for Construction and Operation of the Independent Facilities

Section No.	**FERC Procedures (May 2013)**	**Alaska LNG's Proposed Measure**	**Justification**
		the wetland using the construction right-of-way, where practical.	
VI.B.1. d	The only access roads, other than the construction right-of-way, that can be used in wetlands are those existing roads that can be used with no modifications or improvements, other than routine repair, and no impact on the wetland.	Use existing access roads where possible. The Applicant would request approval by the USACE for the construction of new roads or modification of existing roads in wetlands.	Given the pervasiveness of wetlands of varying types along the route, and the lack of existing road infrastructure given the remoteness of much of the pipeline route, it is not practical to limit access to the construction right-of-way and to existing roads. New access to the right-of-way, across some wetlands will be required.
VI.B.2. e	Limit construction equipment operating in wetland areas to that needed to clear the construction right-of-way, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction right-of-way.	Limit construction equipment operating in wetland areas that will be crossed using ROW construction mode 3 (summer matted wetlands) to that needed to clear the construction right-of-way, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction right-of-way.	Given the pervasiveness of wetlands of differing type along the Project route in Alaska, additional clarity is provided to describe the basis for limiting equipment operation in areas of saturated soils or standing water.
VI.B.2. f	Cut vegetation just above ground level, leaving existing root systems in place, and remove it from the wetland for disposal. The Project sponsor can burn woody debris in wetlands, if approved by the COE and in accordance with state and local regulations, ensuring that all remaining woody debris is removed for disposal.	Cut vegetation just above ground level, grind stumps to achieve a trafficable working surface, leaving existing root systems in place, and remove it from the wetland for disposal. The Applicant can burn woody debris in wetlands, if approved by the USACE and in accordance with state and local regulations, ensuring that all remaining woody debris is removed for disposal.	Improves clarity on construction procedures that would allow for safe use of a work surface by equipment and vehicles.
VI.B.2. g	Limit pulling of tree stumps and grading activities to directly over the trenchline. Do not grade or remove stumps or root systems from the rest of the construction right-of-way in wetlands unless the Chief Inspector and Environmental Inspector determine that safety-related construction constraints require grading or the removal of tree stumps from under the working side of the construction right-of-way.	Limit pulling of tree stumps to directly over the trenchline and the spoil side where grading is performed. Do not grade or remove stumps or root systems from the rest of the construction right-of-way in wetlands unless the Chief Inspector and Environmental Inspector determine that safety-related construction constraints require grading or the removal of tree stumps from under the working side of the construction right-of-way.	Wetlands with cross slopes require grading to build a flat, working surface that provides safe access by equipment and vehicles.
VI.B.2.h	Segregate the top 1 foot of topsoil from the area disturbed by trenching, except in areas where	Segregate approximately the top 1 foot of organic material from the area disturbed by grading (trench	Changed reference from topsoil to organic material to reflect the varying depth of topsoil throughout

TABLE 2.6-1

Requested Alternative Measures from the 2013 FERC Procedures for Construction and Operation of the Independent Facilities

Section No.	FERC Procedures (May 2013)	Alaska LNG's Proposed Measure	Justification
	standing water is present or soils are saturated. Immediately after backfilling is complete, restore the segregated topsoil to its original location.	and spoil side), except in areas where standing water is present or soils are saturated or frozen or where the ditch is opened by "Drill & Shoot". Immediately after backfilling is complete, restore the segregated organic material back to the trench.	the Project area. The depth of 1 foot reflects the practical minimum depth of organic material that can be segregated. Additional notes added to reflect the conditions under which it is technically infeasible, due to location conditions, to segregate organic material e.g. inundated wetlands, frozen ground (winter construction) or 'drill and shoot' is required to open the trench. See Section 2.6.3 for additional justification
VI.B.2. i	Do not use rock, soil imported from outside the wetland, tree stumps, or brush riprap to support equipment on the construction right-of-way.	Do not use tree stumps, or brush riprap to support equipment on the construction ROW. Gravel fill work pads may be used to provide safe working conditions for equipment and personnel and minimize disturbance to the underlying permafrost and thaw-sensitive soil regime.	Project may, where necessary, use locally sourced granular fill to minimize disturbance to underlying permafrost and thaw sensitive soils, and provide safe working conditions in sloping terrain conditions in the season of construction (slopes >5% grade in winter and any slope in summer where permafrost or thaw sensitive soil is found in the subsurface.
VI.B.2. j	If standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the topsoil and subsoil in wetlands, use low-ground-weight construction equipment, or operate normal equipment on timber riprap, prefabricated equipment mats, or terra mats.	If standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the organic material and subsoil in wetlands, use low-ground-weight construction equipment, or operate normal equipment on timber riprap, prefabricated equipment mats, or terra mats. Soil fill or rock riprap may be used to stabilize the ROW where authorized as permanent fill by the USACE for jurisdictional wetlands. Frost-packing may be used during winter construction in thaw-stable permafrost and non-permafrost areas.	Ground freezing (frost packing) is a principal means of improving ground support for construction equipment. Project may, where necessary, use imported granular fill to construct a safe work pad and access within wetland areas.
VI.B.2. k	Remove all project-related material used to support equipment on the construction right-of-way upon completion of construction.	Remove all project-related material used to support equipment on the construction right-of-way upon completion of construction except where permanent fill is authorized by the USACE for jurisdictional wetlands.	Added provision to allow continued access by equipment needed for post-construction restoration over long-term restoration timeframes in arctic/sub-arctic regions. Material to support equipment is proposed to remain in place to prevent further disturbance, subject to USACE authorization.

TABLE 2.6-1

Requested Alternative Measures from the 2013 FERC Procedures for Construction and Operation of the Independent Facilities

Section No.	FERC Procedures (May 2013)	Alaska LNG's Proposed Measure	Justification
VI.B.3	Install sediment barriers (as defined in section IV.F.3.a of the Plan) immediately after initial disturbance of the wetland or adjacent upland.	Install sediment barriers as defined in section IV.F.3.a of the Applicant's Plan immediately after initial disturbance of the wetland or adjacent upland in summer or in winter prior to the spring snow melt.	Clarifies that temporary sediment barriers would be installed in advance of spring breakup and snowmelt. Refer also to the Winter & Permafrost Construction Plan in Resource Report No, 1, Appendix M.
VI.C.7	Ensure that all disturbed areas successfully revegetate with wetland herbaceous and/or woody plant species.	Ensure that all disturbed areas successfully revegetate with wetland herbaceous and/or woody plant species except where surface stabilization measures or native conditions preclude revegetation such as on slopes covered with wood chips to control permafrost degradation or exposed bedrock.	The revised text is intended to reflect the application of the Applicant's Plan (Appendix D in Resource Report No. 7(Best Management Practices in Resource Report No. 2, Appendix J SWPPP.
VI.C.8	Remove temporary sediment barriers located at the boundary between wetland and adjacent upland areas after revegetation and stabilization of adjacent upland areas are judged to be successful as specified in section VII.A.4 of the Plan.	Remove temporary synthetic sediment barriers located at the boundary between wetland and adjacent upland areas after initial revegetation and/or stabilization of adjacent upland areas are judged to be successful as specified in the Alaska LNG Restoration Plan.	Clarifies that organic based sediment barriers may be left in place. Synthetic barriers would be removed. Clarifies that stabilization may not include revegetation. Removed section callout to refer to the Project Restoration Plan (See Resource Report No. 3, Appendix P).

2.6.1 Construction ROW Width Greater than 75 feet in Wetlands

The rationale and details for selection of the construction ROW widths is presented in the Resource Report No. 1 in the following sections and related appendices:

- 1.5.2.3.1.1.1 Construction Spreads and Seasons;
- 1.5.2.3.1.1.2 ROW Construction Modes;
- 1.5.2.3.1.1.3 Selection of the ROW Construction Mode;
- 1.5.2.3.1.1.4 Selection of the ROW Width;
- *Rationale for the Selection of Pipeline ROW Width* (Resource Report No. 1, Appendix G); and
- *Winter and Permafrost Construction Plan* (Resource Report No. 1, Appendix M).

The Applicant considered multiple factors to select the most appropriate construction season, ROW mode, and associated construction ROW width, including the following:

- Health and safety of workers is more at risk during the dark, cold, and snowy winter conditions;
- Steep terrain is preferentially deemed summer construction for operational safety of heavy equipment on steep slopes as well as safer footing for workers on the ground;
- Non-permafrost wetland environments preferentially deemed winter construction when the wetland can support heavy equipment traffic and pipe lower-in loads while frozen;
- Costs of equipment operation and maintenance are significantly higher in winter months;
- Worker and equipment productivity and efficiency is significantly lower in winter months;
- Thaw-unstable permafrost, flat terrain, and water availability allow construction of Ice Work Pad Mode in winter;
- Thaw-unstable permafrost, rolling terrain or flat terrain lacking sufficient water sources dictate use of Granular Work Pad Mode in either winter or summer;
- ROW accessibility from the road system;
- Season length (winter or summer); and
- Balancing total schedule between summer and winter to best utilize resources, to optimize linear construction and minimize spread moves, and to provide continuity of employment for personnel.

The ROW Modes considered viable for the Project include:

- Ice work pads over permafrost in flat terrain with ample, permittable water sources on the Arctic Coastal Plain;
- Frost-packed work pads over permafrost and over non-permafrost wetlands constructed during winter;
- Conventional grading in thaw-stable permafrost and non-permafrost. Drill and shoot grading as needed with conventional earth moving equipment would be used to create a level work pad by cut and fill;
- Granular work pads over thaw-sensitive permafrost terrain and over thaw-stable soils with a thick organic layer to create a stable work surface; and
- Matting for short, isolated and saturated wetlands to provide a stable work surface.

The *Winter and Permafrost Construction Plan* (Resource Report No. 1, Appendix M) was prepared to fulfill the requirements of FERC's Procedures and Plan (May 2013 version). Because of the Project's unique crossing of hundreds of miles of permafrost terrain in both summer and winter, the Winter Construction Plan is combined with a description of methods used to cross Permafrost terrain in both summer and winter. Most permafrost terrain is classified as wetlands, so this report also addresses the Project-specific exceptions needed to meet the requirements of Section VI of the FERC Wetland and Waterbody Construction and Mitigation Procedures

ROW access was also a key consideration in determining ROW widths. Much of the pipeline route is parallel to and reasonably close to existing primary highways. However, there a very few existing access roads crossing the ROW centerline and some significant long pipeline sections that are remote and require special access to and along the ROW. This resulted in increased ROW widths needed to travel and bypass lines as detailed in the *Winter and Permafrost Construction Plan*.

As discussed in Section 2.4.2.5, large wetland complexes that would be crossed by the Project. Due to the abundance of water in Alaska and the corresponding abundance of wetlands, numerous wetlands complexes would be crossed by the Project. The construction procedures and required construction ROW width within wetlands were determined based on the construction season and other ROW mode criteria summarized above. Information on locations where the proposed ROW width would be greater than 75 feet within wetlands is provided in Table 2.6.1-1.

TABLE 2.6.1-1

Proposed Construction Right-of-Way Modes that are Greater than 75 feet wide in a Wetland

ROW Mode Description [a, b]	NWI Classification [d]	Justification
01 Ice Work Pad	PEM, PSS	The width required for ROW Mode 01 is 145 feet. This includes a minimum width of 110 feet, as described in the *Rationale for the Selection of Pipeline ROW Width* (Resource Report No. 1, Appendix G) and additional width for

TABLE 2.6.1-1

Proposed Construction Right-of-Way Modes that are Greater than 75 feet wide in a Wetland

ROW Mode Description [a, b]	NWI Classification [d]	Justification
		travel lanes (20 feet) and bypass lanes (15 feet). Travel and bypass lanes would be required for this ROW Mode because of the absence of existing access roads from MP 0-56.8, and to optimize construction efficiency to minimize disturbance to one winter construction season. ROW Mode 1 was developed for use during winter construction on the Arctic Coastal Plain, which is almost entirely covered by wetlands with a shallow, active (seasonally thawed) soil layer and underlain by thaw-unstable ice rich permafrost soils. To minimize impacts to the tundra and permafrost, the Project team would take advantage of three conditions that make ice work pads feasible: flat terrain; long winters with subzero temperatures; and abundant fresh water and ice. Once completed, the ice pad can support heavy loads and pipeline construction equipment without damage to the underlying vegetation and soil. The process to construct ice roads and pads is well established and endorsed by the state, local and federal land management agencies. Application of this ROW mode during winter confines the area of tundra (wetland) disturbance to the trenchline, thereby providing a level of mitigation comparable to a 75-foot ROW width.
02 Frost Packing	PEM, PSS, PFO	The width required for ROW Mode 02 is 110 feet as described in the *Rationale for the Selection of Pipeline ROW Width* (Resource Report No. 1, Appendix G). Additional ROW width would be required for travel (20 feet) and bypass (15 feet) lanes, by exception, for long sections of ROW without access roads to provide safe ingress/egress to the work and spoil areas. ROW Mode 2 was developed for use in winter construction on flatter terrain with soils that may not have the strength to support construction equipment without rutting or soil mixing. Once completed, the frost packed ROW can support heavy loads and pipeline construction equipment without significant damage to the underlying vegetation or mixing of the surface organics and sub-soils. Frost packing is most suitable on terrain underlain by either non-permafrost soils or thaw stable permafrost soils (i.e., soils with low segregated or massive ice content). The technique is also limited to flatter terrain because it is not safe to operate equipment on sloping ground that is frozen. The application of this ROW mode during winter minimizes disturbance to the underlying vegetation mat, and associated surface organic soils adjacent to the trenchline, providing a level of mitigation comparable to a 75-foot ROW width.
03 Summer Wetland (Matted Organics)	PEM, PSS, PFO	The width required for ROW Mode 03 is 110 feet as described in the *Rationale for the Selection of Pipeline ROW Width* (Resource Report No. 1, Appendix G). No travel or bypass lanes are envisaged for this ROW Mode. ROW Mode 3 was developed for summer construction across wetlands that cannot support equipment without rutting, which causes surface organics and subsurface soil mixing. To cross inundated wetlands, mats are planned to be placed on the surface to support equipment and materials. Mats help to distribute loads across a wide surface and minimize compaction of the underlying vegetation and soils. Mats can be made from a variety of materials but are typically hardwood timber. If available, locally sourced logs from the ROW might be used to build a "corduroy" pad. Typical wetlands that would be crossed by the Project using this technique include wetlands that are characterized by flooding or inundation on a

TABLE 2.6.1-1

Proposed Construction Right-of-Way Modes that are Greater than 75 feet wide in a Wetland

ROW Mode Description [a, b]	NWI Classification [d]	Justification
		seasonally, semi-permanent, or permanent basis. Using mats would provide a level of mitigation comparable to a 75-foot ROW width.
04 Granular Work Pad	PEM, PSS, PFO	The width required for ROW Mode 04 is 110 feet as described in the *Rationale for the Selection of Pipeline ROW Width* (Resource Report No. 1, Appendix G). Additional ROW width would be required for travel (20 feet) and bypass (15 feet) lanes, by exception, for long sections of ROW without access roads to provide safe ingress/egress to the work and spoil areas. ROW Mode 4 was developed for flat or sloping terrain that is underlain by fine-grained thaw unstable permafrost or by thaw stable permafrost with a thick organic mat. It may be used in summer or winter. Several construction ROW modes were considered for fine-grained, thaw-sensitive permafrost terrain. However, since disturbance of vegetation covering fine-grained thaw sensitive permafrost usually causes thermal degradation and thaw settlement, most alternate modes were eliminated. ROW Mode 4 serves to minimize disturbance to the structural integrity of the vegetative layer that protects fine-grained thaw-unstable or thaw stable permafrost from thermal exposure. This ROW mode is required to address unique local Alaska conditions in the form of fine grained thaw-unstable or thaw stable permafrost that is crossed extensively by the Project. Granular work pads would achieve a level of mitigation of impacts to fine-grained thaw-unstable or thaw stable permafrost, compared to a 75-foot ROW width.
05A Graded	PEM, PSS, PFO	The width required for ROW Mode 05 is 110 feet as described in the *Rationale for the Selection of Pipeline ROW Width* (Resource Report No. 1, Appendix G). Additional ROW width would be required for travel (20 feet) and bypass (15 feet) lanes, by exception, for long sections of ROW without access roads to provide safe ingress/egress to the work and spoil areas. ROW Mode 5A may be used in both the winter and summer seasons and was developed for flat or sloping terrain, which is underlain by thaw stable permafrost and non-permafrost soils. This ROW mode is typical for non-Arctic regions but would be used in all spreads where these soils conditions are found, unless the organic mat is too thick for efficient removal and replacement. In those cases, frost packing (ROW Mode 2) or a thin structural granular work pad (ROW Mode 4) would be considered. ROW Mode 5A would be used across wetlands that are drier and more stable than those wetlands discussed in ROW Mode 3. When used in flat wetlands during the summer, thin surface organics would be stripped to an approximate depth of one foot across the full ROW and stockpiled to the sides of the ROW. When used in sloping wetlands during the summer, thin surface organics would be stripped to an approximate depth of 1 foot from the trench and spoil area only and stockpiled upslope. Organics segregation and re-use for ROW restoration employed for ROW Mode 5A during summer construction provides a level of mitigation comparable to a 75-foot ROW width.
06 PTTL (Ice Work Pad)	PEM, PSS	The ROW width for construction would be 80 feet. Additional ROW width would be required for travel (20 feet), by exception, for long sections of ROW without access roads to provide safe ingress/egress to the work and spoil areas.

TABLE 2.6.1-1

Proposed Construction Right-of-Way Modes that are Greater than 75 feet wide in a Wetland

ROW Mode Description [a, b]	NWI Classification [d]	Justification
		ROW Mode 6 was developed for use in winter on the Arctic Coastal Plain for the PTTL. The PTTL pipeline would be constructed "aboveground" and placed on VSMs (except for a few stream crossings). The PTTL runs perpendicular to the hydrologic gradient and is smaller in diameter than the Mainline. Like ROW Mode 1, ice roads and pads would be used to minimize impacts to the tundra and permafrost. Application of this ROW mode during winter confines the area of tundra (wetland) disturbance to the trenchline for the buried stream crossings, and diameter of the VSMs thereby minimizing disruption of the protective thermal layer to the underlying permafrost. Construction during the winter and using ice roads to support equipment provides for a level of mitigation comparable to a 75-foot ROW width.

Notes:

[a] Proposed Construction ROW Modes for wetland crossings are based on a 42-inch pipeline for Mainline Route Rev. C. Wetland crossing methods would be assessed and sized appropriately to account for terrain, soil conditions, site configuration, site-specific construction method, and construction season.

[a] ROW Mode Description is described fully in Resource Report 1, Appendix G.

[b] Starting milepost (MP) is for demonstration purposes and does not represent a contiguous length of the affected wetlands crossed by the Project.

[c] NWI Wetland Classification System as defined in Cowardin et al. (1979): PEM - Palustrine Emergent; PSS - Palustrine Scrub-Shrub; and PFO - Palustrine Forested, which may be Temporarily, Seasonally or Semi-permanently flooded or saturated.

A detailed table of wetland crossed by MPs and the associated ROW modes is provided as an Appendix E, Table 2 summary of by spread is provided in Table 2.6.1-2 below that includes number of existing access roads crossing the ROW in each spread.

TABLE 2.6.1-2

Summary of Wetlands Crossed by Construction Spread

Spread	Crossing Mode Description	ROW Mode No.	Length Crossed (mi)	Wetlands Crossed (mi)	Thaw Unstable Permafrost (mi) [a]	Slope >2% (mi) [b]	Winter Spread (mi)	Summer Spread (mi)	Existing Access Roads [c]
1	Ice Work Pad	1	56.57	53.39	56.57	1.37	56.57	0.00	1
	Frost Work Pad	2	0.74	0.73	0.73	0.58	0.75	0.02	0
	Matted Work Pad	3	0.05	0.00	0.04	0.00	0.00	0.05	0
	Granular Work Pad	4	123.49	109.95	118.87	63.87	49.95	73.54	6
	Grade Work Pad	5A	24.98	8.10	4.60	17.79	11.08	13.88	6
	Mountain Grade	5B	0.00	0.00	0.00	0.00	0.00	0.00	0
	Ice Bridge	16	1.73	0.64	1.10	1.01	1.33	0.00	0

TABLE 2.6.1-2

Summary of Wetlands Crossed by Construction Spread

Spread	Crossing Mode Description	ROW Mode No.	Length Crossed (mi)	Wetlands Crossed (mi)	Thaw Unstable Permafrost (mi) [a]	Slope >2% (mi) [b]	Winter Spread (mi)	Summer Spread (mi)	Existing Access Roads [c]
	Bridge	17	1.33	0.75	0.54	1.07	0.01	1.72	1
Spread Section 1 Subtotal			***208.89***	***173.56***	***182.45***	***85.68***	***119.69***	***89.21***	***14***
2	Ice Work Pad	1	0.00	0.00	0.00	0.00	0.00	0.00	0
	Frost Work Pad	2	2.04	1.25	0.00	0.59	1.97	0.07	0
	Matted Work Pad	3	0.01	0.01	0.00	0.00	0.00	0.01	0
	Granular Work Pad	4	139.53	83.00	137.10	93.53	45.46	94.07	18
	Grade Work Pad	5A	46.21	15.25	13.15	33.35	5.06	41.15	6
	Mountain Grade	5B	0.47	0.00	0.00	0.47	0.00	0.47	0
	Ice Bridge	16	1.89	0.49	1.22	0.63	1.55	0.12	0
	Bridge	17	1.68	0.92	0.82	0.71	0.01	1.88	0
Spread Section 2 Subtotal			***191.83***	***100.92***	***152.28***	***129.28***	***54.05***	***137.77***	***24***
3	Ice Work Pad	1	0.00	0.00	0.00	0.00	0.00	0.00	0
	Frost Work Pad	2	49.27	29.22	40.29	13.77	49.27	0.00	4
	Matted Work Pad	3	0.20	0.18	0.18	0.17	0.00	0.20	0
	Granular Work Pad	4	27.16	12.89	21.38	11.42	18.79	8.36	1
	Grade Work Pad	5A	126.17	26.91	22.71	68.91	49.40	76.77	9
	Mountain Grade	5B	0.94	0.00	0.00	0.94	0.00	0.94	0
	Ice Bridge	16	1.45	0.25	0.11	0.88	1.45	0.00	0
	Bridge	17	1.45	0.26	0.95	0.81	0.00	1.45	0
Spread Section 3 Subtotal			***206.64***	***69.71***	***85.61***	***96.90***	***118.91***	***87.72***	***14***
4	Ice Work Pad	1	0.00	0.00	0.00	0.00	0.00	0.00	0
	Frost Work Pad	2	17.35	8.92	10.72	2.61	17.32	0.02	0
	Matted Work Pad	3	0.30	0.29	0.24	0.00	0.00	0.30	0
	Granular Work Pad	4	1.27	1.22	1.27	0.09	0.94	0.32	0
	Grade Work Pad	5A	149.89	16.68	64.74	90.37	91.45	58.44	2
	Mountain Grade	5B	0.86	0.00	0.00	0.38	0.86	0.00	0
	Ice Bridge	16	1.21	0.34	0.41	0.52	1.08	0.02	0
	Bridge	17	1.10	0.19	0.99	0.32	0.47	0.74	0
Spread Section 4 Subtotal			***171.96***	***27.64***	***78.37***	***94.30***	***112.12***	***59.84***	***2***

TABLE 2.6.1-2

Summary of Wetlands Crossed by Construction Spread

Spread	Crossing Mode Description	ROW Mode No.	Length Crossed (mi)	Wetlands Crossed (mi)	Thaw Unstable Permafrost (mi) [a]	Slope >2% (mi) [b]	Winter Spread (mi)	Summer Spread (mi)	Existing Access Roads [c]
		Spread Totals	**779.32**	**371.83**	**498.71**	**406.16**	**404.77**	**374.56**	**54**

Notes:

[a] Length of thaw unstable permafrost located within Mainline construction ROW.

[b] Cross slope is defined by Worley-Parsons Geomatic Slope Calculator. Level = less than 2%; Gentle = ≥ 2% to < 10%; Steep ≥ 10% to < 50%; and Very Steep = ≥ 50%. Simplified slope classes contain both - / + slopes.

[c] Number of existing access roads that cross Mainline construction ROW by spread.

2.6.2 Additional Temporary Workspace (ATWS) within 50 feet of Wetlands and Waterbodies

Additional temporary workspaces (ATWS) would be located at least 50 feet away from wetland and waterbody boundary, topographic and other site-specific conditions permitting. As discussed in Section 2.6.1, wetlands and waterbodies are abundant within the Project footprint, locating all proposed ATWS at least 50 feet away from wetlands and waterbodies is technically infeasible due to site-specific conditions. Where conditions do not permit a 50-foot setback along the pipeline, modification to the FERC *Procedures* would be requested. The measures defined in the Applicant's *Procedures* (see Appendix N) would be implemented to ensure wetlands and waterbodies are adequately protected. Table 2.6.1-2 specifies the justifications required by FERC for proposed ATWS located in or within a 50-foot wetland and waterbody boundary.

TABLE 2.6.2-1

Proposed Additional Temporary Workspaces Located in or within 50 feet of a Wetland or Waterbody [a]

ATWS Description [b]	Number of ATWS [c]	Nominal Dimension (feet) [d]	ATWS Total Acreage [e]	Justification [f]
WATERBODY CROSSINGS (Open Cut)	1997	320-340 x 35-50 (work side) 110-130 x 40-50	295.44	For dry ditching crossing methods (i.e., dam and pump, flume, and channel diversion), additional workspace is required for containment berms for wet spoil stockpile due to extra depth of the trenched ditch and wide width (high bank to high bank relative to the watercourse), vehicle crossing, stringing and staging prefabricated pipe, and tie-in bell holes.
BURIED TRENCHLESS CROSSINGS (i.e., Horizontal Directional Drilling or Directional Micro-tunneling)	26	200 x 250	6.43	Buried trenchless crossings requiring additional workspace for entry and exit locations for drilling, pipe string, and trenchless equipment (e.g., generators, water pump, drilling mud tanks, cutting settlement tanks, side booms, testing equipment, etc.).

TABLE 2.6.2-1

Proposed Additional Temporary Workspaces Located in or within 50 feet of a Wetland or Waterbody [a]

ATWS Description [b]	Number of ATWS [c]	Nominal Dimension (feet) [d]	ATWS Total Acreage [e]	Justification [f]
FALSE ROW (For Pull Back)	16	100 x "L" *where "L" is length of crossing*	1.95	Additional temporary workspace required for pipeline drag and pull back sections for waterbody and bored road crossings.
ROAD CROSSINGS	246	80-180 x 35-50 360-500 x 35-50 (work side)	47.58	For open cut and bored road crossings, additional workspace is required for spoil storage due to depth of the trenched ditch at each crossing, pipe string and assembling areas, insertion of the pipe, and transition bends and tie-in bell holes.
RAILROAD CROSSING	8	180 x 35 180 x 35 (work side)	1.28	Additional workspace for spoil storage due to extra depth of the trenched ditch for bored crossings, pipe insertion, transition bends, and tie-in bell holes. Also, temporary workspace for pipe string and assembling area and equipment turnaround, since the railroad cannot be crossed by construction equipment.
FOREIGN PIPELINE CROSSINGS	50	180 x 20 (work side) 120 x 3560	8.10	Additional workspace is required for spoil storage due to extra depth of the trenched ditch for bored crossings, pipe insertion, transition bends, and tie-in bell holes. Also, temporary workspace for pipe string and assembling area.
UTILITY CROSSINGS	6	180 x 20 (work side) 120 x 3560	0.85	Additional temporary workspace is required for spoil storage due to extra depth of the trenched ditch for bored crossings, pipe insertion, transition bends, and tie-in bell holes. Also, temporary workspace for pipe string and assembling area.
FAULT CROSSINGS	46	Varies, depends on fault type	27.15	Site-specific criteria depending on strip-slip, reverse or thrust faults belowground and aboveground crossing design. Additional workspace is necessary to install sleeper beams on a granular pad located within thaw sensitive permafrost sloped areas. Also, induction bends, bell holes and tie-ins requiring additional spoil storage.
ATIGUN SDA	52	Special Engineering Design TBD	3.27	Special design area with steep side-slopes requiring additional workspace to accommodate spoil storage from the bench cut and extra workspace on each end of the sloped sections for equipment staging.
DENALI SDA	19	Special Engineering Design TBD	7.52	Special design area with steep side-slopes requiring additional workspace to accommodate spoil storage from the bench cut and extra workspace on each end of the sloped sections for equipment staging.
SPREAD BREAKS	5	600 x 250	6.86	Workspace for construction equipment at the end/beginning of spread breaks for mobilization and demobilization of construction spreads.

TABLE 2.6.2-1

Proposed Additional Temporary Workspaces Located in or within 50 feet of a Wetland or Waterbody [a]

ATWS Description [b]	Number of ATWS [c]	Nominal Dimension (feet) [d]	ATWS Total Acreage [e]	Justification [f]
TIMBER DECKS	27	300 x 40	2.85	Additional workspace required for storage of de-limbed and topped merchantable timber salvaged from the right of way. The width is based on the predicted height of timber in Alaska once the timber has been topped. The length varies depending on the volume of timber being salvaged within an appropriate skidder distance, which is approximately 1300 feet.
TURN AROUNDS	61	200 x 80	20.21	Additional temporary workspace required for equipment turnaround in construction spread with limited or no existing road access.
HORIZONTAL BENDS	937	80 x 20 left 60 x 15 right	57.99	Workspace necessary for the installation of horizontal induction bends. Additional workspace is required for extra spoil storage from bell holes needed to tie-in welds on each end of the bend. Nominal dimension of the ATWS varies depending on the angle of the bend.
ATWS	5	Varies	1.96	Additional temporary workspace necessary for onshore winch pull and for Cook inlet crossing
DENALI ROCKFALL PROTECTION	2	Varies	0.16	Special design area with steep side-slopes requiring additional workspace to accommodate rock fall protection for safety.
THRUCUT	195	200 x 250	22.14	Additional workspace to accommodate spoil storage from the bench cut needed for leveling workspace on sloped sections and equipment staging.
CUTFILL	2250	Varies	183.49	Additional workspace is required to accommodate spoil storage from the bench cut and extra workspace on each end of the sloped sections for equipment staging.
PTTL ATWS ROADS AND WATERBODY CROSSINGS	40	80-180 x 35-50 360-500 x 35-50 (work side) 110-400 x 40-50 110-425 x 35-90 (work side)	20.60	Additional temporary workspace requiredas stated previously for waterbody crossings. Extra workspace for roads is required for the construction of ice roads and ice work pads for equipment.

Notes:

[a] Proposed Additional Temporary Workspaces (ATWS) are based on a 42-inch pipeline for Mainline Route Rev. C. ATWS would be assessed and sized appropriately to account for terrain, soil conditions, site configuration, site-specific construction method, and construction season.

TABLE 2.6.2-1

Proposed Additional Temporary Workspaces Located in or within 50 feet of a Wetland or Waterbody [a]

ATWS Description [b]	Number of ATWS [c]	Nominal Dimension (feet) [d]	ATWS Total Acreage [e]	Justification [f]

[b] Atigun and Denali Special Design Areas (SDA) and Denali Rockfall Protection require site-specific conditions due to the steep topography within these regions. Waterbody Crossings refers to minor, intermediate, and major crossings as defined by FERC.

[c] Number of ATWS refers to the total number of additional workspaces based on the description; actual number may vary at time of construction and subject to change.

[d] Nominal dimensions are based on CAD typicals for planning purposes, actual size may vary at time of construction.

[e] Acreage is calculated in GIS. Total acreage does not represent wetlands temporarily affected by construction workspace.

[f] Wetlands are abundant within the Project footprint, locating all proposed ATWS at least 50 feet away from wetlands and waterbodies is technically infeasible due to site-specific conditions. Measures defined in the *Applicant's Procedures* (Appendices N) would be implemented to ensure wetlands and waterbodies are adequately protected.

2.6.3 Topsoil Segregation

The permafrost terrain prevalent in Alaska that comprises 80 percent of the northern 600 miles of the Alaska LNG Pipeline route requires special construction techniques to limit thermal degradation and erosion. Because most permafrost is capped by a poorly drained organic wetland mat in both flat and sloped terrain, permafrost construction techniques are significantly different in terms of management of uppermost layer of organic and nutrient-rich earth that is equated to topsoil. In Alaska, topsoil is commonly known as the organic root zone, in which grasses and herbaceous plants germinate and sustain growth during the growing season. It is typically between 2 to 8 inches thick. It has a high moisture-retention capacity and a high concentration of seeds, stolons, rhizomes and microorganisms relative to the underlying subsoil. Organic soil is most often composed of organic materials, such as moss (sphagnumand feather) peat, sedge peat, or wood peat, and is commonly known as peat (peatland), muck or bog/fen (muskeg). It develops in poorly to very-poorly drained areas where saturation occurs for prolonged periods. Organic soils are typically layered having a fibric (weakly decomposed), mesic (medium decomposed) and humic (strongly decomposed) layer from surface to depth. Organic soils can have a mineral component; however, the organic carbon must be greater than 17 percent (30 percent organic matter) to be considered an organic soil.

As outlined in Section 2.6.1, the Applicant considered multiple factors to select the most appropriate construction season and ROW modes for crossing wetlands that included the management of underlying topsoil organic layer. The Applicant concluded the following:

Winter Construction – Topsoil salvaging within the ROW and trenchline for segregation is impracticable because sections because the topsoil profile will be frozen and bonded to the underlying mineral soil. Conventional excavation equipment (backhoes, trenchers, and excavators) typically would not be able to properly separate frozen organics from the mineral soil underneath. Such a mixture would provide little to no benefit to revegetation efforts because trenching would grind up the roots and rhizomes of arctic tundra plants making it difficult for them to re-establish on the trench backfill. Instead, the material graded from the ROW or excavated from the trench will be spread or backfilled following pipeline installation to facilitate restoration.

Thaw Unstable Permafrost – Topsoil segregation is not practicable in thaw-unstable permafrost during the summer or the fall shoulder season because a flat and stable platform for the trenching equipment must be created on the ditch line. Removing and segregating the organic layer and soil beneath would not be possible until it had thawed down to the active layer, which won't occur until late summer. Even if the frozen organic layer and soil could be stripped, the solar radiation and warm air temperatures of summer would turn the stripped ditch line into a melting strip of muck, which would not support the use of continuous trenchers or backhoes, which require a stable surface. Use of granular workpads on the working side and a thin granular leveling course on the ditch line will protect the permafrost from thawing, while providing all heavy pipeline equipment with a stable working surface. The granular workpad must be placed in the winter season when it is not possible to separate the frozen organic layer. If the organic layer were stripped in the summer prior to winter placement of granular workpad, the thermal erosion of the stripped area would turn the ditch line into a linear bog due to active layer thawing.

Conventional grading may be used in winter and summer seasons, and across uplands and non-saturated wetlands that are generally dry and stable. When used in flat thaw-stable permafrost or non-permafrost wetlands during the summer, thin surface organics will be stripped across the full ROW and stockpiled to the sides of the ROW. When used in sloping wetlands during the summer, thin surface organics will be stripped from the trench and spoil area only and stockpiled upslope.

Table 2.6.3-1 provides summary and spread and ROW mode of the anticipated topsoil segregation in wetlands based on the criteria described above.

TABLE 2.6.3-1

Summary of Wetland Topsoil Segregation by Construction Spread and Right-of-Way Mode

Spread	Crossing Mode Description	ROW Mode No.	Length Crossed (mi)	Wetlands Crossed (mi)	Winter Spread (mi)	Summer Spread (mi)	Cross Slope >2% (mi) [a]	Thaw Unstable Permafrost (mi) [b]	Topsoil Segregation (mi)
1	Ice Work Pad	1	56.57	53.39	56.57	0.00	0.63	56.56	0.00
	Frost Pack Work Pad	2	0.77	0.73	0.75	0.02	0.38	0.74	0.00
	Matted Work Pad	3	0.05	0.00	0.00	0.05	0.00	0.04	0.00
	Granular Work Pad	4	123.48	109.95	49.95	73.54	69.79	119.67	0.00
	Graded Work Pad	5A	24.96	8.10	11.08	13.88	16.37	4.54	13.88
	Mountain Grade	5B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ice Bridge	16	1.33	0.64	1.33	0.00	0.99	0.56	0,00
	Bridge	17	1.73	0.75	0.01	1.72	1.05	1.11	0.00
Spread Section 1 Subtotal		***208.89***		***173.56***	***119.69***	***89.21***	***89.21***	***183.22***	***13.88***
2	Ice Work Pad	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Frost Pack Work Pad	2	2.04	1.25	1.97	0.07	0.63	0.00	0.00
	Matted Work Pad	3	0.01	0.01	0.00	0.01	0.00	0.00	0.00
	Granular Work Pad	4	139.53	83.00	45.46	94.07	94.91	137.57	0.00

TABLE 2.6.3-1

Summary of Wetland Topsoil Segregation by Construction Spread and Right-of-Way Mode

Spread	Crossing Mode Description	ROW Mode No.	Length Crossed (mi)	Wetlands Crossed (mi)	Winter Spread (mi)	Summer Spread (mi)	Cross Slope >2% (mi) [a]	Thaw Unstable Permafrost (mi) [b]	Topsoil Segregation (mi)
	Graded Work Pad	5A	46.21	15.25	5.06	41.15	32.85	12.88	41.15
	Mountain Grade	5B	0.47	0.00	0.00	0.47	0.47	0.00	0.00
	Ice Bridge	16	1.68	0.49	1.55	0.12	0.77	0.83	0.00
	Bridge	17	1.89	0.92	0.01	1.88	0.67	1.21	0.00
Spread Section 2 Subtotal		***191.83***		***100.92***	***54.05***	***137.77***	***130.30***	***152.49***	***41.15***
3	Ice Work Pad	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Frost Pack Work Pad	2	49.27	29.22	49.27	0.00	11.64	40.38	0.00
3	Matted Work Pad	3	0.20	0.18	0.00	0.20	0.10	0.18	0.00
3	Granular Work Pad	4	27.16	12.89	18.79	8.36	11.38	21.49	0.00
3	Graded Work Pad	5A	126.17	26.91	49.40	76.77	70.03	22.76	76.77
3	Mountain Grade	5B	0.94	0.00	0.00	0.94	0.94	0.00	0.00
3	Ice Bridge	16	1.45	0.25	1.45	0.00	0.52	0.64	0.00
3	Bridge	17	1.45	0.26	0.00	1.45	0.88	0.10	0.00
Spread Section 3 Subtotal		***206.64***		***69.71***	***118.91***	***87.72***	***95.49***	***85.55***	***76.77***
4	Ice Work Pad	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Frost Pack Work Pad	2	17.35	8.92	17.32	0.02	2.95	10.75	0.00
4	Matted Work Pad	3	0.30	0.29	0.00	0.30	0.02	0.26	0.00
4	Granular Work Pad	4	1.27	1.22	0.94	0.32	0.10	1.27	0.00
4	Graded Work Pad	5A	149.89	16.68	91.45	58.44	84.07	63.64	58.44
4	Mountain Grade	5B	0.86	0.00	0.86	0.00	0.61	0.00	0.00
4	Ice Bridge	16	1.10	0.34	1.08	0.02	0.36	0.99	0,00
4	Bridge	17	1.21	0.19	0.47	0.74	0.47	0.41	0.00
Spread Section 4 Subtotal		***171.98***		***27.64***	***112.12***	***59.84***	***88.58***	***77.32***	***58.44***
Spreads Total		**779.33**		**371.83**	**404.77**	**374.54**	**403.58**	**498.58**	**186.19**

Notes:

[d] Length of thaw unstable permafrost located within Mainline construction ROW.

[e] Cross slope is defined by Worley-Parson's Geomatic Slope Calculator. Level = less than 2%; Gentle = ≥ 2% to < 10%; Steep ≥ 10% to < 50%; and Very Steep = ≥ 50%. Simplified slope classes contain both - / + slopes.

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