U.S. Department of Energy

ALASKA LNG PROJECT

Final
Supplemental Environmental Impact Statement

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COVER SHEET

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Cooperating Agencies: None

Title: **Final** Supplemental Environmental Impact Statement for the Alaska LNG Project (DOE/EIS-0512-S1)

Location: North Slope, Alaska

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Abstract:

The U.S. Department of Energy (DOE) prepared this **Final** Supplemental Environmental Impact Statement (SEIS) to evaluate the potential environmental impacts associated with natural gas production on the North Slope of Alaska (North Slope) and life cycle greenhouse gas emissions associated with authorizing Alaska LNG Project LLC (Alaska LNG) to export liquefied natural gas (LNG) as part of the Alaska Gasline Development Corporation's proposed Alaska LNG Project (Project). DOE is in the process of rehearing DOE/Office of Fossil Energy Order No. 3643-A issued in August 2020 (Alaska LNG Order), which authorized export of LNG to non-Free Trade Agreement (FTA) countries. This **Final** SEIS supplements the Final Environmental Impact Statement published by the Federal Energy Regulatory Commission, as adopted by DOE (DOE/EIS-0512) on March 16, 2020, and will support DOE's decision-making process. Following completion of the National Environmental Policy Act (NEPA) process, DOE intends to issue an order under Section 3(a) of the Natural Gas Act in which DOE may exercise its authority to reaffirm, modify, or set aside the Alaska LNG Order.

DOE prepared this **Final** SEIS in accordance with the National Environmental Policy Act of 1969 (42 United States Code 4321 *et seq.*) and in compliance with the Council on Environmental Quality implementing regulations (Title 40 *Code of Federal Regulations* [CFR] Parts 1500 to 1508) and DOE NEPA procedures (10 CFR 1021). This **Final** SEIS evaluates the potential environmental impacts associated with natural gas production in the North Slope and includes a life cycle analysis calculating the greenhouse gas emissions for LNG exported from the proposed Alaska LNG Project.

Comment Period:

On June 29, 2022, DOE published a Notice of Availability in the *Federal Register* announcing the availability of the Draft SEIS, presenting the date, time, and access information for a virtual public meeting and initiating a 45-day public comment period that ran from July 1, 2022 until August 15, 2022 (*Federal Register* Volume 87, Number 124). DOE also placed notification advertisements in newspapers, sent notification letters, placed hard copies of the Draft SEIS at libraries, and placed an electronic version of the document on DOE's website.

DOE held a virtual public meeting on July 20, 2022. The purpose of the meeting was to collect verbal comments on the Draft SEIS and to provide an opportunity for the public to learn more about the proposed Alaska LNG Project. During the public comment period, agencies, tribal governments, non-governmental organizations, and members of the public submitted verbal comments during the public meeting and written comments via mail, email, and regulations.gov. DOE considered all comments received during the public comment period in preparation of this Final SEIS. The Comment Response Document (Appendix D to this SEIS) summarizes the public notification process and the public comments received during the comment period, along with DOE's responses to the comments.

Changes from the Draft SEIS:

In this Final SEIS, bold text and vertical lines in the margin indicate where DOE has revised or supplemented the Draft SEIS (as exemplified by this paragraph). Deletions are not demarcated.

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ACRONYMS AND ABBREVIATIONS

Acronym	**Definition**
°C	degrees Celsius
°F	degrees Fahrenheit
AAC	Alaska Administrative Code
ACEC	areas of critical environmental concern
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation and Public Facilities
AGDC	Alaska Gasline Development Corporation
AHRS	Alaska Heritage Resources Survey
Alaska LNG	Alaska LNG Project LLC
ANILCA	Alaska National Interest Lands Conservation Act
AOGCC	Alaska Oil and Gas Conservation Commission
APDES	Alaska Pollutant Discharge Elimination System
APE	Area of Potential Effect
AS	Alaska Statute
AWC	Anadromous Waters Catalog
AWQS	Alaska Water Quality Standards
Bcf	billion cubic feet
BIA	Biologically Important Area
BLM	Bureau of Land Management
BMP	best management practice
CCS	carbon capture and sequestration
CDP	**Census Designated Place**
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CGF	Central Gas Facility
CH_4	methane
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
CWA	Clean Water Act
dB	decibel
dBA	A-weighted decibel
DOE	Department of Energy
DOG	Division of Oil and Gas
EFH	Essential Fish Habitat

Acronym	**Definition**
EI	Environmental Inspector
EIS	Environmental Impact Statement
E.O.	Executive Order
EOR	enhanced oil recovery
ESA	Endangered Species Act
FE	Office of Fossil Energy
FERC	Federal Energy Regulatory Commission
FSC	fish stocks of concern
FTA	free trade agreement
FY	fiscal year
GHG	greenhouse gas
GTP	Gas Treatment Plant
HSM	horizontal support member
HUC	Hydrologic Unit Code
IBA	Important Bird Area
IPCC	Intergovernmental Panel on Climate Change
KRU	Kuparuk River Unit
LCA	Life Cycle Analysis
Ldn	day-night average sound level
Leq	equivalent sound level
LNG	liquefied natural gas
MBTA	Migratory Bird Treaty Act
MGS	Major Gas Sales
MLRA	Major Land Resource Areas
MLV	mainline valve
MMPA	Marine Mammal Protection Act
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NGA	Natural Gas Act
NGCC	**natural gas combined cycle**
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NNIS	non-native invasive species
NOI	Notice of Intent
NPS	National Park Service
NRHP	National Register of Historic Places
NS-RAQM	**North Slope-Regional Air Quality Modeling**
O_3	ozone

Acronym	Definition
OOIP	original oil in-place
OPS	Office of Pipeline Safety
PBU	Prudhoe Bay Unit
PHMSA	Pipeline and Hazardous Materials Safety Administration
$PM_{2.5}$	**fine particulate matter of diameter 2.5 microns or less**
Project	Alaska LNG Project
PSD	Prevention of Significant Deterioration
psi	pound-force per square inch
PTTL	Point Thomson Unit Gas Transmission Line
PTU	Point Thomson Unit
RCP	representative concentration pathway
RHA	Rivers and Harbors Act
ROD	**Record of Decision**
ROI	region of influence
ROW	right-of-way
SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Office
SPCC	Spill Prevention, Control, and Countermeasures
SUA	special use area
SVRA	sensitive visual resource area
SWPPP	Stormwater Pollution Prevention Plan
Tcf	trillion cubic feet
UIC	Underground Injection Control
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSM	vertical support member

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) has prepared this **Final** Supplemental Environmental Impact Statement (SEIS) to evaluate the potential environmental impacts associated with natural gas production on the North Slope of Alaska (North Slope) and life cycle greenhouse gas (GHG) emissions associated with authorizing Alaska LNG Project LLC (Alaska LNG)[1] to export liquefied natural gas (LNG) to countries that do not have a free trade agreement (FTA) requiring national treatment for trade in natural gas, and with which trade is not prohibited by U.S. law or policy (non-FTA countries). Alaska LNG's request for authorization is part of the Alaska Gasline Development Corporation's (AGDC)[2] proposed Alaska LNG Project (Project). DOE is in the process of rehearing DOE/Office of Fossil Energy (FE) and Carbon Management Order No. 3643-A issued in August 2020 (Alaska LNG Order), which authorized export of LNG to non-FTA countries. This **Final** SEIS supplements the Final Environmental Impact Statement (EIS) published by the Federal Energy Regulatory Commission (FERC), as adopted by DOE (DOE/EIS-0512) on March 16, 2020, and will support DOE's decision-making process. Following completion of the **Final** SEIS and the National Environmental Policy Act (NEPA) of 1969 process, DOE intends to issue an order under Section 3(a) of the Natural Gas Act (NGA) in which DOE may exercise its authority to reaffirm, modify, or set aside the Alaska LNG Order.

DOE prepared this **Final** SEIS in accordance with NEPA (42 United States Code [USC] 4321, *et seq.*) and in compliance with the Council on Environmental Quality (CEQ) implementing regulations for NEPA (Title 40 *Code of Federal Regulations* [CFR] Parts 1500 to 1508) and DOE NEPA procedures (10 CFR 1021). This chapter of the **Final** SEIS provides background on the proposed Project and a description of the purpose of and need for agency action. This chapter also includes additional information on the NEPA process and previous NEPA efforts undertaken by FERC and DOE.

1.1 BACKGROUND

Alaska LNG filed an application with DOE, in Docket No. 14-96-LNG on July 18, 2014, seeking authorization to export LNG to both FTA and non-FTA countries. DOE issued its *Order Granting Long-Term Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Proposed Alaska LNG Project in the Nikiski Area of the Kenai Peninsula, Alaska, to Free Trade Agreement Nations* on November 21, 2014 (DOE/FE Order No. 3554).

On May 28, 2015, DOE issued its *Order Conditionally Granting Long-Term, Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Proposed Alaska LNG Terminal in Nikiski, Alaska, to Non-FTA Nations* (DOE/FE Order No. 3643). LNG export was authorized for non-FTA countries, conditioned on the satisfactory completion of the environmental review process to comply with NEPA under FERC Docket Nos. PF14-21-000 and CP17-178-000, and on DOE issuance of a Record of Decision pursuant to NEPA, among other requirements.

FERC published a Final EIS in March 2020 to evaluate the Alaska LNG Project proposed by AGDC[3]. AGDC requested authorization to construct and operate new gas treatment facilities, an 806.9-mile-long natural gas pipeline and associated aboveground facilities, and a liquefaction facility with a capacity of 20 million metric tons per year. The proposed Project would commercialize the natural gas resources of the North Slope. Figure 1.1-1 provides an overview of the proposed Project.

[1] Alaska LNG is a Delaware limited liability company with its principal place of business in Anchorage, Alaska. As of June 30, 2020, its member companies are: ExxonMobil Alaska LNG LLC, ConocoPhillips Alaska LNG Company, and Hilcorp Alaska, LLC.

[2] AGDC is an independent public corporation of the State of Alaska. The Alaska State Legislature provided AGDC with the authority and primary responsibility for developing a LNG project on the State's behalf.

[3] Federal Energy Regulatory Commission (FERC). 2020. Alaska LNG Project Final Environmental Impact Statement. FERC/EIS-0296F.

Source: AGDC 2022; ADNR DOG 2021a; BLM 2019; North Slope Science Initiative 2021; USCB 2021; USGS 2022a
LNG = liquefied natural gas; MP = Milepost

Figure 1.1-1. Alaska LNG Project Overview

The March 2020 Final EIS (2020 EIS) assessed the potential environmental effects of Project construction and operation in accordance with the requirements of NEPA. As described in the 2020 EIS, approval of the proposed Project would result in a number of significant environmental impacts. Implementation of the impact avoidance, minimization, and mitigation measures proposed by AGDC, AGDC's commitments to additional measures, and measures recommended by FERC in the 2020 EIS would reduce the majority of impacts to less-than-significant levels. However, some of the adverse impacts would remain significant even after the implementation of mitigation measures (see Chapter 4, Impacts of the Proposed Action, for a summary of findings by resource area contained within the 2020 EIS). Based on findings of the 2020 EIS, FERC issued an Order on May 21, 2020, granting AGDC authorization under Section 3(a) of the NGA to site, construct, and operate the proposed Alaska LNG Project.

To fulfill its obligations under NEPA, DOE participated as a cooperating agency in FERC's review of the proposed Alaska LNG Project. FERC issued the Final EIS for the Alaska LNG Project on March 6, 2020, and DOE adopted the Final EIS on March 16, 2020 (DOE/EIS-0512). Following FERC's completion of the NEPA process under FERC Docket Nos. PF14-21-000 and CP17-178-000, on August 20, 2020, DOE issued DOE/FE Order No. 3643-A[4] (the Alaska LNG Order) to Alaska LNG Project LLC (Alaska LNG)[5] under Section 3(a) of the NGA.[6] Concurrently with its issuance of the Alaska LNG Order, DOE issued a Record of Decision under NEPA (DOE Docket No. 14–96–LNG). DOE authorized Alaska LNG to export LNG produced from Alaskan sources to non-FTA countries.[7] Alaska LNG is authorized to export this LNG in a volume equivalent to 929 billion cubic feet per year (Bcf/year) of natural gas (2.55 Bcf per day), by vessel from a liquefaction facility to be constructed in the Nikiski area of the Kenai Peninsula in south central Alaska (Liquefaction Facility). According to Alaska LNG, this Liquefaction Facility will be part of the "*largest integrated gas/LNG project of its kind ever designed and constructed*," called the Alaska LNG Project.[8] Alaska LNG's DOE authorization is for a term of 30 years, with export operations required to commence within 12 years of the date that the Alaska LNG Order was issued.[9]

DOE's Alaska LNG Order included the condition that Alaska LNG comply with the 165 environmental conditions adopted in the FERC Order. **Mitigation measures beyond those included in DOE/FE Order No. 3643-A that are enforceable by other federal and state agencies are additional conditions of DOE/FE Order No. 3643-A.** Exports would occur by vessel from the Liquefaction Facility, which would be part of the proposed Alaska LNG Project and was analyzed in the 2020 EIS.

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[4] Alaska LNG Project LLC, DOE/FE Order No. 3643-A, Docket 14-96-LNG, *Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations* (Aug. 20, 2020) [hereinafter Alaska LNG Order]. DOE granted Alaska LNG's application filed in 2014. See Alaska LNG Project LLC, *Application for Long-Term Authorization to Export Liquefied Natural Gas*, Docket No. 14-96-LNG (July 18, 2014) [hereinafter Alaska LNG App.].

[5] Alaska LNG is a Delaware limited liability company with its principal place of business in Anchorage, Alaska. Alaska LNG Order at 13. As of June 30, 2020, its member companies are: ExxonMobil Alaska LNG LLC, ConocoPhillips Alaska LNG Company, and Hilcorp Alaska, LLC. See U.S. Dep't of Energy, Response to Notification Regarding Change in Control (Alaska LNG Project LLC), Docket No. 14-96-LNG, at 2 (Aug. 12, 2020).

[6] 15 USC § 717b(a). The authority to regulate the imports and exports of natural gas, including liquefied natural gas, under Section 3(a) of the NGA (15 USC § 717b) has been delegated to the Assistant Secretary for FE in Redelegation Order No. S4-DEL-FE1-2021, issued on March 25, 2021.

[7] The United States currently has FTAs requiring national treatment for trade in natural gas with Australia, Bahrain, Canada, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Honduras, Jordan, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, Republic of Korea, and Singapore. FTAs with Israel and Costa Rica do not require national treatment for trade in natural gas. Alaska LNG also holds a separate authorization to export LNG to FTA countries, which DOE granted in 2014 in Order No. 3554, pursuant to Section 3(c) of the NGA, 15 USC § 717b(c). That FTA order is not at issue.

[8] Alaska LNG App. at 3.

[9] Alaska LNG Order at 36, 41. DOE uses the terms "order" and "authorization" interchangeably.

Subsequently, on September 21, 2020, Sierra Club filed a Request for Rehearing of the Alaska LNG Order. Sierra Club argued that DOE violated NEPA by relying on an EIS that did not examine all of the reasonably foreseeable impacts of the proposed Alaska LNG Project. On April 15, 2021, DOE issued an Order on Rehearing[10]. In that Rehearing Order, DOE granted Sierra Club's Request for Rehearing for the purpose of conducting Alaska-specific environmental studies and related public process. DOE noted that, since the issuance of the Alaska LNG Order, the President had issued two Executive Orders (E.O.s) relevant to the Alaska LNG proceeding:

- **E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*.** E.O. 13990 directs agencies to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change.
- **E.O. 14008, *Tackling the Climate Crisis at Home and Abroad*.** E.O. 14008 sets forth additional policies to address climate change, specifically to "organize and deploy the full capacity of [Federal] agencies to combat the climate crisis." E.O. 14008 further requires the "Federal Government [to] drive assessment, disclosure, and mitigation of climate pollution and climate-related risks in every sector" of the U.S. economy.

Consistent with these E.O.s and considering the arguments on rehearing, DOE stated that it was appropriate to further evaluate the environmental impacts of exporting LNG from the proposed Project to non-FTA countries. On July 2, 2021, DOE published its Notice of Intent (NOI) in the *Federal Register* to prepare a SEIS for the Alaska LNG Project (DOE/EIS-0512-S1). DOE announced in the NOI and Rehearing Order that it would examine the environmental effects of natural gas production on the North Slope and GHG emissions associated with exports of LNG from Alaska from a life cycle perspective. This **Final** SEIS presents the potential environmental effects of upstream production and related life cycle GHG emissions.

Table 1.1-1 presents the sequence of applicant and regulatory/federal agency actions pertaining to the proposed Project to date. This includes the timeline of events discussed above along with other Project milestones.

Table 1.1-1. Highlights of Actions Related to the Alaska LNG Project

Date	Action
July 18, 2014	Alaska LNG submitted *Application for Long-Term Authorization to Export Liquefied Natural Gas* to DOE (Docket No. 14-96-LNG).
September 5, 2014	AGDC, BP Alaska LNG LLC, ConocoPhillips Alaska LNG Company, ExxonMobil Alaska LNG LLC, and TransCanada Alaska Midstream LLP filed a *Request to Commence Pre-Filing Process* to FERC for the proposed Project.
November 21, 2014	DOE issued its *Order Granting Long-Term Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Proposed Alaska LNG Project in the Nikiski Area of the Kenai Peninsula, Alaska, to Free Trade Agreement Nations* (DOE/FE Order No. 3554).
September 2014 – January 2017	FERC staff worked with the proposed Project proponents, agencies, Alaska Natives, and stakeholders to implement the pre-filing process.
September 12, 2014	FERC approved the request and assigned the proposed Project Docket No. PF14-21-000.

[10] On December 16, 2020, after DOE had issued a tolling order but before DOE had issued any subsequent order addressing Sierra Club's Rehearing Request, Sierra Club filed a petition for review of the Alaska LNG Order in the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit). See Sierra Club v. U.S. Dep't of Energy, Petition for Review, Case No. 20-1503 (D.C. Cir. Dec. 16, 2020). That case is currently being held in abeyance in light of DOE's ongoing rehearing proceeding involving this SEIS.

Table 1.1-1. Highlights of Actions Related to the Alaska LNG Project

Date	Action
March 4, 2015	FERC issued a *Notice of Intent to Prepare an Environmental Impact Statement for the Planned Alaska LNG Project and Request for Comments on Environmental Issues*. The NOI established a 9-month public scoping period for the submission of comments, concerns, and issues related to environmental aspects of the proposed Project. The extended 9-month (versus traditional 45-day) scoping period was in recognition of subsistence harvesting windows observed by communities potentially affected by the proposed Project.
May 28, 2015	DOE issued its *Order Conditionally Granting Long-Term, Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Proposed Alaska LNG Terminal in Nikiski, Alaska, to Non-Free Trade Agreement Nations* (DOE/FE Order No. 3643). The authorization is conditioned on the satisfactory completion of the environmental review process to comply with NEPA under FERC Docket Nos. PF14-21-000 and CP17-178-000, and on DOE issuance of a ROD pursuant to NEPA.
July 27, 2016	FERC issued a *Supplemental Notice Requesting Comments on the Denali National Park and Preserve Alternative for the Planned Alaska LNG Project*. The supplemental notice was issued to solicit feedback from the public and agencies regarding the Denali Alternative, an alternative route that would pass directly through the Denali National Park and Preserve entrance area and be closely aligned with the Parks Highway.
August 17, 2016	USCG issued a Letter of Recommendation regarding the suitability of the waterway for LNG marine traffic.
January 4, 2017	AGDC informed FERC that it had taken over sole ownership of the proposed Project.
April 17, 2017	AGDC filed an application with FERC in Docket No. CP17-178-000 for approval of the proposed Project pursuant to Section 3(a) of the NGA and Part 153 of the FERC's regulations.
June 28, 2019	FERC published its *Notice of Availability of the Draft EIS for the Alaska LNG Project* proposed by the AGDC. The comment period for the Draft EIS closed on October 3, 2019.
September 9, 2019	PHMSA granted four Special Permits for the Mainline Pipeline associated with the proposed Project. Each permit includes special permit terms and conditions that are intended to ensure safety or environmental protection, or that are otherwise in the public interest (PHMSA-2017-0044, 0045, 0046, and 0047).
March 6, 2020	FERC issued the Alaska LNG Project Final EIS. The Final EIS contained 164 site-specific environmental mitigation measures, which are attached as conditions to any authorization of the Alaska LNG Project.
March 16, 2020	After an independent review, DOE adopted the Alaska LNG Project Final EIS.
May 21, 2020	FERC Commissioners issued an authorization to AGDC to construct and operate the Alaska LNG Project subject to 165 environmental conditions—the recommended 164 environmental mitigation measures, plus one additional condition.
August 20, 2020	DOE issued the *Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations*, DOE/FE Order No. 3643-A. DOE conditioned the Alaska LNG Order on Alaska LNG's compliance with the 165 environmental conditions adopted in the FERC Order, among other requirements. Concurrently with its issuance of the Alaska LNG Order, DOE issued a ROD under NEPA (Docket No. 14–96–LNG).
September 21, 2020	Sierra Club timely filed a Request for Rehearing of DOE/FE Order No. 3643-A stating that DOE violated NEPA by relying on an EIS that did not examine all of the reasonably foreseeable impacts of the Alaska LNG Project.
October 6, 2020	AGDC filed a Motion for Leave to Answer Sierra Club's Request for Rehearing disputing the Sierra Club's claims on the sufficiency of the EIS analysis.

Table 1.1-1. Highlights of Actions Related to the Alaska LNG Project

Date	Action
October 20, 2020	DOE issued a Notice stating, "*Unless DOE/FE acts upon a request for rehearing within 30 days after it is filed, the request may be deemed to have been denied*", indicating denial of Sierra Club's Request for Rehearing. DOE stated that, "*Sierra Club's Request for Rehearing and AGDC's Motion will be further considered and addressed in a future order.*" DOE also noted that, "*[c]onsistent with NGA section 19(a), DOE/FE may modify or set aside DOE/FE Order No. 3643-A, in whole or in part, in such manner as it shall deem proper until the record in this proceeding is filed in a court of appeals.*"
December 16, 2020	Before DOE issued any subsequent order addressing the Sierra Club's Rehearing Request, Sierra Club petitioned the United States Court of Appeals for the District of Columbia Circuit for review of DOE/FE Order No. 3643-A.
April 15, 2021	DOE issued Order No. 3643-B that: (i) grants AGDC's Motion for Leave to Answer; (ii) grants Sierra Club's Rehearing Request for the purpose of conducting two Alaska-specific environmental studies and related public process (collectively, the Alaska environmental study proceeding), in light of E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, and other legal and policy considerations; and (iii) denies Sierra Club's request for DOE to withdraw the Alaska LNG Order, without prejudice to Sierra Club's ability to request relief in the future, should circumstances change. Accordingly, the Alaska LNG Order will remain in effect pending completion of the Alaska environmental study proceeding and DOE's issuance of an order under Section 3(a) of the NGA.
July 2, 2021	DOE published an NOI in the *Federal Register* to announce its intent to prepare a SEIS for the Alaska LNG Project (DOE/EIS-0512-S1).

AGDC = Alaska Gasline Development Corporation; DOE = Department of Energy; EIS = Environmental Impact Statement; E.O. = Executive Order; FE = Office of Fossil Energy; FERC = Federal Energy Regulatory Commission; LNG = liquefied natural gas; NEPA = National Environmental Policy Act; NGA = Natural Gas Act; NOI = Notice of Intent; PHMSA = Pipeline and Hazardous Materials Safety Administration; ROD = Record of Decision; SEIS = Supplemental Environmental Impact Statement; USCG = U.S. Coast Guard

1.2 PURPOSE AND NEED

1.2.1 Department of Energy

DOE must meet its obligation under Section 3(a) of the NGA to authorize the import and/or export of natural gas, including LNG, unless it finds that the proposed import or export would not be consistent with the public interest. By law, under Section 3(c) of the NGA, applications to export natural gas to countries with which the United States has FTAs that require national treatment for trade in natural gas are deemed to be consistent with the public interest, and DOE must grant authorizations without modification or delay. In the case of applications to export LNG to non-FTA countries, Section 3(a) of the NGA requires DOE to conduct a public interest review and grant authority to export unless DOE finds that the proposed exports would not be consistent with the public interest. Additionally, NEPA requires DOE to consider the potential environmental effects of its decisions regarding applications to export natural gas to non-FTA countries.

DOE prepar**ed** this **Final** SEIS in furtherance of its Rehearing Order, and to more fully evaluate the potential environmental impacts associated with natural gas production on the North Slope and consider a life cycle analysis (LCA) for GHG emissions of exporting LNG from the proposed Project to non-FTA countries. This also includes evaluation consistent with two recent Executive Orders: E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad*. The SEIS will inform DOE's consideration of potential environmental impacts and GHG emissions associated with Alaska LNG's exports to non-FTA countries. Following completion of the SEIS, DOE intends to issue an order under Section 3(a) of the NGA in which DOE may exercise its authority to reaffirm, modify, or set aside the Alaska LNG Order.

1.2.2 Alaska Gasline Development Corporation and Alaska LNG

Alaska LNG's purpose and need for the proposed Project was defined in their application to DOE. The proposed Project's purpose is to commercialize the natural gas resources of Alaska's North Slope, primarily by converting the existing natural gas supply to LNG for export by Alaska LNG and providing gas to users within Alaska. Specifically, the stated purpose and need for the proposed Project is to:

- commercialize natural gas resources on the North Slope during the economic life of the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU) and achieve efficiencies through the use of existing common oil and gas infrastructure and economies of scale;
- bring cost-competitive LNG from Alaska to foreign markets in a timely manner; and
- provide interconnections along the pipeline to allow for in-state gas deliveries, benefiting Alaskan gas users and supporting long-term economic development.

While the design life and the amount of gas reserves available on the North Slope may extend beyond DOE's initial authorization, analysis beyond the proposed Project lifespan is considered speculative given the dynamic nature of the LNG market. Operation of the proposed Project beyond DOE's Alaska LNG Order would require issuance of a new order subject to new environmental reviews and approvals.

AGDC does not have plans to abandon the facilities at the end of the proposed Project's lifespan. However, options for abandoning facilities generally include converting the facilities for a different use or carrying a different product, leaving them in place (e.g., the pipeline is purged of material, capped, but left in the ground), removing them (e.g., aboveground facilities and pipe are physically removed), or a combination of one or more of these options. Regardless, future Project-related activities—such as permit renewals, decommissioning, or abandonment of the facilities—would warrant a new evaluation under NEPA, providing an opportunity for agencies and the public to review and evaluate the proposed activities. The federal land-managing agencies would need to evaluate any proposed abandonment under the terms of the Right-of-Way (ROW) Grant. The Bureau of Land Management (BLM) must consider the final disposition of the pipeline facilities in accordance with 43 CFR 2886 and would require AGDC to address termination and restoration issues.

1.3 PURPOSE AND SCOPE OF THIS FINAL SEIS

This **Final** SEIS supplements the 2020 EIS[11] to consider additional potential Project impacts associated with LNG exported from Alaska over DOE's term of authorization. This **Final** SEIS also re-evaluates North Slope "non-jurisdictional" activities[12] discussed in the 2020 EIS related to upstream development that would support the proposed Project (see Section 2.5 for details on the activities). This **Final** SEIS does not include projects that were analyzed in detail in the 2020 EIS as part of AGDC's proposed Project, such as the proposed 62.5-mile-long, 32-inch-diameter Point Thomson Unit Gas Transmission Line (PTTL) that would be located in the North Slope (see Section 2.1.3.6 of the 2020 EIS). This **Final** SEIS will inform DOE's assessment under NEPA of the potential impacts from the Project's proposed exports to non-FTA countries.

[11] The 2020 EIS is available for review and download from **DOE's** website: https://www.energy.gov/nepa/articles/doeeis-0512-final-environmental-impact-statement.

[12] FERC considered facilities to be "non-jurisdictional" in the 2020 EIS if they do not fall under the jurisdiction of **FERC**. Non-jurisdictional facilities may be integral to the project need or they may be associated as minor components that would be built as a result of the jurisdictional facilities.

The scope of this **Final** SEIS conforms to CEQ NEPA Implementing Regulations (40 CFR 1500–1508) regarding tiering and incorporation by reference:

- **§ 1501.11 Tiering.** *"(c) Tiering is appropriate when the sequence from an environmental impact statement or environmental assessment is: …From an environmental impact statement or environmental assessment on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or assessment at a later stage (such as environmental mitigation). Tiering in such cases is appropriate when it helps the lead agency to focus on the issues that are ripe for decision and exclude from consideration issues already decided or not yet ripe."*
- **§ 1501.12 Incorporation by reference.** *"Agencies shall incorporate material, such as planning studies, analyses, or other relevant information, into environmental documents by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. Agencies shall cite the incorporated material in the document and briefly describe its content."*
- **§ 1502.1 Purpose of environmental impact statement.** *"Agencies shall focus on significant environmental issues and alternatives and shall reduce paperwork and the accumulation of extraneous background data. Statements shall be concise, clear, and to the point, and shall be supported by evidence that the agency has made the necessary environmental analyses."*

As such, this **Final** SEIS **includes analysis of potential environmental impacts associated with natural gas production on the North Slope of Alaska and a LCA calculating the GHG emissions for LNG exported from the proposed Alaska LNG Project**.

1.4 PUBLIC INVOLVEMENT

1.4.1 Summary of 2020 EIS Public Involvement Activities

As part of FERC's NEPA process, FERC conducted extensive public involvement activities including public scoping and opportunities for commenting on the Draft EIS. Table 1.4-1 highlights public involvement activities conducted during the 2020 EIS process.

Table 1.4-1. Highlights of Past Alaska LNG Project Public Involvement

Date	Action
March 4, 2015	FERC issued a *Notice of Intent to Prepare an Environmental Impact Statement for the Planned Alaska LNG Project and Request for Comments on Environmental Issues.* FERC sent the NOI to over 1,850 interested parties, including federal, state, and local officials; agency representatives; conservation organizations; Alaska Native communities; local libraries; and newspapers in the Project area, as well as property owners along the pipeline route and within 0.5 mile of the planned compressor stations and LNG Plant. The issuance of the NOI established a 9-month public scoping period for the submission of comments, concerns, and issues related to the environmental aspects of the proposed Project. The official scoping period for the proposed Project ended on December 4, 2015.
Fall of 2015	FERC held 12 public scoping meetings during the formal scoping period to inform the various communities about FERC's environmental review process and gather key comments and concerns from the communities in the Project area that should be addressed in the EIS. During the scoping meetings, FERC gathered feedback from the local communities, including residents, elected officials, Alaska Native leaders, community leaders, and other interested stakeholders.
July 27, 2016	FERC issued a *Supplemental Notice Requesting Comments on the Denali National Park and Preserve Alternative for the Planned Alaska LNG Project.* The supplemental notice was issued to solicit feedback from the public and agencies regarding the Denali Alternative, which passes directly through the park entrance area and is closely aligned with the Parks Highway. The official comment period for the supplemental notice formally closed on September 25, 2016. On August 16, 2019, AGDC adopted the portion of the route through the park as part of the proposed route for the Mainline Pipeline.

Table 1.4-1. Highlights of Past Alaska LNG Project Public Involvement

Date	Action
June 28, 2019	FERC issued a *Notice of Availability of the Draft Environmental Impact Statement for the Proposed Alaska LNG Project*. FERC mailed the Draft EIS to 1,341 federal, state, and local government agencies; elected officials; Alaska Native governments and ANCSA Corporations; local libraries and newspapers; property owners that could be affected by Project facilities; individuals requesting intervenor status in FERC's proceedings; and other interested parties (i.e., individuals and environmental and public interest groups who provided scoping comments or asked to remain on the mailing list). The distribution list for the 2020 EIS is included as Appendix A of that document. The public had 90 days after the date of publication in the *Federal Register* to review and comment on the Draft EIS either in the form of written comments and/or at public comment meetings held in the Project area. The comment period closed on October 3, 2019.
March 6, 2020	FERC issued a *Notice of Availability of the Final Environmental Impact Statement for the Proposed Alaska LNG Project*.

AGDC = Alaska Gasline Development Corporation; ANCSA = Alaska Native Claims Settlement Act; EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; LNG = liquefied natural gas; NOI = Notice of Intent

1.4.2 SEIS Scoping

As part of this SEIS process, DOE published an NOI in the *Federal Register* on July 2, 2021, announcing its intent to prepare a SEIS (Volume 86, Number 125). DOE did not conduct public scoping as a public scoping process is not required for a DOE-issued SEIS (10 CFR 1021.311(f)). As stated in Section 1.2, the purpose of this **Final** SEIS is to consider potential environmental impacts associated with natural gas production on the North Slope and a LCA calculating the GHG emissions for LNG exported from the proposed Alaska LNG Project. No changes to the proposed Project design have occurred since issuance of the 2020 EIS that affect the analysis or conclusions presented within the 2020 EIS and that would warrant additional public scoping.

1.4.3 Cooperating Agencies

Section 1.2 of the 2020 EIS identified FERC as that EIS's Lead Federal Agency with the following cooperating agencies: U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard, BLM, U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), DOE, and National Marine Fisheries Service (NMFS) due to jurisdiction by law or special expertise with respect to environmental resources and environmental impacts associated with the proposed Project. Several of the cooperating agencies also had NEPA obligations in order to issue their respective permits on the proposed Project (see Section 1.6). DOE invited these agencies to be cooperating agencies as part of this **Final** SEIS (see Appendix A, Agency and Alaska Native Coordination); however, no agencies accepted the invitation. Section 1.6 provides a history of related federal actions and updates since the 2020 EIS.

1.4.4 Public Review of the Final SEIS

DOE provid**ed** opportunities for public review and comments, including a public hearing, on th**e** Draft SEIS. **On June 29, 2022, DOE published a Notice of Availability in the *Federal Register* announcing the availability of the Draft SEIS, presenting the date, time, and access information for a virtual public meeting and initiating a 45-day public comment period that ran from July 1, 2022 until August 15, 2022 (*Federal Register* Volume 87, Number 124). DOE also placed notification advertisements in newspapers, sent notification letters, placed hard copies of the Draft SEIS at libraries, and placed an electronic version of the document on DOE's website.**

DOE held a virtual public meeting on July 20, 2022. The purpose of the meeting was to collect verbal comments on the Draft SEIS and to provide an opportunity for the public to learn more about the proposed Alaska LNG Project. During the public comment period, agencies, tribal governments,

non-governmental organizations, and members of the public submitted verbal comments during the public meeting and written comments via mail, email, and regulations.gov. DOE considered all comments received during the public comment period in preparation of this Final SEIS. Comments received after the close of the public comment period were considered to the extent practicable. The Comment Response Document (Appendix D to this SEIS) summarizes the public notification process and the public comments received on the Draft SEIS (205 total), along with DOE's responses to the comments.

As required by CEQ regulations (40 CFR 1506.10), DOE will issue a Record of Decision no sooner than 30 days after publication of the USEPA's Notice of Availability of th**is** Final SEIS.

1.4.5 Alaska Native Government-to-Government Consultation and Coordination

As the lead federal agency for this **Final** SEIS, DOE is responsible for tribal consultation and coordination with federally recognized American Indian and Alaska Native tribes (federally recognized tribes) that could be affected by the proposed Project based on geographic location, tribal resources, or tribal ownership considerations. DOE contacted each of the 78 Alaska Native Tribes (124 coordination letters hard-mailed on December 9, 2021) involved in the 2020 EIS process, notifying them of DOE's decision to prepare a SEIS and to inquire about their interest. Additionally, DOE provided an opportunity for the Alaska Native Tribes to contribute any traditional knowledge regarding resources on the North Slope potentially affected by upstream development that was not included in the 2020 EIS (see Appendix A, Agency and Alaska Native Coordination, for a distribution list and sample letter). DOE has not received responses from any Alaska Natives.

Section 4.13.2 of the 2020 EIS describes the consultation with Alaska Natives that occurred as part of the National Historic Preservation Act (NHPA) Section 106 process during FERC's NEPA review.

1.5 TRADITIONAL KNOWLEDGE

Traditional knowledge incorporates knowledge of ecosystem relationships and a code of ethics governing appropriate use of the environment. This code includes rules and conventions promoting desirable ecosystem relations, human-animal interactions, and even social relationships, since the latter continues to be established and reaffirmed through hunting and other activities on the land. Traditional knowledge provides additional context to non-traditional knowledge forming a rich and distinctive understanding of life and the world. The Director General of the United Nations Educational, Scientific and Cultural Organization defines traditional knowledge as follows (FERC 2020):

> *The indigenous people of the world possess an immense knowledge of their environments, based on centuries of living close to nature. Living in and from the richness and variety of complex ecosystems, they have an understanding of the properties of plants and animals, the functioning of ecosystems and the techniques for using and managing them that is particular and often detailed. In rural communities in developing countries, locally occurring species are relied on for many – sometimes all - foods, medicines, fuel, building materials and other products. Equally, people's knowledge and perceptions of the environment, and their relationships with it, are often important elements of cultural identity.*

Section 1.4 of the 2020 EIS discusses the methods of collecting information on the characteristics of Alaskan natural resources including vegetation, wildlife, and subsistence; and about use or management practices that are passed down from generation to generation and contribute to the cultural, social, and spiritual identity of Alaska Native communities. This **Final** SEIS uses traditional knowledge from the 2020 EIS to supplement the affected environment descriptions and to inform resource impact analyses and conclusions. Specifically, this **Final** SEIS considers traditional knowledge of resources on the North Slope identified within the 2020 EIS where upstream production occurs, as well as changes in climate as they relate to the proposed Project's contribution to GHGs, based on the LCA Study **(see Section 2.2.3 for additional information on the LCA Study)**. Table 1.5-1 summarizes tribal knowledge topics from the 2020 EIS relevant to this **Final** SEIS.

Table 1.5-1. Topics Identified in the 2020 EIS by Alaska Natives Relevant to Scope of this Final SEIS

Subject	Representative Issues and Concerns	Relevant Sections of SEIS
Permafrost	Upstream development related to the Alaska LNG Project could induce impacts on and observed changes to permafrost.	3.2.4, 4.2.4
Water Quality	Upstream development related to the Alaska LNG Project could adversely affect marine and freshwater quality.	3.3.3, 4.3.3
Invasive Species	Upstream development related to the Alaska LNG Project could introduce or spread invasive species, including dandelions and white sweetclover.	3.5.4, 4.5.4
Native Plants	Upstream development related to the Alaska LNG Project could adversely affect native plants.	3.5.3, 4.5.4
Socioeconomics/ Environmental Justice	Upstream development related to the Alaska LNG Project could adversely affect local populations during and after construction.	3.11, 4.11.4
Socioeconomics	Upstream development related to the Alaska LNG Project could induce a higher cost of living during construction.	3.11, 4.11
Socioeconomics/ Environmental Justice	Upstream development related to the Alaska LNG Project could induce adverse effects to the local populations through lack of local hiring and lack of equal employment opportunities for pipeline jobs.	3.11, 4.11
Cultural Resources	Upstream development related to the Alaska LNG Project could adversely affect historic trails, cultural sites, and paleontological resources.	3.13, 4.13.4
Air Quality	Upstream development related to the Alaska LNG Project could create fugitive dust and release other construction-related air emissions.	3.15, 4.15.4
Vegetation	Upstream development related to the Alaska LNG Project could adversely affect existing native plant communities due to construction and use of ice roads.	3.5, 4.5.4
Cumulative Effects	Cumulative effects due to GHG emissions and climate change may affect sea ice, currents, and tides, change waterbody levels and associated access to subsistence areas; adversely affect wetlands; change local weather patterns; and affect timing and range of subsistence resources.	3.19, 4.19
Wildlife	Traditional knowledge topics discussed within the 2020 EIS included the health and abundance of animal populations, including migration routes and habitat.	3.6, 3.14, 4.6.4, 4.14.4
Waterfowl	Traditional knowledge topics discussed within the 2020 EIS included the importance of waterfowl for subsistence.	3.14, 4.14.4
Marine Animals	Traditional knowledge topics discussed within the 2020 EIS included a general concern for the health and abundance of marine life populations, including migration routes and habitat.	3.7, 3.8, 4.7.4, 4.8.4
Human Health	Traditional knowledge topics discussed within the 2020 EIS included a general concern for human health.	3.17, 4.17.4
Human Health	Traditional knowledge topics discussed within the 2020 EIS included a general concern regarding social problems, including increases in drug and alcohol use.	3.17, 4.17.4
Socioeconomics	Traditional knowledge topics discussed within the 2020 EIS included a general concern regarding increased population and lack of available housing for local residents.	3.11, 4.11.4
Ice Roads	Traditional knowledge topics discussed within the 2020 EIS included a general concern regarding impacts of ice roads on the environment.	2.5.1, 4.1 – 4.18

EIS = Environmental Impact Statement; GHG = greenhouse gas; LNG = liquefied natural gas; SEIS = Supplemental Environmental Impact Statement

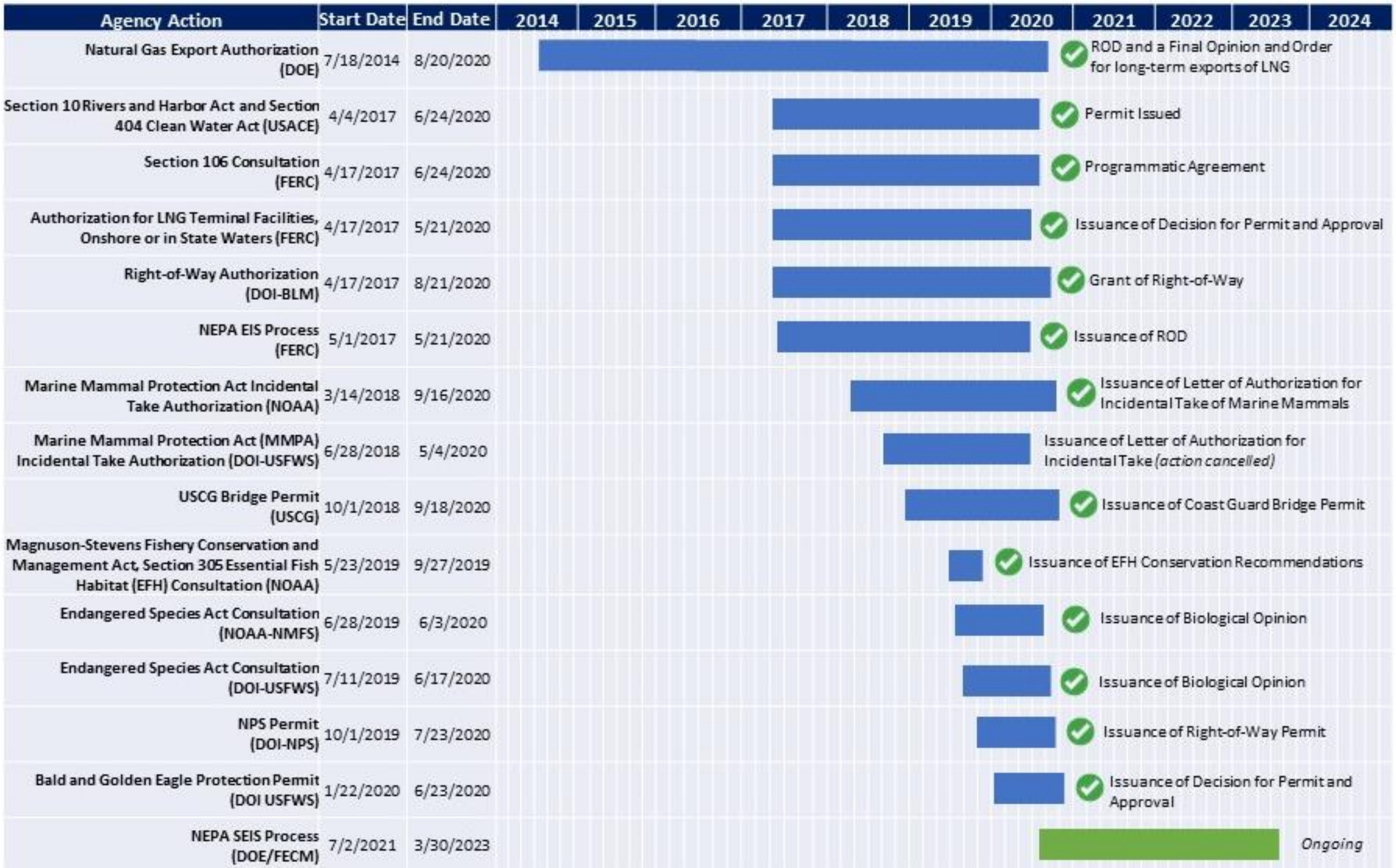
1.6 PERMITS, APPROVALS, CONSULTATIONS, AND REGULATORY REQUIREMENTS

Section 1.6 of the 2020 EIS contains information about regulatory requirements of federal laws and state requirements that involve consideration of the proposed Project's potential impact on a range of environmental resources. This includes compliance with the following regulations, which were taken into account in the preparation of the 2020 EIS:

- Section 7 of the Endangered Species Act of 1973 (ESA),
- Section 106 of the National Historic Preservation Act of 1966 (NHPA),
- Migratory Bird Treaty Act of 1918 (MBTA),
- Magnuson-Stevens Fishery Conservation and Management Act of 1976,
- Bald and Golden Eagle Protection Act of 1940,
- Marine Mammal Protection Act of 1972 (MMPA),
- Rivers and Harbors Act of 1899 (RHA),
- Clean Water Act of 1972 (CWA),
- Safe Drinking Water Act of 1974 (SDWA),
- Clean Air Act of 1963 (CAA),
- Federal Land Policy and Management Act of 1976,
- Marine Protection, Research, and Sanctuaries Act of 1972,
- Wild and Scenic Rivers Act of 1968,
- Mineral Leasing Act of 1920,
- National Trails Systems Act of 1968, and
- Alaska National Interest Lands Conservation Act of 1980 (ANILCA).

Figure 1.6-1 provides an update of actions or decisions made by agencies undertaking federal authorizations regarding the proposed Project since issuance of the 2020 EIS. As indicated in the figure, all permitting and approvals for the proposed Project are complete with the exception of DOE's preparation of this **Final** SEIS.

In addition to the federal permits and approvals summarized here for the proposed Project, upstream development activities that would be led by other private entities on the North Slope, discussed in Section 4.19 of the 2020 EIS, and additional infrastructure development, discussed in Chapter 2, Proposed Agency Action and Alternatives, of this **Final** SEIS, would require future federal approvals. This includes authorizations from the USACE and USEPA, and consultations with various resource agencies, such as the USFWS and NMFS. The USACE would determine whether to issue a permit for construction of these projects under Section 404 of the CWA and Section 10 of the RHA. In addition, the USACE would likely be the lead agency responsible for conducting environmental reviews of these projects under NEPA (see Section 2.5 for further details). Chapter 4, Impacts of the Proposed Action, of this **Final** SEIS includes a discussion of the potential for additional future approvals and requirements by resource for upstream development activities within the North Slope.



✅ = authorization/permit completed; BLM = Bureau of Land Management; DOE = Department of Energy; DOI = Department of Interior; EFH = Essential Fish Habitat; EIS = Environmental Impact Statement; FECM = Office of Fossil Energy and Carbon Management; FERC = Federal Energy Regulatory Commission; LNG = liquefied natural gas; MMPA = Marine Mammal Protection Act; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NPS = National Park Service; ROD = Record of Decision; SEIS = Supplemental Environmental Impact Statement; USACE = U.S. Army Corps of Engineers; USCG = U.S. Coast Guard; USFWS = U.S. Fish and Wildlife Service

Figure 1.6-1. Status of Federal Permits and Approvals for the Alaska LNG Project

1.7 ORGANIZATION AND CONTENTS OF THE FINAL SEIS

The balance of this **Final** SEIS is organized into the chapters with associated contents described below.

Chapter 2, Proposed Agency and Action Alternatives, briefly summarizes the contents of the 2020 EIS and describes AGDC's Proposed Action, the No Action Alternative, and alternatives considered in the 2020 EIS but determined not to be reasonable. The chapter also describes potential scenarios related to upstream development and findings of the LCA Study as it relates to DOE's Proposed Action to meet its obligation under Section 3(a) of the NGA. The discussion considers the Request for Rehearing of the Alaska LNG Order to further evaluate the environmental impacts considering the potential environmental effects of natural gas production on the North Slope (i.e., the upstream analysis), the global nature of GHG emissions associated with exports of LNG from Alaska from a life cycle perspective, and the two recent Executive Orders: E.O. 13990 and E.O. 14008.

Chapter 3, Affected Environment, describes the baseline conditions on the North Slope. Each section describes the region of influence (ROI) of relevant project activities as part of this **Final** SEIS and applicable regulations. The chapter also includes a discussion of GHGs and the latest studies in climate change and predicted regional effects.

Chapter 4, Impacts of the Proposed Action, describes the method of analysis and discusses the potential impacts from upstream development and the No Action Alternative for the resource topics evaluated in the 2020 EIS. The chapter also considers findings of the LCA Study and relevance to climate change and the proposed Project's potential contribution to climate change. As appropriate for each resource, the chapter describes measures to mitigate adverse impacts, potential cumulative impacts, and other subjects required by NEPA and CEQ regulations.

Chapter 5, Regulatory and Permit Requirements, summarizes the required regulatory approvals and permitting required for any upstream development activity on the North Slope.

Chapter 6, Mitigation Measures, provides a consolidated summary of potential mitigation measures, best management practices (BMPs), and plans that could apply to each environmental resource area.

The final chapters provide technical references (Chapter 7, References), the distribution list for the **Final** SEIS (Chapter 8, Distribution List), and a list of **Final** SEIS preparers (Chapter 9, List of Preparers).

The Final SEIS Appendices located in Volume 2 include Appendix A, Agency and Alaska Native Coordination; Appendix B, North Slope Production Study; Appendix C, Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project; Appendix D, Comment Response Document; and Appendix E, Social Cost of Greenhouse Gases. All references and any additional supporting documents, data and analyses will be included in the final administrative record for this SEIS.

2.0 PROPOSED AGENCY ACTION AND ALTERNATIVES

This chapter presents a summary of Alaska LNG Project components and alternatives to orient the reader toward the locations of detailed discussions in the 2020 EIS. The summary is followed by a discussion of resources used to identify potential upstream development activities including information from the 2020 EIS, a DOE-initiated study of North Slope production effects, and the LCA Study. Then, this chapter provides a discussion of the Proposed Action and alternatives considered in the **Final** SEIS, followed by a discussion of construction procedures focusing on unique construction procedures for the North Slope. Finally, this chapter presents an overview of environmental inspection, compliance monitoring, and post-construction monitoring requirements; and operational, maintenance, and safety procedures related to the upstream development activities.

2.1 ALASKA LNG PROJECT

2.1.1 Summary of Project Components and Alternative Analysis from the 2020 EIS

In the 2020 EIS, FERC identified and independently evaluated reasonable alternatives to the proposed Project and its various components to determine whether any such alternatives would have significant environmental advantages. This included evaluation of the No Action Alternative, system alternatives, Gas Treatment Facilities alternatives, Mainline Pipeline route and aboveground facility alternatives, Liquefaction Facilities alternatives, and additional work area alternatives. Table 2.1-1 provides the location in the 2020 EIS for existing information related to the Alaska LNG Project and summarizes the information therein.

Table 2.1-1. Summary of Project Components Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
2.0	**Project Description**	Presented in Sections 2.1 through 2.6 (see details below).
2.1	**Proposed Facilities and Land Requirements**	
2.1.1	**Proposed Facilities**	The Alaska LNG Project would involve the construction and operation of Gas Treatment, Mainline, and Liquefaction Facilities. Once operational, AGDC states that the proposed Project facilities would each have a nominal design life of 30 years.
2.1.2	**Land Requirements**	Constructing the proposed Project would require the use of about 35,474 acres of land, of which approximately 16,069 acres of land (45 percent) would be permanently affected by the proposed Project. Table 2.1.2-1 of the 2020 EIS provides a detailed breakdown of land requirements by Project component.
2.1.3	**Gas Treatment Facilities**	Includes the GTP, West Dock Causeway, gravel mine, water reservoir, PBU Gas Transmission Line (PBTL), PTU Gas Transmission Line (PTTL), and additional work areas.
2.1.4	**Mainline Facilities**	Includes the Mainline Pipeline, aboveground facilities, and additional work areas.
2.1.5	**Liquefaction Facilities**	Includes the LNG Plant, Marine Terminal, and additional work areas.

Table 2.1-1. Summary of Project Components Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
2.2	**Construction Procedures**	Discussion includes special construction considerations for work in areas containing permafrost, crossing of roads, pipelines, and utilities, wetland and waterbody crossings, offshore construction procedures, fault crossings, winter construction procedures, and conditions for post-construction restoration and monitoring. Table 2.2-1 of the 2020 EIS includes information on construction- and restoration-related environmental plans that AGDC would prepare and implement to reduce environmental effects.
2.3	**Construction Schedule and Workforce**	Construction and commissioning of the Alaska LNG Project would take about 8 years to complete with two phases of construction. The first phase (6 years) would involve installation of the LNG Plant, Marine Terminal, Mainline Facilities including compressor stations, GTP trains, PBTL, and PTTL to a point that would allow transport and export of the first production of LNG. The second phase (2 years) would include completion of the remaining Project facilities (additional trains and compressor stations) required for full production.
2.4	**Environmental Inspection, Compliance Monitoring, and Post-Construction Monitoring**	Outlines the Environmental Inspection, Compliance Monitoring, and Post-Construction Monitoring requirements and commitments to which AGDC would adhere.
2.5	**Operation, Maintenance, and Safety Procedures**	AGDC would operate and maintain the proposed Project in accordance with PHMSA regulations in 49 CFR 192, the Commission's guidance at 18 CFR 380.15, and the maintenance provisions of the Project Plan and Procedures. As required by 49 CFR 192.615, AGDC would establish a Pipeline Right-of-Way Operational Monitoring and Maintenance Plan (Pipeline Operation and Maintenance Plan) that includes procedures to minimize the hazards (e.g., fire, combustible gas leaks, and low temperature LNG spills) in a natural gas pipeline and an emergency response program. The program would outline the potential hazards associated with Project facilities; the communication protocols with fire, police, and public officials; and prevention measures undertaken to minimize community impacts.
2.6	**Operations Workforce**	The proposed Project and future upstream facilities would be operated in compliance with federal and state workforce regulations and programs. The anticipated workforce associated with operations of the Gas Treatment Facilities is 125 on-site workers and 170 permanent support workers at AGDC's Anchorage office; 225 workers and 105 permanent support workers in Anchorage for Mainline Facilities; and 310 workers in the Nikiski and Kenai/Soldotma areas with 70 support workers in Anchorage for Liquefication Facilities.

AGDC = Alaska Gasline Development Corporation; CFR = *Code of Federal Regulations*; EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; GTP = Gas Treatment Plant; LNG = liquefied natural gas; PBU = Prudhoe Bay Unit; PBTL = Prudhoe Bay Unit Gas Transmission Line; PHMSA = Pipeline and Hazardous Materials Safety Administration; PTTL = Point Thomson Unit Gas Transmission Line; PTU = Point Thomson Unit

The 2020 EIS evaluated a wide range of potential system alternatives, alternative designs, and feasible locations (see Table 2.1-2 for a high-level summary or Section 3.2 of the 2020 EIS for additional detail).

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS			
Section		**Heading**	**Section Highlights**
3.0		**Alternatives**	FERC evaluated a range of reasonable alternatives to the proposed Project and its components to determine whether any would have significant environmental advantages over the Proposed Action. An alternative would be preferable to the Proposed Action if it meets the stated purpose of the proposed Project, is technically and economically feasible, and offers a significant environmental advantage.
3.1		**No Action Alternative**	The CEQ regulations for implementing NEPA require FERC to consider and evaluate the No Action Alternative. If the No Action Alternative is selected, the proposed facilities would not be constructed, and the associated environmental impacts would not occur. Additionally, the opportunity to commercialize North Slope natural gas would not be realized, and in-state deliveries of natural gas through interconnections would not be achieved. As part of the 2020 EIS No Action Alternative, FERC considered that if the proposed Project was not constructed, another project would likely be developed to transport natural gas for export and for in-state deliveries. Any future project would have environmental effects similar to those described in the EIS; as such, the No Action Alternative was dismissed from further consideration.
3.2		**System Alternatives**	System alternatives would make use of other existing or proposed facilities to meet the objectives of the proposed Project. The purpose of identifying and evaluating system alternatives is to determine whether the environmental impacts associated with Project construction and operation could be avoided or reduced by using existing facilities.
	3.2.1	**Existing and Proposed Alaska System Alternatives**	The Kenai LNG Terminal is located in Nikiski, about 0.5 mile north of the proposed Liquefaction Facilities site. However, it is not able to accommodate the 20 MMTPA design capacity of the proposed Project, and the Kenai LNG Terminal would not be able to meet the proposed Project objective in its current configuration. The terminal cannot be expanded due to insufficient land available and adjacent development. Therefore, using the Kenai LNG Terminal would not meet the proposed Project purpose. The ASAP Project is designed to deliver natural gas from the North Slope to south-central Alaska. However, this project does not include an LNG export terminal and would not meet Project objectives. Modifying the ASAP Project to include an LNG export terminal would require a significant expansion of the ASAP Project pipeline, which would result in significant environmental impacts. Therefore, there would be no significant environmental advantage to modifying the ASAP Project. Qilak LNG has announced plans for an LNG liquefaction facility on the North Slope that would ship LNG to Asian markets. However, this project would be designed to export 4 MMTPA of LNG compared to 20 MMTPA for the proposed Project. There would be fewer terrestrial environmental effects from the Qilak LNG Project due to not needing pipeline. However, impacts on the marine environment and vessel traffic would be greater. Therefore, there would be no significant environmental advantage.
	3.2.2	**Existing and Proposed Canadian and Contiguous United States System Alternatives**	A number of existing and proposed LNG export terminals on the coasts of Canada and the contiguous United States could be expanded or modified to export additional LNG. However, any of these facilities would need additional liquefaction infrastructure and potentially expanded docking facilities to meet the additional export

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS			
Section		**Heading**	**Section Highlights**
			capacity of the proposed Project. Any new terminal would have large environmental impacts, and using one of the existing or proposed LNG export terminals would require constructing a much longer pipeline from the North Slope. Therefore, these alternatives would not offer a significant environmental advantage and are not feasible.
	3.2.3	**Natural Gas Export via Pipeline**	FERC considered an alternative that would use a pipeline to export natural gas to markets outside North America. A subsea pipeline to Asian markets would require crossing the northern Pacific Ocean, which has an average depth of 13,000 feet. FERC is not aware of any subsea pipelines constructed at this depth, and even if it were feasible to construct, the costs would be prohibitive. Constructing a natural gas pipeline to a foreign market is neither technically nor economically practical, nor would it offer a significant environmental advantage over the proposed Project. Therefore, it is not considered further.
3.3		**Gas Treatment Facilities Alternatives**	Feedback from interagency meetings recommending explaining why the GTP site could not be sited away from the North Slope. Locating the GTP site at the pipeline terminus at or near the Liquefaction Facilities would not meet the proposed Project objective of providing in-state deliveries. Moving the GTP away from the North Slope would reduce efficiencies and increase costs. Without additional pipeline infrastructure, the proposed Project would not be able to provide the GTP by-product stream to the PBU for reinjection. Locating the GTP at the beginning of the Mainline Pipeline allows the system to transport dry "pipeline-quality" gas suitable for domestic and industrial consumption, reducing corrosion risks caused by the presence of CO_2, H_2S, and water within the raw gas produced from the PBU and PTU. Based on USEPA recommendations, the EIS evaluates alternative GTP sites and facility configurations.
	3.3.1	**GTP Alternative Sites**	FERC evaluated four alternative North Slope locations as potential GTP sites. The North of Put-23 Site and the Northwest of PBU CGF Site compare closely with the proposed site and would affect the same acreage of wetlands. The Southwest of Deadhorse Airport Site is the farthest from the PBU CGF. The additional distance would affect 11 more acres of wetlands than the proposed site and would require more compression to move gas to the site. The North of PBU CGF Site would avoid the need to transport modules over land but would require construction of a new dock. This alternative would not utilize the existing West Dock Causeway, would require extensive dredging, and would cause 23 acres of additional wetland impacts over the Proposed Action. None of these four alternatives would reduce impacts on wetlands, and none would provide a significant environmental advantage over the proposed site.
	3.3.2	**Alternative GTP Facility Configurations**	FERC evaluated alternative configurations for the GTP pad and operations center/camp pad, as well as GTP facility access roads and wastewater disposal. No alternative configuration of the GTP pad would meet all relevant regulations, codes, and guidelines. AGDC evaluated collocating the operations center with the processing facilities on the GTP pad to reduce the overall footprint. However, safety considerations and nearby waterbodies and infrastructure constrain space available for this. Therefore, no alternative facility configurations are technically practical. Alternatives to the proposed access roads to the Gas Treatment Facilities included seasonal ice roads and different road routes. Ice roads would not meet AGDC's need for year-round access.

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
		Alternative routes would include the road length. The minor reduction in wetland impacts achieved by an alternative would not offset the increased air impacts and would not provide a significant environmental advantage over the proposed access road route. Use of existing permitted UIC Class I injection wells was evaluated as a potential alternative to the proposed two new injection wells at the GTP site. However, the nearest existing injection well is about 5.4 miles south and is inactive. Three active injection wells are located about 7.7 miles east of the proposed site. The capacities of these wells are unknown, but construction of a wastewater pipeline to reach them would disturb at least 93 acres, most of which are wetland. As such, existing wells were not considered further because they would not provide a significant environmental advantage over the proposed new injection wells at the GTP site.
3.3.3	**Module Delivery System Alternatives**	FERC evaluated several alternatives to the proposed module delivery system. Use of larger or smaller modules would not reduce environmental impacts. Transporting modules from the south via the Dalton highway or via a combination of rail and highway (versus the proposed delivery by barge) would require major infrastructure modifications. Doubling the width of the Dalton Highway and widening and/or strengthening multiple bridges would allow for delivery of smaller module components but would result in substantial environmental impacts. Consequently, this alternative would not provide a significant environmental advantage. Fabricating the modules onsite could eliminate the need for major dock and road improvements. However, components exceeding the maximum load allowance of 100 tons on the Dalton Highway would still need to be brought to the West Dock Causeway by barge and transported by truck over the same access road as the Proposed Project. On-site fabrication of the necessary GTP components would also require more than 200 additional acres of workspace at the 228-acre site and would increase the construction duration by 2 to 3 years. Therefore, on-site fabrication would not provide a significant environmental advantage to the proposed delivery system.
3.3.4	**North Slope Dock Alternatives**	FERC evaluated five alternative docking locations to the proposed West Dock Causeway modifications for delivery of gas treatment unit modules to the GTP site. Each alternative site would require the construction and use of an expanded access road network. Extended travel time adds impacts on air quality and noise. All of the alternative dock sites require dredging, which the proposed site would not. None of the alternative dock sites would provide a significant environmental advantage.
3.3.5	**West Dock Causeway Alternatives**	FERC evaluated alternatives that would require less marine disturbance than the proposed use of, or upgrades to, the West Dock Causeway infrastructure. Two alternatives would require significant amounts of dredging and causeway upgrades similar to the proposed site. Therefore, they would not provide any significant environmental advantage. The Dock Head 2 Alternative would eliminate the need to upgrade the causeway to the proposed Dock Head 4. However, it would require the dredging of 4.5 million cubic yards of material. Additionally, there is a risk of sedimentation infill, which could require additional dredging in the summer prior to each sealift. Impacts to the marine environment would therefore far exceed those caused by upgrading the existing causeway and related bridges.

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
3.3.6	**Gravel Mine Site Alternatives**	Use of an existing gravel mine was evaluated as an alternative to the proposed new mine. Two existing mines, the Put-23 and Pit-203 sites, lie farther from the GTP site than the proposed new mine site. Use of these existing mine sites exclusively would result in wetland impacts similar to the proposed new mine site. Use of these existing mine sites would also involve incrementally greater haul distances; air emissions would be greater in proportion to the haul distances. Therefore, sourcing granular fill from existing mines would not provide a significant environmental advantage over the proposed new site.
3.3.7	**Water Supply System**	Existing municipal water sources and natural lakes were evaluated as potential alternatives to the proposed construction of a Project-specific reservoir. Obtaining water from the North Slope Borough's water treatment facility would require construction of an 8-mile-long pipeline and disturbance of about 100 acres. Moreover, the water treatment plant would need to be expanded to meet the needs of the proposed Project and would result in environmental impacts. Therefore, this is not a technically practical alternative, nor does it provide a significant environmental advantage over the proposed water supply system. The saltwater treatment plant at the West Dock Causeway is not a technically practical alternative because the process removes oxygen from the water but does not desalinate it. Additional treatment would still be required. Using existing lakes and mine sites would depend on trucks to haul process water to the GTP site on a more-or-less continuous basis. In addition, a number of natural lakes near the GTP have the capacity of meeting the proposed Project's annual water demands but freeze to the bottom part of the year and would be unable to provide water year-round. This reduced reliability of water would pose an unacceptable risk to GTP operation. Deepening natural lakes would require excavation and disposal of large volumes of sediment. This would affect water quality, aquatic resources, and wetlands. There would be no significant environmental advantage in deepening natural lakes. Existing flooded gravel mine sites were considered as potential sources, but most of this water has been allocated to other uses. The uncommitted volume of water is not sufficient to meet the proposed Project needs. Such options are not technically practical alternatives to the construction and use of a Project-specific reservoir. Appendix J of the 2020 EIS details potential surface water resources that could support the proposed Project.
3.4	**PTTL Alternatives**	FERC did not identify any alternative gas transmission alternatives for the PTTL that could provide a significant environmental advantage over the proposed route. Existing VSMs supporting other pipelines are not designed to accommodate an additional large-diameter pipeline.
3.5	**PBTL Alternatives**	Because of its short (1-mile) length, limited resource impacts, and the lack of other options to avoid resources, FERC's analysis of the PBTL did not identify any siting alternatives that could reduce impacts while still meeting the proposed Project's objectives.
3.6	**Mainline Pipeline Route Alternatives**	Commentors requested evaluations of alternative Mainline Pipeline routes. Many of the considered variations have already been incorporated into the proposed Mainline Pipeline route evaluated in

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
		Section 4.0 of the 2020 EIS. Additional alternatives are considered in the following subsections.
3.6.1	**Cook Inlet Alternatives**	Concerns related to the proposed route across the Cook Inlet were related to impacts on beluga whales, safety, dredging, fishing operations, and salmon streams. Two alternatives were considered. The East Alternative would add about 13 miles to the proposed pipeline length and disturb over 200 additional acres. In addition, the East Alternative would cross 24 miles of sensitive beluga whale critical habitat. However, it would cross 14 fewer waterbodies than the proposed route. The East Alternative's advantage in reducing the number of waterbody crossings is more than offset by its greater marine impacts, especially to the federally listed beluga whale. It would not provide a significant environmental advantage over the proposed route. The West Alternative would result in an additional 2.6 miles of impact on beluga whale critical habitat and have a greater construction footprint. However, it would affect less forested land, devilsclub habitat, and wetlands than the proposed route. Landfall alternatives in Nikiski Bay present problems associated with proximity to existing pipelines. The West Alternative would provide certain advantages compared to the proposed route; however, it would not provide a significant environmental advantage.
3.6.2	**Denali Alternatives**	FERC evaluated suggested alternative routes in or near the Denali National Park and Preserve. A comment suggested a route adjacent to the west side of the Parks Highway; however, this route would encroach on the designated Denali Wildlife Area and was not considered. FERC did consider a route using the Nenana River Bridge and Park Station. This would avoid disruptions to pedestrian traffic but would significantly disrupt vehicle traffic on the highway bridge, requiring a 69-mile-long detour for trucks during the construction period. While technically feasible, the resulting disruption of critical transportation service would render the alternative incapable of providing a significant environmental advantage. Selection of either the proposed route or the Denali Avoidance Alternative would be acceptable, without significant environmental advantages from either; the overall impacts from either route would be comparable.
3.6.3	**Fairbanks Alternative**	FERC considered a route alternative that would locate the Mainline Pipeline closer to the City of Fairbanks, shortening the length of any future interconnecting pipeline. This alternative would decrease the length of a future lateral to Fairbanks by about 25.7 miles, but it would increase the length of the larger diameter Mainline Pipeline by about 37.5 miles, resulting in a greater overall environmental impact. About 370 additional acres would be disturbed under the Fairbanks Alternative. This alternative would also affect a greater number of wetlands and waterbodies than the proposed route. Overall, the Fairbanks Alternative does not provide a significant environmental advantage over the proposed route.
3.7	**Mainline Pipeline Aboveground Facility Alternatives**	FERC considered two mainline pipeline aboveground facility alternatives.
3.7.1	**Aboveground Pipeline Alternative**	The Aboveground Pipeline Alternative, while technically feasible, is not technically practical due to the risk to normal commercial facility operations posed by condensation of the gas stream. The estimated

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
		34 acres of permafrost avoided by the alternative is not a significant environmental advantage to the proposed construction method.
3.7.2	**Compression Alternatives**	FERC evaluated using electric-driven compressors to reduce noise levels and air emissions. However, the required electricity would likely be generated by older coal- and oil-fired power plants. Because combustion of coal and oil emits more pollutants than natural gas, the overall air quality benefits favor the proposed gas-fired turbine design. Electric-driven compressors would not provide a significant environmental advantage over the proposed gas-fired, turbine-driven compressors.
3.8	**Liquefaction Facilities Alternatives**	FERC evaluated several alternatives for the liquefaction facilities, as well as alternative dredged material disposal locations for construction of the proposed Liquefaction Facility site at Nikiski. Siting the LNG facility on the North Slope is not technically practical due to the limited ice-free window (2-3 months per year), and the shallow Beaufort Sea would not accommodate LNG carriers until about 20 miles offshore. Construction of the Liquefaction Facilities and GTP would require module delivery to both sites at the same time. If both sites are on the North Slope, additional docking facilities would be required. Other sites beyond the Cook Inlet-to-Prince William Sound area were not considered reasonable alternatives due to ice-cover restrictions, lack of infrastructure, and potential impacts to environmentally sensitive areas.
3.8.1	**Liquefaction Facilities Site Alternatives**	FERC evaluated the seven site alternatives identified by AGDC, as well as the associated pipeline. Screening criteria included a waterfront site of at least 400 acres with a minimum depth of 53.5 feet to allow for safe transit and berthing in Cook Inlet. Additional factors included proximity to existing infrastructure, ice conditions, avoidance of geological hazards, and compatible existing land uses. None of the seven alternative sites considered by AGDC for construction of the Liquefaction Facilities would provide a significant environmental advantage over the proposed site.
3.8.2	**Dredged Material Placement Alternatives**	USEPA recommended that the EIS evaluate alternative dredging methods and disposal sites against the proposed disposal of dredged material at one of two open water disposal locations. One currently permitted dredge spoil disposal area exists in Cook Inlet, but it is too far from the dredging area for Project use. It is also only permitted for USACE-dredged material and is unavailable for private use. AGDC did not identify any known upland sites in the Project area that need, or are seeking, large volumes of fill. Sites farther from the Project area would likely have greater environmental impacts. Using dredged spoils for beach nourishment or coastal bluff erosion stabilization was dismissed as not a practical alternative to the proposed Project.
3.9	**Additional Work Area Alternatives**	FERC considered alternative locations, configurations, and transportation methods for the proposed Mainline MOF, proposed as a permanent facility adjacent to the existing Beluga barge landing facility. Road transport was considered but would require constructing a 50-mile-long access road, affecting over 240 acres. Compared to the proposed facility that would only disturb 6 acres, the road transport alternative would not provide any significant environmental advantage. FERC evaluated the use of two different existing berthing and docking facilities and the use of heavy-lift helicopters to transport

Table 2.1-2. Summary of Alternatives Analyzed within the 2020 EIS

Where Information for the Proposed Project is Found in 2020 EIS		
Section	**Heading**	**Section Highlights**
		materials to the Project area. However, none of these alternatives were technically practical or provided a significant environmental advantage over the Proposed Mainline MOF.
3.10	**Conclusions**	FERC evaluated alternatives, many of which appear to be technically feasible. However, none of the identified alternatives would provide a significant environmental advantage over the proposed Project. FERC concluded that the proposed Project, as modified by recommended mitigation measures, is the preferred alternative that can meet the proposed Project objectives.

AGDC = Alaska Gasline Development Corporation; ASAP = Alaska Stand Alone Pipeline; CEQ = Council on Environmental Quality; CGF = Central Gas Facility; CO_2 = carbon dioxide; EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; GTP = Gas Treatment Plant; H_2S = hydrogen sulfide; LNG = liquefied natural gas; MMTPA = million metric tonnes per annum; MOF = Material Offloading Facility; NEPA = National Environmental Policy Act; PBU = Prudhoe Bay Unit; PBTL = Prudhoe Bay Unit Gas Transmission Line; PTTL = Point Thomson Unit Gas Transmission Line; PTU = Point Thomson Unit; UIC = Underground Injection Control; USACE = U.S. Army Corps of Engineers; USEPA = U.S. Environmental Protection Agency; VSM = vertical support member

2.1.2 Alternatives Considered in the 2020 EIS

FERC concluded that based on the analysis conducted and comments received, many of the alternatives appear to be technically feasible; however, no alternative would provide a significant environmental advantage over the proposed Project. Therefore, FERC also concluded that the proposed Project, as modified by FERC's recommended mitigation measures (see Appendices X and Y of the 2020 EIS), is the preferred alternative that can meet the proposed Project objectives.

2.2 NORTH SLOPE PRODUCTION EFFECTS

As discussed in Section 1.1, on April 15, 2021, DOE granted a Request for Rehearing of the Alaska LNG Order based on the Sierra Club's September 21, 2020, Request for Rehearing. In the Rehearing Order, DOE stated that it was appropriate to further evaluate the potential environmental impacts associated with natural gas production on the North Slope from exporting LNG from the proposed Project to non-FTA countries. On July 2, 2021, DOE published its NOI in the *Federal Register* to prepare a SEIS for the Alaska LNG Project (DOE/EIS-0512-S1). DOE announced in the NOI and Rehearing Order that it would examine the potential environmental effects of natural gas production on the North Slope and the global nature of GHG emissions associated with exports of LNG from Alaska from a life cycle perspective. This **Final** SEIS presents the findings of DOE's study on and the potential environmental effects of upstream production on the North Slope and related life cycle GHG emissions. It also fulfills DOE's commitment to study these issues as part of the Alaska environmental study proceeding.

2.2.1 Summary of North Slope Development from the 2020 EIS

Section 4.19 of the 2020 EIS discusses potential development on the North Slope necessary to support the proposed Project's Major Gas Sales (MGS) under cumulative impacts. These activities are summarized below by Unit (PTU, PBU, and Kuparuk River Unit [KRU]). Although these activities are not part of AGDC's proposed Project and are being pursued by other entities, DOE is considering these activities involving the gas production related to the Project in this **Final** SEIS to understand the larger induced effects of the proposed Project from upstream development on the North Slope. As stated in Section 1.3, although the proposed PTTL would be constructed on the North Slope, this proposed pipeline is not re-evaluated in this **Final** SEIS as the proposed pipeline was analyzed in detail in the 2020 EIS as part of AGDC's Project. Section 2.5 contains a discussion of standard construction methods used on the North Slope which take into account the unique environment, including the common occurrence of permafrost. Some of these standard methods are included in the discussion below.

2.2.1.1 Point Thomson Unit (PTU)

As stated in the 2020 EIS, about 25 percent of the natural gas shipped on the proposed Project would originate from the Point Thomson Reservoir, a high-pressure gas condensate production field operated by **Hilcorp**. Existing facilities at the PTU are used to extract condensate from the reservoir through a process of cycling (i.e., reinjection of natural gas into the reservoir). The PTU Expansion Project proposed by ExxonMobil, as described in Section 4.19.2.1 of the 2020 EIS, would enhance and expand the existing facilities to produce natural gas for delivery to the proposed Project rather than reinjecting the gas back into the reservoir. The PTU Expansion Project would involve the following activities (see Figure 2.2-1 for additional details):

- Incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Figure 2.2-1 provides an example 7-acre area relative to the existing 51-acre Central Pad for illustrative purposes.
- Three new production wells would be drilled at the Central Pad.
- One existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Source: AGDC 2022

EIS = Environmental Impact Statement; PTTL = Point Thomson Unit Gas Transmission Line; PTU = Point Thomson Unit; ROW = right-of-way

Figure 2.2-1. Point Thomson Unit Central Pad

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost. A recent study published in Geosciences "S*imulating Thermal Interaction of Gas Production Wells with Relict Gas Hydrate-Bearing Permafrost*" found the radius of thawing around a gas well with non-insulated lifting pipes operating for 30 years may reach 10 meters (approximately 33 feet) or more, while in the case of insulated lifting pipes, no thawing would be expected (Chuvilin et al. 2022).

The PTU Expansion Project facilities would be fabricated off site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require maintenance dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed on land to the west of the Point Thomson marine facilities.

Further dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual winter ice road, and in the summer by barge or boat.

Construction of the PTU Expansion Project would occur over about 2 years beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at Point Thomson as well as existing or new camps at Prudhoe Bay and Badami.

The PTU Expansion Project would require the following authorizations and consultations with various resource agencies:

- A CWA Section 404 Permit and a RHA Section 10 Permit from the USACE. The USACE additionally would be the lead agency responsible for conducting an environmental review of the project under NEPA which would require the following consultations:
  - USFWS regarding species protected under Section 7 of the ESA and examination of impacts to migratory birds and bald and golden eagles under the MBTA and Bald and Golden Eagle Protection Act.
  - NMFS regarding species protected under the MMPA.
  - Alaska Office of History and Archaeology regarding Section 106 compliance under the NHPA.
- USEPA issued a permit (AK-1I015-B) on March 8, 2020, for the UIC Class I disposal well under the UIC program governing construction, operation, and closure requirements for injection wells to AGDC. Additionally, the USEPA would require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the CWA. If the project anticipates discharge of any pollutants into waters of the United States, Alaska Department of Environmental Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit.

At the state level, the Alaska Department of Natural Resources (ADNR) approved ExxonMobil's Plan of Development for the PTU Expansion in December 2017. In September 2018, ADNR and the PTU owners/operators agreed to an extension of a 2012 Settlement Agreement to align work commitments and timelines with the Alaska LNG Project. Under the extension, the PTU owners/operators will provide work plans to ADNR to develop Point Thomson for MGS within 90 days of a Final Investment Decision on the Alaska LNG Project.

Permits for water appropriation on a temporary basis and for operational purposes would be required from the ADNR, Division of Mining, Land, and Water. ADEC would determine whether to grant water quality certification under Section 401 of the CWA, a construction stormwater permit under Section 402 of the CWA, and a Prevention of Significant Deterioration (PSD) permit for air pollutant emissions. **A State of Alaska air quality construction permit would be required from ADEC for any new proposed emitting units. In addition, ADEC would also require an oil discharge prevention and contingency plan.** Wastewater disposal would require APDES permits from ADEC. The Alaska Department of Fish and Game (ADF&G) would determine whether to issue a Fish Habitat Permit for construction activities within fish-bearing streams.

The Alaska Oil and Gas Conservation Commission (AOGCC) would issue a Permit to Drill for development and injection wells and would also need to authorize gas production from the PTU. The AOGCC oversees oil and gas drilling, development and production, reservoir depletion, and metering operations on all lands subject to the state's policing powers. The AOGCC acts to prevent waste and improve ultimate recovery. Currently, PTU gas is reinjected into the field to enhance recovery of condensate. Numerous other minor state and local permits would be required as well.

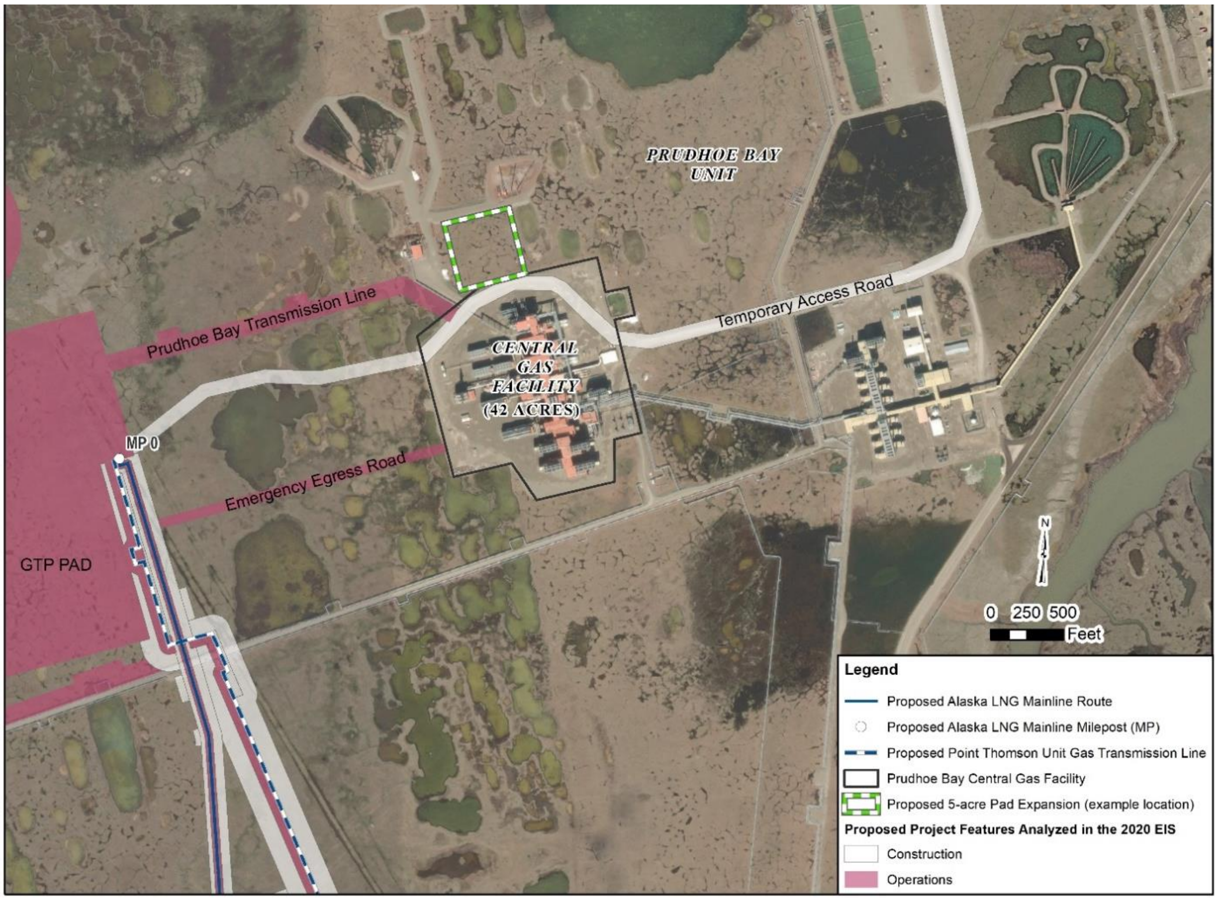
USEPA noted during the Draft SEIS public comment period that if the aggregate oil storage at the PTU reaches one million gallons or more, then a Facility Response Plan will need to be prepared and submitted to USEPA's Region 10 office in Anchorage in accordance with 40 CFR 112.20(a)2(iv).

2.2.1.2 Prudhoe Bay Unit (PBU)

As stated in the 2020 EIS, 75 percent of the natural gas expected to be transported by the proposed Project would come from PBU. Oil and natural gas are extracted from about 900 existing wells on 40 drilling pads at the PBU, but the gas is currently compressed and reinjected into the field. The PBU MGS Project, as described in Section 4.19.2.2 of the 2020 EIS, would expand and enhance the existing facilities within the PBU to produce natural gas for delivery to the proposed Project rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, totaling about 514 acres, and includes (see Figure 2.2-2 for additional details):

- A 5-acre expansion of the existing Central Gas Facility (CGF) pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering module for feed gas at the CGF. Figure 2.2-2 provides an example 5-acre area relative to the existing 42-acre CGF pad for illustrative purposes.
- Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad.
- A short, larger diameter pipeline to connect the new valve module with the new metering module on the same pad.
- A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date.

- Four new by-product pipelines measuring 25, 3, 8, and 8 miles in length (diameter to be determined) to send Gas Treatment Plant (GTP) by-product to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by vertical support members (VSMs), permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet).
- About 10 new production and injection wells could be drilled after the proposed Project is commissioned to enhance gas recovery at the PBU.
- Some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments), based on factors such as field efficiency, gas sales, gas injection, oil production, GTP by-product injection, and well integrity.



Source: AGDC 2022
EIS = Environmental Impact Statement; GTP = Gas Treatment Plant; LNG = liquefied natural gas; MP = Milepost

Figure 2.2-2. Prudhoe Bay Unit Central Gas Facility Pad

Construction of the PBU MGS Project facilities would occur during winter seasons over a 4- to 6-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project. Drilling would begin in Year 5 and be completed in Year 9 of the Alaska LNG Project. If necessary, to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU.

The PBU MGS Project would require environmental reviews and permits similar to the PTU Expansion Project, other than permits for injection wells, which are not proposed. The USACE would be the lead agency for conducting an environmental review of the project under NEPA. An application to the USACE for the PBU MGS Project has not been submitted. The AOGCC would also need to authorize gas production from the PBU. Currently, PBU gas is reinjected for enhanced oil recovery (EOR).

2.2.1.3 Kuparuk River Unit (KRU)

The 2020 EIS did not consider any activities within the KRU; however, DOE's North Slope Production Study identified this unit as a potential location for carbon dioxide (CO_2) EOR (see Section 2.2.2.2).

2.2.2 North Slope Production Study

DOE prepared a North Slope Production Study consisting of a series of three reports **(see Appendix B, North Slope Production Study)**. The study evaluates the capacity of natural gas supply from the PBU and PTU on the North Slope to meet the authorized LNG export volumes over the Project's operational lifetime (Production Report 1). The study also examines potential upstream production effects of existing oil and natural gas fields (Production Report 2). Lastly, the study considers options for the management of CO_2 produced by the proposed Project including EOR (Production Report 2) and geologic storage (Production Report 3). The DOE study assessed two reasonable options for management of the CO_2 removed from the natural gas to produce a marketable product. These carbon management options bound the range of high and low GHG intensity for management of CO_2 in the North Slope for consideration in this **Final** SEIS, though may not be the identical means or location for sequestration of CO_2 produced that is selected by Project operators. All three reports are provided in Appendix B, North Slope Production Study.

Commonly Used Terminology

Unit (e.g., Prudhoe Bay Unit [PBU]) is a conventional oil and gas field with common oil and gas facilities and infrastructure to support production activities. The boundary of the Unit is defined by the lease area of the pools that comprise the unit.

Pool (e.g., Prudhoe Oil Pool) is a subsurface accumulation of a resource. For the purpose of this **Final** SEIS, a pool could include oil or gas.

Fields can consist of one or more pools or distinct reservoirs within a single large impermeable rock formation.

Satellite Fields are production fields adjacent to or nearby the main field (e.g., Prudhoe Bay Oil Field has several Eastern and Western Satellite Fields including Aurora, Borealis, Orion, etc.).

Reservoir Interval is the subsurface accumulation of vertical reservoir segments that may contain the gross and net pay of hydrocarbon (i.e., petroleum) accumulations contained in porous or fractured rock formations.

Saline Aquifers are geological formations consisting of porous and water-permeable rocks that contain saline fluid in the pore spaces between the rock grains. CO_2 that has been pressurized to a phase between gas and liquid may be injected into a saline aquifer for storage.

Miscibility is the capability of two substances to mix and fully dissolve in each other to form a single phase that does not separate. For petroleum reservoirs, miscibility is defined as that physical condition between two or more fluids that will permit them to mix in all proportions without the existence of separation.

With DOE's authorization, the proposed Project could export up to 2.55 Bcf per day of natural gas over the term of authorization from its proposed LNG Facility in Nikiski to overseas markets. In addition to the authorized volumes of natural gas exports, notable volumes of natural gas would be produced for lease fuel, local sales, gas reinjection fuel for the existing Central Compressor Plant and the CGF, extraction of natural gas liquids, and for other uses. Operation of the Gas Treatment Facilities, the Mainline Pipeline, and the LNG Facility associated with the proposed Project would also require natural gas for fuel. Production of natural gas from the North Slope for the proposed Project would mark a considerable change in PBU management as oil production has, so far, been the primary objective. Currently, most of the gas produced on the North Slope is reinjected for pressure management or used for miscible gas injection to maintain oil production.

Natural gas produced by the proposed Project would be processed to remove CO_2 and other by-products from the gas stream before being conveyed through the Mainline Pipeline to the LNG Facility. DOE estimates the volume of by-product CO_2 to be separated by the GTP from the gross natural gas production stream from PBU and PTU to be 350 million cubic feet per day, equal to about **202** million metric tons of by-product CO_2 over the term of authorization. As explained in Section 2.1.3.1 of the 2020 EIS, the CO_2 removed from the natural gas stream would be sent to the PBU Treated Gas Distribution System as part of the PBU MGS Project. The 2020 EIS addressed the PBU MGS Project in Section 4.19.2 as a non-jurisdictional facility since it does not fall under the jurisdiction of FERC. As a result, management of the removed CO_2 was not fully analyzed in the 2020 EIS. The North Slope Production Study prepared to support this **Final** SEIS considers options for management of CO_2 produced by the proposed Project including EOR (Production Report 2) and geologic storage (Production Report 3) as discussed in Sections 2.2.2.2 and 2.2.2.3, respectively.

2.2.2.1 Production Report 1 – Establishing the Sources of Natural Gas Supply for the Alaska LNG Project

DOE developed Production Report 1, *Alaska LNG Upstream Study Report 1: Establishing the Sources of Natural Gas Supply for the Alaska LNG Project* (Kuuskraa et al. 2022a) to evaluate the capacity of natural gas supply from the PBU and the PTU on the North Slope to support the Alaska LNG Project for the term of authorization. Production Report 1 concludes "*…sufficient natural gas resources will most likely be available from PBU and PTU on the North Slope of Alaska to meet the authorized volumes of natural gas exports by the Alaska LNG Project… The PBU and PTU have available natural gas resources to provide essentially all 27.83 Tcf [trillion cubic feet] of the 27.87 Tcf of natural gas resources authorized for export*" (Kuuskraa et al. 2022a). The report, however, acknowledges achieving the volumes of natural gas supply and resource from the PTU and the PBU would likely entail some additional development:

- **Point Thomson Unit (PTU).** A fourth (new) production well on an existing well pad may be required. This fourth well is in addition to the three wells discussed in Section 4.19 of the 2020 EIS for the proposed Project (also refer to Section 2.2.1.1 of this **Final** SEIS). Combined, the four wells would support the estimated volume of natural gas production at PTU required to sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.
- **Prudhoe Bay Unit (PBU).** Ten additional new production and injection wells may need to be drilled to increase gas recovery at the PBU, which is consistent with Section 4.19 of the 2020 EIS for the proposed Project (also refer to Section 2.2.1.2 of this **Final** SEIS). The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. As stated in the 2020 EIS, and supported by Production Report 1, in addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others would be worked over (i.e., subjected to major maintenance or remedial treatments) to maintain production.

The 2020 EIS considered these development activities in the cumulative impacts analysis section (see Section 4.19.2 of the 2020 EIS) with the exception of the fourth new production well at PTU identified in Production Report 1. The fourth new well is also considered under the Proposed Action in this **Final** SEIS. Production Report 1 also concluded the start of the proposed Project would lead to lower volumes of gas available for reinjection causing the PBU reservoir pressure and the oil production to decline (see Table**s** 2.**2-**1 **and 2.2-2** for a comparison of oil and gas production related to the proposed Project).

2.2.2.2 Production Report 2 – Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential

DOE prepared Production Report 2, *Alaska LNG Upstream Study Report 2: Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential* (Wallace et al. 2022), to examine the impacts of the Alaska LNG Project on oil production at the PBU and to discuss options for utilizing the by-product CO_2 stream from the Alaska LNG GTP for CO_2 EOR operations on the North Slope.

As discussed in the 2020 EIS, the proposed Project would likely reinject by-product CO_2 into the Prudhoe Oil Pool to maintain reservoir pressure. Production Report 2, however, concludes that maintaining reservoir pressure above minimum miscibility pressure at the Prudhoe Oil Pool through injection of by-product CO_2 would not allow for gas production to meet the Alaska LNG pipeline demand of 2.55 Bcf per day. Therefore, in order to maintain MGS and to manage the by-product CO_2 from the GTP (approximately 350 million cubic feet per day), the CO_2 stream would not be reinjected into the Prudhoe Oil Pool. Rather, by-product CO_2 would need to be injected into oil pools outside of the Prudhoe Oil Pool, not involved in the MGS, or into saline formations. As a result, Production Report 2 also examines the potential for CO_2 storage with CO_2 EOR in the KRU next to the PBU.

To evaluate potential upstream effects on oil production, Production Report 2 focused on three potential cases (referred to as “scenarios” in this **Final** SEIS), including: (1) a “business as usual” baseline scenario that evaluates oil production without the proposed Project; (2) a Project scenario that considers oil production effects if by-product CO_2 produced is not used for EOR; and (3) a Project scenario that considers oil production effects if by-product CO_2 is used for EOR outside of the Prudhoe Oil Pool. Key features related to these scenarios and the North Slope are presented in Figure 2.2-3 and further described below.

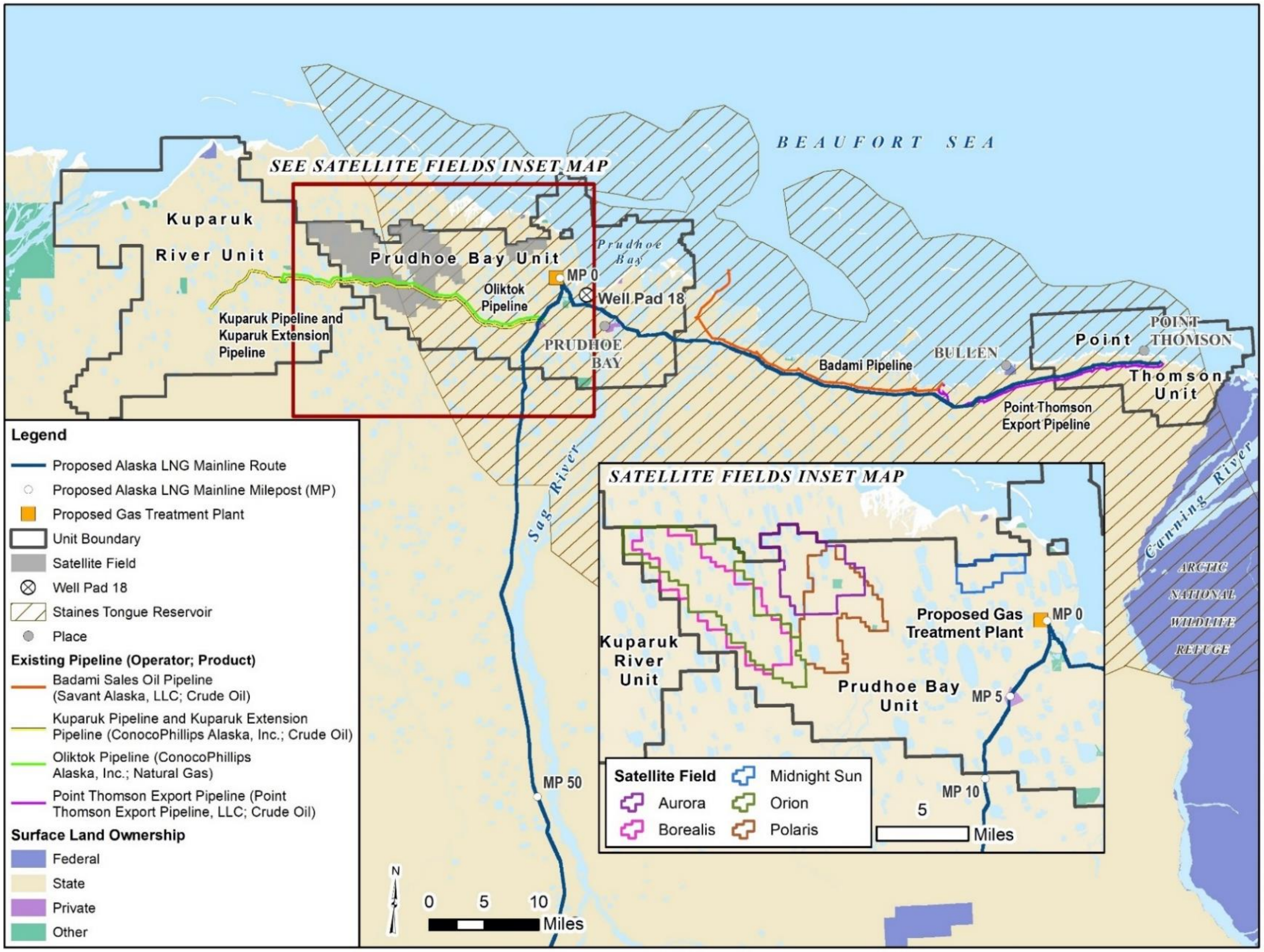
- **Scenario 1 “Business as Usual”.** This scenario examines the remaining oil production potential from the PBU without MGS and no Alaska LNG Project. The currently produced gas and its CO_2 content would continue to be reinjected into the PBU for pressure maintenance and miscible injection. This scenario essentially serves as the No Action case for th**e LCA Study**, with no development of a pipeline or other means to export gas from the PBU and PTU. **Without construction of the Alaska LNG Project, the LCA Study recognizes the possibility that continued gas demand of foreign markets would remain and could be fulfilled from an alternate source (i.e., an equivalent LNG and oil energy service is provided to society), so DOE modeled GHG emissions associated with LNG produced and supplied from the global market using the U.S. average production from the Lower 48 as a representative proxy. For purposes of the GHG analysis presented in this Final SEIS, Scenario 1 is referred to as No Action Alternative 1 (DOE LCA Study “Business as Usual" Scenario 1, Equivalent Energy). This Final SEIS also includes No Action Alternative 2 (SEIS Non-equivalent Energy Baseline), which presents GHG emissions related to a baseline (see Section 4.19), that only considers the GHG emissions associated with the estimated production of oil from the North Slope and the associated emissions from the transport, refining, and use of the oil. The No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) accounts for only the life cycle GHG emissions directly attributed to the energy production from the North Slope that would be impacted by the Alaska LNG Project. The No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) intentionally excludes GHG emissions from energy production from non-North Slope operations to meet equivalent LNG (and crude oil) services as described above as “No Action Alternative 1 (DOE LCA Study “Business as Usual” Scenario 1, Equivalent Energy)”. While presented in this Final SEIS and using data from the LCA, No Action Alternative 2 is not part of the LCA itself. Section 2.4, below, discusses these Alternatives further. Future net global changes in GHG emissions related to this Project, including those presented under Scenarios 2 and 3, would be driven by a range of factors, including, among others, future oil and gas market conditions, the adoption of policies and measures to limit GHG emissions, and the penetration of low-carbon energy sources.**

- **Scenario 2 "Reduced Gas Reinjection".** This scenario examines the reduction in oil production from the PBU given the decreasing volumes of gas injection and the steady decline in reservoir pressure due to the Alaska LNG Project. The start of a MGS project at the PBU would switch the priority of operations from oil production to gas production. As a result, reservoir pressure would steadily decrease as gas is extracted for MGS, reducing the volume of oil produced from the PBU. This scenario assumes that by-product CO_2 is not used in EOR and is stored in saline formations beneath the PBU. See Section 2.2.2.3 for a summary of Production Report 3, which addresses the feasibility of CO_2 storage. Also refer to Sections 2.2.1.1 and 2.2.1.2 for upstream development activities occurring in PTU and PBU required to support the proposed Project.
- **Scenario 3 "Use and Storage of By-product CO_2".** This scenario examines the potential for utilization and storage of the by-product CO_2 using CO_2 EOR. Production Report 2 models the injection of the by-product CO_2 into the nearby Kuparuk River Field to examine the KRU's capacity to store CO_2 and obtain an incremental increase in oil production. DOE has identified the KRU as a likely candidate for EOR due to its proximity to the PBU and its reservoir capacity for utilizing CO_2. EOR activities have occurred within KRU in the past; however, broader application of these activities has been constrained by the limited supply of miscible injectant (e.g., natural gas liquids or CO_2**)**. The volume of oil produced from PBU and from EOR activities at KRU related to Project-produced CO_2 is modeled to be slightly higher than the amount of oil produced under Scenario 1**. H**owever, these modeled estimates suggest **that** in practice the two scenarios have the potential to produce similar volumes based on known variability in future reservoir performance (see Section 2.3 for a comparison of oil and gas production among the scenarios). Scenario 3 would require an approximately 30-mile CO_2 pipeline to transfer the separated CO_2 from the proposed Alaska LNG Project GTP within the PBU to the KRU gas-handling operations. The CO_2 transportation pipeline would **be expected to** utilize existing or adjacent ROW to the maximum extent possible.

Currently, pipelines for sending natural gas liquids and returning produced oil are in place between PBU and the KRU. In 2020 KRU received an average of 65.8 million cubic feet per day of miscible injectant, which was utilized at 71 of the 334 existing injection wells on 24 drill pads. DOE assumes an adequate number of injection wells exist to support CO_2 EOR at KRU, without the need for drilling new injection wells. Existing injection wells would require some retrofitting, such as replacing the existing tubing with corrosion-resistant tubing. A new CO_2 distribution pipeline system would be required to deliver CO_2 from the KRU CO_2 gas-handling facilities to the injection well pads. The series of CO_2 distribution pipelines would connect consecutively from well pad to well pad and total approximately 19 miles. DOE assumes that any CO_2 distribution pipelines within KRU to transport CO_2 to individual injection wells would be located within or directly adjacent to existing pipelines that send natural gas liquids to the existing injection wells. The exact configuration and specifications for near and long-term development of a CO_2 EOR project at KRU would be determined by the project operator.

2.2.2.3 Production Report 3 – Storing By-product CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit

Production Report 3, *Alaska LNG Upstream Study Report 3: Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit* (Kuuskraa et al. 2022b), identifies and assesses the viability of storing the by-product CO_2 from the GTP in a deep saline reservoir at the PBU. Using a series of deep well logs at the PBU, including well logs from the PBU Western Satellite oil fields and from the Prudhoe Oil Pool, DOE identified the Staines Tongue of the Sagavanirktok Formation (see Figure 2.2-3) as a candidate saline formation for storing CO_2. The top of the Staines Tongue reservoir exists between 4,200 feet and 4,800 feet in the well log investigation area, providing a favorable depth for storing CO_2 in a dense phase. The gross thickness of the storage interval is 1,445 feet. Approximately 1,250 feet of shale overlies the Staines Tongue reservoir, which would likely provide a significant seal overlying the CO_2 storage formation.



Source: AGDC 2022; ADNR DOG 2021a, 2021b; BLM 2019; North Slope Science Initiative 2021; Wilson et al. 2015
LNG = liquefied natural gas; MP = Milepost

Figure 2.2-3. North Slope of Alaska Existing Features and Proposed Facilities

To evaluate the adequacy of the formation to store the approximately **202** million metric tons of CO_2 that would be produced by the Alaska LNG Project's term of authorization, DOE conducted geologic and reservoir modelling (sector model). The modelling provided estimates for the size of the CO_2 storage site that could be created, the number of CO_2 storage wells that would need to be drilled, and the spatial location of these CO_2 injection wells. The geologic storage site evaluated is located near the existing PBU gas processing plant and near the future site of the proposed GTP. This location would reduce the extent of new pipeline construction and infrastructure for the CO_2 storage operation. Production Report 3 concludes that infrastructure required for storing by-product CO_2 within the Staines Tongue of the Sagavanirktok Formation would include:

- Seven new CO_2 injection wells horizontally drilled from the existing Well Pad 18 with a maximum lateral distance of up to 2.5 miles from the pad. The Staines Tongue CO_2 storage project design within Production Report 3 considers lateral well placement that encompasses 6 square miles each for a total **reservoir study** area of 42 square miles. Each well could inject up to 50 million cubic feet of CO_2 per day, for a combined total daily injection volume of 350 million cubic feet per day, meeting by-product CO_2 storage needs of the Alaska LNG Project.
- A 3-mile CO_2 delivery pipeline would connect the GTP to the CO_2 injection wells at Pad 18.

Production Report 3 determined that after the term of authorization, the CO_2 plume could cover an area of up to 1.8 square miles in the top layer of the Staines Tongue formation (Kuuskraa et al. 2022b).

2.2.3 Life Cycle Analysis Study

DOE prepared a LCA Study, *Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project* (Skone et al. 2022), to quantify the potential life cycle GHG emissions from the implementation of the proposed Alaska LNG Project **(see Appendix C)**. **The DOE LCA Study is an attributional LCA that is not linked to analysis of potential energy market changes in alternate scenarios. The analysis in the LCA holds total oil and natural gas demand constant across scenarios – if oil or natural gas is not produced in one area, it will be produced in another.** The LCA Study evaluates the life cycle global warming potential of delivering LNG from Alaska to four destination countries: Japan, South Korea, China, and India. The LCA Study addresses scenarios identified in Section 2.2.2.2 and considers global warming potential effects of generating electricity with and without use of carbon capture and sequestration (CCS) in the LNG destination countries. The results of the LCA Study also provide cumulative emission profiles for each scenario over the entire timespan of the proposed Project. **The emission profile for Scenario 1 "Business as Usual" within the LCA Study recognizes the continued gas demand of foreign markets without the Alaska LNG Project (i.e., an equivalent LNG and crude oil service is provided to society). Scenario 1 is the basis for No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1) for the GHG analysis in Section 4.19.**

Recognizing the uncertainties in global energy supply and demand response that would result from not constructing the Alaska LNG Project, this Final SEIS also includes GHG emissions results for a "SEIS Non-equivalent Energy Baseline" for Scenarios 1, 2, and 3. Figure 4.19-1 in Section 4.19 provides an overview of the difference between the study boundaries for the SEIS Equivalent Energy LCA Study results and the alternative, Alaska only, SEIS Non-equivalent Energy Baseline results developed from the LCA Study emissions data. The other two scenarios (Scenario 2 "Reduced Gas Reinjection" and Scenario 3 "Use and Storage of By-product CO_2") presented in the LCA serve as Proposed Action alternatives for the GHG analysis in Section 4.19.

Global energy systems are dynamic and are currently in transition, with carbon reduction policies in place or under consideration in many countries, including the destination markets analyzed in this SEIS, creating uncertainty. The analysis does not attempt to account for future energy market changes and non-LNG or oil market substitution energy effects.

The No Action Alternative 1 and No Action Alternative 2 provide two different perspectives for assessing the cumulative GHG effects in comparison to the Proposed Action Scenarios 2 and 3 results. Future net global changes in GHG emissions related to this Project, including those presented under Scenarios 2 and 3, would be driven by a range of factors, including, among others, future oil and gas market conditions, the adoption of policies and measures to limit GHG emissions, and the penetration of low-carbon energy sources. No Action Alternative 1 compared to the Proposed Action scenarios summarizes the GHG effects based on the global perspective that if LNG and oil were not produced from this Project, they would be produced from another global source and result in GHG emissions. No Action Alternative 2 provides an estimate of GHG emissions that does not include any emissions associated with alternatives that could be used to provide the equivalent service to society that would be provided by the Project's LNG and oil. This SEIS presents these two No Action Alternatives because there is inherent uncertainty regarding the particular present or future supply and demand responses that would lead to net changes in production and consumption, and associated emissions, of LNG and oil that would be produced on the North Slope in association with the Project.

Table 2.2-1 compares oil and gas production and life cycle GHG emissions of the Proposed Action and the No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1). Table 2.2-2 compares oil and gas production and life cycle GHG emissions of the Proposed Action and No Action Alternative 2 (SEIS Non-equivalent Energy Baseline). These oil and gas production and GHG emissions estimates are based on the North Slope Production Study and the LCA Study, which are provided in **Appendix B, North Slope Production Study, and** Appendix C, Life Cycle Analysis Study, of this **Final** SEIS**. T**he results of the LCA Study and potential related environmental effects from GHG emissions under each **Alternative** are further discussed in Section 4.19, Greenhouse Gases and Climate Change.

2.3 PROPOSED AGENCY ACTION

DOE's Proposed Action is to meet its obligation under Section 3(a) of the NGA to authorize the export of natural gas, including LNG, unless it finds that the proposed export would not be consistent with the public interest. In considering this action, DOE **is** review**ing** its existing Alaska LNG Order, Sierra Club's Request for Rehearing, and two recent Executive Orders: E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad*. DOE has conducted further evaluation of the environmental impacts associated with the action and **is** consider**ing** the findings contained in this **Final** SEIS concerning impacts associated with potential development activities associated with natural gas production on the North Slope and the LCA Study. Following completion of the NEPA process, DOE intends to issue an order under Section 3(a) of the NGA in which DOE may exercise its authority to reaffirm, modify, or set aside the Alaska LNG Order.

Beyond the No Action Alternative, DOE did not identify any additional alternatives beyond those identified in the 2020 EIS. However, as part of DOE's assessment of potential upstream development and the LCA, DOE did consider a range of "scenarios" for the 2020 EIS Preferred Alternative regarding activities on the North Slope as described in Section 2.2.1. These scenarios represent a range of activities that could occur based on findings of the North Slope Production Study and considered in the LCA Study. Under the Proposed Action, where DOE would reaffirm or modify the order to authorize Alaska LNG to export LNG in a volume equivalent to 929 Bcf per year of natural gas (2.55 Bcf per day) over the term of authorization, DOE considers that development activities similar to those described under Scenario 2 and Scenario 3 would likely occur and are therefore analyzed in this **Final** SEIS. DOE consulted with AGDC regarding the scenario development for CO_2 management.

Table 2.2-1. Comparison of Oil and Gas Production and Life Cycle Greenhouse Gas Emissions between the No Action Alternative 1 (DOE LCA "Business as Usual" Scenario 1) and Upstream Development Scenarios

Activity	No Action Alternative 1 (DOE LCA "Business as Usual" Scenario 1)	Proposed Action Scenario 2 (PBU Storage)	Proposed Action Scenario 3 (KRU EOR)
Oil Production			
Oil Production (MMbbl)	1,402 (Total) 1,356 (PBU) 47 (Lower 48)	1,402 (Total) 849 (PBU) 554 (Lower 48)	1,402 (Total) 849 (PBU) 512 (KRU) [120 – 600][a] 42 (Lower 48)
Change in Oil Production (MMbbl) from No Action	0	0 (Total) -507 (PBU) +507 (Lower 48)	0 (Total) -507 (PBU) +512 (KRU) [120 – 600][a] -5 (Lower 48)
Major Gas Sales to GTP			
Major Gas Sales Production (Tcf)[b]	0	36.7	36.7
Change in Gas Production (Tcf) from No Action	0	+27.3 (PBU) +9.4 (PTU)	+27.3 (PBU) +9.4 (PTU)
Available Gas for LNG Export			
Available Gas for LNG Export (Tcf)[b]	27.83 (Lower 48)	27.83 (PBU + PTU)	27.83 (PBU + PTU)
Change in Gas Production (Tcf) from No Action	0	0 (Total) +27.83 (PBU+PTU) -27.83 (Lower 48)	0 (Total) +27.83 (PBU+PTU) -27.83 (Lower 48)
Carbon Dioxide Storage on North Slope of Alaska			
CO_2 Storage (Tcf) CO_2 Storage (MMmt)	0	3.84 202	3.84 202
Life Cycle Greenhouse Gas Emissions[c]			
End Use Power Generation (without CCS) in Receiving Destination			
Cumulative Life Cycle GHG Emissions (MMmt CO_2-eq)	3,011 to 3,023	2,737 to 2,797	2,737 to 2,797
Change in Life Cycle GHG Emissions Relative to No Action (MMmt CO_2-eq)	–	*-274 to -226*	*-274 to -226*
End Use Power Generation (with CCS) in Receiving Destination			
Cumulative Life Cycle GHG Emissions (MMmt CO_2-eq)	1,714 to 1,728	1,443 to 1,519	1,443 to 1,519
Change in Life Cycle GHG Emissions Relative to No Action (MMmt CO_2-eq)	–	*-271 to -209*	*-271 to -209*

[a] The range of 120 – 600 million barrels reflects uncertainty surrounding CO_2-EOR performance (see Table 4.19-3, footnote a). For modeling purposes, the DOE LCA Study used a volume of 512 million barrels.

[b] The PBU and PTU have available natural gas resources to provide essentially all – 27.83 Tcf of the 27.87 Tcf – of the natural gas resources authorized for export (Wallace et al. 2022). Given the conservative nature of the natural gas resources portion of the study, the recently recognized improved operating practices at the PBU (not included in the natural gas resources study), and inherent uncertainties during the authorized export term, the study determines that sufficient natural gas resources will be available to meet the authorized volumes of LNG exports. The difference between Major Gas Sales to the GTP and Available Gas for LNG Export is the reduction in 8.8 Tcf for extraction of CO_2 and fuel use of pipeline grade natural gas to support the GTP, gas pipeline, and liquefaction operations.

[c] GHG emissions for power generation with and without CCS are provided for comparison only. CCS may be implemented by the end users of exported LNG and would not be related to oil and gas production on the North Slope.

CCS = carbon capture and sequestration; CO_2 = carbon dioxide; CO_2-eq= carbon dioxide equivalent; EOR = enhanced oil recovery; GHG = greenhouse gas; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; LNG = liquefied natural gas; MMbbl = million barrels of oil; MMmt = million metric tons; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; Tcf = trillion cubic feet

Note: Totals may not add up due to rounding.

Table 2.2-2. Comparison of Oil and Gas Production and Life Cycle Greenhouse Gas Emissions between the No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) and Upstream Development Scenarios

Activity	No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)	Proposed Action Scenario 2 (PBU Storage)	Proposed Action Scenario 3 (KRU EOR)
Oil Production			
Oil Production (MMbbl)	1,356 (PBU)	849 (PBU)	1,360 (Total) 849 (PBU) 512 (KRU) [120 – 600][a]
Change in Oil Production (MMbbl) from No Action	0	-507 (PBU)	+4 (Total) -507 (PBU) +512 (KRU) [120 – 600][a]
Major Gas Sales to GTP			
Major Gas Sales Production (Tcf)[b]	0	36.7	36.7
Change in Gas Production (Tcf) from No Action	0	+27.3 (PBU) +9.4 (PTU)	+27.3 (PBU) +9.4 (PTU)
Available Gas for LNG Export			
Available Gas for LNG Export (Tcf)[b]	0	27.83	27.83
Change in Gas Production (Tcf) from No Action	0	+27.83	+27.83
Carbon Dioxide Storage on North Slope of Alaska			
CO_2 Storage (Tcf) CO_2 Storage (MMmt)	0	3.84 202	3.84 202
Life Cycle Greenhouse Gas Emissions[c]			
End Use Power Generation (without CCS) in Receiving Destination			
Cumulative Life Cycle GHG Emissions (MMmt CO_2-eq)	853	2,440 to 2,501	2,714 to 2,775
Change in Life Cycle GHG Emissions Relative to No Action (MMmt CO_2-eq)	–	*1,587 to 1,648*	*1,861 to 1,922*
End Use Power Generation (with CCS) in Receiving Destination			
Cumulative Life Cycle GHG Emissions (MMmt CO_2-eq)	853	1,146 to 1,223	1,420 to 1,496
Change in Life Cycle GHG Emissions Relative to No Action (MMmt CO_2-eq)	–	*293 to 369*	*567 to 643*

[a] The range of 120 – 600 million barrels reflects uncertainty surrounding CO_2-EOR performance (see Table 4.19-3, footnote a). For modeling purposes, the DOE LCA Study used a volume of 512 million barrels.

[b] The PBU and PTU have available natural gas resources to provide essentially all – 27.83 Tcf of the 27.87 Tcf – of the natural gas resources authorized for export (Wallace et al. 2022). Given the conservative nature of the natural gas resources portion of the study, the recently recognized improved operating practices at the PBU (not included in the natural gas resources study), and inherent uncertainties during the authorized export term, the study determines that sufficient natural gas resources will be available to meet the authorized volumes of LNG exports. The difference between Major Gas Sales to the GTP and Available Gas for LNG Export is the reduction in 8.8 Tcf for extraction of CO_2 and fuel use of pipeline grade natural gas to support the GTP, gas pipeline, and liquefaction operations.

[c] GHG emissions for power generation with and without CCS are provided for comparison only. CCS may be implemented by the end users of exported LNG and would not be related to oil and gas production on the North Slope.

CCS = carbon capture and sequestration; CO_2 = carbon dioxide; CO_2-eq= carbon dioxide equivalent; EOR = enhanced oil recovery; GHG = greenhouse gas; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; LNG = liquefied natural gas; MMbbl = million barrels of oil; MMmt = million metric tons; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; Tcf = trillion cubic feet

Note: Totals may not add up due to rounding.

The additional development activities under Scenarios 2 and 3 provide a basis for the evaluation of representative potential environment effects that could occur on the North Slope due to the proposed Project and are a focus of this **Final** SEIS. These activities are based on North Slope development activities identified in the 2020 EIS (see Section 2.2.1) and the potential scenarios presented in the North Slope Production Study (see Section 2.2.2). These scenarios do not represent specific actions that have been planned or proposed by the Applicant or others but are considered to represent a **reasonable** range of outcomes for the purpose of environmental impact analysis. Ultimately, the North Slope oil field operators, Alaska LNG, or other entities would select development and management options that best meet their operational requirements and economic criteria. Where possible, Chapter 4, Impacts of the Proposed Action, provides quantitative information based on the best existing and available information for the purpose of identifying the range of environmental effects that may occur under the Proposed Action. In the absence of specific planning or design information, DOE has also conducted qualitative analysis where appropriate to describe the types and range of impacts anticipated.

2.4 NO ACTION ALTERNATIVE

The CEQ regulations for implementing NEPA (40 CFR 1502.14(c) require federal agencies to consider and evaluate a No Action Alternative. On March 6, 2020, FERC issued the Final EIS for the Alaska LNG Project (2020 EIS). In evaluating the No Action Alternative, the 2020 EIS concluded that if the proposed Project was not constructed, environmental impacts would occur from the likely development of other LNG projects seeking to transport gas from the North Slope for export in foreign commerce and for in-state deliveries. The 2020 EIS determined that the development of these alternative projects would result in similar impacts and would not provide a significant environmental advantage over the proposed Project. The 2020 EIS, therefore, did not consider the No Action Alternative further.

DOE adopted the 2020 EIS on March 16, 2020. In its Request for Rehearing and petition for review of DOE's export authorization for the Alaska LNG Project, Sierra Club argued that DOE adopted an EIS that failed to meaningfully consider a No Action Alternative. Sierra Club asserted that a proper NEPA analysis must inform DOE of the consequences of refusing to approve any exports from Alaska to non-FTA countries altogether. Sierra Club also contended there is no factual support for the assumption that, if Alaska LNG's authorization to export LNG to non-FTA countries was denied, a comparable project would take its place.

The No Action Alternative considered in this **Final** SEIS assumes that the Alaska LNG Project would not be constructed and the associated environmental impacts from the proposed Project would not occur. The commercial prospects of an alternative project to the Alaska LNG Project are unclear. North Slope natural gas is challenged by the remote location of the gas supply and high estimated cost of bringing the gas to market. As a result, the natural gas supply is stranded on the North Slope without the infrastructure for transport to market. As with the Alaska LNG Project, infrastructure for an alternative project would also require the development of new natural gas production in an extreme environment, gas treatment, and construction of hundreds of miles of pipeline from the North Slope to a liquefaction facility and export point in southern Alaska. Therefore, if the Alaska LNG Project was not constructed, DOE considers it unlikely that an alternative LNG export project would be constructed to access natural gas reserves on the North Slope in the foreseeable future. Thus, the opportunity to commercialize North Slope natural gas would not be realized, and in-state deliveries of natural gas through interconnections would not be achieved. DOE, therefore, defines the No Action Alternative as lacking the potential environmental impacts, and potential benefits, that could occur through development and operation of the proposed Project.

In this Final SEIS, specifically for the GHG analysis (see Section 4.19.2), the No Action Alternative includes two different perspectives for assessing the cumulative GHG effects in comparison to the Proposed Action Scenarios 2 and 3 results, presented as No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1), which represents the same amount of LNG being supplied to the market, and No Action Alternative 2 (SEIS Non-equivalent Energy Baseline), which only presents

GHG emissions associated with the estimated production of oil from the North Slope and the associated emissions from the transport, refining, and use of the oil. No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) accounts for only the life cycle GHG emissions directly attributed to the energy production from the North Slope that would be impacted by the Alaska LNG Project. The No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) intentionally excludes GHG emissions from energy production from non-North Slope operations to meet equivalent LNG (and crude oil) services. This Final SEIS takes no position on whether there will be a market demand for the LNG produced by the Alaska LNG Project. The analysis presented in this Final SEIS examines the impacts that could occur if the LNG demand for the volumes associated with the Alaska LNG Project exist. Future net global changes in GHG emissions related to this Project, including those presented under Scenarios 2 and 3, would be driven by a range of factors, including, among others, future oil and gas market conditions, the adoption of policies and measures to limit GHG emissions, and the penetration of low-carbon energy sources. No Action Alternative 1 compared to the Proposed Action scenarios summarizes the GHG effects based on the global perspective that if LNG and oil were not produced from this Project, they would be produced from another global source and result in GHG emissions. No Action Alternative 2 provides an estimate of GHG emissions that does not include any emissions associated with alternatives that could be used to provide the equivalent service to society that would be provided by the Project's LNG and oil. This SEIS presents these two No Action Alternatives because there is inherent uncertainty regarding the particular present or future supply and demand responses that would lead to net changes in production and consumption, and associated emissions, of LNG and oil that would be produced on the North Slope in association with the Project.

2.5 CONSTRUCTION PROCEDURES

AGDC’s application and subsequent filings to FERC provide plans describing how AGDC would construct and maintain the proposed Project. These plans also include measures to avoid or minimize potential impacts on the environment. The environmental avoidance and impact minimization measures identified in AGDC’s plans are based on FERC’s *Upland Erosion Control, Revegetation and Maintenance Plan* (FERC Plan) and *Wetland and Waterbody Construction and Mitigation Procedures* (FERC Procedures). Section 2.2 of the 2020 EIS details construction procedures for the Gas Treatment, Mainline, and Liquefaction Facilities. AGDC would abide by these conditions, as applicable, for any additional infrastructure required for upstream components of the proposed Project on the North Slope analyzed within this **Final** SEIS. Where applicable, resource sections within this **Final** SEIS discuss construction measures contained within the 2020 EIS that would be used to avoid or minimize impacts from construction of additional upstream facilities. Table 2.5-1 includes a summary of construction and restoration environmental plans identified in Section 2.2 of the 2020 EIS that would likely apply to upstream development activities to reduce the level of adverse impacts.

Table 2.5-1. Construction and Restoration Environmental Plans

Plan Name	Project Phase	Brief Description	Resources Addressed
Air Transport Plan	Construction	Details the planned number of project-related aircraft operations at the airports and airstrips.	Transportation
Fugitive Dust Control Plan	Construction	Describes the procedures to be used to minimize fugitive dust.	Soils and Sediments; Freshwater; Wetlands; Vegetation; Fisheries Resources; Air Quality; Public Health and Safety
Gravel Sourcing Plan and Reclamation Measures	Construction	Describes the material requirements, sources, extraction protocols, transportation logistics, and reclamation measures during construction and reclamation.	Geologic Resources

Table 2.5-1. Construction and Restoration Environmental Plans

Plan Name	Project Phase	Brief Description	Resources Addressed
Health, Safety, Security and Environmental Plan	Construction	Describes the health and safety objectives and performance criteria for construction contractor compliance.	Public Health and Safety
Journey Management Plan	Construction	Describes the process to be followed for planning and safely undertaking transport activities to avoid conflicts with existing marine and road traffic.	Transportation; Public Health and Safety
Lighting Plan	Construction and Operations	Describes the measures to be followed to provide adequate lighting for the prevention of accidents and compliance with Occupational Safety and Health Administration requirements while reducing visible light disturbance to the public and wildlife, as practicable, and reducing the potential for light pollution, including backscatter into the sky.	Terrestrial Wildlife; Avian Resources; Threatened, Endangered, and Other Special Status Species; Visual Resources
Marine Mammal Monitoring and Mitigation Plan	Construction	Describes measures to be implemented during in-water construction activities (e.g., noise mitigation measures from dredging activities at PTU) in Prudhoe Bay to comply with the MMPA and ESA.	Marine Mammals; Threatened, Endangered, and Other Special Status Species
Migratory Bird Conservation Plan	Construction and Operations	Describes the procedures to be implemented during construction, operation, and maintenance for avian protection.	Avian Resources; Threatened, Endangered, and Other Special Status Species
Noxious/Invasive Plant and Animal Control Plan	Construction and Operations	Describes preventative and control measures to be used to avoid and/or minimize the introduction and spread of non-native invasive plant and animal species.	Vegetation; Fisheries Resources; Wildlife Resources; Threatened, Endangered, and Other Special Status Species
Paleontological Resources Management Plan	Construction	Describes the procedures to be used to protect paleontological resources in accordance with NEPA and the Paleontological Resources Preservation Act of 2009.	Geologic Resources
Paleontological Resources Unanticipated Discoveries Plan	Construction	Describes the procedures to be used to reduce the potential for damage to these resources in the event that unanticipated paleontological resources are encountered.	Geologic Resources
Plan for Unanticipated Discovery of Cultural Resources and Human Remains	Construction	Describes the procedures to be used in the event that previously unreported historic properties or human remains are found.	Cultural Resources
Polar Bear and Pacific Walrus Avoidance and Interaction Plan	Construction and Operations	Provides guidance to avoid or minimize adverse effects on and human interaction with polar bears and Pacific walrus during construction and operational activities on the North Slope and Beaufort Sea.	Threatened, Endangered, and Other Special Status Species
Restoration/ Revegetation Plan	Post-Construction	Describes the procedures, performance standards, and performance goals for restoring construction areas.	Soils and Sediments; Freshwater; Wetlands; Vegetation; Avian Resources; Terrestrial Wildlife; Threatened, Endangered, and Other Special Status Species; Land Use

Table 2.5-1. Construction and Restoration Environmental Plans

Plan Name	Project Phase	Brief Description	Resources Addressed
Spill Prevention, Control, and Countermeasure Plan	Construction	Describes the management procedures for the prevention and cleanup of releases of fuels, lubricants, and coolants, as well as potentially hazardous materials to be implemented.	Soils and Sediments; Groundwater Resources; Freshwater; Marine Waters; Wetlands; Marine Mammals; Fisheries Resources; Threatened, Endangered, and Other Special Status Species; Public Health and Safety
Stormwater Pollution Prevention Plan	Construction	Describes the potential sources of pollution that could reasonably be expected to affect the quality of stormwater discharges from construction and the practices to be used to reduce the pollutants in stormwater discharges, and assures compliance with the terms and conditions of the Alaska Construction General Permit.	Soils and Sediments; Freshwater; Marine Waters; Water Use; Wetlands; Avian Resources; Marine Mammals; Fisheries Resources; Threatened, Endangered, and Other Special Status Species
Traffic Mitigation Plan	Construction	Describes the measures to be implemented to mitigate potential traffic delays and congestion during construction.	Public Health and Safety; Transportation
Water Use Plan	Construction	Describes the different uses of water resources during construction, including information about water volumes, source locations, discharge locations, and any proposed treatments.	Water Use; Fisheries Resources; Public Health and Safety
Wetland Mitigation Plan	Construction	Describes strategies that would be considered to mitigate permanent wetland impacts.	Wetlands
Winter and Permafrost Construction Plan	Construction	Describes the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan would discuss soil stabilization measures to be implemented to limit thermal and erosional degradation of the permafrost.	Soils and Sediments; Wetlands; Fisheries Resources

ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; NEPA = National Environmental Policy Act; PTU = Point Thomson Unit

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone the necessary design and engineering processes by the respective project proponent[13]. The discussion of construction procedures within this **Final** SEIS focuses on special construction considerations for work on the North Slope that would be considered in design and construction of these facilities. Information within this section is based on a compilation of methods developed by the USACE during the preparation of the Point Thomson Project EIS Appendix G North Slope Construction Methods (USACE 2011).

2.5.1 Ice Construction

In general, temporary ice infrastructure allows construction during the winter months, largely eliminating the need for permanent gravel roads. Ice roads and pads melt in the spring and leave no significant damage to the tundra (USACE 2011). Prior to construction, the locations for ice pads and the routes of ice roads

[13] Development activities within the respective units would be led by the respective entity in charge (e.g., ExxonMobil as the project proponent for the PTU Expansion Project) and not AGDC.

would be surveyed and staked. These locations and routes would be planned to avoid tussock areas, deep holes in streams, steep riverbanks, cultural resources, the previous year's ice pad locations and road routes, and to minimize the distance between water sources and the final placement of the water. Permitted and unpermitted potential water sources would be identified, and the water use permitting process begins midsummer. For currently unpermitted water sources, the tundra travel permit applicant would be required to document that the source recharges annually. Permitted water sources may be shared, with several North Slope operators holding permits for the same water source with a single total withdrawal limit. It is the operators' responsibility to divide the permitted withdrawal volumes between themselves, and each operator reports its own withdrawals for the source (USACE 2011).

Two typical ice infrastructure elements are ice roads and ice pads, which share similar construction methodology. Ice construction begins once the temperature and snow cover, or snow slab, on the tundra meet ADNR criteria for tundra travel (USACE 2011):

> *DNR will implement tundra opening for general cross-country travel in wet sedge tundra when a minimum 15 centimeters (6 inches) of snow cover is available and ground hardness reaches a minimum of 75 drops of the slide hammer to penetrate one foot of ground. At this combination of ground and snow conditions, no significant change in the depth of active layer, soil moisture, or vegetation composition and structure is anticipated. DNR has determined that once a minimum threshold of 23 centimeters (9 inches) of snow cover and a ground hardness of 25 drops of the slide hammer for one foot of soil penetration has been attained, general tundra opening in tussock tundra can proceed without a significant change in active layer depth, soil moisture, or vegetation community composition and structure.*

The tundra travel permit applicant can install temperature readers, or thermistors, along its proposed ice road routes to monitor the ground temperature and can notify ADNR once readings are consistently reporting -5 degrees Fahrenheit (°F). ADNR will perform onsite penetrations of the tundra to verify the readings before granting a permit. Once ADNR has permitted tundra travel for the area in question, approved all-terrain vehicles compact the snow along the route or pad area to provide a level base. There is no scraping or snow removal because the snow insulates the permafrost layer and limits the impact of traffic and development activities on the tundra itself. If the existing snow is not sufficient to provide a level base, then the base layer is supplemented by ice aggregate, or ice chipped from permitted water sources in 6-inch or smaller chips, transported via large dump trucks and mixed with water to set the ice. Once the base is complete, large dump trucks haul ice aggregate or snow from cleared areas. The chips are laid on the roadbed water is spread over the chip base; as each layer freezes solid, the next layer is applied until the road or pad is the desired thickness (USACE 2011).

Because of rising temperatures due to climate change, permafrost is seasonally thawing earlier and freezing later in the year (see Section 3.19.3 for a discussion on climate change effects). According to the USEPA, Alaska's unfrozen season has grown longer at an average rate of about four days per decade, with 2019 having 20 more unfrozen days than the long-term (1979 to 2019) average (USEPA 2020). The shorter season of frozen soils and snow and ice cover could ultimately shorten the duration of and use for ice construction techniques described within this section. A recent Pan-Arctic analysis of the effects of climate change on winter activities used a reference time period of 1971 to 2000 to estimate a 30 percent reduction in ice road construction days in the near future (2021 to 2050) (Gädeke et al. 2021). The estimated reduction in ice road construction days can be linked to a reduction in all ice construction activities.

2.5.1.1 Ice Roads

Ice roads could be required for construction of pads, wells, and pipeline infrastructure. Ice roads are used primarily for seasonal access to remote sites. These roads are built entirely of frozen water, either in snow or ice form, and can cross either tundra or sea ice. Historically, tundra travel permits are issued by the DNR, and ice road construction begins on or about December 15 of each year. Completion times vary depending on the kind of ice road; tundra ice roads require a fabricated ice base and are ready near February 15, while sea ice roads, built on existing sea ice, can be ready for use around February 1. The ice road season lasts between 2 and 2.5 months and ends with the spring thaw on or near April 15 (USACE 2011).

There are two primary kinds of ice road: "standard" ice roads, and "rig-ready" ice roads. Standard, bidirectional ice roads are generally 50 feet wide (minimum 35 feet on tundra), with minimal slope from crest to base. The roads are designed to carry module loads of up to 300,000 pounds. Rig-ready ice roads are designed to support the weight and significant width of modules and drill rig components weighing up to 1,300 tons. The rig-ready ice road is generally 75 feet wide. Because the ice sheet underlying a rig-ready sea ice road may already be thick enough to support the modules or rig components, the rig-ready sea ice road may be ready for transport on or near February 15. A rig-ready tundra ice road, however, may require an additional 3 weeks before it reaches the standard 12-inch to 18-inch thickness required to support the heavier, wider loads (USACE 2011).

The availability of water between the initiation point and the terminus of the ice road determines its route, as do the slope and other terrain features such as lakes, streams, and vegetation. If a sensitive area, such as a previously unidentified tussock area, is identified along a surveyed ice road route during construction, the route is adjusted to avoid that area. A standard tundra ice road capable of use by large trucks can require one million gallons of fresh water per mile; a rig-ready ice road requires approximately 1.25 million gallons of fresh water per mile to construct. Similar sea ice roads require 800 thousand gallons and 1.24 million gallons, respectively.

Sea ice roads require less fresh water than tundra ice roads because they use sea water for the majority of construction. Trucks with augers drill through the existing sea ice to the water level to flood the road area. The salt water is allowed to freeze, and an additional hole is drilled to flood the roadbed with another lift of ice. This process is repeated until the water is within 1 foot of the seafloor, at which depth the water becomes silty and unusable for the ice road. The saltwater ice is capped with 6 inches of ice from freshwater over the completed road; this cap of freshwater enables any melt during the day to refreeze at night faster than it might if the roadbed were all saltwater. Sea water cannot be used to construct tundra ice roads because of the increase in groundwater salinity once the sea water ice melts into the tundra (USACE 2011).

Tundra ice roads crossing rivers or streams must be grounded or cross the waterbody at a point where the river or stream is frozen from the surface to the riverbed. Sea ice roads must be grounded or thickened to support the heaviest anticipated load. Once the ice roads are thick enough to support their intended loads, a road-grader blade scars the road to create traction grooves; the roads are not sanded, salted, or graveled to increase traction. Because of the size of the loads transported on ice roads and their lack of artificial traction, road grades may not exceed 3 percent and should not include abrupt or "S" curves that pose a traffic hazard (USACE 2011).

Snow is removed as necessary from both tundra and sea ice roads over the course of the season to maintain traction, define the location of the road, and facilitate melting in the spring. The ice roads are inspected daily to maintain width, thickness, and surface, and any spills, chemical releases, or litter along the ice roads are removed before the ice melts. At the end of the ice road season, crews trace the route to remove reflectors and any litter, and additional surveys for litter are performed during breakup, when the ice roads are allowed to melt naturally (USACE 2011).

As previously mentioned, because of rising temperatures due to climate change, the changes in permafrost, and the shorter season of frozen soils and snow and ice cover, the winter season and ultimately the ice construction period has potential to keep shortening. Using a reference time period of 1971 to 2000, there will be an estimated 30 percent reduction in ice road construction days (in the winter season) in the near future (2021 to 2050) (Gädeke et al. 2021).

2.5.1.2 Ice Pads

The additional 7-acre multi-season ice pad adjacent to the Central Pad in PTU for construction offices, warehousing, and equipment storage would involve ice pad construction. Multi-season ice pads are designed for use over multiple winter and summer seasons, with the goal of avoiding permanent fill for temporary activities. These pads begin with snow compaction and a base layer of ice, similar to standard ice pads. Once the layers of ice are of a height required for the operation to be conducted on the pad, generally 3 to 4 feet at a minimum, a vapor barrier is placed over the ice to prevent melting from rain and evaporation. Four-inch-thick foam insulation mats are placed over the vapor barrier and covered by white tarp to reflect sunlight and heat. The pads are covered by rig mats made of wood, steel, or composite materials if they are intended for summer use (USACE 2011).

Multi-season ice pads must be rehabilitated each year by removing mats and insulation to fill and level any ice lost to melting over the summer, and the vapor barrier, insulation, and tarp are replaced. The insulation board currently used on the North Slope is a Styrofoam™ base, either with or without plywood backing, and after more than one season the foam can degrade, requiring crews to collect and dispose of crumbled foam pieces that can be spread by wind. Once a multi-season ice pad has served its purpose, the rig mats, tarp, insulation, and vapor barrier are removed, any spills or releases are cleaned, and the ice base is allowed to melt over the course of the summer.

2.5.2 Gravel Construction

Permanent infrastructure on the North Slope is usually made from gravel, which insulates the permafrost layer year-round against the heat generated by vehicles, equipment, and facilities in the same way that ice insulates that layer in the winter. Geological surveys identify material sites, which are staked during the summer. Because mines are excavated on soft tundra, they are excavated during the winter to prevent damage to the equipment on the extremely soft ground and minimize damage to the surrounding area. When the ground has frozen, any snow is scraped and trimmers remove the active layer of tundra, which ranges from 8 to 80 inches depending on drainage. Then organic matter is piled, loaded, and hauled to a storage area, usually located on an ice pad (USACE 2011).

The fill site, whether road or pad, is surveyed and staked. Snow is removed from the site, with a 4-inch snow barrier left atop the tundra. Gravel is transported in belly dump units to the site and spread with a fill dozer in 1-foot layers, or lifts. Each lift is compacted by multiple passes with a slow-moving vibratory compactor, and traffic is routed over the area to assist in compaction. Subsequent lifts are installed and compacted in the same way, until the road or pad achieves its design elevation (USACE 2011).

In subarctic areas, the moisture content of the gravel typically ranges between 10 and 25 percent, and the gravel can be mined, compacted, and used for transport in the same season. The moisture content on the North Slope, however, ranges between 25 and 35 percent, and the gravel must be “seasoned” before it can be used. Natural seasoning, in which the gravel is spread over its intended final location on a pad or road and allowed to dry and settle, can take up to two seasons for a 5-foot depth. To speed the process, producers often farm the gravel, or lay it in its intended location and turn the upper layers once or twice in a single season to expose the buried areas and facilitate drying, and water is placed on the gravel for both compaction and dust suppression. Once the gravel is seasoned, the combination of large and fine particles is compacted and usable for transport or building (USACE 2011).

2.5.2.1 Gravel Roads

This **Final** SEIS assumes that existing road networks exists for the PBU and PTU pad expansion projects as they would be constructed off of existing developed infrastructure. Additional gravel roads, however, could be required for construction of pipeline infrastructure. Because gravel roads are constructed during the winter, an ice road must first be installed to protect the permafrost and tundra from the equipment used for gravel installation (see Section 2.5.1.1). Once the ice road is in place, construction of the gravel road begins as described above. Similar to ice roads, gravel road depth and width are determined by the size of the largest vehicle intended to travel the road. On average, gravel roads used for transport of rig components are nominally 5 feet thick and 32 feet wide at the crown, with a 2:1 slope to the base, and support bidirectional traffic unless being used for module or rig component transport (USACE 2011).

Gravel road routes are designed to avoid, to the greatest extent possible, large bodies of water and use culverts and standard bridge-building techniques when crossing streams. The design vehicle for the road determines the load capacity and width of the bridge. The North Slope hydrology, however, consists of defined streams and areas of undefined, or sheet, flow. To accommodate the natural sheet flow, gravel roads incorporate 24-inch-diameter (minimum) culverts approximately every 500 feet, and more frequently in particularly wet areas. While corrugated pipe is commonly used for culverts, on the North Slope such pipe can be damaged by ice during spring thawing, and North Slope culverts are generally constructed from the same kind of steel pipe used in pipelines (USACE 2011).

2.5.2.2 Gravel Pads

The 5-acre expansion of the existing CGF pad in PBU and the 7-acre expansion of the existing Central Pad in PTU would require gravel pad construction. Gravel pads are surveyed, staked, and filled in the same method as gravel roads. They do not require culverts but do have embankments at the edge of the pad to minimize snow drifting, which is a constant problem on the North Slope. The gravel pad insulates the permafrost because in the winter the gravel itself freezes, and the inner core of the pad remains frozen throughout the year. To prevent greater-than-necessary thawing over the summer, buildings on the pads are raised above the ground elevation on piles or pipe in the tundra. The piles can be driven vertically with a vibratory hammer through the gravel pad into the tundra below, or drilled and then cemented or foam supported in place. These piles allow for a cushion of cool ambient air between the facility and the gravel (USACE 2011).

2.5.3 Pipelines

Hydrocarbon production lines are divided into two major categories: infield lines and export pipelines. Infield lines transport gas, produced water, seawater, and diesel fuel within a field and typically consist of gathering lines that connect the drill sites within a single field to that field’s processing facility, and flowlines that transport processed hydrocarbons within the field. For example, a flowline may return injection gas from a compressor plant to a reinjection well. Export pipelines transport a field’s processed hydrocarbons to a common carrier line, such as the Trans Alaska Pipeline, or point of sale. New, cross-tundra pipelines on the North Slope are installed during the winter to limit damage to the surrounding tundra (USACE 2011).

Oil and gas industry standard practice worldwide is to bury pipelines, which minimizes visual impacts and provides a measure of security for the pipeline. The nature of the polar environment and permafrost layer, however, has posed significant challenges to buried pipelines. Hydrocarbons extracted from the North Slope range in temperature from 145°F to 180°F and are cooled to between 85°F and 120°F. The permafrost layer in which that line might be buried must maintain a temperature of 32°F or lower or it will destabilize and create pressure on the pipeline (USACE 2011).

Because of the challenges associated with buried pipelines, oil producers on the North Slope have designed a network of elevated pipelines that keep the lines well above the tundra (typically 6 feet above the ground surface). Vertical pipes topped by horizontal I-beams, called vertical and horizontal support members (VSMs and HSMs, respectively) keep the line above the ground. Many North Slope operators design these elevated pipelines either with bridge-like caribou crossings or large (up to 7 feet) elevations to enable the free movement of wildlife around the pipeline. The pipe rests in saddles on the HSMs, and the pipe’s freedom of movement, combined by periodic Z-shaped or offset routing in the pipeline, allow for temperature-induced expansion and contraction, and a measure of flexibility in the event of an earthquake (USACE 2011).

2.5.3.1 Pipeline Construction

The proposed additional pipeline infrastructure at PBU and the proposed CO_2 pipeline as part of the scenarios analyzed within this **Final** SEIS would require pipeline construction. As with other permanent infrastructure construction on the North Slope, pipeline construction typically begins with ice road construction. Because aboveground pipelines do not interrupt hydrology in the same way that roads can, pipeline routes are often more direct than roads and do not necessarily parallel existing gravel roads. Pipeline construction is also phased, with multiple work crews constructing different sections of a pipeline simultaneously in different areas. These multiple simultaneous operations create travel hazards and often require one road dedicated to pipeline construction, and another for standard traffic to and from a facility or work site (USACE 2011).

In the first phase of pipeline construction, surveyors mark the VSM positions, the spacing of which is determined by engineering and pipeline diameter but is typically 55 feet apart. Following the VSM marking, an air drill auger drills the VSM to a depth determined by the soil profile at that point along the route. The holes are covered with plywood for personnel safety until the VSMs are placed. The VSM setting crew follows the survey and drilling crews, and uses hydraulic cranes, side boom tractors, or hydraulic forklifts to place the VSMs along the road next to the holes. VSMs generally consist of line pipe approved for structural uses. The HSMs are bolted to the pile cap on the VSMs, and the assembly, or pipe rack, is set in the drilled holes and leveled. Angle iron jigs, welded to the VSM, stabilize it in the hole until the hole is filled with sand slurry from mixer trucks and allowed to freeze (USACE 2011).

Once the sand slurry has set, the HSMs are equipped with saddle assemblies, which cradle the pipe, along the upper flange of the I-beam. After the support members are in place along the pipeline route, the line pipe is laid out along the road, welded into long sections, and placed on wooden skids. While on the skids, the welds are tested using X-ray or other nondestructive examination methods, and the pipe is coated and insulated per specification. The insulated sections are then lifted into the pipe saddles on the HSMs by a series of side boom tractors, cranes, and loaders. The elevated sections are then welded into a single continuous pipeline, and cleaning and gauging tools known as “pigs” are pushed through the pipeline with compressed air to remove any construction debris (USACE 2011).

2.5.3.2 Hydrostatic Testing

Before the pipeline can be used to transport hydrocarbons, the operator must verify that all welds and flanges are secure and that the pipeline is impermeable. To do this, the summer after pipeline construction, a series of hoses, tanks, and high-pressure pumps connect a water source to the pipeline. The pumps fill the pipeline with water to more than its intended operating pressure, and hold that pressure for at least 4 hours, if the lines are completely visible, and 8 hours if the lines are not completely visible (49 CFR 195.300). Any water leaking from the pipeline will identify a breach in the pipeline, which will be resolved and retested before the line can enter hydrocarbon service (USACE 2011).

After a successful hydrostatic test, the pumps are replaced with a pig launcher and a pig pushes the water through the pipe’s terminus, where the water is filtered of any anticorrosive additives and injected into a disposal well or treated and discharged to the tundra according to a discharge permit. Air compressors and dehydration equipment dry the line, and it is filled with nitrogen or another inerting agent to prevent internal corrosion until the line begins active service (USACE 2011). **Discharge of hydrotesting water that contains additives may require an APDES permit.**

2.5.4 Construction Equipment

Table 2.5-2 provides a list of standard North Slope construction equipment by activity.

Table 2.5-2. Standard North Slope Construction Equipment and Uses

	Ice Construction		Gravel Construction		Pipelines	
	Road	Pad	Road	Pad	Construction	Hydrotesting
Vehicles						
Fuel truck	X	X	X	X	X	
Mechanic truck	X	X	X	X	X	
Personnel bus	X	X	X	X	X	
Pickup truck	X	X	X	X	X	X
Service truck	X	X	X	X	X	
Slurry truck			X[a]		X	
Snow blower	X	X				
Snowmobile (survey vehicle)	X	X			X	
Tanker	X	X				X
Tire truck	X	X			X	
Tool van			X	X		
Tractor trailer	X	X				
Vac truck	X	X			X	
Water truck	X	X	X	X	X	
Welding truck					X	
Equipment						
Backhoe					X	
Boom truck					X	
Buffing truck					X	
Chipper	X	X				
Compactor			X	X		
Compressor					X	X
Crane (e.g.,120+ ton)			X[a]	X[a]	X	X
Dozer (e.g.,D7G)	X	X			X	
Drill				X[a]	X	
End dump					X	
Generator	X	X	X	X	X	X
Grader (e.g.,CAT 16G)	X	X	X	X		
Hauler	X	X				
Heater, portable	X	X	X	X	X	
Hydrotest pump						X
Loader (e.g., Caterpillar 966)	X	X		X[a]	X	X
Manlift			X[a]		X	
Preheat truck					X	
Rolligon™	X	X				
Sideboom					X	
Steaming unit			X[a]			
Tack rig					X	
Tractor trailer					X	X
Transfer pump						X
Vibratoryhammer			X[a]			
Welding machine			X[a]		X	X

[a] For bridge building or piling

2.5.5 Well Development

Development wells would require well construction and permitting approval. In order to drill a well for oil, gas, or geothermal resources in Alaska, an Applicant must obtain a Permit to Drill from the AOGCC. This requirement applies not only to exploratory, stratigraphic test, and development wells, but also to injection and other service well development related to oil, gas, and geothermal activities. The specific statutory authority for Permits to Drill is Alaska Statute (AS) 31.05.090. The AOGCC's regulations pertaining to drilling are 20 Alaska Administrative Code (AAC) 25.005 through 20 AAC 25.080, and Permits to Drill application requirements are particularly addressed in 20 AAC 25.005. The AOGCC's oversight of drilling operations focuses on ensuring that appropriate equipment is used and appropriate practices are followed to maintain well control, protect groundwater, avoid waste of oil, gas, or geothermal resources, and promote efficient reservoir development. The AOGCC's issuance of a Permit to Drill does not relieve the applicant of any obligations to comply with the permit or regulatory requirements of other state, local, or federal agencies before drilling. Local agencies that should be contacted by the operator are the affected borough and city. Federal and state agencies involved in permitting a well may include:

- **Army Corps of Engineers.** Any related well development work involving conducting activities, construction, dumping, or depositing dredge or fill material in navigable waters of the U.S. are subject to obtaining permit from the USACE under the RHA (33 USC 401, *et seq*.) and the Federal Water Pollution Control Act Section 404 Authority (33 USC 1344)**.**

- **Alaska Department of Environmental Conservation.** Under the authority of AS 46.14 and the Air Permit Program (18 AAC 50), the ADEC and Division of Air Quality issue permits used for the construction, operation, or relocation of a Portable Oil and Gas Operation, as described in 18 AAC 50.990(124). "Portable Oil and Gas Operati**on**" refers to an operation that moves from site to site to drill or test an oil or gas well, and that uses drill rigs, equipment associated with drill rigs and drill operations, well test flares, and equipment associated with well test flares. Under these conditions oil and gas drilling rig equipment may be subject to require a Minor General Permit 1, Minor General Permit 2, or a Minor Source Specific permit.

- **Bureau of Indian Affairs.** The Assistant Secretary – Indian Affairs advises the Secretary of the Interior on Indian Affairs policy issues, communicates policy to and oversees the Bureau of Indian Affairs and can be used as a resource to provide leadership in consultations with tribes, and serve as the Department of Interior official for intra- and inter-departmental coordination on related activities falling under the Bureau of Indian Affairs' domain.

- **Alaska Department of Natural Resources.** Work activities related to well development may be subject to permitting, leasing, and fee payment for the Division of Oil and Gas Services (11 AAC 05). Additionally, under the Division of Oil and Gas, well data, and geologic and engineering data for unit actions are subject to submittal to the department per application submittal requirements.

- **Bureau of Land Management.** The BLM is involved in issuing permits to drill oil and gas wells, permits for geophysical exploration, authorization to construct pads and install production facilities, and administers the federal onshore oil and gas leasing program in Alaska, specifically including the National Petroleum Reserve Alaska on the North Slope. The BLM cannot approve an application for permit to drill until the operator meets the requirements of certain laws and regulations, including the NHPA, ESA, and NEPA. Upon receiving an application for permit to drill, BLM typically conducts an onsite inspection with surface and/or mineral estate owners, resource specialists, the operator, and when applicable, other Surface Management Agencies.

- **Environmental Protection Agency.** Under the UIC Program the Region 10 (Alaska, Idaho, Oregon, Washington) USEPA issues permits for Class I, III, IV, V, and VI injections wells in Alaska and on all tribal lands. **Alaska, Oregon, and Washington have primary enforcement authority (primacy) for Class II injection wells, with oversight from USEPA.** Additional information on the UIC Program is discussed later in this section.
- **Federal Aviation Administration.** The Federal Aviation Administration is subject to involvement in the case that work activities require access to remote air strips for transportation, such as the strip at Umiat on the North Slope, which is only accessible by air and river.
- **Fish and Wildlife Service.** To acquire a permit to drill, associated with federal oil and gas rights, the operator must meet the requirements of the ESA (16 USC 1536(a)(2), which requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. If the actions "may affect" a protected species, the agency is required to consult with the USFWS and/or the NMFS, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)).
- **National Marine Fisheries Service.** See comment above regarding the ESA and NMFS's potential involvement under 50 CFR 402.14.

A Permit to Drill from the AOGCC is often the last step in the overall approval process, and usually all of the other concerned agencies have given their go-ahead by the time the operating company (defined by 20 AAC 25.990(46)) applies to the AOGCC for a Permit to Drill. The AOGCC review ensures:

- Correct well placement with respect to property lines and existing wells;
- Operator is bonded;
- No other affected parties exist;
- No exceptions to regulations or AOGCC orders are needed;
- Casing program is adequate to protect all known underground sources of drinking water;
- Casing program is adequate for collapse, tension, burst, and permafrost;
- Cement program is adequate;
- Adequate tankage will be provided;
- Diverter and blow out prevention equipment are adequate;
- Drilling fluid program and equipment are adequate;
- Choke manifold complies with American Petroleum Institute recommended practices;
- Verification of mechanical condition of potentially affected offset wells located within 1 mile;
- Adequate preparations are made if hydrogen sulfide gas is encountered;
- Potential geo-pressured intervals are identified; and
- Shallow gas hazards are identified.

Hydrocarbon drilling on the North Slope is restricted to the winter, between November and April. During the summer months, drilling activities would include drilling above the reservoir and completing the wells for production after they were drilled to depth (USACE 2011). The drilling sequence for multiple wells in a location would be determined by the ability of the drill rig to move between drill locations, i.e., if a well could not be drilled to depth before April and the only route to the next well were an ice road, the drill rig would complete surface drilling at the first well before moving to the second to begin drilling.

New drilling technology has led to major advances in reducing the industry's footprint on the North Slope. In 1970, a typical drill site utilized 20 acres, reaching a subsurface area of 502 acres or a surrounding area of 0.08 square miles, or 1 mile out from the drill pad. Modern drill sites can now be limited to 6 acres, with a subsurface drillable area of 32,170 acres or a surrounding area of 50.3 square miles, or 8 miles out from the pad. Production wells would be designed to access the reservoirs using both traditional and long-reach directional drilling from a drill rig. Drill cuttings on the North Slope are typically disposed of through slurry injection into a **permitted Class I or** Class II well.

The SDWA (under 40 CFR 144) **authorizes** the USEPA **to establish minimum federal requirements for UIC programs**. Through a Memorandum of Agreement with the USEPA, AOGCC has primacy for Class II wells in Alaska. **The** AOGCC **verifies** the integrity of injection wells, determine**s** if appropriate injection zones and overlying confining strata are present, determine**s** the presence or absence of freshwater aquifers, and ensure**s** their protection, and prepare**s** quarterly reports of both in-house and field monitoring for the USEPA. Injection wells are also subject to meet the injection order requirements per 20 AAC 25.402 and 20 AAC 25.412. The area injection orders describe, evaluate, and approve subsurface injection on an area wide basis for EOR and disposal purposes.

2.5.6 Restoration

Areas disturbed by construction would be stabilized with temporary erosion controls until construction is complete unless covered by equipment, granular fill, or other covering. Project-specific plans and procedures (e.g., stormwater pollution prevention plan [SWPPP], Section 404 permit conditions) required through federal and state approvals and permitting, would describe required erosion control and soil stabilization measures to be used during restoration. Following construction, sites affected by construction would be permanently stabilized by application or establishment of granular fill, concrete, asphalt, or revegetation/ landscaping.

2.6 ENVIRONMENTAL INSPECTION, COMPLIANCE MONITORING, AND POST-CONSTRUCTION MONITORING

Section 2.4.1 of the 2020 EIS includes a discussion of AGDC inspection and monitoring requirements for the proposed Project. This section focuses on the general requirements to which the respective project proponent would be required to adhere for activities described in Section 2.2.

Prior to construction, the project proponent would provide contractors with Project design documents, including environmental alignment sheets, and copies of all applicable federal, state, and local permits. All Project personnel would receive training on environmental permit requirements and the project's environmental specifications before a contractor or project proponent employee is allowed on a work area. The project proponent would hire Environmental Inspectors (EIs) who would report to a Chief Inspector. Each EI would be trained and responsible for ensuring that construction of the projects comply with the construction procedures and any mitigation measures identified by regulatory and permitting agencies. The EIs would have the responsibility and authority to stop activities that violate any conditions imposed by permitting or regulatory agencies. The EIs would also be responsible for advising the Chief Inspector when conditions (such as wet weather) make it advisable to restrict construction activities. Duties of the EIs include maintaining status reports and training records.

Regarding post-construction monitoring, the project proponent would conduct follow-up inspections and monitoring of disturbed areas and conduct post-construction restoration in accordance with approved project Revegetation Plans, Noxious/Invasive Plant and Animal Control Plans (Invasives Plan, and Invasive

Species Prevention and Management Plans). The Revegetation Plan would define the project's restoration performance standards, performance periods, specific restoration practices, and monitoring plan. Oversight of the project area would continue after construction by reviewing the applicant's annual monitoring reports and conducting field compliance inspections. The applicant would be required to continue revegetation efforts until performance standards have been met, per the project-specific Revegetation Plan. Monitoring and management of non-native invasive species (NNIS) would occur before, during, and after construction through the performance period.

2.7 OPERATION, MAINTENANCE, AND SAFETY PROCEDURES

Pipeline facilities would be designed, constructed, operated, and maintained in accordance with PHMSA regulations in *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards* (49 CFR 192), the Commission's guidance at 18 CFR 380.15, and the maintenance provisions of pipeline-specific plans and procedures. As required by 49 CFR 192.615, the project proponent would establish a Pipeline ROW Operational Monitoring and Maintenance Plan (Pipeline Operation and Maintenance Plan) that includes procedures to minimize the hazards in pipeline transport and an emergency response program. The program would outline the potential hazards associated with project facilities; the communication protocols with fire, police, and public officials; and prevention measures undertaken to minimize community impacts. Pipeline operation standards are subject to 49 CFR 195 subpart F, with additional inspection requirements per 49 CFR 195.412, AS 406.04.060, and 18 AAC 75. Under these inspection requirements the facility operator shall inspect the pipeline ROW at intervals not exceeding 3 weeks, be subject to inspections and structural integrity testing, and follow all applicable testing requirements under the Oil Pollution Prevention (18 AAC 75). Section 2.5 of the 2020 EIS details operation, maintenance, and safety procedures for AGDC Project-related Gas Treatment, Mainline, and Liquefaction Facilities.

After well development, the oil and gas facilities would be subject to AOGCC's oversight of drilling activities, annular disposal program, and inspection program. Surveillance activities are intended to ensure that operators are acting to prevent waste and maximize recovery of oil and gas. The AOGCC undertakes independent analysis of subsurface information to assess recovery efficiencies for oil and gas reservoirs. The goal of the annular disposal program is to provide an efficient means for the on-site and safe disposal of waste from drilling activates. The AOGCC reviews and approves specific wastes for annular disposal (20 AAC 25.235) and takes a very active role in ensuring permitted wells adequately contain injected waste. Under the annular disposal program, operators are required to report all flaring events in excess of 1 hour. Flaring events over one hour would be analyzed and investigated, if necessary.

Additionally, under 20 AAC 25.205 any uncontrolled release exceeding 10 barrels of oil or 1,000 standard cubic feet of gas from a well or production handling operation or any uncontrolled release that results in a shutdown of operations at a production facility shall be immediately reported by the operator to AOGCC. Within 5 days of the reported release the operator shall submit a preliminary written report to AOGCC detailing the following facts:

- The time of the incident;
- The location where the incident took place;
- The volumes of oil and gas released and recovered;
- The cause of the release;
- Responsive actions taken to prevent additional releases; and
- Plans, actions, equipment, or procedural changes to prevent or minimize the risk of future releases.

A final written report should be provided to AOGCC within 30 days of the reported release.

Under the inspection program, an inspection arm of the AOGCC would act as a liaison between the AOGCC and operator to oversee safety requirements and provide services such as: Meter Proving, Mechanical Integrity Testing, Blow Out Prevention Equipment Testing, and Safety Valve Testing. Additional maintenance services can be provided by a third party and would include the following services:

- Camp maintenance;
- Infrastructure, facility, and pipeline maintenance;
- Heavy and light duty equipment repair;
- Wellhead maintenance and well work support;
- Roads pads, and process facility maintenance;
- Production equipment maintenance;
- Instrumentation installation and maintenance;
- Electrical installation and maintenance; and
- Valve maintenance.

Regular maintenance helps maximize production efficiency, reduces release incidents, machinery failure and stoppages, and helps ensure the facility's proper operating conditions are maintained to provide a safer work environment. Proper operating conditions and various maintenance standards are presented in the Alaska Department of Labor and Workforce Development Petroleum Drilling and Production Standards adopted by reference under 8 AAC 61.1180.

General occupational and facility safety for oil and gas well drilling, and servicing operations are covered in Occupational Safety and Health Administration standard 29 CFR 1910 and should be followed by the facility and all employees. Additionally, all facility employees would be required to take a 6-part, 8-hour training course from the North Slope Training Cooperative prior to arrival on the North Slope. This training allows employees to travel unescorted within and between operating fields. Topics covered include:

- Alaska Safety Handbook;
- Camps and safety orientation;
- Environmental excellence;
- Hazard communication;
- Hazardous Waste Operations and Emergency Response awareness; and
- Personal protection equipment.

In addition, 40 CFR 110 requires any person in charge of a vessel or of an onshore or offshore facility to notify the National Response Center immediately after becoming aware of any discharge of oil. If direct reporting to the National Response Center is not practicable, reports may be made to the U.S. Coast Guard or USEPA predesignated On-Scene Coordinator for the geographic area where the discharge occurs.

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3.0 AFFECTED ENVIRONMENT

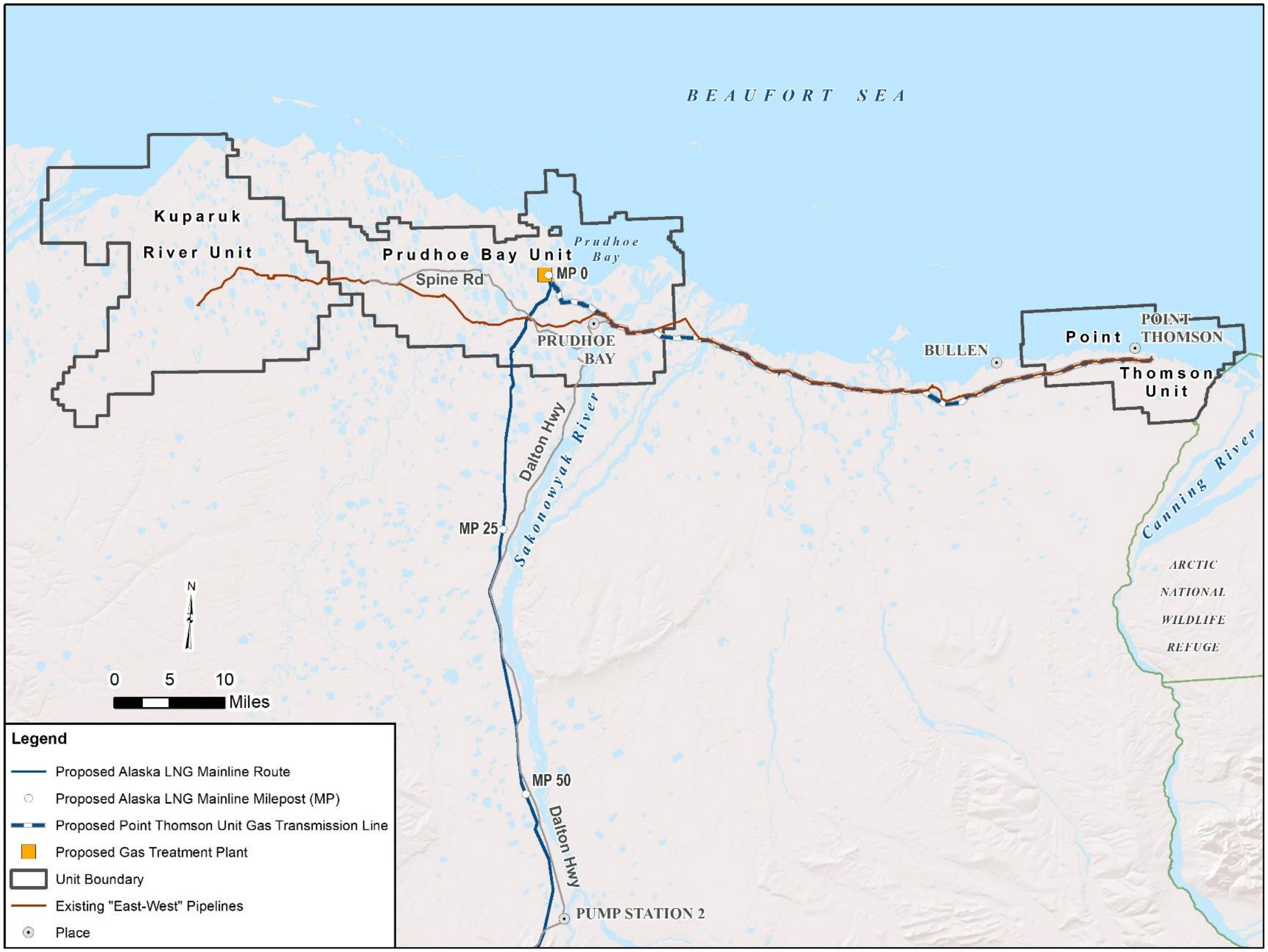
This chapter presents the affected environment for resources with the potential to experience environmental impacts. Consistent with NEPA and CEQ regulations, the description of the affected environment focuses on those resources and conditions potentially subject to effects. The 2020 EIS contains detailed descriptions of the affected environment within the entire Project area. As stated in Section 1.3, the scope of this **Final** SEIS is focused on additional development within the North Slope related to the proposed Project. As summarized in Sections 2.3 and 2.5, this specifically includes potential development in the PTU, PBU, KRU, and the required pipeline infrastructure to transport natural gas and by-product CO_2 from the proposed GTP for storage or reuse. Specific to the affected environment, this includes a description of resources within the North Slope (see Figures 3.0-1 through 3.0-4 for additional detail).

The description of the affected environment for each resource area provides the context for understanding the environmental consequences described in Chapter 4, Impacts of the Proposed Action, and serves as a baseline for evaluating potential environmental impacts. To analyze impacts, the region of influence (ROI) for each resource area has been identified. Each ROI is specific to the type of effect evaluated for the resource area and encompasses the geographic area where potential impacts could be expected to occur. Table 3.0-1 briefly describes the ROI for each resource area evaluated in this **Final** SEIS.

Description of Baseline and Data Sources

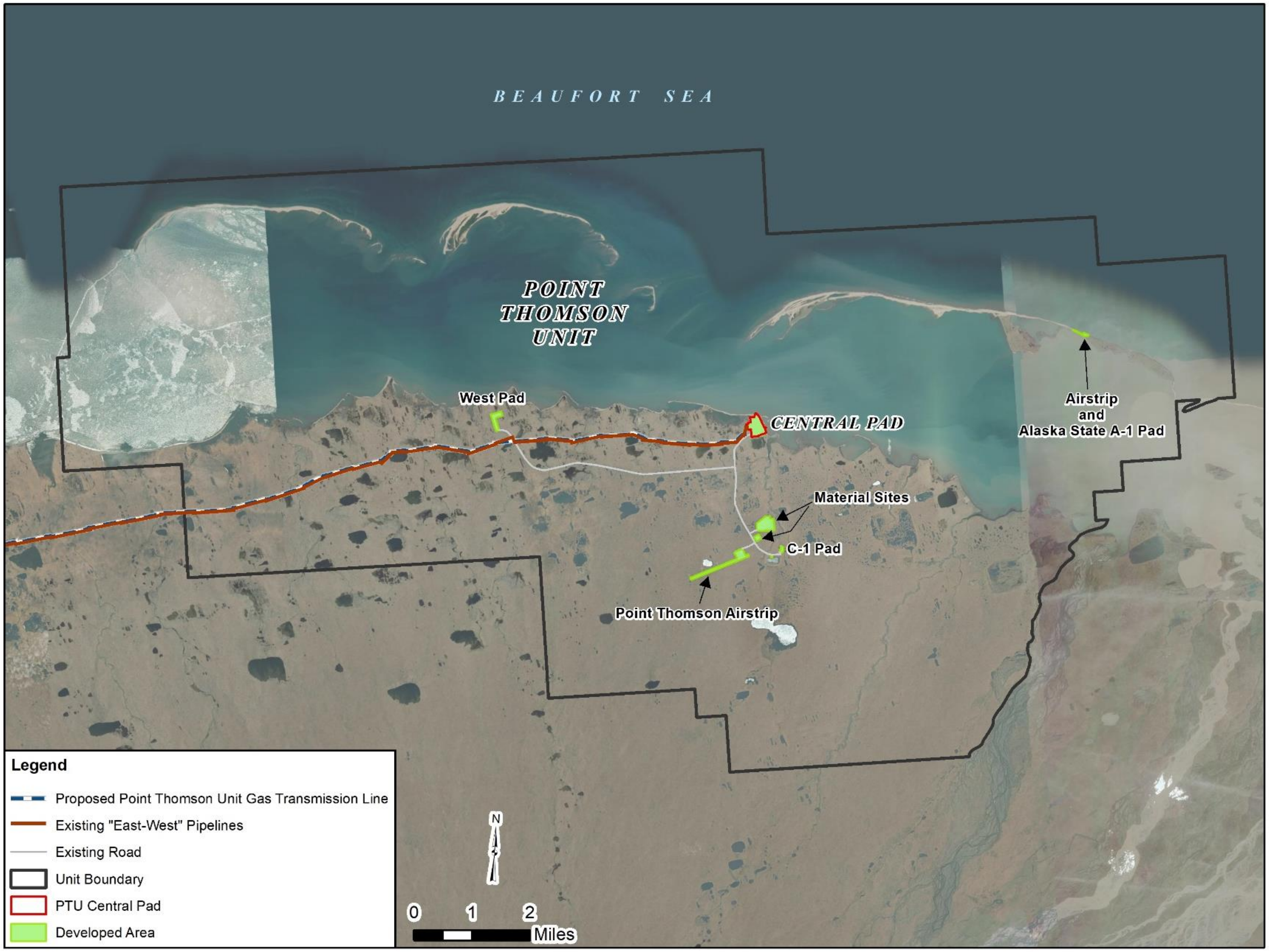
As stated in Section 2.3, the additional North Slope development activities analyzed under Scenarios 2 and 3 are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Therefore, the description of the affected environment within this **Final** SEIS relies on existing available information. The project proponent would survey specific development locations for resources and construction suitability once an actual project is developed during the planning and engineering design phase. As such, the following types of data were used to characterize the affected environment discussion within the **Final** SEIS:

- Federal and state Geographical Information System data, including land cover, vegetation, hydrology, wetlands, sensitive species, recreation, and existing infrastructure.
- Aerial imagery, including mapping and cartographic products that utilize Alaska High Resolution Imagery (0.5-meter resolution) web mapping tile service compiled in 2020.
- Regional and local reports, including Natural Resources Conservation Service Soil Surveys and the North Slope Production Study.
- Previous NEPA documentation, including the Alaska LNG Project Final EIS (FERC 2020) and the Point Thomson Expansion Final EIS (USACE 2012).
- Agency and Alaska Native consultation (see Sections 1.4, 1.5, and Appendix A, Agency and Alaska Native Coordination).
- The North Slope Area Plan (ADNR 2021) developed by the ADNR Division of Mining, Land and Water Resource Assessment & Development Section to direct principles of multiple use and sustained yield on all public domain lands.



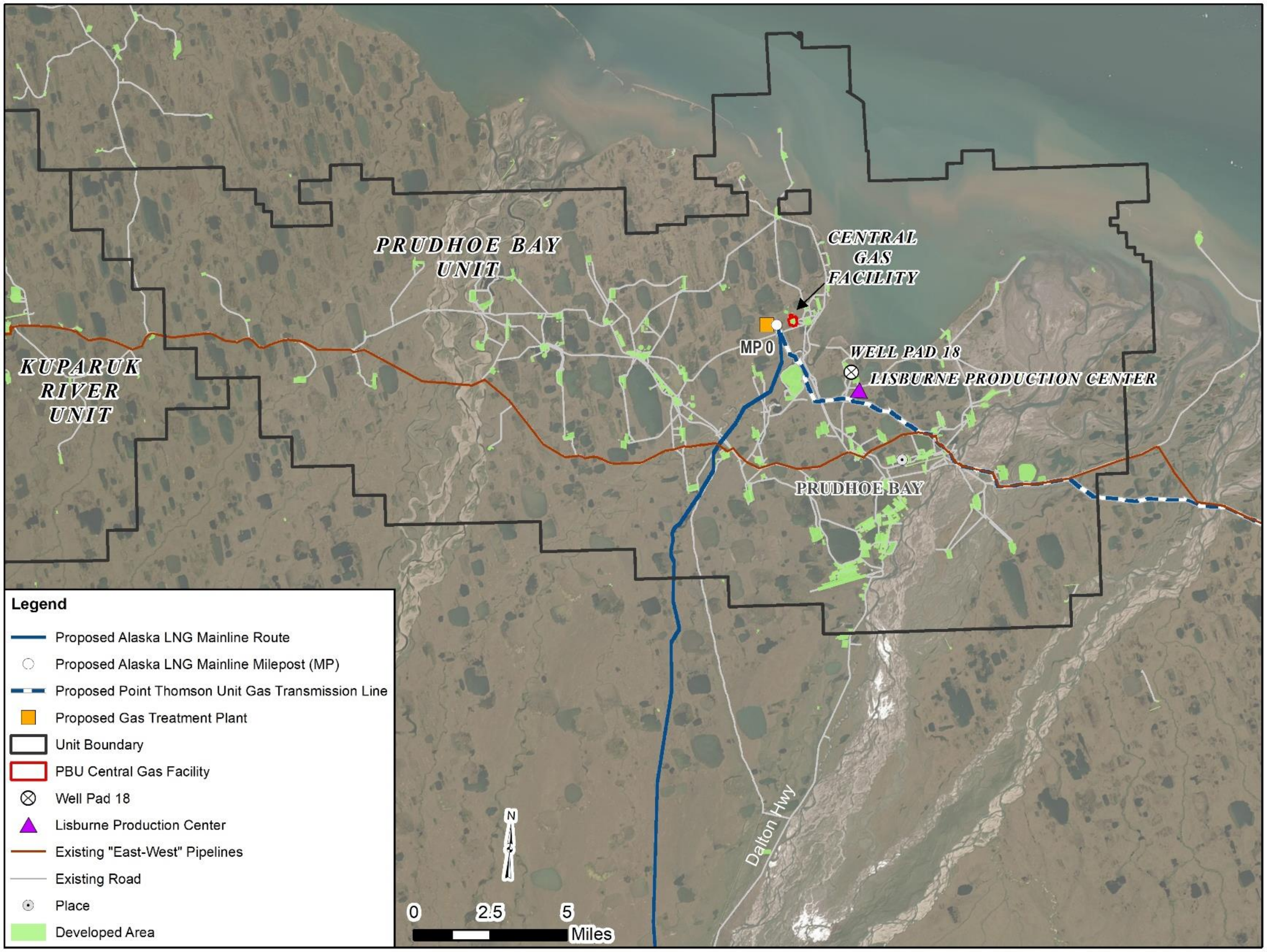
Source: AGDC 2022; ADNR DOG 2021a; North Slope Science Initiative 2021
LNG = liquefied natural gas; MP = Milepost

Figure 3.0-1. North Slope Region of Influence



Source: AGDC 2022; ADNR DOG 2021a; North Slope Science Initiative 2021
PTU = Point Thomson Unit

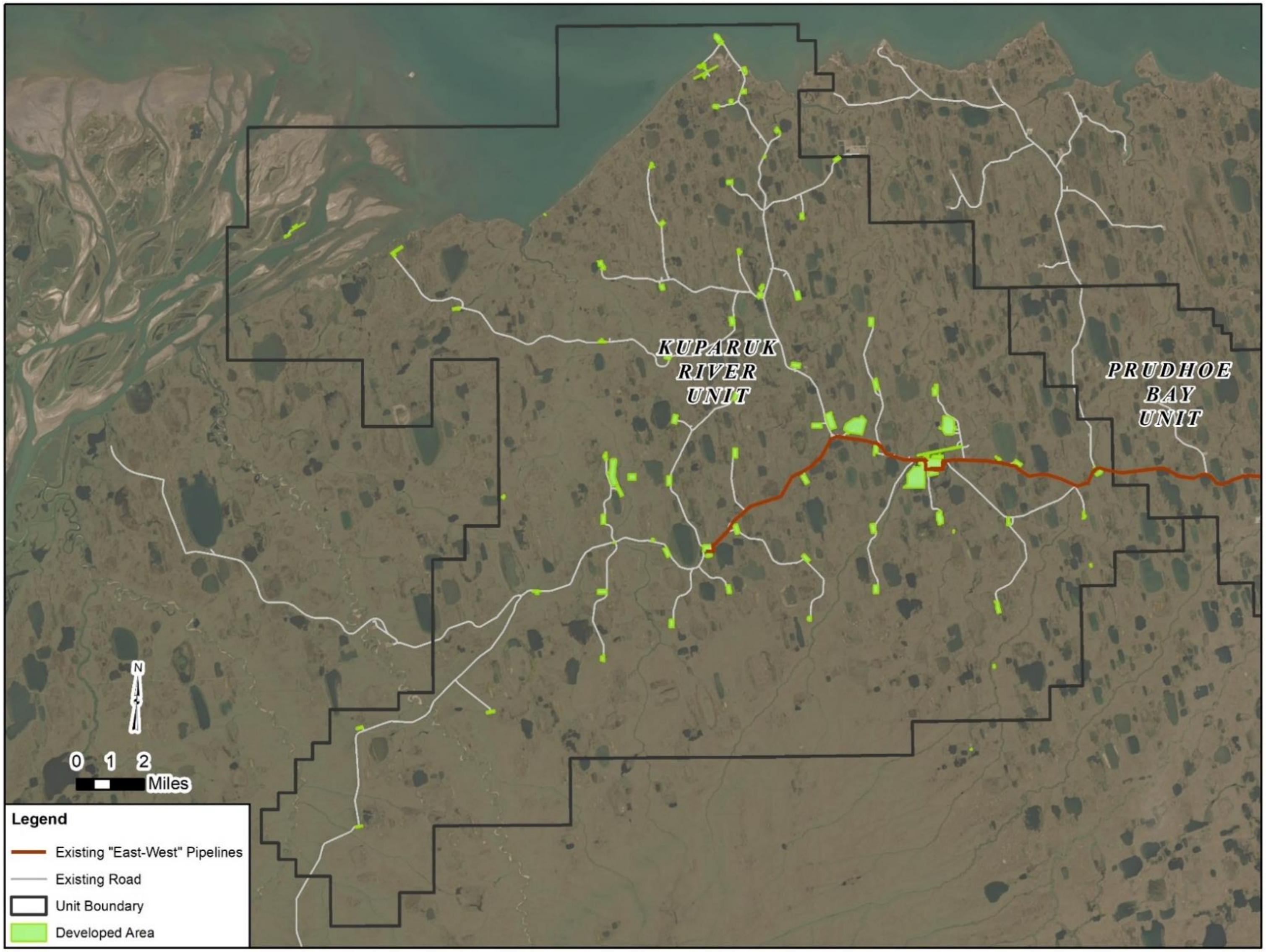
Figure 3.0-2. Point Thomson Unit



Source: AGDC 2022; ADNR DOG 2021a; North Slope Science Initiative 2021

LNG = liquefied natural gas; MP = Milepost; PBU = Prudhoe Bay Unit

Figure 3.0-3. Prudhoe Bay Unit



Source: AGDC 2022; ADNR DOG 2021a; North Slope Science Initiative 2021

Figure 3.0-4. Kuparuk River Unit

Table 3.0-1. General Regions of Influence by Resource Area

Resource	Region of Influence
Geologic Resources and Geologic Hazards	Geological features beneath the North Slope with an emphasis on where additional development activities could occur within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Soils and Sediments	Soil types and properties on the North Slope with an emphasis on permafrost and highly erodible soils occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Water Resources	Water resources on the North Slope with an emphasis on features occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Wetlands	Wetland resources on the North Slope with an emphasis on features occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Vegetation	Vegetation and habitat types on the North Slope with an emphasis on communities occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Wildlife Resources	Wildlife communities on the North Slope with an emphasis on species occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Aquatic Resources	Aquatic resources on the North Slope with an emphasis on aquatic habitat within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Threatened, Endangered, and Other Special Status Species	Protected species and habitat on the North Slope with an emphasis on species and critical habitat occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Land Use, Recreation, and Special Interest Areas	Land use, recreation, and special interest areas on the North Slope, emphasizing areas within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Visual Resources	Visual resources on the North Slope, emphasizing areas within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Socioeconomics	Socioeconomic conditions on the North Slope.
Transportation	Transportation resources on the North Slope, emphasizing transportation infrastructure within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Cultural Resources	Cultural resources on the North Slope, emphasizing resources within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Subsistence	Subsistence activities on the North Slope, emphasizing resources within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Air Quality	Ambient air quality on the North Slope, including the general area within and surrounding the PTU, PBU, and KRU where development activities would occur.
Noise	Noise environment on the North Slope, emphasizing noise levels within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Public Health and Safety	Public health and safety concerns within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Reliability and Safety	Reliability and safety considerations within the PTU, PBU, KRU, and existing pipeline ROWs between the PBU and KRU.
Greenhouse Gases and Climate Change	Existing regional, national, and global GHG emissions and future trends, and predicted climate change impacts that could occur over the life of the proposed Project and upstream development activities, especially impacts that are likely to occur within Alaska and on the North Slope.

GHG = greenhouse gas; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROW = right-of-way

3.1 GEOLOGIC RESOURCES AND GEOLOGIC HAZARDS

3.1.1 Introduction

Section 4.1 of the 2020 EIS includes a description of the geologic resources and geologic hazards present in the Project area, and their potential impacts related to various Project components, including the Gas Treatment, Mainline, and Liquefaction Facilities. This includes a full discussion of the physiographic and geologic setting, mineral resources, geologic hazards, and paleontological resources potentially affected by the entire Project, including areas within the North Slope. The discussion presented within this **Final** SEIS focuses on geologic resources specific to the North Slope and upstream development, including oil and natural gas, and geologic hazards within PTU, PBU, KRU, and the existing pipeline ROWs between the units.

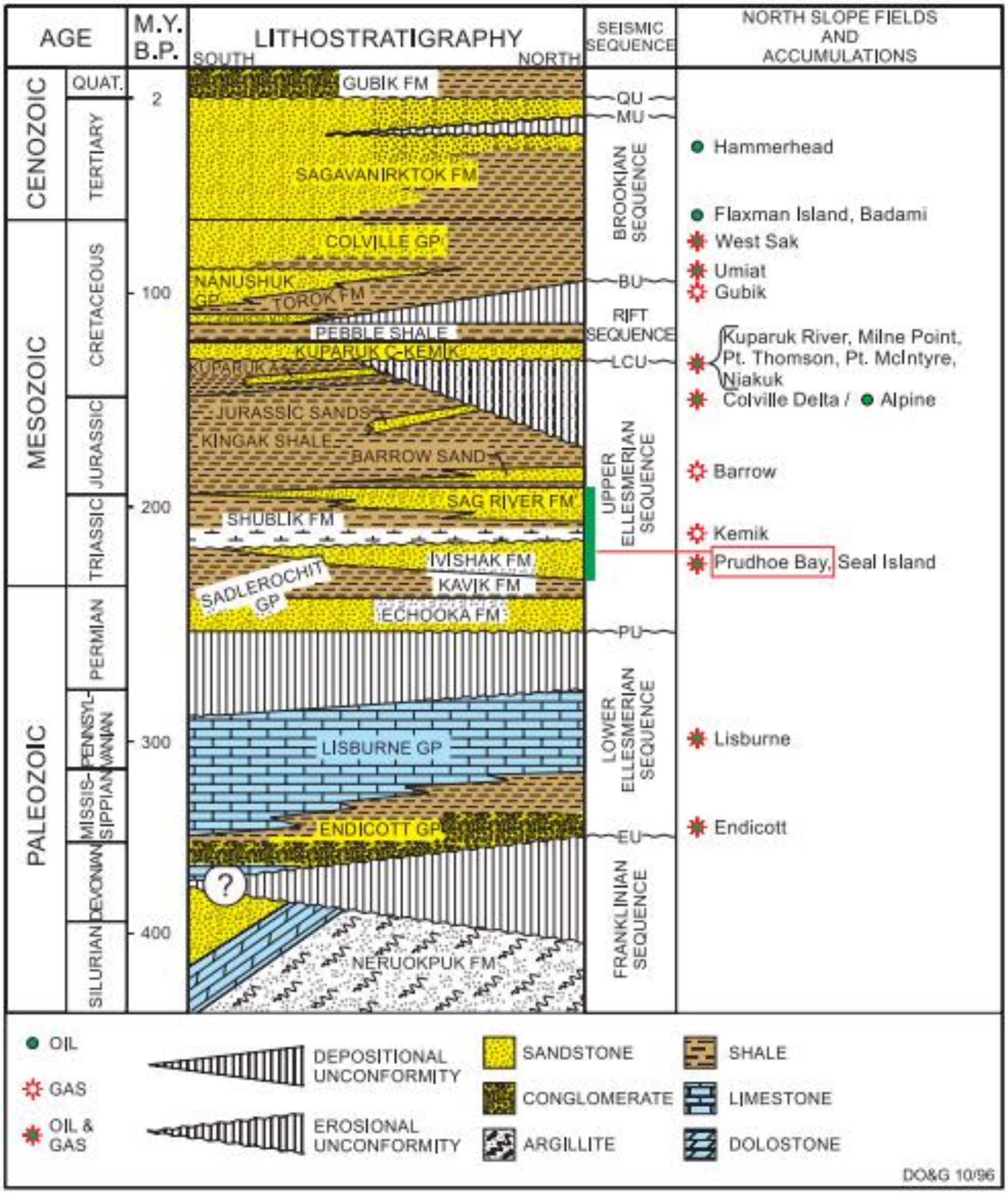
3.1.2 Regional Context

Alaska contains a combination of tectonostratigraphic terranes, accumulated over time on the North American craton, consisting mainly of accreted fragments of igneous arcs, accretionary-wedges, and subduction-zone complexes. A tectonostratigraphic terrane, sometimes referred to as an accreted or exotic terrane, is a fault-bounded geologic entity with a distinctive stratigraphic sequence of rock that differs from neighboring, similarly aged materials. Terranes in the cordillera of Alaska and Canada outboard of the North American craton are grouped into seven composite terranes, including the Arctic, Central, Yukon, Togiak-Koyukuk, Oceanic, Wrangellia, and Southern Margin composite terranes (FERC 2020). The North Slope is located within the Arctic composite terrane, extending northward of the Brooks Range (an extension of the Rocky Mountains), along the Chukchi Sea and Beaufort Sea Coasts. The Arctic composite terrane is further divided based on similar physiographic features. Section 4.1.1.1 of the 2020 EIS describes the seven physiographic provinces crossed by the entire Project. This section covers the physiographic province setting of the North Slope specific to the PTU, PBU, and KRU and geologic properties related to oil and gas reservoirs.

The PTU, PBU, and KRU are located within the North Slope's northernmost province, the Arctic Coastal Plain Province of the Interior Plains Division. The Arctic Coastal Plain Province encompasses a total area of about 26,000 square miles (Bird 1993). Permafrost is typical in the area and is ice rich. Permafrost is usually overlain by an active layer that seasonally thaws and, therefore, is not always perennially frozen. Soils are very poorly drained due to permafrost at depths of 6 inches to 4 feet below the ground surface (FERC 2020). Further context of the existing permafrost in the area is discussed in Section 3.2.4.1.

Located in the Beechey Point quadrangle, the geology of the North Slope mainly consists of Quaternary-age, undivided, unconsolidated surficial deposits. These are poorly to well-sorted, poorly to moderately well-stratified deposits that consist of predominantly alluvial, colluvial, marine, lacustrine, eolian, and swamp deposits, which may include some glacial and periglacial deposits. The glacial deposits are of Holocene and Pleistocene age and may include small areas of potentially latest Tertiary deposits (Wilson et al. 2015). The average elevation range in the Arctic Coastal Plain Province is about 200 to 600 feet above mean sea level. The coastal plain is flat to undulating with very low relief. Ice-cored pingos contribute to minor topographic highs between 20 and 230 feet above the plain, and polygonal ground features provide small-scale topographic variations. The Arctic Coastal Plain Province also features oriented oval- or rectangular-shaped thaw lakes, which can range from 2 to 20 feet deep, and less than a mile to 9.0 miles long (FERC 2020).

Figure 3.1.1 shows the general lithostratigraphy of the North Slope including the various geological formation units, such as the Sagavanirktok River, Shublik, and Ivishak formations, which make up the Prudhoe Bay Oil Field. Within the formations other oil and gas pool accumulations are also identified, amongst which are the Kuparuk River and Point Thomson Pools. The upper Mesozoic and Cenozoic formations predominately consist of sandstone and shale. The interbedding of the sandstone and shale layers produce significant resource extraction pools. The general Quaternary formation layers of the North Slope differ between mainly conglomerate in the south and shale in the north.



Source: AOGCC 2022a

Figure 3.1-1. Generalized North Slope Stratigraphic Column Displaying Oil and Gas Reservoirs and Associated Accumulations

3.1.3 Oil and Gas Resources

The North Slope is one of the most subsurface resource-rich regions in North America and is the focus of many large- and mid-scale oil and gas interests. Oil and gas activities on the North Slope have occurred steadily since commercial exploration began in the 1950s and development began during the 1970s. The Prudhoe Oil Pool was discovered in 1968 and has since been deemed the largest conventional oil field in both the United States and North America. Additionally, Prudhoe Bay is one of the largest single natural gas concentrations in North America (ADNR 2021).

In the year following the discovery of the Prudhoe Oil Pool, more exploration wells were drilled than any other year in north Alaska. Some of the largest producing oil fields discovered after Prudhoe Bay were the Kuparuk River field in 1969, Point Thomson oil field in 1975, Endicott field in 1978, Point McIntyre field in 1989, and Alpine field in 1994. Forty-five producing oil pools and four gas pools currently exist in north Alaska (ADNR 2021). Amongst the gas pools is also the PTU gas field, which was discovered in 1977 (Hydrocarbons Technology 2022).

The PTU, PBU, and KRU are primarily underlain by surficial unconsolidated Quaternary Period marine sediments and Lower Tertiary Period sedimentary bedrock. The area's bedrock is composed of gently north-dipping formations of sandstone, siltstone, and shale. These sedimentary deposits have been targets for petroleum exploration due to the regular presence of oil and gas reservoirs within them. Unconsolidated marine and terrestrial sediments caused by sea level changes in the Pleistocene Epoch overlie the sedimentary bedrock and extend about 50 miles offshore near Prudhoe Bay (FERC 2020).

The PTU, PBU, and KRU are underlain by sedimentary sequences within the Beaufort Sea and North Slope where oil and gas sales areas are designated by the ADNR. These areas account for important oil and natural gas well development due to the moderate to high potential for resource extraction through production wells (FERC 2020).

3.1.3.1 Prudhoe Bay Unit

The PBU contains multiple geological features related to upstream development activities. This includes the Prudhoe Bay Oil Field which contains commercial oil and gas resources, and the Staines Tongue of the Sagavanirktok Formation, which could serve as a potential storage unit for by-product CO_2. The PBU encompasses three deep Permian/Triassic-age sandstone formations: the Sagavanirktok River, Shublik, and Ivishak. The Ivishak, also called the Sadlerochit, is the major oil and gas producing formation in the PBU, as shown in Figure 3.1-1. The reservoir is a combination structural and stratigraphic trap, bounded on the north by major faults and on the east by a Lower Cretaceous truncation. Based on information from Production Report 3, the PBU has over 800 active oil-producing wells in addition to 220 gas, water, and miscible gas injection wells (Kuuskraa et al. 2022b).

<u>Prudhoe Bay Oil Field</u>

The Prudhoe Bay Oil Field is defined as the accumulation of the oil that is common to, and which correlates with, the accumulations found in the Atlantic Richfield – Humble Prudhoe Bay State No. 1 well between the depths of 8,110 and 8,680 feet (AOGCC 2022**a**). The oil field produces initial oil flows of 10,000 barrels per well, per day. The high productivity of the reservoirs is supported by a nearly 500-foot-thick oil column with high permeability that averages 300 millidarcies, strong initial reservoir pressure of 4,335 pound-force per square inch (psi), and a low oil viscosity of 0.8 centipoise (Kuuskraa et al. 2022b).

The Prudhoe Bay Oil Field is estimated to contain about 25 billion barrels of original oil in-place (OOIP). Through the application of new technologies and improved understanding of the key oil displacement mechanisms, the initial estimated oil recovery factor of about 40 percent of OOIP has increased to more than 60 percent of OOIP. The condensate recovery factor is estimated at 80 percent of original condensate in-place. This has raised the expected oil recovery at the Prudhoe Bay Oil Field from an initial estimate of 9.6 billion barrels of oil to a range of 14 to 15 billion barrels of oil (Kuuskraa et al. 2022b). At the end of 2020, approximately 13 billion barrels of oil in total had been recovered from the PBU, of which 12 billion barrels were sourced from the Prudhoe Bay Oil Field and the remainder from various satellite fields within the unit (Kuuskraa et al. 2022b).

The primary oil recovery mechanisms include gravity drainage (below the large gas cap), solution-gas drive, and a weak water drive. Primary recovery mechanisms have been augmented with reinjection of produced gas to maintain reservoir pressure and produce a portion of the residual oil in the gas cap. More recently, field operators have undertaken injection of water into the gas cap, using reinjection of produced water supplemented by seawater injections (Kuuskraa et al. 2022b).

Natural Gas

The PBU is also one of the two primary sources of natural gas supply for the proposed Project's LNG facility. Total original gas in-place for the PBU is estimated at 47.4 Tcf. The oil field is overlain by a major gas cap, and the reservoir oil contains gas in solution with an original solution gas-oil ratio of 735 standard cubic feet per barrel. Based on information provided by BP Exploration (Alaska) Inc. to the AOGCC, the Prudhoe Bay Oil Field could produce 24.8 Tcf over the proposed Alaska LNG Project's term of authorization (Kuuskraa et al. 2022a). Production Report 1 estimates PBU has available natural gas resources of about 30.7 Tcf (Kuuskraa et al. 2022a).

CO_2 Storage Potential

The primary geologic horizon identified by Production Report 3 for storing the by-product CO_2 from the GTP is the Tertiary-age Sagavanirktok Formation within the Brookian Sequence and its Staines Tongue and Mikkelson Tongue members. The Staines Tongue of the Sagavanirktok Formation overlies the Prince Creek Formation and underlies the Mikkelsen Tongue of the Canning Formation. The Staines Tongue contains sediments that were deposited on a marine shelf in associated deltaic and fluvial environments. The overlying Mikkelsen Tongue is a major transgressive deposit consisting of a massive shale section and minor sandstone units that serves as the regional seal for the Staines Tongue saline reservoir (Kuuskraa et al. 2022b).

Only limited, regional-level information on the geologic setting and reservoir properties exists for the Staines Tongue of the Sagavanirktok Formation. Therefore, DOE obtained a study of a series of well logs within and beyond the PBU area. These well logs were analyzed in Production Report 3 to develop more site-specific information for the Staines Tongue at the PBU. The data was used to assess the potential CO_2 storage capacity offered by the Staines Tongue saline formation. The log analysis also included defining and characterizing the important reservoir seal, the overlying Mikkelsen Tongue of the Canning Formation. The presence of the Staines Tongue saline reservoir at the PBU is confirmed by the analyzed well logs and cross-section. The top of the Staines Tongue reservoir is located between 4,200 feet and 4,800 feet, which provides a favorable depth with sufficient pressure for storing CO_2 in a dense phase (Kuuskraa et al. 2022b).

3.1.3.2 Point Thomson Unit

The PTU is located approximately 60 miles east of the PBU, adjacent to the Arctic National Wildlife Refuge, and encompasses an area of about 93,000 acres. The Point Thomson fields are the second of the scheduled primary sources of natural gas for the proposed Project. The PTU contains 22 wells, 16 of which penetrate the Thomson formation (Kuuskraa et al. 2022a).

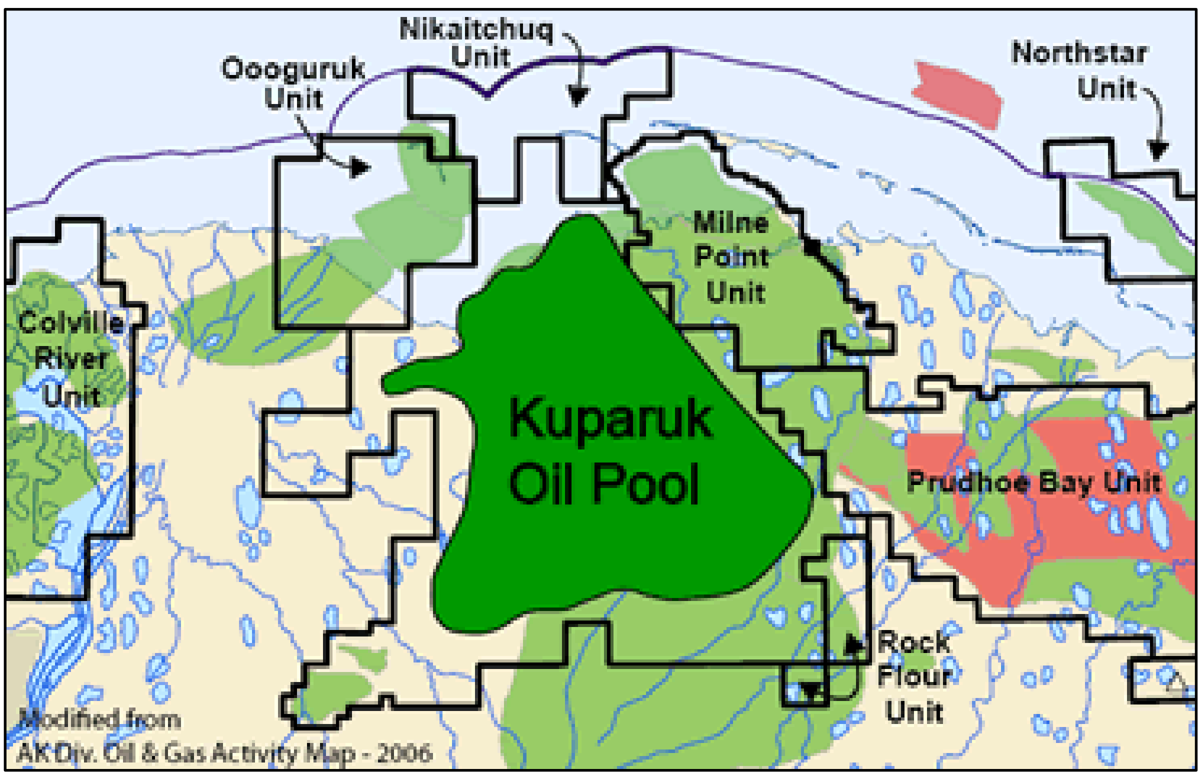
The primary hydrocarbon-producing interval in the Point Thomson field is the early Cretaceous-age Thomson Sand, located at a depth of about 12,700 feet. The Thomson Sand is abnormally pressured with an average reservoir pressure of about 10,100 psi and a pressure gradient of about 0.8 psi per foot. The Thomson Sands also have a net sand depth of 200 to 300 feet, porosity of 5 percent to 34 percent, and permeability that reaches more than 10 darcies in portions of the field. These favorable reservoir properties along with the high reservoir pressure allow production well PTU No. 17 to flow at about 200 million cubic feet per day (Kuuskraa et al. 2022a). Production Report 1 estimates PTU has available natural gas resources of about 10.4 Tcf (Kuuskraa et al. 2022a).

3.1.3.3 Kuparuk River Unit

The KRU contains the second largest oil field in Alaska, behind the PBU, and it is located approximately 40 miles west of PBU's central facilities. The aerial extent of the Kuparuk Oil Pool is shown in Figure 3.1-2. Oil production at the KRU began in 1981, reaching its peak production of 120 million barrels per year (330,000 barrels per day) in 1992. Production since has declined to a current (2020) total of 23 million barrels a year (63,000 barrels per day). At of the end of 2020, total oil production from the KRU reached approximately 2.5 billion barrels. The KRU has approximately 740 active wells, including 406 production wells and 334 injection wells (Wallace et al. 2022).

The main oil production in the KRU is sourced from two major sandstone reservoirs identified as the A Sand and the C Sand. Evaluations from Production Report 2 establish an OOIP of approximately 3.95 billion barrels for the 107,400 acres of A Sand and 2.31 billion barrels for the 149,700 acres of C Sand. The A Sand reservoir is located at a depth of 6,250 feet and has a porosity of 21 percent, permeability of 130 millidarcy (md), and oil viscosity of 1.62 centipoise. The C Sand reservoir is located at a depth of 6,000 feet and has a porosity of 23 percent, permeability of 100 md, and an oil viscosity of 1.57 centipoise. Both Sands have an initial pressure of 3,135 psi. Field-wide characteristic averages for the KRU include a permeability of 150 md, porosity of 2 percent, and an American Petroleum Institute (API) oil gravity of 24 degrees (Wallace et al. 2022).

Due to their properties, proximity to the PBU, existing EOR activities in the form of miscible water-alternating-gas, and analyses in Production Report 2, KRU's major oil field reservoirs are subject to CO_2 storage and EOR per the proposed Project's Scenario 3.



Source: AOGCC 2022**b**

Figure 3.1-2. KRU Oil Field Location

3.1.4 Geologic Hazards

Geologic hazards are natural, physical conditions that can damage land and structures or injure people. Such hazards typically include seismicity (e.g., earthquakes, surface faults, soil liquefaction, and tsunamis and seiches), permafrost, mass wasting, subsidence, acid rock drainage, naturally occurring asbestos, and hydrologic processes and flooding. Section 4.1.3 of the 2020 EIS covers geologic hazards related to the entire scope of the proposed Project. This section will focus on the geologic hazards specifically associated with the the North Slope and the facilities encompassed within that area.

3.1.4.1 Seismicity

Earthquakes generally occur when the two sides of a fault suddenly slip past each other. This movement creates ground motion, which, with enough force intensity, can cause property and structure damage. In contrast to the seismically active southern portion of Alaska, the northern portion has generally been in a state of inactivity or dormancy. On August 12, 2018, a 6.4 magnitude earthquake was recorded about 52 miles southwest of Kaktovik in the Sadlerochit Mountains and about 25 miles south of the Beaufort Sea. This is the largest recorded earthquake on the North Slope. The epicenter was about 40 miles southeast of the PTU. No damage was reported to any North Slope oil-production facilities or networks, including the Trans Alaska Pipeline System and Prudhoe Bay Oil Field facilities (FERC 2020). The 2020 EIS considered the event a naturally caused earthquake from the stick-slip tectonics in the region. The location and magnitude of the 6.4 magnitude earthquake were atypical, however stick-slip events similar to the event are common in the Brooks Range, producing a few magnitude 4 to 5 earthquakes per year. Alaska State Seismologists have stated that the August 12, 2018, earthquake coincides with historic occurrences of tectonic patterns of previous, smaller earthquakes, indicating the earthquake is not related to factors such as permafrost thawing from climate change or oil field activity (FERC 2020). More recent interferometric synthetic aperture radar (i.e., a method to measure earthquake surface displacement) and seismology data revealed that the 6.4 magnitude 2018 earthquake occurred on previously unknown active right-lateral faults that are conjugate to the central deforming zone, striking east-southeast. The 6.4-magnitude mainshock nucleated on the western fault and propagated unilaterally eastward onto the eastern fault, where a majority of the slip and energy release occurred (Gaudreau et al. 2019). Since the August 12, 2018, incident no other major (5+ magnitude) earthquake events have occurred on the North Slope (USGS 2022b).

3.1.4.2 Soil Liquefaction

Soil liquefaction is a process induced by earthquake shaking, or other rapid loading, that reduces the strength and stiffness of a saturated non-cohesive soil resulting in the transformation of solid soil to a liquid state. Typically, a combination of loose, granular soil materials, saturation of the soil materials by groundwater, and severe shaking are factors necessary for liquefaction to occur (FERC 2020).

Since soil liquefaction does not occur where soils are frozen, this is not considered a hazard on the North Slope because of the location in an area of historically low seismic risk and regularly occurring permafrost. A testament to the North Slope’s low seismic risk and soil liquefaction is the August 12, 2018, magnitude 6.4 earthquake discussed above, in which it was determined that little to no soil liquefaction occurred (FERC 2020).

3.1.4.3 Mass Wasting

Mass wasting is defined by geologic hazards that involve down-slope movement of several types of materials, including rock, soil, sediment, snow, or ice, at timescales ranging from slow and creeping to fast and catastrophic. Gravity is generally the causing force of mass wasting events; however, they can be triggered by heavy precipitation, freeze-thaw cycles and melting of permafrost, earthquake vibrations, or human activities. Mass wasting events are classified into falls, slides, and flows depending on the type of movement (FERC 2020).

Mass wasting hazards in the Arctic Coastal Plain, and other Project areas where permafrost is present, could take the form of frozen debris lobes, rock glaciers, or movement caused by solifluction or thaw layer detachment. However, with an average gradient of about 4 feet per mile, the relatively flat elevation of the North Slope has a low risk of mass wasting (FERC 2020).

3.1.4.4 Tsunamis and Seiches

Tsunamis are large waves generated by seafloor vertical fault displacement that propagate through water, while seiches are oscillating waves in partially or entirely enclosed waterbodies that can be generated by submarine landslides, submarine and subaerial mass movements, earthquakes, storms, and strong winds. Both types of waves are hazardous in shallow water and have the potential to inundate coastal areas.

Based on the 2020 EIS review of publicly available information, including the National Oceanic and Atmospheric Administration's 1996 *Tsunamis Affecting Alaska* report and recent tsunami data, there have been no reported tsunami instances on the North Slope. The previously mentioned August 12, 2018, magnitude 6.4 earthquake that occurred on the North Slope did not generate a tsunami alert (FERC 2020).

3.1.4.5 Subsidence

Subsidence involves the downward displacement of the ground surface due to settlement or collapse. It can be caused by naturally occurring or human-triggered activities. Karst terrain, which is formed by the dissolution of carbonate bedrock, is generally associated with subsidence caused by the collapse of underground caves or voids.

Subsidence hazards would not be anticipated on the North Slope because no karst terrain has been identified within 30 feet of the existing facilities near where upstream development activities would be concentrated. Additionally, there are no known underground mines in the area (FERC 2020).

3.1.5 Paleontological Resources

Paleontological resources are classified as any physical evidence of past life including vertebrate and invertebrate fossils, molds, traces, imprints, or frozen remains. These resources are typically encased in bedrock, sediments or permafrost; therefore, field surveys that conduct surface inspections or shallow subsurface testing have limited utility in determining the presence or absence of paleontological resources. The PTU, PBU, and KRU overlay bedrock in the Arctic Coastal Plain Province, including marine sandstone, siltstone, shale, and limestone which is known to be potentially fossil bearing. Both large and small terrestrial vertebrate species such as Mesozoic-Era dinosaurs, Pleistocene-age vertebrate mammals, and marine invertebrates are amongst fossils that could be encountered during project construction. Specifically, significant vertebrate, marine invertebrate, and terrestrial plant fossils have the potential to be encountered respectively in areas where Cretaceous-age sandstone, Devonian sedimentary bedrock, and Middle Jurassic- to Cretaceous-period rocks are encountered (FERC 2020).

According to the BLM data presented in the 2020 EIS, in 1961 fossils representing 12 species of dinosaurs, dating to the Late Cretaceous Period, were recovered about 50 miles west of Prudhoe Bay (FERC 2020).

3.1.6 Regulatory Framework and Permitting Requirements

The ADNR Division of Oil and Gas (DOG) regulates leasing of designated tracts of state land that may be developed for oil and gas exploration and production primarily through lease sales. This adopted system of lease contracts was largely imported from federal laws such as the Mineral Leasing Act of 1920, and state law including the Alaska Constitution Article 8 Section 12, and the Alaska Land Act. U.S. jurisdictions generally confer oil and gas rights by leases. A lease is a contract between the state and a leaseholder that gives the holder the exclusive rights to the resources in a designated track of land for a set amount of time, or primary term, while also reserving a portion of the produced resources for the state as royalties. The lease primary term can be extended by actively drilling, producing, unitizing, or seeking an extension in limited cases.

In order for a leaseholder, or operator, to conduct operations to explore and develop a lease, a Plan of Exploration, Plan of Development, and Plan of Operations must be obtained and submitted through the ADNR DOG (11 AAC 83.158 and 11 AAC 83.346). The Plan of Exploration applies when an operator is conducting initial exploration, and the Plan of Development is submitted annually once the unit is ready for development. Both types of plans detail the type of work commitments by the operator for the coming plan period and specify the short- and long-term plans for the unit. Before the operator can conduct operations, to carry out the work of the specified plans, the Plan of Operations is submitted to demonstrate compliance with mitigation measures attached to each lease in order to minimize the adverse impacts of exploration and development (ADNR 2018a). AS 38.05.035(e) and the departmental delegation of authority provide the ADNR DOG with the authority to impose these mitigation condition or limitations. The type of mitigation efforts imposed on a lease can include sight and sound design and operation constraints; boundary proximity restriction to fish-bearing waterbodies and surface drinking water sources; use of temporary ice access roads or re-use of existing gravel structures; use of existing pipeline transportation corridors; avoidance of significant alterations to migration patterns; explosive restrictions; hazardous substances and waste restrictions; and necessary consultation with applicable local, state, and federal agencies. These measures are put in place to mitigate the potential adverse social and environmental effects on Alaska’s resources including areas of high residential, commercial, recreational, and subsistence use, as well as important fish and wildlife habitats, and archeological sites (ADNR DOG 2016).

Paleontological resources are protected by federal and state acts, such as the Antiquities Act of 1906, Federal and Land Policy and Management Act of 1998, Archeological Resources Protection Act of 1979, and the Alaska Historic Preservation Act.

3.2 SOILS AND SEDIMENTS

3.2.1 Introduction

Section 4.2 of the 2020 EIS includes a description of the soils and sediments present in the Project area and their potential impacts related to various Project components, including the Gas Treatment, Mainline, and Liquefaction Facilities. This includes a full discussion of the existing soil resources, permafrost, soil properties, and sediments along the entire Project, including areas within the North Slope. This **Final** SEIS discussion focuses on existing soil conditions specific to the North Slope and upstream development, including soil types and properties, permafrost and thaw sensitivity occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the units.

3.2.2 Regional Context

In the U.S., soil interpretation at the broadest scale is based on Major Land Resource Areas (MLRA). The North Slope mainly encompasses the Arctic Coastal Plain and Arctic Foothills MLRA. The PTU, PBU, KRU, and existing pipeline ROWs mainly lie within the Arctic Coastal Plain MLRA, with the exception of a 182-acre area in the southern portion of the KRU that lies within the Arctic Foothills MLRA. The Arctic northward-sloping foothills, just north of the Brooks Range and along Alaska's Arctic Ocean coast, consist of low east-west-trending ridges and rolling plateaus with irregular isolated hills. They rise in elevation from approximately 600 feet in the north to 3,600 feet in the south. Except for the east-flowing upper portion of the Colville River, most drainage is northward (ADNR 2021). The Arctic Coastal Plains' physiography is characterized by flat to gently rolling plains rising from the Arctic Ocean to the Arctic Foothills. The soils in this MLRA contain permafrost, evidence of cryoturbation[1], and/or ice segregation near the soil surface (FERC 2020).

The dominant soil order in the Arctic Coastal Plain is Gelisols, which have a pergelic soil-temperature regime, indicating that they have a mean soil temperature of less than 32°F at 20 inches below the surface. Within the U.S., Gelisols are unique to Alaska, but worldwide they make up about 9 percent of the world's ice-free land surface. Gelisols within the Arctic Coastal Plain MLRA are typically poorly and very poorly drained, loamy stratified materials with thaw-sensitive ground ice below 10 inches. Soil groups found within the Gelisols order in the Arctic Coastal Plain MLRA include Aquiturbels, Histoturbels, Haploturbels, Psammoturbels, and Fibristels. Non-soil areas make up about 20 percent of this MLRA, consisting primarily of beaches, ice, waterbodies, and riverwash (FERC 2020).

Soils on the North Slope are very poorly drained due to permafrost at depths of 6 inches to 4 feet below the ground surface. Characterized as the Beechey Point quadrangle, surficial deposits within the northern-most MLRA of the Arctic Coastal Plain mainly consist of unconsolidated, poorly to well-sorted, poorly to moderately well-stratified deposits that consist of predominantly alluvial, colluvial, marine, lacustrine, eolian, and swamp deposits, which may include some glacial and periglacial deposits (Wilson et al. 2015).

3.2.3 Existing Soil Resources

Given the expansive nature and lack of accessibility in Alaska and the North Slope, the U.S. Department of Agriculture Natural Resources Conservation Service has less-detailed Soil Survey Geographic Database information available than is typical in other states. There is currently no Natural Resources Conservation Service Web Soil Survey data available for the North Slope. Therefore, to analyze the soil properties affected by construction and operation of the proposed Project, the 2020 EIS used a combination of available data from the Exploratory Soil Survey of Alaska (USDA NRCS 1979), Digital General Soil Map

[1] Cryoturbation describes all soil movements due to the process of alternate freezing and thawing of moisture in soil, rock and other material, known as frost action, and frost penetration. Cryoturbation is typically characterized by folded, broken, and dislocated beds of unconsolidated deposits including organic horizons and bedrock. Cryoturbated horizons that occur in predominantly dry soils were likely moist soils that dried out (National Snow & Ice Data Center 2022a).

of the United States, and Soil Survey Geographic Database, where available. Additionally, the 2020 EIS used data from Project-specific geotechnical engineering studies conducted by AGDC, including terrain mapping and a digital elevation model data analysis. The terrain mapping was used to identify potentially thaw-stable or thaw-sensitive soils, as defined in Section 4.2.4 of the 2020 EIS.

3.2.4 Soil Types

The majority of the soils within the ROI area are Gelisols. These soils typically have minimal profile development, with most of the soil-forming processes occurring near the surface, which can cause significant accumulation of organic matter. Many Gelisols are waterlogged, which inhibits internal drainage during the summer thaw. They can become boggy wetlands in the summer, providing food and habitat for a variety of wildlife, including caribou, muskox, and migratory birds (FERC 2020).

Gelisols consist of soils that are permanently frozen or contain evidence of permafrost within 6.6 feet (2.0 meters) of the soil surface. They show little morphological development, and due to the low soil temperatures, soil-forming processes such as organic matter decomposition proceed at much slower rates than in other soils. As a result, Gelisols typically store large quantities of organic carbon. Given the frozen condition in which Gelisols are found, they are more sensitive to human activities than other soil orders. Gelisols are divided into three suborders: Turbels, Orthels, and Histels (FERC 2020).

Turbels have one or more horizons that show evidence of cryoturbation in the form of broken, irregular, or distorted horizon boundaries, involutions, organic matter accumulated above permafrost, ice or sand wedges, and oriented rock fragments. Turbels are the dominant soil order and make up the majority of Gelisols in Alaska. Turbels and the various great groups within Turbels represent the largest class of thaw-sensitive permafrost due to the high ground ice content (FERC 2020).

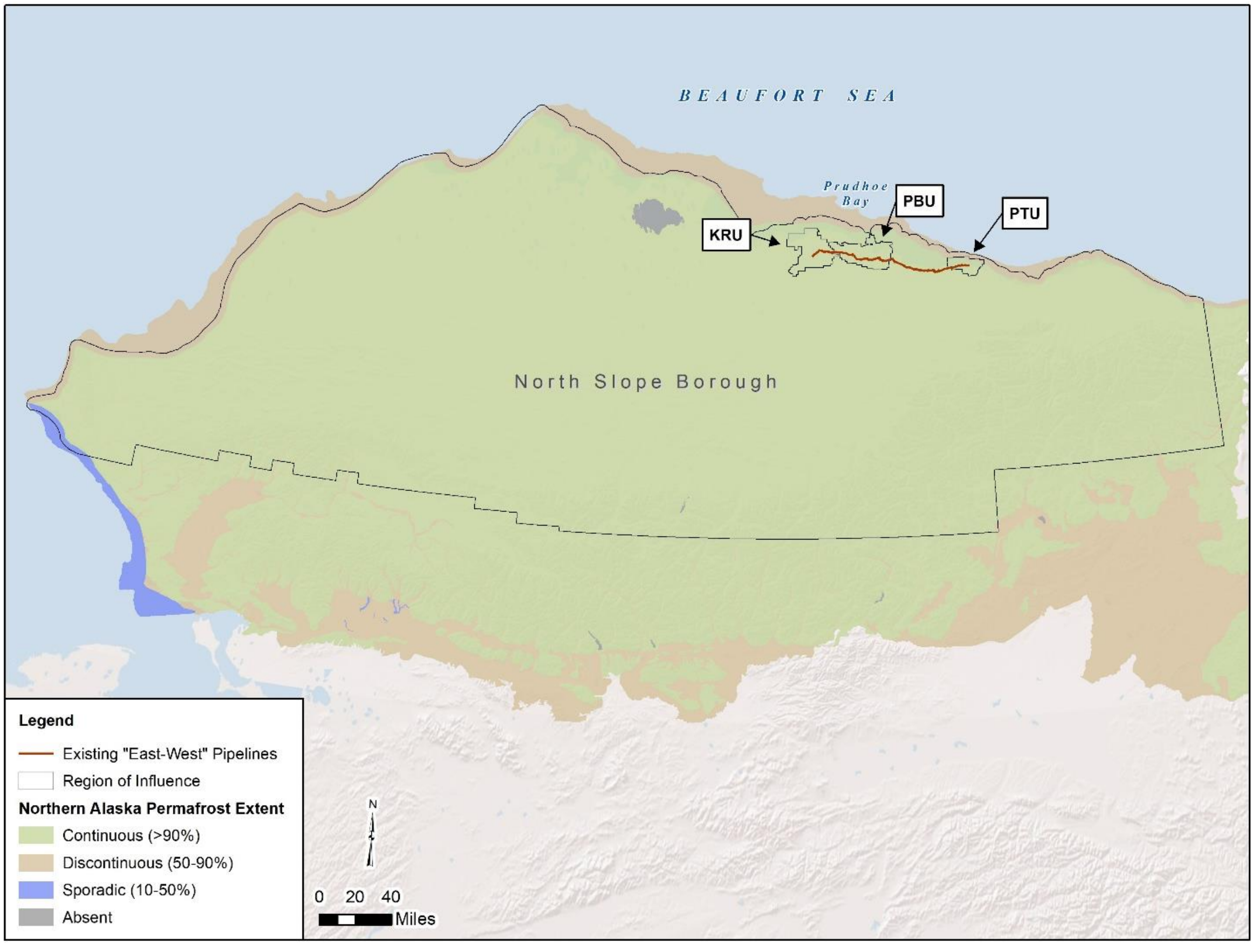
Orthels show little to no evidence of cryoturbation and occur primarily within a zone of widespread permafrost or in areas of coarse-textured materials in a continuous zone of permafrost. Orthels are typically drier than Turbels and Histels. Orthels are the second most common Gelisols in Alaska (FERC 2020).

Histels contain large amounts of organic carbon that typically accumulate under anaerobic conditions or contain organic matter that at least partially fills voids in fragmental, cindery, or pumiceous materials. Cold temperatures also contribute to organic matter accumulation. Within Alaska, Histels are the least common suborder of Gelisols (FERC 2020).

3.2.4.1 Permafrost in the ROI

Permafrost is characterized as ground that remains at or below 32°F for at least two consecutive years, where only a shallow surface zone active layer thaws during the short summer, producing a vast number of small ephemeral lakes and ponds. With the exception of active river systems and taliks[2] beneath waterbodies, the tundra-covered Arctic Coastal Plain, where the PTU, PBU, and KRU are located, is underlain by continuous permafrost (covering approximately 90 to 100 percent of the geographic region), as depicted in Figure 3.2-1. This continuous permafrost ranges from less than 650 feet to more than 1,950 feet in depth, with active layers estimated to range from 0.9 to 4.2 feet, with an average of about 1.5 feet in thickness within the ROI. Active layer depths can reach as deep as 80 inches on the North Slope in well-drained inland gravel sites (FERC 2020).

[2] Taliks describes a layer or body of unfrozen ground occurring in a permafrost area due to a local anomaly in thermal, hydrological, hydrogeological, or hydrochemical conditions (National Snow & Ice Data Center 2022b).



Source: Arctic Landscape Conservation Cooperative 2015
KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit

Figure 3.2-1. Extent of Permafrost on the North Slope

Permafrost can only exist if the amount of yearly heat flowing into the soil is less than or equal to the amount of cooling. Permafrost and ice content are not synonymous; permafrost may be ice-free if the soil contains no moisture or if the water content is saline. While permafrost is defined based on temperature, it is not necessarily always frozen; therefore, it should not be thought of as a permanent feature because natural and anthropogenic (human-caused) changes in terrain and climate can cause ground temperatures to rise above freezing. Additionally, permafrost's active layer is subject to seasonal thaw. The thickness of the active layer is determined by multiple variables, including air temperatures, thawing index, soil texture, water-holding capacity, and vegetation cover. Generally, the active layer is thin in the north and becomes thicker further south, but specific thickness can vary from year to year. Areas with the deepest active layers are usually adjacent to waterbodies. Permafrost with thick organic cover tends to have a shallower active layer than other areas due to the insulation provided by the organic material. Permafrost includes perennial ground ice, but not glacier ice or icings, or bodies of surface water with temperatures perennially below 32°F. Permafrost does include anthropogenic perennially frozen ground, such as around or below chilled pipelines (FERC 2020).

Where permafrost is present, it plays a primary role in the control of water flow paths and distribution. Permafrost typically acts as an impermeable layer that inhibits infiltration and causes surface runoff. Unsaturated permafrost areas can allow for water flow, but once they come into contact with water, they can quickly become saturated and non-permeable. Permafrost has a low hydraulic conductivity, which heavily impacts the movement, storage, and exchange of surface and subsurface water. Subsurface flows can influence the distribution of permafrost by enhancing the transfer of thermal energy through the transfer of heat by the flow of a fluid. When permafrost distribution is modified, hydrologic conditions are also affected, including changes to soil moisture, streamflow seasonality, connectivity of inland waters, and the division of water stored aboveground and belowground (FERC 2020).

A distinct morphologic phenomenon that often develops in permafrost landscapes is patterned ground. While patterned ground is not limited to permafrost areas, it is best developed in regions of intensive frost action. Polygonal ground patterns may develop when winter contraction forms fractures in the surface soils, which fill with water in summer and freeze in the winter. Subsurface ice wedges, mud or frost boils, and turf hummocks grow as a result of seasonal soil surface distortion (FERC 2020).

The conversion of ice to water can, under certain conditions, cause downward displacement of the ground surface known as thaw settlement. As further defined in Section 4.2.4 of the 2020 EIS, permafrost can either be thaw-stable or thaw-sensitive. The majority of the ROI is considered thaw-sensitive. Similar to karst terrain, the irregular surface created by the thawing of ice-rich, thaw-sensitive permafrost is called thermokarst terrain. Thermokarst terrain can occur in localized areas, such as individual depressions, or occupy many square miles and lead to features such as thermokarst lakes. Thermokarst is amplified where flowing water produces thermal erosion, a dynamic process that involves the thawing of ground ice, and by mechanical erosion (i.e., hydraulic transport of soils). Thermal erosion can be significant along river banks or coastal bluffs. The 2020 EIS estimates that there may be as many as 100 thaw lakes near the proposed Project in the Arctic Coastal Plain, which range from around 3 acres or less in size to as large as 117 acres. Light Detection and Ranging analysis estimates that the larger thaw lakes may be about 20 feet deep (FERC 2020).

Permafrost occurrence is influenced by several biotic and abiotic factors, including past and present climate, geology, hydrology, vegetation, and soil type. The relationship between these factors leads to the formation, preservation, and/or degradation of permafrost and ground-ice features. Permafrost degradation occurs as a result of near-surface permafrost thawing and increasing of active layer thickness. Permafrost aggradation is the result of cooling soil temperatures and permafrost propagation. Altering the depth of the active layer can have immediate effects, including changes in the rate of CO_2 and methane (CH_4) release due to microbial respiration of either freezing or thawing organic matter, and freezing and thawing of moisture present in the ground. As GHGs, the release of CO_2 and CH_4 can act as a positive feedback mechanism by increasing the concentration of these radiative gases in the atmosphere. As a result, these gases can trap more heat leading to increased permafrost degradation and gas release.

While permafrost does not necessarily respond directly to air temperature increases, thermal interaction with ecosystem characteristics that are directly affected by air temperature (e.g., vegetation and snow cover) can influence the rate of permafrost degradation. During the summer, key influencers in permafrost temperatures include the length of thaw season and thawing index. During the winter, interactions of seasonal snow cover, vegetation, wind, and microrelief are key factors affecting ground surface and permafrost temperatures. Due to the climate change effects on these seasonal conditions, permafrost is seasonally thawing earlier and freezing later in the year, creating a shorter season of frozen soils and permafrost. According to the USEPA, Alaska’s unfrozen season has grown longer at an average rate of about four days per decade, with 2019 having 20 more unfrozen days than the long-term (1979 to 2019) average (USEPA 2020). The thickness and temperatures of permafrost have also changed since the 1980s, reflecting variations in air temperature and snow depth, as well as extended periods of ice-free conditions. Data collected since the 1980s show that permafrost temperatures are changing along a north–south bioclimatic gradient, with temperatures ranging from 15.8°F to 21.2°F at Arctic Coastal Plain sites. Permafrost on the North Slope has warmed 4°F to 7°F over the past century. Thawing permafrost is more prone to erosion, excessive wetting, plasticity, and unstable sediments. It is expected that the impacts of thawing permafrost will become more pronounced during the life of the planning period and may create significant landscape change in the planning area (FERC 2020). A further discussion on climate change effects is included in Section 3.19.3.

The major soil resource concern identified by the U.S. Department of Agriculture within the Arctic Coastal Plain MLRA is the disturbance of permafrost soils. Disturbing the surficial organic material or vegetative cover, which provides an insulating layer, could cause permanent impacts on the soils, including permafrost thawing. As mentioned above, this thawing could result in ponding, soil subsidence or compaction, erosion, and surface drainage disruption (FERC 2020).

3.2.5 Regulatory Framework and Permitting Requirements

The ADEC, in compliance with the provisions of the CWA, 33 USC 1251 *et seq.*, as amended by the Water Quality Act of 1987, P.L 100-4, issues an APDES General Permit under provisions of Alaska Statutes 46.03, the ACC as amended, and other applicable state laws and regulations. The APDES General Permit authorizes stormwater discharges from large and small construction-related activities that result in a total land disturbance of equal to or greater than 1 acre, where those discharges enter waters of the United States (directly or through a stormwater conveyance system) or a Municipal Separate Storm Sewer System. The permit also authorizes storm water discharges from certain construction support activities and some non-stormwater discharges commonly associated with construction sites. The goal of the permit is to minimize erosion and reduce or eliminate stormwater pollution from construction activity through implementation of appropriate control measures. The permit describes control measures that must be used to manage storm water runoff during construction activities. Additionally, the permit requires a Stormwater Pollution Prevention Plan (SWPPP) be developed and implemented. The SWPPP acts as a sediment and erosion control plan and describes all the site operator’s activities to prevent stormwater contamination, control sedimentation and erosion, and comply with the requirements of the CWA. Authorization of the permit is not required for construction sites that result in a total land disturbance of less than 1 acre of land unless the site is part of a common plan of development or sale that will ultimately disturb 1 or more acres of land (ADEC 2020a).

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3.3 WATER RESOURCES

3.3.1 Introduction

Section 4.3 of the 2020 EIS details water resources potentially affected by the entire Project. This section focuses on water resources potentially found on the North Slope, as identified during a review of appropriate maps and databases, consultation with federal, state, and local agencies, and information presented in the 2020 EIS and the North Slope Area Plan. These descriptions and analyses address groundwater, freshwater, marine waters, and water use within the ROI. For the purposes of this **Final** SEIS, the ROI for water resources encompasses the North Slope with an emphasis on features occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the units. Anadromous species are addressed in Section 3.7.3.1, and federally listed endangered and threatened species dependent on water resources are addressed in Section 3.8.

3.3.2 Regional Context

3.3.2.1 Groundwater

The availability of groundwater in Alaska is influenced by many factors, including average annual precipitation, infiltration through frozen soils, and evapotranspiration. For context on the North Slope, average annual precipitation in Prudhoe Bay is about 4 inches of rain and 39 inches of snow (FERC 2020). The North Slope is located within the Alaska Hydrologic Region (Region 19) (Callegary et al. 2013). Hydrologic regions are defined by climatic and topographic characteristics, which influence the presence or absence of permafrost and groundwater availability and quality. Continuous permafrost covers more than 90 percent of the portion of northern Alaska encompassing the North Slope. In some places, this permafrost can be more than several hundred meters thick. This limits groundwater-surface water interactions to shallow water located above the permafrost and inhibits the formation and use of groundwater throughout much of the ROI (Callegary et al. 2013).

Within the Alaska watershed, groundwater typically occurs underneath the base of the permafrost layer, which may extend to depths of 2,000 feet, and above permafrost where local conditions lower the upper surface of permafrost below the depth of seasonal freezing. The four general geohydrologic environments recognized in Alaska include: 1) alluvium of river valleys (which contain the greatest volume of stored groundwater); 2) glacial and glaciolacustrine deposits of the inner valleys; 3) coastal-lowland deposits; and 4) bedrock of the uplands and mountains. Bedrock stores groundwater in the approximately 75 percent of the state where glacial and alluvial deposits are thin, poorly permeable, or absent. There are four general bedrock types in Alaska: carbonate rocks, sandstone, volcanic rocks, and metamorphic and intrusive igneous rocks (FERC 2020). The extensive presence of permafrost throughout the North Slope limits the size of aquifers and the availability of groundwater (Callegary et al. 2013). As such, no substantial decline in groundwater levels has been observed in Alaska (Konikow 2013).

According to the U.S. Geological Survey (USGS) National Hydrography Dataset, no seeps or springs were identified within 150 feet of proposed project facilities within the ROI. One such feature does exist within the North Slope, but it is located approximately 410 miles from the KRU and approximately 424 miles from the existing pipeline ROW (USGS 2022a).

3.3.2.2 Surface Water

Surface water bodies are generally grouped by watershed. A watershed is an area of land that drains surface waters and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel (USGS 2019a). Watersheds in Alaska are delineated by the USGS using a hierarchical system that classifies drainage areas. Hydrologic Unit Code (HUC) is a unique numeric identifier that describes the level of the watershed (i.e., a 2-digit first-level [HUC2] code to an 8-digit fourth-level [HUC8] code) and geographic location. The Alaska watershed is classified as Region 19 (HUC2). The ROI encompasses 3 third-level watersheds, which are further divided into 5 fourth-level sub-watersheds identified by an 8-digit HUC (HUC8) (USGS 2022c).

Freshwater resources within the North Slope include naturally occurring waterbodies, such as streams, rivers, lakes, and ponds. This **Final** SEIS defines waterbodies as any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing, including lakes and ponds. Waterbodies are further classified by width and flow. Minor waterbodies are 10 feet wide or less, intermediate waterbodies are between 10 and 100 feet wide, and major waterbodies are greater than 100 feet wide at the water's edge at the crossing location. Flow classifications are provided below.

- **Perennial.** Contains water throughout the year, except for infrequent periods of severe drought.
- **Perennial-Multiple.** A subset of perennial waterbodies where there are braided or anastomosed channels and where channels are considered part of the waterbody at that location. Note that this is not a standard National Hydrography Dataset category.
- **Intermittent.** Contains water for only part of the year, but more than just after rainstorms and at snowmelt.
- **Pond/Open Water.** A standing body of water with a predominantly natural shoreline surrounded by land; includes lakes and ponds.

Larger streams in the coastal plain have gravel bars and well-defined banks, while smaller streams may flow through grass-lined swales or exhibit poorly defined or beaded channels (USACE 2012). The majority of streams originating in the Eastern Arctic Watershed are not expected to produce large ice floes or ice damming because these streams are typically dry during late fall and early winter when the ice would form. Major rivers, such as the Sagavanirktok River, are expected to sustain winter base flows and have higher potential for ice dams and ice debris during breakup than smaller streams. Fall storm events in the Brooks Range mountains can cause extensive flooding and erosion of the major rivers with headwaters in the mountains, such as the Sagavanirktok River.

Spring snowmelt, or breakup, on the North Slope is the accumulation of extensive areas of standing water and rapid runoff that can occur over a period of a few days due to the limited infiltration of water into the frozen tundra soils. At this time of the year, stream and river main channels are commonly filled with snow and ice, which can reduce the ability of the channel to contain peak flows. Mean annual runoff in this region is lowest near the Beaufort Sea coast and increases somewhat in the foothills of the mountains of the Brooks Range. The annual runoff peak generally occurs as a result of snowmelt runoff between late May and early June, but late summer and fall rains in August can also produce substantial runoff events. Low flow and freeze up begins as early as late September and continues into January for major rivers and earlier for smaller streams (FERC 2020).

The ROI would generally occur within the Prudhoe Bay Watershed, which includes the Kuparuk River, Sagavanirktok River, and Mikkelsen Bay Subwatersheds. About 1.0 mile of the PTTL and the PTU would also be located within the Eastern Arctic Watershed, which includes the Canning River Sub-watershed. The Prudhoe Bay Watershed originates in the Brooks Range mountains and flows north through the foothills across the coastal plain to the Beaufort Sea. Wetlands, rivers, beaded channels[3], lakes, and tundra ponds dominate the landscape within the Prudhoe Bay and Eastern Arctic Watersheds. The terrain consists of nearly flat and poorly drained low-lying tundra underlain by continuous permafrost that gradually rises to the south with an average gradient of about 10 feet per mile. Table 3.3-1 lists the named rivers occurring within the ROI. The natural freshwater resources within and adjacent to the ROI are shown on Figures 3.3-1, 3.3-2, and 3.3-3.

[3] Beaded channels (beaded streams) are regularly spaced, deep, elliptical pools connected by narrow, flowing waterways. The term "beaded stream" refers to the waterbodies' resemblance to "beads on a string" during the summer low flow period (Arp et al. 2015). Beaded streams are regionally unique features in northern Alaska, occurring in both the coastal plain and the Brooks Range foothills. Within the coastal plain, beaded streams can account for half of the drainage density (Arp et al. 2015).

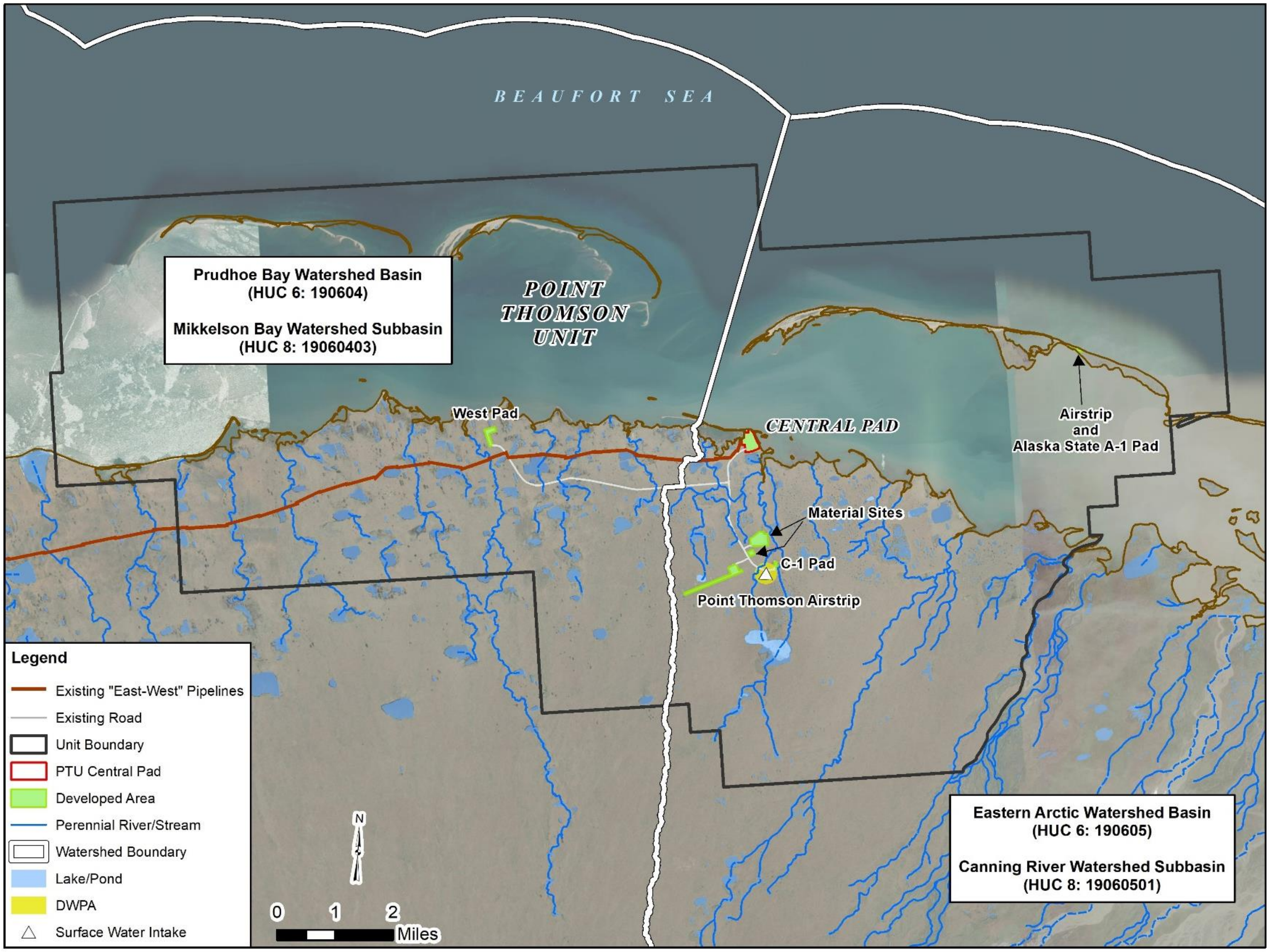
Table 3.3-1. Named Rivers within the ROI

ROI[a]	River	Navigable?	Anadromous?
Existing Pipeline ROW	East Badami Creek	No	**Yes**
	East Sagavanirktok Creek	**Yes**	**Yes**
	Kadleroshilik River	No	No
	Kuparuk River	**Yes**	**Yes**
	Oogrukpuk River	No	**Yes**
	Putuligayuk River	No	No
	Sagavanirktok River	**Yes**	No
	Sakonowyak River	No	No
	Shaviovik River	No	No
	Ugnuravik River	No	**Yes**
	West Channel Sagavanirktok River	**Yes**	**Yes**
KRU	Colville River	**Yes**	**Yes**
	East Fork Kalubik Creek	No	**Yes**
	Kachemach River	No	**Yes**
	Kalubik Creek	No	**Yes**
	Kupigruak Channel	No	**Yes**
	Miluveach River	No	**Yes**
	Nowhere Creek	No	**Yes**
	Oogrukpuk River	No	**Yes**
	Ugnuravik River	No	**Yes**
	West Fork Ugnuravik River	No	**Yes**
PBU	Fawn Creek	No	**Yes**
	Kuparuk River	**Yes**	**Yes**
	Oogrukpuk River	No	**Yes**
	Putuligayuk River	No	**Yes**
	Sakonowyak River	No	**Yes**
	West Channel Sagavanirktok River	**Yes**	**Yes**

Source: ADF&G 2022e; USACE 2022

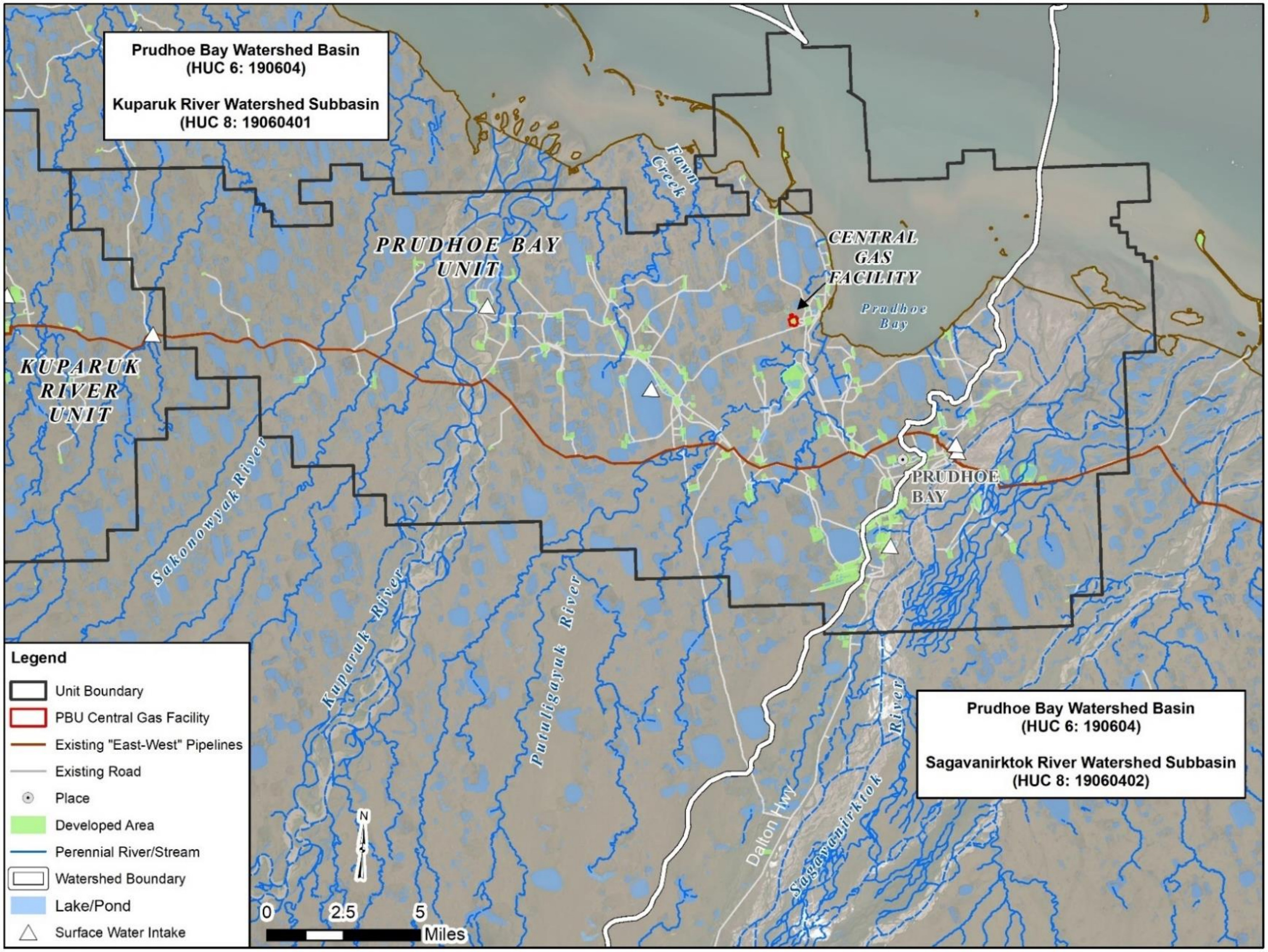
[a] No named rivers occur within the PTU.

KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way



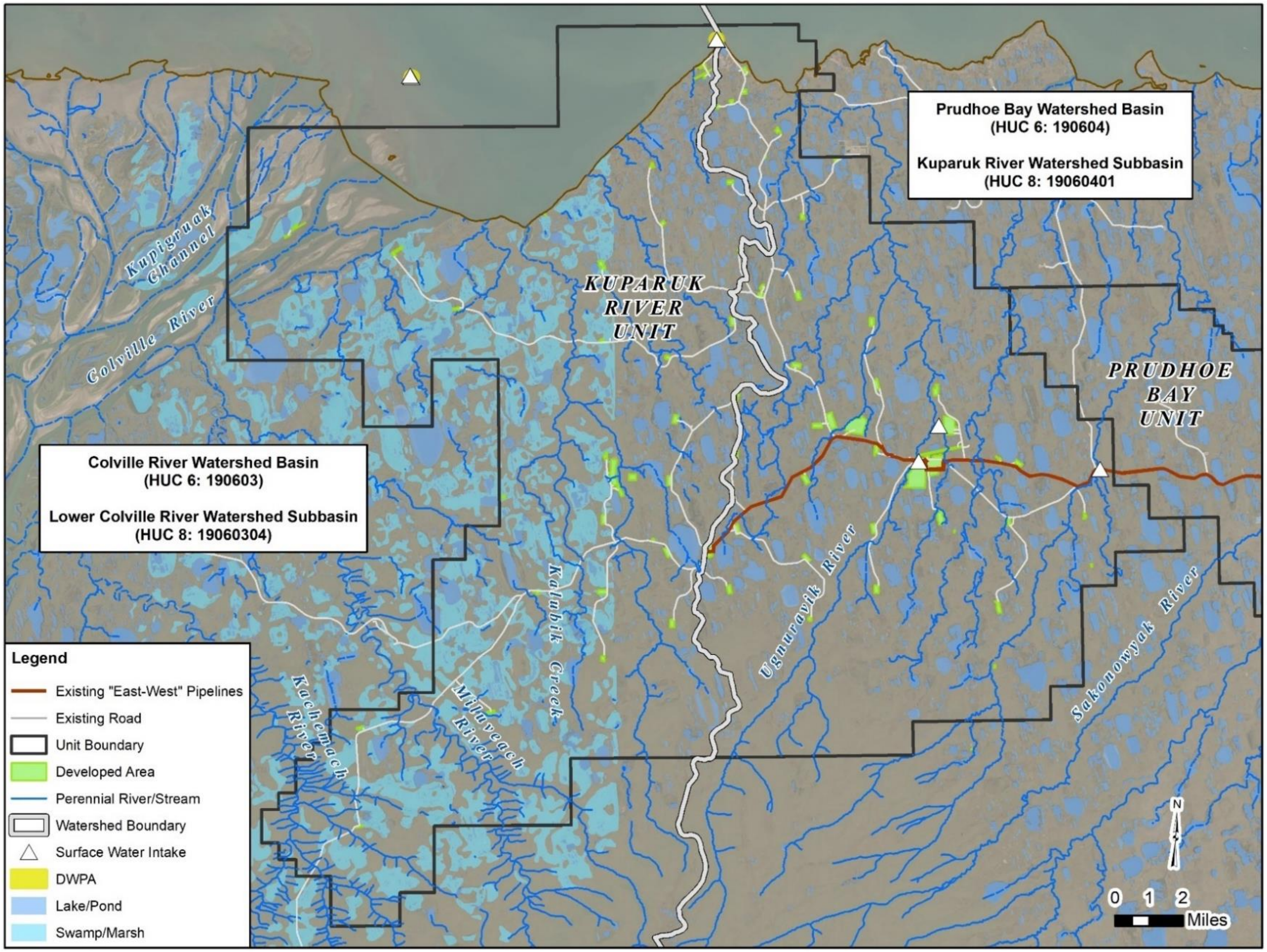
Source: ADNR DOG 2021a; AGDC 2022; North Slope Science Initiative 2021; USGS 2022a
DWPA = Drinking Water Protection Area; HUC = Hydrologic Unit Code; PTU = Point Thomson Unit

Figure 3.3-1. Surface Waters within PTU



Source: ADNR DOG 2021a; AGDC 2022; North Slope Science Initiative 2021; USGS 2022a
HUC = Hydrological Unit Code; PBU = Prudhoe Bay Unit

Figure 3.3-2. Surface Waters within PBU



Source: ADNR DOG 2021a; AGDC 2022; North Slope Science Initiative 2021; USGS 2022a
DWPA = Drinking Water Protection Area; HUC = Hydrologic Unit Code; KRU = Kuparuk River Unit

Figure 3.3-3. Surface Waters within KRU

In the Prudhoe Bay Watershed, the concentration of total suspended solids in streams and rivers typically increases from headwaters to mouth. Minimal glacial input to the tributaries of the major rivers occurs in this watershed and, consequently, the stream water has high clarity in the Sagavanirktok and Kuparuk Rivers (FERC 2020). A 2002 study of dissolved and suspended matter transported by the Sagavanirktok and Kuparuk Rivers reported that arctic rivers typically transport 40 to 80 percent of the annual volume of water during spring floods in May, June, and July. The Kuparuk River's average concentrations of dissolved metals and dissolved organic carbon were higher than the Sagavanirktok River during spring floods, which is related to regional differences in lithology and soil pH (FERC 2020). The Kuparuk and Sagavanirktok Rivers' peak discharge transported more than 80 percent of suspended sediment; more than 33 percent of annual inputs of dissolved copper, iron, lead, zinc, and dissolved organic carbon were discharged to the Beaufort Sea (FERC 2020). For reference, daily water temperatures for the Sagavanirktok River June 1, 2021, and September 1, 2021, ranged from a low of about 4ºC (39ºF) to a high of about 17.7ºC (63.9ºF) (USGS 2021a); daily water temperatures for the Kuparuk River ranged from 0ºC (32ºF) to 19.5ºC (67.1ºF) over the same period (USGS 2021b).

In the Eastern Arctic Watershed, pH levels in the streams are near neutral to slightly alkaline (USACE 2012). In the winter, dissolved oxygen concentrations in lakes and ponds are high when ice is first formed. As winter progresses, the dissolved oxygen concentrations can decrease due to oxygen requirements for organic matter decomposition that occurs in lake and pond bottom sediments, and for consumption by fish if any are present (USACE 2012). The biochemical oxygen demand of 10 of the 13 waterbodies sampled around the PTTL were undetectable except for waterbodies that were smaller and surrounded by vegetation, which could create higher concentrations of organic material on waterbody sediments. The highest biochemical oxygen demand concentration reported for the sampled waterbodies around the PTTL was 6.2 micrograms per liter (USACE 2012).

3.3.2.3 Floodplains

Floodplains are generally defined as low-lying areas adjacent to rivers and streams susceptible to inundation during periods of high flow or discharge. Floodplains attenuate stormwater flow and provide erosion and sediment control, nutrient input, and wildlife habitat. A flood occurs when the level in a stream or river channel overflows the natural or constructed bank. No Federal Emergency Management Agency Flood Insurance Rate Maps are available for locations of the proposed facilities located in the North Slope (FEMA 2022). Although no floodplain mapping exists for the area, flooding does occur along rivers and the coast. Section 3.19.3 contains a discussion on how climate change is affecting both riverine and coastal flooding.

3.3.2.4 Marine Waters

The ROI includes areas along the coasts of Beaufort Sea, specifically Prudhoe Bay. Beaufort Sea has an average depth of approximately 3,239 feet and a narrow continental shelf with a general depth of less than 210 feet. Ice covers the water for most of the year, generally only breaking up in August and September (Britannica 2022). However, Beaufort Sea is a dynamic environment that has experienced recent change as waters warm due to climate change and melting ice. The freshwater content of the Beaufort Sea has increased by approximately 40 percent over the last 20 years (National Science Foundation 2021). This influx of freshwater has also exacerbated the acidification of the Beaufort Sea that already being driven by increased carbon emissions and higher concentrations of CO_2 in the water (McKittrick 2020). Refer to Section 4.3.3 of the 2020 EIS for an in-depth discussion of these marine waters. No additional marine waters beyond those discussed in the 2020 EIS occur on the North Slope or within the ROI assessed within this **Final** SEIS.

3.3.3 Water Quality and Use

3.3.3.1 Existing Water Use

Groundwater in Alaska is used for agricultural, commercial, industrial (mineral extraction), and domestic purposes (Dieter et al. 2018). The groundwater is generally considered to be good quality, although certain areas have naturally high concentrations of iron, arsenic, manganese, and total dissolved solids in the form of calcium or calcium magnesium bicarbonate (hard water). Table 3.3-2 provides known groundwater uses and volumes for North Slope Borough (Dieter et al. 2018). The total withdrawn groundwater volume of 83.92 million gallons per day represents about 66 percent of the total 125.07 million gallons of water withdrawn per day in 2015. Almost all of the groundwater withdrawn within North Slope Borough was saline water used for mining. Minor volumes of freshwater groundwater (about 0.01 million gallons per day) were used for public supply, livestock, and industrial self-supply (Dieter et al. 2018).

Alaska's surface water resources are generally considered to be of high quality due to the absence of human disturbance and resulting pollutants. Surface waters supply freshwater for about 75 percent of all water needed for industry, agriculture, mining, fish processing, and public water use, as well as about 50 percent of the domestic water supply (USEPA 2022a). Table 3.3-2 provides known surface water uses and volumes near or within North Slope Borough (Dieter et al. 2018). The total withdrawn surface water volume of 42.62 million gallons per day represents about 33 percent of the total 125.07 million gallons of water withdrawn per day in 2015. Almost all of the surface water withdrawn within North Slope Borough was saline water used for mining. Comparatively minor volumes of fresh surface water (about 1.47 million gallons per day) were used for public supply, domestic self-supply livestock, and mining (Dieter et al. 2018). **Additionally, use of freshwater and ice chips occurs on the North Slope for ice roads in the winter.**

Lakes and tundra ponds are abundant but generally too small and shallow to provide significant volumes of water. When frozen, these lakes could be used as a source of ice chips for winter ice road and ice pad construction activities. Flooded gravel mine sites are also a freshwater source. Historically, deep mine sites were developed to provide the gravel material needed for road and pad construction for development. When a gravel mine site was exhausted of materials, it was converted, either naturally or by fabricated diversions, to water reservoirs (Ott et al. 2014). Although many of these flooded gravel mine sites provide habitat for fish, state regulatory agencies allow the water to be used by industry. Flooded gravel mine sites do not completely freeze to the substrate in the winter due to the depths being greater than the naturally formed lakes.

Table 3.3-2. Water Use within North Slope Borough (2015)

Type of Water Withdrawal (fresh and saline)	Groundwater Use (Mgal/d)	Surface Water Use (Mgal/d)
Public supply	0.01	0.37
Domestic self-supply	0.00	1.07
Irrigation	0.00	0.00
Livestock	0.01	0.01
Aquaculture	0.00	0.00
Mining – fresh	0.00	0.02
Mining[a] – saline	83.92	41.15
Industrial self-supply	0.01	0.00
Thermoelectric	0.00	0.00

Table 3.3-2. Water Use within North Slope Borough (2015)

Type of Water Withdrawal (fresh and saline)	Groundwater Use (Mgal/d)	Surface Water Use (Mgal/d)
Total fresh water withdrawal	0.03	1.47
Total saline water withdrawal	83.92	41.15
Total water withdrawal	83.95	42.62

Source: Dieter et al. 2018

a Mining water is used for the extraction of minerals and rocks that may be in the form of solids, such as coal, iron, sand, and gravel; liquids, such as crude petroleum; and gases, such as natural gas. The category includes quarrying, milling of mined materials, injection of water for secondary oil recovery or for unconventional oil and gas recovery (such as hydraulic fracturing), and other operations associated with mining activities.

Mgal/d = million gallons per day

3.3.3.2 Drinking Water Supply and Protection

The continuous permafrost prevalent in the Alaska watershed generally confines the unconsolidated alluvium and colluvium deposits and restricts groundwater movement (Callegary et al. 2013). Groundwater in soils within the active zone above permafrost is unreliable as a water source due to seasonal freezes; lack of connection to deeper, subpermafrost groundwater supplies; and high organic content (FERC 2020). Untreated, groundwater is not suitable for use as a drinking water supply in the area north of the Brooks Range on the North Slope. Groundwater resources north of the Brooks Range (including in the ROI) contain high concentrations of total dissolved solids (some exceeding 7,000 milligrams per liter [mg/L]) causing high salinity levels (FERC 2020). Lakes are used as primary water sources in areas of continuous permafrost.

No public wells were identified within PTU or PBU. Of 13 total Drinking Water Protection Areas located on the North Slope Borough, the PTU, PBU, and KRU each contain one 72.09-acre Drinking Water Protection Area (ADEC 2022a):

- **PTU.** Draws surface water from C-1 reservoir to serve the Qiruk Camp operational center.
- **PBU.** Draws surface water from the transfer between the Sagavanirktok River to Webster Lake.
- **KRU.** Draws groundwater from one of three shallow slant walls.

3.3.4 Regulatory Framework and Permitting Requirements

Sections 305(b) and 303(d) of the CWA mandate that states develop programs to monitor and report on the quality of their waters. The resulting *Integrated Water Quality Monitoring and Assessment Report* (Integrated Report) is a comprehensive statewide evaluation of water quality. The Integrated Report assigned waterbodies to five categories:

- **Category 1.** Waters for which there is enough information to determine that water quality standards are attained for all of their designated uses.
- **Category 2.** Waters for which there is enough information to determine that water quality standards are attained for some of their designated uses.
- **Category 3.** Waters for which there is not enough information to determine their status.
- **Category 4.** Waters are impaired but have one of several different types of waterbody recovery plans.
- **Category 5.** Waters are impaired and do not yet have waterbody recovery plans.

Section 303(d) of the CWA also requires states to develop lists of impaired waterbodies that do not meet water quality standards.

ADEC sets the Alaska Water Quality Standards (AWQS) to ensure that existing water uses and the level of water quality necessary to protect existing uses are maintained and protected. The AWQS specify the degree of degradation that may not be exceeded in a waterbody as a result of human actions. If a waterbody is not classified in one of the other categories, it is assumed to be a Category 1 waterbody. **Per the 2020 Integrated Report, 6 waterways were reclassified as Category 2, 15 waterways were added to Category 3, 3 waterways were added to Category 4, and 11 waterways were added to Category 5 (USEPA 2022b)**.

The State of Alaska administers programs that regulate the withdrawal and discharge of water used for hydrostatic testing and specifies measures to ensure consistency with AWQS and the antidegradation policy. The state also administers programs to avoid conflicts in water uses. The ADNR administers a program for Alaskan water rights, which are legal rights to use surface and groundwater under the Alaska Water Use Act. The project proponent would acquire appropriate water rights permits prior to project construction and operation. Water withdrawals from fish-bearing waterbodies additionally would require an authorization from the ADF&G in accordance with its AS Title 16 authority.

The ADEC enforces the AWQS criteria, including but not limited to maximum contaminant levels for water supply (including drinking, agriculture, aquaculture, and industrial), water recreation (including both marine and inland waters), and marine aquatic life criteria (FERC 2020). For drinking water, the AWQS indicate that total dissolved solids may not exceed 500 mg/L, and neither chlorides nor sulfates may exceed 250 mg/L. These water quality standards are used in the development of waterbody recovery goals, wastewater permits, and waterbody monitoring plans and differ from standards used for the regulation of public drinking water.

3.4 WETLANDS

3.4.1 Introduction

Section 4.4 of the 2020 EIS details wetland resources potentially affected by the entire Project. This section focuses on wetlands potentially found on the North Slope, as identified during a review of appropriate maps and databases, consultation with federal, state, and local agencies, and information presented in the 2020 EIS and the North Slope Area Plan. The ROI for wetlands encompasses the North Slope with an emphasis on features occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the units.

Wetlands are among the most productive environments in the world, comparable to rain forests and coral reefs. Many species of wildlife, including a large percentage of threatened and endangered species, depend on wetlands for survival. Wetlands are also important for scientific and educational opportunities and can provide open space for recreation where public access is available.

Wetlands have unique characteristics that set them apart from other environments, providing the basis for wetland identification and classification. These unique characteristics include a layer of soil that is saturated or inundated with water for part of the growing season, soils that contain little or no oxygen, and plants adapted to wet or seasonally saturated conditions (Environmental Laboratory 1987). Wetlands serve many functions, including the storage and slow release of rain, snowmelt, and seasonal floodwaters to surface waters. Additionally, wetlands provide wildlife habitat, stabilize and retain sediment, and perform an important role in nutrient (e.g., nitrogen and phosphorus) cycling. Wetlands also help to maintain stream flow during dry periods and provide groundwater recharge functions.

Following the Cowardin classification system, wetlands are first grouped by systems (e.g., landscape position) as coastal (tidal or estuarine) or inland (non-tidal, freshwater, or palustrine). They are then classified by class (cover-type) (e.g., emergent wetlands, scrub-shrub wetlands, and forested wetlands) and by water regime (temporarily or permanently flooded, saturated) (USEPA 2002).

Although riverine, lacustrine, and marine systems are described by Cowardin classification, those resources and impacts are discussed in detail in Section 3.3 and Section 4.3. A description of Cowardin classification wetland types found within the ROI is provided below.

- **Palustrine emergent.** These wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens, that provide at least 30 percent areal cover. Vegetation is present for most of the growing season in most years. In order to normalize AGDC's data for the 2020 EIS analysis, Cowardin classifications of palustrine ponds (e.g., palustrine aquatic bed and palustrine unconsolidated bottom classes) were reassigned to palustrine emergent based on the vegetation type shown on aerial imagery.
- **Palustrine scrub-shrub.** These wetlands are dominated by woody vegetation less than 20 feet tall that provides at least 30-percent areal coverage. Vegetation includes broadleaf, needle-leaf, and mixed shrub plant communities in Alaska. According to wetland data provided by AGDC, palustrine scrub-shrub wetlands would be the most prevalent wetland type in the ROI.
- **Palustrine forested.** These wetlands are dominated by woody vegetation 20 feet tall or taller with trunk diameter at breast height of 3 or more inches providing at least 30 percent areal coverage.
- **Estuarine.** These wetlands consist of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean. The ocean water is at least occasionally diluted by freshwater runoff from the land. Estuarine wetlands consist of two subsystems, including where the substrate is continuously submerged (subtidal) or is exposed and flooded by tides (intertidal).

3.4.2 Regional Context

More than 43 percent of Alaska's surface area is composed of wetlands (Hall et al. 1994). This amounts to greater than 175 million acres of land. The wetlands located within the ROI are encompassed by the Arctic and Western Region. The three subdivisions in the Arctic and Western Region are the Arctic Coastal Plain, Arctic Foothills, and Brooks Range.

Sixty-one percent of the Arctic and Western Region is comprised of wetlands (Hall et al. 1994). Within this region, the Arctic Coastal Plain, Arctic Foothills, and Brooks Range Subdivisions consist of about 17 million acres (83 percent), 30 million acres (83 percent), and 7 million acres (22 percent) of wetlands, respectively. The Arctic Coastal Plain and Arctic Foothills Subdivisions are underlain by continuous permafrost that prevents drainage and causes waterlogged soils that lead to the establishment of wetland vegetation. The Arctic Coastal Plain Subdivision supports extensive lowland tundra plant communities often dominated by sedges (e.g., water sedge and Bigelow's sedge [*Carex aquatilis* and *C. bigelowii*]) and small shrubs (e.g., willows [*Salix reticulata* and *S. arctica]*). The Arctic Foothills Subdivision supports tussock tundra (e.g., tussock cottongrass [*Eriophorum vaginatum*]), shrub tundra (e.g., dwarf birch [*Betula nana*], and the tealeaf willow [*Salix pulchra*]), and mixed tundra communities. The Brooks Range Subdivision acts as a divide between the Arctic Foothills and the Interior Alaska Highlands Subdivisions. Within the Brooks Range Subdivision, wetlands occur in valleys and lower sloped areas. The predominant vegetation types include sedge tussocks and mixed shrub-sedge tussocks (e.g., tussock cottongrass, Bigelow's sedge, dwarf birch, and mountain cranberry [*Vaccinium vitis-idaea*]) (FERC 2020).

3.4.3 Wetland Resources

The entire ROI occupies areas classified as wetlands. Specific types of wetlands within the ROI include freshwater emergent, freshwater forested/shrub, estuarine and marine wetland, freshwater ponds, lakes, and rivers (refer to Section 3.4.1 for definitions of these wetland types and Section 3.3 for discussions of water resources including ponds, lakes, and marine habitats). Table 3.4-1 summarizes the type and area of wetlands within the ROI; these wetlands are depicted in Figures 3.4-1 and 3.4-2. As shown in Table 3.4-1, the dominant wetland type within PTU, PBU, and KRU is freshwater emergent wetlands, followed by estuarine and marine deepwater, and then lakes. The dominant wetland type within the east-west pipeline ROW is freshwater emergent wetland.

Table 3.4-1. Types and Extents of Wetlands within the ROI (acres)

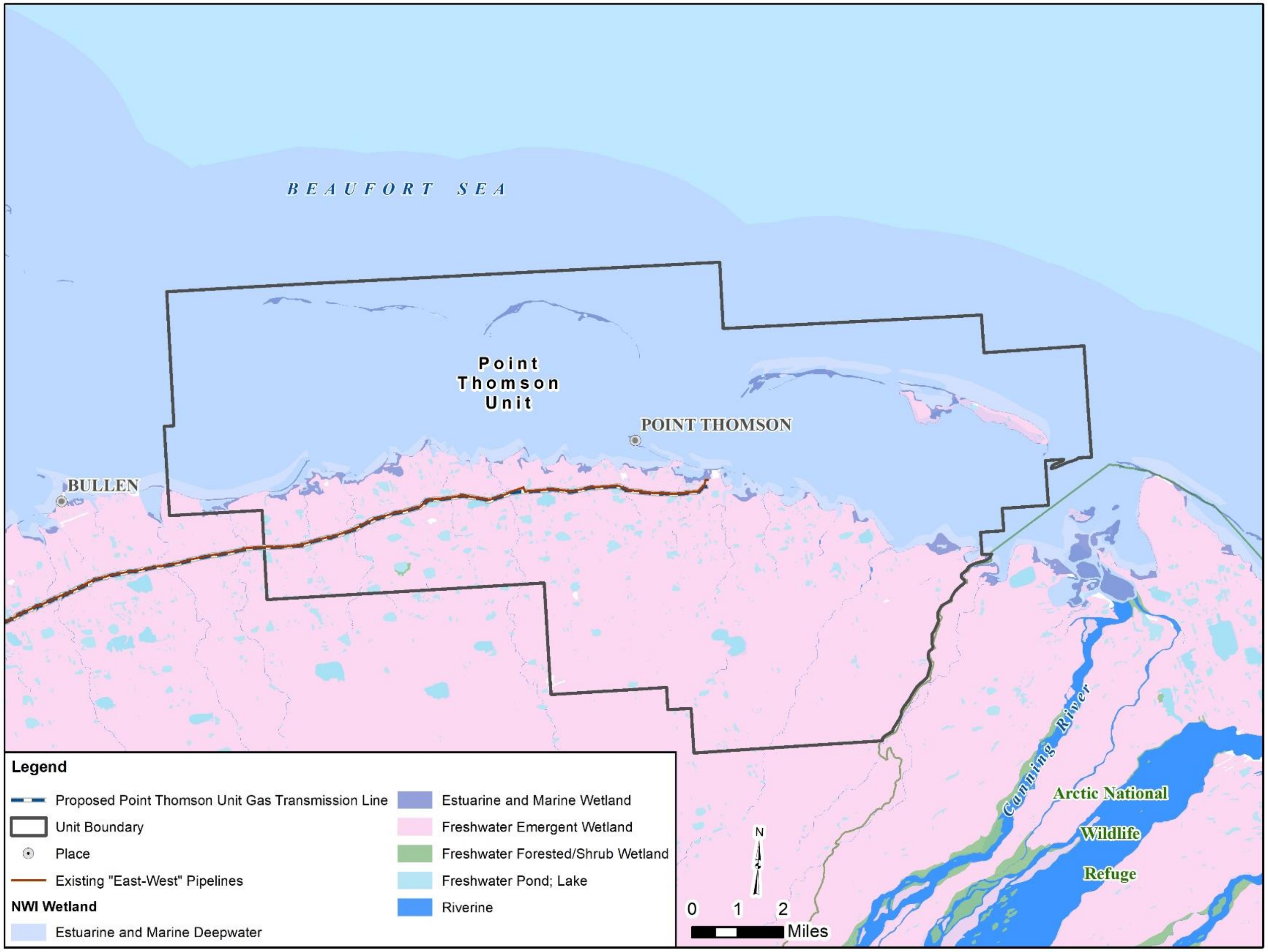
Wetland Type	Pipeline ROW	PTU	PBU	KRU
Estuarine and Marine Deepwater	0	53,014.7	43,200.9	23,082.7
Estuarine and Marine Wetland	0.5	1,221.9	6,136.0	4,586.3
Freshwater Emergent Wetland	917.5	36,788.1	144,719.9	200,383.7
Freshwater Forested/ Shrub Wetland	9.6	16.6	2,703.1	443.6
Freshwater Pond	8.5	1,181.1	10,887.1	10,250.0
Lake	8.8	713.3	27,671.0	20,760.9
Riverine	24.3	84.2	12,597.9	4,755.9
Total	**969.1**	**93,020.0**	**247,915.8**	**264,263.1**

Source: NWI 2022

KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way

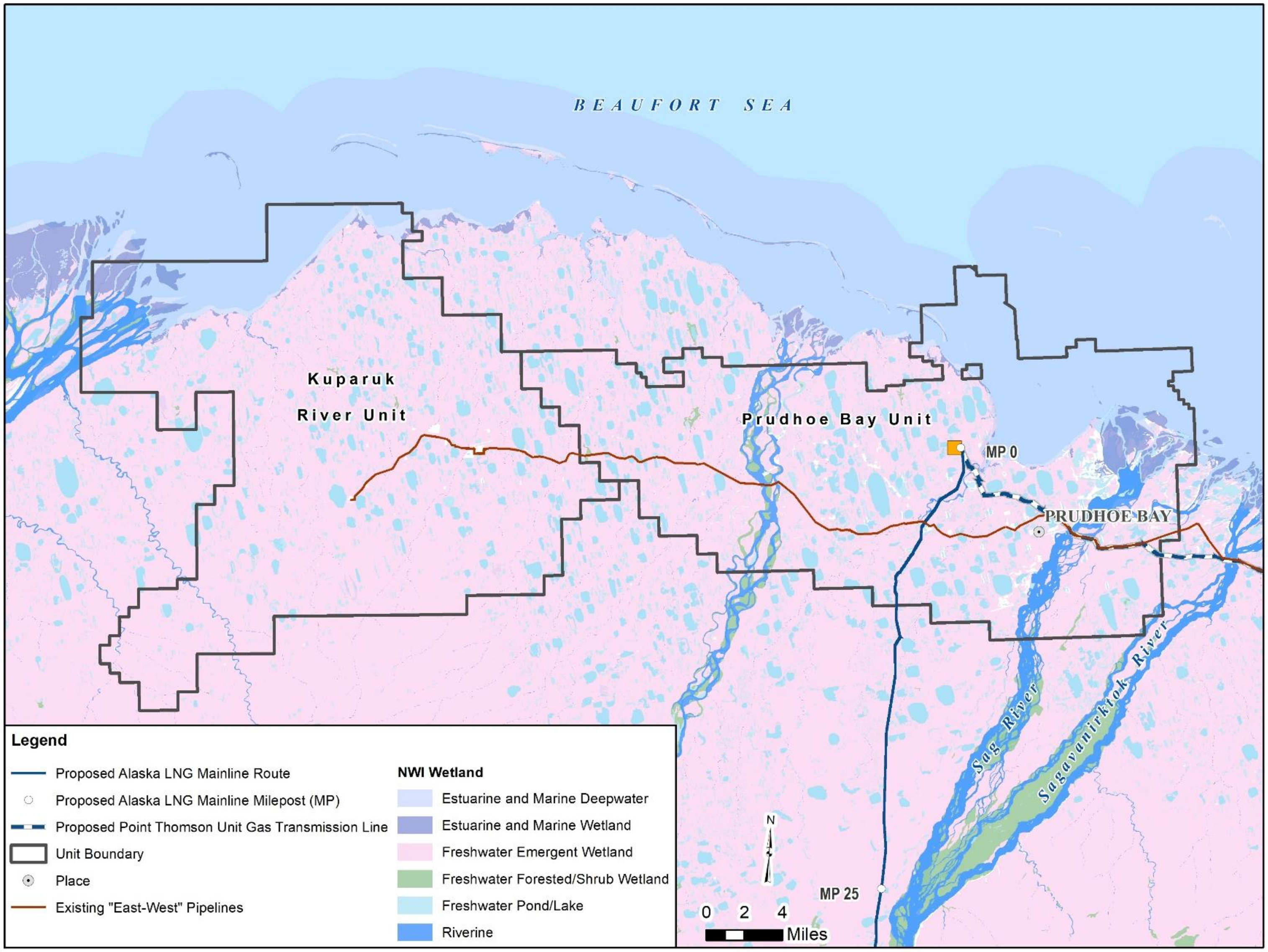
3.4.4 Regulatory Framework and Permitting Requirements

Most of the wetlands affected by upstream development activities are federally regulated by the USACE under Section 404 of the CWA. The USEPA has the authority to review, elevate, and/or object to permits issued by the USACE under Section 404. Permits issued under Section 404 require water quality certification under Section 401 of the CWA to certify that the regulated activity complies with applicable provisions of the Act, including state water quality standards.



Source: ADNR DOG 2021a; AGDC 2022; North Slope Science Initiative 2021; NWI 2022; USGS 2022a
NWI = National Wetland Inventory; PTU = Point Thomson Unit

Figure 3.4-1. Wetlands within PTU



Source: ADNR DOG 2021a; AGDC 2022; North Slope Science Initiative 2021; NWI 2022; USGS 2022a

KRU = Kuparuk River Unit; LNG = liquefied natural gas; MP = Milepost; NWI = National Wetland Inventory; PBU = Prudhoe Bay Unit

Figure 3.4-2. Wetlands within PBU and KRU

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3.5 VEGETATION

3.5.1 Introduction

Section 4.5 of the 2020 EIS details vegetation resources, including rare plant species, potentially affected by the entire Project. This section describes the vegetation, including NNIS, that could be affected by potential upstream development activities. Wetland vegetation, forest products, and subsistence use plants are discussed in Sections 3.4, 3.9, and 3.14, respectively. This section provides a discussion of existing conditions for vegetation within the ROI. For the purposes of this **Final** SEIS, the ROI for vegetation encompasses the North Slope with an emphasis on features occurring within the PTU, PBU, KRU, and existing pipeline ROWs between the units.

3.5.2 Regional Context

Plant communities generally transition from herbaceous, to scrub, to forest-dominated plant communities moving south from Prudhoe Bay. On the North Slope, scrub and herbaceous plant communities consist of tundra, a plant community absent of trees due to climate conditions (Viereck et al. 1992). Growing conditions can vary dramatically with changes in elevation and latitude, with more extreme conditions in the north and at higher elevations. The climate varies from a polar climate in the northern Arctic Tundra Ecoregion to a temperate continental climate in the more southern ecoregions. The Arctic Tundra Ecoregion has a growing season of about 56 days with annual precipitation ranging from 4 to 22 inches, and the average annual temperature ranging from 6°F to 20°F (FERC 2020).

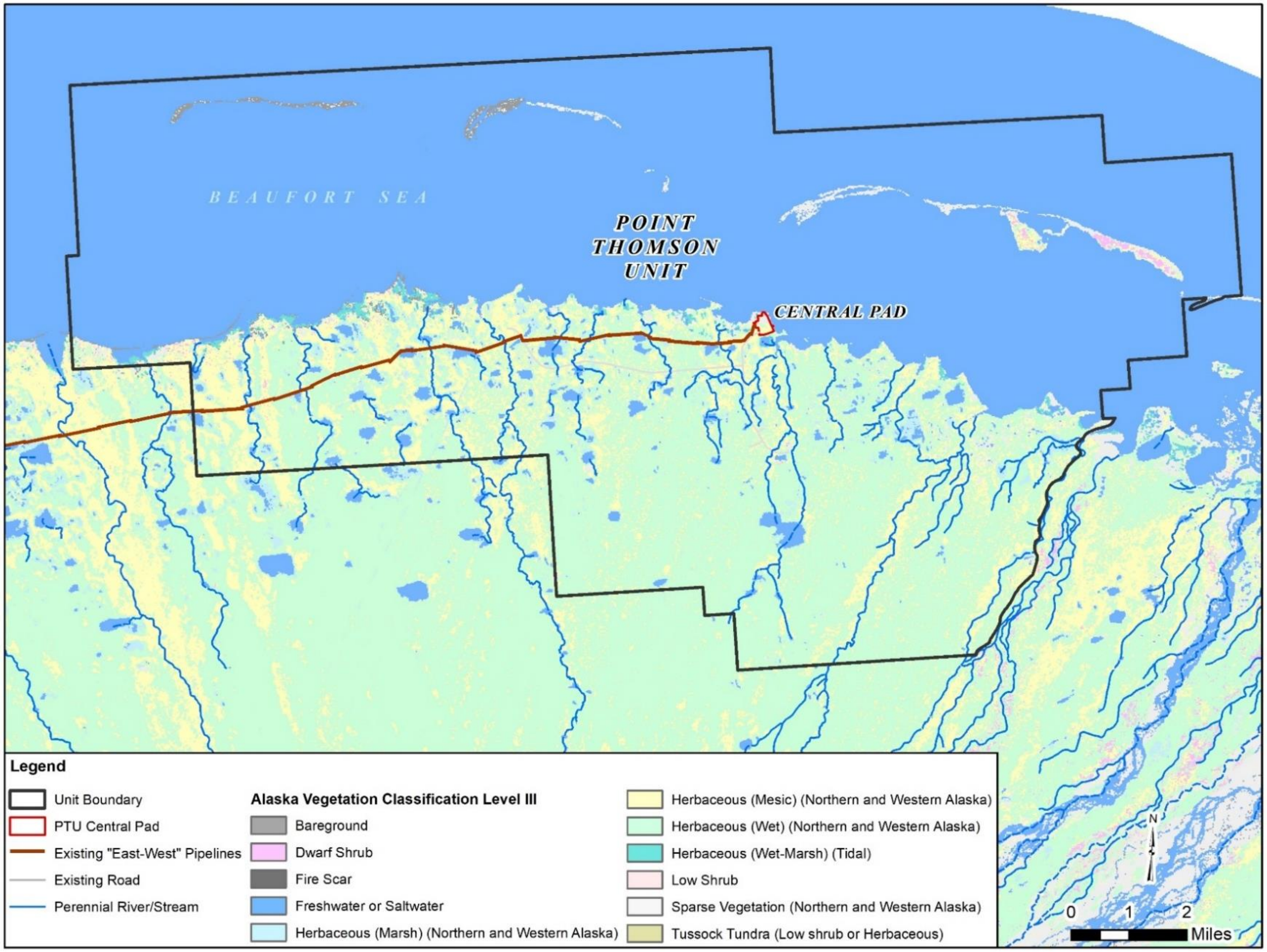
3.5.3 Existing Vegetation Resources

Table 3.5-1 summarizes the types and extents of vegetation communities and land cover within the ROI using a general description found in Level III of the Alaska Vegetation Classification. These vegetation communities are depicted in Figures 3.5-1, 3.5-2, and 3.5-3.

Table 3.5-1. Vegetation within the ROI

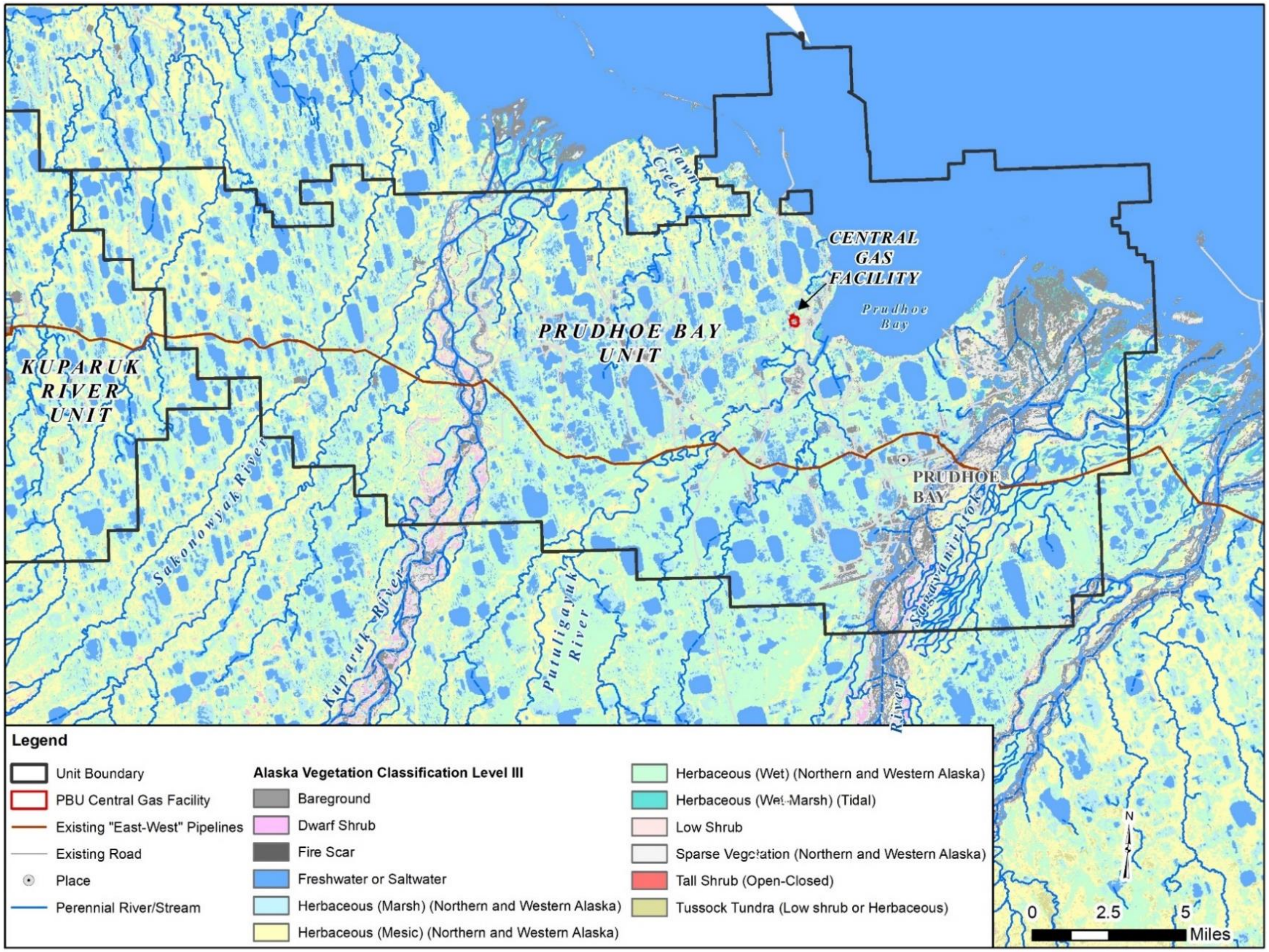
General Description	Acreage within ROI			
	ROW	PTU	PBU	KRU
Bare ground	193.5	367.9	16,017.4	7,397.2
Dwarf Shrub	5.3	185.7	1,937.9	2,735.0
Fire Scar	0	3.1	1.8	3.6
Freshwater or Saltwater	25.4	54,802.4	82,858.1	51,916.2
Herbaceous (Marsh) (Northern and Western Alaska)	134.1	1,715.6	29,988.9	30,184.2
Herbaceous (Mesic) (Northern and Western Alaska)	271.3	9,565.7	39,659.3	103,097.6
Herbaceous (Wet-Marsh) (Tidal)	3.6	440.7	1,962.9	893.1
Herbaceous (Wet) (Northern and Western Alaska)	267.3	24,377.4	66,219.2	65,524.8
Low Shrub	1.6	7.1	1,118.9	230.7
Sparse Vegetation (Northern and Western Alaska)	99.2	1,559.4	14,258.6	1,847.4
Tall Shrub (open-closed)	0	0	0.2	0
Tussock Tundra (low shrub or herbaceous)	0	5.6	63.0	1,205.7

Source: Alaska Center for Conservation Science 2018
KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way



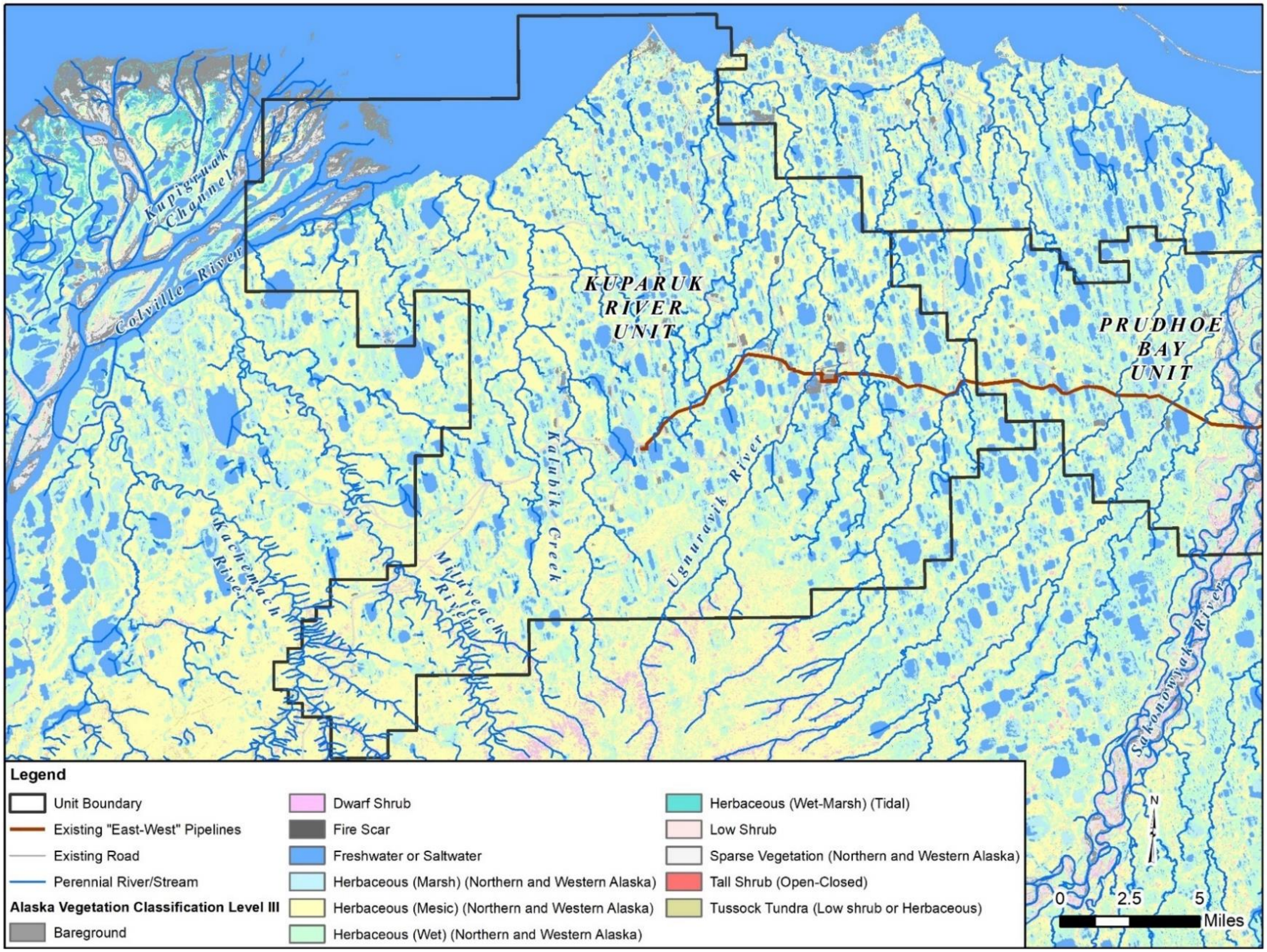
Source: ADNR DOG 2021a; AGDC 2022; Alaska Center for Conservation Science 2018; North Slope Science Initiative 2021; USGS 2022a
PTU = Point Thomson Unit

Figure 3.5-1. General Vegetation Communities within PTU



Source: ADNR DOG 2021a; AGDC 2022; Alaska Center for Conservation Science 2018; North Slope Science Initiative 2021; USGS 2022a
PBU = Prudhoe Bay Unit

Figure 3.5-2. General Vegetation Communities within PBU



Source: ADNR DOG 2021a; AGDC 2022; Alaska Center for Conservation Science 2018; North Slope Science Initiative 2021; USGS 2022a
KRU = Kuparuk River Unit

Figure 3.5-3. General Vegetation Communities within KRU

3.5.3.1 Herbaceous Plant Communities

Herbaceous plant communities dominate the Arctic Tundra Ecoregion, particularly the Beaufort Coastal Plain and Brooks Foothills Subregions, where they make up 98 and 51 percent of the vegetation, respectively, primarily as wetlands. The herbaceous community types that occur in the ROI include graminoid herbaceous (dominated by grasses and sedges, such as tussock tundra and sedge meadow), forb herbaceous (dominated by forbs such as fireweed [*Chamerion angustifolium*] and large umbel species), and bryoid herbaceous (dominated by lichens and mosses). Graminoid herbaceous communities are the dominant herbaceous community throughout the ROI. Examples on the North Slope include wet sedge tundra dominated by water sedge and cottongrass, and *Arctophila* wetlands, which are dominated by pendant grass (FERC 2020).

3.5.3.2 Scrub Plant Communities

Scrub is the second most abundant plant community in the ROI. Scrub communities are grouped by shrub height and include:

- **Dwarf tree scrub**. Ten percent or more of cover in trees less than 10 feet high at maturity.
- **Tall scrub.** Vegetation 5 feet high or greater with 25 percent cover by tall shrubs.
- **Low scrub.** Vegetation 8 inches to 5 feet in height with 25 percent cover by low shrubs.
- **Dwarf scrub.** Vegetation less than 8 inches in height with 25 percent cover by dwarf shrubs.

Dwarf and low scrub communities found within the ROI may include dwarf scrub sedge–mountain avens (*Geum peckii*) tundra, *Vaccinium* tundra (e.g., bog blueberry and other shrubs in the heath family), and low willow communities (e.g., diamondleaf willow [*Salix plainfolia*]) (FERC 2020).

3.5.4 Non-native Invasive Species

NNIS are those that become introduced to a new geographic region. Often highly competitive and adaptive, these species are able to thrive in a new environment to a point where they outcompete native species for resources and force native species into decline. Once introduced, NNIS become difficult to remove. NNIS and NNIS propagules (e.g., seeds, rhizomes, etc.) can be transported and introduced to new areas on vehicles, machinery, tools, shoes, erosion control materials, revegetation seed mixes, and imported fill (including granular fill) associated with construction and operation. In addition to human-caused dispersion, wind and animals can carry seeds into nearby disturbed areas, while streams can provide a pathway for spreading aquatic and riparian NNIS by transporting plants and plant propagules downstream (ADF&G 2022a). As such, the potential spread of NNIS should be of concern during construction of projects related to upstream development.

Three non-native plant species have been identified on the North Slope already: common dandelion (*Taraxacum officinale*), foxtail barley (*Hordeum jubatum*), and Canada thistle (*Cirsium arvense*) (Alaska Center for Conservation Science 2022). Common dandelion and foxtail are two of the most common NNIS across the entire Project area, and the common dandelion has been identified as a high-risk NNIS.

Section 4.5.8.3 of the 2020 EIS and Resource Report No. 3, Appendix K provide further details regarding NNIS, including the three species identified here, their introduction, propagation, and management. Species-specific details are summarized in Table 3.5-2.

Table 3.5-2. Non-Native Invasive Species Found on North Slope

Species	Habitat	Ecological Impact	Method of Spread	Management
Common dandelion (*Taraxacum officinale*)	Common dandelion grows in moist sites, lawns, meadows, pastures, and overgrazed areas. It also occurs in roadsides, waste places, and old fields. Invades partially disturbed or undisturbed native communities and competes with conifer seedlings.	Competes with native plants for moisture and nutrients. Common dandelion is an important source of nectar and pollen for bees in Alaska. Its presence may therefore alter the pollination ecologies of co-occurring plants. This species is a known host for a number of viruses. As an early colonizer, likely causes modest impacts to natural successional processes.	Common dandelion reproduces sexually by seeds and vegetatively by shoots that grow from the root crowns. Each plant can produce up to 5,000 seeds per year, and wind can disperse seeds considerable distances. Seeds are likely transported on vehicles and in horticultural materials. They are common contaminants in crop and forage seeds.	Dandelion can be readily controlled with herbicides and spring burning. Hand pulling and cutting are generally ineffective.
Foxtail barley (*Hordeum jubatum*)	Foxtail barley commonly grows in waste areas, roadsides, and open fields. It is most prevalent on soils with high water tables and high salinities.	This species is a known host for a number of viruses. Foxtail barley accumulates high amounts of salt in its leaves and roots, reducing the salinity of the soil.	Seeds can be dispersed long distances by wind or animals. It is also a potential crop contaminant.	Planting disturbed areas with desirable plants and controlling water levels is effective in reducing populations of foxtail barley. This species can be controlled with herbicides.
Canada thistle (*Cirsium arvense*)	Canada thistle commonly grows in roadsides, railroad embankments, lawns, gardens, abandoned fields, agricultural fields, and pastures. Natural areas that have been invaded by Canada thistle include prairies, wet grasslands, and sedge meadows.	Canada thistle threatens natural communities by competing for water and nutrients, displacing native vegetation, and decreasing species diversity. It produces allelopathic chemicals that assist in displacing competing plant species. Pollinating insects appear to be drawn away from native species to visit Canada thistle. This species has been reported to accumulate nitrates that cause poisoning in animals. Canada thistle is a host for bean aphid, stalk borer, and sod-web worm. Canada thistle can increase fire frequency and severity because of its abundant, readily ignited litter.	Canada thistle spreads as a contaminant in crop seed, hay, and packing material. Additionally, it can be spread in mud attached to vehicles or farm equipment.	Canada thistle is very difficult to control once it has established. Currently, there are no control methods suitable for wide-spread use in natural areas. A combination of mechanical, cultural, and chemical control methods is more effective than any single control method alone.

Source: Alaska Natural Heritage Program 2011a, 2011b, 2011c

3.5.5 Regulatory Framework, Executive Orders, and Permitting Requirements

NNIS are plant species introduced to an ecosystem through human activities likely to cause economic or environmental harm to human health. The federal Plant Protection Act designates certain NNIS as noxious weeds due to their potential to harm agriculture, natural resources, public health, and/or the environment (7 USC 7701). The State of Alaska has a similar designation for noxious weeds and has developed a state noxious weed list (11 AAC 34.400, 34.020), as well as a prohibited aquatic invasive weed list (ADNR 2022). Under 11 AAC 34, the State of Alaska establishes quarantines on noxious and prohibited plants and sets limits on the presence of noxious weed seeds in commercial seed mixes.

E.O. 13112, *Invasive Species*, issued in 1999 and amended in 2016, defines an "invasive species" as a species: 1) that is nonnative to the ecosystem under consideration, and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Nonnative species become invasive in a new environment when the natural predators, diseases, or other biological mechanisms that kept the species in check within its former habitat are missing in its new environment (ADF&G 2022a).

The federal Noxious Weed Act requires federal agencies to develop an undesirable plants management program on federal lands if a similar program is implemented on state or private lands in the same area, where undesirable plants are defined as *"undesirable, noxious, harmful, exotic, injurious, or poisonous, pursuant to State or Federal law"* (7 USC 2814). E.O. 13112 directs federal agencies to identify actions that may cause the introduction, spread, or establishment of invasive species; take action to control and monitor invasive species; provide for the restoration of native systems; and refrain from authorizing any actions likely to result in an increase in invasive species, unless the benefits of the action outweigh the potential harm, and feasible and prudent measures are undertaken to minimize the risk of harm. The federal Noxious Weed Act and E.O. 13112 would apply to activities on BLM and NPS lands. The Carlson-Foley Act of 1968 (43 USC 1241–1243) further authorizes the BLM and the NPS to manage noxious weeds and coordinate with other federal and state agencies in managing noxious weeds on federal lands.

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3.6 WILDLIFE RESOURCES

3.6.1 Introduction

Section 4.6 of the 2020 EIS details wildlife resources potentially affected by the entire Project. This section focuses on wildlife resources potentially found on the North Slope, as identified during a review of available habitat for these species, consultation with federal, state, and local agencies, and information presented in the 2020 EIS and the North Slope Area Plan. Aquatic resources and special status species are discussed in Sections 3.7 and 3.8, respectively.

3.6.2 Regional Context

The North Slope is located within the Arctic tundra habitat, specifically the Beaufort Coastal Plain. Tundra is characterized as being a treeless ecosystem, with long, cold winters and short chilly summers. Tundra has consistently low temperatures that limit plant growth and encourage the creation of permafrost. Lakes, wetlands, rivers, and permafrost-related features, such as pingos, ice-wedge polygon networks, peat ridges, and frost boils, all occur in tundra. Farther from the coast, tundra includes long linear ridges, buttes, and mesas, as well as alluvial valleys and glacial moraines (FERC 2020).

3.6.3 Terrestrial Wildlife

North Slope Borough identifies the following terrestrial mammal species as commonly occurring within its boundaries (North Slope Borough 2022a):

- Alaska marmot (*Marmota broweri*)
- Arctic ground squirrel (*Spermophilus paryii*)
- Beaver (*Castor canadensis*)
- Black bear (*Ursus americanus*)
- Brown bear (*Ursus arctos*)
- Caribou (*Rangifer taranus*)
- Dall sheep (*Ovis dalli*)
- Arctic fox (*Alopex lagopus*)
- Red fox (*Vulpes vulpes*)
- Brown lemming (*Lemmus trimucronatus*)
- Collared lemming (*Dicrostonyx torquatus*)
- Lynx (*Lynx canadensis*)
- Moose (*Alces alces*)
- Muskox (*Ovinbos moschatus*)
- Muskrat (*Ondatra zibethicus*)
- Porcupine (*Erithizon dorsatum*)
- River otter (*Lutra canadensis*)
- Snowshoe hare (*Lepus americanus*)
- Barren ground shrew (*Sorex ugyunak*)
- Tundra shrew (*Sorex tendrensis*)
- Northern red-backed vole (*Clethrionomys rutilus*)
- Tundra vole (*Microtus miurus*)
- Least weasel (*Mustela nivalis*)
- Ermine (*Mustela erminea*)
- Wolf (*Canis lupus*)
- Wolverine (*Gulo gulo*)

The climate of the North Slope limits the number and variety of species able to thrive in the area, thereby reducing the potential biodiversity encountered within the ROI. For example, few insects are able to withstand the extreme cold temperatures of the tundra. Lakes and ponds are plentiful, but they freeze solid for portions of the year and do not allow fish and water-dependent insects to establish populations. No trees or tall shrubs are able to grow, and permafrost extends below the ground surface. As such, species that rely on such habitats for at least part of their life cycle, and in turn those species that are higher on the food chain, are not likely to be able to establish viable, sustaining populations (Bee and Hall 1956). With few habitats available, few numbers and kinds of terrestrial species inhabit the North Slope.

3.6.4 Avian Resources

Alaska is home to 534 naturally occurring species of birds (Gibson et al. 2022). This **Final** SEIS categorizes birds into the following groups: raptors (e.g., eagles and owls), waterbirds (i.e., waterfowls, divers, cranes, shorebirds, and seabirds), passerines (i.e., perching birds within the order Passeriformes, including songbirds), and upland birds (e.g., grouse and ptarmigan). Most of these birds are migratory and spend spring and summer in the Arctic to breed and raise young before moving southward for the fall and winter. On the North Slope, the highest concentrations of migratory birds may be found within wetlands, river deltas, and nearshore marine habitats of the arctic coast and coastal plain (ADNR 2021). However, many other avian species remain in Alaska during winter months. About 25 bird species are known to overwinter in interior and western Alaska, while more than 100 species overwinter along the milder coasts of southern Alaska (ADF&G 2022b).

The Beaufort Coastal Plain Subregion provides habitat for millions of nesting and migrating waterbirds (FERC 2020). Coastal wetlands, wet meadows, lakes, and riparian habitats found within this subregion are particularly important for nesting, foraging, brood rearing, and molting. Diving waterbirds (e.g., including loons and ducks) use the deep, open lakes within this region. Larger lakes are used annually by large numbers of molting geese. Coastal wetlands serve as important feeding, nesting, and staging habitat for waterbirds. Prior to fall migration, tidal and riverine mudflats are used extensively by shorebirds (FERC 2020).

Avian habitat of the Beaufort Coastal Plain is comprised of upland scrub and herbaceous tundra. Nesting habitat for many species includes lowland wetlands on coastal tundra, which are usually large (more than 0.6 mile in diameter), shallow bodies of water that flood after snowmelt and have well-developed emergent and shoreline vegetation. Dominant plants in nesting wetlands of the North Slope include aquatic pendant grass and/or water sedge. Barrier islands, lagoons, and islands in river deltas provide additional nesting habitat. Coastal marine waters provide pelagic species foraging habitat. Winter habitat for some species may include small openings in pack ice, called polynyas. Tidal/riverine mudflats also serve as important bird habitat within this region. Seasonal concentrations of terrestrial avian species concentrate along river corridors. Representative avian species include common eider (*Somateria mollissima*), glaucous gull (*Larus hyperboreau*), greater white-fronted goose (*Anser albifrons*), Lapland longspur (*Calcarius lapponicus*), long-billed dowitcher (*Limnodromus scolopaceus*), long-tailed duck (*Clangula hyemalis*), Pacific loon (*Gavia pacifica*), pectoral sandpiper (*Calidris melanotos*), red-breasted merganser (*Mergus serrator*), red phalarope (*Phalaropus fulicarius*), snowy owl (*Bubo scandiacus*), and wandering tattler (*Tringa incana*) (FERC 2020).

3.6.4.1 Migratory Birds

Migratory birds follow broad routes called flyways between habitats in Alaska and wintering grounds in Central and South America and the Caribbean. Alaska birds migrate to six continents, following different flyways that include the North American flyways (such as the Pacific, Central, Mississippi, and Atlantic flyways), as well as international flyways (National Audubon Society 2022a). Fifty percent of Alaska's waterfowl (e.g., geese, swans, and ducks) use the Pacific flyway, 25 percent use the Mississippi flyway, 10 percent use the Central flyway, and 10 percent use the Atlantic flyway. The remaining 5 percent of waterfowl travel to Mexico, South America, Asia, or the Pacific Islands. Additionally, several species migrate from breeding areas in northern Alaska to winter near Bristol Bay, the Aleutian Islands, or Cook Inlet where they remain throughout the non-breeding season (FERC 2020).

Raptors

Traditionally, federal and state agencies consider raptors as species of special concern. Raptors are high trophic level or apex predatory birds and serve as indicator species of ecological changes or impacts on the ecosystem (ADF&G 2015). The management of raptors in Alaska is conducted primarily by ADF&G and USFWS.

Raptor species that are known to occur or could be present on the North Slope include American kestrel (*Falco sparverius*), American and arctic peregrine falcons (*Falco peregrinus anatum*, *Falco peregrinus tundrius*), bald and golden eagles (*Haliaeetus leucocephalus* and *Aquila chrysaetos*), gyrfalcon (*Falco rusticolus*), merlin (*Falco columbarius*), northern goshawk (*Accipiter gentilis*), northern harrier (*Circus hudsonius*), osprey (*Pandion haliautus*), rough-legged hawk (*Buteo lagopus*), sharp-shinned hawk (*Accipiter striatus*), Swainson's hawk *(Buteo swainsoni*), and western and Harlan's red-tailed hawks (*Buteo jamaicensis* and *Buteo jamaicensis alascensis*). In addition, several species of owls (e.g., boreal owl [*Aegolius funereus*], great gray owl [*Strix nebulosa*], great horned owl [*Bubo virginianus*], northern saw-whet owl [*Aegolius acadicus*], and snowy owl) are known to occur or could be present on the North Slope (FERC 2020).

Waterbirds

Alaska is home to diverse and abundant groups of waterbirds, such as loons (e.g., yellow-billed [*Gavia adamsii*] and red-throated loons [*G. stellata*]), waterfowl (e.g., ducks, geese, and swans), shorebirds (e.g., red-necked phalarope [*Phalaropus lobatus*] and red phalarope [*P. fulicarius*]), and seabirds (e.g., eiders, terns, and gulls) that are dependent on wetlands and waterbodies for certain life history stages (FERC 2020). Alaska supports about 20 percent of North and South America's nesting waterfowl. Several areas in Alaska are particularly important to nesting waterfowl including the Yukon-Kuskokwim Delta, Bristol Bay Lowlands, Yukon Flats, and the Tanana/Kuskokwim Valley. The coastal region is also important to breeding and staging waterfowl (FERC 2020).

In Alaska, 77 species of shorebirds have been recorded; of these, 37 species of shorebirds are regular breeders and 17 species are irregular breeders. While seven species are year-round residents of Alaska, most are migratory. About one third of the world's shorebirds reside in Alaska (Alaska Shorebird Group 2019). Many waterbirds such as common eider, glaucous gull, and brant (*Branta bernicla*) breed and nest in colonies along marine coasts. The Bering, Chukchi, and Beaufort Sea coasts provide habitat for about 4 million nesting birds. In the Arctic region, many migratory bird species, including snow geese (*Anser caerulescens*) and tundra swans (*Cygnus columbianus*) exhibit site fidelity in which they return to the same location year after year (FERC 2020).

Passerines

Many passerines migrate to and breed in Alaska from wintering areas in temperate and tropical regions in the Americas, Africa, Europe, and Asia. In the Beaufort Coastal Plain Subregion, over 30 species of passerines have been recorded; however, only one species, the Lapland longspur, is commonly observed nesting on the tundra. Table 4.6.2-1 of the 2020 EIS provides additional representative passerine species found near the proposed Project.

Upland Birds

Upland birds include grouse and ptarmigan. Alaska is home to four species of grouse, including ruffed (*Bonasa umbellus*), sharp-tailed (*Tympanuchus phasianellus*), spruce (*Falcipennis canadensis*), and sooty (*Dendragapus fuliginosus*). Three species of ptarmigan are found in Alaska and include willow (*Lagopus lagopus*), rock (*L. muta*), and white-tailed (*L. leucura*). All of these species are native to Alaska and are legally hunted through ADF&G's Small Game Program (ADF&G 2022c).

3.6.4.2 Bald and Golden Eagles

Bald and golden eagles occur throughout the North Slope. Alaska has the largest population of bald eagles in the United States, numbering about 70,544 birds. Breeding habitat for bald eagles within Alaska includes coastal areas, bays, rivers, lakes, reservoirs, and other waterbodies providing abundant food sources. Bald eagles typically nest in old-growth timber including black cottonwood trees but have been documented nesting on the ground within the Aleutian Islands. The winter or year-round range of bald eagles is more geographically restricted, including south-central Alaska and the Aleutian Islands, with fewer birds reported wintering in the interior regions of Alaska (FERC 2020).

Golden eagle breeding range extends from the North Slope throughout much of Alaska, but is less common in Kodiak, south-coastal, and southeast regions of Alaska. Recent golden eagle population estimates in Alaska range from 1,000 to 4,000. Golden eagle-preferred habitat in Alaska includes open Arctic and alpine tundra, open wooded country, and mountainous terrain. Breeding habitat includes rugged cliffs or bluffs for nesting. Golden eagle wintering or year-round ranges within Alaska are more geographically restrictive and include portions of east-central Alaska and the Aleutian Islands (FERC 2020).

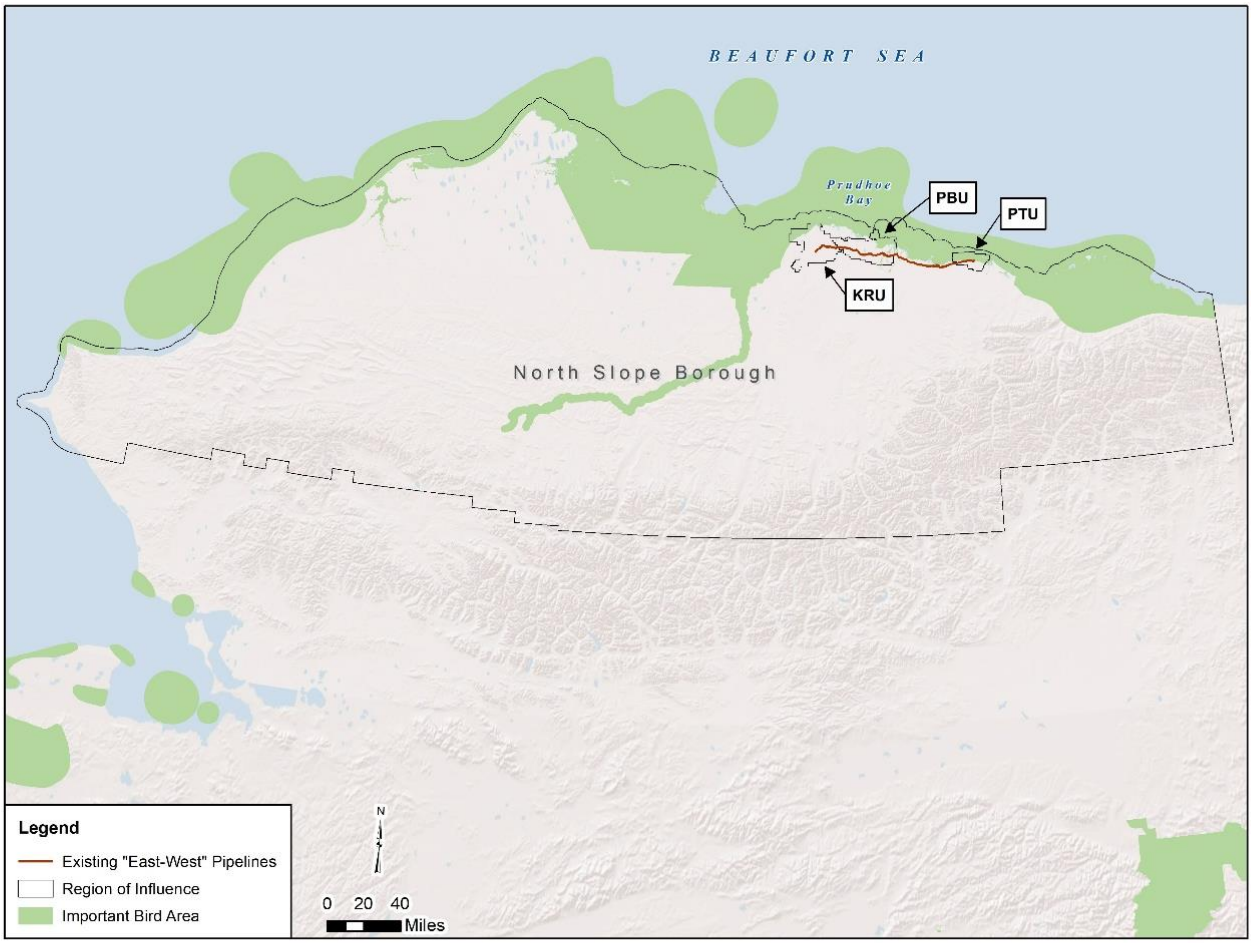
3.6.4.3 Important Bird Areas

Important Bird Areas (IBAs) are sites that provide essential habitat to one or more bird species (including federally protected birds) during a portion of the year (e.g., during breeding, wintering, and/or migrating). Areas that qualify as an IBA must support at least one of the following species (FERC 2020):

- species of conservation concern (e.g., threatened, endangered, or rare species);
- species with a limited or restricted range;
- vulnerable species because their populations are concentrated in one habitat type; or
- species that are vulnerable because they occur at high concentrations due to congregation.

IBAs are ranked at either the global, continental, or state-level depending on their importance to a bird species and could be present on public or private lands, or both.

Alaska has 213 IBAs, including 174 global, 8 continental, and 31 state IBAs (National Audubon Society 2022b). A total of 13 IBAs have been identified on the North Slope; two of these overlap the ROI, as shown in Figure 3.6-1. The Beaufort Sea Nearshore IBA encompasses approximately 52,744 acres of the PTU, 49,632 acres of the PBU, and 3 acres of existing pipeline ROW. The Beaufort Sea Nearshore IBA is an open water habitat and an IBA for glaucous gull and long-tailed duck (National Audubon Society 2022c). Approximately 38,873.96 acres of the KRU fall within the Colville River Delta and Beaufort Sea Nearshore IBAs. The Colville River Delta IBA is a marine open water habitat designated for the glaucous gull (National Audubon Society 2022d).



Source: ADNR DOG 2021a; AGDC 2022; Audubon Alaska 2015; North Slope Science Initiative 2021; USGS 2022a
KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit

Figure 3.6-1. Important Bird Areas of North Slope Borough

3.6.5 Regulatory Framework and Permitting Requirements

Migratory birds are protected under the MBTA (16 USC 703-711); bald and golden eagles are additionally protected under the Bald and Golden Eagle Protection Act (16 USC 668-668d). E.O. 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, (66 FR 3853) directs federal agencies to identify where unintentional take is likely to have a measurable negative effect on migratory bird populations and to avoid or minimize adverse impacts on migratory birds through enhanced collaboration with the USFWS. E.O. 13186 was issued in part to ensure that environmental analyses of federal actions assess the impacts of these actions on migratory birds. It also states that emphasis should be placed on species of concern, priority habitats, and key risk factors, and it prohibits the take of any migratory bird without authorization from the USFWS.

On March 30, 2011, the USFWS and FERC entered into a Memorandum of Understanding that focuses on avoiding, minimizing, or mitigating adverse impacts on migratory birds and strengthening migratory bird conservation through enhanced collaboration between the two agencies. This voluntary Memorandum of Understanding does not waive legal requirements under the MBTA, Bald and Golden Eagle Protection Act, the ESA, the NGA, or any other statute and does not authorize the take of migratory birds.

The Alaska Migratory Bird co-management Council, which was formed in 2000, includes the USFWS, ADF&G, and representatives of Alaska Natives. The Alaska Migratory Bird Co-management Council collaborates with the Pacific Flyway Council to develop migratory bird hunting regulations and coordinate migratory bird conservation and management. In Alaska, all native birds, except for grouse and ptarmigan, are protected under the MBTA; grouse and ptarmigan are managed by the State of Alaska under the ADF&G small game hunting program.

3.7 AQUATIC RESOURCES

3.7.1 Introduction

Section 4.7 of the 2020 EIS details aquatic resources potentially affected by the entire Project. This section focuses on aquatic resources potentially found on the North Slope, as identified during a review of available habitat, potential species found within these habitats, consultation with federal, state, and local agencies, and information presented in the 2020 EIS and the North Slope Area Plan. This section describes freshwater and marine fish found in Alaska's interior rivers and streams and coastal waters that could be affected by upstream development activities. Impacts on fisheries resources are discussed in this section; federally listed and Alaska special status fish species are discussed in Section 3.8.

3.7.2 Regional Context

The Arctic Tundra Ecoregion (comprising northern coastal Alaska) has numerous shallow tundra lakes and tributaries that freeze to the bottom during winter (between September and May). Fish migrate to deep water areas, such as mainstem channels or lakes, to survive the winter. In spring and summer, tributaries provide productive areas for fish to feed and recover from spawning. Beaded streams (pools/lakes and connected stream segments) are important for connecting and providing seasonally productive migratory fish habitats during spring breakup and before freeze-up (Morris 2003). Precipitation is low in the Arctic Tundra Ecoregion, and stream discharge is also relatively low for these waterbodies. The open water season is short (about 3 months) due to the arctic climate, which contributes to a short growing, feeding, and spawning season for fish. Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), capelin (*Mallotus villosus*), Dolly Varden (*Salvelinus malma*), lake trout (*Salvelinus namaycush*), stickleback species (*Gasterosteus* spp.), and whitefish species (*Coregonus* spp.) are species common in this ecoregion (FERC 2020).

3.7.3 Fisheries Resources

3.7.3.1 Fish Communities

Four types of fish communities occur on the North Slope that could occur within locations of potential upstream development activities:

- **Anadromous.** A migratory fish born in freshwater that spends part of its life cycle in marine environments before returning to freshwater to spawn.
- **Freshwater or resident fish.** A fish that resides in freshwater for their entire life cycle.
- **Marine fish.** A fish that resides in a saltwater environment for their entire life cycle.
- **Amphidromous.** A species that moves between fresh and marine waters at certain life stages, but not necessarily for the purpose of breeding. Newly hatched larvae of amphidromous species occur in freshwater/estuaries and may drift into marine environments; the species later returns to freshwater/estuaries to grow into adults and eventually spawn. Amphidromous species are categorized as "anadromous" for purposes of the Anadromous Waters Catalog (AWC) and in the context of this **Final** SEIS.

Fish distribution within the North Slope varies by species and region. Basic movement patterns include movements to spawning areas, which can be in spring (arctic grayling, rainbow trout, eulachon), summer (Pacific salmon), fall (Dolly Varden, ciscoes, whitefish), or winter (burbot, sculpins). The freshet period (spring thaw resulting from snow and ice melt) can be a critical period for fish migrating to spawning grounds. These higher flow periods allow for fish movement through areas otherwise inaccessible during lower flow periods. Freshet periods are typically short term and can last as little as a week when water levels are high enough for fish to move (FERC 2020). Named anadromous rivers located within the ROI include the following (ADF&G 2022d):

Existing Pipeline ROW:

- East Badami Creek
- East Sagavanirktok Creek
- Kadleroshilik River
- Kuparuk River
- Oogrukpuk River
- Putuligayuk River
- Sagavanirktok River
- Shaviovik River
- Ugnuravik River
- West Channel Sagavanirktok River

PBU:

- Fawn Creek
- Kuparuk River
- Oogrukpuk River
- Putuligayuk River
- Sakonowyak River
- West Channel Sagavanirktok River

KRU:

- Colville River
- East Fork Kalubik Creek
- Kachemach River
- Kalubik Creek
- Miluveach River
- Nowhere Creek
- Oogrukpuk River
- Ugnuravik River
- West Fork Ugnuravik River

3.7.3.2 Pacific Salmon

Pacific salmon are the anadromous fish that would be most affected by potential upstream development activities due to their widespread populations, use of a wide variety of aquatic habitats throughout the year, and their importance to subsistence, commercial, and sport fisheries throughout Alaska. On the North Slope, there are five Pacific salmon species that could be affected by the potential upstream development activities: Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), pink (*O. gorbuscha*), and chum (*O. keta*). The typical seasonal movement pattern for salmon species follows these phases:

- adult migration to spawning grounds during spring through fall;
- movement of juveniles to the ocean during spring and early summer;
- movement to summer feeding areas following ice breakup;
- movement within feeding areas during summer; and
- movement in the late summer to wintering areas.

On the North Slope, chum and pink salmon move into spawning streams along the Beaufort Sea coast between July and September, and smolts (young salmon) outmigrate to the ocean during or very near peak breakup flows.

3.7.3.3 Fish Stocks of Concern

If a waterbody is identified as containing fish stocks of concern (FSC), the state may develop a salmon fishery management plan or take regulatory action, as appropriate. The Sustainable Salmon Fisheries Policy defines three levels of concern (yield, management, and conservation) for salmon fisheries with yield being the lowest level of concern and conservation being the highest level of concern. The ADF&G maintains a list of FSCs that is updated on an annual basis. As of April 2020, the list includes: 11 management FSCs and 2 yield FSCs. None of these FSCs are located in the North Slope (ADF&G 2020). As such, FSCs are not discussed further within this **Final** SEIS.

3.7.3.4 Commercial and Recreational Fisheries

No commercial fisheries are present on the North Slope (Menard et al. 2017); therefore, no commercial fisheries would be affected by construction and operation of upstream development activities within the ROI. Section 3.14 discusses the importance of fisheries to subsistence users.

Most of the lakes of the North Slope are inaccessible by road and too shallow to support fish populations; however, some lakes contain lake trout, Arctic char (*Salvelinus alpinus*), Arctic grayling, and burbot. Recreational fisheries on the North Slope are slow growing and support minimal harvest (ADF&G 2022e).

3.7.4 Essential Fish Habitat

Essential Fish Habitat (EFH) has been identified in the Arctic Management Area, which extends into marine waters of the Beaufort Sea along the north coast of Alaska. Specific species with designated EFH that could be affected by the potential upstream development activities include arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*). Descriptions of EFH within the Arctic Management Area for these two species are as follows (North Pacific Fishery Management Council 2009):

- Arctic cod late juveniles and adults – pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 200 meters) and upper slope (200 to 500 meters) throughout Arctic waters. Often associated with ice floes which may occur in deeper waters.
- Saffron cod late juveniles and adults – pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the inner shelf (0 to 50 meters) throughout the Arctic waters and where there are substrates consisting of sand and gravel.

3.7.5 Regulatory Framework and Permitting Requirements

The ADF&G manages freshwater, commercial, and subsistence fisheries as well as marine recreational fishing in Alaska. The ADF&G maintains data on anadromous waters and publishes the *Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (also known as the Anadromous Waters Catalog or AWC) and an associated Atlas (FERC 2020). Identifying waters important for anadromous fish spawning, rearing, or migration is required by AS 16.05.871(a) under the Anadromous Fish Act (AS 16.05.871–.901). The AWC is not a comprehensive list of all anadromous fish waterbodies in Alaska, but rather, a list of waterbodies that have been surveyed by the ADF&G or private parties. Most of Alaska has not been surveyed. Once AWC waters are documented, they are protected by Alaska state law. Project applicants for upstream development activities would need to apply for a Fish Habitat Permit to cross AWC waters as well as any fish-bearing streams.

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act requires federal agencies to consult on all actions or proposed actions authorized, funded, or undertaken by that agency which could adversely affect EFH. The Magnuson-Stevens Fishery Conservation and Management Act defines EFH as *"those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity"* (50 CFR 600). For the purposes of this definition, "waters" means aquatic areas and their associated physical, chemical, and biological properties; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and healthy ecosystem; and "spawning, feeding, and breeding" is meant to encompass the complete life cycle of a species (50 CFR 600). The NMFS, along with the ADF&G and other agencies, work together to identify and protect EFH for federally managed fish species. In Alaska, EFH is designated by Fisheries Management Councils in fishery management plans based on best available scientific information (FERC 2020).

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3.8 THREATENED, ENDANGERED, AND OTHER SPECIAL STATUS SPECIES

3.8.1 Introduction

Section 4.8 of the 2020 EIS 1) details threatened, endangered, and other special status species potentially affected by the entire Project and 2) discusses BLM watch list and sensitive species for areas of the proposed Project's crossing of BLM lands. This **Final** SEIS does not consider BLM watch list and sensitive species as potential upstream development activities would not involve BLM lands. This section focuses on those special status species potentially found on the North Slope and within the ROI And their associated habitats, as identified during a review of appropriate maps and databases; review of websites and publications of USFWS, NMFS, and ADF&G (including the Alaska Wildlife Action Plan); consultation with federal, state, and local agencies; and information presented in the 2020 EIS and the North Slope Area Plan. For the purposes of this **Final** SEIS, the ROI for threatened, endangered, and special status species encompasses the North Slope with an emphasis on species potentially found within the PTU, PBU, KRU, and existing pipeline ROWs between the units. General information regarding vegetation, wildlife, and aquatic resources can be found in Sections 3.5, 3.6, and 3.7, respectively.

3.8.2 Federally Listed Threatened and Endangered Species

Under Section 3 of the ESA, an endangered species is defined as any species in danger of extinction throughout all or a significant portion of its range. A threatened species is any species likely to become an endangered species within the near future throughout all or a significant portion of its range. A proposed species is a species found to warrant listing as either threatened or endangered, and for which listing has been officially proposed in the *Federal Register*. A candidate species is any species that has been announced in the *Federal Register* as undergoing a status review but has not yet been listed. Candidate species do not receive federal protection under the ESA until officially listed as a threatened or endangered species. Critical habitat for federally listed threatened and endangered species is a specific geographic area (or areas) that contain physical or biological features essential to the conservation of the threatened or endangered species and may require management or protection.

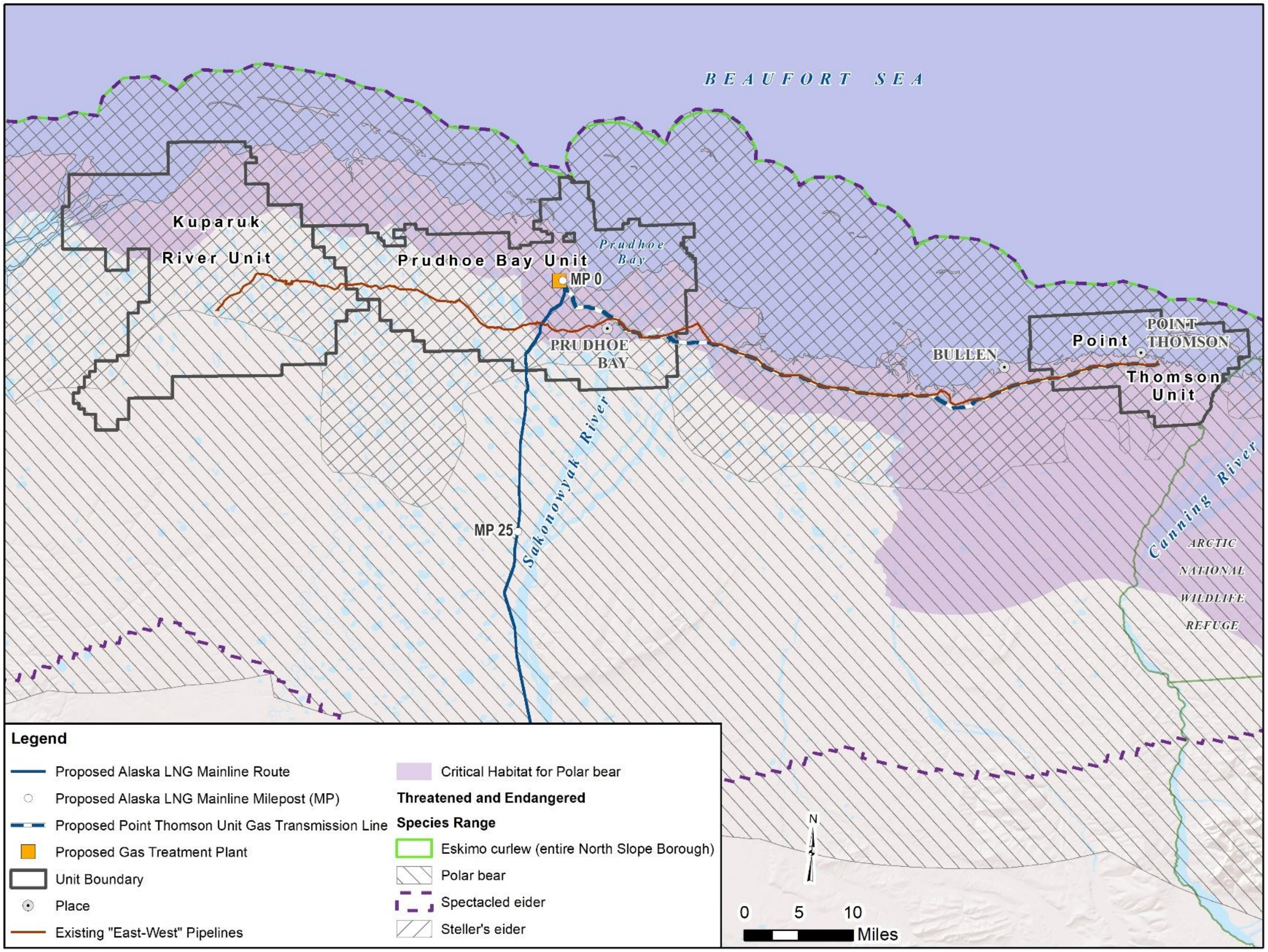
3.8.2.1 U.S. Fish and Wildlife Service Species

Table 3.8-1 lists the federally protected species identified by the USFWS as potentially found within North Slope Borough. This table also summarizes the habitat required for each of these species and includes an indicator of whether each species may be found near locations of potential upstream activities, and therefore, potentially affected by upstream development activities. Figure 3.8-1 depicts these species' ranges within the ROI. Additional information by species is presented following Figure 3.8-1.

Table 3.8-1. ESA-Protected Species within North Slope Borough

Species	Status	Habitat	Potentially Affected by Upstream Development?	Critical Habitat within ROI?
Eskimo curlew (*Numenius borealis*)	Endangered	In Alaska, arrives in breeding areas beginning in late May. Remains in nesting areas until early August. Nests in open arctic tundra, usually in an open site with a wide view. Also found in upland grassy tundra, tundra interspersed with scattered trees, or tundra marshes near Arctic Ocean.	No Species is likely extinct and is no longer present in Alaska.	No
Spectacled eider (*Somateria fischeri*)	Threatened	Nest in lowland wetlands on coastal tundra. These are usually large, shallow bodies of water that flood after snowmelt and have well-developed emergent and shoreline vegetation. Away from breeding areas, this species is pelagic or occupies coastal marine waters. In winter it inhabits small openings in pack ice. Nonbreeding birds remain at sea year-round.	Yes Spectacled eiders nest on tundra habitats on Alaska's Beaufort Coastal Plain.	No However, approximately 242,417 acres of critical habitat exist within North Slope Borough.
Alaska-breeding Steller's eider (*Polysticta stelleri*)	Threatened	Preferred habitat is moss-lichen polygonal tundra. Usually nests inland, away from salt water. Nonbreeding birds can be found in shallow marine water. Often rest on beaches and sandbars.	Yes Alaska-breeding Steller's eiders' current breeding range includes the Arctic Coastal Plain, with concentrations near Utqiagvik. Non-breeding Steller's eiders are found in the Prudhoe Bay area.	No
Polar bear (*Ursus maritimus*)	Threatened	Habitat is closely tied to arctic pack ice. Prefer areas of sea ice located over and near the continental shelf. May wander up to 150 kilometers (93 miles) inland. Pregnant females den in areas near the coast in areas that catch and collect snow in fall and early winter. Dens are typically dug into a hillside snowbank.	Yes Polar bears have been seen near Point Thomson during summer months and near Kaktovik along the coast and are known to den there in the springtime. Polar bears may occur in vessel traffic routes in the Beaufort Sea and on land near the PTU, PBU, and KRU. Critical habitat has been designated along the Beaufort Sea coast and barrier islands.	Yes Approximately 6,923,447 acres of critical habitat exist within North Slope Borough. Within the ROI: • Existing pipeline ROW ○ 633.7 acres • PTU ○ 92,911.3 acres • PBU ○ 136,273,4 acres • KRU ○ 84,427.3 acres

Source: USFWS 2022a; NatureServe Explorer 2022; Sexson et al. 2014, 2011
KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way



Source: ADNR DOG 2021a; AGDC 2022; Audubon Alaska 2015; North Slope Science Initiative 2021; USFWS 2022c, 2022d; USGS 2022a
ESA = Endangered Species Act; LNG = liquefied natural gas; MP = Milepost; ROI = region of influence

Figure 3.8-1. Ranges of ESA-Listed Species within the ROI

Spectacled Eider

The spectacled eider was listed as threatened in 1993. Spectacled eiders are large sea ducks that spend most of their lives on marine waters. Spectacled eiders feed on amphipods, crustaceans, insects, mollusks, and vegetation by diving and dabbling (FERC 2020). Spectacled eiders nest on tundra habitats on Alaska's Beaufort Coastal Plain and western Alaska, molt in coastal areas of the Chukchi and Bering Seas, and winter in polynyas (areas of persistent open water in sea ice) and open water leads in the Bering Sea. The breeding population departs from wintering areas in the Bering Sea following spring leads and openings in the Bering and Chukchi Seas, arriving on the Beaufort Coastal Plain in May and June (Sexson et al. 2014, 2011).

After breeding, males move to nearshore marine waters in late June, undergoing a complete molt of their flight feathers in the eastern Siberian Sea. Nesting females remain on the coastal tundra until the young fledge in late August to early September and then congregate to molt. Female spectacled eiders breeding in Arctic Alaska primarily molt in Ledyard Bay. Nonbreeding females or those with failed nests arrive in molting areas in late July, while successfully breeding females arrive in late August and stay until October. Movement between nesting and molting areas takes several weeks as the eiders make several stops along the Beaufort and Chukchi seacoasts. Concentrations of migrant spectacled eiders along the central Beaufort Sea include areas near the West Dock Causeway, Harrison Bay, and Smith Bay (Sexson et al. 2014, 2011). After molting, spectacled eiders travel to their wintering areas, where they remain from October through March.

While critical habitat for spectacled eiders was designated in 2001, no critical habitat for nesting was designated within North Slope Borough.

Alaska-Breeding Steller's Eider

The Alaska-breeding Steller's eider was listed as threatened in 1997. Steller's eiders are diving sea ducks that breed inland and spend the remainder of the year in marine waters (ADF&G 2022f). Steller's eider pair bonding occurs in the winter with pairs moving to arctic nesting grounds once the sea ice retreats. Females select coastal nest sites typically on islands or peninsulas in tundra lakes and ponds and build nests made from grass and lined with down. These diving ducks spend most of the year in shallow marine waters where they primarily feed on benthic invertebrates (i.e., mollusks and crustaceans) and aquatic plants in waters generally less than 33 feet (10 meters) deep (ADF&G 2022f).

Nesting Steller's eiders have not been documented at Prudhoe Bay. Alaska-breeding Steller's eiders' current breeding range includes the Arctic Coastal Plain, with concentrations near Utqiagvik, but they are rarely found nesting east of the Colville River (FERC 2020). Non-breeding Steller's eiders are found in the Prudhoe Bay area and use waters of the Chukchi and Beaufort Seas. The breeding population of Alaska-breeding Steller's eiders is highly variable, but estimates range from 576 to 680 individuals (Sea Duck Joint Venture 2016).

The winter range for Alaska-breeding Steller's eiders includes the Aleutian Islands, Alaska Peninsula, and the western Gulf of Alaska, including Kodiak and Lower Cook Inlet. The migration in spring occurs along the Bristol Bay Coast of the Alaska Peninsula across Bristol Bay toward Cape Pierce, moving north along the Bering Sea Coast. The Alaska-breeding Steller's eiders population was listed under the ESA due to range contraction. Recent surveys have documented a declining population, which supports this listing (Larned 2012).

Because of the population decline, critical habitat was designated for Alaska-breeding Steller's eiders in 2001, but none of the designated critical habitat for Alaska-breeding Steller's eider is located within North Slope Borough.

Polar Bear

Polar bears breed from March through May. Females typically reproduce every 3 years, creating dens in October and November and giving birth to cubs in December or January. Cubs emerge from natal dens by late March or early April. They primarily feed on ringed seals, but they will also consume bearded seals, walruses, and beluga whales. Polar bears are circumpolar and typically remain with the northern hemisphere pack ice as it seasonally advances and recedes; however, polar bears along the Beaufort Sea coast come on land to rest until shore-fast ice develops in late fall and they follow the pack ice south when it becomes suitable again for hunting (ADF&G 2022g).

Polar bears were listed as threatened in 2008 with critical habitat designated along the Beaufort Sea coast and barrier islands. Primary constituent elements for polar bear critical habitat include (FERC 2020):

- Sea ice habitat used for feeding, breeding, denning, and movements, which is sea ice over waters 984.2 feet (300 meters) or less in depth that occurs over the continental shelf with adequate prey resources (primarily ringed and bearded seals) to support polar bears.
- Terrestrial denning habitat, which includes topographic features, such as coastal bluffs and riverbanks, with the following suitable macrohabitat characteristics:
  - steep, stable slopes (ranging from 15.5 to 50.0 degrees), with heights ranging from 4.3 to 111.6 feet (1.3 to 34 meters), and with water or relatively level ground below the slope and relatively flat terrain above the slope;
  - unobstructed, undisturbed access between den sites and the coast;
  - sea ice in proximity of terrestrial denning habitat prior to the onset of denning during the fall to provide access to terrestrial den sites; and
  - the absence of disturbance from humans and human activities that might attract other polar bears.
- Barrier island habitat used for denning, refuge from human disturbance, and movements along the coast to access maternal den and optimal feeding habitat. This includes barrier islands along the Alaska coast and their associated spits, within the range of the polar bear in the United States, and the water, ice, and terrestrial habitat within 1 mile (1.6 kilometers) of these islands (no-disturbance zone).

Polar bears may occur in vessel traffic routes in the Beaufort Sea and on land. Critical habitat exists within the PTU, PBU, and KRU (see Figure 3.8-1). The number of polar bears spotted near Point Thomson during summer months has increased in recent years. Polar bears have also been seen near Kaktovik along the coast and are known to den there in the springtime (FERC 2020). Section 3.19.3 contains additional discussion on polar bears related to climate change.

3.8.2.2 National Marine Fisheries Service Species

Table 4.8.1-1 of the 2020 EIS presents the species protected by the NMFS that could be affected by vessel traffic in the Beaufort Sea. These include the following five species:

Bearded Seal (*Erignathus barbatus*)

The bearded seal is found off the coast of Alaska over continental shelf waters in the Bering, Chukchi, and Beaufort Seas. Bearded seals are closely associated with sea ice, in particular, pack ice, and their movements typically follow the ice. Bearded seals will move north in late spring and summer as the ice retreats and move south in the fall as sea ice forms. Ice is important for critical life history periods, such as molting and reproduction. The seals prefer ice that has natural openings of open water for access to foraging habitat. A small number of bearded seals, mostly juveniles, can be found on land near the coast in the summer months, and the seals have been observed traveling up rivers (FERC 2020).

Females give birth and nurse young on the broken pack ice in winter and spring. Bearded seals feed primarily on benthic organism, such as invertebrates and fish. They generally feed in waters less than 650 feet deep. Bearded seals are generally solitary. Bearded seals may occur along vessel transit routes through the Beaufort Sea, but their abundance is lessened during the summer and fall months. Ice breaking vessels have been reported to affect ice-breeding seals, such as bearded seals, by directly striking seals on ice or by separating mothers and pups (FERC 2020).

Bowhead Whale (*Balaena mysticetus*)

Bowhead whales likely mate in the Bering Sea during late winter and spring. Females typically have one calf every 3 to 4 years, giving birth between April and early June. Bowhead whales use baleen plates to consume zooplankton (i.e., crustaceans), other invertebrates, and fish. Bowhead whales overwinter in the central and western Bering Sea. As sea ice begins to retreat in April, bowhead whales begin migrating north to the Chukchi and Beaufort Seas. Most bowhead whales continue to migrate eastward into the Beaufort Sea from April through June and remain at summer foraging grounds until late August or early September before migrating westward again toward the Bering Sea. Bowhead whales occupying the Arctic Ocean and surrounding seas spend winters associated with the southern limit pack ice and move north in the spring, following the ice and using leads to reach their summer feeding grounds in the Beaufort Sea (FERC 2020).

Biologically Important Areas (BIAs) for feeding have been identified near Saint Lawrence Island from November through April, and throughout the Beaufort Sea from September through October. BIAs for migration have been identified northward through the Bering Sea from March through June; northward and eastward through the eastern Chukchi and Alaskan Beaufort Seas from April through May; and westward through the Alaskan Beaufort Sea from September through October. BIAs for bowhead whale reproduction include the Alaskan Beaufort Sea during September and October, the eastern Alaskan Beaufort Sea during July and August, and the Barrow Canyon region during April through June (FERC 2020).

Bowhead whales may occur in vessel traffic routes in the Beaufort Seas. They are likely to be affected by traffic and construction noise during their fall migration through the Beaufort and Chukchi Seas.

Gray Whale (*Eschrichtius robustus*)

Gray whales were listed as endangered in 1970. Critical habitat has not been designated for the species. Gray whales often travel in groups of two to three in coastal shallow waters over the continental shelf. Western gray whales feed in the summer and fall off the coast of Russia and the eastern Bering Sea; however, some studies have shown tagged individuals along the western U.S. coast in winter and spring months (FERC 2020).

Females give birth in shallow lagoons and bays in January or February to a single calf every 2 or more years. Gray whales are baleen whales, feeding primarily by dredging through the mud and filtering out bottom-dwelling crustaceans (e.g., amphipods). This area is used by gray whales traveling south from November through January and traveling north from March through May. An additional BIA occurs around the Alaska Peninsula where gray whales are known to feed from April through July, and where they migrate south from November through January and north from March through May (FERC 2020).

Humpback Whale (*Megaptera novaeangliae*)

Humpback whales were listed as endangered in 1970. Critical habitat has not been designated for the species. Humpback whales are usually found alone or in temporary small groups. During migration, they are found at the ocean surface; while feeding and calving, they are typically found in shallow waters. Humpback whales spend summers in temperate and subpolar waters. Breeding and calving take place in tropical and subtropical waters during the winter months. Humpback whales are baleen whales, feeding primarily on euphausiids (e.g., krill) and small schooling fish; they rarely feed during winter and while migrating. Humpback whales tend to concentrate in several areas to feed, including the Barren Islands at the mouth of Cook Inlet and along the Aleutian Islands. Humpback whales are found as far north as the Chukchi Sea during their summer feeding, although there were reports of humpback whales in the Beaufort Sea east of Barrow in 2007 (FERC 2020).

A humpback whale BIA for feeding occurs around Kodiak Island. Humpback whales are known to feed in this area from July to September. Another humpback whale BIA occurs around the Aleutian Islands where humpback whales feed from June through September. Humpback whales may occur in vessel traffic routes near Cook Inlet, in the Gulf of Alaska, the Bering Sea, and the Chukchi Sea; they are rare but could also be found in the Beaufort Sea east of Utqiagvik. They may also be found near the Kachemak Bay staging/anchoring area in the summer (FERC 2020).

Ringed Seal (*Phoca hispida*)

The ringed seal (arctic subspecies) was listed as threatened (effective February 26, 2013) because ice projection models predict a reduction in sea ice habitat in the latter half of the century and snow prediction models predict a reduction in snow accumulation, which could compromise the ability of the seals to construct subnivean (under snow) lairs (77 FR 76706). The reduction of available suitable ice habitat is expected to result in adverse demographic effects.

On December 3, 2014, NMFS announced their proposal to designate critical habitat for the ringed seal to include marine waters from the coastline to the U.S. Exclusive Economic Zone in the northern Bering, Chukchi, and Beaufort Seas (79 FR 71714). On March 11, 2016, the U.S. District Court for the District of Alaska determined that the NMFS listing decision was arbitrary and capricious. The District Court vacated the listing rule and remanded the rule back to NMFS for reconsideration. A notice of appeal of the District Court decision was filed on May 3, 2016. On February 12, 2018, the U.S. Court of Appeals reversed the 2016 decision that vacated the rule. Due to the status and potential for the ringed seal to be, or remain, listed under the ESA, the species was included in the biological assessment, Appendix O of the 2020 EIS. Critical habitat has not been designated for the ringed seal (FERC 2020).

Ringed seals are circumpolar in distribution, occupying the Bering, Chukchi, and Beaufort Seas in Alaska. Adults breed in heavy shorefast ice and juveniles migrate south to the ice edge for the winter. Throughout their range, ringed seals are typically tied to ice-covered waters and are well adapted to occupying both shorefast and pack ice. They remain in contact with ice most of the year and use it as a platform for pupping and nursing in late winter to early spring, for molting in late spring to early summer, and for resting at other times of the year (FERC 2020).

In Alaskan waters, during winter and early spring, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort Seas. Ringed seals in Alaska rarely haul out on land. Ringed seals in Alaska waters belong to the Alaska stock, which includes the arctic subspecies that is found in the Bering, Chukchi, and Beaufort Seas. Ringed seals may occur along vessel transit routes through the Bering, Chukchi, and Beaufort Seas (FERC 2020).

3.8.3 State of Alaska Special Status Species

ADF&G is responsible for determining and maintaining a list of potentially vulnerable species listed as threatened and endangered species in Alaska under AS 16.20.109. The Alaska State Endangered Species List includes the federally listed short-tailed albatross, Eskimo curlew, blue whale, humpback whale, and right whale, which are discussed in Section 3.8.2. In addition, ADF&G uses the 2015 Wildlife Action Plan (ADF&G 2015) as a guide to prioritize Species of Greatest Conservation Need (SGCN). Criteria for determining species considered as SGCN include at least one of the following (ADF&G 2015):

- at-risk species;
- stewardship species;
- culturally important species;
- economically important species;
- ecologically important species; and/or
- sentinel species.

Alaska's SGCN list consists of over 375 species including freshwater and marine invertebrates, marine zooplankton, terrestrial arthropods, and vertebrates (ADF&G 2015). Vertebrate groups included on the SGCN list include 58 fish, 5 amphibians, 192 birds, and 71 mammals (ADF&G 2015). Excluded species from Alaska's list of SGCN include plants, hunted and trapped species, numerous marine aquatic species, reptiles, and peripheral species (e.g., rare or accidental occurrences) (ADF&G 2015). Alaska's *Wildlife Action Plan* previously adapted the Alaska Species Ranking System (Gotthardt et al. 2012) to reflect the taxonomic standing for mammal species and followed Gibson and Withrow (2015) for the inventory of species and subspecies of Alaska birds (Gibson et al. 2015). Appendix B of the *Wildlife Action Plan* lists 15 orders of insects and 116 species listed as SGCN occurring within the North and Arctic Ocean bioregions. Table P-2 of Appendix P of the 2020 EIS lists Alaska SGCN potentially affected by the proposed Project; those listed as occurring within the Beaufort Coastal Plain subregion are summarized in Table 3.8-2. This table presents a ranking for each species; NatureServe state rankings include:

- **S1.** Critically imperiled within the state: at very high risk of extirpation because of very few occurrences, declining populations, or extremely limited range and/or habitat.
- **S2.** Imperiled within the state: high risk of extirpation because of few occurrences, declining populations, limited range, and/or habitat.
- **S3.** Vulnerable.

Federally protected species previously discussed in Section 3.8.2 are not repeated in Table 3.8-2.

Table 3.8-2. Alaska Species of Greatest Conservation Need within Beaufort Coastal Plain Subregion

Species	Ranking	Habitat
Black guillemot (*Cepphus grille*)	S2	In the western Arctic and adjacent Pacific Oceans, black guillemots breed on coastlines and islands of the eastern Siberian, western Chukchi, and Beaufort Seas. In northern Alaska, they are an uncommon, local breeder from Seahorse Island and Point Barrow east to Igalik Island and a rare breeder farther east to Barter Island. In western Alaska, they are an uncommon breeder at Cape Thomson and a regular summer visitor to St. Lawrence Island. In winter, this species spends most of its time on the open ocean near its breeding areas. However, in areas where open water is limited by sea ice, the birds retreat until reaching ice-free coastal areas or mobile pack ice with open water and accessible foraging habitat. Black guillemots are an ice-dependent (pagophilic) species. Their survival is tied to the Arctic pack ice.
Buff-breasted sandpiper (*Calidris subruficollis*)	S2	Inhabits boreal forests, mixed forests, muskeg bogs, birches, and streamside willows, including young and mature spruce and sometimes balsam fir (*Abies balsamea*). In northern Alaska, occurs in a variety of forests, including spruce, mixed spruce, alder, and willow.
Swainson's hawk (*Buteo swainsoni*)	S2	Forages in open grass dominated habitat, sparse shrublands, and small open woodlands. Has adapted to agricultural areas with crops that do not exceed the height of native vegetation. Nests in scattered trees within foraging areas. In the Yukon, sightings have been near riverside cliffs with close access to open tundra.

Source: FERC 2020

3.8.4 Regulatory Framework and Permitting Requirements

Federal agencies, in consultation with USFWS and NMFS, are required by Section 7(a)(4) of the ESA (19 USC 1536(c)), as amended, to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed threatened or endangered species, or result in the destruction or modification of designated critical habitat of a federally listed species. The USFWS and NMFS are responsible for managing federally listed species.

To assist in compliance with Section 7 of the ESA, DOE has provided a copy of this **Final** SEIS to the USFWS and NMFS for their review and to allow input regarding federally listed species and designated critical habitat in the ROI. DOE also provided a copy of this **Final** SEIS to the ADF&G for similar review of State of Alaska special status species known to occur in the vicinity of potential upstream development activities.

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3.9 LAND USE, RECREATION, AND SPECIAL INTEREST AREAS

3.9.1 Introduction

Section 4.9 of the 2020 EIS details land use, recreation, and special interest areas along the entire Project. This section provides a discussion of existing conditions for land use, recreation, and special interest areas specific to the North Slope. The ROI for land use consists of the PTU, PBU, KRU, existing pipeline ROWs between the PBU and KRU, and land immediately adjacent to pipeline ROWs. These descriptions and analyses address a range of topics, including land use, land ownership, recreation areas (including special use areas [SUAs]), and special interest areas. Refer to Section 4.9.6 and Appendix R of the 2020 EIS for information about hazardous waste sites (e.g., landfills, mines, and contaminated sites).

3.9.2 Regional Context

The proposed Project ROI is located within North Slope Borough in Alaska. Although North Slope Borough is primarily open land and open water with extensive barren land and ice in the Arctic landscape, a small percentage of development occurs in the Borough for commercial and industrial land uses.

Given the Arctic landscape, tourism activities in North Slope Borough are generally concentrated along the Dalton Highway north to Deadhorse. Tourism activities occur in regional communities related to cultural activities, as well as for wildlife viewing for species like polar bears and whales. In general, recreation and tourism activities are increasing throughout the region (ADNR 2021).

3.9.3 Land Use/Land Cover

Consistent with the 2020 EIS, land use classifications were determined using data from the National Land Cover Database 2019 (USGS 2019b) with land use types assigned based on the dominant vegetative cover and/or use of the land (e.g., forested land). Four primary land use/land cover types identified in the ROI are described below.

- **Developed Land.** Developed lands include low-intensity, medium-intensity, and high-intensity development along with developed open space. Development can include commercial land, power or utility stations, manufacturing or industrial plants, commercial or retail facilities, roads, military restricted areas, and oil and gas developments.
- **Forested Land.** Forested lands include tracts of upland or wetland deciduous, evergreen, or mixed forest, dominated by trees generally greater than 16.4 feet tall. Additional information concerning forested lands in the ROI is provided in Section 3.5.
- **Open Land.** Open lands include non-forested areas of barren land and areas of dwarf scrub/shrub, grasslands, sedges, emergent herbaceous wetlands, lichens, and/or mosses. Additional information concerning wetland vegetation in the ROI is provided in Section 3.4.
- **Open Water.** Open water includes traditional open water areas and areas with perennial ice and snow coverage. Permafrost areas are discussed in more detail in Section 3.2, and waterbodies are discussed in Section 3.3.

3.9.3.1 Existing Land Use

Table 3.9-1 and Figure 3.9-1 present the existing land uses within the ROI. The land use classifications are based on analysis of the National Land Cover Database.

Table 3.9-1. Land Use Types within the ROI

	Developed (acres)	Forested (acres)	Open Land (acres)	Open Water (acres)
North Slope	21,350.1	26,993.9	54,189,302.3	5,511,747.1
PTU	0[a]	0	38,767.8	54,306.1
PBU	7,643.1	0	165,943.6	80,548.6
KRU	2,969.3	0	209,296.1	52,821.4
Existing Pipeline ROW	172.1	0	813.0	12.9
ROI Total	10,784.4	0	414,820.5	187,689.0
Percent of ROI Total	1.8	0	67.6	30.6

Source: USGS 2019b

[a] Further analysis of developed land on the North Slope found that based on the 2021 data from the North Slope Initiative, there are approximately 165 acres of developed land at PTU. For consistency, this analysis maintains the National Land Cover Database values.

KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way

3.9.4 Land Ownership and Easement Requirements

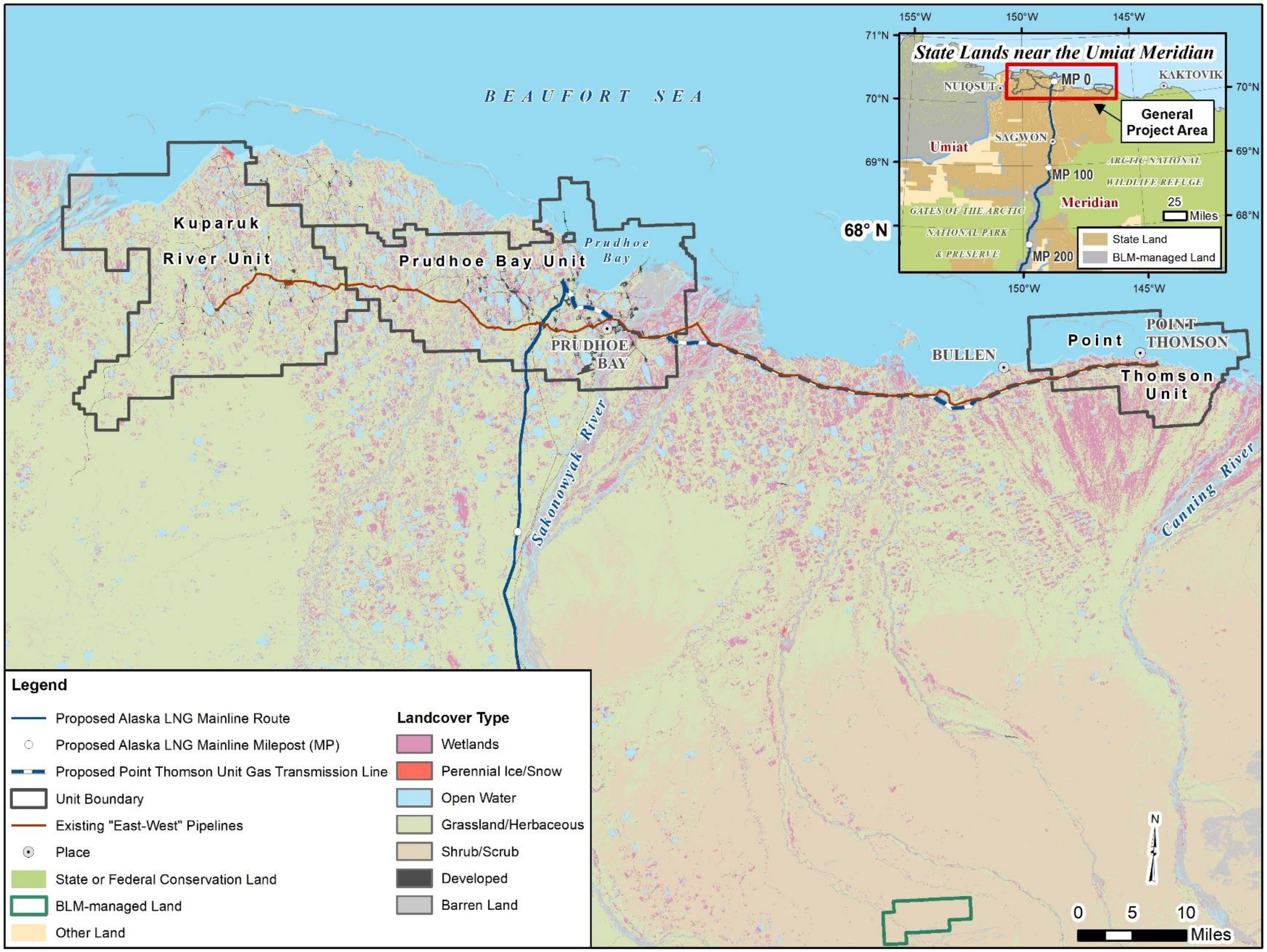
Land on the North Slope is owned and operated by the federal government, State of Alaska, one of the state's boroughs or cities, Alaska Native Corporations or other Alaska Native entities, or private landowners. Undetermined land ownership is specific to non-federal land that does not fall within the other land ownership categories (e.g., waterbodies and coastal land). Table 3.9-2 summarizes the acreage of land ownership in the ROI and shows that the vast majority of the land is state owned.

Table 3.9-2. Land Ownership within the ROI

	Federal (acres)	State (acres)	City/ Borough (acres)	Alaska Native (acres)	Private (acres)	Undeter-mined (acres)
North Slope	38,821,551.9	10,792,112.1	2,534.1	4,872,745.4	2,396.5	3,048,239.9
PTU	32.8	38,804.4	0	0	0	1,109.1
PBU	0	171,620.6	1,516.1	285.5	987.1	35,318.2
KRU	798.8	216,933.3	735.5	706.2	0	23,308.0
Existing Pipeline ROW	0	971.7	0	0	9.3	18.1
ROI Total	831.7	428,330.0	2,251.6	991.7	996.5	59,753.4
Percent of ROI Total	0.2	86.9	0.5	0.2	0.2	12.1

Source: BLM 2022a, 2022b

KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way



Source: ADNR DOG 2021a; BLM 2019; North Slope Science Initiative 2021; USDA NRCS 2019; USFWS 2022b
BLM = Bureau of Land Management; LNG = liquefied natural gas; MP = Milepost; ROI = region of influence

Figure 3.9-1. Land Use Types within the ROI

3.9.5 Recreation Areas

Recreation areas include land managed by federal, state, or other government entities for recreational activity (e.g., hiking, camping, sightseeing, hunting, and fishing) or where recreational activity is a common or expected use, regardless of management provisions. This section describes recreation areas on the North Slope. Table 3.9-3 summarizes the acreage of recreation areas on the North Slope. The locations for potential upstream development activities do not contain any recreational areas.

Table 3.9-3. Recreational Areas on the North Slope

Recreational Area	Acres
Alaska Maritime National Wildlife Refuge	253,747.9
Noatak Wilderness	1,781,717.3
Gates of the Arctic National Park	278,021.8
Gates of the Arctic Wilderness	1,888,971.2
Arctic National Wildlife Refuge	11,971,271.9
Mollie Beattie Wilderness	5,882,399.8

Source: ADNR 2019a; NPS 2019; USFWS 2022b
Note: Refer to Section 4.9.4 of the 2020 EIS for additional detailed information about the federally managed and state-managed recreational areas on the North Slope.

3.9.6 Special Interest Areas

Special interest areas include state or nationally managed land having scenic, historic, archaeological, scientific, biological, recreational, or other special resource values that warrant additional protections and special requirements. This section describes special interest areas within the ROI, including areas of critical environmental concern (ACEC) which are lands where special management attention is needed to prevent irreparable damage to important, unique, and significant historic, cultural, and scenic values; fish or wildlife resources; and natural systems or processes; or to protect life and safety from natural hazards (BLM Manual 1613-.02). This discussion does not consider lands used for recreation since it is discussed in Section 3.9.5 above. Table 4.9.5-1 of the 2020 EIS lists these special interest areas and summarizes the acreage of the proposed Project's construction and operational footprint within these areas. The ROI for upstream development activities does not contain Special Interest Areas but the following ACECs are located within North Slope Borough: Galbraith Lake ACEC, Nigu-Iteriak ACEC, Toolik Lake Research Natural Area, West Fork Atigun River ACEC, and Western Arctic Caribou Insect Relief ACEC.

SUAs in Alaska are those that have been designated according to 11 AAC 96.014 as having scenic, historic, archaeological, scientific, biological, recreational, or other special resource values that warrant additional protections and special requirements. The North Slope SUA includes all state lands in the Umiat Meridian (essentially, the area north of 68 degrees latitude). Under 11 AAC 96.014, *"a permit is required for motorized vehicle use [in the North Slope SUA], unless that use is for subsistence or is on a graveled road."* Table 3.9-2 presents the acreage of state lands within the ROI. Refer to Section 4.9.5 of the 2020 EIS for detailed information about the federal and state resources special interest areas.

3.9.7 Regulatory Framework and Permitting Requirements

The State of Alaska regulates land use under 11 AAC 55.010-55.280. It provides planning guidelines to establish a system of land classification based on a land use planning process that recognizes the varied resources of the state and the many competing demands for those resources.

To date, there is no comprehensive land use plan for state lands on the North Slope. Several regional and site-specific plans exist in developed areas of the North Slope, including the Dalton Highway Master Plan, the North Slope Borough Comprehensive Plan, Nanushuk Site Specific Plan, and the Deadhorse Lease Tracts Site Specific Plan. Outside of these areas, approximately 4 million acres of lands were previously classified without a comprehensive plan by the ADNR (ADNR 2021).

The North Slope Borough Permitting and Zoning Division provides administrative approvals and development permits under North Slope Borough Municipal Code. The Division approves or denies permits and administrative approvals for any construction, operation, or studies conducted in North Slope Borough.

The North Slope Borough Municipal Code 19.50 and 19.60 defines developments that must receive approval prior to commencement to ensure consistency with the Comprehensive Plan, including issuance of a Certificate of Clearance as a formal approval process to ensure that all sites listed in North Slope Borough’s Traditional Land Use Inventory are protected.

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3.10 VISUAL RESOURCES

3.10.1 Introduction

This section discusses the existing visual resources of the North Slope. Visual resources include all visible features – natural and manmade, moving and stationary – that make up the landscape and can influence the visual appeal of that landscape for a viewer. Viewers can include tourists, travelers, workers, and residents from nearby communities. The 2020 EIS contains an extensive analysis in the Project area of the existing visual environment of the proposed Project (see Section 4.10 of the 2020 EIS). This section provides a similar discussion, though specific to the North Slope.

3.10.2 Regional Context

The ROI for visual resources on the North Slope consists of the PTU, PBU, KRU, existing pipeline ROWs between the PBU and KRU, and land immediately adjacent to these areas. The ROI is located on state land (ADNR), managed for oil and gas development; therefore, developed areas within the PTU, PBU, and KRU can be described as predominantly commercial and industrial. The natural landscape surrounding these sites is mainly undeveloped and uninhabited. The PTU, PBU, and KRU are located within the Arctic Coastal Plain Province, which is characteristically open, flat, and dominated by permafrost. Natural life in the area consists of low-lying, hardy vegetation and wildlife that can survive in the harsh arctic conditions. The northern portion of the North Slope comprises the Arctic Tidelands and Arctic Coast. The North Slope also includes clusters of water bodies throughout the region, including Colleen Lake (in Deadhorse) and the Sagavanirktok River.

Seasonal factors have a major influence on the quality and visibility of landscape features on the North Slope. Changing weather conditions, especially inclement weather, greatly decrease visibility. Seasonal changes result in the occurrence of different wildlife and the changing color and density of vegetation in the visible landscape. Additionally, the region experiences extreme periods of light and darkness, where there are approximately 2 months of darkness during the winter and almost 3 months of daylight during the summer months. Between these extremes are long periods of slow sunrises and sunsets and low-angled sun, which colors the environment.

The North Slope planning area includes small portions of land owned by Alaska Natives, while the eastern and western locations outside of the ROI also includes land managed by the NPS and BLM, respectively.

3.10.3 Baseline Visual Conditions of North Slope

As previously mentioned, the developed portions of the PTU, PBU, and KRU are predominantly commercial and industrial, while the immediately surrounding natural landscape could be described as relatively flat and open, usually with permafrost and low-lying, hardy vegetation, and including various waterbodies clustered throughout the region. Beaufort Sea and its coast, islands, and ice pack dominate the landscape to the north.

No publicly accessible roads exist for the KRU and PTU. The closest point where the general public can access the PBU portion of the ROI is located at the northern terminus of Dalton Highway in Deadhorse, which is adjacent to Colleen Lake and the Deadhorse Airport. This viewpoint was identified as key observation point 1 (Colleen Lake) as part of the visual impacts analysis in the 2020 EIS (see Section 4.10.1.5 of the 2020 EIS). Results from the analysis show that at this key observation point the ratings for scenic quality (a measure of the visual appeal) and viewer sensitivity (measure of public concern for scenic quality) were both rated low (refer to Table 4.10.1-4 of the 2020 EIS).

From the Colleen Lake observation point, various manmade structures and waterbodies can be seen. Nearby manmade structures consist primarily of white, gray, and tan metal buildings. The landform is generally horizontal and flat, with small rectangular buildings and existing oil and gas infrastructure visible above the horizon about 1.5 miles away. Airplanes can be seen flying in and out of the Deadhorse Airport. Commercial activities and buildings also dot the visible landscape. Vegetation within this landscape consists of low plants in rough clumps. The vegetation ranges from green and brown with seasonal yellows and reds. No trees are visible from this point (FERC 2020).

3.10.4 Regulatory Framework

The State of Alaska has established visual resource goals for protecting visual and aesthetic resources on the North Slope, as well as the isolation and unique wilderness characteristics of the planning area. Objectives within the North Slope Area Plan relating to visual resources include (ADNR 2021):

- **Objective A.** Manage state land within the planning area for multiple uses without eliminating, or unreasonably limiting recreation, tourism, or scenic resources.
- **Objective B.** Consider the needs of recreational use to minimize user conflict, provide for a quality experience for a range of user groups, and protect the natural values and attributes of the planning area.

3.11 SOCIOECONOMICS

3.11.1 Introduction

Section 4.11 of the 2020 EIS details socioeconomic conditions along the entire Project including the Gas Treatment Facilities, Mainline Facilities, and Liquefaction Facilities. This section focuses on population demographics, housing occupancy data, property values, economic and employment characteristics, tax revenues, and public services specific to the North Slope. This section was prepared based on publicly available data published by a variety of federal and state agencies, including the U.S. Census Bureau (USCB); U.S. Bureau of Labor Statistics; Alaska Department of Labor and Workforce Development; and Alaska Department of Commerce, Community and Economic Development. The socioeconomic analysis encompasses North Slope Borough, which serves as the ROI.

Within the North Slope Borough, the socioeconomic analysis focuses on the census-designated places of Anaktuvuk Pass, Atqasuk, Nuiqsut, Kaktovik, Utqiagvik, Point Hope, Point Lay, Prudhoe Bay, and Wainwright. Most residents of the North Slope Borough are located in one of these communities. Also, they are the closest geographically to the potential upstream development activities and are more likely to experience localized effects on community culture, subsistence, employment, and income.

3.11.2 Regional Context

The Iñupiaq have inhabited the North Slope for thousands of years, and the current residents of the North Slope honor their cultural ties to the land and their ancestors by practicing traditional Iñupiaq values. Despite the changes in social and political organization over time, the core of Iñupiaq social organization is similar on the North Slope today. Recent development on the North Slope is primarily characterized by activities related to oil and gas development, and is therefore commercial in nature, especially in the Deadhorse and Kuparuk areas. The social and economic setting of the North Slope is shaped by its remote location, sparse population, traditional values, and cultural history.

3.11.3 Population

3.11.3.1 Existing Population

According to the USCB American Community Survey's 5-year estimates, the population in North Slope Borough totaled 9,375 in 2020 (USCB 2020a). North Slope Borough is an approximately 88,695-square mile area that is predominantly remote and sparsely populated, with an average population density of 0.1 person per square mile in 2010 (USCB 2012). Table 3.11-1 shows population data for Alaska and the communities on the North Slope in 2000, 2010, and 2020. While North Slope Borough has increased in population, the communities within the Borough have experienced increases and decreases in population since 2000 that can be attributed to job opportunities and migration (Robinson et al. 2020).

Table 3.11-1. Population in North Slope Borough

Area	Population 2000	Population 2010	Population 2020	Percent Change (2000-2020)
Alaska	626,932	710,231	736,990	17.6
Total North Slope Borough	7,385	9,430	9,375	26.9
Anaktuvuk Pass	282	324	251	-11.0
Atqasuk	228	233	135	-40.8
Kaktovik	293	239	178	-39.2
Nuiqsut	433	402	535	23.6
Point Hope	757	674	660	-12.8
Point Lay	247	189	176	-28.7

Table 3.11-1. Population in North Slope Borough

Area	Population 2000	Population 2010	Population 2020	Percent Change (2000-2020)
Prudhoe Bay	5	2,174	1,416	28,220.0
Utqiagvik[a]	4,581	4,121	4,354	-5.0
Wainwright	546	556	437	-20.0

Source: USCB 2020a; USCB 2012; USCB 2001

[a] Utqiagyik is also referred to as the town of Barrow. U.S. Census data for this location is available under the name Barrow through 2017 and under the name Utqiagyik beginning in 2018.

3.11.4 Economy and Employment

Employment and income patterns provide insight into local economic conditions, including the strength of the local economy and the well-being of the residents. As described in Section 4.11.2.1 of the 2020 EIS, the Alaskan economy is driven by federal government spending, petroleum, new and traditional resources, and personal assets. Employment varies seasonally in Alaska, with the highest employment rates in Alaska occurring throughout the summer months and the highest unemployment rates occurring in the winter months for the trade, transportation, utilities, and leisure and hospitality industries. Table 3.11-2 shows summary statistics covering these economic parameters.

Table 3.11-2. Existing Income and Employment Conditions on the North Slope in 2020

Area	Per Capita Income	Median Household Income	Labor Force (Persons)	Unemployment Rate (%)
Alaska	$37,094	$77,790	386,787	7.2
Total North Slope Borough	$45,889	$79,083	5,744	9.8
Anaktuvuk Pass	$21,315	$61,953	107	23.6
Atqasuk	$20,584	$93,750	50	14.0
Kaktovik	$29,366	$75,625	81	11.7
Nuiqsut	$31,786	$67,361	276	13.0
Point Hope	$21,765	$59,375	233	32.2
Point Lay	$21,322	$60,250	69	14.5
Prudhoe Bay	$106,660	Not provided	1,412	0.8
Utqiagvik[a]	$29,900	$87,870	2,094	17.4
Wainwright	$27,536	$69,167	189	7.9

Source: USCB 2020b

[a] Utqiagyik is also referred to as the town of Barrow. U.S. Census data for this location is available under the name Barrow through 2017 and under the name Utqiagyik beginning in 2018.

% = percent

About one-third of workers in Alaska and most of the workers in North Slope Borough do not reside in the communities in which they work. In 2020, 13 percent of all workers across the state were non-local residents, while 18 percent were non-residents of Alaska. During the same year, 48 percent of all workers in North Slope Borough were non-local Alaska residents and 33 percent resided outside the state (ADOLWD 2020).

3.11.5 State and Local Taxes and Government Revenues

Section 4.11.4 of the 2020 EIS details the existing state and local taxes and government revenue with values from fiscal year (FY) 2017. Reviewing FY2021 data, the State of Alaska collected $27.4 billion in revenue, with the majority of this revenue coming from oil taxes and royalties. Other revenue sources for the state included funding from the federal government and investment earnings, primarily from the Alaska Permanent Fund. The State of Alaska does not collect personal income or sales taxes.

Unlike other states in the country, Alaska receives nearly a third of its total revenues from the oil and gas industry. The oil and gas production contribution to the Alaska Permanent Fund is an important revenue source for Alaska residents. For many Alaska residents, the Alaska Permanent Fund dividend payments they receive from the state actually exceed the local taxes they pay.

In FY2021, the state spent $11.9 billion. The largest percentage of expenditures was on health and human services (31 percent), education (15 percent), and transportation (10 percent) (ADA 2021).

Table 4.11.4-3 of the 2020 EIS shows local government revenues for FY2017 including North Slope Borough. The FY2021 property taxes in 2021 totaled to $404,161,483 with the majority of the received revenue from oil and gas property taxes (North Slope Borough 2021).

3.11.6 Housing

As described in Section 4.11.2.1 of the 2020 EIS, the Alaska cost of living is high relative to other states due to many factors, including remoteness and small population (Goldsmith 2010). The Alaska cost of living varies significantly by community, with some communities experiencing very high costs of living. Limited suppliers, high transportation costs, and high energy costs are some of the primary reasons why the cost of the living is greater in small, remote communities. Typically, the more remote the community, the higher its cost of living. As shown in Table 4.11.2-1 of the 2020 EIS, the North Slope Borough communities had a cost-of-living index of 150 in 2018 (FERC 2020).

As presented in Table 4.11.5-1 of the 2020 EIS, North Slope Borough contains 2,550 total housing, of which approximately 20 percent are vacant (FERC 2020).

3.11.7 Public Services

This section describes public services in North Slope Borough, including schools, law enforcement, fire protection, and utilities (e.g., electricity, heating, waste disposal, sewage treatment, and drinking water).

The North Slope Borough School District has a total of 11 schools with 33 percent of the school facility capacity used. The average daily membership of the school district was 1,883 in 2017 (Alaska DEED 2017). In addition to traditional public schools, a number of students in Alaska, particularly those who live in remote areas without convenient access to school facilities, can attend correspondence schools or virtual schools. The total average daily membership for correspondence schools was estimated to be about 11,120 students in 2016, or 10 percent of total average daily membership in Alaska (FERC 2020).

North Slope Borough provides police and fire services to the community. The North Slope Borough Police Department has its headquarters in Utqiagvik, where they operate a jail and 24-hour dispatch center along with offices and staff in each of the seven outlying villages and Prudhoe Bay (North Slope Borough 2022b). The North Slope Borough Fire Department is staffed by community volunteer firefighter and career personnel to provide services to the community (North Slope Borough 2022c).

Refer to Section 4.11.6.3 of the 2020 EIS for information about the availability of construction materials expected to be sourced within Alaska for the proposed project, including gravel/granular material, wood/timber, diesel fuel, waste management, and electric utilities. Since these resources are sourced throughout Alaska, they would be consistent with the ROI evaluated in this **Final** SEIS.

As described in Section 4.11.7.1 of the 2020 EIS there is very little tourism in North Slope Borough due to its remote location. Refer to Section 4.11.7 of the 2020 EIS for details about tourism and coastal recreations resources within Alaska.

3.11.8 Environmental Justice

3.11.8.1 Existing Minority and Low-Income Populations

As shown in Figure 3.11-1, the ROI crosses two block groups. Census Tract 3, Block Group 1 would encompass the PBU, KRU, and a portion of the CO_2 pipeline route; and Census Tract 2, Block Group 3 would include PTU and the balance of the CO_2 pipeline route. Table 3.11-3 identifies the racial/ethnic characteristics of these two block groups on the North Slope and the percentage of population at or below the poverty level.

Environmental justice populations are present within the ROI. Approximately 36 percent of Alaska's population is minority, with American Indian and Alaska Native accounting for approximately 14 percent of the total population in Alaska. At approximately 71 percent, the minority population in North Slope Borough is about double the state's percentage. **Census Tract 2, Block Group 3, where PTU is located, has both high percentages of minority populations and populations below the poverty level when compared to statewide and North Slope Borough percentages.** Census Tract 3, Block Group 1, where PBU and KRU are located, however, has low minority population and low percentage of the population below the poverty level. The percentage of people living below the poverty level on the North Slope is only slightly higher than the statewide level while the two census tracts within the ROI are below the statewide level of 10.1 percent.

The USEPA EJScreen tool was used to conduct additional analysis for communities within the ROI plus a 5-mile radius which includes Prudhoe Bay Census Designated Place (CDP). The EJScreen tool uses the 80th percentile or higher threshold for Census block groups as a screening tool for environmental justice index concerns by combining environmental factors with demographic indexes. Environmental justice indexes for Prudhoe Bay CDP are below the 80th percentile exposure for 10 of the 12 environmental indicators: Diesel Particulate Matter; Air Toxics Cancer Risk; Air Toxics Respiratory Hazard Index; Traffic Proximity; Lead Paint; Risk Management Plan Facility Proximity; Hazardous Waste Proximity Superfund Proximity; Underground Storage Tanks and Leaking Underground Storage Tanks; and Wastewater Discharge. The EJScreen tool does not provide data for fine particulate matter of diameter 2.5 microns or less ($PM_{2.5}$) or ozone (O_3) for the area of analysis (USEPA 2022f).

Although Prudhoe Bay is the only CDP within the ROI, subsistence activities are practiced by environmental justice populations from communities outside of the ROI. The 2020 EIS considered subsistence users from any community within 30 miles of the Project along with any community more than 30 miles from the Project area but with a subsistence use area within 30 miles of the Project area. Using these criteria, DOE identified the communities of Nuiqsut (located 13 miles west of KRU's western boundary) and Kaktovik (approximately 55 miles east of the PTU's eastern boundary) as subsistence users within the ROI. Section 3.14 provides more information regarding subsistence users and activities within the ROI.

Table 3.11-3. Race and Ethnicity in the Environmental Justice ROI

Location	Total Population	Population at or below the Poverty Level (%)	Total Minority Population[a]	Minority Population (%)	Alaska Native / American Indian Population (%)	Hispanic/ Latino Population (%)
Alaska	719,445	10.3	262,103	36.4	14.4	7.1
North Slope Borough	9,260	9.4	6,598	71.3	52.3	3.7
Census Tract 3, Block Group 1	2,550	0.7	545	21.4	10.2	4.5
Census Tract 2, Block Group 3	2,439	15.9	2,134	87.5	79.3	2.6
Prudhoe Bay CDP[b]	**1,414**	**0.28**	**319**	**22.5**	**40.1**	**19.1**

Source: USCB 2020c

[a] Includes persons who indicated Black or African American, American Indian or Alaska Native, Native Hawaiian and Other Pacific Islander, Other Race, or Two or More Races. Hispanic or Latino may be of any race.

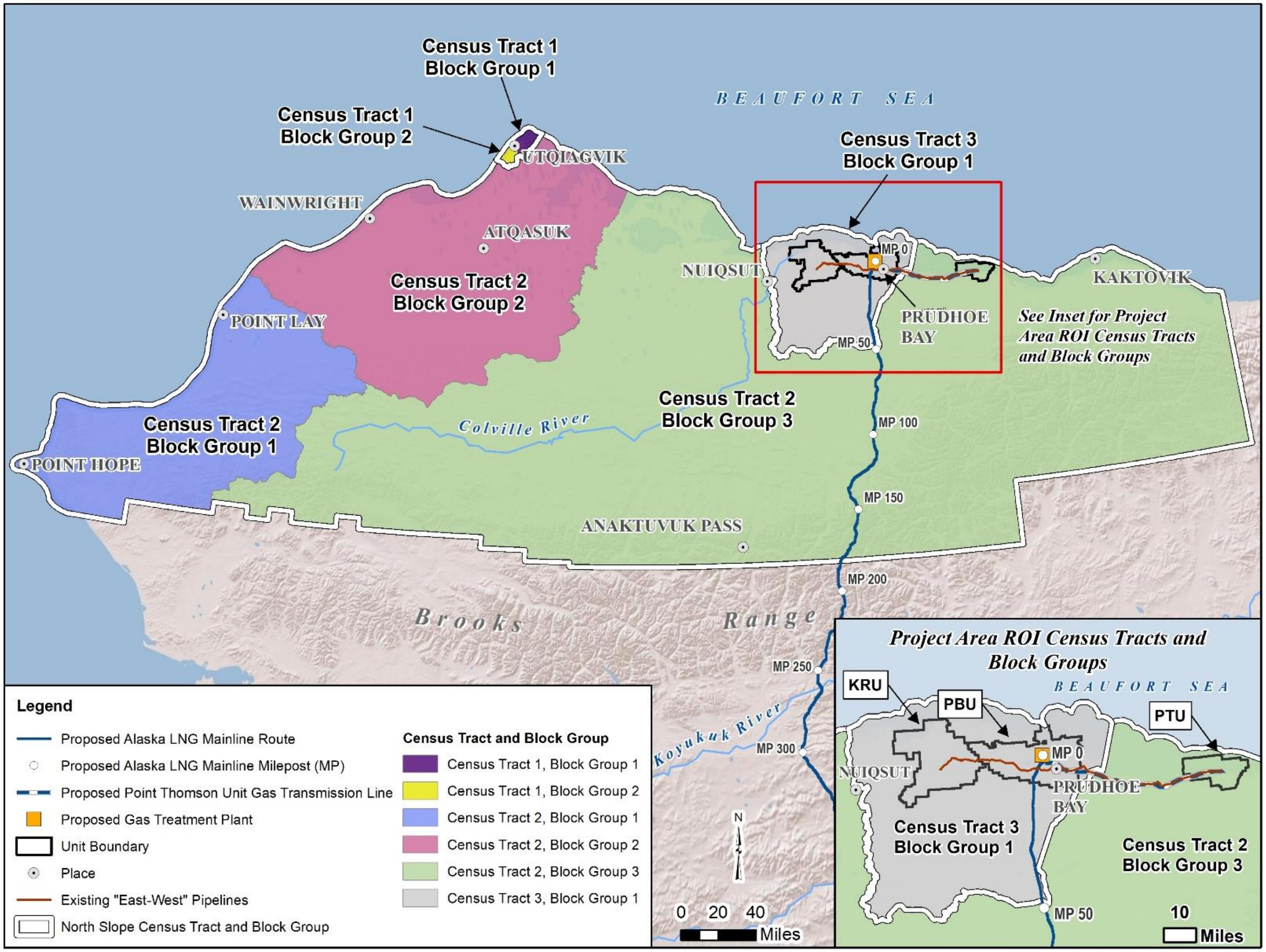
[b] Prudhoe Bay CDP is the only community within a 5-mile radius of the ROI. Nuiqsut is 7 miles to the west of the ROI and is the next closest community.

% = percent; **CDP = Census Designated Place;** ROI = region of influence

3.11.9 Regulatory Framework, Executive Orders, and Permitting Requirements

E.O. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires federal agencies to consider if impacts on human health or the environment (including social and economic aspects) would be disproportionately high and adverse for minority and low-income populations and appreciably exceed impacts on the general population or other comparison group. **In addition, USEPA's 2016 environmental justice guidance stresses the importance of providing minority or low-income populations with meaningful engagement in environmental review processes. Extensive coordination with and involvement of Nuiqsut and Kaktovik residents occurred during the development of the 2020 EIS to understand community concerns and subsistence use of communities within the North Slope. This included conducting household surveys, subsistence mapping interviews, traditional knowledge workshops, and use of subsistence mapping by ADF&G and AGDC (see Section 4.14 of the 2020 EIS for additional information).** Refer to Section 4.11.8 of the 2020 EIS for definitions of minority population and low-income population.

As described in Section 1.1, E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis* directs federal agencies to prioritize both environmental justice and employment. E.O. 13990 supports the national objective to improve public health and the environment; ensure access to clean air and water; limit exposure to dangerous chemicals and pesticides; and hold polluters accountable, including those who disproportionately harm communities of color and low-income communities. **Section 3.19 includes a discussion of climate change effects to environmental justice populations and Section 4.11 includes a discussion of potential effects of upstream development activities to the communities of Nuiqsut and Kaktovik that rely on portions of the ROI for subsistence.**



Source: USCB 2021

KRU = Kuparuk River Unit; LNG = liquefied natural gas; MP = Milepost; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence

Figure 3.11-1. Census Tracts and Census Blocks within the ROI

3.12 TRANSPORTATION

3.12.1 Introduction

Section 4.12 of the 2020 EIS details transportation resources along the entire Project, including the Gas Treatment Facilities, Mainline Facilities, and Liquefaction Facilities. This section describes the transportation resources that exist on the North Slope, specifically within the PTU, PBU, KRU, and existing pipeline ROWs between PBU and KRU. The majority of the transportation infrastructure in these areas revolve around the oil and gas industries and mostly include a network of ice and gravel roads. Major transportation resources on the North Slope include Dalton Highway, Spine Road, and Deadhorse Airport. Due to the seasonal characteristics of the region, gas and oil activities vary significantly between the winter and summer months, with ground transportation for these industries limited mostly to the winter months, marine transportation in the summer months, and air transportation available year-round (ADNR 2021).

3.12.2 Roadway Transportation

Regional ground transportation on the North Slope largely consists of the Dalton Highway, Spine Road, and a distribution of smaller gravel and ice roads that support the oil and gas industries in the region. Due to the sensitive nature of the physical landscape, industrial activities are limited to winter months when temporary ice roads can be built. These ice roads are constructed to supplement the existing transportation system for the use of hauling heavy, oversized equipment to industrial sites.

Dalton Highway (also referred to as James Dalton Highway, Haul Road, or State Route 11) is the only year-round public road on the North Slope and, therefore, is the main roadway that connects the North Slope to the wider state and also serves as an important link to local communities. Dalton Highway is a two-lane roadway that extends 414 miles from Livengood, a small community north of Fairbanks, to its northern terminus, Deadhorse on the North Slope. The highway is mostly gravel and dirt surfaces with intermittent pavement, with harsh travel conditions occurring throughout the year. According to the Alaska Department of Transportation and Public Facilities (ADOT&PF), the majority of traffic on the Dalton Highway consists of commercial vehicles bound north to deliver fuel, supplies, equipment, and other goods to support commercial activity on the North Slope (ADOT&PF 2022a). Although it was originally constructed in 1974 to support the development of the Trans-Alaska Pipeline and to service the oil fields on the North Slope, it was opened to the public in 1994 and is owned and maintained by the State of Alaska, providing access to industrial sites. Traffic volume on this highway is usually low. Although mostly used by trucks, other noncommercial users include hunters and local residents, typically during the summer and on the southern portion of the highway. In the 2020 EIS, the State of Alaska commented that the ADOT&PF does not place seasonal weight restrictions on the Dalton Highway, but no permits for oversize loads are approved for the highway during spring breakup.

The extensive network of smaller roadways serving the oil and gas industries on the North Slope includes hundreds of miles of gravel roads, with Spine Road being the main gravel roadway. From Deadhorse, Spine Road extends from Endicott in the east to Kuparuk in the west. This road serves as an important connector road, linking to the smaller roads and providing access to the various industrial operations, development, and exploration in the North Slope. Although Spine Road is a private easement, owned and maintained by private companies, limited use for local residents is allowed when conditions are safe. During the winter, some communities are connected to Spine Road via ice road or trail. Currently, there are no permanent roads east of Prudhoe Bay providing access to Point Thomson. Point Thomson is accessed by vehicles via seasonal and temporary ice roads, marine vessels via Beaufort Sea, and rotary-wing aircraft.

In 2018, North Slope Borough built approximately 300 miles of snow roads for the local communities to provide access to Dalton Highway (North Slope Borough 2019). Known as the Community Winter Access Trails program, this network of improved snow trails connects the local communities, allows residents to travel in a much safer manner during the winter season, and reduces high barge and airfreight costs incurred by the communities (ADNR 2021).

3.12.3 Marine Transportation

On the North Slope, marine transportation is limited to the Arctic Coast and Arctic Tidelands regions. Because of the sea ice that forms along the coast, marine transport occurs in the summer. Barges deliver freight to the coastal communities, though port facilities do not exist for these communities. Marine transportation is important to the oil and gas industries on the North Slope as it is used for the transport of equipment and materials during open water seasons when ice roads are not available or when heavy loads are not able to be transported via aircraft. General freight cargo and petroleum products generate approximately 15 barge trips traveling to Utqiagvik, Prudhoe Bay, and Kaktovik between July and September (USACE 2012). The West Dock Causeway in Prudhoe Bay and the Thomson Marine Facilities at Point Thomson are both port facilities that are owned and used by private entities for the transport of construction equipment, materials, and petroleum products. The private port facilities are accessed via the Beaufort Sea and Prudhoe Bay. Smaller vessels also access industrial sites through these port facilities for routine and maintenance activities.

The West Dock Causeway is a 2.2-mile-long, gravel causeway docking facility along the northwest shore of Prudhoe Bay and has two unloading facilities. In 1981, an extension elongated the causeway an additional 5,010 feet to its current length but does not include unloading facilities on the extension. Because this facility is not a deepwater port, cargo ships and oceangoing barges typically use shallow-draft or medium-draft barges to transport cargo and people to shore. Arrival and offloading occur during the ice-free window, usually from August to September. Other activities involved at the West Dock Causeway include maintenance and erosion control activities.

The Thomson Marine Facilities accommodate coastal barges and oceangoing (sealift) barges (USACE 2012). Constructed in 2013, this facility is used in the transport of modules, equipment, and material needed to support construction at Point Thomson.

3.12.4 Air Transportation

Air transportation is an important mode of transportation in the region as it is available year-round and links communities on the North Slope that are otherwise lacking access to roads and navigable waters. The region’s main air transportation system consists of designated airports for each North Slope community, a number of small restricted and unrestricted airstrips, and the Deadhorse Airport. The community airports provide passenger, cargo, and emergency services. The Deadhorse Airport and a heliport, both owned by the state, are located in the PBU. The Deadhorse Airport is the main airport in the region and provides passenger, cargo, freight, and fuel services for the greater Prudhoe Bay region. Industry airstrips at Kuparuk, Alpine, Badami, and other locations are used regularly for oil industry activity (North Slope Borough 2019). The Point Thomson airstrip and helipad – air facilities that an applicant could use on the North Slope – are located at the PTU. The airstrip is a private oilfield airstrip made of gravel. It is used to transport passengers, equipment, and supplies from Deadhorse Airport (USACE 2012).

3.12.5 Regulatory Framework and Permitting Requirements

Dalton Highway – the only public road linking North Slope to the state-wide highway system – is maintained by ADOT&PF. The state has designated the Dalton Highway Corridor as a special use site, or Legislatively Designated Area, which includes restrictions and stipulations related to motorized use within and outside of the highway, as detailed in the James Dalton Highway Master Plan (ADNR 2021). The BLM, State of Alaska, and North Slope Borough have developed Dalton Highway Corridor management plans and other documents that have addressed concerns with public safety, services, wildlife management, viewsheds, and the need to comply with requirements of North Slope Borough ordinances, as well as any applicable state and federal regulations (North Slope Borough 2019).

The State of Alaska authorizes home-rule boroughs to provide transportation systems as determined by that borough's charter or ordinance. North Slope Borough is responsible for the maintenance of approximately 100 miles of smaller roads that are primarily located within the regional communities (ASCG 2005). North Slope Borough Municipal Code Title 12 (Transportation) provides guidance on review procedures for transportation projects, although transportation-related ordinances are found throughout the municipal code. Specifically, the code calls for a North Slope Borough comprehensive transportation plan. The municipal code also requires a planning commission review for all major transportation projects constructed or funded in the borough by the state or federal government.

The State of Alaska has established transportation resource goals on the North Slope: to prioritize shared infrastructure and facilities within industrial areas; to encourage opportunities for community connectivity through the development of new transportation routes, as well as through opportunities to plan industry infrastructure to support community access and use; and to encourage the use and development of shared ground, air, and marine transportation routes and facilities that provide for both community and industry needs. Objectives within the North Slope Area Plan relating to transportation include (ADNR 2021):

- **Objective A.** All transportation systems should be constructed in such a way that minimizes potential adverse impacts to the environment and surrounding resources to the maximum extent practicable without jeopardizing other resources and activities.
- **Objective B.** Transportation throughout the region should accommodate and balance the needs of resource development, subsistence uses, and community connectivity.
- **Objective C.** All facilities should be sited and constructed in such a way that minimizes potential adverse impacts to the environment and surrounding resources to the maximum extent practicable without jeopardizing other resources and activities.

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3.13 CULTURAL RESOURCES

3.13.1 Introduction

Section 4.13 of the 2020 EIS details cultural resources along the entire proposed Project. This section focuses on cultural resources on the North Slope. As specific locations for activities related to upstream development have not been identified, this **Final** SEIS broadly considers the Area of Potential Effect (APE) to include the PTU, PBU, KRU, and existing pipeline ROWs between PBU and KRU. DOE did not conduct specific cultural resource surveys within this broad APE, rather DOE accessed the Alaska Heritage Resources Survey (AHRS) data repository for identification of known cultural resources (archaeological sites, buildings, structures, objects or locations, etc.).

3.13.2 Regional Context

The North Slope Arctic coast served as a migration corridor for early nomads arriving from Asia across the Bering land bridge. Archeological evidence of human occupation and use of the Arctic coastal plain dates back to 10,000 B.C. The new migrants began exploring the Brooks Range foothills when glaciers began retreating to the Brooks Range. Cultural sites within the North Slope include sod houses, graves, storage pits, ice cellars, bones, and relics. The record of human existence on the North Slope is characterized by several distinct cultural periods marked by changes in tool style primarily by Iñupiat people. The environmental characteristics of the Arctic shaped Iñupiat culture into a semi-nomadic society with a tradition of whaling and an emphasis on seasonal inland hunting (ADNR 2021).

The Paleoindian period, dating between 13,700 and 9,800 years ago, was the first widespread Native American cultural tradition that was well-documented by the archaeological record and included small mobile bands that hunted large game. Environmental changes at the end of the Pleistocene era and the disappearance of the large mammals on which they survived led to the disappearance of the Paleoindian tradition. The pattern of land use remained unchanged until the second half of the 19th century with the arrival of westerners, new tools, and other natural events (ADNR 2021).

The discovery of bowhead whale paths led to a dramatic increase in commercial whaling activity between 1850 and 1890. Several whaling stations were built along the coast and provided regular contact and trading with the Iñupiat population. In 1900, a report by the U.S. Navy provided the first written documentation about petroleum resources on the North Slope by verifying oil shale deposits along the Etivluk River. The USGS completed the first comprehensive survey in 1901 and published the results in 1904. The USGS report noted the presence of geological formations that could have petroleum deposits as well as natural oil seepages near Cape Simpson. The Iñupiat people knew about the existence of oil seeps on the North Slope long before they were formally located and described by the USGS in 1901. Some of the first documented petroleum deposits and oil seeps were found near Cape Simpson (ADNR 2021).

Smallpox and influenza outbreaks decimated North Slope Iñupiat populations during the final quarter of the 19th century. A simultaneous decline in caribou populations resulted in famine and caused inland Iñupiat to relocate to coastal communities, such as Utqiaġvik. By 1910, the population decline reduced the Iñupiat population to between 20 and 25 percent of its 1850 population (ADNR 2021).

Following extensive exploration work by the USGS and the U.S. Navy, producible oil was first discovered at Umiat, along the Colville River. Natural gas was first discovered at Umiat and Utqiagvik. In 1949, the South Barrow Gas field was developed. The federal government began exploring for oil in 1923 with the establishment of the Naval Petroleum Reserve No. 4. Some of the lands used by Alaska's first people have been conveyed to individuals as Native Allotments. On the North Slope there are currently 145 allotments totaling almost 11,000 acres. The number and acreage will change as more allotments are conveyed under existing federal laws (ADNR 2021).

Many traditional uses of the land continue today in the Iñupiat and Nunamiut communities and surrounding areas. These traditions, cultural practices, and subsistence lifestyle are passed down to the younger generations of Alaska Native people (ADNR 2021).

3.13.3 Cultural Resources Surveys

DOE did not conduct specific cultural resource surveys within the broad APE, rather DOE accessed the AHRS and North Slope Borough data repositories for identification of known cultural resources (archaeological sites, buildings, structures, objects or locations, etc.). The AHRS is an inventory of all reported historic and prehistoric sites within the State of Alaska and is maintained by the Office of History and Archaeology. The AHRS is used to identify known cultural resource sites and ensure they are addressed during a project should one be proposed where a cultural resource exists. The North Slope Borough Department of Planning and Community Services, Land Management Regulation Division also maintains a separate database of known cultural sites, the Traditional Land Use Inventory. Table 3.13-1 summarizes the number of sites in proximity to potential upstream development activities based off AHRS and North Slope Borough data. Figures 3.13-1 through 3.13-3 show occurrences of cultural sites within PTU, PBU, and KRU based on this data.

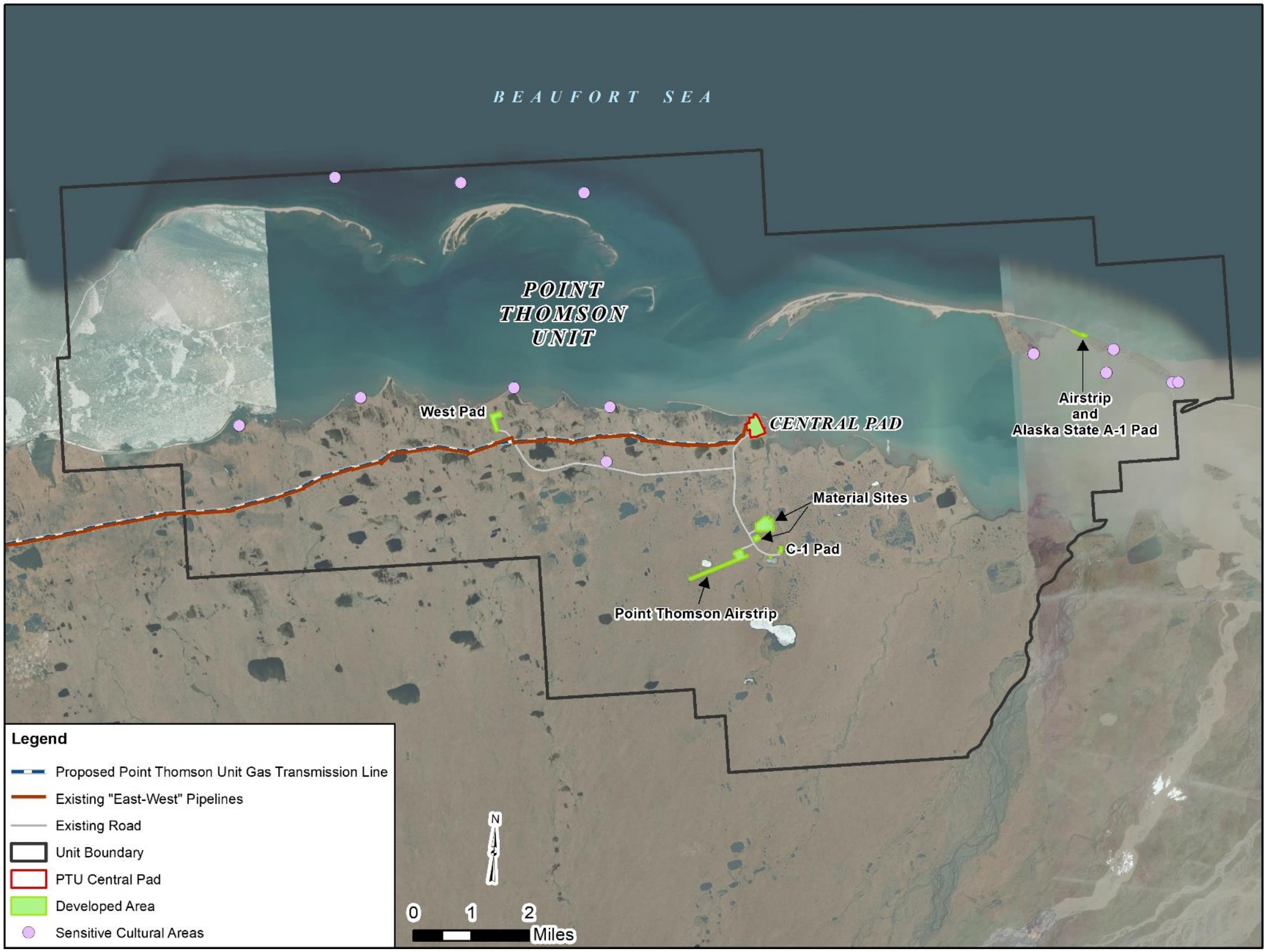
Table 3.13-1. Cultural Sites Identified within the AHRS and North Slope Borough Databases

ROI Unit/Project Feature	Sensitive Cultural Areas
PTU	**17**
Central Gas Pad 0.25-mile buffer from Pad Perimeter	0 0
PBU	**31**
Well Pad 18 0.25-mile buffer from Pad Perimeter Central Gas Facility 0.25-mile buffer from Facility Perimeter	0 0 0 0
KRU[a]	**36**
Existing 80-foot East-West Pipeline ROW 100-foot Buffer from Edge of ROW	**0** 0

Source: OHA 2022; North Slope Borough 2022d

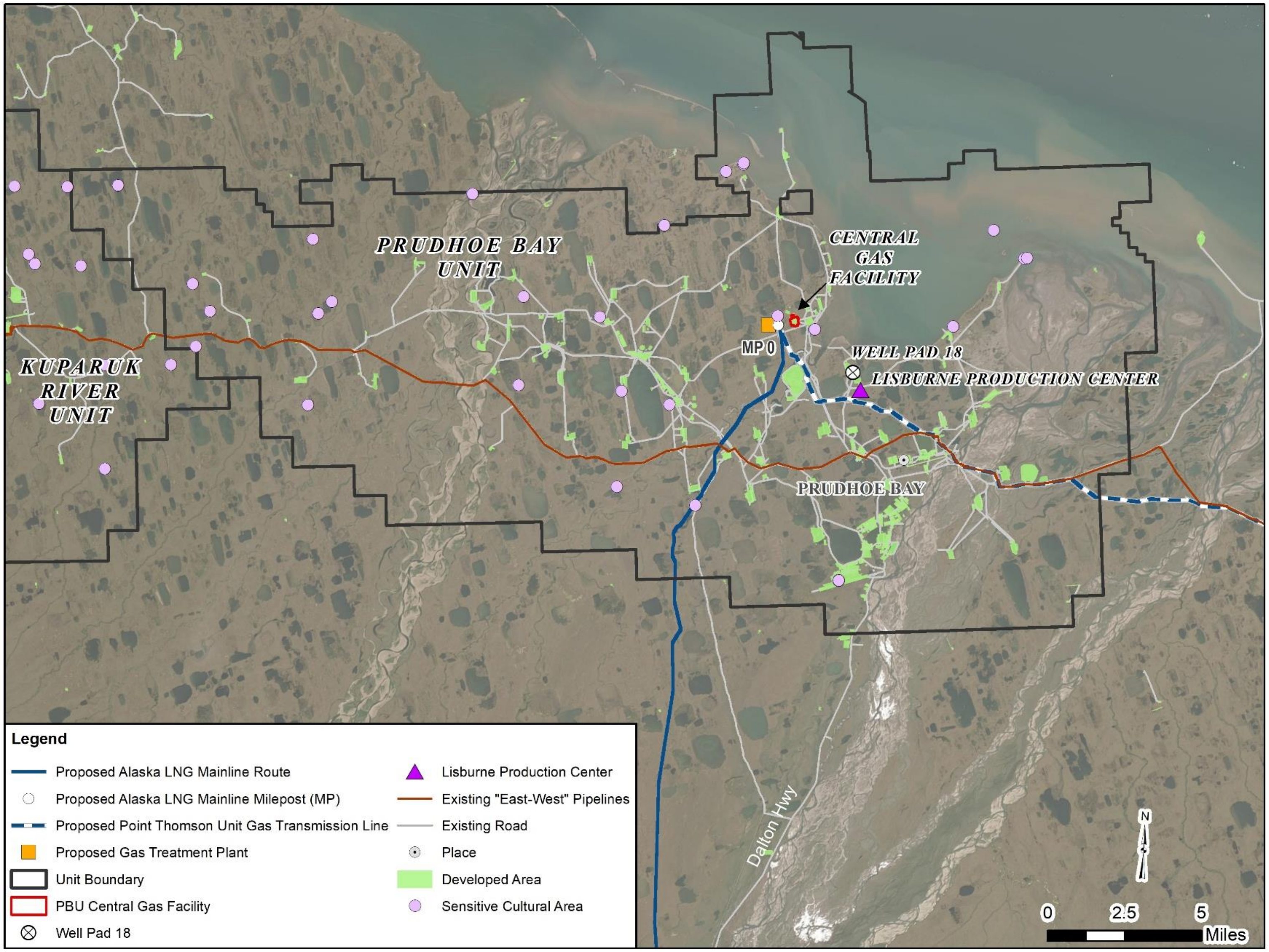
[a] Specific locations for activities related to upstream development in KRU have not been identified. The AHRS and North Slope Borough databases contain 36 sensitive cultural areas identified within KRU.

AHRS = Alaska Heritage Resources Survey; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way



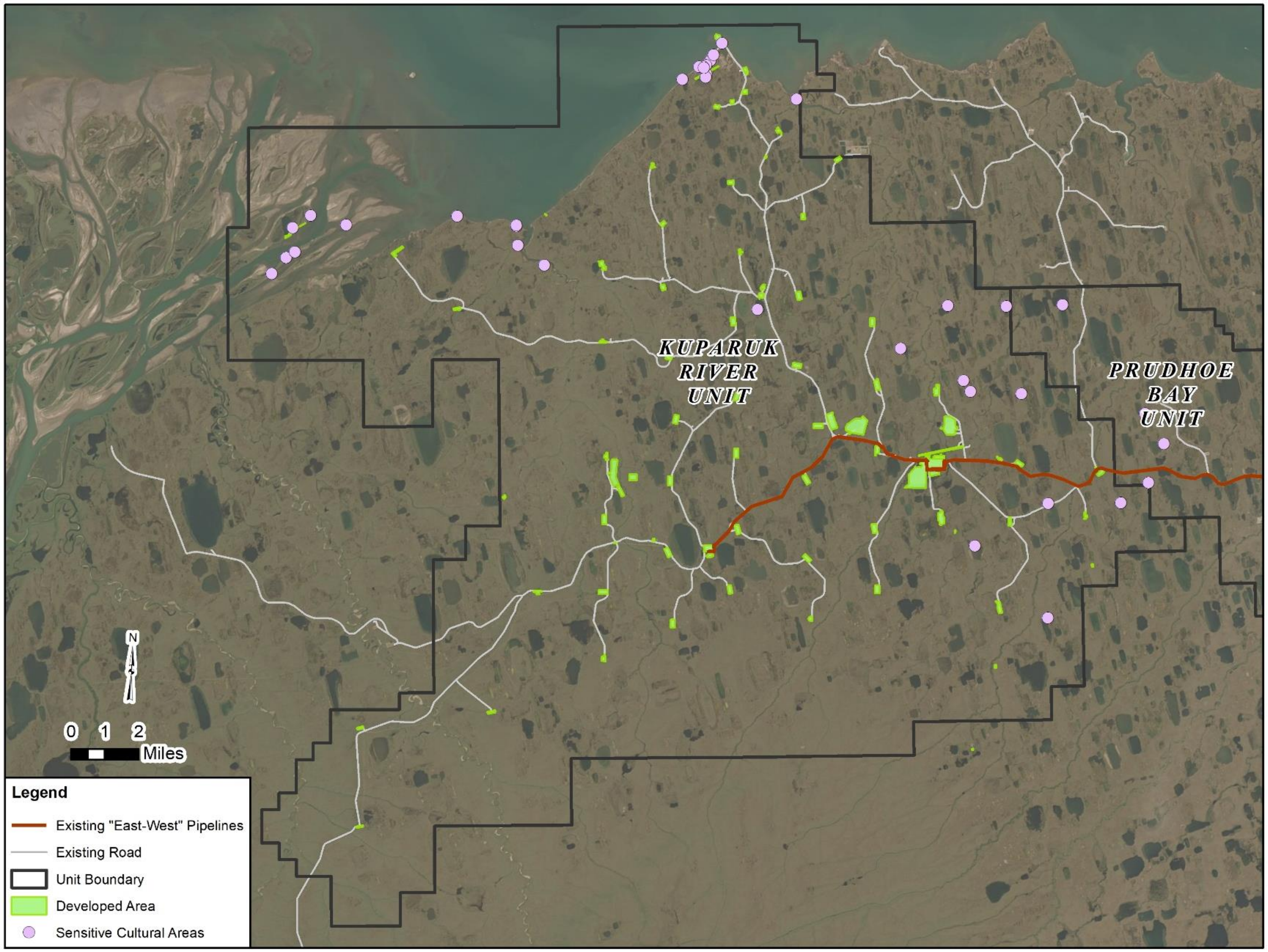
Source: ADNR DOG 2021a; AGDC 2022; North Slope Borough 2022d; North Slope Science Initiative 2021; OHA 2022; USGS 2022a
AHRS = Alaska Heritage Resources Survey; PTU = Point Thomson Unit

Figure 3.13-1. Cultural Sites Identified within the AHRS Database for PTU



Source: ADNR DOG 2021a; AGDC 2022; North Slope Borough 2022d; North Slope Science Initiative 2021; OHA 2022; USGS 2022a
AHRS = Alaska Heritage Resources Survey; LNG = liquefied natural gas; MP = Milepost; PBU = Prudhoe Bay Unit

Figure 3.13-2. Cultural Sites Identified within the AHRS Database for PBU



Source: ADNR DOG 2021a; AGDC 2022; North Slope Borough 2022d; North Slope Science Initiative 2021; OHA 2022; USGS 2022a
AHRS = Alaska Heritage Resources Survey; KRU = Kuparuk River Unit

Figure 3.13-3. Cultural Sites Identified within the AHRS Database for KRU

3.13.4 Regulatory Framework and Permitting Requirements

Section 106 of the NHPA, as amended, requires DOE to take into account the effects of its undertakings on properties listed on or eligible for listing on the National Register of Historic Places (NRHP) and afford the Advisory Council on Historic Preservation an opportunity to comment. Cultural resources are generally considered "historical" in age around the 50-year mark, and therefore require further consideration under historic preservation law.

In addition, the Alaska Historic Preservation Act establishes the state's basic goal to preserve, protect, and interpret the historic, prehistoric, and archaeological resources of Alaska so that the scientific, historic, and cultural heritage values embodied in these resources may pass undiminished to future generations. Lands with heritage and cultural significance are managed according to the objectives and management guidelines which related to North Slope oil and gas development activities to preserve, protect, and interpret the historic, prehistoric, and archaeological resources within the North Slope (ADNR 2021):

- **Objective A.** Preserve, protect, and interpret the historic, prehistoric, and archaeological resources within the planning area.
  - **Guideline A-1.** Identify and determine the significance of cultural resources on state land through the following actions:
    1. Cultural resource surveys conducted by qualified personnel;
    2. Research about cultural resources on state land by qualified individuals and organizations; and,
    3. Cooperative efforts for planned surveys and inventories between state, federal, and local or Alaska Native groups.
  - **Guideline A-2.** Protect significant cultural resources through the following actions:
    1. The Office of History and Archeology within the Division of Parks and Outdoor Recreation reviews authorizations, construction projects, or land uses for potential conflict with cultural resources (OHA 2022). The office determines if there may be an adverse effect on heritage resources and makes recommendations to mitigate these effects cooperating with concerned government agencies, Alaska Native corporations, statewide or local groups, and individuals to develop guidelines and recommendations on how to avoid or mitigate identified or potential conflict.
    2. Require the establishment of buffers a minimum of 50 feet or greater around significant cultural resources as part of the overall protection process when subdividing or otherwise using state lands.

3.14 SUBSISTENCE

3.14.1 Introduction

Section 4.14 of the 2020 EIS details subsistence activities along the entire Project. Efforts included identification of subsistence communities near the proposed Project and characterization of subsistence behaviors within these communities based on household surveys, interviews, and traditional knowledge workshops and a review of the vegetation; wildlife; aquatic; and threatened, endangered, and other special status species. This section focuses on subsistence activities on the North Slope based on information within the 2020 EIS as well as the North Slope Area Plan.

Subsistence and Harvest Subsistence use refers to the customary and traditional uses of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation. Subsistence use also includes the making and selling of handicrafts made from nonedible by-products of fish and wildlife resources taken for personal or family consumption, for barter, or sharing for personal or family consumption (ADNR 2021). The customary and traditional use of wildlife resources has been important to Alaska Native communities for millennia. Alaska Natives have a long relationship with and connection to the land and water resources within their traditional territories. The land and all it provides are considered essential to Alaska Native economic and cultural identity and continuity. Alaska Natives view subsistence holistically as a way of being or a way of life and a significant element of their cultural identity and relationship with the land and resources of Alaska. More recently, subsistence use has also become an important way of life for many non-Natives, especially for rural Alaska residents (FERC 2020).

Furthermore, the holistic nature of subsistence encompasses traditional activities that include transmission of knowledge between generations, connection of people to their land and environment, maintenance of a healthy diet and nutrition, and support of social and spiritual aspects of life. The knowledge and skills needed to subsist involve an understanding of relationships between people, animals, and the natural environment that is the basis for the Alaska Native system of stewardship (FERC 2020).

Subsistence in Alaska is characterized by a high level of consumption of wild foods (game, fish, and vegetation), hunting and gathering activities organized by kinship groups, and the pursuit of these activities within traditional territories. Subsistence activities are generally carried out using small-scale tools and machines to harvest and process natural resources. The technologies used are typically a mix of traditional equipment—fish nets and drying racks, knives and axes, and game traps—and modern equipment—firearms, snowmachines, land-based vehicles, and motor boats. Subsistence harvest levels vary widely among individuals in a community, from one community to the next, and from year to year. Sharing of subsistence resources is common in rural Alaska; often, the proportion of households giving or receiving resources exceeds 80 percent (FERC 2020).

3.14.2 Regional Context

The harvesting of fish, game, and other wild resources for food, shelter, clothing, transportation, handicrafts, and trade is an important part of subsistence culture for residents within the North Slope (predominantly Iñupiaq inhabitants) within the communities of Utqiagvik (Barrow), Nuiqsut, Kaktovik, and Anaktuvuk Pass (FERC 2020). Subsistence and harvest activities throughout the North Slope are diverse, with unique regional and temporal concentrations. Subsistence use is extensive not only in terms of geographic extent but also in terms of the number and variety of species harvested and used. Oftentimes, these activities are based on important cultural traditions that are intertwined with the existence of the rural **I**ndigenous communities across the North Slope (ADNR 2021).

On the North Slope, nearly all lands and waters are used for traditional subsistence activities, including the harvest of fish, game, and other wild resources. A majority of the North Slope is retained in public ownership and managed to maintain subsistence and traditional use harvest opportunities. This includes protection of subsistence resources sufficient to conserve a diversity of biological resources to support traditional harvest opportunities in areas that receive high levels of subsistence uses. ADNR management of state land and resources is consistent with the requirements of sustained yield, as expressed in the State Constitution (ADNR 2021). Table 3.14-1 summarizes the subsistence activities on the North Slope by season as discussed in the 2020 EIS.

Table 3.14-1. Primary North Slope Subsistence Activities by Season

Spring (Apr – May)	Summer (Jun – Aug)	Fall (Sep – Oct)	Winter (Nov – Mar)
Caribou harvests Waterfowl and bowhead whales harvest during migration Furbearer hunting and trapping Beginning of intensified harvests of freshwater fish Seal harvests become a focus of the coastal communities Upland bird and small land mammal harvests	Caribou harvests Waterfowl harvests Furbearer hunting and trapping Fish harvests continue and intensify over the summer with the addition of salmon and marine non-salmon fish harvests Additional large land mammal harvests of moose, bear, and muskoxen Coastal communities focus on marine mammal resources, such as bearded seals Limited plant and berry harvests due to a brief growing period	Caribou harvests Waterfowl and bowhead whales harvest during migration Subsistence activity for moose, muskoxen Fish harvests including freshwater fish (particularly arctic cisco, broad whitefish, and burbot, amplifies) Limited plant and berry harvests comes to an end	Caribou harvests Furbearing animals and upland birds harvest Dall sheep harvest Freshwater fishing generally declines with the exception of burbot fishing Marine mammals, specifically ringed seals, continue to be harvested through the winter in the coastal communities

Source: FERC 2020
Apr = April; Aug = August; Dec = December; Jun = June; Nov = November; Oct = October; Sep = September

For the North Slope, marine mammal and large land mammal harvests comprise the majority of the total subsistence catch (about 40 percent each), with the remaining harvest coming from non-salmon fish (15 percent), migratory birds (2 percent), and upland game birds and vegetation (about 1 percent each). Furbearers are also caught for subsistence purposes but their meat is rarely consumed; thus, the contribution of furbearers is typically not included in the total harvest of edible resources (ADNR 2021).

Subsistence users travel along land, waterway, and air routes to reach harvest areas throughout the North Slope. Annual variation in travel routes is common, but harvesters often follow similar routes to specific harvesting locations that have proven to be efficient (e.g., based on terrain or a road system). Depending on the resource and proximity to the harvester community, the primary modes of access include foot, dog sled, highway vehicle, off-road recreational vehicle, snowmachine, boat/airboat, and airplane. Successful subsistence harvests also depend on access to subsistence resources and use areas. Access is affected by weather, fuel prices, equipment costs, personal time demands, travel distances, road conditions, competition, management practices, and physical barriers such as infrastructure and utility work (FERC 2020).

3.14.2.1 Kaktovik

The main community involved in subsistence activities within the ROI involving PBU and PTU is Kaktovik, located on Barter Island at the northern boundary of the Arctic National Wildlife Refuge, approximately 55 miles east of the PTU's eastern boundary. Subsistence activity for the Kaktovik residents is highest in the spring and late summer and declines mid-winter, with the fewest resources targeted in January and February (see Table 3.14-2). The spring season in Kaktovik is focused around the migration and harvest of migratory birds, although other subsistence activities occur during this time, including the harvest of marine mammals, caribou, moose, Dall sheep, small land mammals, and freshwater fish. Dall sheep, brown bear, gray wolf, and wolverine become less desirable after mid-May. In late May and early June, migratory waterfowl hunting begins with a focus on geese and eider. Waterfowl hunting continues through the summer and early fall months. Subsistence activities in June are limited due to a lack of snow for snow machine transportation and ice conditions that make boat travel difficult (FERC 2020).

Table 3.14-2. Kaktovik Subsistence Harvest Timing

Resource	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fish												
Upland bird/eggs												
Waterfowl												
Plants and berries												
Moose												
Caribou												
Bear												
Muskoxen												
Dall sheep												
Furbearers												
Seals												
Bowed whale												

Source: FERC 2020
Apr = April; Aug = August; Dec = December; Feb = February; Jan = January; Jul = July; Jun = June; Mar = March; Nov = November; Oct = October; Sep = September

During the summer season (June through August), Kaktovik residents target the greatest number of resources in August. Summer caribou hunting peaks in July when animals seek relief from insects at the coast, and the harvest continues into the fall months. The majority of the fish are harvested in the summer months. Dolly Varden, arctic cisco, and broad whitefish are primarily harvested in July and August; however, fall fishing extends into September. Recent studies show Kaktovik hunters harvest bearded, ringed, and spotted seals by boat throughout the summer and fall months (July through September). Plants and berries are harvested during summer, as well as marine invertebrates and muskox, with a resumption of small land mammal harvests in August (FERC 2020).

The fall season (September and October) is focused primarily on harvests of bowhead whale, although caribou and fish are also important resources during this time. The majority of bowhead whale harvests occur during the month of September when the whales migrate closest to shore. Several sources report the harvesting of bowhead whales starting in August and continuing with increasing intensity into fall. At the end of the whaling season, hunters once again focus on caribou, supplementing these resources with fish, plants, berries, and the occasional muskox, bear, or moose. (FERC 2020).

Kaktovik residents pursue few resources during the winter as the length of daylight diminishes (November through April). The primary winter subsistence resources are furbearers, Dall sheep, caribou, gray wolf, wolverine, an occasional moose, and fish. Freshwater and marine non-salmon fish, small land mammals, marine mammals, and upland birds are also taken during the winter months (FERC 2020).

3.14.2.2 Nuiqsut

Off-shore portions of KRU is a subsistence use area for the Nuiqsut community which is located 13 miles west of KRU's western boundary. The majority of Nuiqsut use areas are concentrated around the Colville River, overland areas to the south and southwest of the community (outside of the ROI), offshore areas north of the Colville River delta, and northeast of Cross Island within the KRU. Areas consistently used by Nuiqsut residents to harvest caribou extend from the Beaufort Sea coast south to the foothills of the Brooks Range, and from the Sagavanirktok River and Prudhoe Bay in the east to Utqiagvik and Atqasuk to the west (FERC 2020). Nuiqsut residents hunt caribou often by boat during the summer and fall and by snow machine during the winter and spring. The majority of winter hunting occurs west of the community, outside of the ROI toward Fish Creek and south toward the foothills of the Brooks Range. During the summer and fall harvests, hunters travel by boat both along the coast and inland along various rivers. The 2020 EIS indicated several people commented that hunting has declined east of the community due to activities associated with oil and gas development (within the KRU).

Nuiqsut's location on the Colville River and proximity to the Beaufort Sea (offshore of the KRU) offers harvesting opportunities for many species, including migratory species. Several species of whitefish live in the Colville River for portions of their life cycle. Of particular importance is arctic cisco, which migrates from the Mackenzie River Delta in Canada to the drainages of the North Slope. Whaling is based from Cross Island about 12 miles northeast of Prudhoe Bay. Caribou migrate through the area, and migratory waterfowl nest in nearby tundra (FERC 2020).

Table 3.14-3 shows subsistence harvest times for the Nuiqsut community. Specific to the subsistence areas located offshore of the KRU, after the ice breaks, ringed and bearded seal harvests begin in March and continue throughout the summer and into the fall with a peak in July. Whaling begins in late August and continues through mid- to late September, but occasional bowhead whale harvests have occurred in mid-October (FERC 2020).

Table 3.14-3. Nuiqsut Subsistence Harvest Timing

Resource	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fish	X	X	X	X	X	X	X	X	X	X	X	
Bird/eggs	X	X	X	X	X	X	X	X	X	X	X	X
Berries						X	X	X				
Moose							X	X	X			
Caribou	X	X	X	X	X	X	X	X	X	X	X	X
Furbearers	X	X	X	X	X					X	X	X
Polar Bears	X	X	X	X	X					X	X	X
Seals			X	X	X	X	X	X	X	X	X	X
Bowed whales								X	X			

Source: FERC 2020

Apr = April; Aug = August; Dec = December; Feb = February; Jan = January; Jul = July; Jun = June; Mar = March; Nov = November; Oct = October; Sep = September

3.14.3 Regulatory Framework, Executive Orders, and Permitting Requirements

The federal government and the State of Alaska regulate subsistence harvesting under a dual management system. The federal government recognizes subsistence priorities on federal public lands for rural residents, while the state considers all residents to have an equal right to participate in subsistence hunting and fishing when resource abundance and harvestable surpluses are sufficient to meet the demand for all subsistence and other uses. Federal subsistence regulations apply to federally qualified subsistence users on federal public lands, including federal subsistence fisheries. With the enactment of ANILCA in 1980, Congress protected about 100 million acres of public land in Alaska. ANILCA, Title VIII, defines "subsistence uses" as *"customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade"* (Section 803). ANILCA also establishes a subsistence priority for rural Alaskans on federal public lands and waters (Section 804) and provides for a system of regional advisory councils to insure the participation of rural residents in subsistence management (Section 805). Section 810 of ANILCA requires an evaluation of subsistence needs to be completed for a federal decision to lease or permit the use of federal lands; however, this does not apply to potential upstream development activities as these actions would occur on state lands within the PTU, PBU, and KRU. Appendix U of the 2020 EIS provides Section 810 evaluation for the proposed Project completed by the BLM for activities on federal lands.

In addition, Section 4–4, Subsistence Consumption of Fish and Wildlife, of E.O. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies, whenever practicable and appropriate, to collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence in order to assist in identifying the need for ensuring protection of populations with differential patterns of subsistence consumption of fish and wildlife.

State of Alaska regulations apply to state subsistence fisheries and hunts on all Alaska lands and waters, including lands of Alaska Native Corporations established under Alaska Native Claims Settlement Act. Alaska residents may hunt and fish under state regulations and harvest limits unless pre-empted by federal law (FERC 2020). The state distinguishes subsistence harvests from personal use, general hunting, sport, or commercial harvests based on where the harvest occurs, and the resource being harvested, not where the harvester resides (as is the case under federal law). State of Alaska law also provides for subsistence hunting and fishing regulations in areas outside the boundaries of "nonsubsistence areas," as defined in state regulations (5 AAC 99.015). The ROI for this **Final** SEIS does not fall within a nonsubsistence area.

The ROI includes ADF&G Game Management Subunit 26b. Game Management Units each have a specific set of regulations governing the harvest limit and timing of hunts for the wildlife species in that unit. ADF&G has designated a 432-square-mile area within 26b as the Prudhoe Bay Closed Area, which is closed to the taking of big game. This area encompasses the Prudhoe Bay industrial complex and extends west to include the Kuparuk River area. It was based on public safety and security issues associated with the extensive oil field facilities in the area (ADF&G 2022h).

The State of Alaska has established subsistence goals on the North Slope for maintaining traditional use of resources, continued public ownership of lands and protection of subsistence resources, managing sustainable yields, and continued contribution of subsistence resources to economic diversity. Objectives within the North Slope Area Plan relating to subsistence include (ADNR 2021):

- **Objective A.** Use and implement adequate protection measures to ensure the sustainability of fish and wildlife habitat, populations, and the continuation of other uses of the area. The management of state land and resources are to be consistent with the requirements of maximum use and sustained yield consistent with the public interest, as described in Article VIII of the State Constitution.

Subsistence and harvest needs of Alaska residents and the North Slope communities that extensively utilize these resources are to be considered in activities on the North Slope. ADF&G is to be consulted regarding uses and activities that potentially impact the harvest of subsistence resources in areas designated for harvest.

- **Objective B.** Maintain and enhance the natural environment in areas known to be important as habitat for fish and wildlife necessary for subsistence harvest. This includes maintaining to the maximum extent practicable the underlying integrity of the ecological systems supporting this traditional way of life on the North Slope. When resource development projects occur, actions that change the quality and quantity of fish and wildlife habitat should be avoided. ADNR decisions related to activities on the North Slope are to carefully consider the effects of a proposed project or activity upon these uses and resources, and authorizations are to ensure that adverse impacts are avoided, minimized, or mitigated consistent with the North Slope Area Plan.
- **Objective C.** Other guidelines affecting subsistence and harvest should be considered. The most commonly affected resource that can directly or indirectly affect subsistence activities include impacts to public access, transportation and infrastructure, water resources, subsurface resources, and recreation and tourism. Effects to these resources within the North Slope from upstream development are considered within this **Final** SEIS.

3.15 AIR QUALITY

3.15.1 Introduction

Air pollution is the presence of one or more contaminants (e.g., dust, fumes, gas, mist, odor, smoke, vapor) in the outdoor atmosphere in quantities and of characteristics and duration such as to be injurious to human, plant, or animal life. Air quality, as a resource, incorporates components that describe air pollution within a region, sources of air emissions, and regulations governing those emissions. Regional climate, local terrain features, and meteorological conditions also influence ambient air quality. See Section 3.19 for a discussion of GHGs and climate change.

Section 4.15 of the 2020 EIS details air quality conditions along the entire Project. This section focuses on air quality within North Slope Borough. Unlike many of the other resources analyzed within this **Final** SEIS, the ROI for air quality extends beyond land-based construction and operational boundaries of the potential upstream development activities to include surrounding areas within North Slope Borough, since air pollution from a given source can be dispersed regionally through the atmosphere. This **Final** SEIS considers the following data types for characterizing air quality:

- Ambient air monitoring station data for North Slope Borough,
- National Ambient Air Quality Standards (NAAQS), and
- Designations of attainment or nonattainment (i.e., meeting or not meeting the NAAQS).

3.15.2 Regional Climatology

Alaska's diverse climate is characterized by widely varying temperature ranges and weather phenomena due to the state's size, highly variable topographical features, and location within the high latitudes. Climatic and meteorological variability would influence Project design and operation, as well as dispersion of air pollutants emitted by Project facilities. The National Oceanic and Atmospheric Administration has classified 13 climate divisions for Alaska. The North Slope, where the upstream development activities would be located, is north of the Brooks Range within the Beaufort Coastal Plain Subregion. It is dominated by an arctic climate characterized by very cold winters, persistent high wind episodes, and frequent fog conditions influenced by wind flow from the ice shield, especially in the warmer months.

3.15.3 Existing Ambient Air Quality

3.15.3.1 Ambient Air Quality Standards

The USEPA sets NAAQS and develops regulations to help ensure good air quality. In the state of Alaska, the ADEC is responsible for monitoring compliance with ambient air quality standards and regulating air pollutant emissions. ADEC samples boroughwide areas and compares the data with NAAQS. States may develop and enforce state-specific ambient air quality standards that are more stringent than federal regulations but cannot enforce rules that are less stringent.

NAAQS represent the maximum levels of background pollution that are considered safe, with an adequate margin of safety, to protect the public health and welfare (Table 3.15-1).

Table 3.15-1. National and State Ambient Air Quality Standards

Pollutant	Primary / Secondary	Averaging Time	National	Alaska[a]
CO	Primary	8-hour[b]	9 ppm (10,000 µg/m^3)	9 ppm (10,000 µg/m^3)
	Primary	1-hour[b]	35 ppm (40,000 µg/m^3)	35 ppm (40,000 µg/m^3)
NO_2	Primary	1-hour[c]	100 ppb (188 µg/m^3)	100 ppb (188 µg/m^3)
	Primary and Secondary	Annual mean	53 ppb (100 µg/m^3)	53 ppb (100 µg/m^3)
O_3	Primary and Secondary	8-hour[d]	0.07 ppm	0.07**0** ppm
Pb	Primary and Secondary	Rolling 3-month average[e]	0.15 µg/m^3	0.15 µg/m^3
$PM_{2.5}$	Primary	Annual mean[f]	12.0 µg/m^3	12.0 µg/m^3
	Secondary	Annual mean[f]	15.0 µg/m^3	15.0 µg/m^3
	Primary and Secondary	24-hour[g]	35 µg/m^3	35 µg/m^3
PM_{10}	Primary and Secondary	24-hour[h]	150 µg/m^3	150 µg/m^3
SO_2	Primary	1-hour[i]	75 ppb (196 µg/m^3)	75 ppb (196 µg/m^3)
	Secondary	3-hour[b]	0.5 ppm	0.5 ppm
	N/A	24-hour[b]	N/A	365 µg/m^3
	N/A	Annual	N/A	80 µg/m^3
Ammonia	N/A	8-hour[b]	N/A	2.1 mg/m^3

Source: ADEC 2020b; USEPA 2022**c**

[a] State ambient air quality standards only supersede NAAQS if more stringent.
[b] Not to be exceeded more than once per year.
[c] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average must not exceed 100 ppb.
[d] The 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured over each year must not exceed the standard.
[e] NAAQS for lead not to be exceeded.
[f] To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentration must not exceed the standard.
[g] The 3-year average of the 98th percentile of 24-hour concentrations must not exceed 35 µg/m^3.
[h] Not to be exceeded more than once per year on average over 3 years.
[i] To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average must not exceed 0.075 ppm.

µg/m^3 = microgram per cubic meter; CO = carbon monoxide; mg/m^3 = milligram per cubic meter; N/A = not applicable; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; ppb = parts per billion; ppm = parts per million; SO_2 = sulfur dioxide

3.15.3.2 Air Quality Control Regions and Attainment Status

An Air Quality Control Region is defined under 42 USC 7407(c) as *"...any interstate area or major intrastate area which [the Administrator of the USEPA] deems necessary or appropriate for the attainment and maintenance of ambient air quality standards."* Each Air Quality Control Region, or portion(s) of an Air Quality Control Region, may be classified as either attainment, nonattainment, or maintenance with respect to the NAAQS.

Areas where ambient air concentrations of the criteria pollutants are below the levels listed in the NAAQS are considered in attainment. If ambient air concentrations of criteria pollutants are above the NAAQS levels, then the area is considered to be in nonattainment. Areas that have been designated nonattainment but have since demonstrated compliance with the NAAQS are classified as maintenance for that pollutant. Maintenance areas are treated similarly to attainment areas for the permitting of stationary sources, but specific provisions may be incorporated through the state's approved maintenance plan to ensure that air quality would remain in compliance with the NAAQS for that pollutant. Maintenance areas retain the classification for 20 years before being reclassified as attainment areas. Areas where air quality data are not available are considered to be unclassifiable and are treated as attainment areas.

The potential upstream development activities would be located in areas classified as attainment for all criteria pollutant standards. North Slope Borough is not a designated non-attainment area for any criteria air pollutant (USEPA 2022**d**).

3.15.3.3 Air Quality Monitoring and Background Concentrations

ADEC operates and oversees a network of outdoor air quality monitoring stations across the state. The air monitoring stations are composed of instrumentation owned and operated both by state agencies and other cooperating agencies. The monitoring stations measure concentrations of the specific air pollutants relevant to that regional area and local meteorological conditions, such as wind speed and temperature. The monitoring stations also measure pollutant levels to track concentrations of air pollution over time and determine compliance with NAAQS and the state ambient air quality standards, thus assisting in the designation of nonattainment areas. The **closest government operated** air quality monitoring system includes one **BLM operated** monitoring station in North Slope Borough. The monitoring station is located at Kaktovik, approximately 55 miles east of Point Thomson and approximately 110 miles east of Prudhoe Bay. **Although this monitoring station is not officially part of the Alaska Monitoring Network, t**he ADEC Air Quality Index website (ADEC 2022b) displays an air quality index and monitored pollutant concentrations at the BLM-Kaktovik site.

3.15.4 Regulatory Framework and Permitting Requirements

The potential upstream development activities may be subject to ADEC or federal air permitting requirements. Pipeline pump and compressor stations could be considered stationary sources of air emissions if they are operated using natural gas or other fuels. It is assumed that they would be operated by similar energy sources as existing equipment at these locations, which would consist of natural gas or electrical power supplied by offsite sources.

According to 40 CFR 93.153(b), federal actions require a Conformity Determination for each pollutant where the total of direct and indirect emissions in a nonattainment or maintenance area caused by a federal action would equal or exceed any of the rates in paragraphs 40 CFR 93.153(b)(1) or (2). However, North Slope Borough is classified as in attainment for all NAAQS (USEPA 2022**d**); therefore, no Conformity Determination is required.

State air quality rules govern the issuance of air permits for construction and operation of a stationary emission source. The state air quality rules are part of the USEPA-approved State Implementation Plan, developed in accordance with Section 110 of the CAA. The USEPA retains enforcement and oversight authority to provide assurance the state complies with CAA requirements. ADEC is the lead air permitting authority for the potential upstream development activities. ADEC's air quality regulations are codified in 18 AAC 50, which incorporates the federal program requirements and establishes permit review procedures for facilities that emit pollutants to the ambient air (see Table 3.15-2). New facilities are required to obtain an air quality permit prior to initiating construction.

Table 3.15-2. Alaska Air Quality Regulations Pertaining to Construction

Title	Details	Applicability to Upstream Development
18 AAC 50.045. Prohibitions	(d) A person who causes or permits bulk materials to be handled, transported, or stored, or who engages in an industrial activity or construction project shall take reasonable precautions to prevent particulate matter from being emitted into the ambient air.	Construction activities would require excavation, temporary storage, moving and grading of soil, which can result in airborne particulate matter.

Source: ADEC 2020b
AAC = Alaska Administrative Code

3.15.5 Class I Areas

Under the CAA, Class I area designations were given to 156 areas that met certain criteria (e.g., national parks greater than 6,000 acres, national wilderness areas and national memorial parks greater than 5,000 acres, and one international park) (40 CFR 81.400). The purpose of the Class I areas is to provide a protection program for specific air quality concerns at each Class I area. Section 162(a) of the CAA granted these areas special air quality protections. Generally, air quality impacts at Class I areas are evaluated when a proposed emissions source is a major source and is within 100 kilometers (62 miles) of a Class I area. Alaska has four Class I areas subject to the Regional Haze Rule: Denali National Park, Tuxedni National Wildlife Refuge, Simeonof Wilderness Area, and Bering Sea Wilderness Area (ADEC 2022c). They were designated Class I areas in August 1977. None of these areas are located within 100 kilometers of the potential upstream development activities. Denali National Park, the closest Class I Area, is located approximately 500 miles south of Prudhoe Bay.

3.15.6 Black Carbon

Black carbon is a by-product of incomplete combustion and is a major component of $PM_{2.5}$. It consists of the sooty black material that is emitted from sources that burn biomass or fossil fuels including natural gas, such as engines and gas flares. It is quickly removed from the atmosphere through wet and dry deposition, and typically has an atmospheric residence time of a few days to weeks. Black carbon is small enough to be easily inhaled into the lungs and has been associated with adverse health effects (USEPA 2011). Whether black carbon is itself toxic or functions as an indicator of other co-pollutants is currently under debate. However, black carbon is clearly associated with a range of negative health outcomes including asthma and other respiratory problems, low birth rates, heart attacks, and lung cancer.

3.16 NOISE

3.16.1 Introduction

Section 4.16 of the 2020 EIS details the noise environment along the entire Project. This section provides a discussion of existing conditions for noise on the North Slope. These descriptions and analyses address ambient noise levels near potential upstream development activities that would be directly or indirectly affected by construction and operation. The ROI includes the noise environment on the North Slope and emphasizes noise levels within the PTU, PBU, KRU, and existing pipeline ROWs between the units.

3.16.1.1 Principles of Noise

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, that are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing or is otherwise intrusive. Human response to noise varies depending on the type and characteristics of the noise, distance between noise source and receptor, receptor sensitivity and time of day. Noise is often generated by activities essential to a community's quality of life, such as construction or vehicular traffic.

Sound varies by both intensity and frequency. The physical intensity or loudness level of noise is expressed quantitatively as the sound pressure level. Sound pressure levels are defined in terms of decibels (dB), which are measured on a logarithmic scale. Sound can be quantified in terms of its amplitude (loudness) and frequency (pitch). Frequency is measured in hertz, which is the number of cycles per second. The typical human ear can hear frequencies ranging from approximately 20 hertz to 20,000 hertz. Typically, the human ear is most sensitive to sounds in the middle frequencies, where speech is found, and is less sensitive to sounds in the low and high frequencies.

Since the human ear cannot perceive all pitches or frequencies equally, measured noise levels in dB will not reflect the actual human perception of the loudness of the noise. Thus, the sound measures can be adjusted or weighted to correspond to a scale appropriate for human hearing. The common sound descriptors used to evaluate the way the human ear interprets dB from various sources are as follows:

- **Decibel (dB).** Sound pressure level measurement of intensity. The decibel is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level.
- **A-Weighted Decibel (dBA).** Often used to describe the sound pressure levels that account for how the human ear responds to different frequencies and perceives sound.
- **Hertz.** Measurement of frequency or pitch.
- **Equivalent Sound Level (Leq).** The Leq represents the average sound energy over a given period, presented in decibels.
- **Day-Night Average Sound Level (Ldn).** The Ldn is the 24-hour Leq, but with a 10-dB penalty added to nighttime noise levels (10 p.m. to 7 a.m.) to reflect the greater intrusiveness of noise experienced during this time.
- **Sensitive Receptors.** Locations or land uses associated with indoor or outdoor areas inhabited by humans that may be subject to significant interference from noise (i.e., nearby residences, schools, hospitals, nursing home facilities and recreational areas).

The adjusted scales are useful for gauging and comparing the subjective loudness of sounds to humans. The threshold of perception of the human ear is approximately 3 dB. A 5-dB change is considered to be clearly noticeable to the ear, and a 10-dB change is perceived as an approximate doubling (or halving) of the noise level (MPCA 1999).

Ambient or background noise is a combination of various sources heard simultaneously. Calculating noise levels for combinations of sounds does not involve simple addition, but instead uses a logarithmic scale (HUD 1985). As a result, the addition of two noises, such as a garbage truck (100 dBA) and a lawn mower (95 dBA) would result in a cumulative sound level of 101.2 dBA, not 195 dBA.

Noise levels decrease (attenuate) with distance from the source. The decrease in sound level from any single noise source normally follows the "inverse square law." That is, the sound level change is inversely proportional to the square of the distance from the sound source. A generally accepted rule is that the sound level from a stationary source would drop approximately 6 dB each time the distance from the sound source is doubled. Sound level from a moving "line" source (e.g., a train or vehicle) would drop 3 dB each time the distance from the source is doubled (USDOT 2012).

Barriers, both manmade (e.g., sound walls) and natural (e.g., forested areas, hills, etc.) may reduce noise levels, as may other natural factors, such as temperature and climate. Standard buildings typically provide approximately 15 dB of noise reduction between exterior and interior noise levels (USEPA 1978). Noise generated by stationary and mobile sources has the potential to impact sensitive noise receptors, such as residences, hospitals, schools, and churches. Persistent and escalating sources of sound are often considered annoyances and can interfere with normal activities, such as sleeping or conversation, such that these sounds could disrupt or diminish quality of life.

Section 4.16.1 of the 2020 EIS details general principles of noise including definitions, types of noise measurements, noise intensity, and typical sound levels of various activities. Table 4.16.1-1 of the 2020 EIS demonstrates the relative dBA noise levels of common sounds measured in the environment and industry.

3.16.2 Regional Context

Given the vast Arctic landscape of North Slope Borough, existing noise sources are minimal and infrequent. Noise would primarily occur in or near one of the communities in the Borough: Anaktuvuk Pass, Atqasuk, Kaktovik, Nuiqsut, Point Hope, Point Lay, Utqiagvik, and Wainwright. Noise would be associated with human activity along with vehicular noise and industrial (oil and gas) development.

Noise sources within the PTU, PBU, and KRU would be typical of industrial sites where such activities occur within the unit. The dominant noise sources would consist of equipment and vehicle noise related to operations of oil and gas facilities. Air transportation via existing airstrips and heliports support critical logistical activities in the North Slope such as transport of personnel, equipment, construction materials, and supplies to construction sites. Such existing transportation activities are a source of existing noise in the region. Background sound levels at the existing GTP were assessed for the Alaska Pipeline Project and found to be about 66 dBA Ldn near the GTP site and at levels ranging from 52 to 57 dBA Ldn within 2 to 4 miles from the GTP site (FERC 2020).

Noise levels within the existing pipeline ROW from PBU to KRU are generally quiet but include noise due to piping and periodic ROW patrols and maintenance activities.

3.16.3 Regulatory Framework and Permitting Requirements

In 1974, the USEPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin on Safety*, which evaluated the effects of environmental noise with respect to health and safety (USEPA 1974). The document provides information for state and local agencies to use in developing their ambient noise standards. As set forth in the publication, the Ldn of 55 dBA outdoors and 45 dBA indoors is the threshold above which noise could cause interference or annoyance (USEPA 1974). As set forth in this publication, the USEPA determined that noise levels should not exceed an Ldn of 55 dBA, which is the level that protects the public from activity interference and annoyance with indoor and outdoor activities. An Ldn of 55 dBA is equivalent to a continuous noise level of 48.6 dBA for facilities that operate at a constant level of noise. A 55 dBA Ldn noise level equates to a Leq of 48.6 dBA (i.e., a facility that does not exceed a continuous noise impact of 48.6 dBA would not exceed 55 dBA Ldn).

The State of Alaska has no regulations that would limit noise generated from construction activities. There are no other identified numeric regulatory requirements at the local or borough level specific to construction or operational noise for any potential activities associated with upstream development.

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3.17 PUBLIC HEALTH AND SAFETY

3.17.1 Introduction

Section 4.17 of the 2020 EIS provides a detailed analysis of public health and safety conditions for the entire Project area. This includes discussion of: social determinants of health; accidents and injuries; exposure to potentially hazardous materials; food, nutrition, and subsistence activity; infectious diseases; water and sanitations; non-communicable and chronic diseases; and health services infrastructure and capacity. In addition, Appendix V of the 2020 EIS contains a Health Impact Assessment for the proposed Project that presents baseline health data provided by the Alaska Department of Health and Social Services. This section provides a summary of public health within North Slope Borough of Alaska where upstream development activities would occur. The nearest community to potential upstream development activities is Prudhoe Bay, which is located in the PBU.

Health status is also influenced by many demographic factors such as education, employment, and household income. Section 3.11 provides overall population and demographic data for the ROI. The communities of Kaktovik and Nuiqsut use the locations within the PTU, PBU, and KRU for subsistence activities as a means of survival. Section 3.14 provides information on types of subsistence activities for these two communities within the ROI.

3.17.2 Regional Context

As the villages in North Slope Borough are very small (i.e., total populations less than 500), health information privacy concerns and problems with statistical validity limit the ability to analyze information at the village level. Both state and tribal health authorities will not publicly report an "observation" if they document fewer than six cases. Therefore, the health baseline data is aggregated at a regional level for North Slope Borough and not at an individual village level.

This **Final** SEIS uses health data from the Alaska Native Tribal Health Consortium Epidemiology Center to characterize health indicators for the North Slope (referred to as the Arctic Slope by the Epidemiology Center). Table 3.17-1 provides a comparison of mortality rates for selected indicators that can have linkage to environmental factors. Mortality rates are provided for Alaska Natives living in the Arctic Slope, Alaska Natives statewide, and non-Alaska Native statewide. Mortality rates for Alaska Natives living in the Arctic Slope are consistently higher than compared to Alaska Native statewide rates and both are higher than non-Alaska Natives statewide rates for the same indicators.

Table 3.17-1. Mortality Rates in the Arctic Slope

Indicator	Definition and Relevance	Alaska Native (Arctic Slope)	Alaska Native (statewide)	Non-Alaska Native (statewide)
All-Cause Mortality Rate[a]	The all-cause mortality rate is the death rate from all causes of death per 100,000 population per year. The all-cause mortality rate is an indicator of general population health, which examines all deaths that occur in a population regardless of the cause.	1,200.8	1,174.4	659.2
Chronic Obstructive Pulmonary Disease (COPD) Mortality[b]	COPD mortality is the rate of death due to COPD per 100,000 population. COPD mortality includes deaths from bronchitis, emphysema, and other chronic lower respiratory diseases, excluding asthma. The most significant risk factor for COPD is long-term exposure to tobacco smoke. Other risk factors include occupational or environmental exposure to dusts or chemicals, age, and genetics.	113.9	68.0	35.2

Table 3.17-1. Mortality Rates in the Arctic Slope

Indicator	Definition and Relevance	Alaska Native (Arctic Slope)	Alaska Native (statewide)	Non-Alaska Native (statewide)
Chronic Lower Respiratory Disease (CLRD)[c]	The CLRD mortality rate is the rate of death due to chronic lower respiratory disease per 100,000 population per year. CLRD mortality primarily includes deaths from chronic obstructive pulmonary diseases, such as bronchitis emphysema, and certain cases of asthma. Key risk factors for these include exposure to tobacco smoke, air pollutants, and respiratory infections.	122.5	69.3	31.4
Cancer Mortality[d]	The cancer mortality rate is the rate of death due to malignant neoplasms (cancer) per 100,000 population per year. Cancer is a major public health concern worldwide and is the leading cause of death among Alaska Native people. The most common types of cancers are primarily due to behavioral, occupational, and environmental factors. These cover external factors that include tobacco, diet, exercise, viruses, radiation, chemicals in the workplace, and factors due to the environmental pollution of air, water, and food.	325.0	232.1	145.3
Infant Mortality[e]	The infant mortality rate is the number of deaths of children under one year of age, divided by the number of live births during the year per 1,000 live births. It is used to compare and monitor the health and well-being of populations throughout the world. Specifically, this rate may be an indicator of the quality and accessibility of primary health care available to pregnant women and infants as well as reflecting the impact poverty and substandard living conditions have on maternal and infant health. Infant mortality can be affected by factors such as level of education of the mother, household income, sanitary conditions, prenatal and post-natal care, and other factors.	10.1	9.6	4.7
Unintentional Injury Mortality[f]	Unintentional injury mortality is the total number of deaths due to unintentional injuries per 100,000 persons. It is the third leading cause of death among Alaska Native people.	96.4	99.4	38.9

[a] Data from 2013-2017 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019a)
[b] Data from 2012-2015 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2017a)
[c] Data from 2013-2017 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019b)
[d] Data from 2013-2017 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019c)
[e] Data from 2013-2017 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019d)
[f] Data from 2012-2015 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2017b)
CLRD = Chronic Lower Respiratory Disease; COPD = Chronic Obstructive Pulmonary Disease
Note: The North Slope is referred to as the Arctic Slope by the Alaska Native Tribal Health Consortium Epidemiology Center.

Table 3.17-2 provides a comparison of health risk factors for selected indicators that can have linkage to health conditions affecting mortality. Comparison percentages are provided for Alaska Natives living in the Arctic Slope, Alaska Natives statewide, and non-Alaska Native statewide. Obesity within Alaska Natives living in the Arctic Slope is higher than Alaska Native statewide and both are higher than non-Alaska Natives statewide. Access to adult health care and rural water and wastewater service is better in the Arctic Slope than in the comparative populations.

Table 3.17-2. Health Risk Factors in the Arctic Slope

Indicator	Description and Relevance	Alaska Native (Arctic Slope)	Alaska Native (statewide)	Non-Alaska Native (statewide)
Adult Obesity[a] (shown as percentage of population)	Body mass index (BMI) is a calculation using a person's weight (in kilograms) and height (in meters). Adult obesity is measured as adults aged 18 years and older having a BMI of 30 kg/m^2. The healthy range is 18.5 to 24.9. Obesity is an important risk factor for chronic diseases and other health problems such as heart disease, cancers, high blood pressure, type 2 diabetes, stroke, and respiratory problems.	50.5	37.2	29.8
Adolescent Obesity[b] (shown as percentage of population)	Adolescent obesity is the percentage of students in grades 9-12 with a BMI equal to or greater than the age- and sex-specific 95th percentile.	19.4	15.4	10.7
Adult Physical Activity[c] (shown as percentage of population)	Adult physical activity is measured as adults aged 18 years and older who meet national recommendations for physical activity. Every week adults should do at least 150 minutes of moderate-intensity aerobic physical activity, 75 minutes of vigorous-intensity aerobic activity, or an equivalent combination of moderate and vigorous intensity aerobic activity. Additionally, adults should do muscle-strengthening activity of moderate or greater intensity that involves all major muscle groups on two or more days a week. Physical activity has many health benefits including improved cognition, reduced clinical depression, reduced symptoms of anxiety, and improved physical function.	Not Available	46.7	58
Adolescent Physical Activity[d] (shown as percentage of population)	Physical activity is defined as high school students, grades 9-12, who were physically active for a total of at least 60 minutes per day, including doing any kind of physical activity that increased their heart rate and made them breathe hard some of the time.	15.4	21.2	21.3
Adult Health Care Access[e] (shown as percentage of population)	Adult health care access is measured as adults aged 18 years and older who did not see a doctor in the past 12 months when they needed because of cost. Access to affordable, quality health care is important to physical, social, and mental health.	9.1	14.4	14.3
Rural Water & Wastewater Service[f] (shown as percentage of population)	Access to in-home water and sewer service, either through piped connections or closed haul systems, has a positive impact on public health and can help stop the spread of diseases and illnesses.	99	83.5	Not Available

Table 3.17-2. Health Risk Factors in the Arctic Slope

Indicator	Description and Relevance	Alaska Native (Arctic Slope)	Alaska Native (statewide)	Non-Alaska Native (statewide)
Chlamydia (CT) [g] (shown as incident rate per 100,000)	CT is a common sexually transmitted infection caused by the bacterium *Chlamydia trachomatis*. Both men and women can get CT. Most people who have CT have no symptoms. Untreated CT can lead to permanent damage to a woman's reproductive system, making it difficult to get pregnant.	2701.5	1,650.0	187.2
Gonorrhea (GC)[h] (shown as incident rate per 100,000)	GC is a sexually transmitted infection caused by the bacterium *Neisseria gonorrhea*. Gonorrhea can infect both men and women. It can cause infections in the genitals, rectum, and throat. GC can lead to permanent damage to a woman's reproductive system.	511.9	436.7	44.2

[a] Data from 2012-2016 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019e)
[b] Data from 2011-2013 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2016a)
[c] Data from 2012-2016 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019f)
[d] Data from 2011-2013 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2016b)
[e] Data from 2012-2016 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2019g)
[f] Data from 2016 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2017c)
[g] Data from 2015 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2017d)
[h] Data from 2015 (Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center 2017e)
BMI = Body Mass Index, CT = Chlamydia; GC = Gonorrhea; kg/m^2 = kilogram per square meter
Note: The North Slope is referred to as the Arctic Slope by the Alaska Native Tribal Health Consortium Epidemiology Center.

3.17.3 Regulatory Framework and Permitting Requirements

Currently, NEPA regulations and the State of Alaska do not contain specific regulatory guidelines for performing analysis of health impacts.

3.18 RELIABILITY AND SAFETY

3.18.1 Introduction

Section 4.18 of the 2020 EIS provides a detailed analysis of reliability and safety conditions for the entire Project. This includes discussions of LNG facility regulatory oversight; PHMSA siting requirements; Coast Guard safety regulatory requirements, LNG marine vessel historical record, safety regulatory oversight and routes and hazard analysis; AGDC's waterway suitability assessment; LNG facility security regulatory requirements; LNG facility historical record; FERC engineering and technical review of the preliminary engineering design; geotechnical and structural design; external impacts; emergency response plans; and pipeline safety. This section provides a summary of reliability and safety considerations specific to upstream development activities within PTU, PBU, KRU, and existing pipeline ROWs between the units. New project facilities discussed within this **Final** SEIS that were not evaluated within the 2020 EIS include CO_2 pipelines, injection wells, and production wells.

3.18.2 Operational Safety Record

PHMSA, a division of the U.S. Department of Transportation, collects reports from pipeline operators regarding annual pipeline mileage and incidents involving releases of hazardous liquids (including CO_2) and LNG. 49 CFR 195 requires pipeline operators to report to PHMSA any event involving a pipeline that results in any of the following:

- Explosion or fire not intentionally set by operator;
- Release of 5 gallons or more, except that no report is required for a release of less than 5 barrels (210 gallons) resulting from a pipeline maintenance activity if the release is:
  - Not otherwise reportable under this section;
  - Not one described in Section 195.52(a)(4) (i.e., not one that resulted in pollution of any stream, river, lake, reservoir or other similar body of water that violated applicable water quality standards, caused a discoloration of the surface of the water or adjoining shoreline, or deposited a sludge or emulsion beneath the surface of the water or upon adjoining shorelines);
  - Confined to company property or pipeline ROW; and
  - Cleaned up promptly.
- Death of any person;
- Personal injury necessitating hospitalization; and/or
- Estimated property damage, including cost of clean-up, the value of lost product and damage to property of the operator or others, or both, exceeding $50,000.

These data are made available to members of the public through its website; DOE utilized the Incident Reports Database to review reported incidents occurring along CO_2 pipelines and at LNG facilities between 2010 and March 2022.

To simplify the analysis of the causes and consequences of releases of CO_2, DOE uses five spill size categories that were developed through a review of pipeline incident data, case studies for releases, and prior studies prepared for the analysis of releases from pipelines.

- **Incidental spill.** A release of less than 0.1 barrel (5 gallons). Incidental spills are typically associated with normal operations and are not required to be reported; therefore, DOE does not carry incidental spills forward for detailed analysis within this **Final** SEIS.
- **Small spill.** A release of at least 0.1 barrel (5 gallons) and up to 50 barrels (2,100 gallons).

- **Medium spill.** A release of more than 50 barrels (2,100 gallons) and up to 1,000 barrels (42,000 gallons).
- **Large spill.** A release of more than 1,000 barrels (42,000 gallons) and up to 10,000 barrels (420,000 gallons).
- **Catastrophic spill.** A release of more than 10,000 barrels (420,000 gallons).

3.18.2.1 CO_2 Pipelines

There are no CO_2 pipelines recorded in the PHMSA 2020 annual report database for Alaska (PHMSA 2020a). As such, PHMSA's incident database contains no records of reported releases from CO_2 pipelines in Alaska since 2010 (PHMSA 2022b). However, there have been a nation-wide total of 65 reported incidents releasing more than 5 gallons of CO_2 occurring along U.S. onshore CO_2 pipelines since 2010. Table 3.18-1 compares the number and size of reported releases of CO_2 with the annual mileage of onshore CO_2 pipelines in the United States.

Table 3.18-1. CO_2 Pipeline Incidents (2010-2021)

Year	CO_2 Pipeline Mileage	Small (5 gal – 50 bbl)	Medium (50 – 1,000 bbl)	Large (1,000 – 10,000 bbl)	Catastrophic (>10,000 bbl)
2010	4,520.96	5	1	0	0
2011	4,735.31	3	0	1	0
2012	4,840.30	2	0	0	0
2013	5,190.03	4	0	0	0
2014	5,275.56	3	1	1	0
2015	5,240.50	6	0	1	0
2016	5,194.84	4	4	1	0
2017	5,207.19	7	2	0	0
2018	5,205.67	4	1	0	0
2019	5,076.44	3	1	0	0
2020	5,150.40	3	1	1	1
2021[a]	5,150.40	2	2	0	0
Total		46	13	5	1
Incident rate per 1,000 miles of CO_2 pipeline		0.76	0.21	0.08	0.02

Source: PHMSA 2022a, 2022b

[a] Total CO_2 pipeline mileage for 2021 is not yet available. For purposes of this analysis, DOE assumes the same mileage for 2020.

bbl = barrels; CO_2 = carbon dioxide; gal = gallon

Of the 65 reported incidents releasing at least 5 gallons of CO_2, most involved a release from a valve (29 incidents, or 44.6 percent) or from the pipe itself (14 incidents; 21.5 percent) (PHMSA 2022b). The most frequent cause of these releases was equipment failure (35 incidents; 53.8 percent), followed by incorrect operation (10 incidents; 15.4 percent), material failure of pipe or weld (8 incidents; 12.3 percent), and corrosion failure (7 incidents; 10.8 percent). The remaining five incidents were caused by natural force damage, other incident cause, or other outside force damage (PHMSA 2022b). Almost all of these reported CO_2 incidents were either totally contained on operator-controlled property (43 incidents; 66 percent) or within the pipeline ROW (17 incidents; 26.2 percent). In only five of these incidents (7.7 percent) did released CO_2 migrate off of operator-controlled property (PHMSA 2022b).

The proposed CO_2 pipelines would transport product as a supercritical fluid, such that its density resembles a liquid but it expands to fill space like a gas. If CO_2 was released from a pipe, it would expand rapidly as a gas and, depending on temperature and pressure, could include both liquid and solid (i.e., dry ice) phases. Supercritical CO_2 has a very low viscosity and a density of approximately 70 to 90 percent that of liquid water. As a gas, CO_2 is approximately 50 percent heavier than air and would disperse horizontally following the ground contours. The potential vapor plume from a CO_2 pipeline rupture or puncture would be small in areal extent, and its position would depend on the wind direction, speed, and stability conditions at the time of the release. The rapid release of high-pressure CO_2 from the pipeline would result in a relatively narrow band of CO_2 extending laterally in the immediate vicinity of the release point. The rapid decompression of the CO_2 would result in extreme cooling at the rupture site, with rapid formation of CO_2 liquids, solids, and gases in the immediate vicinity. In the immediate discharge zone, phase changes would subsequently occur (i.e., from solid or liquid to gas). With distance, the CO_2 gas would expand and disperse as the pressure reduced and it mixed with ambient air (DOE 2013).

An example of a release involving a U.S. onshore pipeline is the catastrophic release of CO_2 **that** occurred on October 7, 2020, along a segment of the Delhi pipeline system operated by Denbury Gulf Coast Pipelines, LLC and located near Satartia, Mississippi. While attempting to reconnect a pipeline segment at the Satartia mainline valve (MLV), the MLV would not seal properly due to there being more product within the pipeline than anticipated. Product blow-by caused ice to form and for a blowdown valve to freeze in the open position. Attempts to close the MLV were unsuccessful, and product continued to escape. Highway 3, located adjacent to the pipeline ROW, was shut down to avoid the possibility of a vehicle accident due to low visibility caused by the CO_2 cloud. Emergency response contractors conducted air monitoring in the surrounding area, and atmospheric testing was performed in and around the release site overnight. Oxygen remained at adequate levels throughout the monitoring period. Once the pipeline pressure had decreased enough to prevent CO_2 blowby through the MLV, the blowdown valve could be closed and the release was stopped at approximately 6:00 pm on October 8 (PHMSA 2022b).

Satartia, Mississippi was also the site of a prior CO_2 release along the same pipeline segment. Heavy rains resulted in a landslide that placed excessive strain on the pipeline and caused it to rupture on February 22, 2020. The PHMSA incident database records the unintentionally released volume as approximately 9,532 barrels of CO_2 (PHMSA 2022b); however, a subsequent accident report states the total volume released as 31,405 barrels (PHMA 2022d). Atmospheric conditions at the time of the release and the unique topography of the area delayed dissipation of the resulting vapor cloud. As such, people in the surrounding area were exposed to high concentrations of CO_2. According to the official accident report, 200 residents surrounding the rupture location were evacuated and unable to return to their homes for approximately 12 hours following the release. While no fatalities were reported, 45 people were taken to the hospital. Symptoms of CO_2 exposure may include headache, drowsiness, rapid breathing, confusion, increased cardiac output, elevated blood pressure, increased arrhythmias, and, at extreme concentrations, asphyxiation (PHMSA 2022d).

3.18.2.2 LNG Facilities

PHMSA also collects data related to releases of LNG from facilities across the United States. A review of that database found only one LNG incident reported in Alaska since 2011. This event occurred in 2021 and was therefore not captured within the analysis presented in the 2020 EIS. On November 21, 2021, at an LNG storage and vaporization site operated by Interior Gas Utility and located in Fairbanks, a temperature switch on the vaporizer malfunctioned and closed a valve to stop the flow of LNG through the vaporizer. The glycol heater turned off due to low demand. An operator opened the closed vaporizer valve via remote control, but did not notice that the boiler was not firing. Due to the malfunctioning temperature switch, the control system did not stop the flow of LNG through the vaporizer. Cold gas or LNG entered the distribution system and embrittled and ruptured an underground pipeline within operator-controlled property.

No volume of LNG released is provided, and the database states that no commodity release was involved in the incident (PHMSA 2022c).

Overall, the LNG incident database provides records for 32 incidents occurring since 2011. Of this total, 14 incidents (43.8 percent) involved natural gas while being handled in the gaseous phase, and 6 incidents (18.8 percent) involved LNG being handled in the liquid phase. The 14 incidents involving natural gas were caused by a variety of factors, including incorrect operation (5 incidents, 35.7 percent), equipment failure (4 incidents, 28.6 percent), natural force damage (2 incidents, 14.3 percent), corrosion failure (1 incident, 7.1 percent), material failure of pipe or weld (1 incident), and other incident cause (1 incident). Four of the six incidents involving LNG were caused by equipment failure, one was caused by incorrect operation, and one was the result of another miscellaneous incident cause (PHMSA 2022c).

3.18.2.3 Wells

The U.S. Energy Information Administration releases an annual report regarding productivity of oil and gas production wells across the United States (EIA 2022a). Appendix C of the annual report details the number of wells of each type by state and year; Table 3.18-2 presents the number of natural gas production wells in Alaska each year for the period from 2000 through 2020. The proportion of natural gas wells has increased over this time. In 2000, natural gas wells represented approximately 7.5 percent of total oil and gas production wells in Alaska; in 2010, they represented approximately 10.4 percent; and in 2020, they represented approximately 43.5 percent of the total (EIA 2022a).

Table 3.18-2. Natural Gas Wells in Alaska (2000 – 2020)

Year	# Wells	Year	# Wells	Year	# Wells
2000	164	**2007**	215	**2014**	308
2001	172	**2008**	225	**2015**	316
2002	157	**2009**	237	**2016**	300
2003	176	**2010**	238	**2017**	313
2004	182	**2011**	242	**2018**	467
2005	199	**2012**	259	**2019**	1,016
2006	213	**2013**	275	**2020**	1,011

Source: EIA 2022a

One recent release from a drilling site on the North Slope involved a release of natural gas from a sand layer in a well located in the CD1 pad at the Colville River Unit, also known as Alpine (ConocoPhillips 2022). The underground release was detected while a drilling rig was drilling a waste disposal well on March 4, 2022 (DeMarban 2022). Approximately 7.2 million standard cubic feet of natural gas is estimated to have been released to the atmosphere between March 4 and 8. Additional volumes of natural gas were captured into the Alpine Central Facility and others may continue to escape from subsurface strata into the atmosphere over time. Air monitoring did not detect any natural gas outside of the wellhouses or off of the CD1 pad. On March 7, ConocoPhillips relocated non-essential personnel away from the site out of an abundance of caution, but the safety zone was limited to the CD1 pad (ConocoPhillips 2022). Source remediation activities began on March 30 and will conclude with the final plug, abandonment, and permanent cementing of the WD-03 well (ConocoPhillips 2022).

A release occurring at a North Slope oil and gas production well operated by BP in 2017 sparked a review of thousands of additional wells in the area. On April 14, two leaks were discovered in a single well that resulted in releases of both crude oil and natural gas. As of ADEC's last situation report on the leak, dated April 17, 2017, the cause and volume of the release remained unknown, but observed impacts were limited to the reserve pit of the gravel pad (ADEC 2017). Per BP, the spill occurred due to a flaw in the well casing that failed due to thawing permafrost exerting uneven pressure on the casing. BP identified five additional wells of similar design. This prompted the AOGCC to issue an emergency order calling for all wells on the North Slope of similar design to be shut in and reported to the state (McChesney 2017). While that review found no additional wells of that design, the AOGCC still announced a new regulation requiring companies to set surface casings (defined as *"a pipe that protects the well from outside contaminants and keeps the sides of the well from caving in"*) below the base of permafrost (McChesney 2018).

3.18.3 Regulatory Framework and Permitting Requirements

PHMSA's mission is to protect people and the environment from the risks of pipeline incidents. PHMSA works closely with state pipeline safety programs and others at the federal, state, and local levels. PHMSA provides for a state agency to assume all aspects of the safety program for intrastate facilities by adopting and enforcing, at a minimum, the federal standards. A state may also act as PHMSA's agent to inspect interstate facilities within its boundaries; however, PHMSA is responsible for any enforcement action. Currently, Alaska does not have a state program, so PHMSA has full regulatory oversight over both interstate and intrastate pipelines in Alaska.

Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under the SDWA. USEPA currently has the authority to issue and administer the required UIC permits. **Natural gas could be injected under a Class I UIC permit from USEPA or under a Class II UIC permit from AOGCC.**

Multiple state-level agencies have authority over aspects of Alaska's oil and gas industry. For example:

- The ADNR Division of Oil and Gas manages lands for oil and gas exploration and development. The State Pipeline Coordinator's Section of this division provides regulatory oversite of transportation pipelines authorized under the ROW Leasing Act (AS 38.35).
- The ADEC manages spill responses efforts across the state. State law requires releases of oil and hazardous substance to be reported to the ADEC. The department's Prevention, Preparedness, and Response Program works to prevent, mitigate the effects of, and cleanup releases of oil and hazardous substances.
- The ADF&G helps develop standards and review proposed discharges for possible effects on fish, wildlife, and their habitats. ADF&G also reviews oil spills contingency plans, participates in spill drills and spill response, and assists with actual oil spill response efforts.

3.18.3.1 Pipeline Regulatory Oversight

There are no current federal regulations related to siting of CO_2 pipelines. General pipeline construction is discussed briefly in Section 2.5.3. A list of general U.S. quality specifications for CO_2 pipelines is summarized in Table 3.18-3; these generally relate to restricting constituents within the product *stream "to ensure that the transported fluid's minimum miscible pressure in crude oil will not be so high as to restrict its use for EOR"* (ICF International 2009). The most important factor of those included in Table 3.18-3 is the maximum amount of water allowed within the pipeline, as excess water could result in the formation of carbolic acid that could corrode a standard carbon steel pipeline (ICF International 2009).

Table 3.18-3. General U.S. CO_2 Pipeline Quality Specifications

Constituent	Type of Limit	Value of Limit	Reason for Concern
CO_2	Minimum	95%	Minimum miscible pressure for EOR
Nitrogen	Maximum	4%	Minimum miscible pressure for EOR
Hydrocarbons	Maximum	5%	Minimum miscible pressure for EOR
Water	Maximum	30 lbs/MMcf	Corrosion
Oxygen	Maximum	10 ppm	Corrosion
H_2S	Maximum	10-200 ppm	Safety
Glycol	Maximum	0.3 gal/MMcf	Operations
Temperature	Maximum	120°F	Materials

Source: ICF International 2009

% = percent; °F = degrees Fahrenheit; CO_2 = carbon dioxide; EOR = enhanced oil recovery; gal = gallons; H_2S = hydrogen sulfide; lbs= pounds; MMcf = million cubic feet; ppm = parts per million; U.S. = United States

3.18.3.2 Well Regulatory Oversight

Section 2.5.5 summarizes well construction and permitting approval requirements. As stated in that section, state-specific regulations from AOGCC pertaining to drilling are found in 20 AAC 25.005 through 20 AAC 25.080. Well spacing requirements are outlined in 20 AAC 25.055 and state that, in the absence of an order by the commission establishing drilling units or prescribing a spacing pattern for a pool, the following statewide spacing requirements apply to gas wells:

- For a well drilling for gas, a wellbore may be open to test or regular production within 1,500 feet of a property line only if the owner is the same and the landowner is the same on both sides of the line.
- If gas has been discovered, the drilling unit for the pool is a governmental section; not more than one well may be drilled to and completed in that pool on any governmental section; and a well may not be drilled or completed closer than 3,000 feet to any well drilling to or capable of producing from the same pool.

Per 20 AAC 25.070, each well operator shall *"keep a detailed accurate daily record of the actual drilling, completion, workover, repair, and plugging operations, and of the tests required."*

Blowout prevention equipment and diverter requirements are outlined in 20 AAC 25.035. A high-capacity flow diverter system must be installed to provide safety for personnel and equipment before rotary rig drilling is performed below a well's structure or conductor casing, unless the casing is equipped with blowout prevention equipment. Regulations regarding the assembly of the diverter system and requirements for assembly and testing of blowout prevention equipment are outlined in the section.

State regulations regarding enhanced recovery operations are outlined in 20 AAC 25.402. Specifically, the operator must demonstrate that the proposed operation will not allow the movement of fluid into sources of freshwater. Injection wells must be cased, the casing cemented, and the wells operated in manner that will isolate the injection zone. An application for injection must include:

- A plat showing the location of each proposed injection well, abandoned or other unused well, production well, dry hole, and other well within a 0.25-mile radius of each proposed injection well;
- A list of all operators and surface owners within a 0.25-mile radius of each proposed injection well;

- An affidavit showing that the operators and surface owners within a 0.25-mile radius have been provided a copy of the application for injection;
- A full description of the particular operation for which approval is requested;
- The names, descriptions, and depths of the pools to be affected;
- The name, description, depth, and thickness of the formation into which fluids are to be injected, and appropriate geological data on the injection zone and confining zone, including lithologic descriptions and geologic names;
- Logs of the injection wells if not already on file with the commission;
- A description of the proposed method for demonstrating machinal integrity of the casing and tubing and for demonstrating that no fluids will move behind casing beyond the approved injection zone, and a description of the proposed casing program;
- A statement of the type of fluid to be injected, the fluid's composition, the fluid's source, the estimated maximum amounts to be injected daily, and the fluid's compatibility with the injection zone;
- The estimated average and maximum injection pressure;
- Evidence to support a commission finding that each proposed injection well will not initiate or propagate fractures through the confining zones that might enable the injection fluid or formation fluid to enter freshwater strata;
- A standard laboratory water analysis, or the results of another method acceptable to the commission, to determine the quality of the water within the formation into which fluid injection is proposed;
- A reference to any applicable freshwater exemption;
- The expected incremental increase in ultimate hydrocarbon recovery; and
- A report on the mechanical condition of each well that has penetrated the injection zone within a 0.25-mile radius of a proposed injection well.

In addition, the mechanical integrity of an injection well must be demonstrated before injection begins, and the operator will monitor injection pressure and rate. All monitored data must be reported on a Monthly Injection Report (Form 10-406). Additional requirements include pressure-testing, notifying the commission of intended injection at least 10 days prior to commencement, keeping records, and filing monthly and annual reports.

Federal regulations under 40 CFR Section 112.10, SPCC Requirements for Onshore Oil Drilling and Workover Facilities, require owners or operators of onshore oil drilling and workover facilities to meet specific discharge prevention and containment procedures, including:

- **Positioning or locating mobile drilling or workover equipment so as to prevent a discharge.**
- **Providing catchment basins or diversion structures to intercept and contain discharges of fuel, crude oil, or oily drilling fluids.**
- **Installation of a blowout prevention assembly and well control system before drilling below any casing string or during workover operations. The assembly and well control system must be capable of controlling any well-head pressure that may be encountered while the assembly and well control system are on the well.**

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3.19 GREENHOUSE GASES AND CLIMATE CHANGE

3.19.1 Introduction

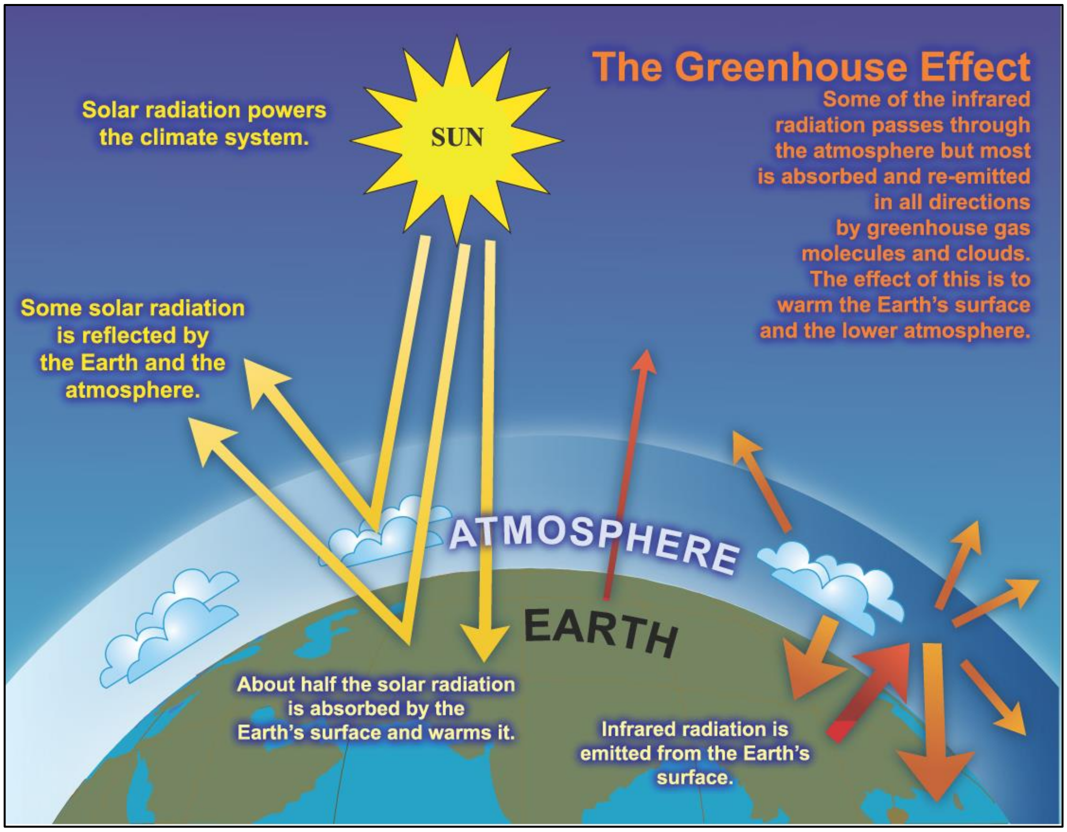
This section presents information on how greenhouse gases (GHGs) affect the climate, trends in GHG emissions globally and within the United States, and observed changes in climatic conditions. Rising atmospheric GHG concentrations are significantly altering global climate systems with the potential for long-term impacts on human society and the environment. The ROI for GHGs differs from other resource areas considered in this **Final** SEIS since the concerns about GHG emissions are primarily related to climate change, which is global and cumulative in nature. Therefore, the affected environment is discussed broadly using a global, national and regional framework to provide context for the analysis of potential GHG impacts from the proposed Project.

This **Final** SEIS considers the following data sources for characterizing GHGs and climate change:

- Intergovernmental Panel on Climate Change (IPCC), *Special Report – Global Warming of 1.5°C* (2018);
- U.S. Global Change Research Program, *Fourth National Climate Assessment*, *Volume I* (2017) and *Volume II* (2018);
- USEPA *Inventory of U.S. GHG Emissions* (2020);
- World Resources Institute *Historical Emissions Data* (2018);
- International Energy Agency *Perspectives for the Energy Transition*, *Investment Needs for a Low-Carbon Energy System* (2017);
- National Oceanic and Atmospheric Administration *Trends in Atmospheric Carbon Dioxide* (2018) and Oak Ridge National Laboratory *Current GHG Concentrations* (2018); and
- Other reports that provide current global assessments of climate change including basic scientific information on causes of climate change, GHG emissions, and observed and projected climate change impacts.

3.19.2 Greenhouse Gases

GHGs include water vapor, CO_2, O_3, CH_4, nitrous oxide (N_2O), and several classes of halogenated substances that contain fluorine, chlorine or bromine (including chlorofluorocarbons). GHGs in the earth's atmosphere help regulate the temperature of the planet by trapping solar heat. When solar radiation (sunlight) reaches the earth, part is reflected back into space, and about half is absorbed by the earth's surface and then re-emitted as infrared radiation. Figure 3.19-1 illustrates the greenhouse effect that occurs when gases in the earth's atmosphere absorb some of this emitted infrared radiation and cause the atmosphere's temperature to rise.



Source: IPCC 2007

Figure 3.19-1. The Greenhouse Effect

After water vapor, CO_2 is the second most abundant GHG in the atmosphere and accounts for the majority of anthropogenic GHG emissions. It can remain in the atmosphere for centuries and tends to mix quickly and evenly throughout the lower levels of the global atmosphere. Other significant GHGs include CH_4, N_2O, and industrial fluorinated gases. In addition, gases such as carbon monoxide, nitrogen oxides, and non-CH_4 volatile organic compounds (VOCs) have an indirect effect on terrestrial or solar radiation absorption by influencing the formation or destruction of GHGs such as O_3. Extremely small particles, such as sulfur dioxide or elemental carbon emissions, can also affect the absorptive characteristics of the atmosphere and therefore influence the greenhouse effect.

3.19.2.1 Greenhouse Gas Emissions

Global GHG emissions have increased steadily since the onset of the Industrial Revolution around 250 years ago, with the rate of emissions accelerating rapidly in the 20^{th} century. For example, about half of all CO_2 emissions from human activity have occurred in the decades since 1970. Global GHG emissions equaled approximately 48,940 million metric tons of CO_2 equivalent (CO_2-eq) in 2018, up from 22,341 million metric tons CO_2-eq in 1970 and 33,823 million metric tons CO_2-eq in 1990 (World Resources Institute 2022).

CO_2-equivalent (CO_2-eq) – Greenhouse GHG are typically reported as metric tons of CO_2-eq, which is a measurement that normalizes all GHGs in terms of their climate change impact relative to CO_2, the predominant global GHG.

Human activities from all sectors of the economy emit GHGs into the atmosphere. Notably, energy generation, transportation, and industrial and agricultural activities release CO_2, CH_4, N_2O, O_3, and chlorofluorocarbons. GHG emissions from burning fossil fuels account for the majority of global emissions, and the contribution of fossil fuel emissions toward climate change has continued to increase in recent decades (World Resources Institute 2022).

Within the United States, overall anthropogenic GHG emissions in 2020 totaled approximately 5,981 million metric tons CO_2-eq. Annual U.S. emissions have decreased by 7.3 percent from 1990 to 2020. However, emissions decreased in 2008 and 2009 due to the economic slowdown, and more recently due to the shift in power generation from coal to natural gas. Additionally, warmer winter conditions in 2016 resulting in decreased heating demand. Emissions also decreased in 2020 as a result of the economic slowdown caused by the global COVID-19 pandemic (USEPA 2022**e**).

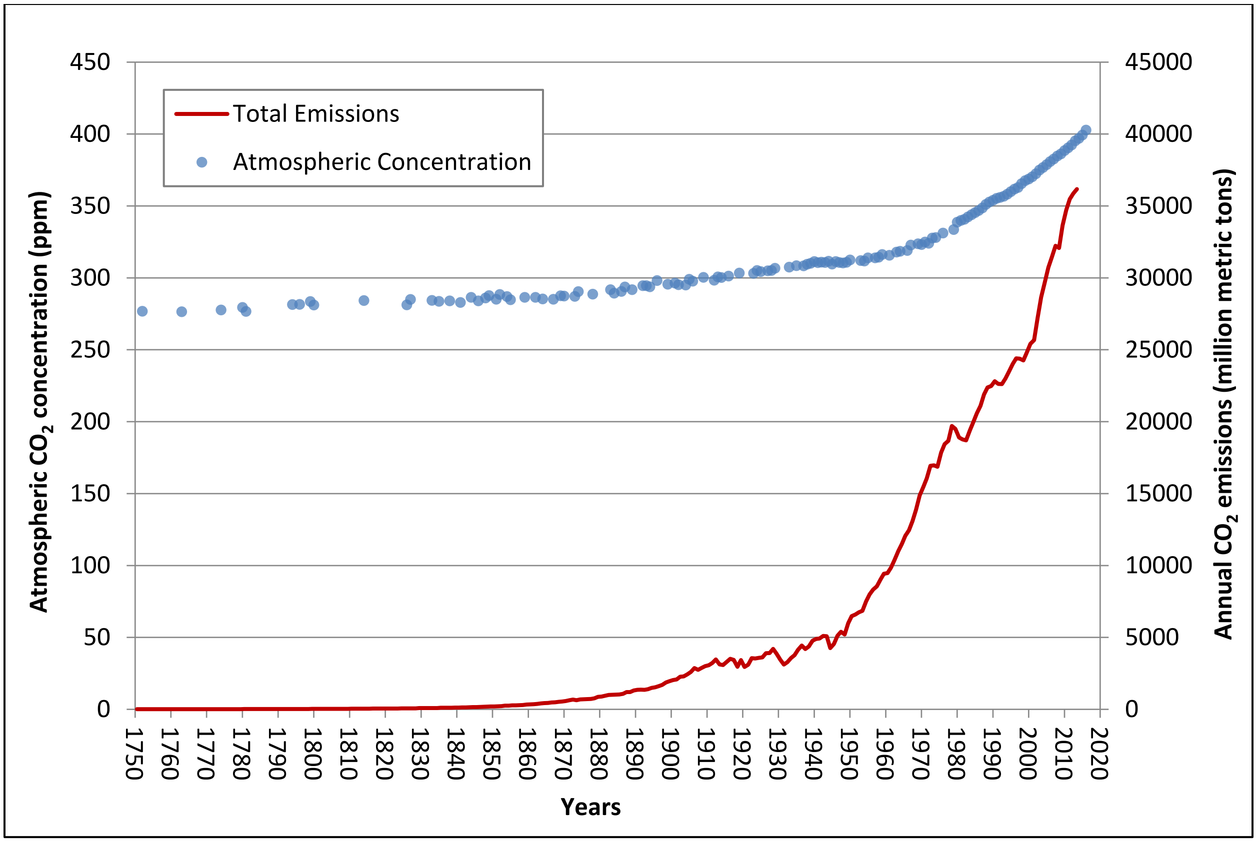
Fossil fuel combustion is the predominant source of GHG emissions in the United States, accounting for nearly 79 percent of total GHG emissions in 2020. In 2020, emissions of CO_2 from fossil fuel combustion equaled approximately 4,571 million metric tons, which was 93.5 percent of U.S. CO_2 emissions. Natural gas accounted for approximately 34 percent of total U.S. energy use and 36 percent of CO_2 emissions, with the energy sector consuming 38 percent of the natural gas, the industrial sector consuming another 32 percent, and smaller amounts going to the residential (15 percent), commercial (10 percent) and transportation (3 percent) sectors (EIA 2022b).

3.19.2.2 Atmospheric Greenhouse Gas Concentrations

The global atmospheric CO_2 concentration in 2020 reached 412 parts per million (ppm), a level that is higher than at any point in the past 800,000 years. The annual rate of increase in atmospheric CO_2 over the past 60 years has been about 100 times faster than during any previous era in history, including the end of the last ice age 11,000 – 17,000 years ago when earth underwent a natural warming period (NOAA 2022a).

At the beginning of the industrial era (circa 1750 AD), the concentration of CO_2 in the atmosphere was approximately 280 ppm (Etheridge et al. 1998). From the 1700s to the present, global atmospheric concentrations of CO_2 have risen approximately 47 percent. In 1958, C.D. Keeling and others began measuring the concentration of atmospheric CO_2 at Mauna Loa in Hawaii. These measurements show that the amount of CO_2 in the atmosphere has been steadily increasing. In 1959, the concentration of CO_2 at Mauna Loa was approximately 316 ppm, in November 2017 it was approximately 405 ppm, and by April 2022 it had exceeded 420 ppm. The average annual CO_2 concentration growth rate at Mauna Loa has been significantly higher during the last decade (2011 – 2020 average: 2.43 ppm per year) than the average CO_2 growth rate during the previous two decades (2001 – 2010 average: 2.04 ppm per year; 1991–2000 average: 1.55 ppm per year) or during the last 50 years (1961–2010 average: 1.47 ppm per year) (NOAA 2022b).

The trend in atmospheric CO_2 concentrations at other global observation sites is similar. In 2021, the globally averaged marine surface annual mean CO_2 concentration was approximately 415 ppm, and between 2011 and 2020, this number increased by an average of 2.38 ppm per year (NOAA 2022a, 2022b). Data analysis correlates this increase in global concentrations of CO_2 with increased GHG emissions resulting from human activities, such as the use of fossil fuels and changes in land use. Figure 3.19-2 depicts the changes in global CO_2 concentrations and CO_2 emissions from fossil fuel use since the beginning of the industrial era (circa 1750).



Source: Developed from Boden et al. 2017; Etheridge et al. 1998; NOAA 2022a
CO_2 = carbon dioxide; ppm = parts per million

Figure 3.19-2. Historical Trends in Global Atmospheric CO_2 Concentrations and Emissions

Like CO_2, atmospheric concentrations of other GHGs have also increased since the start of the Industrial Revolution (pre-1750). Methane concentrations have increased from approximately 720 parts per billion (ppb) to around 1,896 ppb in 2021 (NOAA 2022c), while nitrous oxide concentrations have increased from approximately 270 ppb to approximately 334 ppb. Current atmospheric concentrations of other industrial GHGs, including chlorofluorocarbons, hydrofluorocarbons, and halons, were essentially zero in the pre-industrial era, but currently range from a few parts per trillion to a few hundred parts per trillion (USEPA 2016).

3.19.2.3 Black Carbon

Black carbon strongly absorbs sunlight and can contribute to atmospheric warming by direct absorption. It can also form mixed clouds with water, but there is considerable uncertainty about the overall effect of these clouds on global warming. Finally, black carbon deposited on the ground can also contribute to warming effects, especially when it is deposited on snow or ice. Black carbon has a strong impact on Arctic regions due to its ability to change the reflective properties of ice and snow. When black carbon is deposited on ice or snow, it darkens the ground, decreasing the reflectiveness of the surface (i.e., the albedo) and warming the surface. Black carbon deposited onto ice and snow can increase rates of melting and exacerbate warming, as darker and more absorbent land and water surfaces are exposed as a result (Bond et al. 2013). The effect of black carbon emissions on snow and ice albedo can vary depending on region, latitude, the extent of snow and ice cover, and snow and ice characteristics (Kang et al. 2020).

3.19.3 Changes to Climatic Conditions

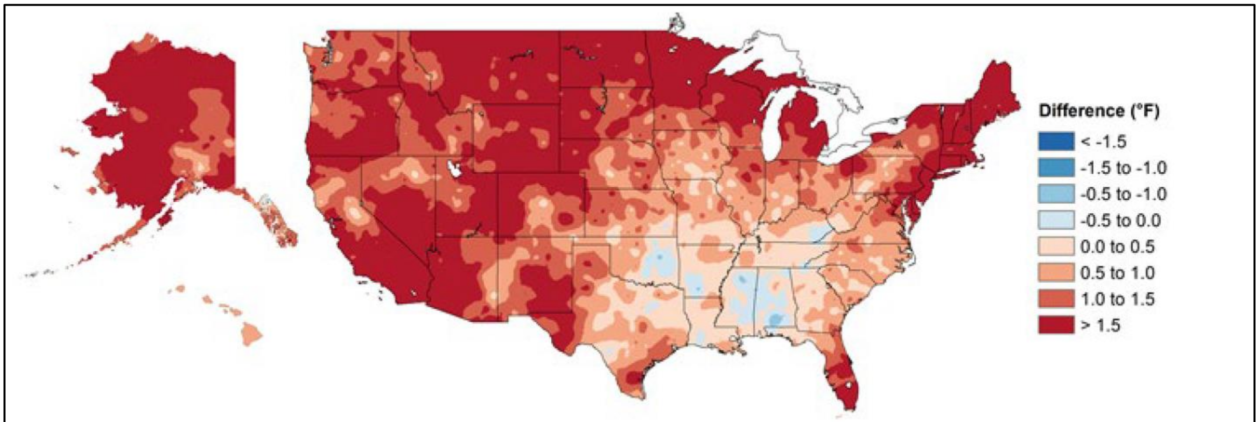
Increasing GHG concentrations in the atmosphere are linked to a range of ongoing and potential changes to global climate. Assessments of future climate change are strongly dependent on predicted trends in GHG emissions, which depend on future policy and other actions to reduce GHG emissions. The remainder of this section provides a summary of current climatic conditions, observed trends in recent decades and predictions of future climate change.

3.19.3.1 Changes to Global and U.S. Climate

Rising GHG concentrations in the atmosphere affect a range of ongoing and predicted changes in global climate, including rising surface temperatures, changes in precipitation, rising sea levels and an increase in extreme weather events. However, these changes are not geographically uniform across the planet, and some regions are likely to experience greater change than others (IPCC 2018).

Rising Surface Temperatures

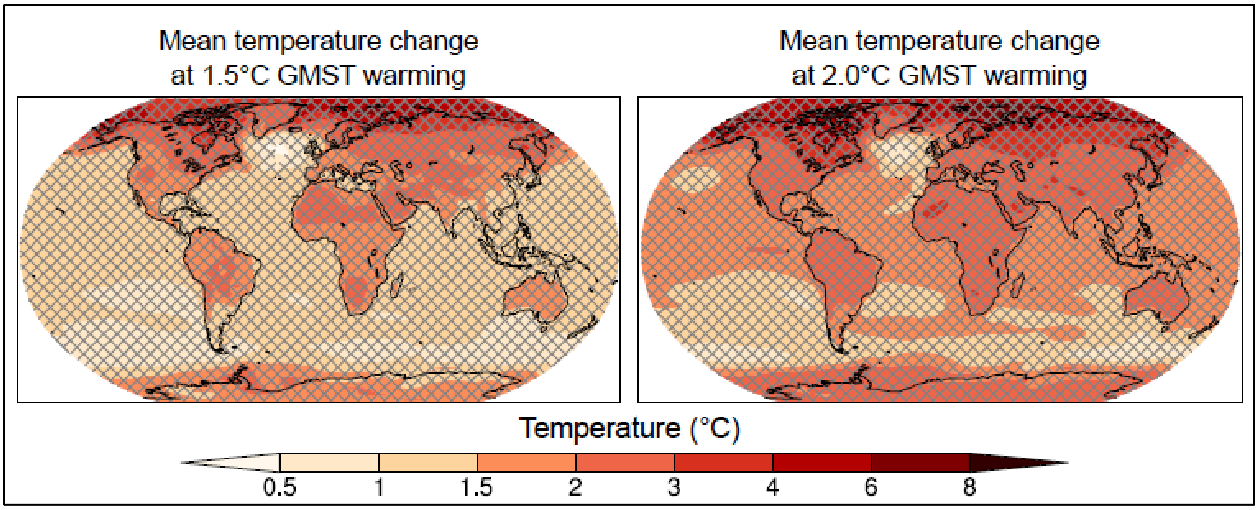
Global surface temperatures have increased by approximately 1.8°F (1.0°C) over the last 115 years (1901 to 2016), which is the warmest in the history of modern civilization (USGCRP 2017). Across the globe, 2020 and 2016 were the two warmest years on record, and the seven years leading up to 2021 were the seven warmest years on record (NASA 2021). Observations indicate the greatest changes have occurred in the polar regions (USGCRP 2017). Annual average temperature over the contiguous United States also increased by 1.8°F (1.0°C) since the beginning of the 20th century. Alaska is warming faster than any other state, at a rate twice as fast as the global average (USGCRP 2018). Figure 3.19-3 illustrates this change and highlights the geographical variability in temperature changes across the country. Along with the increase in annual average temperatures across the United States, the frequency of cold waves has decreased since the early 1900s, and the frequency of heat waves has increased since the mid-1960s. The number of high temperature records set in the past two decades far exceeds the number of low temperature records (USGCRP 2017).



Source: USGCRP 2017
°F = degrees Fahrenheit; U.S. = United States

Figure 3.19-3. Observed U.S. Temperature Change, 1986 to 2015, Relative to 1901 to 1960

The National Climate Assessment (USGCRP 2017) projects annual average temperature over the contiguous United States will continue to rise in the future. Increases of approximately 2.5°F are projected for the period 2021 to 2050 relative to 1976 to 2005 in all future GHG emissions scenarios (also known as representative concentration pathways, or RCPs), and larger rises are projected by late century (2071 to 2100): 2.8°F to 7.3°F in a lower scenario (RCP4.5) and 5.8°F to 11.9°F in the higher scenario (RCP8.5). Extreme temperatures in the contiguous United States are projected to increase even more than average temperatures. The temperatures of extremely cold days and extremely warm days are both expected to increase. Cold waves are projected to become less intense and the number of days below freezing is projected to decline. On other hand, heat waves will likely become more intense and the number of days above 90°F is expected to rise (USGCRP 2017). Figure 3.19-4 presents projected changes to mean temperatures for two possible future scenarios.

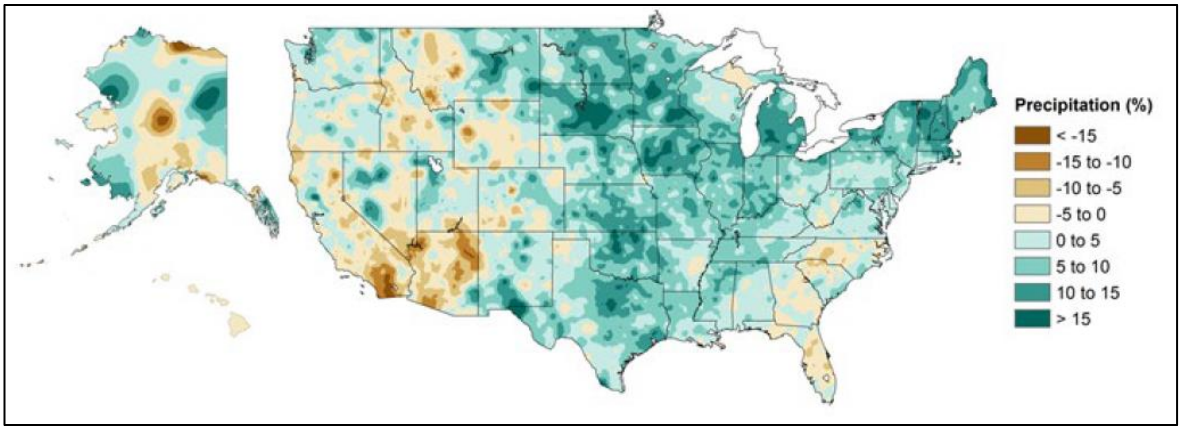


Source: IPCC 2018
°C = degrees Celsius; °F = degrees Fahrenheit; GMST = global mean surface temperature

Figure 3.19-4. Projected Changes to Mean Temperature at 2.7°F (1.5°C) and 3.6°F (2.0°C) of Global Warming Compared to Pre-Industrial Period (1861 to 1880)

Changes in Precipitation

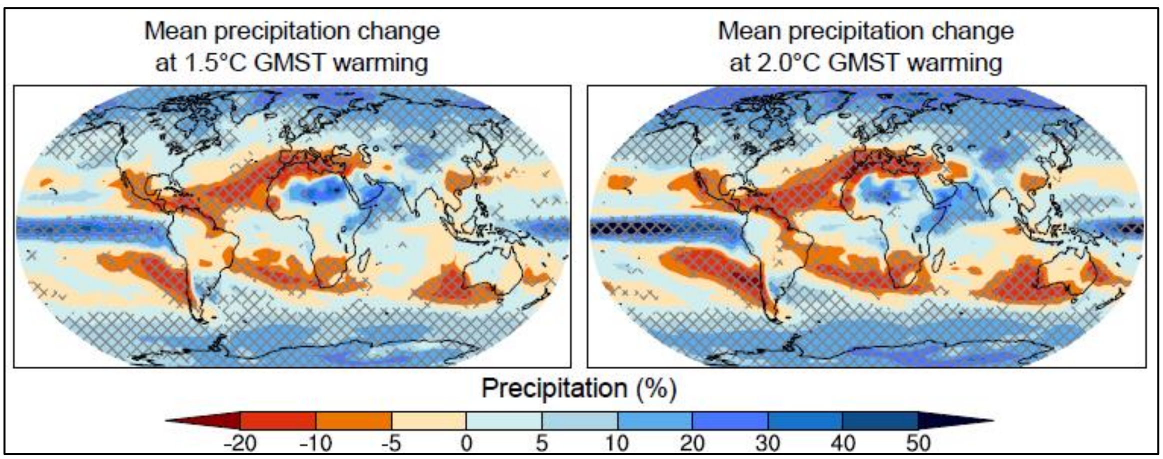
Global warming has resulted in changes to earth's water cycle and the amount of global precipitation. Over the past century, atmospheric moisture levels and annual average precipitation across global land areas have increased. Changes in precipitation regimes include an increase in precipitation in some areas and reduced precipitation and longer dry spells in others (USGCRP 2017). In the United States, annual precipitation has decreased in much of the West, Southwest, and Southeast and increased in most of the northern and southern Great Plains, Midwest, and Northeast (USGCRP 2017). A national average increase of 4 percent in annual precipitation since 1901 is mostly a result of large increases in the fall season. Heavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901, as shown in Figure 3.19-5. There are important regional differences in trends, with the largest increases occurring in the northeastern United States. In particular, mesoscale convective systems (organized clusters of thunderstorms) – the main mechanism for warm season precipitation in the central part of the United States – appear to have increased in occurrence and precipitation amounts since 1979 (USGCRP 2017).



Source: USGCRP 2017
% = percent; U.S. = United States

Figure 3.19-5. Observed U.S. Annual Precipitation Change, 1986 to 2015, Relative to 1901 to 1960

The IPCC's 2018 report projects changes to mean precipitation levels under the two global warming scenarios of reaching 2.7°F (1.5°C) and 3.6°F (2°C) over pre-industrial levels (IPCC 2018). Figure 3.19-6 presents these projected changes to mean precipitation for both scenarios.



Source: IPCC 2018
°C = degrees Celsius; °F = degrees Fahrenheit; GMST = global mean surface temperature

Figure 3.19-6. Projected Changes to Mean Precipitation at 2.7°F (1.5°C) and 3.6°F (2.0°C) of Global Warming Compared to Pre-Industrial Period (1861 to 1880)

The National Climate Assessment (USGCRP 2017) projects the frequency and intensity of heavy precipitation events in the United States will continue to increase over the 21st century. Mesoscale convective systems in the central United States are expected to continue to increase in number and intensity in the future. There are, however, important regional and seasonal differences in projected changes in total precipitation: the northern United States, including Alaska, is projected to receive more precipitation in the winter and spring, and parts of the southwestern United States are projected to receive less precipitation in the winter and spring (USGCRP 2017).

<u>Decreasing Ice Cover</u>

As global temperatures are rising, sea ice cover is decreasing. The minimum extent of Arctic sea ice cover (typically occurring in September) has decreased at a rate of 11 to 16 percent per decade since the early

1980s. In the Arctic, annual average temperatures have increased more than twice as fast as the global average. Studies predict that by mid-21st century, the Arctic will be nearly free of sea ice in late summer (USGCRP 2018). Ice loss results in increased expanses of open water, that can increase evaporation and add more water vapor to the atmosphere. Ice loss can also increase the north-south meanders of the jet stream. Both of these phenomena are consistent with the occurrence of unusually cold and snowy winters in the northern United States in several recent years (USGCRP 2018).

Because of rising temperatures, permafrost (frozen soil found in the Arctic regions) is thawing earlier and freezing later in the year, which allows microbes to decompose organic matter that was previously locked away within the frozen ground (Mooney 2017). Observational and modeling evidence indicates that permafrost is thawing and releasing CO_2 and CH_4, accounting for additional warming of approximately 0.14°F (0.08°C) to 0.9°F (0.5°C) on top of climate model projections.

Sea Level Rise

Across the globe, melting ice is contributing to rising sea levels. Over the 20th century, global sea levels rose by about 7 to 8 inches, with almost half (about 3 inches) of that rise occurring since 1993. This rate of sea level rise is greater than during any preceding century in at least 2,800 years (USGCRP 2017). Recent studies predict sea levels will likely rise to 1 to 4 feet by 2100, with the possibility of rise being even higher depending on the future stability of the Antarctic ice sheet. Predictions of sea level rise coupled with a possible increase in extreme weather events are leading to rising concerns about potential damage to infrastructure and communities, especially in coastal areas. Along the U.S. coast, annual median sea level (with land motion removed) has increased by about 9 inches since the early 20th century as oceans have warmed and land ice has melted (USGCRP 2018).

Changes in Land-Based Ecosystems

Other consequences of rising surface temperatures are changes to land-based ecosystems, such as lengthening of the annual growing season. Across the contiguous United States, the average length of the growing season has increased since the early 20th century, such that on average, the last spring frost occurs earlier, and the first fall frost arrives later (USGCRP 2017).

In hotter, drier areas, plants may face increasing heat and water stress, and may also face an increased risk of a longer fire season. Plant hardiness zones may shift northwards, consistent with changes in surface temperatures and growing seasons. Changes to growing seasons impact the animals dependent on the ecosystem's food sources. A recent study of 48 migratory bird species found that 9 of the species did not keep pace with the changing spring "greening" of plants in the period 2001 to 2012. This mismatch in timing between arrival of migratory birds and peak resource availability can cause declines in adult survival and breeding success. Climate change also exacerbates the spread of invasive species, as conditions could become more advantageous to non-native species (USGCRP 2018).

Changes to Ocean Temperatures and Chemistry

As global surface temperatures rise, ocean temperatures also rise as the oceans absorb heat. The oceans absorb more than 90 percent of the heat that anthropogenic GHG emissions trap in the atmosphere and have warmed nearly 40 percent faster in recent decades than they did in the mid-20th century (USGCRP 2018). The oceans act as a buffer, protecting the atmosphere from significantly higher temperature increases, but increased ocean temperatures enhance evaporation and wind speeds that in turn intensify the frequency and severity of storms (Borunda 2019; Mora et al. 2018).

Changes in ocean temperatures, rates of precipitation and evaporation, and other climate changes have also caused changes in ocean salinity and levels of dissolved oxygen. The northern oceans and Arctic have decreased in salinity from melting glaciers and ice sheets, while other regions on the planet have increased in salinity from higher evaporation rates. Warming ocean temperatures hold less oxygen. Average oxygen levels in the world's oceans have reduced by 2 percent since 1960. These reductions in dissolved oxygen have increased the frequency of marine "dead zones," where oxygen levels are too low to support oxygen-dependent life (IPCC 2018).

The oceans are also becoming more acidic in an emerging global problem, known as ocean acidification, that will intensify with continued CO_2 emissions. Ocean acidification negatively affects organisms such as corals, crustaceans, crabs, mollusks, and other calcium carbonate-dependent organisms. Ocean acidification also affects pteropods (free-swimming pelagic sea snails and sea slugs) and manifests itself as severe shell dissolution, impaired growth, and reduced survival. More importantly, these effects are observed in the natural environment, making pteropods one of the most susceptible indicators for ocean acidification (USGCRP 2018).

Extreme Weather Events, Flooding, and Wildfires

Across the United States, over the last 50 years, there has been an increase in extreme weather events, including prolonged periods of excessively high temperatures, heavy downpours, more intense hurricanes and tornadoes, severe floods, and droughts. As average global temperatures have risen, extreme high temperatures have become more frequent and extreme cold temperatures less frequent. From 2001 to 2012, more than twice as many daily high temperature records were broken in the United States, compared to low temperature records. In U.S. cities, heat waves, which are periods of abnormally hot weather that last days to weeks, have increased by over 40 days since the 1960s (USGCRP 2018).

Studies reveal that the heaviest rainfall amounts from intense storms, including hurricanes, have increased by 6 to 7 percent, on average, compared to what they would have been a century ago. In particular, the 2017 hurricanes Harvey and Maria set record rainfall amounts. Harvey's multiday total rainfall in Texas and Louisiana exceeded that of any known historical storm in the continental United States, while Maria's rainfall intensity was likely even greater than Harvey's, with some locations in Puerto Rico receiving multiple feet of rain in just 24 hours (USGCRP 2018). Hurricanes Harvey and Maria were the 2nd and 3rd most costly hurricanes in United States, at over $125 billion and $90 billion, respectively (with Katrina in 2005 being the costliest) (NOAA 2018). Most models agree that climate change through the 21st century is likely to increase the average intensity and rainfall rates of hurricanes in the Atlantic and other basins (USGCRP 2018).

Tornado activity in the United States has become more variable, particularly over the 2000s, with a decrease in the number of days per year with tornadoes but an increase in the number of tornadoes on these days. And, as the climate has warmed, the incidence of large forest fires in the western United States and Alaska has increased since the early 1980s and is projected to further increase in those regions, with profound changes to affected ecosystems and potential impacts on communities in those areas (USGCRP 2017). Monitoring data from the National Interagency Fire Center indicate that since at least the early 1980s, wildfires in the United States have been getting larger and fire seasons are lasting longer (Ingrahm 2018).

Impacts to Human Society and Health

Future changes to surface temperature, hydrology and ecosystems (discussed earlier) are likely to affect the availability of food through impacts to agriculture, livestock and fisheries, as well as the quantity and quality of water available for human use. Sea level rise, extreme weather events, wildfires, and other climate-related hazards can have adverse impacts on infrastructure including power generation and distribution, transportation and buildings; as well as other economic impacts such as property damage, loss of productivity, and impacts to tourism, natural resources, and other economic sectors. Finally, all of these changes have the potential to result in increased societal stress and conflict due to increasing competition for resources, population migrations and the temporary breakdown of law and order following extreme weather events (Mora et al. 2018; USGCRP 2018).

Climate changes are increasingly having an adverse impact on the health and well-being of people, particularly populations that are already vulnerable. Climate change exposes more people in more places to extreme weather-related events like heat waves, floods, droughts, wildfires and heavy rainfalls. These events cause economic and personal stress to victims as it costs money to repair any damages, and the events may result in forced relocations of households and disruptions to businesses. Increased stress may exacerbate underlying medical conditions and lead to adverse mental health effects (Mora et al. 2018; USGCRP 2018).

Climate change also results in changes to the spread of infectious diseases through vectors, food, and water. For example, climate change alters the geographic range, seasonal distribution and abundance of vector-borne diseases like Lyme disease carried by ticks, and viruses carried by mosquitos (e.g., West Nile, Zika, etc.). Increasing water temperatures alter the geographical range and growth of harmful algae and coastal pathogens. Increased runoff and flooding from more intense storms can compromise the quality and safety of recreational waters and drinking water sources, including more frequent sewage overflow events. Climate change also affects global and U.S. food production when responding to extreme weather events and is also projected to adversely affect global and U.S. food security and safety by altering exposures to certain food pathogens and toxins (USGCRP 2018).

Climate is also an important factor in influencing air quality and its impact on human health. The National Climate Assessment (USGCRP 2018) states that higher temperatures and drier conditions will worsen levels of ground-level O_3 and particulate matter, resulting in increases in adverse respiratory and cardiovascular health effects, including premature deaths. More frequent and severe wildfires would increase incidences of respiratory illnesses from exposure to wildfire smoke. Also, climate changes, like earlier spring arrival, warmer temperatures, and changes in precipitation, will also increase exposure to airborne pollen allergens, increasing the frequency and severity of allergic illnesses, including asthma and hay fever (USGCRP 2018).

The health impacts of climate change are not felt equally, as some populations are at higher risk than others, such as older adults, children, and low-income and minority communities. Low-income and minority communities are often disproportionally affected, and less resilient to, the adverse health impacts of climate change (USGCRP 2018).

3.19.3.2 Climate Change in Alaska

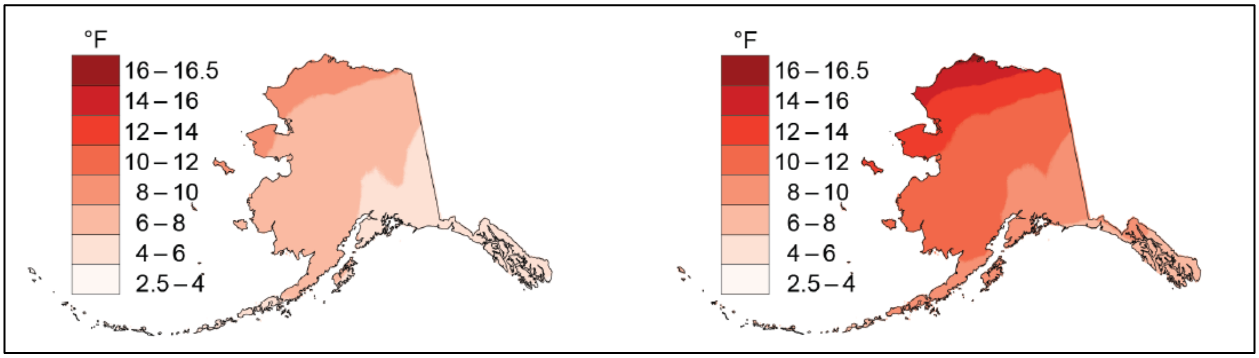
Alaska is the largest state in the Nation, almost one-fifth the size of the combined **L**ower 48 United States (**L**ower 48) and is rich in natural capital resources. Alaska is often identified as being on the front lines of climate change since it is warming faster than any other state and faces a myriad of issues associated with a changing climate (USGCRP 2018).

Climate-driven changes from thawing, flooding, and changes in precipitation are projected to cost the state of Alaska (without adaptation measures) as much as $5.5 billion from 2015 to 2099 in damage to public infrastructure. Other studies suggest that in the next 35 years, accounting as well for cost savings from less heating required, climate changes will cost the state $340 to $700 million, or 0.6 to 1.3 percent of Alaska's Gross Domestic Product over the same period. Related to these economic impacts, ice roads within the North Slope crucial for the oil and gas industry as well as local communities are threatened as there are no clear cost-effective alternatives to move supplies, including the industry rigs, north to Prudhoe Bay and other oil and gas locations within the North Slope (Steffen et al. 2021). Impacts to subsistence users from communities within the North Slope are described later within this section.

Temperature and Precipitation Changes

The rate at which Alaska's temperature has been warming is twice as fast as the global average since the middle of the 20th century. Statewide average temperatures for 2014–2016 were notably warmer as compared to the last few decades, with 2016 being the warmest on record (USGCRP 2018).

In the future, more warming is projected in the Arctic and interior areas than in the southern areas of Alaska, and average annual precipitation increases are projected for all areas of the state, with greater increases in the Arctic and interior and the largest increases in the northeastern interior (see Figure 3.19-7). Temperatures in Alaska are projected to increase by up to 6°F to 8°F by the end of the 21st century under the medium scenario (RCP4.5) and by more than 10°F more under the higher scenario (RCP8.5). Annual maximum one-day precipitation is projected to increase by 5 –10 percent in southeastern Alaska and by more than 15 percent in the rest of the state, although the longest dry and wet spells are not expected to change over most of the state (USGCRP 2018).



Source: USGCRP 2018
Note: Temperature change shown is the difference between the average temperatures for the period 2070-2099 and 1970-1999.
°F = degrees Fahrenheit; GHG = greenhouse gas; RCP = representative concentration pathway

Figure 3.19-7. Projected Change in Average Temperature in Alaska, for Medium (left; RCP 4.5) and High (right; RCP 8.5) GHG Emissions Scenarios

Changes to Sea Ice

Since the early 1980s, annual average arctic sea ice extent has decreased between 3.5 and 4.1 percent per decade, and September sea ice extent, which is the annual minimum extent, has decreased between 10.7 and 15.9 percent per decade. As the climate continues to warm, it is likely that there will be a sea ice-free Arctic during the summer within this century. Sea ice provides an important surface for algal production and growth in marine ecosystems. In the Arctic, higher-level organisms such as Arctic cod, polar bears, and walruses are dependent upon sea ice for foraging, reproduction, and resting and are directly affected by sea ice loss and thinning (USGCRP 2018).

Polar bears and walruses are both dependent on sea ice during parts of their lives. Polar bears rely on sea ice to access prey and establish maternal dens, and Pacific walruses rely on drifting sea ice as a platform to rest on between foraging dives. Changes in the distribution of seasonal sea ice have resulted in changes in the behavior, migration, distribution, and, in some areas, population dynamics of both species. Changes in spring ice melt have affected the ability of Alaska coastal communities to meet their walrus harvest needs, resulting in low harvest levels in several recent years (USGCRP 2018).

Changes to Permafrost

About half of Alaska is underlain by permafrost, and construction in the Arctic depends on the ability of permafrost to remain frozen. While permafrost does not necessarily respond directly to air temperature increases, thermal interaction with ecosystem characteristics that are directly affected by air temperatures can influence the rate of permafrost degradation (FERC 2020). Since the 1970s, Arctic and boreal regions in Alaska have experienced rapid rates of warming and thawing of permafrost, with spatial modeling projecting that near-surface permafrost will likely disappear on 16 to 24 percent of the landscape by the end of the 21st century (USGCRP 2018). The climate change effects on conditions of influence have caused the temperature of permafrost to increase, seasonal thawing to occur earlier, and freezing to occur later in the year, creating a shorter season of frozen soils and permafrost. Data collected since the 1980s show that permafrost temperatures are changing along a north–south bioclimatic gradient, with temperatures in the North Slope increasing 4°F to 7°F over the past century (FERC 2020). According to the USEPA, Alaska's unfrozen season has grown longer at an average rate of about four days per decade, with 2019 having 20 more unfrozen days than the long-term (1979 to 2019) average (USEPA 2020).

Permafrost degradation impacts society in many ways. Physical impacts of thawing permafrost include unsafe food storage and preservation, decreased bearing capacities of building and pipeline foundations, damage to road surfaces, deterioration of reservoirs and impoundments that rely on permafrost for wastewater containment, reduced operation of ice and snow roads in winter, and damage to linear infrastructure (such as roads and power lines) from landslides. As permafrost thaws, the ground sinks (known as subsidence), causing damage to buildings, roads, and other infrastructure; these impacts are likely to increase in the future. In addition to physical impacts, thawing permafrost has important societal impacts that cannot be quantified, such as the loss of archaeological sites, structures, and objects, as well as traditional cultural properties.

Soil Liquefaction

Soil liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading (University of Washington 2022). Liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world. Liquefaction occurs in saturated soils, that is, soils in which the space between individual particles is completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. Research has linked sea level rise to increased potential for soil liquefaction during earthquakes in coastal areas (Quilter et al. 2015). Rising sea levels can induce an increase in groundwater levels, which can in turn increase soil liquefaction potential.

Wildfires

While the annual area burned by wildfires in Alaska varies greatly from year-to-year, the frequency of big fire years (larger than 2 million acres burned) has been increasing. Three out of the top four fire years in terms of acres burned have all occurred since 2000. The area burned by wildfires may increase further under a warming climate. Projections of burned area for 2006–2100 are estimated at 98 million acres under a lower climate change scenario (RCP4.5) and 120 million acres under a higher scenario (RCP8.5) (USGCRP 2018).

Coastal and River Erosion

Flooding and erosion of coastal and river areas affect over 87 percent of the Alaska Native communities, with some coastal areas also threatened by changes in sea ice and increased storm intensity. Offshore and landfast sea ice is forming later in the season, which allows coastal storm waves to build while leaving beaches unprotected from wave action. Rates of erosion vary throughout the state, with the highest rates measured on the Arctic coastline at more than 59 feet per year. Longer sea ice-free seasons, higher ground temperatures, and relative sea level rise are expected to worsen flooding and accelerate erosion in many regions, leading to the loss of terrestrial habitat and cultural resources and requiring entire communities to relocate to safer terrain (USGCRP 2018).

Many Alaska communities that are not located on the coast are adjacent to large rivers, where riverine erosion is a serious problem. Similar to coastal communities, some riverine communities have also been forced to relocate housing and other infrastructure due to erosion and flooding. In both coastal and river communities, various types of infrastructure and cultural resources are being threatened (USGCRP 2018).

Biological Resources

Climate change is having an effect on vegetation communities within the North Slope, showing an increased greenness in satellite imagery from 2014–2018 relative to the longer-term (post-1982) average. This is also reflected in the increased number of Growing Degree Days since 2014 across Alaska (Thoman & Walsh 2019). Reduction in the amount of snow- and ice-covered surfaces to vegetation-covered surfaces decreases the surface albedo (i.e., the surface's ability to reflect sunlight) which contributes to increased temperatures.

Increased temperatures have also caused migration and habitat impacts within the North Slope, including delayed beluga whale migration. Data from beluga whales tagged with satellite-linked transmitters show that, comparing 1998– 2002 to 2007–2012, beluga whales from the Chukchi Sea population delayed fall migration by about 33 days, resulting in a prolonged presence in the Beaufort Sea correlated with significantly later sea ice freeze-up. Additionally, in the past four years, a dramatic shift in Bering Strait ice conditions has impacted ice habitat for walruses. Walruses use sea ice for molting, mating, and nursing, and as a platform for dives to the bottom of shallow shelf seas for clams and other food. As sea ice recedes beyond the shallow shelf seas of northern Alaska, female walruses and calves must either remain on sea ice in water too deep for feeding or come onshore where stampedes are a risk (Thoman & Walsh 2019). Researchers have also predicted a wide range of impacts of climate change on polar bear demography and conditions including a major reduction in sea ice habitat reducing the availability of ice associated seals, the main prey of polar bears, and a loss and fragmentation of polar bear habitat (Wiig et al. 2008).

Other changes with the potential to impact biological communities in the Arctic include changes to sea ice and ocean acidification. As the climate continues to warm, it is likely that there will be a sea ice-free Arctic during the summer within this century. Sea ice provides an important surface for algal production and growth in marine ecosystems during spring. This production beneath the sea ice is an important source of carbon for pelagic grazers, such as copepods and krill, and for benthic detritivores, such as clams and worms that feed on dead, organic material. In turn, the abundance of these animals provides food for higher trophic-level organisms such as fish, birds, and mammals. The presence or absence of sea ice also affects the transfer of heat, water temperature, and nutrient transport, as well as other processes that affect ecosystem productivity (USGCRP 2018). In addition, ocean acidification impacts are likely to have an adverse effect on Arctic marine ecosystems, similar to the impacts discussed under Section 3.19.3.1.

Subsistence

Subsistence hunting, fishing, and gathering are a major source of food in many Alaska Native villages (USGCRP 2018). Producing, preparing, sharing, and consuming these foods also provide spiritual, cultural, social, and economic benefits. Traditional foods are widely shared within and between communities and are a way of strengthening social ties. **For many Indigenous people, subsistence is much more than the use and provision of resources for consumption, and is linked with culture and worldview via knowledge sharing, learning about respect, and various meanings of food.** Climate change is altering the physical setting in which these subsistence activities are conducted. Examples include:

- Reducing the presence of shore-fast ice used as a platform to hunt seals or butcher whales;
- Reducing the availability of suitable ice conditions for hunting seals and walrus; and

- Exacerbating the risks of winter travel due to increasing areas of thin ice and large fractures within the sea ice (commonly referred to as "leads") as well as water on rivers.

The loss of coastal sea ice and river ice has significant impacts for people living in the region by eliminating opportunities for snow- and ice-dependent travel between communities including those within the North Slope. As ocean temperatures rise and acidification increases, fish stocks' distribution, abundance, and behavior are shifting which directly impacts subsistence activities and sport and commercial fishing in Alaska (Steffen et al. 2021). Shellfish populations, an**other** important subsistence and commercial resource along the Alaska coast, have been declining for more than 20 years throughout coastal Alaska, with ocean warming and ocean acidification contributing to the decline (USGCRP 2018). Warm temperatures and increased humidity are also affecting ice cellars used traditionally to store food, thereby making it harder to air-dry meat and fish on outdoor racks, causing food contamination. Some communities have found new storage methods or have changed to an increasingly Western diet. Subsistence foods decrease the costs of feeding a family compared to purchased foods, which in rural Alaska are almost twice the cost of those in Anchorage. One net result of all these changes is an overall decrease in food security for residents of rural Alaska Native communities. As the environment changes, overall well-being can also suffer from losing the spiritual and cultural benefits of providing and sharing traditional foods.

Human Health

As discussed above under Section 3.19.3.1, climate change can lead to a range of human health impacts. In Alaska, these include direct exposure to conditions such as high temperatures, increased risk of falling through ice or otherwise being exposed to unsafe travel conditions on sea ice and other frozen waterbodies, and the risk of exposure to flooding and severe weather. There is also the potential for severe weather to damage water and sanitation infrastructure, leading to the risk of water-related diseases. An increase in wildfires and pollen due to climate change also has the potential to lead to adverse respiratory health impacts. Indirect effects include degraded water supplies due to the effects of permafrost thaw on water infrastructure, increased risk of exposure to diseases as vectors expand their geographic range, disease-carrying organisms surviving over winter in greater numbers under warming conditions, and the risk of food spoilage increasing as ice cellars melt. Finally, climate change is leading to increased mental illness and psychological stresses, as Alaskan communities, and especially Indigenous people, deal with the effects of climate change on their livelihoods and traditional cultural ways of live (USGCRP 2018).

A 2018 report from the Alaska Department of Health and Social Services further highlighted climate change impacts on the health of Alaskans, including mental health and well-being; accidents and injuries; exposure to hazardous materials; food, nutrition, and subsistence activities; infectious diseases and toxins; chronic diseases; water and sanitation; and access to health services. Impacts are often greater within Alaska's rural and mostly Indigenous communities due to their tight connections to the environment via subsistence resource harvests, traditional knowledge and worldview, and other practices going back thousands of years. Although there are exceptions, climate change generally appears to exacerbate existing health challenges at both the community and individual levels. There are several different pathways by which climate change can affect health, including direct impacts such as injuries caused by fires or storm surges, and indirect impacts such as changes in quantity and quality of subsistence foods. Climate-associated health impacts on communities are often magnified by additional social and economic stresses (State of Alaska Epidemiology 2018).

Climate Change Policy Development in Alaska

Absent clear federal and state policies for climate change, local Alaskan communities have been creating policies to take action on both climate mitigation and adaptation through creation of climate

action or climate adaptation plans. The majority of the climate policies are located in small rural communities with negligible local contributions of GHGs to the global load, and have a focus on adaptation. Inconsistencies in funding and guidance affect climate actions in Alaska because many local climate activities rely on some funding, guidance, and oversight from external sources and agencies at the federal and state levels. A 2017 review of documents related to climate adaptation planning among Alaska Native communities identifies inadequate funding as the most frequently citied barrier to climate adaptation planning (Steffen et al. 2021).

Over 19 climate action efforts (i.e., plans and strategies) have emerged from Indigenous communities. These actions overwhelmingly focus on assessing and adapting to the current impacts of climate change that threaten ways of life, rather than focusing on climate change mitigation (Steffen et al. 2021). DOE did not identify any climate policy or action plan for communities within the PTU, PBU and KRU; however, the community of Nuisquit directly to the west of KRU has prepared a hazards assessment report entitled *Climate Change in Nuiqsuit, Alaska Strategies for Community Health* to raise awareness about current, emerging, and potential future climate change to help make informed planning decisions, find community appropriate development strategies, and pursue a safe, healthy, and sustainable future (Brubaker et. al. 2014). The report findings include:

- **It is becoming warmer with an increase in average annual air temperature. Temperatures have increased in every month of the year except July. More extreme warm days are expected.**
- **It is becoming wetter with a longer period when rain occurs. The amount of precipitation has increased in seven months. Winter rain events are expected to occur more frequently.**
- **Extreme weather is increasing, including thunderstorms. Lightning and wildfires are also increasing with related risks: poor air quality, infrastructure damage and loss of caribou forage areas.**
- **Warming has resulted in decreases in snow and ice. This is affecting conditions for travel on rivers, lakes and on the sea. Poor ice conditions are preventing some types of subsistence activities.**
- **The season for hunting on the sea ice is becoming shorter. The season for open water travel is however, becoming longer and hunters are adapting with new equipment and methods.**
- **Sea conditions are becoming more challenging and dangerous for navigation. This is resulting from sea ice loss, increased effect of wind fetch, and resulting increase in wave size.**
- **Higher water is increasing river access. Residents report the ability to travel further upriver for hunting than ever before, expanding and improving access to subsistence use areas.**
- **Erosion is causing loss of the riverbank and historical sites. Ice cellars and traditional harvesting sites have been lost. Armoring the shoreline would protect infrastructure that would otherwise need to be relocated.**
- **Permafrost thaw is affecting food security. Some ice cellars have failed because of warming air and soils condition. Adaptations such as phased relocation to better cellar sites, retrofits with cooling systems or alternative cold storage facilities are under consideration.**
- **Sea level rise will increase flood risk. Better sea level trend data is needed through tide stations and projection scenarios to look at combined effects of thawing, erosion, ice change and sea level rise.**

- **Community members are concerned about food security. Changes are affecting subsistence, including the abundance, availability, timing, and quality of food resources. Climate change has resulted in poor conditions for food preservation. Residents report that unseasonable weather has resulted in poor conditions for drying fish and seal and other foods.**
- **Climate models project continued rapid change. Residents should expect that some plants and wildlife will be stressed during a period of rapid environmental change, but that new resources and opportunities will emerge that can benefit Nuiqsut.**
- **Change will bring new challenges including natural disasters. As climate and environmental conditions are changing so are the risks for disasters. Updating hazards mitigation plans is recommended to address climate change related threats.**

4.0 IMPACTS OF THE PROPOSED ACTION

This chapter presents the potential direct, indirect, and cumulative impacts of the Proposed Action scenarios discussed in Section 2.3 and the No Action Alternative scenario discussed in Section 2.4. As stated in Section 1.3, the focus of this **Final** SEIS is to supplement the 2020 SEIS to include consideration of impacts from potential upstream development activities within the North Slope associated with the proposed Project along with life cycle GHG emissions generated by the proposed Project. This **Final** SEIS also re-evaluates North Slope "non-jurisdictional" activities discussed in the 2020 EIS related to upstream development that would support the proposed Project. See Section 2.5 for details on these activities.

No changes to the proposed Project have occurred since issuance of the 2020 EIS that affect the analysis or conclusions presented within the 2020 EIS. The analysis in this **Final** SEIS considers the additional impacts from potential upstream development along with the GHG emission estimates contained within the LCA Study. Findings from the 2020 EIS are summarized at the beginning of each resource section within this chapter to provide context for the totality of impacts to the resource taking into consideration the potential upstream development.

Characterization of Impacts

The analyses of potential impacts on the environmental resource areas presented in this chapter identify the type and intensity of impacts associated with the potential development activities on the North Slope and GHG emission estimates from the LCA Study. As stated in Section 2.3, the potential development activity scenarios are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Where possible, this chapter provides quantitative information based on the best existing and available information. However, specific quantification of impacts to certain resources are unknown due to the lack of specific design for the potential development activities. Where impacts cannot be quantified, the analyses present a qualitative assessment of the potential impacts. The analyses also consider mitigation measures identified within the 2020 EIS and newly identified mitigation measures specific to North Slope development or minimization of GHG emissions. Table 4.0-1 outlines the activities analyzed within this **Final** SEIS related to upstream development based on the information provided in the North Slope Production Study (see Appendix B, North Slope Production Study) and the LCA Study (see Appendix C, Life Cycle Analysis Study), as discussed in Chapter 2, Proposed Agency and Action Alternatives.

Table 4.0-1. North Slope Activities Addressed within this Final SEIS

Activity	Assumptions/Notes
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	*Applicable to Scenarios 2 and 3.* Proponent has not identified a specific location, but expansion would occur directly adjacent to the Central Pad avoiding off-shore waters.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	*Applicable to Scenarios 2 and 3.* Proponent has not identified a specific location, but expansion would occur directly adjacent to the Central Pad avoiding off-shore waters.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	*Applicable to Scenarios 2 and 3*. Proponent has not identified a specific location within the Central Pad. Number of wells includes the three identified in the 2020 EIS and an additional well identified by the North Slope Production Study required to support the term of authorization (see Section 2.3).

Table 4.0-1. North Slope Activities Addressed within this Final SEIS

Activity	Assumptions/Notes
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	*Applicable to Scenarios 2 and 3*. Proponent has not identified a specific well within the Central Pad.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	*Applicable to Scenarios 2 and 3*. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed would be placed on land to the west of the Point Thomson marine facilities.
Ice road construction (see Section 2.5.1 regarding the potential use of ice roads for construction of pads, wells, and pipeline infrastructure).	*Applicable to Scenarios 2 and 3*. Although not identified as an activity for the PTU Expansion Project, ice road construction may be required to access construction sites and deliver equipment. It is assumed no additional gravel roads would be required.
Operations	*Applicable to Scenarios 2 and 3*. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual winter ice road, and in the summer by barge or boat using existing facilities.
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	*Applicable to Scenarios 2 and 3*. Proponent has not identified a specific location, but expansion would occur directly adjacent to the CGF Pad.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	*Applicable to Scenarios 2 and 3*. Proponent has not identified specific well locations within the PBU. Wells would be drilled after the proposed Alaska LNG Project is commissioned. It is assumed that new wells would be drilled from existing pads.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	*Applicable to Scenario 2*. Well drilling activities would occur within existing disturbed areas associated with Well Pad 18. Laterals would be directionally drilled below the surface at depths likely ranging between 4,200 and 4,800 feet to reach the upper boundary of the Staines Tongue reservoir.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	*Applicable to Scenarios 2 and 3*. Proponent has not identified specific pipeline lengths or locations, but activities would occur within the CGF Pad.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	*Applicable to Scenarios 2 and 3*. Proponent has not identified specific pipeline length or location, but activities would occur within the CGF Pad.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	*Applicable to Scenarios 2 and 3*. Proponent has not identified specific locations but indicated permanent disturbance of about 1.5 acres.

Table 4.0-1. North Slope Activities Addressed within this Final SEIS

Activity	Assumptions/Notes
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	*Applicable to Scenarios 2 and 3*. Proponent has not identified specific locations, but it is assumed, similar to the other pipelines, the pipelines would be aboveground, supported by VSMs. It is also assumed that this pipeline would likely follow ROW associated with the proposed PTTL analyzed in the 2020 EIS.
Ice road construction (see Section 2.5.1 regarding the potential use of ice roads for construction of pads, wells, and pipeline infrastructure).	*Applicable to Scenarios 2 and 3*. Although not identified as an activity for the PBU MGS Project, ice road construction may be required to access construction sites and deliver equipment. It is assumed no additional gravel roads would be required.
Operations	*Applicable to Scenarios 2 and 3.* Following the construction and installation of the proposed components described above, it is assumed that they would remain in operation for the remainder of Project's term of authorization. The exception would be ice roads, if proposed, which would be utilized for a single season. Operations would also include the long-term maintenance of the proposed wells and pipelines.
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed Alaska LNG Project GTP at PBU to KRU for geologic sequestration (see Section 2.5.3 regarding pipeline construction methods).	*Applicable to Scenario 3*. It is assumed the pipeline would be aboveground, supported by VSMs, and it would likely follow an existing ROW associated with the Kuparuk and Kuparuk Extension pipelines located within and between PBU and KRU.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	*Applicable to Scenario 3*. It is assumed any CO_2 distribution pipelines within KRU to transport CO_2 to individual injection wells would be located within or adjacent to an existing ROW.
Operations	*Applicable to Scenario 3.* Following the construction and installation of the proposed components described above, it is assumed that they would remain in operation for the remainder of the Project's term of authorization. Operations would also include the long-term maintenance of the proposed pipelines.

CGF = Central Gas Facility; CO_2 = carbon dioxide; EIS = Environmental Impact Statement; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; LNG = liquefied natural gas; MGS = Major Gas Sales; PBU = Prudhoe Bay Unit; PTTL = Point Thomson Unit Gas Transmission Line; PTU = Point Thomson Unit; ROW = right-of-way; SEIS = Supplemental Environmental Impact Statement; UIC = Underground Injection Control; VSM = vertical support member

This **Final** SEIS assumes the project proponent would use construction procedures specific to the North Slope (see Section 2.5) for potential development activities. This **Final** SEIS also assumes development of new pipeline infrastructure would occur within an existing ROW or directly adjacent to an existing ROW if space was not available.

Table 4.0-2 provides context to impact terminology used within this **Final** SEIS. While this **Final** SEIS uses the term "less-than-significant" to characterize minor and moderate impacts, the terms "minor" and "moderate" are still used when discussing or summarizing impacts as they were presented in the 2020 EIS.

Table 4.0-2. Final SEIS Impact Terminology

Impact Type	Definition
Beneficial	Impacts would improve or enhance the resource.
Adverse	Impact would negatively affect the resource.
Negligible	No apparent or measurable impacts are expected, and may also be described as "none," if appropriate.
Less-than-Significant	The action would have a noticeable or measurable adverse impact on the resource. This category could include potentially significant impacts that could be reduced by the implementation of mitigation measures.
Minor	The action would have a barely noticeable or measurable adverse impact on the resource.
Moderate	The action would have a noticeable or measurable adverse impact on the resource. This category could include potentially significant impacts that could be reduced by the implementation of mitigation measures.
Significant	The action would have obvious and extensive adverse impacts that could result in potentially significant impacts on a resource despite mitigation measures.
Direct	Those caused by the proposed project and occurring at the same time and place (e.g., habitat destruction, wetland disturbance, air emissions and water use).
Indirect	Those caused by the proposed project but occurring later in time or farther removed in distance from the action (e.g., changes in surface water quality resulting from runoff).
Temporary	Temporary, short-term impacts generally occur during construction with the resource returning to its preconstruction condition almost immediately afterward. A short-term impact could continue for up to 3 years following construction. A subset of temporary impacts would include areas that would be disturbed intermittently for shorter periods during a construction or maintenance phase.
Permanent	Permanent, long-term impacts could occur as a result of any activity that modifies a resource to the extent that it would not return to preconstruction conditions during the life of the portion of the proposed project. An impact is considered long-term if the resource would require more than 3 years to recover.

SEIS = Supplemental Environmental Impact Statement

4.1 GEOLOGIC RESOURCES AND GEOLOGIC HAZARDS

4.1.1 Summary of Geologic Resource and Geologic Hazard Impacts from the 2020 EIS

Table 4.1-1 provides a summary of potential impacts from the proposed Project as identified within the 2020 EIS. As indicated in the table, FERC determined the proposed Project would not have any significant adverse effects on geologic resources, and geologic hazards would not pose a significant risk to the proposed Project.

Table 4.1-1. Summary of Geologic Resource and Geologic Hazard Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Hazardous waste and contaminated media from historic mining could be present within the proposed Project area and could be transported via runoff, groundwater movement, or wind dispersion. • Impacts from development of granular fill sites could result from topsoil stripping, overburden removal, blasting, excavation, and dewatering. • Paleontological resources could be directly affected by ground-disturbing activities causing damage, fragmentation, or stratigraphic displacement. Potential indirect effects include increased potential for erosion and vandalism. • Potential impacts from blasting include turbidity in water wells or springs, damage to nearby structures or utilities, displacement of wildlife, and permafrost degradation. • Geologic hazards that could affect the proposed Project include seismicity, soil liquefaction, mass wasting, and acid rock drainage.	• The proposed Project would not result in significant adverse effects on geologic resources. Geologic hazards would not pose a significant risk to the proposed Project.	4.1; 5.1.1

EIS = Environmental Impact Statement

4.1.2 Methodology to Assess Geologic Resource and Geologic Hazard Impacts

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific geological surveys but instead uses historic regional, geological unit and well data, and Production Reports 1, 2, and 3 (see Appendix B, North Slope Production Study) to assess existing and potentially existing resource conditions at sub-surface depths. This analysis focuses on subsurface construction activities associated with upstream development activities and the potential impacts to existing oil, gas, and CO_2 storage resources. This analysis also considers potential impacts to paleontological resources based on the 2020 EIS conclusions that the North Slope is an area of paleontological potential. Section 4.2 considers surficial construction impacts to soil resources and permafrost.

Additionally, the analysis also considers the impacts of potential geologic hazards to upstream development activities, operations, and geologic resources on the North Slope. Potential geologic hazards associated with the area are discussed in Section 4.1.3 of the 2020 EIS and in Section 3.1.4 of this **Final** SEIS.

4.1.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to geologic resources as described in Section 4.1 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.1.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities related to well development and CO_2 storage on the North Slope could impact geologic resources as these activities breach sub-surface depths. Sections 4.1.4.1 through 4.1.4.3 discuss the types of impacts by activity on the North Slope that could occur as a result of the proposed Project.

Direct effects on paleontological resources could occur during construction activities such as grading, trenching, and material site development; however, these effects would be limited to fossils within the late Quaternary sands and gravels across the North Slope. Impacts on deeper located resources, though unlikely, would be limited to the pulverization of fossils located within wellbores during drilling activities. Indirect effects on these resources could result from erosion caused by slope regrading, vegetation clearing, and exposure to wind, water, and freeze–thaw cycles.

Based on regional historic data reviewed in the 2020 EIS and discussed in Section 3.1, the North Slope has no significant risk, or low probability, for geologic hazards to affect upstream development activities or the oil, gas, or CO_2 storage resources on the North Slope. **Under Scenario 3, the injections of CO_2 into the KRU for EOR could trigger seismic activity in the area. However, the potential for adverse effects is minimal due to the success of previous EOR injection projects in the KRU (DOE 2005) and minor historic seismic activity in the surrounding areas**. Further discussion on the impact potential of geologic hazards to the proposed Project can be found in Section 4.1.3 of the 2020 EIS.

4.1.4.1 Point Thomson Unit

Table 4.1-2 summarizes the potential for impacts to geologic resources within the PTU based on activity. Although the exact locations of the components of the PTU Expansion Project are unknown at this time, the majority of activities would only affect surficial soil resources and have minimal impact on the deep geological features encompassed in the area. Drilling activities and operations for production and injection wells would have direct impacts on natural gas resources.

Table 4.1-2. Potential Geologic Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would have no adverse impacts on geologic resources due to only surficial levels of disturbance. Granular material for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would have no adverse impacts on geologic resources due to only surficial levels of disturbance.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would have permanent impacts on geologic resources due to the drilling of wells 12,700 feet deep to reach reservoir depths. Any resources within the well borings would be pulverized from drilling activities. Overall impacts would be less-than-significant. As stated within Section 3.1.6, development of wells would be subject to new or updated submittals of Plan of Exploration, Plan of Development and Plan of Operations by the ADNR DOG. As stated within Section 2.5.5, permits for well drilling issued by the AOGCC would require review/approval by the ADNR and consideration of existing geological strata and resources.

Table 4.1-2. Potential Geologic Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Overall impacts would be less-than-significant. See discussion above regarding well drilling. As indicated by Production Report 1, an USEPA UIC Class I disposal permit has been acquired for the conversion of an existing gas injection well on the Central Pad and drilling of a new disposal well at the same location. All regulations and monitoring requirements of the UIC Program must be met.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	Dredging would have no adverse impacts on geologic resources due to only surficial levels of disturbance. Any excess material removed by dredging would be placed on land to the west of the Point Thomson marine facilities.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have no adverse impacts on geologic resources due to only surficial levels of disturbance.
Operations	Operations of proposed activities would have permanent impacts on geologic resources as natural gas resources would be extracted and diminished from its geological source. Taking into consideration reservoir growth, 10.1 Tcf of gas would be available to meet the 8.7 Tcf gas supply requirement of the Point Thomson Expansion Project's extended time frame. Operation activities related to the Class I disposal well would permanently alter the composition of deep, isolated rock formations due to the injection of hazardous and non-hazardous waste. Overall impacts would be less-than-significant.

ADNR = Alaska Department of Natural Resources; DOG = Division of Oil and Gas; AOGCC = Alaska Oil and Gas Conservation Commission; PTU = Point Thomson Unit; Tcf = trillion cubic feet; UIC = Underground Injection Control; USEPA = U.S. Environmental Protection Agency

4.1.4.2 Prudhoe Bay Unit

Table 4.1-3 summarizes the potential for impact to geologic resources within the PBU based on activity. A majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells at PBU Well Pad 18 under Scenario 2. Although the exact locations of the components of the PBU MGS Project are unknown at this time, most of the activities would only affect the PBU area at a surficial level and have minimal impact on the deep geological features. Drilling activities and operations for production and injection wells would have direct impact on oil, gas, and CO_2 storage resources.

Table 4.1-3. Potential Geologic Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the existing CGF Pad would have no adverse impacts on geologic resources due to only surficial levels of disturbance. Granular fill material will be sourced from outside the PBU Project area according to Section 4.1.2.1 of the 2020 EIS.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of up to 10 new production and injection wells within the PBU would have permanent impacts on geologic resources due to the drilling of wells 8,000 feet deep to reach gas reservoir depths just above the oil reservoirs. Any resources within the well borings would be pulverized from drilling activities. Overall impacts would be less-than-significant.

Table 4.1-3. Potential Geologic Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
	As stated within Section 3.1.6, development of wells would be subject to new or updated submittals of Plan of Exploration, Plan of Development, and Plan of Operations to the ADNR DOG. As stated within Section 2.5.5, permits for well drilling issued by the AOGCC would require review/approval by the ADNR and include consideration of existing geologic resources.
Scenario 2 only. **Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Any resources within the well borings would be pulverized from drilling activities. Overall impacts would be less-than-significant. See discussion above regarding well drilling.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines would have no adverse impacts to geologic resources due to only surficial levels of disturbance.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	No adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	No adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope. As stated in Section 2.2.1.2, approximately 1.5 acres of total direct disturbance is anticipated.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	No adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have no adverse impacts on geologic resources due to only surficial levels of disturbance.
Operations	Operations of proposed activities would have permanent impacts on geologic resources as natural gas resources would be extracted and diminished from its geological source and under certain scenarios, CO_2 would be injected into unit storage reservoirs, altering the subsurface composition and pressure. In Scenario 2, the PBU would switch the priority of operations from oil production to gas production. As a result, reservoir pressure would steadily decrease as gas is extracted for MGS, reducing the volume of oil produced from the PBU. This scenario assumes that by-product CO_2 is not used in EOR and is stored in saline formations beneath the PBU. In comparison to Scenario 1, this option reduces total PBU oil production by 452 million barrels if initiated in 2029. Production Report 3 evaluates the use of the PBU's Staines Tongue reservoir for CO_2 storage. Data in the report shows the reservoirs viability to store 350 million cubic feet of by-product CO_2 per day. The

Table 4.1-3. Potential Geologic Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
	injected CO_2 plume would be well contained within the 42-square-mile project area after the Project's term of authorization. Once injection wells are shut-in, the pressure in the saline formation would decline and the CO_2 concentration within the CO_2 plume would reach equilibrium, thus making storage in the Staines Tongue feasible.

ADNR = Alaska Department of Natural Resources; DOG = Division of Oil and Gas; AOGCC = Alaska Oil and Gas Conservation Commission; CGF = Central Gas Facility; CO_2 = carbon dioxide; EIS = Environmental Impact Statement; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; MGS = Major Gas Sales; PBU = Prudhoe Bay Unit

4.1.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.1-4 summarizes the potential for impact to geologic resources within the KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU. Although the exact locations of the components of the KRU Development are unknown at this time, the majority of activities would only affect the unit and existing pipeline ROW area at a surficial level and have minimal impact on the deep geological features encompassed in the area. Operations for production and injection wells would have direct impact on oil and CO_2 storage resources **as well as the potential for indirect impacts on seismicity from CO_2 injections into the KRU reservoirs for EOR.**

Previous studies have found correlation between earthquakes, or seismic activity, and CO_2 injection for EOR (Gan and Frohlick 2013), concluding that large-scale geological storage of CO_2 carries a high probability of triggering earthquakes and finding that "even small- to moderate-sized earthquakes threaten the seal integrity of CO_2 repositories" (Zoback and Gorelick 2012). These studies state that an increased reservoir pressure or pressure build-up could cause stress on pre-existing faults, triggering seismic activity. These studies, however, focus on CO_2 injection into brittle rocks found within the continental interior, or the region between the Rocky Mountain and Appalachia-Ouachita fronts (Zoback and Gorelick 2012). Under Scenario 3, CO_2 injections would occur in the KRU, a historically established reservoir for gas and water injections. In mid-1988, CO_2 rich hydrocarbon miscible injection projects began in the KRU in stages through 1996, which encompassed 260 injection wells covering 70,000 acres (DOE 2005). The project was deemed a success producing incremental oil yields as stated by a 2005 DOE report. The same report identified active injecting of 0.2 Bcf/day and 0.2 MMbbl/day from 2 gas injection wells and 13 water injection wells, respectively. As previously discussed in Section 3.1.4.1, the KRU and the North Slope are characterized as generally inactive in terms of seismicity, with the latest major seismic activity having occurred on August 12, 2018, on previously unknown active right-lateral faults. While a higher seismic risk could be linked to a higher risk of reservoir leakage from an adversely impacted seal capacity, it is not always indicative of high leakage risk. This is evident from Cook Inlet data, where natural gas accumulations indicate various seals have not been breached, even in an area that continues to have strong and frequent seismic activity (Shellenbaum and Clough 2010). Additionally, data from a 2010 ADNR report depicts the North Slope as having good CO_2 reservoir and seal potential (Shellenbaum and Clough 2010). Therefore, while CO_2 EOR injection does have the potential for indirect adverse impact on geological resources and inducing seismic activity, the potential is low in the KRU.

Table 4.1-4. Potential Geologic Resource Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines would have no adverse impacts on geologic resources due to only surficial levels of disturbance.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	No adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would have permanent impacts on geologic resources as oil resources would be extracted and diminished from its geological source and under Scenario 3, CO_2 would be injected into unit storage reservoirs, altering the subsurface composition and pressure. A total of 3.62 Tcf of CO_2 would be stored in depths ranging from 6,000 to 6,250 ft in the C and A Sands of the KRU over the MGS period. This would meet the proposed Project's storage requirements. Under Scenario 3, utilization of by-product CO_2 from the proposed Project for CO_2 EOR on the North Slope could increase oil production by 473 million barrels. **Additionally, increased reservoir pressure from CO_2 EOR storage has the potential to cause an increase in seismic activity and indirectly have an adverse impact on reservoir seals leading to leakage. This adverse potential is minimized due to the nature of low seismic activity and good reservoir seals within the KRU.**

CO_2 = carbon dioxide; EOR = enhanced oil recovery; ft = feet; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; MGS = Major Gas Sales; PBU = Prudhoe Bay Unit; Tcf = trillion cubic feet

4.1.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operations of facilities on the North Slope considered within this **Final** SEIS could affect geologic resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include the following:

- Preparation of a Gravel Sourcing Plan and Reclamation Measures for construction activities requiring gravel that identifies the material volumes to be acquired from material sites, finalized in coordination with appropriate agencies. The plan would describe material requirements, sources, extraction protocols, transportation logistics, and reclamation measures.
- Preparation of a Project Paleontological Resources Management Plan and Project Paleontological Resources Unanticipated Discoveries Plan that address paleontological resources and includes specific mitigation measures that would be implemented to avoid or reduce adverse disturbance where there is high potential to encounter paleontological resources, or in the event that undocumented planetological resources are discovered.

Although the North Slope contains no anticipated adverse impacts from geologic hazards, the following mitigation measure would be considered to further reduce and monitor potential affects to upstream development facilities.

- To address earthquake and seismicity potential to cause damage to structures, all structures should be in compliance with the International Building Code, which requires structures to be designed to withstand ground accelerations expected to occur at the site location based on seismic hazard analysis.

4.1.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact geologic resources within the ROI. Overall, negligible to less-than-significant impacts would occur from construction and operation of project activities. Negligible impacts would occur for construction and operation of project features with only surficial levels of disturbance. Minor permanent impacts would occur due to operation of project features that interact with deeper geological features such as resource reservoirs or paleontological resources. Overall, the North Slope has no significant risk of impact from geologic hazards.

Overall adverse effects to geologic resources would be similar between Scenarios 2 and 3, including the additional potential adverse effects from lateral injection well construction required under Scenario 2 and the additional potential adverse effects from pipeline construction required under Scenario 3. The main difference in the scenarios' effects to geologic hazards, as described in Production Report 2, is that Scenario 2 would reduce the volume of total PBU oil production by 452 million barrels if initiated in 2029, while Scenario 3 would use captured by-product CO_2 for CO_2 EOR that would increase North Slope oil production by 473 million barrels and store approximately 3.62 Tcf of CO_2 in storage reservoirs. **While potential indirect, adverse impacts may result from the increased risk of seismic activity caused by CO_2 EOR injections, the potential risk is minimized due to the properties and location of the storage reservoir in the KRU. Other p**otential impacts would be mitigated by monitoring, regulation compliance, adherence to Project-specific plans, and implementation of mitigation measures identified in Section 4.1.5 and as required by state regulatory agencies such as the ADNR DOG for development of wells (see Section 3.1.6).

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4.2 SOILS AND SEDIMENTS

4.2.1 Summary of Soil and Sediment Impacts from the 2020 EIS

Table 4.2-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, FERC determined the proposed Project could have significant impacts to soils from permafrost degradation.

Table 4.2-1. Summary of Soil and Sediment Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Various construction activities, such as clearing, grading, granular fill placement, excavation, and foundation installation, could affect soil resources. Potential impacts from construction and operation of the proposed Project include compaction, permafrost degradation, differential thaw settlement, erosion and sedimentation, frost bulb development, frost heave, and the loss of soils to impervious surfaces for granular work pads. • Installation of granular work pads would conduct solar radiation to underlying soils, resulting in changes to thermal regimes in areas with thaw-sensitive permafrost. • Equipment and vehicle traffic could cause soil compaction or create fugitive dust. This dust would create a darker surface that would absorb more solar radiation and warm permafrost, resulting in a permanent effect. • Spills of fuel, oil, or other hazardous materials during construction and operation could contaminate soil.	• Most Project effects on soils would be less-than-significant. However, the long-term to permanent impacts on permafrost and substantial loss of soils due to granular fill placement would be significant.	4.2.4; 5.1.2

EIS = Environmental Impact Statement

4.2.2 Methodology to Assess Soil and Sediment Impacts

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. This analysis focuses on surface construction activities associated with upstream development activities and the potential impacts to soil stability and permafrost.

4.2.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to soils and sediments as described in Section 4.2 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.2.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities could impact soils and sediments. Land-clearing activities remove the protective vegetative cover and expose the soil to wind and rain, which increases the potential for soil erosion and sedimentation of sensitive areas. Erosion and generation of fugitive dust could warm permafrost soils resulting in thermokarst as the darker surface would absorb more solar radiation than adjacent snow-covered areas, thereby increasing surface temperatures. Additionally, grading, use of gradual fill, and equipment traffic could affect permafrost. The 2020 EIS identified that using granular fill in permafrost areas (e.g., pad development) could raise the soil surface temperature approximately 3.6 to 5.4ºF (2 to 3ºC) compared to the original vegetative layer, thereby increasing the thickness of the active layer. Granular pads can also act as heat sources that can become up to 50-percent warmer than surrounding areas during the summer (FERC 2020). Additionally, as stated in Section 2.2.1.1, typical well operations can cause a 10-meter (approximately 33-foot) radius of disturbance to near-bore permafrost around a non-insulated gas well operating for 30 years.

Permafrost degradation could permanently alter hydrology (e.g., by causing subsidence and thermokarst development, solifluction, soil creep, thawed layer detachment, and increased erosion) and vegetation, effects that, in addition to continued permafrost thaw, could spread laterally past the disturbance footprint as described above. **In addition, disturbance to permafrost and thermokarst development can cause the release of carbon in the form of the potent GHGs, CO_2 and CH_4, as well as sequestered atmospheric nitrogen in the form of N_2O (Voigt et al. 2017). Studies from nearby Utqiaġvik, Alaska, show thawing permafrost has the potential to increase CH_4 emissions by around 30 percent (Lara et al. 2019). These GHG emissions occur when frozen peat soils are stripped of their insulative vegetative mat and exposed to warmer in-situ temperatures.**

Construction activities such as trenching in permafrost soils could result in subsidence causing local changes in drainage patterns and potential irreparable impacts to wetland habitats for fish and wildlife. Once subsidence occurs, thermokarst becomes very difficult, if not impossible, to restore to its previous state. Maintaining the integrity of the insulating active layer is critical in regard to construction and maintenance of infrastructure in areas of continuous and discontinuous permafrost. Sections 4.2.4.1 through 4.2.4.3 discuss the type of impacts by activity on the North Slope that could occur as a result of the proposed Project.

Additionally, construction and operation activities have the potential for generating soil contamination from equipment use and the potential for releases of fuels, lubricants, and coolants. This potential would exist for all upstream development activities considered in this **Final** SEIS.

4.2.4.1 Point Thomson Unit

Table 4.2-2 summarizes the potential for impacts to soil resources within the PTU based on activity.

Table 4.2-2. Potential Soil Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad could have adverse impacts on soil resources due to required land clearing and potential for generation of fugitive dust and placement of gravel within permafrost soils. These effects could cause permafrost degradation that could extend beyond the immediate 7-acre footprint. Clearing and grading of the construction work area would affect permafrost and thermal energy balance due to the removal of vegetation and snow cover. The effects of permafrost alteration due to construction of the 7-acre Central Pad expansion area could include hydrologic impacts; subsidence and thermokarst development; and increased erosion. As described in Section 2.5, construction of the pad expansion would consider techniques to reduce potential impacts to permafrost such as buildings on the pads above the ground elevation on piles or pipe which allow for a cushion of cool ambient air between the facility and the gravel.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would have negligible adverse impacts on soils. No soils would be disturbed for the construction of the pad, which is created by snow compaction and adding a base layer of ice. As described in Section 2.5, construction of this pad would utilize a vapor barrier over the ice to prevent melting

Table 4.2-2. Potential Soil Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
	from rain and evaporation and insulation mats are placed over the vapor barrier and covered by white tarp to reflect sunlight and heat. They are rehabilitated each year by removing mats and insulation to fill and level any ice lost to melting over the summer, and the vapor barrier, insulation, and tarp are replaced. Therefore, potential for permafrost degradation would be reduced.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would have less-than-significant impacts on soil resources as the drilling activities would occur within the existing developed Central Pad that has been previously disturbed. Impacts would be localized to the drilling site and could produce minor amounts of fugitive dust.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Overall impacts would be less-than-significant. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	Dredging would have less-than-significant impacts to soil resources. Any excess material removed by dredging would be placed on land to the west of the Point Thomson marine facilities. Placement of excess material over permafrost soils could cause areas of degradation as dredged materials would absorb more solar radiation than adjacent snow-covered areas, thereby increasing surface temperatures.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have less-than-significant impacts to soil resources. As stated in Section 2.5.1, ice roads are built entirely of frozen water, either in snow or ice form, and require a permit from the ADNR. The permit for use considers minimum snow depths and ground hardness to prevent significant change in the depth of active layer, soil moisture, or vegetation composition from use.
Operations	Operations of proposed activities would generate less-than-significant impacts on soil resources. As previously described, both gravel pads and operation of wells can heat up the surrounding soil environment causing permafrost degradation outside the immediate operational footprint. Design considerations, including pad installation above ground level on piles or pipe and the installation of insulated conductors at production and disposal wells would minimize heat transfer and reduce adverse effects to permafrost.

ADNR = Alaska Department of Natural Resources; UIC = Underground Injection Control

4.2.4.2 Prudhoe Bay Unit

Table 4.2-3 summarizes the potential for impact to soil resources within the PBU based on activity. A majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells at PBU Well Pad 18 under Scenario 2.

Table 4.2-3. Potential Soil Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad could have adverse impacts on soil resources due to required land clearing, potential generation of fugitive dust, and placement of gravel within permafrost soils. These effects could cause permafrost degradation that could extend beyond the immediate 5-acre footprint. Clearing and grading of the construction work area would affect permafrost and thermal energy balance due to the removal of vegetation and snow cover. The effects of permafrost alteration due to construction of the 5-acre CGF expansion area could include hydrologic impacts; subsidence; thermokarst development; and increased erosion. As described in Section 2.5, construction of the pad expansion would consider techniques to reduce potential impacts to permafrost such as buildings on the pads above the ground elevation on piles or pipe which allow for a cushion of cool ambient air between the facility and the gravel.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of up to 10 new production and injection wells within the PBU would have less-than-significant impacts on soil resources. Impacts from land clearing and grading would be localized to the drilling site and could produce small amounts of fugitive dust.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Overall impacts would be negligible as the drilling would be conducted within existing developed areas.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines would have less-than-significant impacts on soil resources. As discussed in Section 2.5.3, pipeline construction would be aboveground and involves the use of VSMs. Direct impacts would be limited to the location of each support but could include generation of fugitive dust from land clearing and grading at support locations. VSM construction would reduce heat transfer to the underlying soils, thereby minimizing impacts on areas of thaw-sensitive permafrost.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.

Table 4.2-3. Potential Soil Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have less-than-significant impacts to soil resources. As stated in Section 2.5.1, ice roads are built entirely of frozen water, either in snow or ice form, and require a permit from the ADNR. The permit for use considers minimum snow depths and ground hardness to prevent significant change in the depth of active layer, soil moisture, or vegetation composition from use.
Operations	Operations of proposed activities would generate less-than-significant impacts on soil resources. As previously described, both gravel pads and operation of wells can heat up the surrounding soil environment causing permafrost degradation outside the immediate operational footprint. Design considerations, including pad installation above ground level on piles or pipe and the installation of insulated conductors at production and disposal wells would minimize heat transfer and reduce adverse effects to permafrost.

ADNR = Alaska Department of Natural Resources; CGF = Central Gas Facility; GTP = Gas Treatment Plant; PBU = Prudhoe Bay Unit; VSM = vertical support member

4.2.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.2-4 summarizes the potential for impact to soil resources within the KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.2-4. Potential Soil Resource Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of a 30-mile new pipeline would have less-than-significant impacts on soil resources. As discussed in Section 2.5.3, pipeline construction would be aboveground and involve the use of VSMs. Direct impacts would be limited to the location of each support but could include generation of fugitive dust from land clearing and grading at support locations. VSM construction would reduce heat transfer to the underlying soils, thereby minimizing impacts on areas of thaw-sensitive permafrost.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would generate less-than-significant impacts on soil resources. As previously described, the use of VSMs and aboveground nature of the pipelines would reduce overall potential for permafrost degradation.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; VSM = vertical support member

4.2.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operations of facilities on the North Slope considered within this **Final** SEIS could affect soil resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in

Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Fugitive Dust Plan that would contain procedures to minimize fugitive dust, reducing potential adverse effects of deposition on adjacent areas of permafrost and prevention of permafrost degradation. Measures could include using dust control abatement measures as needed during construction and operation; applying water to affected unpaved roads and staging areas; applying approved dust suppressants such as calcium chloride or water/magnesium chloride mixture; and reducing speed limits on unpaved roads.
- Preparation of a Restoration/Revegetation Plan that would reduce the potential for erosion and loss or movement of soil resources.
- Preparation of a SPCC Plan that would address the prevention of accidental spills and contamination of soils and address cleanup of releases of fuels, lubricants, and coolants.
- Preparation of a SWPPP that would manage construction sediments and prevent offsite migration in stormwater discharges.
- Preparation of a Winter and Permafrost Construction Plan that outlines the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan would discuss soil stabilization measures to be implemented to limit thermal and erosional degradation of the permafrost. Measures could include constructing in thaw-sensitive permafrost during the winter where possible.

Due to the sensitivity of permafrost and importance of permafrost cover to soil and infrastructure stability, maintaining natural hydrology and fish and wildlife habitats, and carbon sequestration, impacts to permafrost soils in areas of development activities would be avoided wherever possible. This includes placing proposed pipelines in permafrost areas on VSMs. In addition, DOE would consider requiring project proponents to implement monitoring of permafrost down to the depth of the active layer and incorporate adaptive management to minimize thawing and thermokarst development of permafrost soils associated with project construction and operations. Additionally, discharge of hydrostatic test water would be conducted in limited and designated areas to prevent thermal erosion or thermokarst development of permafrost.

In areas where topsoil would be disturbed, topsoil would be salvaged, wherever practicable, for use to facilitate restoration of temporarily disturbed areas. This would include salvaging frozen topsoil using equipment such as a frozen topsoil cutter specifically designed to remove frozen topsoil. The initial effort required to salvage and replace the topsoil would help facilitate recolonization of native species and, therefore, decrease impacts associated with slower revegetation (e.g., colonization by invasive non-native species, erosion, maintenance and associated costs, long-term impacts to aesthetic value, reseeding, fertilizing, and slower return of wetland functions).

4.2.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact soil resources within the ROI. Overall, less-than-significant impacts would occur from construction and operation of project activities. Impacts would primarily result from the disturbance of permafrost and resulting effects of permafrost degradation. The level of adverse effects to soil resources would be slightly greater under Scenario 3 due to the additional new pipeline required for CO_2 EOR. Potential impacts would be mitigated by monitoring, regulation compliance, adherence to Project-specific plans, and implementation of mitigation measures identified in Section 4.2.5 and as required by state regulatory agencies such as the ADNR for permitting permafrost construction.

4.3 WATER RESOURCES

4.3.1 Summary of Water Resource Impacts from the 2020 EIS

Table 4.3-1 provides a summary of potential impacts to water resources resulting from the proposed Project as assessed within the 2020 EIS. As indicated in the table, construction and operation of the proposed Project could adversely affect groundwater, freshwater, marine water, and water use. However, implementation of BMPs and adherence to Project-specific plans and federal and state permitting requirements would reduce or avoid these anticipated impacts. Most impacts are expected to be temporary and minor during construction. Potential long-term or permanent effects to floodplains and marine waters could occur but would be negligible or minor in severity. No significant impacts to groundwater, freshwater, marine water, or water use would be expected during construction or operation of the proposed Project.

Table 4.3-1. Summary of Water Resource Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
Groundwater		
• Surface drainage and groundwater recharge patterns could be affected by construction activities, such as clearing, grading, trenching, and site preparation. • Groundwater contamination could result from spills of fuel, oil, or other hazardous materials during construction and operation. • Blasting could temporarily affect water quality and yields in wells and springs by increasing turbidity.	• Short-term, minor to moderate groundwater impacts would be expected during Project construction. The potential for minor to moderate impacts from releases that could contaminate groundwater would also extend through Project operation. • If wells or springs are temporarily affected, AGDC would provide a new temporary or permanent source, repair the source, or compensate the owner for a comparable source. Such measures and additional BMPs, including discharging water into well-vegetated upland areas, would reduce or avoid potential adverse impacts. • Proper implementation of the following Project-specific plans would further reduce or avoid potential impacts to groundwater: ○ Project SPCC Plan ○ Project Procedures and Waste Management Plan ○ Groundwater Monitoring Plan ○ Project Acid Rock Drainage/Metal Leaching Management Plan ○ Project Water Well Monitoring Plan ○ Project Blasting Plan ○ Project Pipeline Right-of-Way Operational Monitoring and Maintenance Plan	4.3.1.5; 5.1.3
Freshwater		
• AGDC proposes use of five different methods to install the Mainline Pipeline beneath or across waterbodies with varying degrees of potential impact: ○ Wet-ditch open-cut method would disturb streambanks and beds resulting in temporary increases in turbidity and sedimentation.	• Most freshwater impacts due to increased turbidity and sedimentation would be localized and minor with implementation erosion and sediment controls and streambank stabilization procedures. These and other BMPs are outlined in the Project Plan and Procedures, SWPPP, and Revegetation Plan for the proposed Project.	4.3.2.4; 5.1.3

Table 4.3-1. Summary of Water Resource Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
○ Dry-ditch open-cut and frozen-cut methods would minimize these impacts by isolating flow or leveraging low floe or frozen conditions, but temporary increases in turbidity and sedimentation would occur when flow is re-established. ○ The aerial span method would avoid direct impacts by installing the pipeline above waterbodies on bridge-type structures or supports, though clearing and grading of streambanks could result in temporary impacts due to erosion. ○ The DMT method would avoid direct impacts because the pipeline would be installed beneath waterbodies by drilling. • During construction of the Mainline Pipeline, temporary bridges would be installed across waterbodies along the pipeline route. Installing these bridges would disturb substrate materials and streambanks, which would reduce water quality. These bridges could also impede stream flow during high flow events. • Construction dewatering, blasting, and accidental spills or releases of fuel and other hazardous materials could adversely affect water quality. • Material extraction in river channels could increase turbidity and sedimentation, potentially modify channel morphology, and negatively affect fish habitat. • Surface flow patterns within floodplains would be affected by clearing and ground-disturbing activities. Placement of granular fill would modify natural drainage and slightly reduce flood storage capacity.	• Impacts resulting from construction of bridges would be temporary and localized. Use of the bridges by construction equipment would avoid in-water impacts from traffic. The temporary bridges would be constructed to withstand a 10-year flood event in order to avoid the potential downstream impacts of a bridge wash out. • Implementation of BMPs in accordance with Project-specific plans would avoid, minimize, or mitigate potential impacts on water quality from construction dewatering, blasting, and accidental spills. • Installation of appropriate culverts would maintain streamflow following placement of granular fill for access roads and in-stream structures. • The proposed Project would result in minor short-term, long-term, and permanent impacts on floodplains. Short-term impacts on flood storage capacity and surface flow patterns from construction would be minor. A minor but permanent reduction in flood storage capacity would occur in areas where granular fill is required. • Excavated depressions from material sites could retain water, potentially providing beneficial functions, such as stormwater retention or habitat.	
Marine Waters		
• Nearshore construction activities could result in sedimentation in marine waters due to erosion from stormwater runoff and dewatering. • Inadvertent spills of fuel, oil, or other hazardous materials could affect water quality. • Disposal of dredged materials could cause localized temporary increases in turbidity and sedimentation. • Construction of offshore facilities would result in the permanent loss of open marine habitat. • The permanent extension of the West Dock Causeway and construction of Dock Head 4 could impede nearshore circulation, affecting local hydrographic conditions.	• Temporary, minor to moderate impacts to marine waters could result from nearshore construction activities in Prudhoe Bay. Impacts would be reduced or avoided through installation of erosion controls, adherence to APDES permits, and implementation of BMPs in accordance with Project Procedures and SWPPP for the proposed Project. • Accidental releases of fuel, oil, and other hazardous materials could affect marine water quality. Impacts would be reduced to less-than-significant levels through implementation of the material handling measures outlined in the Project Procedures and Project Water Management Plan, along with the fueling, storage, containment, and	4.3.3.3; 5.1.3

Table 4.3-1. Summary of Water Resource Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
	cleanup measures in a site-specific SPCC Plan for the proposed Project. • Turbidity and sedimentation caused by construction of offshore facilities, screeding, dredging, pile driving, anchoring, and other seabed disturbing activities would be temporary, localized, and minor. • Increases in vessel traffic would not increase turbidity or shoreline erosion due to the low speed of travel required for operational safety of the vessels.	
Water Use		
• AGDC would require the use of water for a variety of construction and operational activities, including hydrostatic testing, mixing drilling mud, ice road construction, dust control, and routine maintenance and repairs.	• Water withdrawals for the proposed Project would be subject to state permitting, including Temporary Water Use Authorizations and groundwater allocation permits issued by the ADNR. • On the North Slope, hydrostatic testing may occur year-round and require use of additives. This water would be discharged to two UIC Class I wells installed at the GTP. • Impacts on water sources from ice road and ice pad construction would be temporary and minor because surface water volumes would be replenished during spring melt. Ice bridges could affect stream flow at spring breakup, but AGDC would cut slots in the ice to direct meltwater and minimize flooding potential. • Water for proposed Project operation would be withdrawn from the GTP reservoir, which would avoid impacts on other surface waters. The reservoir would require annual withdrawal from the Putuligayuk River at peak flows, and effects on water level and quality would be temporary and minor. • Wastewater at the Gas Treatment Facilities would be discharged into two UIC Class I injection wells installed within the GTP pad footprint. Hydrostatic test water associated with the PTTL would be discharged to upland and wetland areas in accordance with applicable federal and state permit requirements.	4.3.4.3; 5.1.3

ADNR = Alaska Department of Natural Resources; AGDC = Alaska Gasline Development Corporation; APDES = Alaska Pollutant Discharge Elimination System; BMP = best management practice; DMT = directional micro-tunneling; EIS = Environmental Impact Statement; GTP = Gas Treatment Plant; PTTL = Point Thomson Unit Gas Transmission Line; SPCC = Spill Prevention, Control and Countermeasures; SWPPP = Stormwater Pollution Prevention Plan; UIC = Underground Injection Control

4.3.2 Methodology to Assess Water Resource Impacts

DOE assessed the potential impacts on water resources based on whether the proposed Project would:

- Deplete groundwater supplies on a scale that would affect the available capacity of a groundwater source for use by existing water rights holders, or interfere with groundwater recharge;
- Conflict with established water rights allocations or regulations that protect groundwater for future beneficial uses;
- Potentially contaminate drinking water aquifers;
- Conflict with tribal, regional or local aquifer management plans or goals of governmental water authorities;
- Alter stormwater discharges, which could adversely affect drainage patterns, flooding, erosion, and sedimentation;
- Alter infiltration rates, which could substantially increase or decrease the volume of surface water that flows downstream;
- Conflict with applicable stormwater management plans or ordinances;
- Violate any federal, tribal, state or regional water quality standards or discharge limitations;
- Modify surface waters such that water quality no longer meets water quality criteria or standards established in accordance with the CWA, state regulations or permits (including downgrades of surface water use classification or listing on the Nationwide Rivers Inventory [NRI]);
- Change the availability of surface water resources for current or future uses; or
- Increase riverine flooding (flooding risk to nearby properties) through altered land uses (e.g., development in floodplain areas) that change current flooding levels or patterns.

The following analysis considers impacts to water resources during construction and operations of the upstream facilities.

4.3.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to water resources as described in Section 4.3 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.3.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific surveys of water resources but instead uses data to identify water resources on the North Slope that may be affected by construction activities within the existing pipeline ROW and the PTU, PBU, and KRU.

Project construction would require the use of surface water and groundwater for hydrostatic testing, directional micro-tunneling activities, ice road construction, potable water, and activities such as dust control. PHMSA requires hydrostatic testing to be completed on pipeline segments before they are placed in service (see Section 2.5.3). Operations would require water for a variety of activities, including hydrostatic testing, emergency repairs, and potable water. The water needed for the construction and operational activities would be primarily sourced from surface waters, but substantial groundwater withdrawals would also be required.

ADEC developed an APDES general permit that authorizes the discharge of seven waste streams, including hydrostatic test water, from the construction, operation, and maintenance of oil and gas pipelines. The project applicant would obtain the required permits for all wastewater discharges (e.g., industrial and stormwater) associated with Project construction and operation. The specific sources, volumes, types, frequencies, rates, treatments, and disposal mechanisms for wastewater discharges, as well as the locations of potential outfalls and discharge points, would be determined by the project applicant as construction plans are finalized and through the acquisition of the required permits from ADEC (or the USEPA for discharges within the Denali National Park and Preserve). The project applicant would also obtain permits for injecting water discharged from hydrostatic testing into new UIC wells. See Section 1.6 for additional discussion of permits and authorizations applicable to the potential upstream development activities.

Sections 4.3.3.1 through 4.3.3.3 discuss the type of impacts by activity on the North Slope that could adversely affect groundwater, freshwater, marine water, and water use. As stated in Section 3.3, no floodplain mapping exists for the North Slope. **Although no mapping of the floodplains for waterways exists for the Project area, development of infrastructure such as pipelines and ice roads under Scenarios 2 and 3 within areas prone to flooding along waterways could adversely affect the course of floodwaters and the infrastructure placed within these locations. For example, proposed VSM and HSM pipeline construction could affect flow of floodwaters and cause debris jams that could also affect the integrity of the pipeline.** Section 3.19.3 contains a discussion on how climate change is affecting both riverine and coastal flooding**,** and Section 4.21 contains a discussion of incomplete and unavailable information.

4.3.4.1 Point Thomson Unit

Table 4.3-2 summarizes the potential for impacts to water resources within the PTU based on activity. These activities would occur under both Scenarios 2 and 3.

Table 4.3-2. Potential Water Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which could increase erosion and sedimentation and adversely affect water quality. This could adversely affect water quality in nearby surface waters and the Beaufort Sea to less-than-significant levels. There is one non-transient, non-community water system associated with the C-1 reservoir at Qiruk Camp within the PTU. However, the surface water intake for the system is located approximately 2.1 miles south of the Central Pad. As such, no impacts to this public water system would be anticipated during expansion of the Central Pad.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would temporarily affect water use. However, water used for construction of the proposed ice pad would be drawn from permitted surface water sources **approved by the ADNR Division of Mining, Land, and Water** (unpermitted sources would also be identified during the permitting process and avoided). Permitted water sources recharge annually, so no long-term reduction in water availability would be anticipated.

Table 4.3-2. Potential Water Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would occur in accordance with all applicable federal and state permitting requirements. As such, and since the proposed wells would be installed on the same pad as existing wells, no significant adverse impacts would be anticipated to water quality or overall water availability.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	No significant adverse impacts anticipated. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	As the dredging would occur in previously dredged/disturbed areas, no new or significant impacts to water resources would be expected. The dredged sediment material would be placed along the Beaufort Sea shoreline and could temporarily increase sedimentation and turbidity. All dredging would be performed in strict accordance with federal and state permitting regulations. As such, impacts to marine waters would remain negligible or less-than-significant.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	No significant adverse impacts anticipated. See discussion above regarding ice pads.
Operations	Operations of proposed activities would require water use and disposal of water into injection wells following hydrostatic testing of new pipelines associated with the proposed construction at the Central Pad. Adherence to project-specific plans and federal and state permitting requirements would reduce potential impacts to less-than-significant levels.

PTU = Point Thomson Unit; UIC = Underground Injection Control

4.3.4.2 Prudhoe Bay Unit

Table 4.3-3 summarizes the potential for impact to water resources within the PBU based on activity. The majority of impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells proposed at PBU Well Pad 18 under Scenario 2.

Table 4.3-3. Potential Water Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which could increase erosion and sedimentation and adversely affect adjacent water quality to less-than-significant levels. There are five surface water intakes and one public drinking water protection area located within the PBU. The drinking water intakes draw surface water from the Kuparuk Reservoir, Big Lake Reservoir, Webster Lake Reservoir, and Sagavanirktok River Reservoir and are located approximately 6.5 miles to 9.9 miles from the CGF Pad. However, due to the distances of these intakes from the CGF Pad, no impacts to this public water system would be anticipated during expansion.

Table 4.3-3. Potential Water Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells would cause some land disturbance localized to the drilling site. Drilling activities would be conducted in accordance with all applicable federal and state permitting requirements. As such, no significant adverse impacts would be anticipated to water quality or overall water availability.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	No significant adverse impacts anticipated. See discussion above regarding well drilling. Impacts would be negligible as the drilling would be conducted from existing developed areas.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could affect water resources through increased sedimentation and erosion or accidental release of product. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground. While this method of pipeline construction would reduce direct impacts to surface waters, construction near shorelines could increase local erosion and sedimentation.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would temporarily affect water use. However, water used for construction of the proposed ice road would be drawn from permitted surface water sources **approved by the ADNR, Division of Mining, Land, and Water** (unpermitted sources would also be identified during the permitting process and avoided). Permitted water sources recharge annually, so no long-term reduction in water availability would be anticipated.
Operations	Operations of proposed activities would require water use and disposal of water into injection wells following hydrostatic testing of new pipelines associated with the proposed construction at the CGF. Adherence to project-specific plans and federal and state permitting requirements would reduce potential impacts to less-than-significant levels.

GF = Central Gas Facility; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; ROI = region of influence; ROW = right-of-way; VSM = vertical support member

4.3.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.3-4 summarizes the potential for impact to water resources within the KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.3-4. Potential Water Resource Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could increase erosion and sedimentation in adjacent surface waters. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur. As such, adverse impacts to water quality would be less-than-significant.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would require water use and disposal of water into injection wells following hydrostatic testing of new pipelines. Adherence to project-specific plans and federal and state permitting requirements would reduce potential impacts to less-than-significant levels. All other project activities would occur within previously disturbed areas and are unlikely to result in new impacts to water resources.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.3.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect water resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Fugitive Dust Plan that would contain procedures to minimize fugitive dust, reducing potential adverse effects of deposition in water resources from ground disturbances during construction.
- Preparation of a Restoration/Revegetation Plan that would reduce the potential for runoff and sedimentation into adjacent waters.
- Preparation of a SPCC Plan that would address the prevention of accidental spills and contamination of soils and address cleanup of releases of fuels, lubricants, and coolants prior to reaching adjacent surface water or groundwater resources.
- **Preparation of a Project Culvert Design and Maintenance Plan to include provisions for maintaining the floodplain integrity both up and downstream from waterway crossings (e.g., roads) to the greatest extent possible.**

- Preparation of a SWPPP that would reduce the pollutants in stormwater discharges into adjacent waters during construction.
- Preparation of a Water Use Plan to identify different uses of water during construction. The plan would identify estimated operational water use volumes and sources. The plan would also demonstrate that reuse of water (e.g., for hydrostatic testing) has been considered and applied where practicable.
- **Preparation of a Facility Response Plan to demonstrate preparedness for a worst-case oil discharge, and a SPCC Plan to prevent environmental damage from the discharge of oil.**

In addition, any project involving disturbance to waters of the United States would require the applicant to obtain a USACE Section 404 Permit containing site-specific waterbody crossing plans and mitigation measures. **This would include design of upstream development activities such as VSM and HSM pipeline and ice road locations to avoid or minimize impacts to areas prone to flooding along waterways.**

4.3.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional water resources beyond those identified in the 2020 EIS. Overall adverse effects to water resources would be similar between Scenarios 2 and 3 with the exception of additional potential adverse effects from lateral injection well construction required under Scenario 2 compared to additional potential adverse effects from pipeline construction required under Scenario 3. DOE did not identify effects to water resources beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.3.5.

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4.4 WETLANDS

4.4.1 Summary of Wetland Impacts from the 2020 EIS

Table 4.4-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, construction and operation of the proposed Project could adversely affect wetlands within the ROI. However, implementation of BMPs and mitigation measures and adherence to Project-specific plans and federal and state permitting requirements would reduce or avoid these anticipated impacts. Potentially significant adverse impacts could arise from permanent loss and conversion of wetlands due to the use of granular fill and the long recovery time for forested wetland vegetation.

Table 4.4-1. Summary of Wetlands Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction and operation would affect palustrine emergent, shrub-scrub, forested, and estuarine wetlands. Impacts would result from clearing, granular fill placement, pipeline and facility installation, materials site and water reservoir development, fugitive dust, spills and leaks of fuel or other hazardous materials, invasive species, hydrostatic test water discharges, changes in drainage patterns, blasting, inadvertent releases from waterbody crossings, and use of ice roads and ice pads. • Granular fill placed in wetlands would result in substantial conversion to uplands and loss of wetland functions. • Development of the gravel mine and water reservoir would result in the permanent conversion of wetlands to open water.	• Most impacts would be temporary, short-term, or long-term, largely dependent on the vegetation affected. However, the substantial permanent loss and conversion of wetlands and wetland functions due to the use of granular fill and long recovery time for forested wetland vegetation would result in significant adverse impacts.	4.4.2; 5.1.4

EIS = Environmental Impact Statement

4.4.2 Methodology to Assess Wetland Impacts

DOE assessed the potential impacts on wetlands based on whether the proposed Project would:

- Direct loss of wetlands because of placement of dredge or fill material; or
- Alter or convert wetland function because of the removal of vegetation or contamination.

The following analysis considers impacts to wetlands during construction and operations of the upstream facilities.

4.4.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to wetlands as described in Section 4.4 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.4.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are “scenario”-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific wetland surveys but instead uses habitat data and past site data to identify wetlands on the North Slope that may be affected by construction activities within the existing pipeline ROW and the PTU, PBU, and KRU. Time of year can affect the extent of potential impacts; construction during winter months (i.e., outside of the growing period) would reduce potential impacts to wetland vegetation and to migrating birds that may utilize the wetlands.

Sections 4.4.4.1 through 4.4.4.3 discuss the type of impacts by activity on the North Slope that could adversely affect wetlands.

4.4.4.1 Point Thomson Unit

Table 4.4-2 summarizes the potential for wetland impacts within the PTU based on activity. These activities would occur under both Scenarios 2 and 3.

Table 4.4-2. Potential Wetlands Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which could increase erosion and sedimentation and adversely affect water quality and function of local wetlands. Approximately 22.6 acres of perennial lakes and ponds exist within 0.25 mile of the Central Pad. While construction would attempt to avoid direct impacts to wetland areas, the prevalence of such areas may mean that some permanent fill or temporary or permanent alteration of hydrology or vegetation could occur during construction. While permanently affected wetlands within this 7-acre area would represent a negligible proportion of overall wetland area on the North Slope, individual wetland areas may experience adverse effects as a result of the proposed expansion. Implementation of the plans and mitigation measures outlined in Section 4.4.5 would reduce these impacts to less-than-significant levels.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would temporarily affect wetland water quality and vegetation. However, no permanent fill would be required to construct the ice pad, and the ice pad would be allowed to melt at the end of its useful phase. As such, no permanent effects would be anticipated. Overall water levels would remain unchanged following the temporary use of the ice pad.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would occur in accordance with all applicable federal and state permitting requirements. As such, and since the proposed wells would be installed on the same pad as existing wells, no significant adverse impacts would be anticipated to wetlands.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	No significant adverse impacts anticipated. See discussion above regarding well drilling.

Table 4.4-2. Potential Wetlands Impacts within the Point Thomson Unit

Activity	Description of Impact
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	The proposed dredging would occur in previously dredged/disturbed marine areas, and the dredged material would be placed on land to the west of Point Thomson marine facilities. As such, increases in sedimentation and erosion could result in less-than-significant adverse impacts to wetlands.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	No significant adverse impacts anticipated. See discussion above regarding ice pads.
Operations	Operations of proposed activities would be unlikely to adversely affect wetlands as operational activities would be confined to existing disturbed/approved locations.

UIC = Underground Injection Control

4.4.4.2 Prudhoe Bay Unit

Table 4.4-3 summarizes the potential for wetland impacts within the PBU based on activity. The majority of impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells proposed at PBU Well Pad 18 under Scenario 2.

Table 4.4-3. Potential Wetlands Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 7 acres of ground disturbance, which could increase erosion and sedimentation and adversely affect water quality and function of local wetlands. Approximately 16.34 acres of perennial lakes and ponds exist within 0.25 mile of the CGF Pad. While construction would attempt to avoid direct impacts to wetland areas, the prevalence of such areas may mean that some permanent fill or temporary or permanent alteration of hydrology or vegetation could occur during construction. While permanently affected wetlands within this 5-acre area would represent a negligible proportion of overall wetland area on the North Slope, individual wetland areas may experience adverse effects as a result of the proposed expansion. Implementation of the plans and mitigation measures outlined in Section 4.4.5 would reduce these impacts to less-than-significant levels.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells would generate localized land disturbance at the drilling location, which could include wetlands. Drilling would occur in accordance with all applicable federal and state permitting requirements including Section 404 permit requirements and any specified avoidance and mitigation measures associated with permitting. As such, no significant adverse impacts to wetlands would be anticipated.
Scenario 2 only. **Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	No significant adverse impacts anticipated. See discussion above regarding well drilling. Impacts would be negligible as the drilling would be conducted from existing developed areas.

Table 4.4-3. Potential Wetlands Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could affect wetlands through increased sedimentation and erosion or accidental release of product. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground. While this method of pipeline construction would reduce direct impacts to surface waters, less-than-significant impacts may occur during construction.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would temporarily affect wetlands. However, no permanent fill would be required to construct the ice road, and the ice road would be allowed to melt at the end of its useful phase. As such, no permanent effects would be anticipated. When possible, the ice road would be routed to avoid direct impacts to wetlands; however, due to the prevalence of such resources in the area, temporary effects could occur. Water used to construct the proposed ice pad would be drawn from permitted surface water sources **approved by the ADNR, Division of Mining, Land, and Water**; permitted water sources would not include wetlands. During the use of the proposed ice pad, any potentially displaced wildlife would have abundant availability of temporary local alternative habitat. Overall water levels would remain unchanged following the temporary use of the ice pad. Potential temporary impacts to wetlands are expected to be less-than-significant.
Operations	Operations of proposed activities would be unlikely to adversely affect wetlands as operational activities would be confined to existing disturbed/approved locations.

CGF = Central Gas Facility; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.4.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.4-4 summarizes the potential for impact based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.4-4. Potential Wetlands Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could increase erosion and sedimentation in adjacent wetlands. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would be unlikely to adversely affect wetlands as operational activities would be confined to existing disturbed/approved locations.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.4.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect wetland resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Fugitive Dust Plan that would contain procedures to minimize fugitive dust, reducing potential adverse effects of deposition in wetland resources from ground disturbances during construction.
- Preparation of a Restoration/Revegetation Plan that would address restoration of wetland vegetation in areas temporarily disturbed from construction and avoid sedimentation into adjacent wetlands from ground disturbances.
- Preparation of an SPCC Plan that would provide management procedures for the prevention and cleanup of releases of fuels, lubricants, and coolants, as well as potentially hazardous materials to be implemented, reducing potential accidental discharge into wetlands.
- Preparation of a SWPPP that would reduce the pollutants in stormwater discharges into adjacent wetlands during construction.
- Preparation of a Wetland Mitigation Plan in conjunction with the USACE Section 404 permit process to mitigate unavoidable impacts to wetlands. **Fill placed in wetlands for temporary project needs would be removed to reclaim wetland functions wherever practicable.**
- Preparation of a Winter and Permafrost Construction Plan that outlines the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan would include measures to be implemented to limit thermal and erosional degradation of the permafrost and prevent impacts to wetlands and wetland hydrology.

Additionally, as required by the Section 404 permit process:

- The project applicant would file with USACE final wetland delineation reports that document the results of all field delineations completed for proposed project footprints. The reports would identify the type, location, and acreage for each wetland and provide impact summaries, indicating if permanent fill (including granular fill and cut fill material) is required in wetlands.

4.4.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional wetlands beyond those identified in the 2020 EIS. Overall adverse effects to wetlands would be similar between Scenarios 2 and 3 with the exception of additional potential adverse effects from lateral injection well construction required under Scenario 2 compared to additional potential adverse effects from pipeline construction required under Scenario 3. DOE did not identify effects to wetlands beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.4.5.

4.5 VEGETATION

4.5.1 Summary of Vegetation Impacts from the 2020 EIS

Table 4.5-1 provides a summary of potential vegetation impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, construction and operation of the proposed Project could adversely affect vegetation. However, implementation of BMPs and mitigation measures and adherence to Project-specific plans and federal and state permitting requirements would reduce or avoid these anticipated impacts. Potentially significant adverse impacts could arise if proposed construction and operation activities would permanently alter the existing vegetative community.

Table 4.5-1. Summary of Vegetation Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction and operation would result in temporary to permanent impacts due to disturbance, granular fill placement, clearing, facility installation, materials and disposal site development, and ROW maintenance. • Granular fill placement would result in the permanent loss of vegetation. • Soil impacts due to grading and trenching would affect plant composition and growth. Damage to soil structure and mixing of topsoil, subsoil, and rocks would reduce plant health and productivity. • Forest fragmentation and edge effects would occur along portions of the Mainline Pipeline corridor and new access roads. • Plant pests introduced as a result of construction could have a detrimental effect on plant communities. Construction and operations could spread NNIS, affecting adjacent plant communities or causing revegetation efforts to fail. • Fugitive dust and air pollution could have an adverse effect on biological soil crusts; ground disturbance could remove them.	• Overall impacts on scrub and herbaceous communities would be less-than-significant. Impacts on forest would be significant due to the larger area affected, longer recovery time, and long-term or permanent conversions to other cover types.	4.5.2; 5.1.5

EIS = Environmental Impact Statement; NNIS = non-native invasive species; ROW = right-of-way

4.5.2 Methodology to Assess Vegetation Impacts

DOE assessed the potential impacts on vegetation based on whether the proposed Project would:

- Diminish the value of habitat for plants;
- Permanently covert the existing vegetative community to another land cover or land use; or
- Introduce noxious or invasive plant species.

The following analysis considers impacts to vegetation during construction and operations of the upstream facilities.

4.5.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to vegetation as described in Section 4.5 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.5.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific vegetation surveys but instead uses land cover data and past site data to identify vegetation on the North Slope that may be affected by construction activities within the existing pipeline ROW and the PTU, PBU, and KRU. Time of year can affect the extent of potential impacts, with fewer impacts expected during winter months outside of the growing season.

Sections 4.5.4.1 through 4.5.4.3 discuss the types of impacts by activity within the ROI that could adversely affect vegetation.

4.5.4.1 Point Thomson Unit

Table 4.5-2 summarizes the potential for impacts to vegetation within the PTU based on activity. These activities would occur under both Scenarios 2 and 3.

Table 4.5-2. Potential Vegetation Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance and the clearing of existing vegetation within the construction area. However, any permanently affected vegetation within this 7-acre area would represent a negligible proportion of overall area on the North Slope. The location of construction adjacent to an existing industrial facility would reduce potential impacts to vegetation. As such, impacts to vegetation are expected to be negligible to less-than-significant.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would temporarily affect vegetation. Construction and use of an ice pad would crush herbaceous vegetation. However, no permanent fill would be required to construct the ice pad, and the ice pad would be allowed to melt at the end of its useful phase. As such, no permanent effects would be anticipated, and vegetation in the area would be allowed to recover following the useful life of the proposed ice pad. Effects to vegetation would be negligible to less-than-significant.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would not be expected to affect local vegetation.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	No impacts are anticipated. See discussion above regarding well drilling.

Table 4.5-2. Potential Vegetation Impacts within the Point Thomson Unit

Activity	Description of Impact
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	The proposed dredging would occur in previously dredged/disturbed marine areas, and the dredged material would be placed on land to the west of Point Thomson marine facilities. As such, negligible impacts to vegetation would be expected.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Negligible impacts are anticipated. See discussion above regarding ice pads.
Operations	Operations of proposed activities would be unlikely to adversely affect vegetation as operational activities would be confined to existing disturbed/approved locations.

UIC = Underground Control Unit

4.5.4.2 Prudhoe Bay Unit

Table 4.5-3 summarizes the potential for impacts to vegetation within the PBU based on activity. The majority of impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells proposed at PBU Well Pad 18 under Scenario 3.

Table 4.5-3. Potential Vegetation Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance and the clearing of existing vegetation within the construction area. However, any permanently affected vegetation within this 5-acre area would represent a negligible proportion of overall area on the North Slope. The location of construction adjacent to an existing industrial facility would reduce potential impacts to vegetation. As such, impacts to vegetation are expected to be negligible to less-than-significant.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production and injection wells could result in localized vegetation clearing at the drill site. Overall impacts are anticipated to be less-than-significant.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Construction of up to 7 new injection wells within Well Pad 18 would not be expected to affect local vegetation.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could affect vegetation. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground. While this method of pipeline construction would reduce the footprint affected on the ground and reduce direct impacts to vegetation, negligible to less-than-significant impacts to vegetation may occur during construction.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.

Table 4.5-3. Potential Vegetation Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of proposed ice road would temporarily affect vegetation. Construction and use of ice roads would crush herbaceous vegetation. However, no permanent fill would be required to construct the ice road, and the ice road would be allowed to melt at the end of its useful phase. As such, no permanent effects would be anticipated, and vegetation in the area would be allowed to recover following the useful life of the proposed ice road. Effects to vegetation would be negligible to less-than-significant.
Operations	Operations of proposed activities would be unlikely to adversely affect vegetation as operational activities would be confined to existing disturbed/approved locations.

CGF = Central Gas Facility; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.5.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.5-4 summarizes the potential for impact based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.5-4. Potential Vegetation Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could affect vegetation. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground. While this method of pipeline construction would reduce the footprint affected on the ground and reduce direct impacts to vegetation, negligible to less-than-significant impacts to vegetation may occur during construction.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would be unlikely to adversely affect vegetation as operational activities would be confined to existing disturbed/approved locations.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.5.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect vegetation. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Fugitive Dust Plan that would contain procedures to minimize fugitive dust, reducing potential adverse effects of deposition on vegetation from ground disturbances during construction.
- Preparation of a Noxious/Invasive Plant and Animal Control Plan to minimize the introduction and spread of invasive plant species in project work areas. This could include requirements for pre-construction NNIS surveys to identify and manage invasive plant species within or adjacent to project areas.
- Preparation of a Restoration/Revegetation Plan that would address restoration of vegetation in areas of temporarily disturbed from construction. This includes establishment of percent vegetation cover restoration goals and monitoring requirements for revegetation success. **As stated in Section 4.2.5, topsoil would be salvaged, wherever practicable, to facilitate restoration of temporarily disturbed areas and recolonization of native species, therefore decreasing impacts associated with slower revegetation (e.g., colonization by invasive non-native species, erosion, maintenance and associated costs, long-term impacts to aesthetic value, reseeding, fertilizing, and slower return of wetland functions).**

4.5.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional areas of land and associated vegetation. However, due to the existing developed oil and gas infrastructure within the ROI and the likely locations of proposed activities within and directly adjacent to existing pads and pipeline ROW with ongoing human activity, the extent of potential impacts to vegetation would be limited. Only short-term, less-than-significant, adverse effects would be anticipated within the ROI. DOE did not identify any potential adverse effects to vegetation beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.5.5.

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4.6 WILDLIFE RESOURCES

4.6.1 Summary of Wildlife Impacts from the 2020 EIS

Table 4.6-1 provides a summary of potential wildlife impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, construction and operation of the proposed Project could adversely affect wildlife. However, implementation of BMPs and mitigation measures and adherence to Project-specific plans and federal and state permitting requirements would reduce or avoid these anticipated impacts. Potentially significant adverse impacts could arise if proposed construction and operation activities would permanently displace wildlife or alter associated habitat.

Table 4.6-1. Summary of Wildlife Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
Terrestrial Wildlife		
• Project construction and operation would affect terrestrial wildlife due to loss or alteration of habitat and fragmentation. Impacts would be permanent at aboveground facilities, granular fill sites, along access roads, and in areas where cover types are modified for ROW maintenance. • Direct injury or mortality could occur due to construction or maintenance activities or vehicle and equipment collisions. • Clearing and grading in winter could affect hibernating mammals. • Trenching for the Mainline Pipeline could temporarily block animal movements across the ROW, which could disrupt seasonal activities or migration patterns. • Construction and operational noise could affect terrestrial wildlife. Most impacts would be behavioral, such as displacement to adjacent habitats, but noise could also disrupt breeding, hibernation, predation, and other temporal patterns. • Artificial lighting would temporarily and permanently affect behavior and habitat use. • The presence of humans could cause behavior changes, a decrease in reproduction success due to stress, and mortality.	• Project effects would be less-than-significant on most terrestrial species. Impacts would be greater for species with specialized habitat requirements where construction or operation would occur in sensitive habitats and/or during sensitive periods. However, population-level impacts on these species would not be anticipated. • For the Central Arctic Caribou Herd, impacts would be significant due to the timing of impacts during sensitive periods, permanent impacts on sensitive habitats, and the proposed Project location at the center of the herd's range.	4.6.1; 5.1.6.1
Avian Resources		
• Project construction and operation would affect avian resources as a result of habitat degradation and loss; increased stress, injury, and mortality; disturbance and displacement; and loss of reproductive opportunity. • Impacts would result from clearing and grading, granular fill placement, facility installation, water withdrawal and discharge, ROW maintenance, noise, light, collisions, spills, vessel traffic, aircraft, and human disturbance. • The discharge of hydrostatic test water during the nesting season could destroy eggs and nestlings of ground-nesting birds. • Impacts on nesting habitat would be permanent in areas affected by granular fill placement or where full recovery of vegetation is not possible.	• Impacts on birds from Project-related noise would not be significant. The proposed Project would not result in significant adverse effects on avian resources.	4.6.2; 5.1.6.2

Table 4.6-1. Summary of Wildlife Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Permanent habitat loss for birds would result from habitat conversion or loss due to maintenance of the ROW and installation of aboveground facilities. • Some open water habitat would be created at material extraction sites, which could benefit waterbirds. • Construction noise would temporarily displace birds from adjacent habitats. Operational noise could make the habitat around these facilities uninhabitable by birds. • Artificial light from construction and operation can be disorienting for birds, increase the risks of collision and predation, and affect foraging behavior and navigation. • Increased vehicle, aircraft, and vessel traffic could disturb or displace birds or cause injury or death due to collisions. Birds are also susceptible to collisions with facility structures, such as flare stacks, buildings, and communication towers. • Construction camps and permanent facilities would create the potential for bird-human interactions and changes in bird behavior or habitat use. • Waste generation could attract bird predators.		

EIS = Environmental Impact Statement; ROW = right-of-way

4.6.2 Methodology to Assess Wildlife Impacts

DOE assessed the potential impacts on wildlife based on whether the proposed Project would:

- Displace terrestrial or aquatic communities or result in loss of habitat;
- Diminish the value of habitat for wildlife;
- Interfere with the movement of native resident or migratory wildlife species; or
- Conflict with applicable management plans for terrestrial and avian and their habitat.

The following analysis considers impacts to wildlife during construction and operations of the upstream facilities.

4.6.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to wildlife as described in Section 4.6 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.6.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific wildlife surveys but instead uses habitat data and past site data to identify wildlife resources on the North Slope that may be affected by construction activities within the existing pipeline ROW and the PTU, PBU, and KRU. Time of year can affect the extent of potential impacts. Construction timed to avoid nesting seasons and migration seasons (i.e., generally during the winter months) would reduce or avoid adverse impacts from construction and operations.

Construction and operation of upstream development activities on the North Slope could affect wildlife resources, including terrestrial species and avian resources (potential impacts to aquatic resources and to threatened and endangered species are discussed in Sections 4.7 and 4.8, respectively). Sections 4.6.4.1 through 4.6.4.3 discuss the types of impacts by activity within the North Slope that could adversely affect wildlife.

4.6.4.1 Point Thomson Unit

Table 4.6-2 summarizes the potential for impacts to wildlife within the PTU based on activity. These activities would occur under both Scenarios 2 and 3.

Table 4.6-2. Potential Wildlife Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which has the potential to adversely affect local wildlife and surrounding habitat. Due to the current existence of the Central Pad and the associated human activity, it is unlikely that the affected area supports high-quality wildlife habitat. Potential impacts are likely limited to noise and temporary disturbance or displacement during construction. Potential adverse impacts to wildlife expected to be less-than-significant.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which has the potential to adversely affect local wildlife and surrounding habitat. Due to the current existence of the Central Pad and the associated human activity, it is unlikely that the affected area supports high-quality wildlife habitat. Potential impacts are likely limited to noise and temporary disturbance or displacement during construction. The multi-season ice pads are designed to be temporary in nature. At the end of their useful lifespan, the ice pads would be allowed to melt. Over time, the area would revert to its preconstruction tundra habitat. Potential adverse impacts to wildlife expected to be less-than-significant.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Noise associated with construction of the four new production wells within the Central Pad could affect wildlife in the vicinity. The potential for disturbance, however, would be reduced as the Central Pad already supports operational production wells and associated human activity. This is a developed area and previously disturbed, and local wildlife would be accustomed to some noise. Potential effects are likely to be temporary disturbance or displacement during the drilling of wells. Potential adverse impacts to wildlife expected to be less-than-significant.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant impacts anticipated. See discussion above regarding well drilling.

Table 4.6-2. Potential Wildlife Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	Dredging of materials could adversely affect the coastal area where material is deposited, as well as any avian species or terrestrial wildlife within that area. As the dredging would remove a comparatively small volume of material and would occur in previously dredged/disturbed areas, impacts to wildlife would be unlikely. Potential adverse impacts to wildlife expected to be less-than-significant.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Due to their temporary nature, construction and use of ice roads, if required, would be unlikely to have long-term adverse impacts on wildlife. Ice roads in the North Slope are used for approximately 2.5 months of the year. While there may be temporary noise or disturbance during construction, the roads are not likely to form a barrier that would restrict wildlife movement in the area. The potential exists for limited mortality of terrestrial wildlife due to use of the ice road. However, this effect would be less-than-significant and unlikely to affect wildlife on a species level, especially due to the limited timeframe of ice road use.
Operations	Operations of proposed activities would be unlikely to adversely affect wildlife as operational activities would be confined to existing disturbed/approved locations and similar to ongoing activities currently conducted at the Central Pad.

EIS = Environmental Impact Statement; UIC = Underground Injection Control

4.6.4.2 Prudhoe Bay Unit

Table 4.6-3 summarizes the potential for impacts to wildlife within the PBU based on activity. The majority of impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells proposed at PBU Well Pad 18 under Scenario 2.

Table 4.6-3. Potential Wildlife Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which has the potential to adversely affect local wildlife and surrounding habitat. Due to the current existence of the CGF Pad and the associated human activity, it's unlikely that the affected area supports high-quality wildlife habitat. Potential impacts are likely limited to noise and temporary disturbance or displacement during construction. Potential adverse impacts to wildlife expected to be less-than-significant.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Noise associated with construction of the 10 new production wells within the CGF Pad could affect wildlife in the vicinity. The potential for disturbance, however, would be reduced as the CGF Pad already supports operational production wells and associated human activity. This is a developed area and previously disturbed, and local wildlife would be accustomed to some noise. Potential effects are likely to be temporary disturbance or displacement during the drilling of wells. Potential adverse impacts to wildlife expected to be less-than-significant.
Scenario 2 only. **Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	No significant adverse impacts anticipated. See discussion above regarding well drilling. Impacts would be negligible as the drilling would be conducted from existing developed areas.

Table 4.6-3. Potential Wildlife Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could disturb local wildlife. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, potentially restricting impacts to placement of VSMs where ground disturbance would occur. It is not anticipated that the proposed pipeline would introduce a barrier to wildlife movement through the area. The presence of heavy machinery to construct the pipeline would have the potential to cause injury or accidental mortality to some wildlife, though such effects would be negligible and would not represent a population-level effect.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Due to their temporary nature, construction and use of ice roads, if required, would be unlikely to have long-term adverse impacts on wildlife. Ice roads on the North Slope are used for approximately 2.5 months of the year. While there may be temporary noise or disturbance during construction, the roads are not likely to form a barrier that would restrict wildlife movement in the area. The potential exists for limited mortality of terrestrial wildlife due to use of the ice road. However, this effect would be less-than-significant and unlikely to affect wildlife on a species level, especially due to the limited timeframe of ice road use.
Operations	Operations of proposed activities would be unlikely to adversely affect wildlife as operational activities would be confined to existing disturbed/approved locations and similar to ongoing activities currently conducted at the CGF Pad.

CGF = Central Gas Facility; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.6.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.6-4 summarizes the potential for impacts to wildlife within the KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.6-4. Potential Wildlife Resource Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could disturb local wildlife. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, potentially restricting impacts to placement of VSMs where ground disturbance would occur. It is not anticipated that the proposed pipeline would introduce a new barrier to wildlife movement through the area as existing ROW or areas directly adjacent to existing ROW would be used. The presence of heavy machinery to construct the pipeline would have the potential to cause injury or accidental mortality to some wildlife, though such effects would be negligible and would not represent a population-level effect.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would be unlikely to adversely affect wildlife as operational activities would be confined to existing disturbed/approved locations and similar to ongoing activities currently conducted at the KRU.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.6.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect wildlife resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Lighting Plan that would describe required measures to provide adequate lighting for the prevention of accidents and compliance with Occupational Safety and Health Administration requirements while reducing visible light disturbance to wildlife, as practicable.
- Preparation of a Marine Mammal Monitoring and Mitigation Plan that would describe measures to be implemented during in-water construction activities (e.g., noise mitigation measures from dredging activities at PTU) in Prudhoe Bay to comply with the MMPA and ESA.
- Preparation of a Migratory Bird Conservation Plan that contains the procedures to be implemented during construction, operation, and maintenance for avian protection. Measures could include requiring vegetation clearing or initial granular fill placement outside of the nesting season within the boundaries of the IBAs.
- Preparation of a Noxious/Invasive Plant and Animal Control Plan to minimize the introduction and spread of invasive animal species in project work areas.

- **Preparation of a SPCC Plan that would address the prevention of accidental spills and contamination of terrestrial and aquatic habitat and address cleanup of releases of fuels, lubricants, and coolants. Measures would include response associated with spills in an iced environment to reduce the extent of impacts to terrestrial and aquatic habitats.**
- Preparation of a Restoration/Revegetation Plan that would address restoration of vegetation and related wildlife habitat in areas of temporarily disturbed from construction.
- **Preparation of a Winter and Permafrost Construction Plan that outlines the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan would discuss soil stabilization measures to be implemented to limit thermal and erosional degradation of the permafrost. Measures related to wildlife protection would include avoiding use of synthetic monofilament mesh/netted erosion control materials in, and adjacent to, sensitive wildlife habitat as these materials perpetuate in the environment and can disperse into sensitive areas posing a significant threat to wildlife through ingestion and strangulation.**

In addition to the plans above, potential impacts to wildlife could be minimized by performing construction activities during the winter months and localizing construction to locations where oil and gas development activities already occur. Timing these activities during winter months would avoid impacts during times when wildlife are most active (i.e., migration) or during important life stages (i.e., nesting), thereby reducing overall impacts experienced by wildlife. USFWS recommends avoiding clearing vegetation during the following time periods in northern Alaska (USFWS 2009):

- **Shrub or open habitat.** July 1 – July 31 (through August 10 for black scoter habitat)
- **Seabird colonies, including cliff and burrow colonies.** May 20 – September 15
- **Raptor and raven cliffs.** April 15 – August 15

4.6.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional areas of land that may support existing wildlife populations and associated habitat. Overall, adverse effects to wildlife and their associated habitat would be greater under Scenario 3 than Scenario 2. Scenario 3 would require the construction of an approximately 30-mile long, linear CO_2 pipeline that would cross multiple habitats between PBU and KRU. On the other hand, lateral wells constructed under Scenario 2 would originate on the well pad and be emplaced below ground, avoiding impacts to habitats and species at the surface. Due to the existing developed oil and gas infrastructure within the ROI and the likely locations of proposed activities within and directly adjacent to existing pads and pipeline ROW with ongoing human activity, high-quality habitat is not anticipated to be affected during construction and operation. Short-term noise and construction activities could result in the disturbance or temporary displacement of local wildlife, and use of ice roads may result in the accidental mortality of a limited number of individuals. However, long term effects or those at a population scale are not anticipated. Only short-term, less-than-significant, adverse effects would be anticipated within the ROI. DOE did not identify any potential adverse effects to wildlife resources beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.6.5.

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4.7 AQUATIC RESOURCES

4.7.1 Summary of Aquatic Resource Impacts from the 2020 EIS

Table 4.7-1 provides a summary of potential aquatic resources impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, construction and operation of the proposed Project could adversely affect aquatic resources. However, implementation of BMPs and mitigation measures and adherence to Project-specific plans and federal and state permitting requirements would reduce or avoid these anticipated impacts. Potentially significant adverse impacts could arise if proposed construction and operation activities would affect fisheries or alter or reduce overall availability of EFH.

Table 4.7-1. Summary of Aquatic Resource Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction and operation would result in temporary and permanent impacts on freshwater and marine fisheries and their environments. Activities resulting in turbidity and sedimentation, alteration or removal of cover, blasting, introduction of pollutants, introduction of aquatic nuisance and nonindigenous fish species, permafrost degradation, water depletions, or entrainment or impingement could increase rates of stress, injury, or mortality of fish. • Construction activities within or adjacent to streams and wetlands could increase turbidity and sedimentation, alter stream channels or substrate composition, alter or remove cover, increase erosion, or degrade habitat. • Impacts on fish could include displacement; changes in feeding or breeding behaviors; interference with passage; and stress, injury, or death. • Open-cut pipeline crossings at waterbodies with overwintering habitat could increase sedimentation downstream of the crossing through unfrozen deep water. Overwintering fish would not be able to escape construction equipment or increased turbidity, which could affect local populations. • Blasting in waterbodies for material extraction or trench excavation could cause turbidity and downstream sedimentation and potentially harm fish. • Long-term impacts on fish, particularly salmon, could occur if poorly designed or maintained culverts restrict the movement of migrating adults or fry. • Construction activities in the water could result in the permanent loss of fish habitat. • Water withdrawals from surface freshwater sources could affect fish due to entrainment or impingement, reductions in water levels or flows, habitat degradation, or changes in water temperature or quality. Impacts could include reduced productivity; interference with passage; or increased stress, injury, or death. • Artificial light could affect fish. • Temporary and permanent shading of the seabed would result from construction of Project facilities. Shading from over-water structures could displace or cause changes in fish behavior.	• Impacts would generally be localized, temporary, and minor. The proposed Project would not result in significant adverse effects on fisheries.	4.7; 5.1.7.1

Table 4.7-1. Summary of Aquatic Resource Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Noise impacts on fish could result from pile driving, excavation, dredging, screeding, vertical support member installation, directional micro-tunneling, and vessel operations. Impacts could include displacement, behavioral changes, masking, hearing loss, injury, or death. • Additional vessel traffic would increase the risk of spills in marine habitats.		

EIS = Environmental Impact Statement

4.7.2 Methodology to Assess Aquatic Resource Impacts

DOE assessed the potential impacts on aquatic resources based on whether the proposed Project would:

- Conflict with applicable management plans for aquatic species and their habitat;
- Diminish the value of habitat for fish species; or
- Reduce native fish populations.

The following analysis considers impacts to aquatic resources during construction and operations of the upstream facilities.

4.7.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to aquatic resources as described in Section 4.7 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.7.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific surveys but instead uses habitat data and past site data to identify aquatic resources on the North Slope that may be affected by construction activities within the existing pipeline ROW and the PTU, PBU, and KRU.

Sections 4.7.4.1 through 4.7.4.3 discuss the types of impacts by activity within the North Slope that could adversely affect aquatic resources.

4.7.4.1 Point Thomson Unit

Table 4.7-2 summarizes the potential for impacts to aquatic resources within the PTU based on activity. These activities would occur under both Scenarios 2 and 3.

Table 4.7-2. Potential Aquatic Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which has the potential to increase erosion and sedimentation to nearby freshwater and marine waterways. Due to the current existence of the Central Pad, the associated human activity, and the limited nature of the expansion in relation to the area of the North Slope and the PTU, it is expected that erosion and sedimentation would result in temporary, negligible to less-than-significant impacts to aquatic resources.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which has the potential to increase erosion and sedimentation to nearby freshwater and marine waterways. Drawing water from surface waterbodies for creation of the ice pad could impinge fish on intake structures. This impact would be less likely in freshwater lakes and ponds; while freshwater sources are abundant on the North Slope, they only support limited populations of fish, if any at all. Fish entrainment would be more likely if saltwater would be drawn from the Beaufort Sea for the ice pad. The multi-season ice pads are designed to be temporary in nature, and impacts would be expected to be temporary and less-than-significant in relation to overall fish population.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction and operation of four new wells at an existing pad is not expected to affect aquatic resources, including fisheries or EFH.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	No impacts anticipated. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	In general, dredging of materials could adversely affect marine fish or EFH. As the dredging would occur in previously dredged/disturbed areas and would be temporary in nature, new impacts to marine species would be less-than-significant. Dredging would allow for increased vessel traffic within the ROI and the Beaufort Sea as barges deliver equipment required for construction and operation of the proposed Project. The potential impacts on marine species from vessel traffic were assessed in the 2020 EIS and found to be less-than-significant due to the ephemeral nature of vessels in transit. As discussed in Section 4.16, dredging activities would have temporary, less-than-significant impacts to the noise environment; however, activities would not exceed the NMFS's disturbance thresholds for underwater noise levels.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Less-than-significant impacts anticipated. See discussion above regarding the proposed ice pad.
Operations	Operations of proposed activities would be unlikely to adversely affect aquatic resources as operational activities would be confined to existing disturbed/approved locations and similar to ongoing activities currently conducted at the Central Pad.

EFH = Essential Fish Habitat; EIS = Environmental Impact Statement; NMFS = National Marine Fisheries Service; PTU = Point Thomson Unit; ROI = region of influence; UIC = Underground Injection Control

4.7.4.2 Prudhoe Bay Unit

Table 4.7-3 summarizes the potential for impacts to aquatic resources within the PBU based on activity. The majority of impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells proposed at PBU Well Pad 18 under Scenario 2.

Table 4.7-3. Potential Aquatic Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1 and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which has the potential to increase erosion and sedimentation to nearby freshwater and marine waterways. Due to the current existence of the CGF Pad, the associated human activity, and the limited nature of the expansion in relation to the area of the North Slope and the PBU, it is expected that erosion and sedimentation would result in temporary, negligible to less-than-significant impacts to aquatic resources.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction and operation of 10 new production wells and injection wells at existing pads is not expected to have significant impacts to aquatic resources, including fisheries or EFH. It is assumed the wells would not be sited within aquatic habitat.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	No significant adverse impacts anticipated. See discussion above regarding well drilling. Impacts would be negligible as the drilling would be conducted from existing developed areas.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, potentially restricting impacts to placement of VSMs where ground disturbance would occur. The presence of heavy machinery to construct the pipeline and any ground disturbance required to emplace VSMs would have the potential to increase erosion and sedimentation into surface waters. **VSM installation on the North Slope, however, typically takes place during the winter months when ice roads and ice pads would support the heavy equipment reducing the potential for impacts to negligible levels**. Overall impacts to aquatic resources from pipeline construction would be less-than-significant.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.

Table 4.7-3. Potential Aquatic Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Drawing water from surface waterbodies for creation of the ice road could impinge fish on intake structures. This impact would be less likely in freshwater lakes and ponds; while freshwater sources are abundant on the North Slope, they only support limited populations of fish, if any at all. Fish entrainment would be more likely if saltwater would be drawn from the Beaufort Sea for the ice pad. The ice road would be designed to be temporary in nature, and impacts would be expected to be temporary and less-than-significant in relation to overall fish population.
Operations	Operations of proposed activities would be unlikely to adversely affect aquatic resources as operational activities would be confined to existing disturbed/approved locations and similar to ongoing activities currently conducted at the CGF Pad.

CGF = Central Gas Facility; EFH = Essential Fish Habitat; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; VSM = vertical support member

4.7.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.7-4 summarizes the potential for impact based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.7-4. Potential Aquatic Resource Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, potentially restricting impacts to placement of VSMs where ground disturbance would occur. The presence of heavy machinery to construct the pipeline and any ground disturbance required to emplace VSMs would have the potential to increase erosion and sedimentation into surface waters. **VSM installation on the North Slope, however, typically takes place during the winter months when ice roads and ice pads would support the heavy equipment reducing the potential for impacts to negligible levels**. Overall impacts to aquatic resources from pipeline construction would be less-than-significant.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would be unlikely to adversely affect aquatic resources as operational activities would be confined to existing disturbed/approved locations and similar to ongoing activities currently conducted at the KRU.

CO_2 = carbon dioxide; EFH = Essential Fish Habitat; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; VSM = vertical support member

4.7.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect aquatic resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Fugitive Dust Plan that would contain procedures to minimize fugitive dust, reducing potential adverse effects of deposition in aquatic resources from ground disturbances during construction.
- Preparation of a Noxious/Invasive Plant and Animal Control Plan to minimize the introduction and spread of invasive species into aquatic habitats adjacent to project work areas.
- Preparation of a SPCC Plan that would address the prevention of accidental spills and contamination of soils and address cleanup of releases of fuels, lubricants, and coolants prior to reaching adjacent aquatic habitats.
- Preparation of a SWPPP that would reduce the pollutants in stormwater discharges into adjacent aquatic habitats during construction.
- Preparation of a Water Use Plan to identify different uses of water during construction. The plan would identify appropriate water sources and uses to reduce impacts to aquatic resources and habitat. This could include withdrawal rate restrictions to specific surface waters, including waters containing EFH; positioning of water withdrawal pump intakes from the stream bed to avoid the entrainment of eggs or fry from the gravel bed; and use of screen openings on all water withdrawal equipment of 0.25 inch (0.1 inch or less in areas with sensitive life stages, e.g., pink and chum salmon fry, whitefish fry, and arctic grayling fry) to reduce the risk of impingement of small or juvenile fish.
- Preparation of a Winter and Permafrost Construction Plan that outlines the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost, reducing adverse impacts to aquatic habitats.

4.7.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional aquatic resources beyond those identified in the 2020 EIS. Overall adverse effects to aquatic resources would be similar between Scenarios 2 and 3 with the exception of additional potential adverse effects from lateral injection well construction required under Scenario 2 compared to additional potential adverse effects from pipeline construction required under Scenario 3. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.7.5. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.7.5.

4.8 THREATENED, ENDANGERED, AND OTHER SPECIAL STATUS SPECIES

4.8.1 Summary of Impacts to Threatened, Endangered, and Other Special Status Species from the 2020 EIS

Table 4.8-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS.

Table 4.8-1. Summary of Impacts to Threatened, Endangered, and Other Special Status Species from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• USFWS and NMFS identified 32 federally listed threatened or endangered species, distinct population segments, or evolutionarily significant units known to occur in the Project area, including 7 with designated critical habitat in the Project Area. Of these, Project construction and operation would have no effect on 2 species, is not likely to adverse effect 23 species, and is likely to adversely affect 6 species (spectacled eider, polar bear, bearded seal, Cook Inlet beluga whale, humpback whale, and ringed seal). The proposed Project is not likely to adversely affect designated critical habitat for five species and is likely to adversely affect designated critical habitat for two species (polar bear and Cook Inlet beluga whale). • Based on the 2008 and 2010 BLM 6840 Manual, 89 sensitive or watch list species have the potential to occur in the Project area on BLM lands. Five of these species (Alaska-breeding Steller's eider, spectacled eider, northern sea otter, polar bear, and wood bison) are federally listed. • Based on the 2015 Alaska Wildlife Action Plan, 26 species of greatest conservation need have the potential to occur in the Project area. Eight of these (short-tailed albatross, spectacled eider, Alaska-breeding Steller's eider, Cook Inlet beluga whale, blue whale, North Pacific right whale, northern sea otter, and polar bear) are federally listed under the ESA. The Cook Inlet beluga whale, blue whale, North Pacific right whale, northern sea otter, northern fur seal, and polar bear are protected under the MMPA.	• Impacts on six federally listed threatened or endangered species, distinct population segments, or evolutionarily significant units (spectacled eider, polar bear, bearded seal, Cook Inlet beluga whale, humpback whale, and ringed seal) would or could be adverse. • Permanent loss of suitable habitats would be limited, with significant amounts of similar habitats available in adjacent areas. Therefore, impacts on BLM sensitive and watch list species would not be expected to be significant. • Permanent habitat loss would be small in comparison to other habitat available for use. Impacts on most SGCN would be temporary, with the exception of the federally listed Cook Inlet beluga whales, which could be affected by noise impacts from pile driving.	4.8; 5.1.8

BLM = Bureau of Land Management; EIS = Environmental Impact Statement; ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; NMFS = National Marine Fisheries Service; SGCN = Species of Greatest Conservation Need; USFWS = U.S. Fish and Wildlife Service

4.8.2 Methodology to Assess Impacts to Threatened, Endangered, and Other Special Status Species

To evaluate the impacts on threatened, endangered, or other special status species, DOE reviewed the Proposed Action and No Action Alternative to determine whether any activities have the potential to cause the following:

- Direct or indirect "taking" of specific protected species;
- Impairment to critical habitat for specific protected species; or
- Reduction in threatened or endangered species population or community.

The following analysis considers impacts to threatened, endangered, and other special status species during construction and operations of the upstream facilities.

4.8.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to threatened, endangered, and other special status species as described in Section 4.8 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.8.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities on the North Slope could adversely affect threatened, endangered, or other special status species, if present. These could include ESA-listed species, NMFS protected species, and Alaska SGCN. Adverse effects could include the "take" of special status species, or the alteration or destruction of critical habitat. Sections 4.8.4.1 through 4.8.4.3, therefore, discusses the type of impacts by activity within the ROI that could adversely affect a threatened, endangered, or other special status species, or associated critical habitat, if present.

4.8.4.1 Point Thomson Unit

The discussion on adverse effects to threatened, endangered, and other special status species within PTU focuses on potential effects resulting from disturbance occurring within vicinity of the Central Pad and docking facilities affected by the proposed PTU Expansion which would occur under both Scenarios 2 and 3. Prior to any ground disturbance activities, however, the project proponent for the PTU Expansion would conduct the necessary consultation efforts and any required surveys to identify the presence of protected species. Table 4.8-2 summarizes the potential for impact to threatened, endangered, and other special status species within the PTU based on activity.

Table 4.8-2. Potential Impacts to Threatened, Endangered, and Other Special Status Species within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would convert approximately 7 acres of polar bear critical habitat to developed land. This 7-acre parcel represents approximately 0.008 percent of polar bear critical habitat currently existing within the PTU and could also provide habitat for the spectacled eider, which nests in lowland wetland areas on the coastal tundra. The expansion would be located at the existing Central Pad adjacent to a currently developed site and associated human disturbance. As such, it is unlikely that this area supports high-quality terrestrial habitat or that sensitive species are common in the vicinity including the spectacled eider. Direct adverse effects are expected to be unlikely, but sensitive species could be disturbed by noise related to temporary construction activities. While the proposed expansion of the Central Pad could adversely affect sensitive species and polar bear critical habitat, potential impacts are expected to be less-than-significant. This activity would **be un**likely **to** adversely affect federally protected species that may be present in the ROI, including the spectacled eider and polar bear.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad could have less-than-significant, adverse effects on threatened, endangered, and other special status species. As discussed in Section 2.5.1, multi-season ice pads are designed for use over multiple winter and summer seasons, with the goal of avoiding permanent fill for temporary activities. This would avoid permanent impacts and ensure that any effects to habitat would be temporary for the duration of the ice pad. Impacts arising from construction of the ice pad would otherwise be similar to those caused by the proposed expansion of the Central Pad. Potential direct impacts to polar bear critical habitat and spectacled eider nesting habitat would result from the construction and use of the multi-season ice pad. Indirect impacts to sensitive species could also occur from noise disturbances during construction. Overall impacts would be minimized as the pad would be located adjacent to areas with human activity, unlikely to support quality habitat for sensitive species. This activity would **be un**likely **to** adversely affect federally protected species that may be present in the ROI, including the spectacled eider, Steller's eider, and polar bear.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad could result in indirect effects to sensitive species due to noise. The potential for direct disturbance to habitat or the potential take of individuals, however, would be reduced as these activities would occur in existing developed areas within the Central Pad. Impacts would be negligible to less-than-significant. Noise generated during construction activities would **be un**likely **to** adversely affect federally protected species that may be present in the ROI, including the spectacled eider, Steller's eider, and polar bear.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant impacts anticipated. See discussion above regarding well drilling.

Table 4.8-2. Potential Impacts to Threatened, Endangered, and Other Special Status Species within the Point Thomson Unit

Activity	Description of Impact
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	Dredging of materials could adversely affect the coastal area where material is deposited, as well as any sensitive species or critical habitat within that area. As the dredging would remove a comparatively small volume of material and would occur in previously dredged/disturbed areas, impacts to sensitive species and polar bear critical habitat would be unlikely. As discussed in Section 4.16, dredging activities would have temporary, less-than-significant impacts to the noise environment; however, activities would not exceed the NMFS's disturbance thresholds for underwater noise levels. Due to the limited amount of proposed dredging and the slight increase in vessel traffic in the Beaufort Sea, the dredging activities **would be un**likely to adversely affect species protected by the NMFS.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Less-than-significant impacts anticipated. See discussion above regarding ice pad.
Operations	Potential impacts from operations of proposed activities would likely remain negligible and be limited to disturbance of sensitive species by noise and mortality of a limited number of individuals due to incremental increases in human activity and use of ice roads along new routes. Operational activities generally would be confined to limited areas in existing disturbed/approved locations. Operational activities would be unlikely to adversely affect sensitive species or their habitat.

NMFS = National Marine Fisheries Service; PTU = Point Thomson Unit; ROI = region of influence; UIC = Underground Injection Control

4.8.4.2 Prudhoe Bay Unit

The discussion on adverse effects to threatened, endangered, and other special status species within PBU focuses on potential effects resulting from disturbance occurring within vicinity of the CGF Pad and surrounding locations where well development and supporting pipeline construction would occur. Prior to any ground disturbance activities, however, the project proponent for the PBU MGS Project would conduct the necessary consultation efforts and any required surveys to identify the presence of protected species. Table 4.8-3 summarizes the potential for impact based on activity. The majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the seven additional injection wells at PBU Well Pad 18 under Scenario 2.

Table 4.8-3. Potential Impacts to Threatened, Endangered, and Other Special Status Species within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would convert approximately 5 acres of polar bear critical habitat to developed land. This 5-acre parcel represents approximately 0.004 percent of polar bear critical habitat currently existing within the PBU and could also provide habitat for the Steller's eider that nests inland and has been found in Prudhoe Bay. The expansion would be located on the existing CGF Pad adjacent to a currently developed site and associated human disturbance. As such, it's unlikely that this area supports high-quality terrestrial habitat or that sensitive species are common in the vicinity. Direct effects are expected to be unlikely, but sensitive species could be disturbed by noise related to temporary construction activities. While the proposed expansion of the CGF Pad could adversely affect sensitive species and polar bear critical habitat, potential impacts are expected to be less-than-significant. This activity would **be un**likely **to** adversely affect federally protected species that may be present in the ROI, including the Steller's eider and polar bear.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells within the PBU could result in indirect effects to sensitive species due to noise. The potential for direct disturbance to habitat or the potential take of individuals, however, would be reduced as these activities would likely occur in proximity to existing developed areas. Impacts would be negligible to less-than-significant. Noise generated during construction activities would **be un**likely **to** adversely affect federally protected species that may be present in the ROI, including the spectacled eider, Steller's eider, and polar bear.
***<u>Scenario 2 only</u>*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant impacts anticipated. See discussion above regarding well drilling.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could result in direct impacts through disturbance of existing habitat for protected species, including polar bear critical habitat. Indirect effects from construction-related noise would also be expected. Impacts would be reduced to less-than-significant or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur. The use of an existing ROW would also ensure that construction of a new pipeline would not introduce a new impediment to the free travel of wildlife on the North Slope, including the polar bear.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.

Table 4.8-3. Potential Impacts to Threatened, Endangered, and Other Special Status Species within the Prudhoe Bay Unit

Activity	Description of Impact
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads could have less-than-significant, adverse effects on threatened, endangered, and other special status species. As discussed in Section 2.5.1, ice roads are designed with the goal of avoiding permanent fill for temporary activities. This would avoid permanent impacts and ensure that any effects to habitat would be temporary for the duration of the ice road. The increased number of vehicles during construction and operation of the proposed ice road could result in the incidental take of a limited number of terrestrial individuals, including potentially those of protected species. Associated noise could have an indirect effect on sensitive species. While direct and indirect effects from ice roads would be anticipated, these impacts would be less-than-significant.
Operations	Potential impacts from operations of proposed activities would remain negligible and be limited to disturbance of sensitive species by noise and mortality of a limited number of individuals due to incremental increases in human activity and use of ice roads along new routes. Operational activities generally would be confined to limited areas in existing disturbed/approved locations. Operational activities would be unlikely to adversely affect sensitive species or their habitat.

CGF = Central Gas Facility; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; ROI = region of influence; ROW = right-of-way; VSM = vertical support member

4.8.4.3 Kuparuk River Unit and CO_2 Pipeline

The discussion on adverse effects to threatened, endangered, and other special status species within KRU and along the potential 30-mile CO_2 pipeline focuses on potential effects resulting from disturbance occurring within the vicinity of existing injection well sites at KRU or along the existing Kuparuk Pipeline and Kuparuk Extension Pipeline. Prior to any ground disturbance activities, however, the project proponent for the KRU EOR would conduct the necessary consultation efforts and any required surveys to identify the presence of protected species. Table 4.8-4 summarizes the potential for impact based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.8-4. Potential Impacts to Threatened, Endangered, and Other Special Status Species within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of a new pipeline could result in direct impacts through disturbance of existing habitat for protected species, including polar bear critical habitat. Indirect effects from construction-related noise would also be expected. Impacts would be reduced to less-than-significant or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur. The use of an existing ROW would also ensure that construction of a new pipeline would not introduce a new impediment to the free travel of wildlife on the North Slope.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts anticipated. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Potential impacts from operations of proposed activities would likely remain negligible and be limited to disturbance of sensitive species by noise and mortality of a limited number of individuals due to incremental increases in heavy machinery during construction of new pipelines. Operational activities generally would be confined to limited areas in existing disturbed/approved locations. Operational activities would be unlikely to adversely affect sensitive species or their habitat.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.8.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect threatened, endangered, and other special status species. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The construction and restoration environmental plans identified in Sections 4.6 and 4.7 for terrestrial wildlife species and aquatic species, respectively, would also serve to protect threatened, endangered and other special status species. In addition, the following plans specific to protecting threatened and endangered species identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS would likely apply for applicants leading upstream development activities:

- Preparation of a Marine Mammal Monitoring Plan that would contain measures to be implemented during in-water construction activities (e.g., noise mitigation measures from dredging activities at PTU) in Prudhoe Bay to comply with the MMPA and ESA.
- Preparation of a Polar Bear and Pacific Walrus Avoidance and Interaction Plan for guidance to avoid or minimize adverse effects on and human interaction with polar bears and Pacific walrus during construction and operational activities on the North Slope and Beaufort Sea.

In addition, prior to ground disturbance, the project proponent would satisfy ESA and MMPA requirements by completing consultation efforts with appropriate state and federal agencies, including USFWS, NMFS, and ADF&G and, if necessary, survey areas within the ROI for the potential presence of protected species and associated critical habitat.

4.8.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional areas of land that may support threatened, endangered, and other special status species. Overall, adverse effects to protected species and their associated habitat would be greater under Scenario 3 than Scenario 2. Scenario 3 would require the construction of an approximately 30-mile-long, linear CO_2 pipeline that would cross multiple habitats between PBU and KRU. On the other hand, lateral wells constructed under Scenario 2 would originate on the well pad and be emplaced below ground, avoiding impacts to habitats and species at the surface. Potential impacts would be mitigated through consultation efforts with appropriate federal and state agencies, surveys for protected species, and avoidance. DOE did not identify effects to threatened, endangered, and other special status species beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.8.5.

4.9 LAND USE, RECREATION, AND SPECIAL INTEREST AREAS

4.9.1 Summary of Land Use, Recreation, and Special Interest Area Impacts from the 2020 EIS

Table 4.9-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. Since the 2020 EIS covers a much larger project area, the analysis involves additional land uses beyond those present in the ROI for this **Final** SEIS. As indicated in the table, construction and operation of the proposed Project would primarily affect open land and forested land, with less impact on agricultural, industrial/commercial, and residential land.

Table 4.9-1. Summary of Land Use, Recreation, and Special Interest Area Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction and operation would primarily affect open land and forested land, with less impact on agricultural, industrial/commercial, and residential land. • Construction would affect visitors to McKinley Village, campground visitors, and the river tour operator. Visitors to McKinley Village would experience increased noise and traffic, reduced access to businesses during construction, and traffic delays due to temporary land and road closures of the George Parks Highway. • Development of material extraction sites would block access to and permanently remove a portion of the campground at Byers Lake Campground near MP 630 and require temporary closure of the parcel used by the river tour operator near MP 560. • Construction of the Liquefaction Facilities would result in the permanent conversion of residential land to industrial/commercial land, including the removal of 10 residences. • The main impact of Project operation on recreational areas would be the long-term to permanent changes in views due to maintenance of the pipeline ROW or installation of aboveground facilities. • Construction impacts would not generally prohibit recreational uses of Denali National Park and Preserve but could disrupt or delay some uses. • Establishment and maintenance of the pipeline ROW would cause permanent changes to viewsheds within some portions of Denali National Park and Preserve, which would affect the user experience by altering the scenery, vegetation, and wildlife in the affected area. • Noise impacts on the Denali National Park and Preserve from operation of the Healy Compressor Station would be negligible. • Construction noise would affect recreational uses throughout Denali State Park. • Construction would increase traffic on Dalton Highway, which could be perceived as locally significant. Operational impacts would be minor. • Construction impacts on two NRI-eligible waterbodies (Deshka River and Alexander Creek) would be temporary and minor. Project operation would not affect recreational uses of the rivers.	• With the exception of forest, impacts on most land use types would be minor to moderate. Impacts on forested land would be long term to permanent and significant. Impacts on open land north of the Brooks Range could also be significant. • Most impacts on recreation areas during construction would be temporary and minor. Visual impacts during operation could be low to high depending on the location and sensitivity of affected viewers.	4.9.1.2; 4.9.2.1; 4.9.7; 5.1.9

EIS = Environmental Impact Statement; MP = Milepost; NRI = Nationwide Rivers Inventory; ROW = right-of-way

4.9.2 Methodology to Assess Land Use, Recreation, and Special Interest Area Impacts

DOE assessed the potential impacts on land use based on whether the proposed Project would:

- Be compatible with land use adjacent to the ROI including PTU, PBU, KRU, and existing pipeline ROW;
- Result in land use restrictions on adjacent properties;
- Change or reduce public use of recreational areas or special interest areas; or
- Conflict with regional or local land use plans and zoning.

4.9.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to land use, recreation, and special interest areas as described in Section 4.9 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.9.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities on the North Slope could potentially affect land use if impacts occur to recreation, special interest areas, and if land use conversion occurs. Sections 4.9.4.1 through 4.9.4.3 discuss the type of impacts by activity on the North Slope that could occur as a result of the proposed Project.

4.9.4.1 Point Thomson Unit

Table 4.9-2 summarizes the potential for impacts to land use within the PTU based on activity. As stated in Section 3.9, the most prominent land uses in the PTU are open water (58.4 percent) and open land (41.6 percent). Although the exact locations of the components of the PTU Expansion Project are unknown at this time, this analysis assumes that open water areas, to the greatest extent practicable, would be avoided when siting new facilities.

Table 4.9-2. Potential Land Use, Recreation, and Special Interest Area Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which would have less-than-significant, permanent impacts on land use due to the permanent conversion of open land to developed land for oil and gas industrial use.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would not have significant adverse impacts on land use. As discussed in Section 2.5.1, multi-season ice pads are designed for use over multiple winter and summer seasons, with the goal of avoiding permanent fill for temporary activities. The method of construction involves snow compaction and establishing a base layer of ice which would not require land conversion.

Table 4.9-2. Potential Land Use, Recreation, and Special Interest Area Impacts within the Point Thomson Unit

Activity	Description of Impact
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would have less-than-significant, permanent impacts on land use due to permanent conversion of open land to developed land for oil and gas industrial use. As stated within Section 2.5.5, permits for well drilling issued by the AOGCC would require review/approval by the ADNR which includes consideration of land use.
Conversion of an existing gas injection well on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant, adverse impacts. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	The dredging would occur in previously dredged areas and would not require land conversion; therefore, impacts to land use would be unlikely.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would be unlikely to have significant adverse impacts on land use since it would be confined within the PTU. As discussed in Section 2.5.1, the method of construction involves use of frozen water, either in snow or ice form, which would not require land conversion.
Operations	Less-than-significant, permanent impacts would occur during operation of project activities that result in permanent land use conversion of open land to developed land for oil and gas industrial use. No impacts are expected to recreation and special interest areas since they do not occur within PTU.

ADNR = Alaska Department of Natural Resources; AOGCC = Alaska Oil and Gas Conservation Commission; PTU = Point Thomson Unit; UIC = Underground Injection Control

4.9.4.2 Prudhoe Bay Unit

Table 4.9-3 summarizes the potential for impact to land use within the PBU based on activity. A majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the 7 additional injection wells at PBU Well Pad 18 under Scenario 2. As stated in Section 3.9, the most prominent land uses in the PBU are open land (65.3 percent), open water (31.7 percent), and developed land (3.0 percent). Although the exact locations of the components of the PBU MGS Project are unknown, this analysis assumes that open water areas, to the greatest extent practicable, would be avoided when siting new facilities.

Table 4.9-3. Potential Land Use, Recreation, and Special Interest Area Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which would not have significant adverse impacts on land use since it would be confined within the PBU and likely occur in developed areas, such as previously disturbed land. If located outside of existing developed land, areas of open land would permanently convert to developed land for oil and gas industrial use.

Table 4.9-3. Potential Land Use, Recreation, and Special Interest Area Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells would not significantly affect land use since the wells would be located within the PBU and likely in developed areas. If located outside of existing developed land, areas of open land would permanently convert to developed land for oil and gas industrial use. As stated within Section 2.5.5, permits for well drilling issued by the AOGCC would require review/approval by the ADNR which considers land use.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant impacts. See discussion above regarding well drilling.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines is not anticipated to significantly affect land use since the pipelines would be located within the PBU and likely in developed areas. If located outside of existing developed land, areas of open land or open water would permanently convert to developed land for oil and gas industrial use. Impacts would be reduced or avoided through use of existing ROW and infrastructure.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant impacts. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would be unlikely to have significant adverse impacts on land use since it would be confined within the PBU. As discussed in Section 2.5.1, the method of construction involves use of frozen water, either in snow or ice form, which would not require land conversion.
Operations	Negligible to less-than-significant, permanent impacts would occur from operation of project activities. Negligible impacts would occur during operation of project features located within existing developed land. Less-than-significant impacts would occur due to operation of project features that require permanent land use conversion of open land to developed land for oil and gas industrial use. No impacts are expected to recreation and special interest areas since they do not occur within the PBU.

ADNR = Alaska Department of Natural Resources; AOGCC = Alaska Oil and Gas Conservation Commission; CGF = Central Gas Facility; GTP = Gas Treatment Plant; PBU = Prudhoe Bay Unit; ROW = right-of-way

4.9.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.9-4 summarizes the potential for impact to land use within the KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU. As stated in Section 3.9, the primary land uses at KRU are open land (79.0 percent), open water (19.9 percent), and developed land (1.1 percent). The primary land uses along the existing pipeline ROW are open land (81.5 percent), developed land (17.2 percent), and open water (1.3 percent). Although the exact locations of the components of the KRU Development are unknown at this time, this analysis assumes that open water areas, to the greatest extent practicable, would be avoided when siting new facilities.

Table 4.9-4. Potential Land Use, Recreation, and Special Interest Area Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could result in less-than-significant impacts to land use if permanent conversion of land use were to occur. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs that keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Construction of new distribution pipelines is not anticipated to significantly affect land use since the pipelines would be located within the KRU and potentially in developed areas. If located outside of existing developed land, areas of open land would permanently convert to developed land for oil and gas industrial use. Impacts would be reduced or avoided through use of existing ROW and infrastructure.
Operations	Less-than-significant, permanent impacts would occur during operation of project activities that result in permanent land use conversion of open land to developed land for oil and gas industrial use. No impacts are expected to recreation and special interest areas since they do not occur within KRU and the existing pipeline ROW.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.9.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect land use. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Restoration/Revegetation Plan that would restore temporarily disturbed areas to their prior land use.

Additionally, to the extent practicable, the pipeline ROW for the CO_2 pipeline and distribution lines under Scenario 3 would be sited to following existing ROW and infrastructure. No mitigation measures are applicable to recreation and special interest areas since they do not occur within the proposed Project ROI.

4.9.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact land use within the ROI. Overall, negligible to less-than-significant impacts would occur from construction and operation of project activities. Negligible impacts would occur during construction and operation of project features located within existing developed land. Less-than-significant, permanent impacts would occur due to operation of project features that require permanent land use conversion of open land to developed land for oil and gas industrial use.

No impacts are expected to recreation and special interest areas since they do not occur within the ROI. The closest recreational area is the Arctic National Wildlife Refuge which is located approximately 0.2 mile to the east of the PTU boundary. However, as discussed in Section 3.9.6, the entirety of the proposed Project ROI would be in the Umiat Meridian and as a result, the state lands in the ROI would be considered North Slope SUAs. Therefore, if project features are located within state lands/North Slope SUAs then the project operator would obtain necessary permits for motorized vehicle use in the areas in accordance with 11 AAC 96.014.

Overall adverse effects to land use would be similar between Scenarios 2 and 3 including the additional potential adverse effects from lateral injection well construction required under Scenario 2 and the additional potential adverse effects from pipeline construction required under Scenario 3. Potential impacts would be mitigated BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.9.5. DOE did not identify effects to land use beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.9.5.

4.10 VISUAL RESOURCES

4.10.1 Summary of Visual Resource Impacts from the 2020 EIS

A visual impacts analysis was conducted for the proposed Project based on methodologies provided by the BLM and NPS, as detailed in Section 4.10.2 and Appendix S of the 2020 EIS. The primary concern with regard to visual resources is the impact of Project construction and operation on views of or from sensitive visual resource areas (SVRAs). These special areas are defined as areas with federal designations that require special consideration for the protection of visual values and includes Natural Areas, Wilderness or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Areas, Scenic Roads or Trails, and ACECs. Eighty-two SVRAs, including parks, wildlife refuges, trails, historic sites, communities, and other places within the analysis area were identified in the visual impacts analysis. The analysis determined that the proposed Project could be visible from 79 of the 82 SVRAs.

Additionally, 91 potential key observation points were identified within or near SVRAs from which Project visibility and impacts (including impacts on SVRAs) were evaluated in the 2020 EIS's visual impacts analysis. These points were selected based on the presence of more visually intrusive Project features in sensitive areas. The key observation points were selected to represent important views of the analysis area from SVRAs and were generally located along major roads and highways and publicly accessible pull-outs, campgrounds, parks, trails, interpretive areas, and other areas with potential views of Project facilities.

Table 4.10-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. Since the 2020 EIS covers a much larger project area, the analysis involves additional visual resources beyond those present in the ROI for this **Final** SEIS. As summarized in Section 4.10.2 of the 2020 EIS, the visual impacts of the Alaska LNG Project would vary from "none" to "high" depending on location and viewer type.

Table 4.10-1. Summary of Visual Resources Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction would have temporary and permanent visible impacts from activities and structures that cause a noticeable contrast with baseline conditions. Construction activities and structures include clearing of vegetation, presence of vehicles, materials, equipment and storage yards, and use of artificial nighttime lighting. Of the 91 key observation points identified for visual analysis, visual impacts range from "none" to "high," including "high" for 11 key observation points (as summarized in Table 4.10.2-1 of the 2020 EIS). • Project operation would have permanent visible impacts from activities and structures that cause a noticeable contrast with baseline conditions, including changes in vegetation, addition of new facilities and pipelines, condensation plumes, and use of artificial nighttime lights. Of the 91 key observation points identified for visual analysis, visual impacts range from "none" to "high," including "high" for 9 key observation points (as summarized in Table 4.10.2-1 of 2020 EIS).	• Adverse permanent impacts to visual resources would generally be in existing industrial areas or areas with limited viewer visibility. Adverse visual impacts at selected key observation points would be mitigated as outlined in Table 4.10-2 of the 2020 EIS. Therefore, visual impacts are expected to be less-than-significant. • Mitigation strategies include a Project Lighting Plan to minimize the impacts from artificial nighttime lighting. Lighting at the Healy Compressor Station would conform to International Dark-Sky Association guidelines if feasible. • Mitigation strategies include a Project Revegetation Plan to minimize the impacts from land clearing during construction.	4.10.2; 5.1.10; Appendix S

Table 4.10-1. Summary of Visual Resources Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• GTP would introduce horizontal and vertical lines and rectilinear forms on the distant horizon. Colors and textures would be similar to existing surrounding structures. GTP would include new sources of artificial nighttime light. Any changes to vegetation would occur within footprint of GTP. • Mainline Facilities would introduce rectilinear and vertical features to the landscape. Clearing would introduce horizontal forms and lines in vegetation. Condensation plumes associated with compressor and heater stations could be seen. Visual contrast would vary depending on the facility viewed, existing vegetative cover, topography, and the angle of view. Impacts would be greatest in the Brooks and Alaska Ranges, including the Denali National Park and Preserve and Denali State Park, particularly for recreational visitors to these areas. • LNG Plant would introduce large, smooth-textured rectilinear buildings; cylindrical tanks; vertical elements; horizontal linear structures and transmission lines atop flat and paved or graveled surfaces; condensation plumes; and use of artificial nighttime lighting. The Marine Terminal would introduce horizontal geometric structures at the shoreline, along with the presence of LNG carriers.		

EIS = Environmental Impact Statement; GTP = Gas Treatment Plant; LNG = liquefied natural gas

4.10.2 Methodology to Assess Impacts to Visual Resources

DOE assessed the potential impacts on visual resources on whether the proposed Project would:

- Result in a blocked or degraded scenic viewshed; or
- Result in a change in area visual resources.

4.10.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC’s Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to visual resources as described in Section 4.10 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.10.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Visual impacts from a project would depend on viewer sensitivity and the level of contrast the project would produce relative to the baseline visual character and quality of the surrounding landscape. Viewers for upstream development activities include workers at the project sites and the general public, including visitors and residents of nearby communities.

Most of the development of the upstream activities would occur in existing industrial and commercial settings, which would have similar visual characteristics of the existing facilities, structures, and activities. Potential impacts on visual resources could occur during construction when large equipment, excavation activities, spoil piles, staging and laydown areas, and artificial nighttime lighting are visible to viewers. Use of temporary ice roads would introduce construction vehicles traveling between loading/staging/source material areas and the work sites. During operation, potential visual impacts could occur from the introduction of new structures and facilities and presence of maintenance/inspection vehicles in a viewshed. Sections 4.10.4.1 through 4.10.4.3 discuss the type of impacts that could result from the upstream activities within the PTU, PBU, and KRU and CO_2 pipeline, respectively.

4.10.4.1 Point Thomson Unit

Upstream development at the PTU primarily consists of the construction for expansion of the Central Pad, ice pad construction, new well installations, and ice roads construction. Most of the visual impacts would be related to the occurrence of heavy machinery and vehicles, materials, supplies, clearing of the land, artificial nighttime lighting. Visual impacts would be temporary and range from negligible to less-than-significant as construction activities would occur in a setting that is already industrial in nature and would, therefore, contrast minimally with baseline conditions. Additionally, because these activities would occur within the PTU, impacts would be limited to workers, as the general public has no or limited access to this area.

Upstream activities during operation that would result in visual impacts at the PTU include the introduction of new structures, which would have similar visible qualities as the existing setting. Therefore, the new structures would contrast minimally with baseline conditions and result in permanent, but negligible impacts. Additionally, because these activities would occur within the PTU, impacts would be limited to workers, as the general public has no or limited access to this area.

Table 4.10-2 summarizes the potential for impacts to visual resources within the PTU based on activity.

Table 4.10-2. Potential Visual Resources Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would have negligible to less-than-significant, permanent visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as expansion would be within the PTU, where the setting is already industrial in nature and is not open to the general public.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would have negligible to less-than-significant visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as construction would be within the PTU, where the setting is already industrial in nature and is not open to the general public.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of four new production wells within the Central Pad would have negligible to less-than-significant, permanent visual impacts from occurrence of machinery, supplies, and artificial nighttime lights as the new wells would be within the PTU, where the setting is already industrial in nature and is not open to the general public.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Conversion of a well and drilling of a new well would have negligible permanent visual impacts from the occurrence of machinery, supplies, and artificial nighttime lights as the activities would be within the PTU, where the setting is already industrial in nature and is not open to the general public.

Table 4.10-2. Potential Visual Resources Impacts within the Point Thomson Unit

Activity	Description of Impact
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	Dredging activities would involve the use of machinery and placement of dredging material and would result in temporary and less-than-significant visual impacts during dredging activities. Viewers would be mainly limited to workers at the PTU or offshore barge transport and fishing operations.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have negligible to less-than-significant visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as the construction and use of ice roads would be within the PTU, where the setting is already industrial in nature and is not open to the general public.
Operations	Once operational, potential new structures would include an increased pad by 7 acres which would support 4 new production wells. These facilities would be compatible and within or directly adjacent to existing developed areas. Operations would have negligible permanent visual impacts from the introduction of new structures as the activities would be within the PTU, where the setting is already industrial in nature and is not open to the general public.

PTU = Point Thomson Unit; UIC = Underground Injection Control

4.10.4.2 Prudhoe Bay Unit

Upstream development at the PBU primarily consists of the expansion of the CGF Pad, new wells, and new pipelines. Most of the visual impacts during construction would be related to the occurrence of heavy machinery and vehicles, materials, supplies, clearing of the land, and artificial nighttime lighting. Visual impacts would be temporary and range from negligible to less-than-significant as construction activities would occur in a setting that is already industrial in nature and would, therefore, contrast minimally with the baseline conditions. Additionally, because these activities would occur within the PBU, impacts would be mostly limited to workers. The general public may detect construction activities at the PBU from the northern terminus of Dalton Highway; however, the ratings for the scenic quality and viewer sensitivity for this point were rated as low (see Section 4.10.2 of the 2020 EIS) and, therefore, adverse impacts to the viewshed from this point would be less-than-significant during construction for the public.

Upstream activities during operations that would result in visual impacts at the PBU include the introduction of new structures into the viewshed, which would have similar visible qualities as the existing setting. This includes the new pipelines, which would be painted with colors based on BLM standards and located within existing ROWs to the extent possible. Though potentially visible, the vertical and horizontal forms would be difficult to detect, while changes in vegetation would not be visible. Therefore, the new structures would contrast minimally with the baseline conditions and result in permanent, but negligible impacts. Additionally, because these activities would occur within the PBU, impacts would be limited to workers at the PBU and potentially to visitors located at or near the key observation point on Dalton Highway, adjacent to Colleen Lake.

Table 4.10-3 summarizes the potential for impacts to visual resources within the PBU based on activity.

Table 4.10-3. Potential Visual Resources Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would have negligible to less-than-significant, permanent visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as construction would be within the PBU and likely to occur in developed areas. Closest viewpoint for the general public is at the northern terminus of Dalton Highway in Deadhorse, where the viewshed includes commercial and industrial activities and structures.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Drilling of 10 new wells would have negligible to less-than-significant, permanent visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as drilling would be within the PBU and likely to occur in developed areas. Closest viewpoint for the general public is at the northern terminus of Dalton Highway in Deadhorse, where the viewshed includes commercial and industrial activities and structures.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Negligible to less-than-significant, permanent visual impacts. See discussion above regarding well drilling.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of pipelines would have negligible to less-than-significant, permanent visual impacts from the occurrence of machinery, supplies, and artificial nighttime lights as construction would be within the PBU and likely to occur in developed areas. Closest viewpoint for the general public is at the northern terminus of Dalton Highway in Deadhorse, where the viewshed includes commercial and industrial activities and structures. Impacts would be reduced or avoided through use of existing ROW and infrastructure.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant, permanent visual impacts. See discussion above regarding pipeline.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant, permanent visual impacts. See discussion above regarding pipeline.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Negligible to less-than-significant, permanent visual impacts. See discussion above regarding pipeline.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have negligible to less-than-significant visual impacts from the occurrence of machinery, supplies, and artificial nighttime lights as the construction and use of ice roads would be within the PBU. Closest viewpoint for the general public is at the northern terminus of Dalton Highway in Deadhorse, where the viewshed includes commercial and industrial activities and structures.

Table 4.10-3. Potential Visual Resources Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Operations	Once operational, potential new structures would include an increased pad by 5 acres, 10 new production and injection wells, and additional aboveground pipelines for product transport. These facilities would be compatible to existing facilities occurring throughout PBU. Operations of upstream activities would have negligible to less-than-significant, permanent visual impacts as the activities would be within the PBU. New pipelines would introduce new horizontal elements, but would be painted per BLM guidelines to minimize visual impacts. Closest viewpoint for the general public is at the northern terminus of Dalton Highway in Deadhorse, where the viewshed includes commercial and industrial activities and structures.

BLM = Bureau of Land Management; CGF = Central Gas Facility; GTP = Gas Treatment Plant; PBU = Prudhoe Bay Unit; ROW = right-of-way

4.10.4.3 Kuparuk River Unit and CO_2 Pipeline

Upstream development at the KRU primarily consists of the construction of a new 30-mile CO_2 pipeline and other distribution pipelines. Most of the visual impacts would be related to the occurrence of heavy machinery and vehicles, materials, land-clearing, and artificial nighttime lighting. Visual impacts would be temporary and range from negligible to less-than-significant as construction activities would occur in a setting that is already industrial in nature or occur within existing ROWs and would, therefore, contrast minimally with the baseline conditions. Additionally, because these activities would occur within the KRU, impacts would be limited to workers, as the general public has no or limited access in this area.

Construction of the 30-mile CO_2 pipeline may introduce new sources of artificial light along the pipeline route, much of which would be in areas where no similar light sources exist; however, construction would be within or adjacent existing ROWs. To reduce the impact of added artificial lighting and help minimize impacts on dark skies, lighting for work camps, pipe storage yards, and other project facilities and workspaces would follow project-specific lighting plans. Specifically, lighting would be the minimum required for safety and security for nighttime activities.

Upstream activities during operation that would result in visual impacts at the KRU include the introduction of new pipelines. Maintenance and inspection vehicles would occur intermittently throughout the year. New pipelines would be located within existing ROWs to the extent possible and, therefore, the new pipeline would contrast minimally with the baseline conditions and result in permanent, but negligible to less-than-significant impacts. Additionally, because these activities would occur within the KRU, impacts would be limited to workers, as the general public has no or limited access in this area.

Table 4.10-4 summarizes the potential for impacts to visual resources within the KRU based on activity.

Table 4.10-4. Potential Visual Resources Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of a 30-mile pipeline would have temporary, negligible to less-than-significant visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as construction activities would be within the KRU and PBU. KRU is not generally accessible to the general public. Potential visual impacts would be minimized through the use of existing ROW and infrastructure.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Construction of the distribution pipelines would have temporary, negligible to less-than-significant visual impacts from the occurrence of machinery, supplies, land-clearing, and artificial nighttime lights as construction activities would be within the KRU and potentially developed areas and is not generally accessible to the general public. Potential visual impacts would be minimized through the use of existing ROW and infrastructure.
Operations	Once operational, potential new structures would include additional aboveground pipelines for product transport. Operations of upstream activities would have negligible to less-than-significant, permanent visual impacts as the activities would be within the KRU. New pipelines would introduce new horizontal elements but would be within or adjacent existing ROWs to minimize visual impacts. Maintenance and inspection vehicles would occur intermittently throughout year. CO_2 pipeline location is not accessible to general public. Potential visual impacts would be minimized through the use of existing ROW and infrastructure.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way

4.10.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of facilities on the North Slope considered within this **Final** SEIS could affect visual resources. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Lighting Plan that would describe required measures to provide adequate lighting for the prevention of accidents and compliance with Occupational Safety and Health Administration requirements while reducing visible light disturbance to the public and wildlife, as practicable, and reducing the potential for light pollution, including backscatter into the sky.

Additionally, to the extent practicable, the pipeline ROW for the CO_2 pipeline and distribution lines under Scenario 3 would be sited to following existing ROW and infrastructure, further minimizing adverse impacts to visual resources.

4.10.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact visual resources within the ROI. Overall, negligible to less-than-significant impacts would occur from construction and operation of project activities as the setting is heavily industrial in nature and access to the work sites is generally restricted from the general public. Impacts during construction would be temporary and mainly result from the presence of construction machinery and materials, land-clearing, and artificial nighttime lighting. Except for the 30-mile CO_2 pipeline under Scenario 3, construction would largely take place within or near developed areas, where contrast of new structures and construction activities to baseline conditions would be less-than-significant. Under operations, impacts would be result from the introduction of new structures into a viewshed and intermittent occurrences by service vehicles. These impacts would be permanent and range from negligible to less-than-significant as the contrast between the new structures and baseline conditions would be less-than-significant. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.10.5.

4.11 SOCIOECONOMICS

4.11.1 Summary of Socioeconomic Impacts from the 2020 EIS

Table 4.11-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS.

Table 4.11-1. Summary of Socioeconomic Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction would increase population in the area of influence due to worker influx, but impacts would only last the length of construction (8 years) and would be minor in most areas due to the use of closed construction camps and rotation staffing for most workers. • Additional population growth in urban areas could result from indirect and induced impacts, such as subcontractor and supplier hiring. • During operation, population increases due to direct Project hires would be relatively small, but the increases from indirect and induced hires in urban areas could be substantial. • Project construction would result in economic benefits due to worker spending and purchases of materials, supplies, and services. • Project construction would result in temporary, positive impacts on employment rates and wages. Project operation would result in similar impacts on a smaller scale in most of the Project area; however, increased income and spending from permanent hires would be positive and significant in more rural areas. • Project construction could temporarily affect commercial fisheries by impeding access to fishing areas, increasing vessel traffic, or damaging gear. Impacts could be negligible to minor depending on the specific fishery, but construction would not likely affect overall harvest rates. Operational impacts on commercial fisheries due to the transit of LNG carriers would be negligible to minor. • Impacts on housing from worker influx are expected to be low. However, some impacts on housing availability and affordability could occur where demand exceeds supply. Adverse impacts on housing are not expected from the increase in residents and households during Project operation. The proposed Project is not expected to affect residential or commercial property values. Construction of the proposed Project would result in temporary, but positive, impacts on local government revenues due to increased receipts from sales, property, excise, corporate income, and special use taxes. However, there could be a lag between initial spending and increased revenues that would have a temporary to short-term adverse impact on local communities. • Impacts on public services would generally be minor during Project construction and operation. Impacts on police and fire protection could be greater in some areas, particularly where more substantial population increases would occur and areas where resources are limited or understaffed. • Certain impacts from constructing and operating the proposed Project would disproportionately affect some environmental justice populations; however, these impacts would not be high and adverse.	• Most adverse impacts on socioeconomic conditions due to Project construction and operation would be minor to moderate and not significant. Positive impacts on state and local economics in most areas would be temporary but high during construction and minor but long term during operation.	4.11; 5.1.11

EIS = Environmental Impact Statement; LNG = liquefied natural gas

4.11.2 Methodology to Assess Socioeconomic Impacts

To evaluate the impacts on socioeconomic and environmental justice conditions, DOE reviewed the Proposed Action and No Action Alternative to determine whether any activities have the potential to cause the following:

- Adverse impacts to the local economy, housing, public services, property values or traffic and transportation, such as from an influx of workers and their families;
- Additional strain to areas currently experiencing a shortage of health professionals and medical services;
- Beneficial impacts to the local economy (e.g., increased local commerce, increased tax revenues); or
- Cause a disproportionately high and adverse impact to minority or low-income populations.

The following analysis considers impacts to socioeconomic conditions and environmental justice populations during construction and operations of the upstream facilities.

4.11.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Since construction and operations of the proposed Project would not occur, no changes to the existing socioeconomic conditions or effects to minority or low-income populations would occur. Beneficial impacts to the local economy as described for upstream development under Scenarios 2 and 3 would not occur.

4.11.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis considers industry standard staffing levels for construction and operation of oil and gas industry facilities to evaluate potential socioeconomic impacts. In addition, it is assumed that the planning and management of the workforce would be consistent with the practices described in Section 4.11 of the 2020 EIS. This **Final** SEIS evaluates socioeconomic considerations consistent with the 2020 EIS except commercial fishers are not addressed in this **Final** SEIS since they do not occur within the upstream development ROI.

Table 4.11-2 summarizes the potential for socioeconomic impacts based on project activity type.

Table 4.11-2. Potential Socioeconomic Impacts from Upstream Development

Activity	Scenario & Location	Type of Socioeconomic Impact
Expansion and operations of well pads (see Section 2.5.2 regarding gravel construction including pads).	<u>Scenarios 2 & 3:</u> PTU (7 acres) PBU (5 acres)	• Activity is unlikely to increase the permanent population in the North Slope Borough during construction and operations. • Beneficial economic impacts from the purchase of materials, such as gravel or petroleum products, and services from local Alaska-based sources to support the projects and workers.

Table 4.11-2. Potential Socioeconomic Impacts from Upstream Development

Activity	Scenario & Location	Type of Socioeconomic Impact
		• Increased employment opportunities in most industries including oil and gas, mining support services; construction; transportation; and professional, scientific, and technical services. • Increased state and local government revenues generated from taxes due to materials purchases, payroll expenditures, and property and other taxes. • No change in demand or supply of housing in the North Slope Borough. • No impacts to public services (police and fire departments, schools, utilities, materials, and tourism). • Activity would not have disproportionately high and adverse impacts on environmental justice communities.
Construction and use of a multi-season ice pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Scenarios 2 & 3: PTU (7 acres)	• Similar effects to well pad expansion within PTU near the Central Pad; however, effects would be temporary and last approximately one season.
Construction and operations of new wells (see Section 2.5.5 regarding well drilling requirements).	Scenarios 2 & 3: PTU (4 new wells) PBU (10 new wells) Scenario 3 only: PBU (7 additional new wells)	• Activity is unlikely to increase the permanent population in the North Slope Borough during construction and operations. • Beneficial economic impacts from the purchase of materials, such as gravel or petroleum products, and services from local Alaska-based sources to support the projects and workers. • Increased employment opportunities in most industries including oil and gas, mining support services; construction; transportation; and professional, scientific, and technical services. • Increased state and local government revenues generated from taxes due to materials purchases, payroll expenditures, and property and other taxes. • No change in demand or supply of housing in the North Slope Borough. • No impacts to public services (police and fire departments, schools, utilities, materials, and tourism). • Activity would not have disproportionately high and adverse impacts on environmental justice communities.
Dredging	Scenarios 2 & 3: PTU (approximately 5,000 cubic yards of material for barge unloading equipment and modular facilities)	• Activity is unlikely to increase the permanent population in the North Slope Borough during construction and operations. • Beneficial economic impacts from the purchase of materials, such as gravel or petroleum products, and services from local Alaska-based sources to support the projects and workers. • Temporary increased employment opportunities in most industries including oil and gas, mining support services; construction; transportation; and professional, scientific, and technical services.

Table 4.11-2. Potential Socioeconomic Impacts from Upstream Development

Activity	Scenario & Location	Type of Socioeconomic Impact
		• Temporary increases in state and local government revenues generated from taxes due to materials purchases, payroll expenditures, and property and other taxes. • No change in demand or supply of housing in the North Slope Borough. • No impacts to public services (police and fire departments, schools, utilities, materials, and tourism). • Activity would not have disproportionately high and adverse impacts on environmental justice communities.
Ice road construction and use (see Section 2.5.1 regarding ice construction including ice roads).	Scenarios 2 & 3: PTU PBU	• Activity is unlikely to increase the permanent population in the North Slope Borough during construction and operations. • Beneficial economic impacts from the purchase of materials and services from local Alaska-based sources to support the projects and workers. • Temporary increases in employment opportunities in most industries including oil and gas, mining support services; construction; transportation; and professional, scientific, and technical services. • Temporary increases in state and local government revenues generated from taxes due to materials purchases, payroll expenditures, and property and other taxes. • No change in demand or supply of housing in the North Slope Borough. • No impacts to public services (police and fire departments, schools, utilities, materials, and tourism). • Activity would not have disproportionately high and adverse impacts on environmental justice communities.
Construction and operations of new pipelines (see Section 2.5.3 regarding pipeline construction).	Scenarios 2 & 3: PBU (10 pipelines ranging in length from 3 to 25 miles) Scenario 3 only: KRU (30-mile CO_2 pipeline to KRU, approximately 19 miles of internal CO_2 distribution pipelines)	• Activity is unlikely to increase the permanent population in the North Slope Borough during construction and operations. • Beneficial economic impacts from the purchase of materials, such as sand or petroleum products, and services from local Alaska-based sources to support the projects and workers. • Increased employment opportunities in most industries including oil and gas, mining support services; construction; transportation; and professional, scientific, and technical services. • Increases in state and local government revenues generated from taxes due to materials purchases, payroll expenditures, and property and other taxes. • No change in demand or supply of housing in the North Slope Borough. • No impacts to public services (police and fire departments, schools, utilities, materials, and tourism). • Activity would not have disproportionately high and adverse impacts on environmental justice communities.

CO_2 = carbon dioxide; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit

4.11.4.1 Population

Construction

Construction of upstream development activities in the North Slope Borough would require a temporary influx of workers into Alaska. Local and regional population in the North Slope Borough would increase during the construction period. Construction would occur throughout the year but is expected to result in peak employment during the summer and winter months.

The project applicant would use local labor to the extent practicable; however, given the highly specialized skills needed to construct the upstream components, it is estimated that 22 to 68 percent of the construction jobs would likely be filled by non-residents, depending on the construction year. The remaining construction jobs would be filled by Alaska residents. Refer to Section 4.11.1.2 of the 2020 EIS for details about rotation of construction staff and the logistics of worker transport to and from the work sites. Given the temporary nature of the construction jobs for upstream development and the small workforce required for construction of upstream development projects, it is anticipated that most construction workers would not permanently relocate to the North Slope, resulting in negligible impacts.

Operations

Operation of the potential upstream development would require a small percentage of additional permanent personnel beyond the 170 permanent operational personnel planned for the North Slope Borough (see Section 4.11.1.2 of the 2020 EIS). Operational personnel would work in rotating shifts with approximately 65 percent of personnel on rotation at any one time and the remaining 35 percent would be on leave. Consistent with the 2020 EIS, it is assumed that 70 percent of the operational workers would be Alaska residents. The remaining 30 percent would likely reside outside of Alaska while not on rotation. It is anticipated that only 1 percent of the workers that are Alaska residents would be from the North Slope Borough. Therefore, the increase in population due to operation of the upstream development would be small and would have negligible effects on the overall population size.

4.11.4.2 Economy and Employment

Construction

Construction of the upstream development activities would require the purchase of materials and services in addition to the amount estimated for the balance of the Project described in Section 4.11.2.2 of the 2020 EIS. The majority of the large materials needed to construct the upstream facilities would be sourced from outside of the state and the smaller-valued, bulky purchases of materials, such as gravel or petroleum products, would likely be acquired from the local Alaska-based sources. Residential worker spending and materials purchases would occur locally or in the state, while non-resident construction workers living in construction camps would have little opportunity to make purchases within the local economy; therefore, non-resident worker earnings would likely be spent out of the state. The purchase of local materials and services to support the projects and workers would generate beneficial indirect and induced economic impacts in the state of Alaska.

Employment created during the construction phase would increase employment opportunities in most industries including oil and gas, mining support services; construction; and transportation; professional, scientific, and technical services. Unemployed workers with the required skills could find additional jobs opportunities during the construction period. As employers compete for workers, wage inflation could occur but would be most noticeable during the peak construction period and to certain worker skillsets. Following construction, an adjustment period in the economy after the construction boom could occur in portions of some communities. The increased employment opportunities would result in beneficial impacts to employment in the North Slope Borough.

Operations

Most operational workers at the upstream facilities would work on a rotating basis and be housed in self-contained work camps while on rotation. As a result, only a very small amount of employee earnings would be spent in the local economy, and induced economic impacts in the Borough would be less-than-significant. In addition, due to its remote setting, only a limited amount of materials would be sourced from the North Slope Borough. Therefore, the majority of the indirect and induced economic impacts from operation of upstream development facilities would occur in areas outside of the North Slope Borough but would be beneficial to the state of Alaska.

Operation of the upstream development would result in a small percentage of additional permanent personnel beyond the 170 permanent operation personnel planned for the North Slope Borough, as described in Section 4.11.1.2 of the 2020 EIS. Workers recruited from outside the state would be expected to relocate permanently in the area. This would increase the estimated annual payroll for operational workforce anticipated in the North Slope Borough, as presented in Table 4.11.2-8 of the 2020 EIS. The small increase in permanent residents and employment as a result of upstream develop would cause beneficial economic impacts in the North Slope Borough.

4.11.4.3 State and Local Taxes and Government Revenues

Construction

During construction, state and local government revenues generated from taxes would increase due to materials purchases, payroll expenditures, and property and other taxes. Since most of non-resident construction workers would be required to live in construction camps that supply electric utilities, solid waste disposal, water and wastewater services, medical care, and emergency services, local governments would not incur expenditures for these workers.

As stated in Section 4.11.4.2 of the 2020 EIS, the majority of the increased economic activity, and thus the majority of the expected in-migration in excess of the construction workforce, would occur outside of the North Slope Borough, in the urban centers of Anchorage, Fairbanks, and the Kenai Peninsula. Although the majority of population-change induced impacts would occur in areas outside of the North Slope Borough, they would be beneficial to the state of Alaska.

Operations

Most operational workers at the upstream facilities would work on a rotational basis and be housed in self-contained work camps while on rotation. As stated in Section 4.11.4.1, only 1 percent of the workers that are Alaska residents would be from the North Slope Borough. As a result, the increase in population due to operation of the upstream development would be very small in the North Slope Borough and would not have significant impacts to the local government revenues and expenditures.

4.11.4.4 Housing

Construction

Given the temporary nature of the construction jobs for upstream development, it is anticipated that most construction workers would not permanently relocate to the North Slope. Construction crews in the North Slope Borough would be housed in work camps. Therefore, construction of the upstream facilities would not have an impact on the demand or supply of housing in the North Slope Borough or the region.

Operations

While operation of the upstream facilities would require a small percentage of additional permanent personnel, they would work on a rotational basis and be housed in self-contained work camps while on duty. Since housing would be provided, impacts on the local housing market in the North Slope Borough would not be expected.

4.11.4.5 Public Services

Construction

Due to the use of existing construction work camps, potential impacts to public services from construction of the upstream facilities would be negligible.

The use of construction camps would significantly reduce the potential influx of families and dependents to the upstream facilities construction areas. Therefore, construction of the upstream facilities would not increase the number of school-aged children in the North Slope Borough.

During construction, work camps would be self-contained and security services would be provided by private camp security staff. The camp security staff would be responsible for tracking, sorting, and implementing daily transits to and from the camps during rotations, demobilizations, and mobilizations; and for securing the camp perimeter from unauthorized entry or exit. Since construction camps would use private security and construction of the upstream facilities would not significantly increase the population size in the North Slope Borough, the direct impact on local police and fire services would be negligible.

Refer to Section 4.11.6.3 of the 2020 EIS for information about the availability of construction materials expected to be sourced within Alaska for the proposed project including gravel/granular material, wood/timber, diesel fuel, waste management, and electric utilities. Since the resources required for construction of the upstream facilities would be similar, the impacts would be consistent with the 2020 EIS which states the existing supply of materials would not be sufficient to accommodate the proposed Project and existing customers. However, the long planning time associated with the proposed Project would help reduce some of the supply issues associated with Project construction. Suppliers would receive a substantial amount of notice concerning the expected increase in demand for their commodities and would be able to increase production accordingly.

Electricity to power the construction work camp would come from independent power generation units and would not use local electric utilities. These power generation units would include gas turbines for main power generation and diesel generators for essential and backup power generation.

As described in Section 4.11.7.1 of the 2020 EIS there is very little tourism in the North Slope Borough due to its remote location. As a result, construction impacts on tourism or recreation would generally not be anticipated for the upstream facilities.

Operations

Due to the use of operational work camps, potential impacts to public services from operation of the upstream facilities would be negligible.

Project operation would have a negligible impact on the North Slope Borough School District. Operation of the upstream facilities would require a small percentage of additional permanent employees which would reside in operations camps without their dependents, resulting in no increase in the population of school-aged children.

Similar to construction, since operations camps would use private security and operation of the upstream facilities would not significantly increase the population size in the North Slope Borough, the direct impact on local police and fire services would be negligible.

Operation of the upstream facilities and worker camps would not use local electric utilities. The increased resident population of the North Slope Borough during operation would remain well within the capacity of existing electric utilities, so no impacts would be anticipated.

Since there is very little tourism in the North Slope Borough, operational impacts on tourism or recreation would generally not be anticipated for the upstream facilities.

4.11.4.6 Environmental Justice

Construction and Operations

Impacts on environmental justice populations would be similar to those experienced by the general community; however, this analysis considers if low-income or minority populations could experience disproportionately high and adverse impacts. Project impacts that could have the potential to disproportionately affect environmental justice populations include traffic delays and new traffic patterns; visual effects from nighttime lighting or changes to the existing viewshed; interference with subsistence activities or habitats; potential changes to residential property values; and health impacts. This analysis concludes that construction and operation of the upstream facilities considered under Scenarios 2 and 3 **could result in** disproportionately high and adverse impacts on environmental justice communities**, primarily due to potential for impacts to subsistence users of the Kaktovik and Nuiqsut communities**.

Traffic impacts would generally be related to the movement of construction materials, personnel, and supplies by road, rail, and marine vessel, and would be mitigated by the development and implementation of Transportation Mitigation Plan. On the North Slope, marine traffic could temporarily interfere with subsistence activities such as whale hunting, which is further described in Section 4.14. Section 4.12 concludes that the impacts from Project-related traffic would be temporary and not result in significant impacts. Therefore, DOE concludes that traffic impacts would not be disproportionately high and adverse on environmental justice communities.

As described in Section 4.10, the upstream facilities would result in both temporary and permanent impacts on visual resources and views associated with construction activities, artificial nighttime lighting, cleared rights-of-way, access roads, and aboveground facilities. Impacts would vary based on location and viewer sensitivity and would be mitigated by using vegetative cover in front of construction areas, as well as locating access roads away from public areas. The use of lights would be limited during nighttime hours as practicable. Section 4.10 concludes that with mitigation, visual impacts from construction and operation would not be significant. Therefore, DOE concludes that the visual impacts from the proposed Project would not be disproportionately high and adverse on environmental justice communities.

As described in Section 4.14, subsistence in Alaska is characterized by consumption of wild foods; hunting and gathering activities organized by kinship groups, and the pursuit of these activities within traditional territories. Subsistence is an important part of the Alaska Native economic system where individuals and families or households trade wild foods and goods to supplement their income. Within each community's subsistence use area, hunting, fishing, and gathering follow a seasonal cycle that corresponds to animal migration patterns, weather, and the quality of resources in the area. **Alaska Natives living in remote areas and conditions of poverty, including the communities of Nuiqsut and Kaktovik, can be especially vulnerable to upstream development activities that affect subsistence resources upon which these communities rely for economic, nutritional, and cultural reasons. Often, conditions of poverty amplify adverse impacts on subsistence resource use. For example, if subsistence harvests decrease or subsistence-related travel costs increase, lower income households may be unable to spend more**

money on fuel and other subsistence-related expenses, and they may be less able to shift to more expensive commercial food sources, thereby potentially experiencing decreased food security. The Alaska Natives of northern Alaska are also disproportionately affected by climate change, both by the fact that climate change effects are more pronounced in this region and by the fact that subsistence activities in the region are particularly dependent on ice, wind, and permafrost conditions (see Section 3.19 for additional information on climate change and regional effects in Alaska). Section 4.17 concludes that upstream development activities would have the potential to generate low to moderate adverse effects to human health and safety during construction and operation of new facilities. Disproportionately high and adverse human health and safety impacts on the environmental justice communities of Nuiqsut and Kaktovik are not anticipated to occur due to the distance of the towns to the ROI; however, individual impacts could occur to subsistence users traveling to the ROI for subsistence activities. BMPs for minimizing air quality impacts during construction and operations would also serve to protect individuals with upper respiratory conditions. In addition, enforcement of required safety training and implementation of safety plans would serve to minimize accidents and accident-related fatalities while also reducing the potential for adverse safety impacts to subsistence users.

4.11.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of the upstream facilities on the North Slope considered within this **Final** SEIS would not have significant impacts on socioeconomics. Although potential impacts would be minimal, standard BMPs and mitigation measures would be implemented to reduce potential impacts to minority and low-income populations. For example, visual impacts would be managed with a Project Lighting Plan, air permitting to reduce regional haze, and a Transportation Mitigation Plan to reduce potential congestion and damage to roadways. **Additional measures to reduce impacts to subsistence resources and users are discussed in Section 4.14.5.**

4.11.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact socioeconomics, but overall impacts would be beneficial to negligible. While construction and operation of the upstream facilities under Scenarios 2 and 3 would require some additional temporary and permanent personnel, they would work on a rotational basis and be housed in self-contained work camps while on duty. As a result, personnel living in worker camps would have little opportunity to make purchases within the local economy. This would mean there would not be a substantial change in local residences and spending activity that could affect population, housing stock, the economic base, taxes, or public services. The analysis concludes that construction and operation of the upstream facilities **could** have disproportionately high and adverse impacts on environmental justice communities **which use the ROI for subsistence; however, BMPs and mitigation measures would help reduce the potential for adverse impacts**.

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4.12 TRANSPORTATION

4.12.1 Summary of Transportation Impacts from the 2020 EIS

Table 4.12-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS.

Table 4.12-1. Summary of Transportation Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• During construction, truck deliveries and commuting workers would increase traffic volumes, and potentially increase congestion, delays, and safety risks for the following highways: Kenai Spur, Sterling, Seward, Glenn, Parks, Dalton, Steese, Elliott, and Richardson. • During construction, lane closures on portions of Dalton and Park Highways would occur and could lead to delays. • Smaller public and private roads would be impacted during pipeline construction and would require temporary road closures, depending on construction methods. • During operations, Project-related traffic increases would not contribute to congestion or delays to roadway network. • Portion of the Kenai Spur Highway would be relocated and would change traffic patterns, resulting in increased driving time for some residences and businesses.	• Adverse impacts on roadway infrastructure would mainly occur during construction and would be temporary and less-than-significant. Temporary closures on highways would be advertised far in advance to allow road users to make alternate plans. Closures on smaller roads could see detours, one-lane open, and/or steel plates over trenches. Project proponent would work with landowners and tenants to ensure continued access during construction. Following construction, roadways would be restored per agreements with state and municipal authorities and property owners. Project proponent has developed a Traffic Mitigation Plan to reduce impacts which would be reviewed by ADOT&PF. Project proponent would apply for an ADOT&PF driveway permit for each public road crossing and develop a traffic control plan for each crossing (to be approved by ADOT&PF and borough or municipal authorities, as appropriate).	4.12.2; 4.19.2; 5.1.12
• During construction, Project demand of railcars would exceed Alaska Railroad's number of rail cars available and could limit availability of commercial railroad service to other users.	• Assuming no homes, businesses, or private lands would lose access to roads, impacts of the Kenai Spur Highway relocation on traffic patterns would be permanent and minor.	
• During construction, congestion along Alaska Railroad rail line could occur during the summer season due to transport of equipment and material and could cause some travelers, particularly tourists, to avoid rail trips in favor of automobile trips (Section 4.11.7 of 2020 EIS discusses impacts to tourism). • During construction, marine transport of materials and equipment would increase vessel activity and increase port utilization at the following ports: Port of Alaska; Port of Dutch Harbor; Port of Nikiski; Prudhoe Bay Dock Head 4; Port of Whittier; and Port of Seward.	• Adverse impacts on railroad infrastructure would mainly occur during construction phase and would be temporary and less-than-significant. To minimize impacts on passenger rail traffic, Project proponent would conduct some freight movements at night. To reduce impacts to capacity of the Alaska Railroad, Project proponent would implement long-lead contracting, procurement, and cooperation with the Alaska Railroad to mitigate for increased demand on railroad. During pipeline construction across rail lines, Project proponent would use horizontal bore method to avoid impacts on rail traffic and would obtain permission from the Alaska Railroad before boring beneath the rail line or connecting new rail spurs to the existing rail line.	

Table 4.12-1. Summary of Transportation Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• During construction, the following navigation channels would experience increase in vessel traffic from the transport of materials and equipment: Beaufort Sea/Prudhoe Bay; Bering Sea/Norton Sound; Upper Cook Inlet; Resurrection Bay; Kennedy Entrance/Lower Cook Inlet/Kachemak Bay; and Iliuliuk Bay/Iliuliuk Harbor/Dutch Harbor/Captains Bay. • During construction, increased vessel traffic would decrease the available capacity of ports for other users, especially at Ports of Alaska (Anchorage) and Seward and increase the risk of vessel collisions. • During operations, the proposed Project would generate an increase in deep-draft vessel traffic from the transport of LNG in Cook Inlet and could impact commercial fishing vessels and other maritime industry users. Marine vessel hazards could also increase in the Cook Inlet (discussed in Section 4.18.3 of 2020 EIS). • During construction, regional hub airports would experience an increase in passenger travel, mainly associated with the transport of workers. Airport terminals could experience delays and congestion from the increased demand. Some non-Project passengers could be displaced during peak construction. The following airports would be impacted: Anchorage International, Fairbanks International, Kenai Municipal, and Deadhorse. • During construction, local airstrips would experience an increase in use and Project Adverse impacts to marine transportation would be temporary and less-than-significant during construction and permanent and less-than-significant during operation (for Cook Inlet). AGDC would minimize impacts during construction by coordinating with port facilities to plan arrivals. If port utilization were to exceed capacity during construction, AGDC would shift containerized deliveries from the Port of Anchorage to the Port of Seward. Additionally, shipping companies serving the Port of Whittier could add capacity and reduce the potential for significant cumulative impacts on ports.	• Adverse impacts to marine transportation would be temporary and less-than-significant during construction and permanent and less-than-significant during operation (for Cook Inlet). AGDC would minimize impacts during construction by coordinating with port facilities to plan arrivals. If port utilization were to exceed capacity during construction, AGDC would shift containerized deliveries from the Port of Anchorage to the Port of Seward. Additionally, shipping companies serving the Port of Whittier could add capacity and reduce the potential for significant cumulative impacts on ports. • Adverse impacts to air transportation would mainly occur during construction and would be temporary and less-than-significant. Improvements to Ted Stevens Anchorage International Airport and expansion of the terminal at Kenai would be positive cumulative impacts and could help offset any adverse impacts.	

ADOT&PF = Alaska Department of Transportation and Public Facilities; AGDC = Alaska Gasline Development Corporation; EIS = Environmental Impact Statement; LNG = liquefied natural gas

4.12.2 Methodology to Assess Transportation Impacts

To evaluate the impacts on transportation resources, DOE reviewed the Proposed Action and No Action Alternative to determine whether any activities have the potential to cause the following:

- Result in increased vehicular traffic congestion, delays, or safety risks on roadway infrastructure;
- Change accessibility to public or private roadways;
- Result in increased vessel traffic congestion, delays, or safety risks on navigable waters;
- Change operating capacity of marine ports; or
- Result in increased air traffic and delays and change in operating capacity of aircraft facilities.

4.12.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to transportation resources as described in Section 4.12.2 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.12.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, the analysis considers industry standard staffing levels for construction and operation of oil and gas industry facilities to evaluate potential transportation impacts.

The majority of impacts to transportation resources would occur during construction of upstream development activities in the North Slope. Construction personnel, materials, and equipment would be brought to the work sites by year-round air transportation, annual winter ice roads, and/or in the summer by barge or boat. Therefore, construction would potentially increase vehicular, marine, and air traffic volumes and potentially lead to increased delays and congestion to transportation resources. During operations, impacts to transportation resources would primarily be related to LNG carrier activities at the Liquefaction Facilities, which is not within the ROI of this **Final** SEIS. Impacts resulting from LNG carriers to marine transportation resources are discussed in Section 4.12.2.3 of the 2020 EIS. Table 4.12-2 summarizes the potential for transportation impacts based on project activity type.

Table 4.12-2. Potential Transportation Impacts from Upstream Development

Activity	Scenario & Location	Type of Transportation Impact
Expansion and operations of well pads (see Section 2.5.2 regarding gravel construction including pads).	Scenarios 2 & 3: PTU (7 acres) PBU (5 acres)	• For PBU, increased vehicular traffic on Dalton Highway and local roads leading up to existing construction camps for transporting workers could result in traffic congestion and delays, especially during peak construction years. Adverse impacts would be temporary and limited to peak construction hours in the a.m. and p.m. and are considered less-than-significant as majority of impact would occur on private roads supporting industrial activities and shuttles would be used to transport workers from work camps to project sites to minimize vehicular volumes. For PTU, increased traffic volumes would be limited to the PTU footprint as majority of equipment, material, and workers would be transported via barge or air.

Table 4.12-2. Potential Transportation Impacts from Upstream Development

Activity	Scenario & Location	Type of Transportation Impact
		• Increased construction truck traffic on Dalton Highway and local roads from trucks hauling equipment and material could result in delays, especially during peak construction years. Adverse impacts would mainly be limited to roads supporting regional industries, including Spine Road. Adverse impacts would be temporary and are considered less-than-significant as majority of impact would occur on private roads supporting industrial activities. • Increased air traffic mainly from the transport of workers to the PBU and PTU, could adversely impact Deadhorse Airport and the Point Thomson airstrip, especially during peak construction periods. Adverse impacts would be temporary and are considered less-than-significant as majority of users of Deadhorse Airport, mainly consists of industry personnel, and not the general public. Also, impacts would mainly be limited to the beginning and end of construction phases. • Increased marine vessels barging construction equipment and materials and facility modules to West Dock Causeway at PBU and Thomson Marine Facilities at PTU could increase delays to marine vessel traffic and increase transport hazards in the Prudhoe Bay. Adverse impacts would be temporary and are considered less-than-significant as the navigation channels in these areas experience relatively low marine vessels. PTU development would have minimal impacts to local and regional marine facilities as PTU has its own docking facility. • Minimal adverse impacts to roadways expected from low number of maintenance vehicles during operations. No impacts expected to air and marine transportation during operations.
Construction and use of a multi-season ice pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Scenarios 2 & 3: PTU (7 acres)	• Similar effects to well pad expansion within PTU near the Central Pad; however, number of construction workers and amount of supplies would be less. Therefore, only incremental increases in traffic volumes would be expected. Additionally, effects would be temporary and last approximately one season. • Less-than-significant, adverse impacts to roadways expected from low number of maintenance vehicles during use of ice pad. No impacts expected to air and marine transportation during use of ice pads.
Construction and operations of new wells (see Section 2.5.5 regarding well drilling requirements).	Scenarios 2 & 3: PTU (4 new wells) PBU (10 new wells) Scenario 3 only: PBU (7 additional new wells)	• Similar effects to well pad expansion within PTU near the Central Pad; however, number of construction workers and amount of supplies would be less. Therefore, only incremental levels of additional traffic volumes would be expected. • Less-than-significant adverse impacts to roadways expected from low number of maintenance vehicles during operations. No impacts expected to air and marine transportation during operations.

Table 4.12-2. Potential Transportation Impacts from Upstream Development

Activity	Scenario & Location	Type of Transportation Impact
Dredging	Scenarios 2 & 3: PTU (approximately 5,000 cubic yards of material for barge unloading equipment and modular facilities)	• Could potentially result in delays to marine vessel traffic. Adverse impacts would be less-than-significant and temporary. • No impacts expected to road and air transportation during dredging activities.
Ice road construction and use (see Section 2.5.1 regarding ice construction including ice roads).	Scenarios 2 & 3: PTU PBU KRU	• Similar effects to well pad expansion within PTU near the Central Pad; however, number of construction workers and amount of supplies may be more. Therefore, higher levels of additional traffic volumes would be expected. • Less-than-significant, adverse impacts to roadways expected from use of ice roads as general public has limited or no access to ice roads. No impacts expected to air and marine transportation during use of ice roads.
Construction and operations of new pipelines (see Section 2.5.3 regarding pipeline construction).	Scenarios 2 & 3: PBU (10 pipelines ranging in length from 3 to 25 miles) Scenario 3 only: KRU (30-mile CO_2 pipeline to KRU, approximately 19 miles of internal CO_2 distribution pipelines)	• Similar effects to well pad expansion within PTU near the Central Pad; however, number of construction workers and amount of supplies would be more. Therefore, higher levels of additional traffic volumes would be expected. Adverse impacts would be temporary and considered less-than-significant as majority of impact would occur on private roads supporting industrial activities and shuttles would be used to transport workers from work camps to project sites to minimize vehicular volumes. • During operations, adverse impacts to roadways would be limited to maintenance vehicles and, therefore, would be less-than-significant. No impacts expected to air and marine transportation during operations.

CO_2 = carbon dioxide; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit

4.12.4.1 Roadway Transportation

During construction (for both Scenarios 2 and 3), regional roadway infrastructure would experience a temporary increase in vehicular traffic due to the transport of construction equipment, materials, and personnel, though most of the equipment and materials would be shipped via marine vessels. Oversized equipment and materials would initially be barged in and then delivered by trucks. These truck deliveries would mainly be on roads, including Spine Road, that are currently used by commercial vehicles supporting the existing oil and gas industries, and, therefore, are not expected to impact the general public. As there are no permanent access roads leading to the PTU, most of the supplies would be transported via an annual winter ice road and barge in the summer. Therefore, increased vehicular traffic from development at the PTU would be limited to within the PTU footprint and not expected to impact any local roads.

The respective project proponent would transport construction workers by bus, mainly from Deadhorse Airport to construction camps at the beginning and end of each construction season, a process that would take one or more days depending on the distance of the camp to the airport and from the camps to the work sites. Increased traffic from the transport of construction workers to and from the work areas would mainly be on the industry-related roads and a limited portion of Dalton Highway. This incremental increase may be detected by local communities as Dalton Highway normally experiences low vehicular volumes; however, this increase would be limited to the peak commute hours in the a.m. and p.m. and would occur mainly in the northern portion of the highway. Additionally, workers would be shuttled from the camps to the work sites to maintain minimal increases in traffic volumes and result in less-than-significant, adverse impacts. Adverse impacts to the regional road infrastructure would be less-than-significant as the highest increases in traffic volumes would be limited to the peak commute hours and mostly on the smaller roads normally used by the local industries. Construction workers at the PTU would be shuttled between construction camps and project sites and would occur within the PTU footprint, thereby leading to negligible adverse impacts to public local roads.

4.12.4.2 Marine Transportation

During construction (for both Scenarios 2 and 3), the majority of construction equipment and materials would be transported via navigable waters using ships and oceangoing tugs pulling barges. As discussed in Section 4.12.2.3 of the 2020 EIS, primary ports in Alaska, including the West Dock Causeway in Prudhoe Bay, would be used to receive modules, equipment, and material during the ice-free shipping season. Section 2.1.3.2 of the 2020 EIS discusses improvements to the existing West Dock Causeway to receive Project-related modules. Similar methods of delivery would be anticipated for upstream development activities occurring at PBU which would likely use improvements at the West Dock Causeway for marine transport of equipment and materials. Increased marine vessels resulting from the construction at the PTU would not impact regional marine docks as this area uses its own docking facility at the Marine Thomson Marine Facilities.

This increase in marine vessel traffic could result in congestion and increase the risk of accidents in Prudhoe Bay and Beaumont Sea, the navigable waters serving West Dock Causeway and the Thomson Marine Facilities. The additional barge trips to the West Dock Causeway and Thomson Marine Facilities would not likely cause delays or congestion in the ocean shipping lanes as existing marine traffic is relatively low. To ensure a safe and functional traffic management and risk mitigation plan during construction, the respective project proponent for the upstream development activity required marine transportation would prepare a project-specific Journey Management Plan, similar to the plan discussed in Section 4.12.2.3 of the 2020 EIS, to address vessel navigation traffic prior to commencing construction activities.

During operations, minimal increases in vessel marine traffic would be limited to occasional maintenance-related vessels or delivery of equipment/supplies, and, therefore, impacts to marine transportation is expected to be less-than-significant for both Scenarios 2 and 3.

4.12.4.3 Air Transportation

During construction, for both Scenarios 2 and 3, air transportation would be used for the transport of workers, supplies, and equipment. The majority of increased air travel would result from transporting workers at the beginning and end of each construction season. Most of the construction personnel would be transported from Deadhorse Airport to the camp sites via bus, but the upstream development projects could use smaller local airstrips, such as Point Thomson, for specialized trips not associated with workforce rotations. Because Deadhorse Airport and Point Thomson airstrip are primarily used by existing oil and gas industry employees, the upstream development-related project increase in passenger activity would not generally affect the general public. Workers who are already in the area and project personnel would be affected by the increased congestion at the passenger terminal at the Deadhorse Airport, especially during peak construction periods. Peak demands on flights would likely occur over one or a few days at a time (i.e., during rotations), rather than continuously during the respective project's period of construction. Therefore, adverse impacts to air transportation would be considered temporary and less-than-significant.

4.12.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of the upstream facilities on the North Slope considered within this **Final** SEIS would not have significant impacts on transportation resources, which includes road, marine, and air transportation. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of an Air Transport Plan that would detail the planned number of project-related aircraft operations at the airports and airstrips to avoid conflicts with existing air traffic.
- Preparation of a Journey Management Plan that would describe the process to be followed for planning and safely undertaking transportation activities to avoid conflicts with existing marine and vehicle traffic. This could include identification of measures to be implemented to mitigate activities with traffic impedance.
- Preparation of a Traffic Mitigation Plan that provides measures to minimize traffic congestion and delays from construction-related traffic.

4.12.6 Summary of Project and Upstream Development Impacts

The construction and operation of upstream development activities under Scenarios 2 and 3 would have the potential to adversely impact transportation resources due to increased traffic volumes of vehicles, marine vessels, and air travel. The increased traffic volumes would primarily occur during the construction phase from the deliveries of equipment, materials, and modules and from the transport of personnel. This increase in volumes could lead to congestion and delays for road, marine, and air transport; additionally, roadways and navigable waters could experience increased safety hazards. These impacts are expected to be minimal on the roadway infrastructure as Dalton Highway and the smaller distribution of gravel and ice roads currently experience low traffic volumes and mainly support local industries. Impacts to marine transport resources would be minimal as the existing vessel traffic is relatively low in the region and implementation of a project-specific Journey Management Plan by the applicant would reduce risks by addressing navigation traffic. Impacts to air transport would be minimal as the peak demands from workers would be limited to the worker rotation periods and would primarily occur at Deadhorse Airport and Point Thomson airstrip, facilities that are mostly used by personnel of the local industries in the North Slope.

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4.13 CULTURAL RESOURCES

4.13.1 Summary of Cultural Resource Impacts from the 2020 EIS

Table 4.13-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, a Programmatic Agreement restricts AGDC from starting any construction until all cultural surveys and evaluations are complete, treatment and avoidance plans have been prepared and reviewed, and FERC has provided written notice to proceed.

Table 4.13-1. Summary of Cultural Resource Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Field surveys have identified 52 sites that are listed or eligible for listing in the NRHP with SHPO concurrence. Eligibility determinations for another 20 sites require additional information. • The shipwreck database and remote sensing data identified two sonar targets that could represent submerged cultural resource sites.	• AGDC has not completed all cultural resources surveys and/or NRHP evaluations; about 13 percent of the onshore portion of the proposed Project remains to be surveyed for archaeological resources. A Programmatic Agreement stipulates the AGDC should not begin construction until all outstanding archaeological and architectural surveys are complete; survey and evaluation reports and treatment or avoidance plans, if required, have been prepared and reviewed by the appropriate agencies, the ACHP is provided an opportunity to comment if historic properties would be adversely affected; and FERC has provided written notice to proceed.	4.13.5; 5.1.13

ACHP = Advisory Council on Historic Preservation; AGDC = Alaska Gasline Development Corporation; EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; NRHP = National Register of Historic Places; SHPO = State Historic Preservation Office

AGDC has also prepared procedures to be used in the event that any unanticipated historic properties or human remains are encountered during construction and provided the Project Plan for Unanticipated Discovery of Cultural Resources and Human Remains to FERC, the Alaska State Historic Preservation Office (SHPO), and the BLM. The plan includes procedures for notifying consulting and interested parties, including Alaska Native tribes, in the event of any discovery.

4.13.2 Methodology to Assess Cultural Resource Impacts

As summarized in Section 2.5, potential construction activities on the North Slope could include construction of new pads, wells, pipelines for product transport, and related access roads. Detailed locations are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. As a result, this analysis does not rely on site-specific cultural surveys but instead uses AHRS and North Slope Borough data to identify any recorded cultural sites within a 0.25-mile buffer of pads proposed for development and uses a 100-foot buffer from the existing 80-foot east-west pipeline ROW connecting PTU, PBU, and KRU (also see Table 3.13-1).

4.13.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to cultural resources as described in Section 4.13 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.13.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities on the North Slope could adversely affect historic properties (i.e., cultural resources either listed or eligible for listing in the NRHP), if present. These historic properties could include prehistoric or historic archaeological sites, districts, buildings, structures, or objects, as well as locations with traditional value to federally recognized tribes, Alaska Native Claims Settlement Act village and regional corporations, or other groups. Historic properties must generally possess integrity of location, design, setting, materials, workmanship, feeling, and association, and must meet one or more of the criteria specified in 36 CFR 60.4.

Adverse effects could include destruction or damage to all, or a portion, of a historic property; alteration of a property including restoration, rehabilitation, repair, maintenance, or stabilization inconsistent with federal standards; removal of the property from its historic location; change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance; and introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features. As discussed in Section 3.13, the AHRS and North Slope Borough databases did not include any cultural sites, including historic properties in proximity to areas identified for potential upstream development activities (0.25-mile buffer from pads and 100-foot buffer from the existing east-west pipeline ROW). Sections 4.13.2.1 through 4.13.2.4, therefore, discusses the type of impacts by activity within the North Slope that could adversely affect a historic property, if present. The adverse effects to a historic property, if present, could constitute a significant adverse effect under NEPA. Mitigation measures discussed in Section 4.13.5 would serve to reduce adverse effects to less-than-significant.

4.13.4.1 Point Thomson Unit

The discussion of adverse effects to historic properties within PTU focuses on potential disturbance to archaeological sites as no documented historic structures currently exist within the vicinity of the Central Pad and docking facilities affected by the proposed PTU Expansion which would occur under both Scenarios 2 and 3. Prior to any ground disturbance activities, however, the project proponent for the PTU Expansion would conduct the necessary surveys to identify any historic properties within the APE. Table 4.13-2 summarizes the potential for impacts to cultural resources within the PTU based on activity.

Table 4.13-2. Potential Cultural Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which has the potential to adversely affect archaeological sites, if present.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would be unlikely to have adverse impacts on historic properties. As discussed in Section 2.5.1, multi-season ice pads are designed for use over multiple winter and summer seasons, with the goal of avoiding permanent fill for temporary activities. The method of construction involves snow compaction and establishing a base layer of ice which would likely afford protection from disturbance for any archaeological sites below the surface, if present.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad could potentially affect archaeological resources, if present. The potential for disturbance to sites, however, would be reduced as these activities would occur in developed areas, likely previously disturbed. As stated within Section 2.5.5, permits for well drilling issued by the AOGCC would require review/approval by the ADNR which includes the Office of History and Archaeology regarding protection of cultural resources.

Table 4.13-2. Potential Cultural Resource Impacts within the Point Thomson Unit

Activity	Description of Impact
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Significant adverse effects unlikely. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	Dredging of materials could adversely affect underwater archaeological sites. As the dredging would occur in previously dredged/disturbed areas, impacts to underwater archaeological sites would be unlikely.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would be unlikely to have adverse impacts on historic properties. As discussed in Section 2.5.1, the method of construction involves use of frozen water, either in snow or ice form, which would likely afford protection from disturbance for any archaeological sites below the surface, if present.
Operations	Operations of proposed activities would be unlikely to adversely affect historic properties as operational activities would be confined to existing disturbed/approved locations.

ADNR = Alaska Department of Natural Resources; AOGCC = Alaska Oil and Gas Conservation Commission;
UIC = Underground Injection Control

4.13.4.2 Prudhoe Bay Unit

The discussion of adverse effects to historic properties within PBU focuses on potential disturbance to archaeological sites as no historic structures currently exist within the vicinity of the CGF Pad and surrounding locations where well development and supporting pipeline construction would occur. Prior to any ground disturbance activities, however, the project proponent for the PBU MGS Project would conduct the necessary surveys to identify any historic properties within the APE. Table 4.13-3 summarizes the potential for impacts to cultural resources within the PBU based on activity. A majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the 7 additional injection wells at PBU Well Pad 18 under Scenario 2.

Table 4.13-3. Potential Cultural Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which has the potential to adversely affect archaeological sites, if present.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells could potentially affect archaeological resources, if present. As stated within Section 2.5.5, permits for well drilling issued by the AOGCC would require review/approval by the ADNR which includes the Office of History and Archaeology regarding protection of cultural resources.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	No significant adverse effects. See discussion above regarding well drilling. Additionally, the lateral drilling would likely occur at depths well below the potential for historic properties to be present. Adverse effects would also be minimized as the wells would be drilled from existing disturbed areas associated with Well Pad 18.

Table 4.13-3. Potential Cultural Resource Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could potentially disturb archaeological resources, if present. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse effects. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse effects. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse effects. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would be unlikely to have adverse impacts on historic properties. As discussed in Section 2.5.1, the method of construction involves use of frozen water, either in snow or ice form, which would likely afford protection from disturbance for any archaeological sites below the surface, if present.
Operations	Operations of proposed activities would be unlikely to adversely affect historic properties as operational activities would be confined to existing disturbed/approved locations.

ADNR = Alaska Department of Natural Resources; AOGCC = Alaska Oil and Gas Conservation Commission; CGF = Central Gas Facility; GTP = Gas Treatment Plant; HSM = horizontal support member; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.13.4.3 Kuparuk River Unit and CO_2 Pipeline

The discussion of adverse effects to historic properties within KRU and along the approximately 30-mile CO_2 pipeline focuses on potential disturbance to archaeological sites as no historic structures currently exist within the vicinity of existing injection well sites at KRU or along the existing Kuparuk Pipeline and Kuparuk Extension Pipeline. Prior to any ground disturbance activities, however, the project proponent for the KRU EOR would conduct the necessary surveys to identify any historic properties within the APE. Table 4.13-4 summarizes the potential for impacts to cultural resources within the KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.13-4. Potential Cultural Resource Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for geologic sequestration (see Section 2.5.3 regarding pipeline construction methods).	Construction of new pipelines could disturb archaeological resources, if present. Impacts would be reduced or avoided through use of existing ROW and infrastructure. As stated in Section 2.5.3, pipeline construction on the North Slope involves an elevated network using VSMs and HSMs which keep the lines above the ground, restricting impacts to placement of VSMs where ground disturbance would occur.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	No significant adverse effects. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Operations of proposed activities would be unlikely to adversely affect historic properties as operational activities would be confined to existing disturbed/approved locations.

CO_2 = carbon dioxide; GTP = Gas Treatment Plant; HSM = horizontal support member; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; ROW = right-of-way; VSM = vertical support member

4.13.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigations

As discussed above, construction and operation of the upstream facilities on the North Slope considered within this **Final** SEIS could have significant adverse effects on historic properties. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Plan for Unanticipated Discovery of Cultural Resources and Human Remains to detail the procedures to be used in the event that previously unreported historic properties or human remains are found. The plan would be approved by the Alaska SHPO and also include procedures for notifying consulting and interested parties, including Alaska Native tribes, in the event of any discovery.

In addition, prior to ground disturbance, the project proponent would survey areas within the APEs for cultural resources. If NRHP-eligible resources are identified that cannot be avoided, the project proponent would prepare treatment plans for review and approval by the SHPO and interested tribes, as applicable in accordance with the NHPA.

4.13.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact additional areas of land which may contain historic properties. Overall adverse effects to cultural resources would be similar between Scenarios 2 and 3 with the exception of additional potential adverse effects from the additional pipeline construction required under Scenario 3 which could generate greater adverse effects if historic properties were present. Potential impacts would be mitigated through surveys for cultural resources, avoidance, and preparation of treatment plans for unavoidable impacts to historic properties. DOE did not identify effects to historic properties beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.13.5.

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4.14 SUBSISTENCE

4.14.1 Summary of Subsistence Impacts from the 2020 EIS

Table 4.14-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, FERC determined overall impacts to subsistence resources from construction and operation of the proposed Project would be less-than-significant.

Table 4.14-1. Summary of Subsistence Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Project construction and operation have the potential to affect subsistence practices due to reductions in resource abundance and availability, reduced access to traditional harvest areas during construction activities, and temporary increased competition from non-local harvesters. • Impacts would result from the loss or alteration of habitat; loss or displacement of wildlife, birds, or fish; and increased access to remote areas along the pipeline ROW and access roads.	• While Project construction and operation would result in short-term, long-term, and permanent impacts on subsistence resources and activities, FERC concluded that the impacts would be less-than-significant.	4.14.2; 5.1.14

EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; ROW = right-of-way

4.14.2 Methodology to Assess Subsistence Impacts

The 2020 EIS utilized subsistence mapping developed by ADF&G and AGDC along with the traditional knowledge data and community surveys to provide baseline data relevant to measuring changes in subsistence use areas, resources, harvest success, frequency of trips, transportation methods, timing of harvest activity, and harvest effort. This **Final** SEIS follows a similar approach focusing on communities and resources within the North Slope occurring within or near PTU, PBU, KRU, and existing pipeline ROWs between PBU and KRU where potential upstream development activities would occur.

The abundance and quality of subsistence resources; physical and regulatory restrictions affecting access; visual, noise, and other human activity disturbances; and the time and funds available to the harvester are all factors that could affect the subsistence use area and availability of, or access to, an individual resource (FERC 2020). If a portion of a community's subsistence use area is within the Project footprint, a direct impact on subsistence use would occur. In general, with the exception of downstream effects (e.g., movements of migratory terrestrial species), the farther a community's subsistence use area is from the Project area, the less the potential exists for a direct impact on residents' subsistence uses. This **Final** SEIS focuses on subsistence activities of the Kaktovik community whose subsistence use area extends into the PTU, PBU, and KRU areas which could experience upstream development.

Within the 2020 EIS, FERC identified general concerns about Project effects on subsistence including a decrease in the availability of subsistence resources (wildlife, fish, and vegetation); increased costs and greater travel to harvest resources; a reduction in physical access to resources; increased competition for resources; and contamination (e.g., noxious weeds, invasive species, and dust) of vegetation and wildlife habitat. Similar effects are considered in this analysis.

Subsistence Harvest and Resource Competition

Successful subsistence harvests depend on continued availability of healthy populations of wild resources (wildlife, fish, and vegetation) in traditional use areas. Resource availability and condition are affected by weather, wildlife population trends, natural variation, human disturbance, changes to habitat, contamination (e.g., invasive species, dust, and parasites), and federal, state, and tribal management practices.

Avoidance of the Project area by wildlife, the perception by subsistence users that resources have been contaminated, and changes in access to subsistence areas could result in competition among subsistence users from the same community. These impacts could also increase competition for the resources necessary to support subsistence. Increases in trip frequency, length, and duration due to the factors described above could deplete a community's reserves of fuel and increase competition for supplies that are necessary for subsistence activities. Specifically, during the 2020 EIS process, the communities on the North Slope stressed the importance of caribou as a subsistence resource. Residents rely on the predictable annual migration of caribou through traditional hunting areas; however, observed changes include herds using different migratory routes and caribou splitting up into smaller groups rather than traveling in large herds, which reduces chances for successful harvests. Residents noted that disturbances such as the physical presence of pipelines impede passage and/or change migration routes and contribute to shrinking caribou foraging area. Additionally, restrictions to use of access roads associated with new development impedes hunter access to caribou. Where road access was not restricted, residents noted benefits of using the Spur Road for caribou hunting. Additionally, anthropogenic noise during subsistence harvest was noted as undesirable because some terrestrial, avian, and marine resources are sensitive to noise from aircraft and machinery.

These factors are considered in this **Final** SEIS regarding potential effects on subsistence activities from upstream development activities. Section 4.19 discusses potential impacts to resources and subsistence from climate change.

4.14.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Since construction and operations of the proposed Project would not occur, no potential for adverse effects to subsistence activities would occur.

4.14.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

This discussion evaluates the construction and operational on effects to subsistence activities within the ROI which includes PTU, PBU, and KRU, focusing on potential effects on the availability of subsistence resources (wildlife, fish, and vegetation); increased costs and greater travel to harvest resources; a reduction in physical access to resources; increased competition for resources; and contamination (e.g., noxious weeds, invasive species, and dust) of vegetation and wildlife habitat.

In general, construction activities could have negative impacts on resource availability. Construction-related disturbances would occur over a 2-year period for the PTU and a 4-6-year period for the PBU. The specific construction period for KRU is not known at this time. Resource availability could be diminished from wildlife avoidance of construction areas due to noise from construction equipment, air deliveries, and increased human presence. Development of upstream production facilities and infrastructure may also facilitate travel into a community's subsistence use area by subsistence users from other communities or urban areas, resulting in increased competition for local resources. Avoidance of project areas by wildlife, the perception by subsistence users that resources have been contaminated, and changes in access to subsistence areas could also result in competition among subsistence users from the same community. These impacts could also increase competition for the resources necessary to support subsistence. Increases in trip frequency, length, and duration due to the factors described above could deplete a community's reserves of fuel and increase competition for supplies that are necessary for subsistence activities.

Table 4.14-2 summarizes the potential for subsistence impacts within the ROI based on project activity type. Terrestrial subsistence impacts would primarily occur to the Kaktovik community as their subsistence area overlaps with PTU, PBU, and KRU. Impacts to marine harvests, however, could occur to both the Kaktovik and Nuiqsut communities as both communities conduct marine mammal harvests in marine waters of the ROI. **As the primary residents within the ROI include oil and gas industry workers and members of the Kaktovik and Nuiqsut communities, disproportionate high and adverse effects may result from upstream development activities to subsistence users of the Kaktovik and Nuiqsut communities. However,** adverse subsistence impacts discussed in Table 4.14-2 are anticipated to be less-than-significant with implementation of mitigation measures included in Section 4.14.5.

Table 4.14-2. Potential Subsistence Impacts from Upstream Development

Activity	Scenario & Location	Type of Subsistence Impact
Expansion and operations of well pads (see Section 2.5.2 regarding gravel construction including pads).	Scenarios 2 & 3: PTU (7 acres) PBU (5 acres)	• Decrease in the availability of subsistence resources (wildlife and vegetation) from permanent impacts of up to 12 acres for pad expansion. • Activity is unlikely to increase costs and greater travel to harvest resources as the expansion would occur directly adjacent to existing developed pads. • Physical access to vegetation resources would be reduced within the construction areas. Wildlife would likely avoid construction areas and areas directly adjacent due to human activities and noise. • Increased competition for resources would be unlikely due to the relatively small-scale nature of the projects and location occurring directly adjacent to developed areas with ongoing human activities. • Increased potential for contamination (e.g., noxious weeds, invasive species, and dust) of vegetation and wildlife habitat from construction and operational activities.
Construction and use of a multi-season ice pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Scenarios 2 & 3: PTU (7 acres)	• Similar effects to well pad expansion within PTU near the Central Pad; however, effects would be temporary and last approximately one season.
Construction and operations of new wells (see Section 2.5.5 regarding well drilling requirements).	Scenarios 2 & 3: PTU (4 new wells) PBU (10 new wells) Scenario 3 only: PBU (7 additional new wells)	• Decrease in the availability of subsistence resources (wildlife and vegetation) from construction and operation of new wells; overall effects would be less-than-significant as well development would occur within existing or expanded pads (described above) where subsistence activities would be unlikely. • Activity is unlikely to increase costs and greater travel to harvest resources as the expansion would within existing or expanded pads where subsistence activities would be unlikely. • Physical access to vegetation resources would be reduced within the construction areas. Wildlife would likely avoid construction areas and areas directly adjacent due to human activities and noise. • Increased competition for resources would be unlikely due to the relatively small impact area required for well placement and locations occurring within or directly adjacent to developed areas with ongoing human activities. • Increased potential for contamination (e.g., noxious weeds, invasive species, and dust) of vegetation and wildlife habitat from construction and operational activities.

Table 4.14-2. Potential Subsistence Impacts from Upstream Development

Activity	Scenario & Location	Type of Subsistence Impact
Dredging	Scenarios 2 & 3: PTU (approximately 5,000 cubic yards of material for barge unloading equipment and modular facilities)	• Temporary decrease in the availability of subsistence resources (wildlife and fisheries) from maintenance dredging activities in offshore waters at PTU. Associated underwater noise during dredging could cause a change in the migratory behavior of the marine mammals, displacing them from traditional use areas located offshore of PTU. • Activity could increase costs and greater travel to harvest aquatic mammals and fish during dredging activities as the expansion would occur directly adjacent to existing developed pads. • Physical access to aquatic resources would be reduced within the construction areas. Overall impacts would be less-than-significant as mammals and fish would likely avoid the dredging area due to human activities, sediments, and noise. Hunting and fishing activities would occur away from this area during dredging activities. • Increased competition for resources could occur during dredging at PTU as subsistence activities for aquatic mammals and fish would temporarily not occur within the area due to dredging activities. • Increased potential for contamination (e.g., sediments) of aquatic habitat from dredging activities. • Marine mammal harvests and waterfowl harvests could be affected by increased vessel traffic in the Beaufort Sea due to deliveries of equipment. The underwater noise could displace whale, seal and walrus that could occur in vessel transit routes during the summer months; however, this impact would be less-than-significant due to the ephemeral nature of the vessels in transit.
Ice road construction and use (see Section 2.5.1 regarding ice construction including ice roads).	Scenarios 2 & 3: PTU PBU KRU	• Temporary decrease in the availability of subsistence resources (wildlife and vegetation) from placement and use of ice roads for construction access. • Increased costs and greater travel to harvest resources could occur from construction and operation of ice roads during construction. • Physical access to vegetation resources would be reduced within the construction areas. Wildlife would likely avoid construction areas and areas directly adjacent due to human activities and noise. • Increased competition for resources could occur as ice road use could temporarily cause subsistence activities to occur away from these areas. • Increased potential for contamination (e.g., noxious weeds, invasive species, and dust) of vegetation and wildlife habitat from construction and use of ice roads.

Table 4.14-2. Potential Subsistence Impacts from Upstream Development

Activity	Scenario & Location	Type of Subsistence Impact
Construction and operations of new pipelines (see Section 2.5.3 regarding pipeline construction).	Scenarios 2 & 3: PBU (10 pipelines ranging in length from 3 to 25 miles) Scenario 3 only: KRU (30-mile CO_2 pipeline to KRU, approximately 19 miles of internal CO_2 distribution pipelines)	• Decrease in the availability of subsistence resources (wildlife and vegetation) from construction of new pipelines for by-product transport (e.g., CO_2). Greater impacts would occur for locations where new pipeline could not be placed in an existing ROW. • Increased costs and greater travel to harvest resources could occur during construction to avoid construction activities and travel to where wildlife has migrated away from construction noise. • Physical access to vegetation resources would be reduced within the construction areas. Wildlife would likely avoid construction areas and areas directly adjacent due to human activities and noise. • Increased competition for resources could occur as pipeline construction could temporarily cause subsistence activities to occur away from these areas. • Increased potential for contamination (e.g., noxious weeds, invasive species, dust and hydrostatic discharge) of vegetation and wildlife and aquatic habitats during pipeline construction and hydrostatic testing. • The presence of human activity during operations would be slightly increased due to the additional pipelines, but this would be infrequent. • Increased potential for physical barriers to migration between habitat areas or movement to specialized habitats for caribou and other large terrestrial mammal species during pipeline construction and operations. Impacts would be decreased during operations by placement of any new pipelines within existing ROW.

CO_2 = carbon dioxide; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; ROW = right-of-way

In general, impacts to caribou hunts (a species of high importance due to edible weight) would likely be minimized as construction activities associated with upstream development would primarily occur during winter months when caribou hunters are less active, and activities within PBU would occur in locations where oil and gas development has already reduced caribou harvests within the Prudhoe Bay Closed Area (see Section 3.14.2.1). Winter construction would reduce the overall impacts on resource availability for subsistence users as caribou, furbearer, non-salmon fish harvests are the primary harvest activities during the winter. Although caribou hunting occurs nearly year-round, the summer and fall months are a time of cooperative group hunting and extended camping trips. Winter caribou harvest generally occurs when meat supplies are low. Operational impacts to subsistence use areas would occur primarily in or directly adjacent to previously developed areas with existing aboveground pipelines and well infrastructure and in areas of limited harvest activity.

4.14.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigation

As discussed above, construction and operation of upstream facilities on the North Slope considered within this **Final** SEIS could affect subsistence activities. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The construction and restoration environmental plans identified in Sections 4.2 through 4.8 would also serve to protect subsistence resources.

In addition, to the extent practicable, new infrastructure would be sited within or directly adjacent to disturbed areas or within or directly adjacent to existing ROW for new pipeline construction. Similar to mitigation requirements identified in the 2020 EIS, project proponents for upstream development activities involving equipment and material deliveries by barge and for dredging at PTU would be required to coordinate with the NMFS and the Alaskan Eskimo Whaling Commission to avoid and minimize impacts on subsistence whaling and marine mammal hunting to minimize vessel traffic overlapping with subsistence hunts. This could require barging activities would be temporarily halted during peak whale hunting times.

In addition, project proponents for upstream development activities would prepare a site-specific Local Subsistence Implementation Plan, as applicable. The Local Subsistence Implementation Plan would include measures to coordinating with local communities, including tribal councils, to identify locations and times where subsistence activities occur, and modify schedules to minimize work, particularly work that could reduce resource availability or user access, to the extent practicable, in those locations and times.

4.14.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact subsistence areas, subsistence users, and harvest activities. Overall adverse effects to subsistence in the North Slope would be similar between Scenarios 2 and 3 with the exception of additional pipeline infrastructure for CO_2 transport required under Scenario 3 between PBU and KRU and within KRU. Potential impacts would be minimized as construction activities would likely occur during the winter months and be localized to existing locations with oil and gas development activities already occurring. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.14.5.

4.15 AIR QUALITY

4.15.1 Summary of Air Quality Impacts from the 2020 EIS

Table 4.15-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, FERC determined that overall impacts to air quality resources from construction and operation of the proposed Project would be minor to moderate. However, significant, short-term impacts could occur during years when construction and operation of the proposed Project occurs simultaneously, as well as during intermittent operational activities such as flaring.

Table 4.15-1. Summary of Air Quality Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Emissions from vehicles and equipment, marine and air traffic, waste incinerators, open burning, and fugitive dust would affect air quality during Project construction. • Construction of the GTP, PTTL, PBTL, and Mainline Facilities would have temporary, minor impacts on air quality. Construction of the Liquefaction Facilities would have temporary, moderate impacts on air quality, but could contribute to significant impacts during construction years 7 and 8 when combined with operational emissions. • Operation of the GTP, Mainline compressor stations and heater station, and Liquefaction Facilities would result in emissions of criteria pollutants, GHGs, and HAPs. Fugitive air emissions would also be generated by operation of the PTTL, PBTL, and Mainline Facilities, but the resulting impacts on air quality would be minor and limited to the area near the pipeline systems. • The GTP would be a PSD major source for CO, NO_X, VOC, PM_{10}, $PM_{2.5}$, SO_2, and GHGs; a Title V major source for CO, NO_X, VOC, PM_{10}, and $PM_{2.5}$; and a major source for HAPs. Under normal operating conditions, the GTP would not cause or contribute to an exceedance of the NAAQS/AAAQS for any criteria pollutant or exceed PSD incremental thresholds. • Intermittent activities such as flaring could cause short-term impacts on regional haze and deposition. • Annual emissions for each of the compressor stations and heater station along the Mainline Pipeline would be below PSD major source thresholds, though each station would be a Title V major source and a minor source under ADEC's Minor NSR program. • **The USEPA is the regulatory authority for establishing visibility thresholds and sulfur deposition thresholds under the Regional Haze Rule.** The established visibility threshold and sulfur deposition threshold at the Arctic National Wildlife Refuge could be exceeded by emissions from the Galbraith Lake Compressor Station. **The** established nitrogen deposition thresholds at multiple Class I areas would also be exceeded by operation of the compressor stations.	• Adverse impacts on air quality due to normal Project operation would generally be minor to moderate. Emissions could exceed nitrogen and sulfur deposition thresholds and visibility thresholds at nearby Class I national designated protected areas. During the years of simultaneous construction, startup, and operational activities at the Liquefaction Facilities, emissions could exceed the NAAQS/AAAQS for PM_{10} and $PM_{2.5}$. • Activities such as flaring could result in short-term significant effects on air quality.	5.1.15

Table 4.15-1. Summary of Air Quality Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• The Liquefaction Facilities would be a PSD major source for CO_2, NO_X, VOC, PM_{10}, $PM_{2.5}$, SO_2, and GHGs; a Title V major source for CO_2, NO_X, VOC, PM_{10}, and $PM_{2.5}$; and major source for HAPs. Under normal operating conditions, the Liquefaction Facilities would not cause or contribute to an exceedance of the NAAQS/AAAQS for any criteria pollutant or exceed PSD incremental thresholds, nor would cause an exceedance at nearby Class I national designated protected areas. Emissions would exceed the threshold for causing or contributing to visibility impairment in multiple Class I areas. Emissions could also exceed sulfur and/or nitrogen deposition thresholds at four Class I or II areas.		

AAAQS = Alaska Ambient Air Quality Standards; ADEC = Alaska Department of Environmental Conservation; CO = carbon monoxide; CO_2 = carbon dioxide; EIS = Environmental Impact Statement; GHGs = greenhouse gases; GTP = Gas Treatment Plant; HAPs = hazardous air pollutants; NAAQS = National Ambient Air Quality Standards; NO_X = nitrogen oxides; NSR = New Source Review; PBTL = Prudhoe Bay Unit Gas Transmission Line; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; PSD = Prevention of Significant Deterioration; PTTL = Point Thomson Unit Gas Transmission Line; SO_2 = sulfur dioxide; VOC = volatile organic compound

4.15.2 Methodology to Assess Air Quality Impacts

To evaluate impacts on air quality, DOE considered the potential for changes to air quality as a result of the Proposed Action and No Action Alternatives. This **Final** SEIS evaluates the potential changes air quality to determine whether these changes would directly or indirectly cause the following:

- Emissions of criteria pollutants that could exceed relevant air quality or health standards;
- An adverse change in air quality attainment status related to the NAAQS or Alaska standards;
- A violation of any federal or state permits;
- Effects on visibility and regional haze in Class I areas; or
- Conflicts with local or regional air quality management plans to attain or maintain compliance with federal or state air quality regulations.

4.15.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to air quality as described in Section 4.15 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.15.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities on the North Slope, as described, could result in additional air emissions. Sections 4.15.4.1 through 4.15.4.3 discuss the type of impacts by activity on the North Slope that could occur as a result of the proposed Project.

The 2020 EIS did not analyze impacts to air quality associated with upstream development at the PTU, the PBU, and the KRU. However, in support of the 2020 EIS, AGDC developed an air quality and noise resource report; Appendix G of the report included an analysis of air quality impacts associated with upstream development activities at the PTU and the PBU (AGDC 2017). The resource report addressed both construction and operational emissions, and describes the types of equipment that would be installed and operated at the PTU and the PBU. The AGDC report is used as a basis for the impact analysis described below. Note that the scope of the activities analyzed in the AGDC report varies slightly from the upstream development activities analyzed in this **Final** SEIS; however, it provides a useful estimate of the magnitude of impacts to air quality that could occur under Scenarios 2 and 3. The resource report addressed both construction and operational emissions, and describes the types of equipment that would be installed and operated as a result of upstream development.

4.15.4.1 Point Thomson Unit

Table 4.15-2 summarizes the potential for impacts to air quality within the PTU, based on the potential for construction and operation of additional facilities within the PTU Expansion Project. Construction activities at the PTU would result in a temporary increase in air emissions associated with transportation for deliveries of supplies, equipment, and personnel. Operations of the PTU development would result in long-term increases in air emissions.

Table 4.15-2. Potential Air Quality Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which would have temporary, less-than-significant impacts to air quality. Expansion of the Central Pad would involve site preparations, gravel and other materials and equipment delivery, foundations, and construction of facility buildings, with resulting emissions associated with ground-disturbing activities and operation of construction equipment.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would have temporary, less-than-significant impacts to air quality. As discussed in Section 2.5.1, multi-season ice pads are designed for use over multiple winter and summer seasons. The multi-season ice pad would involve site preparations including snow compaction and establishing a base layer of ice, along with materials and equipment delivery and construction of offices, warehouses, and equipment storage. Resulting air emissions would be associated with ground-disturbing activities and operation of construction equipment.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would have temporary, less-than-significant impacts to air quality. Typical drilling equipment would include a drill rig, camp generator engines, well stimulation generator engines, portable heaters and drilling fluid tank farm boilers, heaters, and generator engines.
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant, adverse impacts. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	The dredging activities would have temporary, less-than-significant impacts to air quality. Dredging activities would result in air emissions from fuel use for dredging equipment operations. The dredging activities would have temporary, less-than-significant impacts to air quality.

Table 4.15-2. Potential Air Quality Impacts within the Point Thomson Unit

Activity	Description of Impact
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have temporary, less-than-significant impacts to air quality. As discussed in Section 2.5.1, ice roads are used primarily for seasonal access to remote sites. These roads are built entirely of frozen water, either in snow or ice form, and can cross either tundra or sea ice. Construction would involve site preparations including snow compaction and establishing a base layer of ice, along with materials and equipment delivery.
Operations	Less-than-significant, long-term impacts to air quality would occur from operation of upstream development activities at PTU. New emissions sources would likely include equipment such as gas-fired heaters, combustion turbines, flares, waste incinerators, emergency pump engines, generator engines, used oil-fired heater, and portable heaters.

PTU = Point Thomson Unit; UIC = Underground Injection Control

4.15.4.2 Prudhoe Bay Unit

Table 4.15-3 summarizes the potential for impacts to air quality within the PBU based on upstream development activity at the PBU. A majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the 7 additional injection wells at PBU Well Pad 18 under Scenario 2. Appendix G of the AGDC air quality and noise resource report includes an analysis of air quality impacts associated with upstream development activities at PTU (AGDC 2017). The resource report addressed both construction and operational emissions, and describes the types of equipment that would be installed and operated at the PBU.

Table 4.15-3. Potential Air Quality Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1, and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which would have temporary, less-than-significant impacts to air quality. Expansion of the CGF Pad would involve site preparations, gravel and other materials and equipment delivery, foundations, and construction of facility buildings, with resulting emissions associated with ground-disturbing activities and operation of construction equipment.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells within the CGF Pad would have temporary, less-than-significant impacts to air quality. Typical drilling equipment would include a drill rig, camp generator engines, well stimulation generator engines, portable heaters and drilling fluid tank farm boilers, heaters, and generator engines.
***Scenario 2 only.* Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant adverse impacts. See discussion above regarding well drilling.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of the new gas, propane, and by-product pipelines associated with PBU development were assumed to involve a similar level of effort and types of construction techniques as the PTTL, as described in the 2020 EIS.

Table 4.15-3. Potential Air Quality Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have temporary, less-than-significant impacts to air quality. As discussed in Section 2.5.1, ice roads are used primarily for seasonal access to remote sites. These roads are built entirely of frozen water, either in snow or ice form, and can cross either tundra or sea ice. Construction would involve site preparations including snow compaction and establishing a base layer of ice, along with materials and equipment delivery and other similar activities.
Operations	Operations emissions from PBU MGS project and new facilities would include new valve module heating and fugitive emissions of organic compounds emitted from piping components and connectors. Net PBU emissions are anticipated to decrease once the PBU MGS project begins operations, because PBU turbine usage for gas reinjection would be reduced. The decrease in net PBU emissions would constitute a beneficial impact.

CGF = Central Gas Facility; EIS = Environmental Impact Statement; GTP = Gas Treatment Plant; MGS = Major Gas Sales; PBU = Prudhoe Bay Unit; PTTL = Point Thomson Unit Gas Transmission Line

4.15.4.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.15-4 summarizes the potential for impacts to air quality within the KRU based on upstream development activity at the PBU. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU.

Table 4.15-4. Potential Air Quality Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of the new CO_2 pipeline from PBU to KRU was assumed to involve a similar level of effort and types of construction techniques as the PBU pipelines, as discussed above. Emissions were adjusted for pipeline length, assuming total KRU pipeline length of approximately 45 miles including the PBU-KRU CO_2 transport pipeline and KRU distribution pipelines.
Installation of CO_2 distribution pipelines (approximately 19 miles in total) within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.
Operations	Negligible to less-than-significant, long-term impacts to air quality would occur from operation of CO_2 pipelines that result in new sources of air emissions. Operation of the new pipeline compressor stations would also result in air emissions.

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit

4.15.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigation

As discussed above, construction and operation of upstream facilities on the North Slope considered within this **Final** SEIS could affect air quality, including temporary construction-related impacts as well as more long-term impacts from operations. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Fugitive Dust Plan that would contain procedures to minimize adverse impacts to air quality including control of fugitive dust to minimize increases of particulate matter.

4.15.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact air quality within the ROI. Overall, less-than-significant impacts to air quality would occur from construction and operation of project activities. Adverse effects to air quality would be similar between Scenarios 2 and 3 except for construction of lateral injection well required under Scenario 2, which would result in temporary higher air emissions from drilling activities. **With Project construction and operations, black carbon would be emitted as $PM_{2.5}$ from fossil fuel-fired equipment including engines, boilers, heaters, pumps; vehicles; and flares. Black carbon emissions were not separately quantified due to the lack of available emission factors specific to black carbon; however, as black carbon is a component of $PM_{2.5}$, black carbon emissions are included within the $PM_{2.5}$ emissions estimates presented in this SEIS.**

Table 4.15-5 summarizes **total** construction emissions from upstream development activities**. PTU construction emissions would be spread over a 6-year period, PBU construction emissions would be spread over a 10-year period, and KRU construction emissions would be spread over a 5-year period. Tables 4.15-6 and 4.15-7 summarize annual construction emissions for Scenarios 2 and 3 respectively, including emissions from all project components, i.e., PBU, PTU and KRU. For both Scenario 2 and Scenario 3, construction emissions would increase over time, peaking in year 6, and would decline thereafter.**

Table 4.15-5. Summary of Total Construction Emissions

Project Component	Total Emissions (tons)					
	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_2
PTU						
Construction	804.6	1,990.4	3,184.8	303.2	265.0	3.4
Well drilling	805.7	7,513.8	2,355.5	232.4	153.0	254.1
PBU						
Construction	18.8	92.8	123.2	596.2	66.9	1.2
Well drilling	302.0	2,726.0	824.0	67.0	64.5	2.5
Lateral well drilling (Scenario 2 only)	211.4	1,908.2	576.8	46.9	45.2	1.8
KRU						
Construction (Scenario 3 only)	7.0	50.0	39.4	355.2	38.9	0.1

Source: Derived from AGDC 2017

CO = carbon monoxide; KRU = Kuparuk River Unit; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; PBU = Prudhoe Bay Unit; SO_2 = sulfur dioxide; VOC = volatile organic compound

Table 4.15-6. Summary of Scenario 2 Construction Emissions by Year

Year	Total Emissions (tons)					
	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_2
Year 1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Year 2	**3.6**	**17.0**	**23.4**	**96.7**	**10.9**	**0.3**
Year 3	**94.6**	**247.2**	**388.6**	**187.0**	**47.0**	**0.7**
Year 4	**183.8**	**466.3**	**741.0**	**257.9**	**80.0**	**1.1**
Year 5	**412.4**	**2,606.7**	**1,402.2**	**247.0**	**115.2**	**73.6**
Year 6	**513.3**	**3,524.1**	**1,671.2**	**208.4**	**130.3**	**74.3**
Year 7	**511.7**	**3,515.9**	**1,660.9**	**147.2**	**123.6**	**74.2**
Year 8	**217.8**	**2,000.2**	**616.7**	**56.0**	**43.8**	**37.2**
Year 9	**102.7**	**926.8**	**280.2**	**22.8**	**21.9**	**0.9**
Year 10	**102.7**	**926.8**	**280.2**	**22.8**	**21.9**	**0.9**
Scenario 2 Total	**2,142.5**	**14,231.2**	**7,064.3**	**1,245.7**	**594.6**	**262.9**

Source: Derived from AGDC 2017

CO = carbon monoxide; KRU = Kuparuk River Unit; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; PBU = Prudhoe Bay Unit; SO_2 = sulfur dioxide; VOC = volatile organic compound

Table 4.15-7. Summary of Scenario 3 Construction Emissions by Year

Year	Total Emissions (tons)					
	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_2
Year 1	0.0	0.0	0.0	0.0	0.0	0.0
Year 2	4.6	24.4	29.2	141.2	15.8	0.3
Year 3	96.4	260.7	399.2	275.9	56.8	0.7
Year 4	185.5	478.7	750.8	346.7	89.7	1.1
Year 5	414.1	2,618.1	1,411.2	335.7	124.8	73.6
Year 6	471.8	3,147.8	1,560.0	243.4	126.0	74.0
Year 7	469.4	3,134.3	1,545.5	137.9	114.6	73.9
Year 8	175.5	1,618.6	501.3	46.6	34.8	36.8
Year 9	60.4	545.2	164.8	13.4	12.9	0.5
Year 10	60.4	545.2	164.8	13.4	12.9	0.5
Scenario 3 Total	1,938.1	12,373.0	6,526.9	1,554.1	588.3	261.3

Source: Derived from AGDC 2017

CO = carbon monoxide; KRU = Kuparuk River Unit; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; PBU = Prudhoe Bay Unit; SO_2 = sulfur dioxide; VOC = volatile organic compound

DOE assessed the potential impact of construction emissions to regional air quality by comparing them against results presented in BLM's North Slope-Regional Air Quality Modeling (**NS-RAQM**) **Study (**Zephyr Environmental Corporation 2020). The **NS-RAQM** Study modeled impacts to air quality **on the North Slope from projected oil and gas development in the region. Table 4.15-8 presents the annual oil and gas emissions that were considered in the NS-RAQM** Study.

Table 4.15-8. Annual Oil and Gas Emissions Modeled in the NS-RAQM Study

Criterial Pollutant Emissions (tons per year)					
VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_2
1,687	7,591	4,184	1,101	665	2,160

Source: Zephyr Environmental Corporation 2020

CO = carbon monoxide; KRU = Kuparuk River Unit; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; PBU = Prudhoe Bay Unit; SO_2 = sulfur dioxide; VOC = volatile organic compound

The NS-RAQM Study concluded that oil and gas operations would generally have low to moderate impacts to ambient air quality on the North Slope. Modeled oil and gas sources could contribute to increased ambient concentrations of nitrogen dioxide and sulfur dioxide, especially in the vicinity of oil and gas projects. However, these increases would not be likely to lead to any exceedances of applicable air quality standards. The NS-RAQM Study found that localized exceedances of $PM_{2.5}$ and particulate matter of diameter 10 microns or less air quality standards could occur, but these would be driven primarily by fugitive dust emissions from unpaved roads, rather than emissions from oil and gas operations. Further, the modeled criteria pollutant emissions used as inputs to the NS-RAQM Study (as shown in Table 4.15-8) were significantly higher than annual construction emissions that could occur under the Proposed Action; therefore, DOE believes that construction of the Proposed Project would have less than significant impacts on air quality, and any impacts would be temporary and short-term in nature. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.15.5.

Table 4.15-9 summarizes operational emissions. Operational emissions for PTU and PBU are anticipated to be below federal PSD thresholds (250 tons per year) for new sources but may exceed the threshold for major modifications of existing sources or minor new sources (see Table 4.15.3-1 in the 2020 EIS). Facility operations would be conducted in accordance with all applicable permit requirements. Potential impacts would be reduced by BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.15.5. DOE did not identify effects to air quality other than the types of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.15.5.

Table 4.15-9. Summary of Operational Emissions

Year of Project Operation	Annual Emissions (tons per year)					
	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_2
PTU						
Year 7[a]	0.4	18.1	15.3	1.4	1.4	3.8
Years 8 through 19	0.8	36.3	30.6	2.7	2.7	7.5
Years 20 through 27	8.2	161.1	43.3	16.8	16.8	51.3
PBU[b,c]						
Years 8 through 11	-18.8	-3,212.3	-462.3	-56.3	-56.3	-48.0
Years 12 through 15	-30.8	-5,372.3	-734.0	-96.5	-96.5	-78.8
Years 16 through 19	-49.8	-8,703.0	-1,143.0	-159.5	-159.5	-127.3
Years 20 through 23	-64.8	-11,907.8	-1,371.8	-209.8	-209.8	-163.5
Years 24 through 27	-70.0	-13,205.0	-1,464.0	-228.5	-228.5	-178.5
KRU[d]						
Year 8 through 27	1.0	5.5	0.7	0.1	0.1	0.002

Source: Derived from AGDC 2017

[a] Year 1 represents the start of Project construction activities. PTU operations begin in year 7, and PBU in year 8.

[b] PBU operational emissions change over time; therefore, for simplicity, emissions are shown here as 4-year averages.

[c] Negative PBU emissions represent a decrease in emissions below the existing baseline. As discussed earlier, net PBU emissions are anticipated to decrease once the PBU MGS project begins operations, because PBU turbine usage for gas reinjection would be reduced.

[d] KRU emissions estimated based on CO_2 pipeline operations data from DOE 2013, adjusted for CO_2 volume.

CO = carbon monoxide; CO_2 = carbon dioxide; KRU = Kuparuk River Unit; MGS = Major Gas Sales; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter of diameter 2.5 microns or less; PM_{10} = particulate matter of diameter 10 microns or less; PBU = Prudhoe Bay Unit; PTU = Point Thomson Unit; SO_2 = sulfur dioxide; VOC = volatile organic compound

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4.16 NOISE

4.16.1 Summary of Noise Impacts from the 2020 EIS

Table 4.16-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, construction and operation of the proposed Project could have minor to moderate, temporary to permanent impacts on the ambient noise conditions within the Project ROI. However, implementation of BMPs and mitigation measures and adherence to Project-specific plans and federal and state permitting requirements would reduce or avoid these anticipated impacts.

Table 4.16-1. Summary of Noise Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Noise from construction of the Mainline Pipeline would last from about 6 to 12 weeks at any point along the route, while noise from construction of aboveground facilities would last for months to years at each site. • Impacts would be moderate to high during construction at the Healy Compressor Station. • Noise due to construction of the Liquefaction Facilities would be perceptible and exceed FERC's recommended south level at three NSAs. Construction activities at the Liquefaction Facilities would also noticeably increase noise level at key observation point 54. • Noise impacts on noise-sensitive areas from blasting activities would be limited due to the temporary nature and short duration of blasting. Noise from blasting would affect subsistence resources in two areas. • Construction activities in Prudhoe Bay would produce underwater noise. • Noise due to operation of the Coldfoot and Healy Compressor Stations would be perceptible at the nearest noise-sensitive areas and the Arctic Interagency Visitor Center, but without FERC's recommended sound level of 55 dBA Ldn. • Noise due to operation of the Liquefaction Facilities would be within FERC's recommended sound level of 55 dBA Ldn at nearby noise-sensitive areas, but the noise would be perceptible, with sound intensity doubling at two noise-sensitive areas. • Increased air traffic and use of the helipads would result in periodic and temporary increases in noise.	• Most noise impacts during construction would be temporary and minor. Construction noise would have a minor to moderate effect on noise-sensitive areas or key observation points at three locations where the Mainline Pipeline is installed by directional micro-tunneling and at the Coldfoot Compressor Station, and a moderate to high effect on a noise-sensitive area at the Healy Compressor Station. • Construction of the Liquefaction Facilities would have a moderate to significant effect on noise at noise-sensitive areas and a key observation point. • Project operation would have permanent impacts on ambient noise conditions at aboveground facilities. The direct effects on noise levels in the Project area would be minor to moderate during normal facility operation, with the exception of operation noise associated with the Liquefaction Facilities at the two nearest noise-sensitive areas.	4.16.3; 4.16.4; 5.1.16

dBA = A-weighted decibel; EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; Ldn = day-night average sound level; NSA = Noise Sensitive Area

4.16.2 Methodology to Assess Noise Impacts

To evaluate impacts from noise, DOE considers the potential for noise levels to change as a result of the Proposed Action and No Action Alternatives. This **Final** SEIS evaluates the potential changes in noise levels to determine whether these changes would directly or indirectly cause the following:

- Addition of new mobile and stationary noise sources from activities associated with upstream development;

- Conflict with any federal, Alaska Native, state, or local noise ordinances; or
- Long-term perceptible increases in ambient noise levels above regulatory thresholds at sensitive receptors during operations.

4.16.3 Typical Construction Noise

Onsite construction noise would mainly occur from site preparations, clearing and grading, construction of new pipeline, vehicle traffic, and other associated construction activities including the use of heavy-duty construction equipment (e.g., trucks, backhoes, front end loaders, cranes, etc.). Table 4.16-2 presents noise levels associated with common construction activities. Table 4.16-3 presents typical pipeline construction equipment (mobile and stationary) and the corresponding noise levels.

Table 4.16-2. Noise Levels Associated with Typical Construction Activities

Construction Phase	dBA Leq at 50 feet from Source	Typical Noise Level at 500 feet (dBA)	Typical Noise Level at 1,000 feet (dBA)	Typical Noise Level at 1,500 feet (dBA)
Ground Clearing	84	64	58	54
Excavation, Grading	89	69	63	59
Foundations	78	58	52	48
Structural	85	65	59	55
Finishing	89	69	63	59
Drilling	98	78	72	68

Source: Bolt et al. 1971; USEPA 1974
dBA = A-weighted decibel; Leq = equivalent sound level

Table 4.16-3. Construction Equipment Noise Levels

Equipment	Typical Noise Level at 50 feet (dBA)	Typical Noise Level at 500 feet (dBA)	Typical Noise Level at 1,000 feet (dBA)	Typical Noise Level at 1,500 feet (dBA)
Front Loaders	85	65	59	55
Backhoes, excavators	80	60	54	50
Tractors, dozers	85	65	59	55
Graders, scrapers	89	69	63	59
Trucks	88	68	62	58
Concrete pumps, mixers	85	65	59	55
Cranes (movable)	83	63	57	53
Cranes (derrick)	88	68	62	58
Pumps	76	56	50	46
Generators	81	61	55	51
Compressors	81	61	55	51
Pneumatic tools	85	65	59	55
Jack hammers	88	68	62	58
Pavers Compactors	89	69	63	59
Compactors	82	62	56	52

Source: Lamancusa 2008; USDOT 2018
dBA = A-weighted decibel

In general, average equivalent noise levels from typical construction sites range from 79 to 89 dBA at 50 feet (Bolt et al. 1971). Construction noise levels fluctuate depending on the type, number and duration of use of heavy equipment for construction activities, and differ by the type of activity, distance to noise-sensitive uses, existing site conditions (vegetation to buffer sound) and ambient noise levels. With multiple items of construction equipment operating concurrently, noise levels could be relatively high during daytime periods at locations within several hundred feet of active construction sites. Accounting for the concurrent use of the construction equipment, it is conservatively estimated that noise levels could be up to approximately 85 dBA at 100 feet. Combined construction noise reduces to approximately 65 dBA at 1,000 feet.

4.16.4 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Adverse effects to noise as described in Section 4.16 of the 2020 EIS would not occur as the proposed Project would not be constructed. In addition, upstream development impacts within the PTU, PBU, and KRU under Scenarios 2 and 3 would be unlikely to occur.

4.16.5 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Construction and operation of upstream development activities in the North Slope could affect the noise environment if the addition of new operational noise sources result in a long-term perceptible increase in ambient noise levels above regulatory thresholds at sensitive receptors. Sections 4.16.5.1 through 4.16.5.3 discuss the type of impacts by activity on the North Slope that could occur as a result of the proposed Project.

4.16.5.1 Point Thomson Unit

Table 4.16-4 summarizes the potential for impacts to the noise environment within the PTU based on activity. Although the exact locations of the components of the PTU Expansion Project are unknown at this time, this analysis considered nearby sensitive noise receptors that could experience a change in noise environment.

Construction activities at the PTU would result in a temporary increase in noise associated with transportation for deliveries of supplies, equipment, and personnel. As discussed in Section 3.12.2, currently there are no permanent roads east of Prudhoe Bay providing access to Point Thomson. Point Thomson is accessed by vehicles via seasonal and temporary ice roads, marine vessels via Beaufort Sea, and rotary-wing aircraft. Existing transportation infrastructure would be used during the construction period (e.g., the existing airstrip) and the additional transportation noise would be consistent with existing mobile noise sources in the area.

The closest noise sensitive receptor to PTU Central Pad is the Arctic National Wildlife Refuge located approximately 5.9 miles (31,152 feet) to the east. The next closest receptor is Kaktovik located approximately 54.7 miles (288,816 feet) to the east of the PTU's boundary. As stated in Section 4.16.3, it is conservatively estimated that concurrent noise levels from construction equipment could be up to approximately 85 dBA at 100 feet. At the closest receptor, the Arctic National Wildlife Refuge, construction noise levels would reduce to 35 dBA at 31,152 feet.

The 2012 Point Thomson Project Final EIS (USACE 2012) included a noise technical report to evaluate potential noise effects of construction activities proposed at Point Thomson to the sensitive soundscape of the Arctic National Wildlife Refuge. The study collected sound measurements at the Canning River West Bank within the Arctic National Wildlife Refuge to determine existing sound levels. The monitoring data determined that existing ambient noise levels during the winter ranged from 21 to 23 dBA and in the summer ranged from 33 to 42 dBA (this data is similar to "very quiet/remote areas" that typically have noise levels ranging from 26-30 dBA). The study estimated construction noise levels associated with the project alternatives including construction of well pads, gravel and ice road, pipelines, well drilling, and other activities similar to the PTU Expansion Project considered in this **Final** SEIS. The report concluded that the general trend indicates that the increase over existing noise levels is predicted to be less than 10 dBA at a distance of 10 miles from the western border of the Arctic National Wildlife Refuge. As a result, construction activities at the PTU considered in this **Final** SEIS could cause visitors of the western-most portions of the Arctic National Wildlife Refuge to experience project-related noise when winds are very still. When winds are not still, there is potential that wind would mask the project-related noise. The noise technical report focused on construction noise during winter because that is when the most efficient noise propagation conditions occur (frozen tundra is less acoustically absorptive than living tundra). In summer, the potential increase above the natural ambient sound levels would be less than winter. Ground absorption provided by the acoustically soft tundra would contribute to the lower project-related noise levels inside the Arctic National Wildlife Refuge. The future applicant for the PTU Expansion Project would design measures to avoid or minimize noise impacts such as a noise mitigation plan, noise enclosures, exhaust silencers, and acoustic panels.

Table 4.16-4. Potential Noise Impacts within the Point Thomson Unit

Activity	Description of Impact
Point Thomson Unit Development (see Sections 2.2.1.1 and 2.2.2.1)	
Expansion of the Central Pad by 7 acres (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the Central Pad would result in approximately 7 acres of ground disturbance, which would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. Expansion of the Central Pad would involve site preparations, materials and equipment delivery, foundations, and construction of facility buildings, with noise levels typical of those provided in Section 4.16.3 with average construction noise ranging from 79 to 89 dBA at 50 feet.
Construction of a 7-acre multi-season ice pad adjacent to the Central Pad (see Section 2.5.1 regarding ice construction including multi-seasonal pads).	Construction and use of the 7-acre multi-season ice pad would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. As discussed in Section 2.5.1, multi-season ice pads are designed for use over multiple winter and summer seasons. The multi-season ice pad would involve site preparations including snow compaction and establishing a base layer of ice, along with materials and equipment delivery and construction of offices, warehouses, and equipment storage, with noise levels typical of those provided in Section 4.16.3 with average construction noise ranging from 79 to 89 dBA at 50 feet.
Four new production wells drilled at the Central Pad (see Section 2.5.5 regarding well drilling requirements).	Construction of the four new production wells within the Central Pad would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. The primary sources of noise would be from site preparation activities and well drilling. Noise from site preparation activities would be similar to those discussed in Section 4.16.3. with average construction noise ranging from 79 to 89 dBA at 50 feet. Drilling noise levels are estimated to be 98 dBA at 50 feet. Construction duration is estimated to be approximately 180 days of drilling per well. Once drilling is initiated, drilling of the wells typically occurs over a continuous, 24-hour duration, 7 days per week until completion. The drilling noise would reduce to 72 dBA at 1,000 feet.

Table 4.16-4. Potential Noise Impacts within the Point Thomson Unit

Activity	Description of Impact
Conversion of an existing gas injection on the Central Pad to a production well and drilling of a new UIC Class I disposal well at the same location (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant, adverse impacts. See discussion above regarding well drilling.
Dredging approximately 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading equipment and modular facilities.	The dredging activities would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. Dredging would require excavators, dredgers, backhoes, cranes, and other similar equipment as presented in Table 4.16-2 with average construction noise ranging from 79 to 89 dBA at 50 feet. Dredging activities would generate underwater noise, which is sound that travels as pressure waves through water. Appendix L of the 2020 EIS details underwater noise levels including dredging activities. Dredging activities would not exceed the NMFS's disturbance thresholds for underwater noise levels.
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. As discussed in Section 2.5.1, ice roads are used primarily for seasonal access to remote sites. These roads are built entirely of frozen water, either in snow or ice form, and can cross either tundra or sea ice. Construction would involve site preparations including snow compaction and establishing a base layer of ice, along with materials and equipment delivery and other similar noise levels as mentioned in Section 4.16.3 with average construction noise ranging from 79 to 89 dBA at 50 feet.
Operations	Negligible to less-than-significant, permanent impacts would occur from operation of upstream development at PTU that result in new sources of noise emissions. Operation of the new wells would result in noise emissions from maintenance and monitoring systems. These sources would be temporary in nature and result in minimal impact on the ambient noise levels.

dBA = A-weighted decibel; EIS = Environmental Impact Statement; NMFS = National Marine Fisheries Service; PTU = Point Thomson Unit; UIC = Underground Injection Control

4.16.5.2 Prudhoe Bay Unit

Table 4.16-5 summarizes the potential for impacts to the noise environment based on activity. A majority of the impacts would occur under both Scenarios 2 and 3 with the exception of the 7 additional injection wells at PBU Well Pad 18 under Scenario 2. Although the exact locations of the components of the PBU MGS Project are unknown, this analysis considered nearby sensitive noise receptors that could experience a change in noise environment.

Within the PBU boundary, the unincorporated community of Deadhorse is located within the Census Designated Place of Prudhoe Bay. Deadhorse and Prudhoe Bay are located approximately 7.9 miles (41,712 feet) and 5.7 miles (30,096 feet) from the CGF, respectively. As stated in Section 4.16.3, it is conservatively estimated that concurrent noise levels from construction equipment could be up to approximately 85 dBA at 100 feet. At the closest receptor, the Prudhoe Bay Census Designated Place, construction noise levels at the CGF would reduce to 35 dBA at 30,096 feet and be imperceptible to the receptor. The closest noise sensitive receptor beyond the PBU boundary is the Nuiqsut community located approximately 37.2 miles (196,416 feet) to the west. Given this distance, construction noise would be imperceptible to the Nuiqsut community.

Table 4.16-5. Potential Noise Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Prudhoe Bay Unit Development (see Sections 2.2.1.2, 2.2.2.1 and 2.2.2.3)	
A 5-acre expansion of the existing CGF Pad (see Section 2.5.2 regarding gravel construction including pads).	Expansion of the CGF Pad would result in approximately 5 acres of ground disturbance, which would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. Expansion of the CGF Pad would involve site preparations, materials and equipment delivery, foundations, and construction of facility buildings, with noise levels typical of those provided in Section 4.16.3 with average construction noise ranging from 79 to 89 dBA at 50 feet.
Drilling of up to 10 new production and injection wells within the PBU to enhance gas recovery at the PBU (see Section 2.5.5 regarding well drilling requirements).	Construction of the 10 new production wells within the PBU would have temporary, less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. The primary sources of noise would be from site preparation activities and well drilling. Noise from site preparation activities would be similar to those discussed in Section 4.16.3 with average construction noise ranging from 79 to 89 dBA at 50 feet. Drilling noise levels are estimated to be 98 dBA at 50 feet. Drilling of injection wells typically occur over a continuous, 24-hour duration, 7 days per week until completion. The drilling noise would reduce to 72 dBA at 1,000 feet.
***Scenario 2 only*. Drilling of up to 7 new lateral injection wells from the existing Well Pad 18 with a maximum lateral distance of 2.5 miles** (see Section 2.5.5 regarding well drilling requirements).	Less-than-significant, adverse impacts. See discussion above regarding well drilling.
Installation of three new feed gas pipelines and a propane gas pipeline from the PBU CGF to the new valve module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Construction of the pipelines would have temporary and less-than-significant impacts to the noise environment. Pipeline construction equipment would result in noise emissions from cranes, tractors, forklifts, and other construction equipment discussed in Section 4.16.3. Average construction noise would range from 79 to 89 dBA at 50 feet. Pipeline construction noise would be temporary and spread over the length of the pipeline route.
Installation of a short, larger diameter pipeline to connect the new valve module with the new metering module on the CGF Pad (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.
Installation of four new by-product pipelines measuring 25, 3, 8, and 8 miles in length to send GTP by-product to existing well pads for reinjection into the field (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.
A 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope.

Table 4.16-5. Potential Noise Impacts within the Prudhoe Bay Unit

Activity	Description of Impact
Ice road construction (see Section 2.5.1 regarding ice construction including ice roads).	Construction and use of ice roads, if required, would have temporary less-than-significant impacts to the noise environment. Construction would produce variable noise levels, depending on the work at the time. As discussed in Section 2.5.1, ice roads are used primarily for seasonal access to remote sites. These roads are built entirely of frozen water, either in snow or ice form, and can cross either tundra or sea ice. Construction would involve site preparations including snow compaction and establishing a base layer of ice, along with materials and equipment delivery and other similar noise levels as mentioned in Section 4.16.3 with average construction noise ranging from 79 to 89 dBA at 50 feet.
Operations	Negligible to less-than-significant, permanent impacts would occur from operation of upstream development at PBU that result in new sources of noise emissions. Operation of the new wells and pipelines would result in noise emissions from maintenance and monitoring systems. These sources would be temporary in nature and result in minimal impact on the ambient noise levels.

CGF = Central Gas Facility; dBA = A-weighted decibel; GTP = Gas Treatment Plant; PBU = Prudhoe Bay Unit

4.16.5.3 Kuparuk River Unit and CO_2 Pipeline

Table 4.16-6 summarizes the potential for impact to the existing noise environment of KRU based on activity. These impacts would only occur under Scenario 3 to support CO_2 transport and injection for EOR at KRU. Although the exact locations of the components of the KRU Development are unknown at this time, this analysis considered nearby sensitive noise receptors that could experience a change in noise environment.

The closest noise sensitive receptor to KRU is the community of Nuiqsut located approximately 13.5 miles (71,280 feet) to the west. The closest noise sensitive receptors to the existing pipelines ROW are the communities of Prudhoe Bay and Deadhorse at 0.7 mile (3,696 feet) and 3.4 miles (17,952 feet) to the south, respectively. As stated in Section 4.16.3, it is conservatively estimated that concurrent noise levels from construction equipment could be up to approximately 85 dBA at 100 feet. At the closest receptor to KRU, the community of Nuiqsut, construction noise would reduce to 28 dBA. At the closest receptor to the pipeline, the Prudhoe Bay Census Designated Place, construction noise levels would reduce to 53 dBA and reduce to 40 dBA at the community of Deadhorse. The closest noise sensitive receptor to the pipeline route is the Arctic National Wildlife Refuge approximately 5.8 miles (30,624 feet) to the east. Given this distance, construction noise would be imperceptible.

Table 4.16-6. Potential Noise Impacts within the Kuparuk River Unit

Activity	Description of Impact
Kuparuk River Unit Development (see Sections 2.2.1.3 and 2.2.2.2)	
Installation of an approximately 30-mile pipeline to transport CO_2 from the proposed GTP at PBU to KRU for CO_2 EOR (see Section 2.5.3 regarding pipeline construction methods).	Construction of the pipelines would have temporary and less-than-significant impacts to the noise environment. Pipeline construction equipment would result in noise emissions from cranes, tractors, forklifts, and other construction equipment discussed in Section 4.16.3. Average construction noise would range from 79 to 89 dBA at 50 feet. Pipeline construction noise would be temporary and spread over the length of the pipeline route.
Installation of CO_2 distribution pipelines within KRU to transport CO_2 to individual injection wells (see Section 2.5.3 regarding pipeline construction methods).	Less-than-significant, adverse impacts. See discussion above regarding pipeline construction impacts on the North Slope. Since the CO_2 distribution lines would be contained with the KRU, the closest sensitive receptors are 0.7 mile away and therefore would not experience noise impacts.
Operations	Negligible to less-than-significant, permanent impacts would occur from operation of CO_2 pipelines that result in new sources of noise emissions. Operation of the new pipelines would result in noise emissions from maintenance and monitoring systems. These sources would be temporary in nature and result in minimal impact on the ambient noise levels.

CO_2 = carbon dioxide; dBA = A-weighted decibel; EOR = enhanced oil recovery; GTP = Gas Treatment Plant; KRU = Kuparuk River Unit; PBU = Prudhoe Bay Unit

4.16.6 Identification of Construction and Restoration Environmental Plans and Additional Mitigation

As discussed above, construction and operation of upstream facilities on the North Slope considered within this **Final** SEIS could affect the noise environment, but most impacts would be temporary during construction activities. To reduce potential impacts to the noise environment, the pipeline ROW for the CO_2 pipeline and distribution lines under Scenario 3 would be sited to follow existing ROW and infrastructure with a similar noise environment. As stated in Section 4.16.3, it is conservatively estimated that concurrent noise levels from construction equipment would be up to approximately 85 dBA at 100 feet and further reduced to 65 dBA at 1,000 feet. The closest noise sensitive receptor located beyond the unit boundaries is the Arctic National Wildlife Refuge at 5.9 miles east of the PTU Central Pad. At this distance, construction noise levels would reduce to 35 dBA which, given the very remote setting and quiet noise environment, could be perceptible to visitors of the western-most portions of the Arctic National Wildlife Refuge, depending on the season and weather conditions. The future applicant for the PTU Expansion Project (under both Scenarios 2 and 3) would design measures to avoid or minimize noise impacts such as a noise mitigation plan, noise enclosures, exhaust silencers, and acoustic panels. In general, noise from project-related activities would not be perceptible at the other closest noise sensitive receptors located beyond the boundary of the units in the ROI.

4.16.7 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to impact the noise environment within the ROI. Overall, negligible to less-than-significant impacts to the noise environment would occur from construction and operation of project activities.

Construction-related noise impacts typically would be localized, intermittent and short term since construction in temporary. As a result, construction would produce variable noise levels, depending on the work at the time. Construction equipment would result in noise emissions from cranes, tractors, excavators, loaders, drills, and other construction equipment discussed in Section 4.16.3. Average construction noise would range from 79 to 89 dBA at 50 feet. Drilling activities associated with construction of new wells would result in noise levels of 98 dBA at 50 feet which would reduce to 72 dBA at 1,000 feet.

Overall adverse effects to the noise environment would be similar between Scenarios 2 and 3 except for construction of lateral injection well required under Scenario 2 which would result in temporary higher noise levels from drilling activities. Potential impacts would be reduced by BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.16.5. DOE did not identify effects to the noise environment beyond the type of impacts analyzed in the 2020 EIS. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.16.6.

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4.17 PUBLIC HEALTH AND SAFETY

4.17.1 Summary of Impacts to Public Health and Safety from the 2020 EIS

Table 4.17-1 provides a summary of potential impacts to public health and safety from the proposed Project, as identified in the 2020 EIS. As indicated in the table, FERC determined impacts to health and safety could range from low to high from construction and operation of the proposed Project. The 2020 EIS did not contain any mitigation measures related to health and safety identified by FERC and agreed to by AGDC.

Table 4.17-1. Summary of Public Health and Safety Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• For proposed Project construction, the results of the Health Impact Assessment rated one health effects category as high adverse (infectious diseases); three as medium adverse (social determinants of health; accidents and injuries; and food, nutrition, and subsistence activity); and all others as low adverse. • For proposed Project operation, the Health Impact Assessment rated three health effects categories as medium adverse (social determinants of health; accidents and injuries; and infectious diseases); and all others as low adverse. • Potential positive effects were also identified, including increased employment opportunities and household incomes and future improvements to air quality in the Fairbanks area through conversion from other fuels to natural gas.	• The proposed Project could result in high, medium, and low adverse impacts during construction, as well as medium and low adverse impacts during operation. The proposed Project could also have positive effects.	4.17.3; 5.1.17

EIS = Environmental Impact Statement

4.17.2 Methodology to Assess Public Health and Safety Impacts

This **Final** SEIS considers the potential health and safety impacts from potential upstream development activities based against updated presented in Section 3.17 from the Alaska Native Tribal Health Consortium Epidemiology Center for the Arctic Slope (North Slope). The assessment also considers construction and operation of the potential facilities occurs within existing areas designated for oil and gas development and are subject to extensive state and federal regulations regarding construction standards and the use of toxic and hazardous materials, including, but not limited to:

- Pipeline Safety Regulations (49 CFR 190-199).
- Resource Conservation and Recovery Act (42 USC 3251 *et seq*.).
- Comprehensive Environmental Response, Compensation and Liability Act and the Superfund Amendments and Reauthorization Act (42 USC 9601).
- Emergency Planning and Community Right-to-Know Act (42 USC 9601; 40 CFR 255, 370, and 372).
- Toxic Substances Control Act (15 USC 2601).
- Hazardous Materials Transportation Act (49 USC 1801-1819).
- Occupational Safety and Health Administration (29 USC 651-678).
- **Oil Pollution Prevention (40 CFR 112).**

Sections 3.18 and 4.18 provides additional information on reliability and safety.

4.17.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Since construction and operations of the proposed Project would not occur, no changes to the existing health and safety conditions would occur.

4.17.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Table 4.17-2 summarizes potential impacts from upstream development activities.

Table 4.17-2. Potential Health and Safety Impacts from Upstream Development

Indicator and Section 3.17 Summary	Construction Impacts	Operational Impacts
Unintentional Injury Mortality: The incident rate for unintentional injury mortality among North Slope Alaska Natives is slightly lower (by 3 percent) than rates for Alaska Natives statewide, but considerable higher (by 60 percent) compared to non-Alaska Natives statewide.	Construction activities could cause accidents resulting in fatal injuries. This includes increased trucking-related from transportation of materials and bussing construction workers to work sites as well as increased seaborne and airborne transit-related injuries. Potential for accidents would be reduced from required training; focusing on a strong safety culture including routine assessment of potential risks and safe practices to mitigate risk; and following systematic approaches to safety such as having written safety plans and holding regular safety meetings. **Impacts to local populations would be low adverse as it would be unlikely for individuals outside of the construction contractors to experience unintentional mortality due to construction of upstream development activities.**	Operational activities could result in fatal accidents due to leaks, fires, explosions or other workplace injuries including transit to remote sites. **Impacts to local populations would be low adverse as it would be unlikely for individuals outside of of the operational personnel to experience unintentional mortality due to operations.** Potential for accidents would be reduced from required training; focusing on a strong safety culture including routine assessment of potential risks and safe practices to mitigate risk; maintenance of equipment; and following systematic approaches to safety.
Non-Communicable and Chronic Disease: Rates of non-communicable and infectious disease are consistently higher with North Slope Alaska Native populations. This includes: • COPD rates 40 percent higher than Alaska Natives statewide and 69 percent higher than non-Alaska Natives statewide. • CLRD rates 43 percent higher than Alaska Natives statewide and 75 percent higher than non-Alaska Natives statewide. • Cancer rates 29 percent higher than Alaska Natives statewide and 55 percent higher than non-Alaska Natives statewide.	Construction activities could increase amounts of particulate matter in the air from exposed soils and ground disturbance (see Section 4.2). The increase of particulate matter could exacerbate chronic respiratory conditions to sensitive populations on the North Slope. As existing rates are much higher than statewide averages, less-than-significant impacts could be anticipated. **Impacts to local populations could be moderate adverse due to the existing high levels of COPD and CLRD rates in Alaska Natives. The nearest community to the proposed upstream development activities is Kaktovik, approximately 55 miles east of the PTU's eastern boundary. The distance would help reduce the potential for adverse effects to the community; however, individuals practicing subsistence in the area**	Operation activities would generate air emissions that could affect air quality (see Section 4.15.4). Emissions could exacerbate chronic respiratory conditions to sensitive populations on the North Slope. As existing rates **of COPD and CLRD** are much higher than statewide averages, **impacts to local populations could be moderate adverse due to the existing high levels of COPD and CLRD rates in Alaska Natives. The nearest community to the proposed upstream development activities is Kaktovik, approximately 55 miles east of the PTU's eastern boundary. Similar to construction, the distance would help reduce the potential for adverse effects to the community; however, individuals practicing subsistence in the**

Table 4.17-2. Potential Health and Safety Impacts from Upstream Development

Indicator and Section 3.17 Summary	Construction Impacts	Operational Impacts
	could experience greater effects during construction. Use of BMPs described in Section 4.2, however, would likely reduce the level of impact on individuals to less-than-significant respiratory effects. Construction activities would not be anticipated to affect rates of cancer for North Slope populations.	**area could experience greater effects from operations**. Use of BMPs described in Section 4.15.5, however, would likely reduce the level of impact on individuals to less-than-significant respiratory effects. Operational activities would not be anticipated to affect rates of cancer for North Slope populations.
Infectious Disease: Rates of infectious disease cases reported on the North Slope are 15 to 39 percent higher than Alaska Natives statewide and 91 to 93 percent higher than non-Alaska Natives statewide.	Increase of construction workers in the North Slope could increase the transmission of disease by infected resident or non-resident construction workers. As existing rates are much higher than statewide averages **moderate adverse impacts could occur**. **Preparation of a Health, Safety, Security and Environmental Plan as described in Section 4.17.5 would help reduce the potential for adverse effects including requirements to have worker camps closed to reduce the presence of the outside workforce in communities and providing health education and outreach programs.**	Operational activities would not change existing workforces (see Section 4.11). **Low adverse** impacts on infect**ious** disease are anticipated.
Health Care: North Slope residents have access to health care, with only approximately 9 percent of the North Slope population not seeing a doctor in the past 12 months (based on Alaska Native Tribal Health Consortium Epidemiology Center data from 2012-2016) compared to state averages of 14 percent.	Construction would temporarily increase the workforce (see Section 4.11.4) which could place some strain on health care if the workers require medical attention. However, the small increase of workers would be anticipated to generate **low adverse impacts as the access to health care within the North Slope is higher than state averages**. **Preparation of a Health, Safety, Security and Environmental Plan that requires construction contractors to have adequate health and medical equipment and staff to respond to and prevent medical emergencies would further reduce potential effects to health care by local resident populations.**	Operational activities would not change community access to health care as no negligible increases to the existing workforces are anticipated (see Section 4.11.4). **Low adverse impacts would be anticipated.**
Water and Sanitation: The North Slope has water and sanitation services above the state average, with 99 percent of residents having access to water and sanitary sewer.	Construction activities would not change community access to water and sanitation. **Low adverse impacts would be anticipated.**	Operational activities would not change community access to water and sanitation. **Low adverse impacts would be anticipated.**

BMP = best management practice; CLRD = Chronic Lower Respiratory Disease; COPD = Chronic Obstructive Pulmonary Disease

4.17.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigation

As discussed above, construction and operation of upstream facilities on the North Slope considered within this **Final** SEIS could affect public health and safety. Potential effects would be reduced or avoided through implementation of appropriate plans and related mitigation measures. The proposed Project-specific construction and restoration environmental plans identified in the 2020 EIS and summarized in Table 2.5-1 of this **Final** SEIS that would likely apply for applicants leading upstream development activities include:

- Preparation of a Health, Safety, Security and Environmental Plan that outlines requirements for training, safety meetings, accident investigation, and contractor requirements. This would provide project-wide health and safety objectives and performance criteria for construction contractor compliance in developing project-specific Health and Safety Plans. This could include requirements to have worker camps closed to reduce the presence of the outside workforce in communities; providing health education and outreach programs; and requiring construction contractors to have adequate health and medical equipment and staff to respond to and prevent medical emergencies.
- Preparation of an Emergency Plan and perform safety drills for accidents, injuries, or hazardous material release events which would reduce the risk of accidents and increase preparedness (see Section 4.18.5 for additional details).
- Preparation of a Fugitive Dust Plan that would contain procedures to minimize fugitive dust, reducing potential adverse effects of deposition into surrounding populations and adverse effects to respiratory health.
- Preparation of an SPCC Plan that addresses prevention of accidental spills and contamination of soils and cleanup of releases of fuels, lubricants, and coolants, reducing potential accidental release to water resources and the general public.
- Preparation of a Journey Management Plan that would describe the process to be followed for planning and safely undertaking transportation activities to avoid conflicts with existing marine and vehicle traffic. This could include provisions requiring training for drivers and requiring transportation equipment to meet legal requirements and be in working order. This would serve to reduce potential traffic-related accidents.
- Preparation of a Water Use Plan to identify different uses of water during construction. The plan would identify estimated operational water use volumes and sources and eliminate any potential adverse effects on existing water rights and supplies to the surrounding communities.

Additionally, a Local Subsistence Implementation Plan could be developed, as applicable. The Local Subsistence Implementation Plan would include measures to keep local communities and their leaders informed of the projects by coordinating with local communities, including tribal councils, to identify locations and times where subsistence activities occur, and modify schedules to minimize work. The plan could also include measures to provide community-based participatory monitoring and community engagement to stay aware of and respond to community concerns. This would serve to reduce potential safety concerns for subsistence users during construction activities.

4.17.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to generate human health and safety impacts both during construction and operation of new facilities. Overall adverse impacts to health and safety would be similar under Scenarios 2 and 3 as both require additional construction activities associated with well and pipeline construction and operation. BMPs for minimizing air quality impacts both during construction and operations would also serve to protect individuals with upper respiratory conditions. In addition, enforcement of required safety training and implementation of safety plans would serve to minimize accidents and accident-related fatalities.

4.18 RELIABILITY AND SAFETY

4.18.1 Summary of Impacts to Reliability and Safety from the 2020 EIS

Table 4.18-1 provides a summary of potential impacts related to reliability and safety from the proposed Project, as identified in the 2020 EIS. FERC conducted a preliminary engineering and technical review of the Project design, including potential external impacts based on proposed project-related site locations. Potential external impacts include increased safety risks to the public related to various aspects as summarized in Table 4.18-1. In order to enhance the reliability and safety of the Project, FERC's review resulted in a number of mitigation measures to incorporate as conditions to an order and are outlined in Section 4.18.9 of the 2020 EIS.

Table 4.18-1. Summary of Reliability and Safety Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Increased safety risks to the public related to roadways resulting from transportation of hazardous materials. • Increased safety risks to the public related to railways resulting from proximity to Project-related facilities. • Increased safety risks to the public related to aircraft operations resulting from accidents and proximity to Project-related facilities. • Increased safety risks to the public related to pipelines resulting from incidences. • Increased safety risks to the public related to federally regulated facilities handling hazardous materials and power plants resulting from incidences. • High-pressure piping at the GTP could result in large ruptures and pose a safety risk for workers and the general public.	• With one exception, the proposed Project would result in less-than-significant, adverse impacts to safety. • The potential for a large rupture from high-pressure piping could result in a significant adverse impact to persons at or near the GTP. As such, FERC recommended that Emergency Response Plans be coordinated with the adjacent PBU CGF plant and that AGDC provide validation or verification for the modeling assumptions and methods used for the vapor dispersion and overpressure modeling for the high-pressure pipe systems at the GTP.	4.18.7; 4.18.11; 5.1.18

AGDC = Alaska Gasline Development Corporation; CGF = Central Gas Facility; EIS = Environmental Impact Statement; FERC = Federal Energy Regulatory Commission; GTP = Gas Treatment Plant; PBU = Prudhoe Bay Unit

4.18.2 Methodology to Assess Reliability and Safety Impacts

This **Final** SEIS considers the potential reliability and safety impacts from potential upstream development activities. The assessment also considers construction and operation of the potential facilities occurring within existing areas designated for oil and gas development that are subject to extensive state and federal regulations regarding construction standards and the use of hazardous materials, including, but not limited to:

- Pipeline Safety Regulations (49 CFR 190-199);
- Hazardous Materials Transportation Act (49 USC 1801-1819);
- SDWA (40 CFR 146); or
- UIC Program (40 CFR 147).

Sections 3.17 and 4.17 provide additional information on human health and safety.

4.18.3 No Action Alternative (Scenario 1)

Under the No Action Alternative, the Project would not be constructed. This scenario would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Since construction and operations of the proposed Project would not occur, no changes to the existing reliability and safety conditions would occur.

4.18.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Per Section 2.5.3, an approximately 30-mile pipeline would be required to transport excess CO_2 from the Alaska LNG Project GTP at PBU to KRU, and a total of approximately 19 miles of new distribution pipelines would be required to deliver CO_2 from the KRU CO_2 gas-handling facilities to the injection well pads. Applying the incident rates calculated in Table 3.18-1 to the 49 total miles of proposed new CO_2 pipeline results in anticipated incident rates of approximately 0.037 small spill per year, 0.01 medium spill per year, 0.004 large spill per year, and 0.001 catastrophic spill per year along the new pipelines. This slight increase in risk represents a negligible adverse impact on project reliability and safety.

The level of health effects from a CO_2 release depends on the level of exposure concentration. No health effects to the general public, including susceptible individuals, are expected to occur at CO_2 concentrations of 5,000 ppm or less. This concentration would represent the "no effect" level, or the level below which there would be minimal or no risk of adverse effects. Health effects from inhalation of concentrations of CO_2 gas higher than 5,000 ppm can range from headache, dizziness, sweating, and vague feelings of discomfort to breathing difficulties, increased heart rate, convulsions, coma, and possibly death. Exposure to a concentration of 5,000 ppm up to 30,000 ppm for 1 hour or less could result in mild, reversible effects. Exposure to concentrations above 30,000 ppm but less than 50,000 ppm could possibly result in irreversible effects (DOE 2013).

Up to 14 new production and injection wells (i.e., 4 at PTU and 10 at PBU) would be required to support the proposed Project. These new wells would represent an approximately 1.4 percent increase over the 1,011 natural gas production wells in operation in 2020 (EIA 2022a). While each new well would introduce a new potential location of a release, this slight increase in risk represents a negligible adverse impact on project reliability and safety.

4.18.5 Identification of Construction and Restoration Environmental Plans and Additional Mitigation

Regulations set forth in 49 CFR 195 specify safety standards and reporting requirements for pipeline facilities used in the transportation of hazardous liquids or CO_2. This includes pipeline location standards to avoid private dwellings, industrial buildings, and places of public assembly; stipulations for pipeline depth; and ROW requirements. These regulations also established the Office of Pipeline Safety (OPS), part of the PHMSA. OPS maintains a pipeline incident database and also requires pipeline annual operator reports. OPS develops safety guidelines for pipelines. Amendments issued in 1992 expanded the authority of OPS to evaluate safety and environmental protection related to siting and operation of natural gas, oil, and hazardous liquid pipelines. States may also regulate pipelines under partnership agreements with the OPS. The rules are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance.

In accordance with the PHMSA regulations, the proposed pipelines would be subject to a prescribed safety program. The pipelines would be regularly inspected for leakage and potential pipeline hazards such as construction activity, encroachments, and evidence of recent unmonitored excavations. During scheduled operation and maintenance, the following inspections would occur:

- physically walking and inspecting the pipeline corridor periodically;

- conducting fly-over inspections of the ROW as needed;
- inspecting and maintaining aboveground facilities; and
- conducting leak surveys using external gas detection equipment at least once every calendar year or as required by regulations.

PHMSA requires pipeline operators to place pipeline markers at frequent intervals along the pipeline ROWs, such as where a pipeline intersects a street, highway, railway, or waterway, and at other prominent points along the route. Pipeline ROW markers can help prevent encroachment and excavation-related damage to pipelines. Pipeline markers identifying the owner of the pipeline and a 24-hour telephone number would be placed for "line of sight" visibility along the entire pipeline length, except in active agricultural crop locations and in waterbodies in accordance with PHMSA's requirements. Alaskan state law requires excavators to call the one call "Dig Line" in advance of digging to locate underground utilities.

The continuous monitoring and operation of the pipeline system would be accomplished principally through a supervisory control and data acquisition system, which is a computer system for gathering and analyzing data from real-time systems and operating remote facilities connected to the pipeline. The supervisory control and data acquisition system would gather information from locations along the pipelines, such as meter stations and compressor stations; transmit the information back to the Gas Control Center; compare collected data to pre-set safe operating data points; and organize and display the data including alarm displays for actual operating points that do not meet preset operating criteria.

The minimum standards for operating and maintaining pipeline facilities are prescribed in 49 CFR 192, including the requirement to establish a written plan governing these activities. Under 49 CFR 192.615, each pipeline operator must establish an emergency plan that includes written procedures to minimize hazards in a natural gas pipeline emergency. Key elements of the plan include procedures for the following:

- receiving, identifying, and classifying emergency events, gas leakage, fires, explosions, and natural disasters;
- establishing and maintaining communications with local fire, police, and public officials, and coordinating emergency response;
- emergency shutdown of system and safe restoration of service;
- making personnel, equipment, tools, and materials available at the scene of an emergency; and
- protecting people first and then property, and making them safe from actual or potential hazards.

The project proponent would provide training to all employees responsible for operation and maintenance of the pipelines, compressor stations, and meter stations installed as part of the project, including review of routine and emergency procedures. Employees responsible for future support of the facilities would be given hands-on training to familiarize them with new equipment. In addition to in-house training, equipment vendors would provide training prior to start-up of new facilities.

The project proponent would develop a project-specific Emergency Response Plan that would outline emergency procedures and would provide for the protection of personnel and the public, as well as the prevention of property damage that could occur as a result of incidents at the project-related facilities.

4.18.6 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to generate reliability and safety impacts both during construction and operation of new facilities. Overall adverse impacts to reliability and safety would be similar under Scenarios 2 and 3 as both require additional construction activities associated with well and pipeline construction and operation. BMPs for minimizing impacts from potential releases of natural gas or CO_2 both during construction and operations and adherence to all required federal and state permitting requirements would reduce potential impacts to the human and natural environment. In addition, enforcement of required safety training and implementation of safety plans would serve to minimize accidents and accident-related damages.

4.19 GREENHOUSE GASES AND CLIMATE CHANGE

4.19.1 Summary of Greenhouse Gas and Climate Change Impacts from the 2020 EIS

Table 4.19-1 provides a summary of potential impacts from the proposed Project, as identified in the 2020 EIS. As indicated in the table, FERC determined that overall impacts to GHGs and climate change from construction and operation of the proposed Project would be minor to moderate. The 2020 EIS, however, did not consider the life cycle global warming potential of delivering LNG to destination countries or the cumulative emission profiles for the entire timespan of the proposed Project.

Table 4.19-1. Summary of Greenhouse Gas and Climate Change Impacts from the 2020 EIS

Summary of Potential Impacts	Impact Rating	Section in 2020 EIS
• Emissions from vehicles and equipment, marine and air traffic, waste incinerators, and open burning would lead to GHG emissions during Project construction. • Operation of the GTP, Mainline compressor stations and heater station, and Liquefaction Facilities would result in GHG emissions, and HAPs. Fugitive air emissions, including GHGs, would also be generated by operation of the PTTL, PBTL, and Mainline Facilities. The GTP and Liquefaction Facilities would be PSD major sources for GHGs. • Annual emissions for each of the compressor stations and heater station along the Mainline Pipeline would be below PSD major source thresholds, though each station would be a Title V major source and a minor source under ADEC's Minor NSR program.	• Adverse impacts on GHG emissions due to normal Project operation would generally be minor to moderate.	4.15.4, 4.15.5, 5.1.15
• Climate change related impacts (e.g., sea level changes and temperature increases) could affect Project facilities. AGDC considered the GTP facility and trestle height to account for potential future effects of climate change on the Project area, including potential sea level changes, coastal erosion near the facility, and temperature increases.	• Potential impacts of climate change on the Project could occur but would be mitigated through facility design.	4.2.5.2, 4.19.4.18

ADEC = Alaska Department of Environmental Conservation; AGDC = Alaska Gasline Development Corporation; EIS = Environmental Impact Statement; GHG = greenhouse gas; GTP = Gas Treatment Plant; HAP = hazardous air pollutant; NSR = New Source Review; PBTL = Prudhoe Bay Unit Gas Transmission Line; PSD = Prevention of Significant Deterioration; PTTL = Point Thomson Unit Gas Transmission Line

4.19.2 Methodology to Assess Greenhouse Gas and Climate Change Impacts

This Final SEIS considers the potential life cycle GHG emissions for the Project and upstream development activities associated with natural gas production, transport to destination markets, and final end-use (combustion) for each of the three scenarios and SEIS Non-equivalent Energy Baseline described in Chapter 2, Proposed Agency Action and Alternatives, in addition to the construction and operational emissions analyzed in the 2020 SEIS. The estimates of life cycle GHG emissions from the implementation of the proposed Alaska LNG Project, considering each scenario provides an equivalent amount of LNG (and crude oil), are based on the DOE LCA Study, *Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project* (Skone et al. 2022) in Appendix C. The DOE LCA Study is an attributional life cycle analysis that is not linked to analysis of potential energy market changes in alternate scenarios. The analysis in the LCA Study holds total oil and natural gas demand constant across scenarios - if oil or natural gas is not produced in one area, it will be produced in another. LCA Scenario 1 (called No Action Alternative 1), which is modeled in the LCA Study as a baseline condition, assumes that, absent the Alaska LNG Project, other LNG supply and other oil supply would meet the same energy demand.

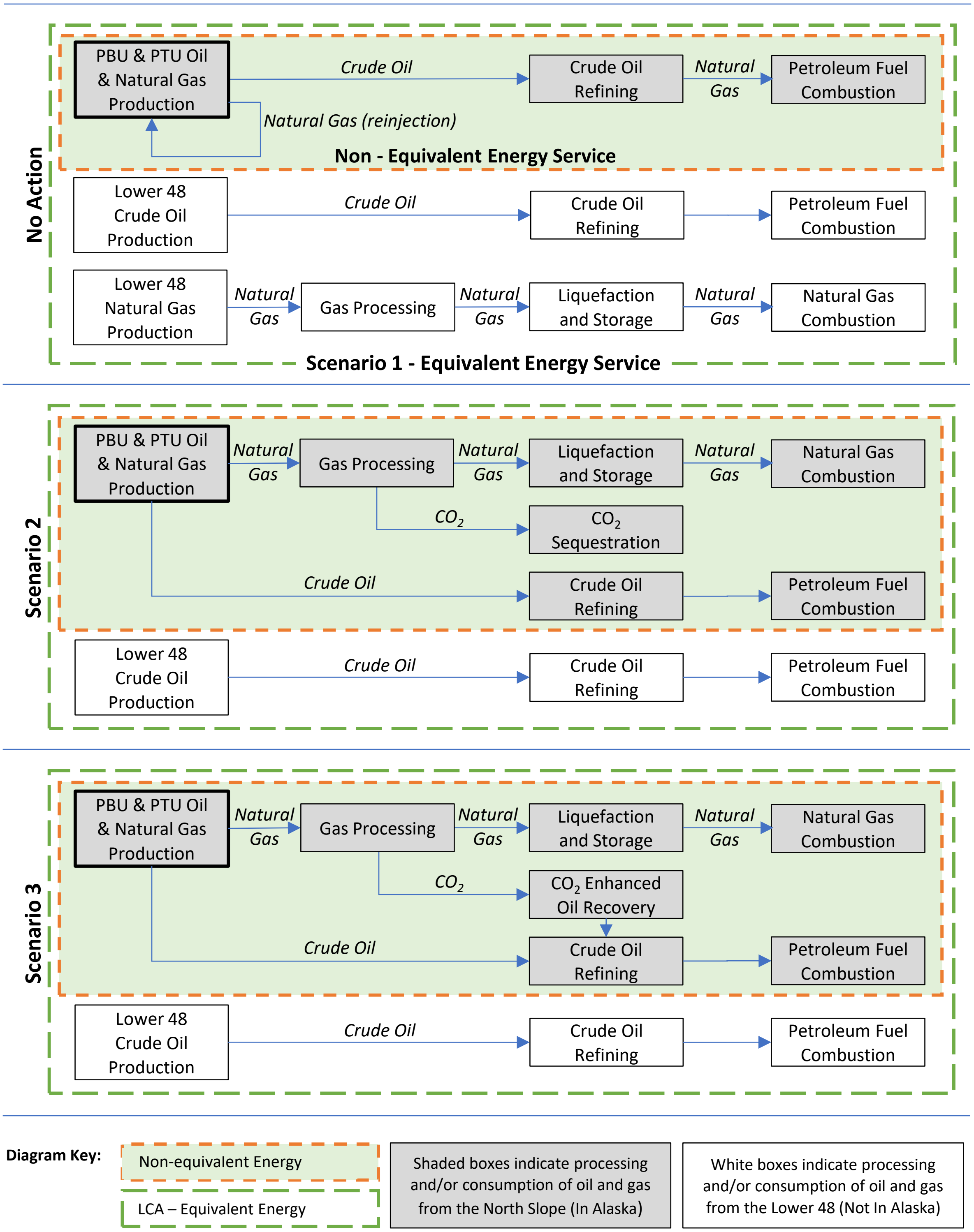
Recognizing the uncertainties in global energy supply and demand response that would result from not constructing the Alaska LNG project, this Final SEIS also includes an additional No Action Alternative 2 that makes no assumption about whether or how energy services that would have been provided by the Alaska LNG Project would be provided if it were not constructed. No Action Alternative 2 is further described in this section and in Section 4.19.3, No Action Alternatives. Global energy systems are dynamic and are currently in transition, with carbon reduction policies in place or under consideration in many countries, including the destination markets analyzed in this Final SEIS, creating uncertainty. The analysis does not attempt to account for future energy market changes and non-LNG or oil market substitution energy effects.

Figure 4.19-1 summarizes the flow for delivering LNG (and crude oil) to markets for an equivalent energy service to society under each of the three scenarios considered in the DOE LCA Study (Appendix C), and for a non-equivalent energy baseline condition as described above. Figure 4.19-1 also presents the boundaries used for the life cycle GHG emissions for each of the three scenarios, for equivalent and non-equivalent energy service conditions. Further, DOE developed estimates of the social cost of GHGs, as discussed in Section 4.19.5 below. Additionally, this Final SEIS considers the potential impacts of climate change on Project facilities.

In accordance with CEQ's "*Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*" (CEQ 2016), DOE prepared estimates of potential GHG emissions under the Proposed Action but did not attempt to quantify the resulting climate change impacts. Potential climate change impacts resulting from any increase in GHG emissions would be consistent with the discussion of national and regional climate change impacts presented in Section 3.19.

For each of the three proposed scenarios, DOE evaluated life cycle GHG emissions associated with producing, processing, delivering, and consuming the LNG for four destination countries: Japan, South Korea, China, and India. **These four countries were chosen to represent geographically proximate delivery destinations from Alaska that, at the time of study initiation, were known or expected to be significant LNG importers. Note that the range of shipping distances to these specific countries (5,000 to 10,000 miles from Alaska) closely approximate those to other emerging LNG importers such as in Europe (about 10,000 miles away via the Panama Canal).**

For modeling purposes, it was assumed that the LNG would be used to generate electricity in each country; however, DOE acknowledges that some of the delivered LNG may be used for other purposes. To ensure consistency in modeling and comparison across the three scenarios, DOE modeled the GHG emissions associated with generating an equal amount of electricity (i.e., 1 megawatt hour) in each destination country. Under Scenarios 2 and 3, the LNG would be supplied by the proposed Project. **DOE has explored two conditions where the Alaska LNG Project is not developed. For the DOE LCA Study "Business as Usual" Scenario 1 (called No Action Alternative 1), DOE assumed the energy demand from foreign markets would remain and would be fulfilled by an alternate source of LNG from the global market. DOE modeled GHG emissions associated with the alternative source of LNG using the U.S. average production from the Lower 48 as a representative proxy.** Further, for each scenario and destination country**,** DOE estimated GHG emissions from electricity generation with and without the use of CCS by the end user.



Source: Developed from Skone et al. 2022

CO_2 = carbon dioxide; LCA = Life Cycle Analysis

Note: **For simplicity, not all steps in the oil and gas life cycle (e.g., transportation) are shown separately. Shaded boxes indicate processing and/or consumption of oil and gas from the North Slope. White boxes indicate processing and/or consumption of oil and gas from alternate global sources, using U.S. average crude oil and gas production in the Lower 48 as a proxy.**

Figure 4.19-1. Overview of LCA Study Scenarios and No Action Alternative Boundaries

The LCA Study did not evaluate alternative uses of exported LNG for non-power applications. It is likely that exported LNG could be used for industrial, commercial, and/or residential purposes to meet energy needs. Non-power use would generally result in higher CH_4 emissions due to leaks from the distribution system. However, alternative uses of LNG would result in approximately the same end use emissions across each scenario and therefore would not change the comparative results of the study, even if there are minor differences in the total cumulative GHG emissions. The technical viability of sequestering carbon from power generation in each destination country was also not evaluated as part of this study. The study brackets the range of GHG effects both with and without CCS. It is worth noting that commercial deployment of carbon capture technology is new, with demonstration projects currently being supported by the U.S. Government. Therefore, end use results without CCS are more likely to reflect existing electricity generating plants today, and the results with CCS are likely to be more representative of future electricity generation, with lower GHG emissions.

In addition, since crude oil is co-produced with natural gas on the North Slope, this **Final** SEIS considers life cycle GHG emissions associated with supplying crude oil to markets in the **L**ower 48. The volume of total crude oil produced and delivered to market **from the North Slope** was estimated to be **different under** Scenarios 1**, 2,** and **3**. **Therefore, for GHG modeling purposes, the total crude oil volumes supplied to market and consumers under the three scenarios were made equal by adding in crude oil production from the global market. DOE used the U.S. average production from the Lower 48 as a representative proxy for the global market crude oil.** Similar to the treatment of LNG, this was done to ensure consistency across the three scenarios given that the same market demand for crude oil would need to be met under each scenario.

While the scenarios discuss the 'Lower 48', this categorization creates a benchmark representation of alternative natural gas sources. By using high-resolution data available from the Lower 48 (e.g., from the USEPA GHG Reporting Program), the LCA Study offers a higher level of data quality and helps to stay consistent with the level of modeling accuracy. It also avoids using far more aggregated data from other regions that would lead to additional uncertainty.

The DOE LCA Study (Skone et al. 2022, see Appendix C) presents results for each scenario; in order to enable direct comparison, the study assumes that each scenario provides an equivalent amount of LNG (and crude oil) service to society. Specifically, the LCA Study modeled the available gas for LNG export and quantity of oil produced in each scenario at 27.8 Tcf of natural gas and 1,402 million barrels of crude oil. In accordance with International Standards Organization 14040 and 14044 for life cycle analysis, DOE's LCA Study considers that end use of LNG would be equivalent, under the No Action and Proposed Action scenarios (ISO 2006a; ISO 2006b). The DOE LCA Study includes both natural gas and oil produced from the North Slope (within the scope of this Project) and natural gas and oil produced on the global market using the average for the U.S. Lower 48 as a representative proxy to make each scenario equivalent. That is, for "Business as Usual" Scenario 1, where the Project is not constructed, the DOE LCA Study includes natural gas and oil supplied from the global market to provide an equivalent amount of LNG (and crude oil) to society as would have been provided by the Project. This provides for a comparison between Scenario 1 and Scenarios 2 and 3, where it is assumed that oil and gas is supplied by the Project to provide equivalent energy service in all cases.

For the purposes of this Final SEIS, "Business as Usual" Scenario 1 is referred to as No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1 (see Section 4.19.3). DOE has included a second baseline condition for the No Action Alternative where no assumption is made that LNG exports from the global market would substitute for LNG that would have been produced and exported under the Proposed Action. Under this second baseline condition, referred to as No Action Alternative 2, SEIS Non-equivalent Energy Baseline, no assumption is made about energy market conditions in the absence of the proposed Project, but oil and gas production activities would continue on the North Slope. This Final SEIS also presents GHG emissions for the Proposed Action,

corresponding to Scenarios 2 and 3, that include oil and gas production on the North Slope but exclude the proxy for alternate LNG and oil supply, which was taken as Lower 48 oil and gas production for illustrative purposes in the other No Action condition assessment (see Figure 4.19-1). Therefore, under No Action Alternative 2, GHG emissions for both the No Action and the Proposed Action include only life cycle GHG emissions associated with oil and gas production on the North Slope of Alaska.

The No Action Alternative 1 and No Action Alternative 2 provide two different perspectives for assessing the cumulative GHG effects in comparison to the Proposed Action Scenarios 2 and 3 results. Future net global changes in GHG emissions related to this Project, including those presented under Scenarios 2 and 3, would be driven by a range of factors, including, among others, future oil and gas market conditions, the adoption of policies and measures to limit GHG emissions, and the penetration of low-carbon energy sources. No Action Alternative 1 compared to the Proposed Action scenarios summarizes the GHG effects based on the global perspective that if LNG and oil were not produced from this Project, they would be produced from another global source and result in GHG emissions. No Action Alternative 2 provides an estimate of GHG emissions that does not include any emissions associated with alternatives that could be used to provide the equivalent service to society that would be provided by the Project's LNG and oil. This SEIS presents these two No Action Alternatives because there is inherent uncertainty regarding the particular present or future supply and demand responses that would lead to net changes in production and consumption, and associated emissions, of LNG and oil that would be produced on the North Slope in association with the Project.

Commenters on the Draft SEIS also requested additional information regarding black carbon emissions and resulting impacts on climate change. Black carbon would be emitted by fossil fuel-fired equipment including engines, boilers, heaters, pumps, vehicles, and flares. Black carbon emissions have not been separately quantified but are included within the $PM_{2.5}$ emissions estimates presented in Section 4.15. Further, there is considerable uncertainty regarding the climate forcing effects of black carbon, and the IPCC and USEPA have not published global warming potential values for black carbon to allow these effects to be quantified.

The following sections describe the cumulative life cycle GHG results from the proposed Project in the context of both the non-equivalent energy baseline (derived from the DOE LCA Study results although not explicitly presented in the Study) and the equivalent energy results presented in the DOE LCA Study, which are described in Appendix C.

4.19.3 No Action Alternatives

Similar to the other Chapter 4 resource sections within this SEIS, under the No Action Alternative, the Project would not be constructed. This would not allow the proposed Project to meet AGDC's Project purpose and need to bring cost-competitive LNG from Alaska to foreign markets. Since construction and operation of the proposed Project would not occur, there would be no change in GHG emissions due to LNG production and export from Alaska.

In this Final SEIS, specifically for the GHG analysis (see Section 4.19.2), the No Action Alternative includes two different perspectives for assessing the cumulative GHG effects in comparison to the Proposed Action Scenarios 2 and 3 results, presented as No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy), which represents the same amount of LNG and oil being supplied to the market, and No Action Alternative 2 (SEIS Non-equivalent Energy Baseline), which only presents GHG emissions associated with the estimated production of oil from the North Slope and the associated emissions from the transport, refining, and use of the oil. No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) accounts for only the life cycle GHG emissions directly attributed to the energy production from the North Slope that would be impacted by the Alaska LNG Project. The No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) intentionally

excludes GHG emissions from energy production from non-North Slope operations to meet equivalent LNG (and crude oil) services.

This Final SEIS takes no position on whether there will be a market demand for the LNG produced by the Alaska LNG Project. The analysis presented in this Final SEIS examines the impacts that could occur if the LNG demand for the volumes associated with the Alaska LNG Project exist. Future net global changes in GHG emissions related to this Project, including those presented under Scenarios 2 and 3, would be driven by a range of factors, including, among others, future oil and gas market conditions, the adoption of policies and measures to limit GHG emissions, and the penetration of low-carbon energy sources. No Action Alternative 1 compared to the Proposed Action scenarios summarizes the GHG effects based on the global perspective that if LNG and oil were not produced from this Project, they would be produced from another global source and result in GHG emissions. No Action Alternative 2 provides an estimate of GHG emissions that does not include any emissions associated with alternatives that could be used to provide the equivalent service to society that would be provided by the Project's LNG and oil. This SEIS presents these two No Action Alternatives because there is inherent uncertainty regarding the particular present or future supply and demand responses that would lead to net changes in production and consumption, and associated emissions, of LNG and oil that would be produced on the North Slope in association with the Project.

4.19.3.1 No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy)

The No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy, assumes that LNG that would have been produced by the Project is instead produced elsewhere in the world (using production in the Lower 48 as a proxy). A cumulative total of approximately 3,011 to 3,023 million metric tons CO_2-eq of GHGs would be emitted, depending on the destination country, if electricity generation at the receiving facility occurs without CCS. Approximately 1,714 to 1,728 million metric tons CO_2-eq of GHGs would be emitted if electricity generation occurs with CCS.

The LCA Study estimates the production of oil from the North Slope without the Alaska LNG Project to be 1,356 MMbbl of oil. Oil production was modeled to estimate oil production from the time period of 2029 through 2061. Oil production declines from 61.96 MMbbl/year in 2029 to an average production rate of 26.85 MMbbl/year in years 2058 through 2061. Natural gas and CO_2 produced with the crude oil is reinjected into the formation to improve oil production rates. As the volume of crude oil produced declines over the study period, the volume of gas available for reinjection also declines from 7.3 Bcfd in 2029 to an average of 5.7 Bcfd in years 2058 through 2061. The No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy also includes the production of 47 MMbbl of oil from global oil supply (modeled as Lower 48 oil production as a proxy) to provide the same amount of oil to society as Scenario 3. Scenario 3 results in the largest volume of oil produced over the time period of 2029 through 2061. As a result, No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy, as well as Proposed Action, Scenario 2, Reduced Gas Injection, were adjusted to include additional crude oil to provide the same amount of oil service to society as Proposed Action, Scenario 3, Use and Storage of By-Product CO_2. No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy also includes LNG production from non-Alaska global source to provide an equivalent amount of LNG energy services to society. This was modeled as production and export from the Lower 48 as a proxy. A total volume of 27.8 TCF of natural gas is produced for export from the global supply (non-Alaska) to provide equivalent LNG energy services to society.

4.19.3.2 No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)

The No Action Alternative 2, SEIS Non-equivalent Energy Baseline, only considers the projected continuation of oil production from the Project area in Alaska, and no assumption is made about

providing the same energy service to society. The scope of the GHG emissions for No Action Alternative 2 includes all emissions from extraction through end use of the oil, accounting for total life cycle GHG emissions. However, as discussed earlier, the scope of the analysis was not expanded to provide an equivalent LNG and oil energy service to society.

The LCA Study results for extraction, processing, pipeline transport, ocean transport to Lower 48, refining, and use of the crude oil were used to represent the No Action Alternative 2, SEIS Non-equivalent Energy Baseline. Oil production was modeled to estimate oil production from the time period of 2029 through 2061. Oil production declines from 61.96 MMbbl/year in 2029 to an average production rate of 26.85 MMbbl/year in years 2058 through 2061. Natural gas and CO_2 produced with the crude oil is reinjected into the formation to improve oil production rates. As the volume of crude oil produced declines over the study period, the volume of gas available for reinjection also declines from 7.3 Bcfd in 2029 to an average of 5.7 Bcfd in years 2058 through 2061. The total volume of oil produced from the North Slope (as it relates to this project) is 1,356 MMbbl over the time period of 2029 through 2061. The No Action Alternative 2, SEIS Non-equivalent Energy Baseline, represents the life cycle from extraction through combustion of 1,356 MMbbl of crude oil. As stated above, the No Action Alternative 2, SEIS Non-equivalent Energy Baseline, only includes the GHG emission resulting from the 1,356 MMbbl of oil. No GHG emissions associated with non-Alaska oil or natural gas production (as it relates to this project) are included in No Action Alternative 2, SEIS Non-equivalent Energy Baseline.

The life cycle GHG emissions from the production and use of 1,356 MMbbl of oil are approximately 853 million metric tons CO_2-eq of GHGs for the years 2029 through 2061. Because there is no equivalent LNG (and crude oil) service considered, the No Action Alternative 2 estimate only includes GHG emissions from the production and end use of oil produced from the North Slope (as defined by the project scope), and therefore, the results are independent of the destination country as no LNG is exported to produce electricity in those countries.

4.19.4 Potential Impacts from Upstream Development (Scenarios 2 and 3)

Life cycle GHG emissions from production, liquefaction, export, and use of natural gas from the North Slope of Alaska (along with related changes in crude oil production) under Scenarios 2 and 3 would be no higher than emissions under the No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy), considering an equivalent LNG and oil service to society.

Results from the LCA Study were used to estimate the life cycle GHG emission from oil and natural gas production on the North Slope (as it relates to the AK LNG Project). The Alaska-only oil and gas production life cycle GHG emissions represent the Alternative 2 data for use in comparing to Alternative 2, SEIS Non-equivalent Energy Baseline discussed in Section 4.19.3. For comparison to the Alternative 1, DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy, Scenario 2 was expanded to include additional global oil production to match the equivalent oil energy services as Scenario 3. A total of 554 MMbbl of global oil supply (non-Alaska oil) are included in Scenario 2 for comparison with Alternative 1, DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy. Scenario 3 also includes the expansion of 42 MMbbl of oil from the global oil supply (non-Alaska oil). This adjustment was added to the Final SEIS modeling to align the oil production data on a year-by-year production schedule to support the inclusion of social cost of carbon. Estimation of social cost of carbon requires the GHG emission data to be on an annual time scale. The Draft SEIS had aggregated GHG emissions into six time periods – this approach, while appropriate for estimating the global warming potential over the life of the project as presented in the Draft SEIS, did not support social cost of carbon methodology. This Final SEIS presents both cumulative global warming potential and social cost of carbon results on a consistent year-by-year emissions profile from the LCA Study. Section 4.19.5 discusses the social cost of carbon results. The following discusses the cumulative global warming potential results.

Life cycle GHG emissions associated with LNG and crude oil from the Lower 48 (used to represent a global proxy for non-Alaskan/North Slope LNG and crude oil under No Action Alternative 1) are estimated to be slightly higher than for LNG and crude oil from the North Slope under Scenarios 2 and 3. This is because the energy burden for producing oil on the North Slope under Scenarios 2 and 3 is reduced with the coproduction of natural gas. The energy burden is also shared between crude oil and natural gas products from the North Slope with the Alaska LNG Project, and to a lesser degree, smaller transport distances also contribute to lower emissions under Scenarios 2 and 3. Further, there is not a substantial difference between life cycle GHG emissions under Scenarios 2 and 3.

- **Scenario 2: Cumulative life cycle GHG emissions would range from approximately 2,737 to 2,797 million metric tons CO_2-eq for electricity generation without CCS, or approximately 1,443 to 1,519 million metric tons CO_2-eq with CCS. When compared to the No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1), Scenario 2 is estimated to result in 7 to 9 percent lower emissions without the use of CCS and 12 to 16 percent lower emissions with CCS.**
- **Scenario 3: Cumulative life cycle GHG emissions equal approximately 2,737 to 2,797 million metric tons CO_2-eq without CCS, or approximately 1,443 to 1,519 million metric tons CO_2-eq with CCS. When compared to No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1), Scenario 3 is estimated to result in 7 to 9 percent lower emissions without the use of CCS and 12 to 16 percent lower emissions with CCS.**

By contrast, life cycle GHG emissions for Scenarios 2 and 3 would be considerably higher than emissions under No Action Alternative 2, SEIS Non-equivalent Energy Baseline, which are presented above in Section 4.19.3.2. The life cycle GHG emissions resulting from natural gas and oil produced from the North Slope only under Scenarios 2 and 3 (not including global proxy volumes from the Lower 48) are summarized below and compared to the No Action Alternative 2, SEIS Non-equivalent Energy Baseline. There is a meaningful difference in emissions between the No Action Alternative 2, and the other scenarios due to the difference in LNG volumes assumed to be delivered to end-users.

- **Scenario 2: Life cycle GHG emissions would range from approximately 2,440 to 2,501 million metric tons CO_2-eq for electricity generation without CCS, or approximately 1,146 to 1,223 million metric tons CO_2-eq with CCS. When compared to the No Action Alternative 2, SEIS Non-equivalent Energy Baseline, Scenario 2 is estimated to have 186 to 193 percent higher GHG emissions without the use of CCS and 34 to 43 percent higher emissions with CCS.**
- **Scenario 3: Life cycle GHG emissions equal approximately 2,714 to 2,775 million metric tons CO_2-eq without CCS, or approximately 1,420 to 1,496 million metric tons CO_2-eq with CCS. When compared to the No Action Alternative 2, SEIS Non-equivalent Energy Baseline, Scenario 3 is estimated to have 218 to 225 percent higher GHG emissions without the use of CCS and 66 to 75 percent higher emissions with CCS.**

Table 4.19-2 summarizes the cumulative GHG emissions described above, for each scenario and destination country.

For both Scenarios 2 and 3, life cycle GHG emissions are very similar across destination countries for each stage except ocean transport, which varies due to different distances between ports. Specifically, the ocean transport stages result in very similar emissions for Japan, Korea, and China since they are in relatively close proximity to each other. As India is farther away from North America, it has distinctly higher emissions from the ocean transport stage, and thus overall emissions are also higher as compared to the other countries. All else equivalent, shorter ocean transport distances would result in lower GHG emissions. The contribution of LNG ocean transport to the total life cycle result across the scenarios ranges between 3 percent and 6 percent of the total cumulative GHG contribution on a 100-year global warming potential timeframe.

Table 4.19-2. Summary of Cumulative Life Cycle Greenhouse Gas Emissions (AR4, 100-yr GWP)

Destination Country	Emissions (million metric tons CO_2-eq)					
	Without CCS			With CCS		
	No Action	Scenario 2	Scenario 3	No Action	Scenario 2	Scenario 3
No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy)						
Japan	3,011	2,737	2,737	1,714	1,443	1,443
South Korea	3,023	2,746	2,746	1,728	1,455	1,455
China	3,023	2,747	2,747	1,728	1,455	1,455
India	3,019	2,797	2,797	1,723	1,519	1,519
No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)						
Japan	853	2,440	2,714	853	1,146	1,420
South Korea	853	2,450	2,724	853	1,159	1,432
China	853	2,450	2,724	853	1,159	1,433
India	853	2,501	2,775	853	1,223	1,496

CCS = carbon capture and sequestration; CO_2-eq = carbon dioxide equivalents; DOE = Department of Energy; GWP = global warming potential; LCA = Life Cycle Analysis

As discussed above, DOE estimated life cycle GHG emissions with and without the use of CCS by the end-user of the exported LNG. When CCS is not used, power generation consistently produces the most emissions of any life cycle stage. When CCS is utilized, the life cycle stage producing the largest amount of emissions varies among scenarios.

The DOE LCA Study is based on the comparison of natural gas and oil produced from the North Slope (Scenarios 2 and 3) to natural gas produced for the global market from a non-Alaska source and oil produced in Alaska (Scenario 1). Scenarios 1, 2, and 3 are also supplemented with additional oil production using the U.S. average from the Lower 48 as a global proxy to ensure system equivalency across scenarios. In the early and later years of the project, Scenario 1 is estimated to produce more oil than Scenario 3. The DOE LCA Study models the end use of the imported natural gas as 100 percent for electricity production in a natural gas combined cycle (NGCC) power plant with and without CCS. Alternative electricity production technologies could also be utilized to meet energy demands of the destination countries modeled. For example, it is reasonable to expect that use of nuclear or renewable electricity production technologies could considerably reduce life cycle GHG emissions on a per unit of delivered power basis, once system equivalency is accounted for (e.g., baseload 24/7 power reliability). Similarly, if a destination country utilized fuel oil or coal to meet electricity demand and reliability, life cycle GHG emissions could increase in comparison to global LNG energy resources.

Tables 4.19-3 and 4.19-4 summarize the quantity of gas and oil produced in each scenario and the corresponding life cycle GHG contribution to the cumulative total for each No Action Alternative and Proposed Action scenario. As described above, each table provides cumulative and comparative results based on the No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1), from the DOE LCA Study in Appendix C, and the No Action Alternative 2 (SEIS Non-equivalent Energy Baseline), derived from the DOE LCA Study results.

Table 4.19-3. Summary and Comparison of Cumulative Life Cycle Greenhouse Gas Emissions without CCS on End Use NGCC Power Plant

	Gas Produced in Each Scenario, TCF	Oil Produced in Each Scenario, MMbbl	Cumulative GHG Emissions Total without CCS on End Use NGCC Power Plant, MMT CO_2-eq, AR4, 100-year			
			Japan	South Korea	China	India
No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1)						
Alaskan Oil Production and End Use: *without Alaska LNG Export Project*	--	1,356	853	853	853	853
Global Proxy based on US Lower 48 LNG Export and End Use: *LCA System Expansion*	27.8	--	2,133	2,144	2,145	2,140
Global Proxy based on US Average Crude Oil Production and End Use: *LCA System Expansion*		47	25	25	25	25
Total	27.8	1,402	3,011	3,023	3,023	3,019
No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)						
Alaskan Oil Production and End Use: *without Alaska LNG Export Project*	--	1,356	853	853	853	853
Proposed Action (Scenario 2: Reduced Gas Injection)						
a. Alaskan Natural Gas Production and End Use: *from Alaska LNG Export Project*	27.8		2,009	2,019	2,019	2,069
b. Alaskan Oil Production and End Use: *with Alaska LNG Export Project*		849	431	431	431	431
c. Global Proxy based on US Average Crude Oil Production and End Use: *LCA System Expansion*		554	296	296	296	296
Total	27.8	1,402	2,737	2,746	2,747	2,797
Proposed Action (Scenario 3: Use and Storage of By-Product CO_2)						
a. Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	27.8		2,006	2,016	2,016	2,067
b. Alaskan Oil Production and End Use: with Alaska LNG Export Project		1,360[a] [969 – 1,449]	708	708	708	708
c. Global Proxy based on US Average Crude Oil Production and End Use: *LCA System Expansion*		42	22	22	22	22
Total	27.8	1,402[a] [1,011 – 1,491]	2,737	2,746	2,747	2,797
Comparison: Alaska and Global Proxy Oil and Gas Production, No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1)						
Total, Scenario 2 (a + b + c) minus No Action	0	0	-275	-276	-276	-221
Total, No Action to Scenario 2, *Percent Change*	0%	0%	-9%	-9%	-9%	-7%
Total, Scenario 3 (a + b + c) minus No Action	0	0	-275	-276	-276	-221
Total, No Action to Scenario 3, *Percent Change*	0%	0%	-9%	-9%	-9%	-7%
Comparison: Alaska Oil and Gas Production Only, No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)						
Scenario 2 (a + b) minus No Action	27.8	-506	1,587	1,597	1,597	1,648
No Action to Scenario 2 (a + b), *Percent Change*	--	-37%	186%	187%	187%	193%
Scenario 3 (a + b) minus No Action	27.8	5[a] [-3,876 – 93]	1,861	1,871	1,871	1,922
No Action to Scenario 3 (a + b), *Percent Change*	--	0.4%[a] [-27% - 7%]	218%	219%	219%	225%

a A screening tool was used to model the CO_2-EOR flood and obtain a first-level assessment of annual incremental oil production based on limited reservoir data. Results suggest that CO_2-EOR application can potentially achieve incremental oil recoveries of around 500 million barrels of oil (LCA Modeled Value: 512). Based on CO_2-EOR performance in analogous oil fields, as well as on Kuparuk secondary and tertiary production history, incremental oil recovery can vary from 2 to 10% of original oil in place, which at Kuparuk is appraised at 6 billion barrels of oil (Hoolahan 1997, Jensen 2012). This means that the assumed CO_2-EOR potential may range from 120 to 600 million barrels of oil over the life of the project. This uncertainty range is added to the cumulative oil production from the PBU to reflect the known uncertainty in CO_2-EOR oil production from Kuparuk oil field. Modeling and review of Kuparuk CO_2-EOR potential has confirmed that the operation can utilize and store the total quantity of CO_2 separated from the GTP to prevent direct release to the atmosphere. The known uncertainty is the actual quantity of oil that will be produced from use of the CO_2 for enhanced oil recovery over the project life.

CCS = carbon capture and sequestration; CO_2 = carbon dioxide; CO_2-eq = carbon dioxide equivalents; GHG = greenhouse gas; LCA = life cycle analysis; MMbbl = million barrels; NGCC = natural gas combined cycle; Tcf = trillion cubic feet.
Note: Totals may not add up due to rounding.

Table 4.19-4. Summary and Comparison of Cumulative Life Cycle Greenhouse Gas Emissions with CCS on End Use NGCC Power Plant

	Gas Produced in Each Scenario, TCF	Oil Produced in Each Scenario, MMbbl	Cumulative GHG Emissions Total without CCS on End Use NGCC Power Plant, MMT CO_2-eq, AR4, 100-year			
			Japan	South Korea	China	India
No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1)						
Alaskan Oil Production and End Use: *without Alaska LNG Export Project*	--	1,356	853	853	853	853
Global Proxy based on US Lower 48 LNG Export and End Use: *LCA System Expansion*	27.8	--	835	849	850	844
Global Proxy based on US Average Crude Oil Production and End Use: *LCA System Expansion*		47	25	25	25	25
Total	27.8	1,402	1,714	1,728	1,728	1,723
No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)						
Alaskan Oil Production and End Use: *without Alaska LNG Export Project*	--	1,356	853	853	853	853
Proposed Action (Scenario 2: Reduced Gas Injection)						
a. Alaskan Natural Gas Production and End Use: *from Alaska LNG Export Project*	27.8		715	727	728	791
b. Alaskan Oil Production and End Use: *with Alaska LNG Export Project*		849	431	431	431	431
c. Global Proxy based on US Average Crude Oil Production and End Use: *LCA System Expansion*		554	296	296	296	296
Total	27.8	1,368	1,443	1,455	1,455	1,519
Proposed Action (Scenario 3: Use and Storage of By-Product CO_2)						
a. Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	27.8		712	724	725	788
b. Alaskan Oil Production and End Use: with Alaska LNG Export Project		1,360[a] [969 – 1,449]	708	708	708	708
c. Global Proxy based on US Average Crude Oil Production and End Use: *LCA System Expansion*		42	22	22	22	22
Total	27.8	1,402[a] [1,011 - 1,491]	1,443	1,455	1,455	1,519
Comparison: Alaska and Global Proxy Oil and Gas Production, No Action Alternative 1 (DOE LCA Study "Business as Usual" Scenario 1, Equivalent Energy)						
Total, Scenario 2 (a + b + c) minus No Action	0	0	-271	-273	-273	-204
Total, No Action to Scenario 2, *Percent Change*	0%	0%	-16%	-16%	-16%	-12%
Total, Scenario 3 (a + b + c) minus No Action	0	0	-271	-273	-273	-204
Total, No Action to Scenario 3, *Percent Change*	0%	0%	-16%	-16%	-16%	-12%
Comparison: Alaska Oil and Gas Production Only, No Action Alternative 2 (SEIS Non-equivalent Energy Baseline)						
Scenario 2 (a + b) minus No Action	27.8	-506	293	305	306	369
No Action to Scenario 2 (a + b) *Percent Change*	--	-37%	34%	36%	36%	43%
Scenario 3 (a + b) minus No Action	27.8	5[a] [-3,876 – 93]	567	579	580	643
No Action to Scenario 3 (a + b) *Percent Change*	--	0.4%[a] [-27% - 7%]	66%	68%	68%	75%

a A screening tool was used to model the CO_2-EOR flood and obtain a first-level assessment of annual incremental oil production based on limited reservoir data. Results suggest that CO_2-EOR application can potentially achieve incremental oil recoveries of around 500 million barrels of oil (LCA Modeled Value: 512). Based on CO_2-EOR performance in analogous oil fields, as well as on Kuparuk secondary and tertiary production history, incremental oil recovery can vary from 2 to 10 % of original oil in place, which at Kuparuk is appraised at 6 billion barrels of oil (Hoolahan 1997, Jensen 2012). This means that the assumed CO_2-EOR potential may range from 120 to 600 million barrels of oil over the life of the project. This uncertainty range is added to the cumulative oil production from the PBU to reflect the known uncertainty in CO_2-EOR oil production from Kuparuk oil field. Modeling and review of Kuparuk CO_2-EOR potential has confirmed that the operation can utilize and store the total quantity of CO_2 separated from the GTP to prevent direct release to the atmosphere. The known uncertainty is the actual quantity of oil that will be produced from use of the CO_2 for enhanced oil recovery over the project life.

CCS = carbon capture and sequestration; CO_2 = carbon dioxide; CO_2-eq = carbon dioxide equivalents; GHG = greenhouse gas; LCA = life cycle analysis; MMbbl = million barrels; NGCC = natural gas combined cycle; Tcf = trillion cubic feet.

Note: Numbers may not add up to totals due to rounding.

4.19.5 Social Cost of Greenhouse Gases

Estimates of the social cost of greenhouse gas (SC-GHG) emissions provide an aggregated monetary measure (in U.S. dollars) of the net harm to society associated with an incremental metric ton of emissions in a given year. These estimates include, but are not limited to, climate change impacts associated with net agricultural productivity, human health effects, property damage from increased risk of natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. In this way, SC-GHG estimates can help the public and federal agencies understand or contextualize the potential impacts of GHG emissions and, along with information on other potential environmental impacts, can inform the comparison of alternatives. DOE used data from the "Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990" released by the Interagency Working Group on Social Cost of Greenhouse Gases (IWG SC-GHG) in February 2021 to estimate SC-GHG for this SEIS. As a member of the IWG, DOE agrees that the interim SC-GHG estimates represent the most appropriate estimates of the SC-GHG until revised estimates are developed reflecting the latest, peer-reviewed science. Tables 4.19-5 and 4.19-6 summarize the cumulative, life cycle SC-GHG estimates by alternative. These tables combine the estimates associated with CO_2, CH_4, and N_2O. Appendix E provides estimates by individual GHG and by year.

4.19.6 Identification of Construction and Restoration Environmental Plans and Additional Mitigation

Mitigation measures to minimize GHG emissions could include the following:

- Use appropriate BMPs to reduce equipment and vehicle emissions (including GHGs) during construction by such practices as maintaining engines according to manufacturers' specifications, minimizing idling of equipment while not in use, and using electricity from the grid if available to reduce the use of diesel or gasoline generators for operating construction equipment.
- **Reduce CH_4 emissions by minimizing operational system upsets, gas flaring and venting, valve leaks, etc.; incorporating innovative technologies in leak detection and continuous monitoring programs for fugitive emissions, such as drones and optical and infrared detectors; and adopting relevant best practices and recommended technologies identified in USEPA's voluntary methane programs - Methane Challenge and Natural Gas STAR.**
- **Monitor CO_2 pipelines and sequestration networks to improve safety while also reducing the number of incidents that result in CO_2 leakage, consistent with CEQ's proposed guidance on carbon sequestration.**
- **Use energy efficient, lower GHG-emitting equipment and promote sustainable land management practices where applicable.**
- Under Scenario 2, develop and implement a USEPA-approved site-specific monitoring, reporting, and verification plan for CO_2 injection wells per Subpart RR of the Mandatory Reporting of Greenhouse Gases Rule. The plan would assure that the **CO_2 is being injected in accordance with Class I UIC permit from the USEPA or under a Class II permit from AOGCC, and is being properly sequestered. Subpart RR requirements are focused on accounting for the amount of CO_2 that is geologically sequestered. Proper accounting of CO_2 sequestration would provide a key indicator of success and serve as a basis for any further mitigation or control measures that may be required.**
- **If DOE exercises its authority to reaffirm the Alaska LNG Order, it is recommended that the following measure be included as an environmental condition of any such export authority: Alaska LNG shall submit to DOE, as part of its monthly report, a statement certifying that the natural gas produced for export in the form of LNG did not result in the venting of by-product CO_2 into the atmosphere, unless required for emergency, maintenance, or operational exigencies and in compliance with the FERC Order.**

Table 4.19-5. Social Cost (SC) of Life Cycle Greenhouse Gas Emissions with and without CCS on End Use NGCC Power Plant (No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1)

Scenario / LNG Destination Country	Cumulative Social Cost of CO_2, CH_4, N_2O without CCS on End Use NGCC Power Plant, Billion 2020$				Cumulative Social Cost of CO_2, CH_4, N_2O with CCS on End Use NGCC Power Plant, Billion 2020$			
	5% Avg	3% Avg	2.5% Avg	3%, 95th Perc	5% Avg	3% Avg	2.5% Avg	3%, 95th Perc
No Action Alternative 1, DOE LCA Study "Business as Usual" Scenario 1 (27.8 TCF Natural Gas, 1,402 MMbbl Oil)								
Japan	33.6	131.6	200.9	395.9	20.3	77.0	116.5	229.7
South Korea	33.7	132.1	201.6	397.2	20.4	77.5	117.3	231.3
China	33.7	132.1	201.6	397.2	20.4	77.6	117.4	231.4
India	33.7	131.9	201.3	396.7	20.4	77.3	117.0	230.7
Proposed Action, Scenario 2: Reduced Gas Injection (27.8 TCF Natural Gas, 1,402 MMbbl Oil)								
Japan	30.2	119.1	182.0	358.7	16.9	64.5	97.8	192.9
South Korea	30.3	119.4	182.6	359.8	17.0	65.0	98.5	194.3
China	30.3	119.4	182.6	359.9	17.0	65.0	98.6	194.4
India	30.7	121.3	185.5	365.6	17.7	67.8	102.8	202.7
Proposed Action, Scenario 3: Use and Storage of By-Product CO_2 (27.8 TCF Natural Gas, 1,402 MMbbl Oil)								
Japan	30.1	119.0	181.9	358.6	16.9	64.5	97.7	192.7
South Korea	30.2	119.4	182.5	359.7	17.0	64.9	98.5	194.2
China	30.2	119.4	182.5	359.7	17.0	64.9	98.5	194.2
India	30.7	121.2	185.4	365.4	17.7	67.7	102.7	202.5
Results Comparison: Scenario 2 *minus* No Action (percent change)								
Japan	-3.4 (-10%)	-12.6 (-10%)	-18.9 (-9%)	-37.1 (-9%)	-3.4 (-17%)	-12.5 (-16%)	-18.7 (-16%)	-36.8 (-16%)
South Korea	-3.4 (-10%)	-12.6 (-10%)	-19.0 (-9%)	-37.4 (-9%)	-3.4 (-17%)	-12.5 (-16%)	-18.8 (-16%)	-37.0 (-16%)
China	-3.4 (-10%)	-12.6 (-10%)	-19.0 (-9%)	-37.4 (-9%)	-3.4 (-17%)	-12.5 (-16%)	-18.8 (-16%)	-37.0 (-16%)
India	-2.9 (-9%)	-10.6 (-8%)	-15.8 (-8%)	-31.2 (-8%)	-2.6 (-13%)	-9.5 (-12%)	-14.2 (-12%)	-28.0 (-12%)
Results Comparison: Scenario 3 *minus* No Action (percent change)								
Japan	-3.5 (-10%)	-12.6 (-10%)	-18.9 (-9%)	-37.3 (-9%)	-3.4 (-17%)	-12.5 (-16%)	-18.8 (-16%)	-37.0 (-16%)
South Korea	-3.5 (-10%)	-12.7 (-10%)	-19.0 (-9%)	-37.5 (-9%)	-3.4 (-17%)	-12.6 (-16%)	-18.9 (-16%)	-37.2 (-16%)
China	-3.5 (-10%)	-12.7 (-10%)	-19.0 (-9%)	-37.5 (-9%)	-3.4 (-17%)	-12.6 (-16%)	-18.9 (-16%)	-37.2 (-16%)
India	-3.0 (-9%)	-10.7 (-8%)	-15.9 (-8%)	-31.3 (-8%)	-2.7 (-13%)	-9.6 (-12%)	-14.3 (-12%)	-28.2 (-12%)

CCS = carbon capture and sequestration; CO_2 = carbon dioxide; CH_4 = methane; LNG = liquefied natural gas; MMbbl = million barrels; N_2O = nitrous oxide; NGCC = natural gas combined cycle; Tcf = trillion cubic feet.

Table 4.19-6. Social Cost (SC) of Life Cycle Greenhouse Gas Emissions, with and without CCS on End Use NGCC Power Plant (No Action Alternative 2, SEIS Non-equivalent Energy Baseline)

Scenario / LNG Destination Country	Cumulative Social Cost of CO_2, CH_4, N_2O without CCS on End Use NGCC Power Plant, Billion 2020$				Cumulative Social Cost of CO_2, CH_4, N_2O with CCS on End Use NGCC Power Plant, Billion 2020$			
	5% Avg	3% Avg	2.5% Avg	3%, 95th Perc	5% Avg	3% Avg	2.5% Avg	3%, 95th Perc
No Action Alternative 2, SEIS Non-equivalent Energy Baseline (0 TCF Natural Gas, 1,356 MMbbl Oil)								
Japan	9.5	37.6	57.5	114.0	9.5	37.6	57.5	114.0
South Korea	9.5	37.6	57.5	114.0	9.5	37.6	57.5	114.0
China	9.5	37.6	57.5	114.0	9.5	37.6	57.5	114.0
India	9.5	37.6	57.5	114.0	9.5	37.6	57.5	114.0
Proposed Action, Scenario 2: Reduced Gas Injection (27.8 TCF Natural Gas, 849 MMbbl Oil)								
Japan	27.2	106.8	163.0	321.5	13.9	52.2	78.8	155.6
South Korea	27.3	107.2	163.6	322.6	14.0	52.7	79.5	157.1
China	27.3	107.2	163.6	322.6	14.0	52.7	79.6	157.1
India	27.8	109.0	166.5	328.3	14.8	55.5	83.8	165.4
Proposed Action, Scenario 3: Use and Storage of By-Product CO_2 (27.8 TCF Natural Gas, 1,360 MMbbl Oil)								
Japan	30.0	118.2	180.7	356.2	16.7	63.7	96.5	190.4
South Korea	30.1	118.6	181.2	357.3	16.8	64.1	97.2	191.8
China	30.1	118.6	181.2	357.4	16.8	64.1	97.2	191.8
India	30.5	120.4	184.2	363.0	17.5	66.9	101.4	200.1
Results Comparison: Scenario 2 *minus* No Action (percent change)								
Japan	17.7 (187%)	69.2 (184%)	105.5 (184%)	207.5 (182%)	4.4 (47%)	14.7 (39%)	21.3 (37%)	41.7 (37%)
South Korea	17.8 (188%)	69.6 (185%)	106.1 (185%)	208.6 (183%)	4.5 (48%)	15.1 (40%)	22.0 (38%)	43.1 (38%)
China	17.8 (188%)	69.6 (185%)	106.1 (185%)	208.7 (183%)	4.6 (48%)	15.2 (40%)	22.1 (38%)	43.1 (38%)
India	18.2 (192%)	71.4 (190%)	109.0 (190%)	214.3 (188%)	5.3 (55%)	17.9 (48%)	26.3 (46%)	51.4 (45%)
Results Comparison: Scenario 3 *minus* No Action (percent change)								
Japan	20.5 (216%)	80.6 (215%)	123.2 (214%)	242.2 (212%)	7.2 (76%)	26.1 (69%)	39.0 (68%)	76.4 (67%)
South Korea	20.6 (217%)	81.0 (216%)	123.7 (215%)	243.3 (213%)	7.3 (77%)	26.6 (71%)	39.7 (69%)	77.8 (68%)
China	20.6 (217%)	81.0 (216%)	123.8 (215%)	243.4 (213%)	7.3 (77%)	26.6 (71%)	39.7 (69%)	77.8 (68%)
India	21.0 (222%)	82.9 (221%)	126.7 (220%)	249.0 (218%)	8.0 (85%)	29.4 (78%)	44.0 (76%)	86.1 (76%)

CCS = carbon capture and sequestration; CO_2 = carbon dioxide; CH4 = methane; LNG = liquefied natural gas; MMbbl = million barrels; N2O = nitrous oxide; NGCC = natural gas combined cycle; Tcf = trillion cubic feet.

4.19.7 Summary of Project and Upstream Development Impacts

Additional upstream development activities discussed within this **Final** SEIS would have the potential to affect GHG emissions. Overall, life cycle GHG emissions under the Proposed Action, including emissions from construction and operation of project activities, as well as upstream production and downstream processing, transport, and end-use, would be no higher than under the No Action Alternative **1 (DOE LCA Study "Business as Usual" Scenario 1)**. Based on the results of the LCA study, DOE believes that exporting LNG from the North Slope would not increase GHG emissions when providing the same services to society (through production of natural gas and oil) as the No Action Alternative **1 (DOE LCA Study "Business as Usual" Scenario 1)**.

As described in Sections 4.19.2 and 4.19.3, DOE has included a No Action Alternative 2 (SEIS Non-equivalent Energy Baseline) in the Final SEIS. Life cycle GHG emissions under the Proposed Action, including emissions from construction and operation of project activities, as well as upstream production and downstream processing, transport, and end-use, would be higher than No Action Alternative 2, as GHG emissions from other equivalent LNG (and crude oil) sources are not considered under this alternative. As a result, there is a meaningful difference in emissions between the No Action Alternative 2 and the Proposed Action Scenarios 2 and 3 due to the difference in LNG volumes assumed to be delivered to end-users. On this basis, exporting LNG from the North Slope could increase GHG emissions compared to the No Action Alternative 2 (SEIS Non-equivalent Energy Baseline). However, there would not be the same LNG (and crude oil) service to society as considered under No Action Alternative 1.

4.19.8 Potential Impacts of Climate Change on the Project

Section 3.19.3.2 of this **Final** SEIS discusses climate change impacts in Alaska. These impacts include warming temperatures and changes in precipitation, changes to sea ice and permafrost, soil liquefaction, wildfires, and coastal and river erosion. These changes could potentially affect Project operations, as discussed below.

<u>Changes to Temperature and Precipitation</u>

Warming temperatures would not have a direct impact on operations of proposed Project equipment and facilities, but episodes of extreme heat could have an adverse effect on worker health and safety. Precipitation is also expected to increase across much of Alaska, which could increase the risk from flooding, both to facilities and equipment and to worker safety.

<u>Changes to Sea Ice</u>

Changes to sea ice are not expected to have a noticeable effect on proposed Project operations.

<u>Changes to Permafrost</u>

Climate change has the potential to affect permafrost stability on the North Slope, with implications for construction activities and existing facilities in the region. As surface temperatures warm, thawing permafrost can lead to unstable ground condition that can damage infrastructure and facilities. These impacts include heaving, subsidence, thermokarst, and solifluction of soils near the facilities, access roads, work pads, and operational material sites (FERC 2020). The Project facilities would be designed to withstand these impacts over their planned life.

Soil Liquefaction

Soil liquefaction is a phenomenon whereby ground shaking, such as that caused by earthquakes, causes water pressure in soil to rise and potentially lead to destructive landslides. Sea level rise has been linked to the potential for increased soil liquefaction by causing groundwater levels in coastal areas to rise which in turn increases the potential for soils to be saturated with water. Further, frozen permafrost is generally not considered to be at risk, but thawing permafrost may be more susceptible to liquefaction depending on soil type. Climate change could increase the risk for liquefaction damage to proposed Project facilities, both by causing coastal groundwater levels to rise and by causing degradation of permafrost.

Wildfires

Climate change has the potential to increase the area impacted by wildfires in Alaska each year and could lead to increased wildfire risk. Wildfires have the potential to cause disruption to proposed Project operations and could present a potential safety hazard to employees.

Coastal and River Erosion

Climate change is increasing the likelihood of increased erosion due to sea level rise and severe storm events, especially in coastal areas and other locations prone to erosion, and due to thawing permafrost. Increased exposure to wildfires also has the potential to degrade surface vegetation and leave exposed soils that are more susceptible to erosion. The increased potential for erosion could impact Project facilities located in certain erosion-prone areas, but this risk would be mitigated through ongoing inspections and maintenance.

Biological Resources

Changes to biological resources due to climate change are not expected to have a noticeable effect on proposed Project operations.

Subsistence

Climate change is altering the physical setting in which the subsistence activities are conducted including disturbance to hunting activities, changes to fish populations, and increasing risks related to winter travel. However, changes to subsistence activities due to climate change are not expected to have a noticeable effect on proposed Project operations.

Human Health

Climate change impacts on the health of Alaskans are related to mental health and well-being; accidents and injuries; exposure to hazardous materials; food, nutrition, and subsistence activities; infectious diseases and toxins; chronic diseases; water and sanitation; and access to health services. Changes to human health due to climate change are not expected to have a noticeable effect on proposed Project operations.

4.20 CUMULATIVE IMPACTS

4.20.1 Introduction

This chapter describes the potential cumulative impacts that could occur from potential upstream development activities analyzed within this **Final** SEIS in combination with other past, present, and reasonably foreseeable future actions, including those impacts anticipated from the Alaska LNG Project described in the 2020 EIS. Reasonably foreseeable actions are those that are likely to be constructed or take place in the foreseeable future (based on permit applications or similar indication of significant intent). Potential long-term and/or permanent effects from these projects and activities may contribute to overall cumulative impacts within the area. As defined in 40 CFR 1508.7, cumulative impacts are the incremental impacts on the environment resulting from the Proposed Action. The analysis of cumulative impacts follows the processes recommended by the CEQ and the regulations in 40 CFR Chapter V.

The 2020 EIS addressed the direct, indirect, and cumulative effects of the Alaska LNG Project in Section 4.19 and provided a table of past, present, and reasonably foreseeable actions in Appendix W. The cumulative analysis in this **Final** SEIS provides updates to projects considered in the cumulative effects assessment in the 2020 EIS and provides new projects identified since the previous analysis, but is focused on projects within North Slope Borough. Since this **Final** SEIS evaluates potential upstream development, a few projects identified as non-jurisdictional facilities in the 2020 EIS are analyzed in greater detail in this **Final** SEIS. See Section 2.2.1 for additional information about the PTU Expansion Project and the PBU MGS Project which are analyzed for potential environmental impacts in Chapters 3, Affected Environment and Chapter 4, Impacts of the Proposed Action.

Table 4.20-1 provides changes to project status since the 2020 EIS and identifies any new projects within North Slope Borough that were not previously under consideration. Figure 4.20-1 provides an overview of the locations of the cumulative projects in relation to upstream development.

Table 4.20-1. North Slope Cumulative Projects Overview

Project Name	Description	Location[a]	Status	Identified in the 2020 EIS (Y/N)
Energy Projects				
Alaskan Beaufort Sea and Chukchi Sea Area Oil and Gas Leasing	BOEM proposed in January 2018 to expand oil and gas leasing in both Beaufort and Chukchi Sea areas, and is preparing an EIS for the 2019-2024 Lease Sale Schedule that includes three sales each in the Beaufort and Chukchi Seas during 2019–2024 (BOEM 2022).	25 miles northeast in the Beaufort Sea and Chukchi Sea.	**The OCS program expired on June 30, 2022. BOEM released a Draft EIS for the 2023-2028 OCS Leasing Program on July 1, 2022.**	Y
Badami Unit Restart	Savant Alaska LLC, a Glacier Oil and Gas company, is completing a facility turnaround at the eastern North Slope Badami unit pad (Petroleum News 2020a).	38 miles east	Savant Alaska LLC anticipated to restart oil production in 2020 (Petroleum News 2020a).	N
BLM Coastal Plain Oil and Gas Leasing	In December 2017, Congress passed the Tax Act (Public Law 115-97) that opened the 1.5 million-acre Coastal Plain (also known as the Alaska National Interest Lands Conservation Act 1002 area) of the Arctic National Wildlife Refuge for oil and gas exploration and development (BLM 2022c).	96 miles east	**The BLM issued a revised Draft SEIS for the Willow Project on July 8, 2022 following litigation of the prior EIS. The GMT-2 facility began production in December 2021.**	Y
Canadian Beaufort Sea and Chukchi Sea Area Oil and Gas Leasing	Projections of oil and gas exploration and development 2013-2028 with target area focus on the northern Yukon Territory, Banks Island, Victoria Island, and Beaufort Sea: 1 or 2 seismic surveys, 1 or 2 shallow shelf wells, 3 or 4 deep shelf wells, production by 2025 (LTLC and Salmo 2013).	26 miles east in the Mackenzie Delta/ Canadian Beaufort Sea region	Canadian government placed 5-year moratorium on offshore drilling in 2016. This does not impact active leases (CIRNAC 2018). DNR DOG completed an assessment on oil and gas leasing in 2019 (ADNR f).	Y
Colville River Unit Oil Development (Alpine: CD-4 &CD-5)	Alpine CD-5 is a new drill site located on the Alaska Native village corporation lands near Nuiqsut and is the first commercial oil production from within the NPR-A. The first production flowed from CD-5 to Alpine Central Processing Facility in 2015. ConocoPhillips plans to continue drilling an additional 18 wells at CD-5 after the original 15 wells were completed, for an eventual total of 33 wells (BOEM 2018a).	57 miles west	In late 2018, ConocoPhillips commenced appraisal of the Putu discovery in the Narwhal trend with a long-reach horizontal well from existing Alpine CD4 infrastructure. The Narwhal appraisal well finished drilling and testing in 2019. A supporting injector well was drilled in 2019 and tested in 2020 (ConocoPhillips 2021).	N
Franklin Bluffs Oil and Gas Exploration	Drilling and testing of an exploratory well from the Franklin Bluffs pad adjacent to the Dalton Highway near Alaska LNG MP 40 (AJC 2018a). Exploration wells (Charlie No.1 and Bravo No.1) are also planned in the Kuparuk basin, which entails building 32 miles of ice road from the Franklin Bluffs pad, crossing the Alaska LNG Project corridor.	68 miles south	Several exploratory wells drilled and in production since 2017. Two new exploration wells (Bravo No. 1 and Charlie No. 1) approved and drilling planned (Petroleum News 2018a).	Y

Table 4.20-1. North Slope Cumulative Projects Overview

Project Name	Description	Location[a]	Status	Identified in the 2020 EIS (Y/N)
North Slope Shale Oil Development – Greater Alkaid and Talitha Unit	A single project is proposed to develop a source reservoir resource. Great Bear Petroleum plans exploration and evaluation wells along the Dalton Highway. Their success in the last two Central North Slope lease sales has secured leases that straddle about 20 miles of the highway, about 30 miles south of Prudhoe Bay (ADNR 2015).	45 miles south	ADNR has approved permitting and an exploration well is being planned in the Talitha prospect in the 2020-21 winter season (Petroleum News 2020b).	Y
Greater Prudhoe Bay Oil and Gas Developments	Hilcorp plans numerous small developments as smaller accumulations of oil are discovered and can be produced using existing infrastructure (BOEM 2018a).	5 miles west	Hilcorp does not propose any new drilling in 2021. Developments would be scattered over the next 10 years (BOEM 2018a).	N
Guitar Unit Oil and Gas Exploration	Alliance Exploration proposes to conduct exploratory drilling on newly unitized state oil and gas leases at the Guitar Unit. It would include a test well and a second well a year later (Petroleum News 2017a). Full development is dependent on results of the test well program.	26 miles southwest	Unitization and Plan of Exploration approved by ADNR DOG in August 2017. The last project update indicated the initial exploratory well was planned for 2019, pending permitting (ADNR 2018b). Second Plan of Exploration was approved in August 2019 (Petroleum News 2019).	Y
Kuparuk River Unit Oil Production and Development	ConocoPhillips is working to improve production at existing drill sites in KRU and slowly expand facilities designed to target undeveloped areas in unit (ConocoPhillips 2021).	31 miles west	Since 2012, various activities have occurred including drilling of an appraisal well, a new drill site completed in 2015, and extension of the Kuparuk field including 4 production wells, 15 injections wells, 5 rotary wells, 17 coiled tubing drilling sidetracks, and associated surface equipment. Additional well workovers are planned (Petroleum News 2018b).	Y
Liberty Unit OCS Oil Development	Hilcorp is constructing an artificial island in the Beaufort Sea OCS to support drilling and production facilities, with 5.6 miles of buried offshore oil pipeline and 1.5 miles of onshore aboveground oil pipeline. Associated onshore activities include use of permitted water sources, construction of onshore gravel pads to support the pipeline tie-in location, onshore and offshore ice roads and ice pad construction, hovercraft shelter, small boat dock, and gravel mine site development west of the Kadleroshilik River (BOEM 2018a).	29 miles west	Final EIS issued by BOEM in September 2018 (Petroleum News 2018c). Project approval was overturned by a federal court and the lease was suspended by Hilcorp for five years in December 2019 (DOI 2019).	Y
Milne Point Unit (MPU), Moose Pad Oil Development, Polymer Injection Research	Hilcorp built a new pad, the Moose Pad, on the west side of the MPU. The new Moose Pad provides Hilcorp access to about 7 square miles of undeveloped oil reserves within the MPU. Development plans for Moose Pad will include developing up to 44 new wells, an oil production pipeline, a	39 miles southwest	Production at Moose Pad came online in early April 2019 (Mat-Su Valley Frontiersman 2019).	Y

Table 4.20-1. North Slope Cumulative Projects Overview

Project Name	Description	Location[a]	Status	Identified in the 2020 EIS (Y/N)
	small tie-in pad, and new pad infrastructure (Petroleum News 2018c). University of Alaska-Fairbanks (UAF) is conducting a polymer flood to test new methods of oil recovery at Schrader Bluff (Dandekar A. et al. 2020).			
Mustang Oil Development Project	BRP has conducted exploratory drilling for onshore oil on Alaska's North Slope. Ultimate development would potentially include an oil processing facility and drilling up to 31 production and injection wells (AJC 2018b). The Mustang field would be equipped with a standalone production facility and pipeline on a gravel pad and road which connects to existing infrastructure at Kuparuk (BOEM 2018a).	50 miles west	In November 2017, BRP conducted flow tests on its North Tarn Well No. 1. The project was shut down in December 2020 due to financial difficulties and is working on plans to reorganize financing and continue development (AJC 2021).	Y
Nanushuk Project (Pikka Unit Oil Development)	Armstrong Energy Oil Search Alaska LLC plans to construct its oil and gas leasehold. The Nanushuk Project consists of three drill pads, one of which will include a central processing facility, an operations center, 25 miles of new access roads, 14 miles of in-field pipelines, and a 25-mile-long oil export pipeline. The project also includes temporary discharges to 5.8 acres of jurisdictional waters of the U.S. for screeding activities at the existing Oliktok Dock (Armstrong 2017).	56 miles west	Final EIS issued in November 2018. USACE permit issued May 2019 with the project expected to come online in 2023 (NS Energy 2022; USACE 2018). Associated Pikka B and C exploratory wells planned for February 2019 (AJC 2018c).	Y
National Petroleum Reserve-Alaska Oil Developments:GMT-1, GMT-2, Willow (Bear Tooth)	ConocoPhillips Alaska, Inc., has been approved for placement of 72.5 acres of fill material to construct the GMT-1 and has filed an application for GMT-2. GMT-1 includes a drill site, an access road, pipeline valve pads, pipelines, bridge abutments, communication equipment, and powerlines for oil and gas production. GMT-2 would include a 14-acre drill pad, an 8.2-mile access road, an 8.6-mile pipeline, and up to 48 wells (BLM 2018). Oil, gas, and water produced from the reservoir would be carried via pipeline for processing. Sales-quality crude would be transported via the Alpine Oil Pipeline and Kuparuk Pipeline to TAPS. Lean gas and Kuparuk-supplied seawater would be delivered via pipelines to the drill sites for injection into the reservoirs. Willow is a new discovery near GMT-2. It will be a Central Processing Facility with three drill sites and a separate camp and shops pad. Pipelines linking to existing Alpine infrastructure/corridors. Future additional development would require additional agency reviews and approvals.	95 miles west	GMT-1 achieved oil production in 2018. DOI issued a Final Supplemental EIS for the GMT-2 project in 2018 (Petroleum News 2018b). The Draft EIS for Willow was published in 2020.	Y

Table 4.20-1. North Slope Cumulative Projects Overview

Project Name	Description	Location[a]	Status	Identified in the 2020 EIS (Y/N)
Nikaitchuq, Nikaitchuq North Eni – Spy Island Oil and Gas Exploration and Development	Eni US proposes drilling up to four exploration wells, consisting of two extended reach main bores and two sidetracks from Spy Island drill site to the OCS, to evaluate the oil and gas resource potential of three of the company's OCS leases in the U.S. Beaufort Sea. Spy Island drill site is located about 3 miles offshore in 6 to 8 feet of water off Oliktok Point (BOEM 2017).	35 miles northwest	BOEM approved a revision to the Plan of Exploration in April 2018 (BOEM 2018b). Eni expected to drill second well in 2nd quarter 2022. (Petroleum News 2020c). Third well drilling was cancelled or delayed (Petroleum News 2022).	Y
Nuna Oil Discovery	The Nuna discovery is an onshore pad designed to develop the southern part of the Torok reservoir that cannot be reached from ODS. Nuna, like ODS, would pay to use Kuparuk facilities to process its oil (ADNR 2014).	59 miles northwest	Conoco Phillips purchased the Nuna discovery in June 2019 (AJC 2019).	Y
Oooguruk Unit Oil and Gas Development	The existing Oooguruk Project includes a 6-acre gravel island about 5 miles offshore in 4.5 feet of water in Harrison Bay and a subsea flowline bundle connecting to an onshore tie-in pad (Offshore Energy 2019).	56 miles northwest	Drilling activities at Oooguruk Unit postponed through 2018 (Petroleum News 2017b); Eni U.S. Operating Co. Inc. is planning future work over campaign and pursuit of new wells (Eni 2019).	Y
Peregrine Development	Oil and gas exploration north of the Umiat Development.	106 miles southwest	Exploration well drilled in 2021 and discovered hydrocarbons. Additional appraisal wells to be drilled in 2022 (88 Energy 2022a).	N
Qilak LNG	In October 2019 Qilak LNG announced plans to partner with ExxonMobil to construct an offshore liquefaction facility on Alaska's North Slope that would ship LNG to Asian markets. The project would be designed to ship 4 million tons per year of LNG annually and would use ice-breaking tankers, taking advantage of declining sea ice in the Arctic (Aker Arctic 2020).	North Slope	In detailed feasibility study phase. Currently considering several design concepts, all of which would involve North Slope offshore facilities (Aker Arctic 2020).	Y
Smith Bay Oil and Gas Exploration	In 2016, Caelus Energy Alaska (Caelus) made a significant light oil discovery on its Smith Bay state leases on the North Slope. If developed, this may require construction of a new pipeline (BOEM 2018a).	141 miles west	Caelus is planning an appraisal program to include drilling an additional appraisal well and acquiring a new 3D seismic survey of additional acreage. Smith Bay Company Alaska is in process of acquiring leases; will continue with an appraisal program (Petroleum News 2021).	N
TAPS Maintenance and Upgrade	The operation and maintenance of the existing 800-mile-long, 48-inch-diameter hot oil pipeline (BLM 2002).	Milepost 0. Same corridor as the Alaska LNG pipeline.	Ongoing	Y

Table 4.20-1. North Slope Cumulative Projects Overview

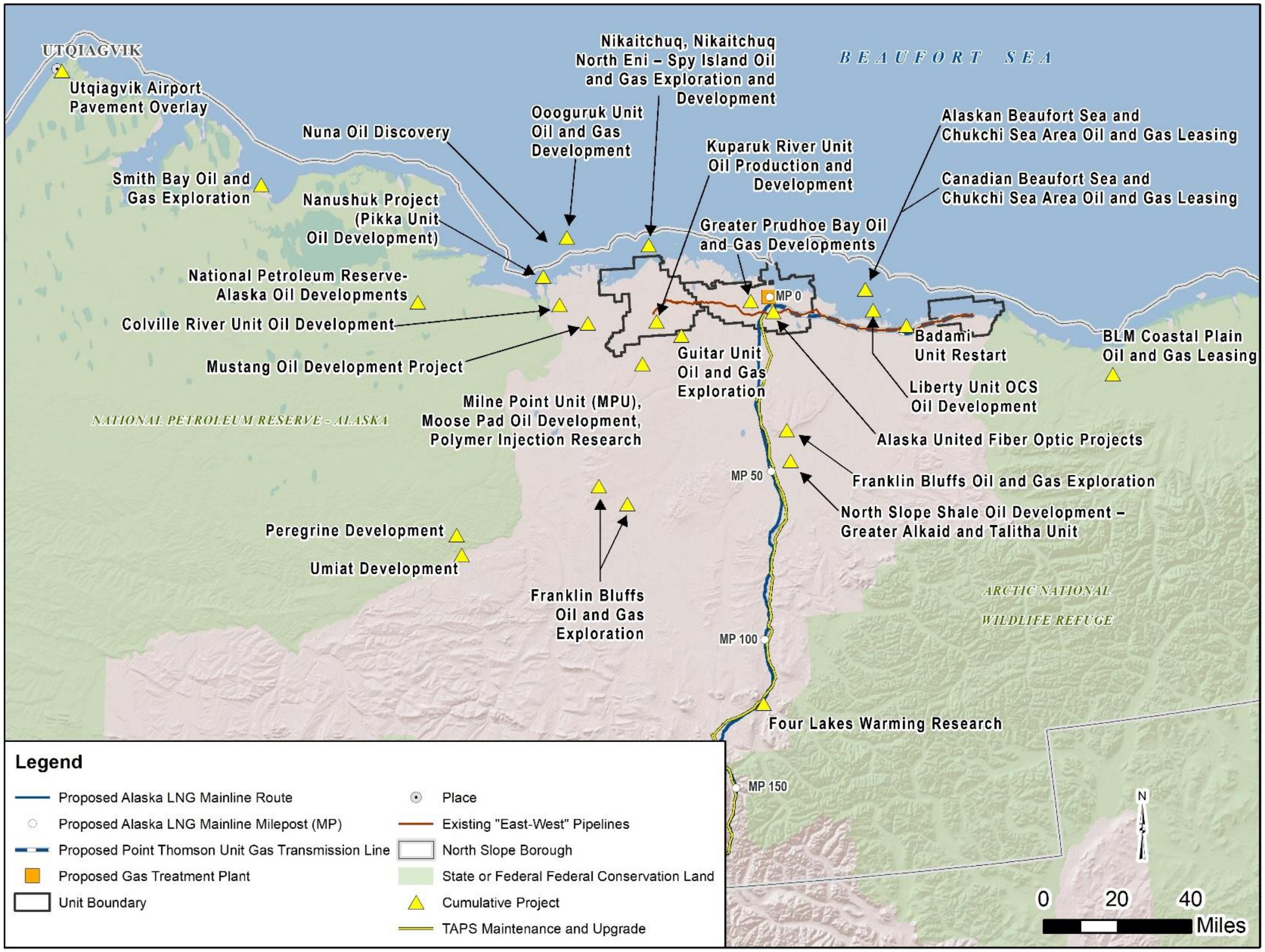
Project Name	Description	Location[a]	Status	Identified in the 2020 EIS (Y/N)
Umiat Development	Continued oil field development in the National Petroleum Reserve-Alaska (88 Energy 2022b).	109 miles southwest	Exploratory wells were drilled in 2013-2014. 88 Energy Acquired Umiat in April 2021. Final condition relating to the acquisition of Umiat was completed in the second quarter of 2021 (88 Energy 2022b).	Y
Transportation Projects				
Highway Maintenance and Upgrades	ADOT&PF plans highway maintenance to the Parks, Dalton, Seward, and Sterling Highways. Proposing to reconstruct the Dalton Highway from its junction of the Elliott Highway near Livengood Highway MPs 0 to 9. Proposing improvements to the Sterling Highway between its eastern intersection with Skilak Lake Road (near historic MP 58) and Kenai Keys Road (near historic MP 79). Plan to rehabilitate and improve the safety of 5.5 miles of the Seward Highway between the communities of Moose Pass and Seward, Alaska (ADOT&PF 2022b, 2022c).	Some locations are near or adjacent to highways. Use of the same marine, air, and highway transportation corridors as Alaska LNG Project.	Ongoing	Y
Noatak Airport Relocation	As part of the relocation, ADOT&PF proposes the following actions: Construct a new 4000-foot by 75-foot runway, apron, taxiway, and aviation support areas. Construct a new SREB. Construct an airport access road from the Village of Noatak to the proposed airport location. Install a single-span bridge over the Kuchoruk Creek at the new airport access road crossing. Develop a material site and necessary access routes during airport construction. Acquire necessary right-of-way for the new airport and access road. Existing Noatak Airport to be decommissioned after relocated airport is operational (ADOT&PF 2022d).	340 miles west of Alaska LNG Project	Currently engineering and environmental studies phase (ADOT&PF 2022d).	N
Point Hope Airport Runway Alignment	The ADOT&PF, in cooperation with the U.S. Department of Transportation FAA, is proposing to construct improvements, including a realignment of the runway, at the Point Hope Airport in Point Hope, Alaska. These improvements are necessary to reestablish an adequate RSA and maintain the existing level maintain the existing level of safe, reliable year-round air access to the community of Point Hope (ADOT&PF 2022e).	438 miles west of Alaska LNG Project	Project is currently in the bidding phase.	N

Table 4.20-1. North Slope Cumulative Projects Overview

Project Name	Description	Location[a]	Status	Identified in the 2020 EIS (Y/N)
Utqiagvik Airport Pavement Overlay	Rehabilitate and level the runway, taxiways, taxi lane, and airport lighting at the Wiley Post-Will Rogers Airport in Utqiagvik. Replace signing and striping, and repair cracking on the runway, taxiways, and taxi lane (AOPN 2018).	201 miles west	Continuing into second year of construction in 2022 (ADOT&PF 2022f).	N
Other Projects				
Alaska United Fiber Optic Projects	Quintillion installed two fiber optic projects adjacent to the Dalton Highway in 2017. Future projects plan to install additional subsea fiber optic cables connecting Nome to Tokyo and Prudhoe Bay through the Canadian arctic to London (Quintillion 2022). GCI is constructing an 860-mile subsea network to serve Unalaska and the Aleutian Islands (GCI 2022).	4 miles south along same corridor as the Alaska LNG pipeline.	Terrestrial projects went into service in 2017. Permafrost thawing along the trenchline has been observed at about 20 locations; restoration/remediation efforts are in progress (Alaska Public Media 2018). Quintillion expansion is in planning and development phase (Quintillion 2022). The GCI project broke ground in Fall 2021 and is expected to be completed by late 2022 (GCI 2022).	Y
Four Lakes Warming Research	ADOT&PF researchers would experimentally raise upper layer lake temperatures by 2-4 degrees Celsius, delaying ice formation by approximately 30 days, over a period of 5 years. Data gathered from the project is to gauge the effect of long and warmer growing seasons on ecosystem and community composition and to predict lake temperatures with a coupled, lake climate model (BLM 2017).	110 miles south	Environmental assessment completed in 2017.	Y

[a] Location reflects the distance from the proposed Alaska LNG Project Gas Treatment Facilities at Milepost 0 to the cumulative project.

3D = three dimensional; ADNR = Alaska Department of Natural Resources, DOG = Division of Oil and Gas; ADOT&PF = Alaska Department of Transportation and Public Facilities; BLM = Bureau of Land Management; BOEM = Bureau of Ocean Energy Management; BRP = Brooks Range Petroleum; DOI = Department of the Interior; EIS = Environmental Impact Statement; FAA = Federal Aviation Administration; GCI = GCI Communication Corp; GMT-1 = Greater Mooses Tooth 1; GMT-2 = Greater Mooses Tooth 2; KRU = Kuparuk River Unit; LNG = liquefied natural gas; MP = milepost; MPU = Milne Point Unit; NPR-A = National Petroleum Reserve in Alaska; OCS = Outer Continental Shelf; ODS = Oooguruk Drill Site; PBU = Prudhoe Bay Unit; RSA = Runway Safety Area; SREB = Snow Removal Equipment Building; TAPS = Trans Alaska Pipeline System; UAF = University of Alaska – Fairbanks; U.S. = United States; USACE = U.S. Army Corps of Engineers



Source: ADNR 2021; North Slope Science Initiative 2021; USCB 2021; USFWS 2022b
BLM = Bureau of Land Management; LNG = liquefied natural gas; MP = Milepost; OCS = Outer Continental Shelf; TAPS = Trans-Alaska Pipeline System

Figure 4.20-1. Cumulative Projects

4.20.2 Cumulative Impact Analysis

This **Final** SEIS discusses the cumulative impacts of the Proposed Action and No Action Alternative along with other past, present and reasonably foreseeable actions. This **Final** SEIS discusses cumulative actions both quantitatively, where appropriate, and qualitatively in narrative form to differentiate impacts among the alternatives. The evaluation of cumulative effects in this section relates primarily to physical disturbance of environmental resources and changes in land use associated with construction and other ground-disturbing activities. Detailed locations of upstream development associated with the Alaska LNG Project are not available since the potential development activities in Section 2.3 are "scenario"-based and not actual projects, and the development activities in Section 2.5 have not undergone design and engineering. The evaluation of cumulative impacts also takes into consideration regulatory controls and industry standard BMPs. Projects and actions evaluated in the cumulative impact analysis typically require siting studies, some level of environmental review, and compliance with federal and state permits. Efforts to avoid, minimize and mitigate project impacts occur throughout the project application, permitting, construction, and operations processes.

The primary impacts from the regional projects listed in Table 4.20-1 result from long-term and/or permanent physical effects to land-based resources from construction and other ground-disturbing activities.

The following sections describe the potential cumulative impacts by resource considering the Proposed Action and No Action Alternative in conjunction with the projects listed in Table 4.20-1. These analyses are qualitative and quantified to the extent possible.

4.20.2.1 Geologic Resources and Geologic Hazards

The ROI for cumulative impacts analysis for geologic resources is defined as areas with upstream development to support the Alaska LNG Project including oil and natural gas, and geologic hazards within PTU, PBU, and KRU.

The past, present, or reasonably foreseeable projects listed in Table 4.20-1 are located within North Slope Borough. Projects located outside of the ROI are not considered as contributing actions to cumulative effects on geologic resources. For projects within or adjacent to the ROI, such as the KRU Oil Production and Development Project, cumulative impacts on existing mineral resources and/or future mineral development are possible, but unlikely as described below. Cumulative impacts on other geologic resources are not anticipated.

Section 3.1.3 identifies existing geologic resources (e.g., oil and gas resources) in proximity to the North Slope and upstream development within the PTU, PBU, and KRU. Upstream development associated with the Alaska LNG Project and other cumulative projects could limit future development of mineral resources within the ROI and immediately adjacent lands. But as described in Section 4.1.6, potential increases and decreases in oil production would depend on scenario selection, and potential impacts would be mitigated by monitoring, regulation compliance, adherence to project-specific plans, and implementation of mitigation measures identified in Section 4.1.5 and as required by state regulatory agencies such as the ADNR DOG for development of wells. No significant impacts on ongoing oil and gas exploration and production from upstream development of the Alaska LNG Project and other projects would be anticipated.

Projects in the immediate vicinity of the upstream development would be subject to similar geologic hazards, such as seismicity and mass wasting. As discussed in Section 4.1.3 of the 2020 EIS, the Alaska LNG Project would be designed and constructed in accordance with required design standards to mitigate impacts from geologic hazards. Other projects similarly would be required to implement applicable design standards for hazard mitigation. Therefore, no significant cumulative impacts due to geologic hazards are anticipated.

4.20.2.2 Soils and Sediments

Impacts on soils and sediments during construction of upstream development would occur during clearing, grading, granular fill placement, backfilling, dredging, drilling, and the movement of construction equipment. Some of the cumulative projects identified in Table 4.20-1, such as the Nanushuk Project, would require the expansion of existing facilities or construction of new infrastructure, including well pads, access roads, or pipelines. While these types of activities could increase the potential for soil erosion, sedimentation, and compaction, most impacts would be limited to the area of direct disturbance due to the implementation of various mitigation measures (e.g., the installation of erosion and sediment controls). Construction activities affecting surface vegetation and soils could affect permafrost, with impacts extending beyond the limits of the construction area. Permafrost degradation is also possible during operation due to heat transfer from facilities to surrounding soils. Degradation of permafrost could increase the potential for soil erosion, with sedimentation from soil loss concentrated to common watershed outlets. Due to the sensitivity of permafrost from development, cumulative impacts could be significant.

Operators of upstream development and cumulative projects could minimize direct construction impacts associated with soil erosion, sedimentation, and compaction through the implementation of the mitigation measures and plans (e.g., Winter Permafrost Construction Plan and SWPPP). These measures include the installation of erosion and sediment controls, construction of facilities in winter or frozen ground conditions, and restoration of areas temporarily disturbed by construction. With consideration of these measures, the projects cumulatively could result in less-than-significant impacts.

4.20.2.3 Water Resources

The Alaska LNG Project could contribute to cumulative impacts on groundwater resources where other actions occur within the same aquifers for which withdrawals are ongoing or planned. Upstream development associated with the Alaska LNG Project would be built within the Alaska Hydrologic Region (Region 19). Although permafrost covers more than 90 percent of the North Slope and inhibits the formation and use of groundwater throughout much of the ROI, as shown in Table 3.3-2, most of the groundwater withdrawals on the North Slope are saline water used for mining **which includes injection of water for secondary oil recovery or for unconventional oil and gas recovery (such as hydraulic fracturing), and other operations associated with mining activities**. Construction and operation of the upstream facilities and cumulative projects would require water for a variety of activities **including use of freshwater and ice chips for ice road construction in the winter**. It is anticipated that water needs on the North Slope would be met primarily with sources from surface waters, but substantial groundwater withdrawals would also be required.

As stated in Section 4.3.4, construction and operation of upstream facilities would require water for hydrostatic testing, ice road construction, potable water, and other activities and it is anticipated that cumulative projects listed in Table 4.20-1 would require water for similar construction and operational activities as well. Since water on the North Slope would primarily be sourced from surface waters potential cumulative impacts could occur. Surface water withdrawals for both the upstream development and other past, present, or reasonably foreseeable actions would be subject to state permitting requirements, such as volume restrictions and reporting, to ensure adequate volumes of water remain in surrounding freshwater sources to support aquatic life. While water withdrawals could create a temporary drawdown, water levels would be restored, so cumulative impacts on surface water resources would be less-than-significant.

Water uses and discharges due to construction and operation of the projects, such as the National Petroleum Reserve-Alaska Oil Developments Projects, would be subject to state regulatory requirements, including the development of project-specific SWPPPs and Water Use Plans. Therefore, cumulative impacts to water resources from the projects would be less-than-significant.

4.20.2.4 Wetlands

Impacts on wetlands from construction and operation of upstream development would result from construction of new pads, wells, pipelines for product transport, and related access roads. Most of the cumulative projects listed in Table 4.20-1 involve oil and gas development that would include similar construction activities. Detailed locations of upstream development are not available but since 61 percent of the Arctic and Western Region of the ROI is comprised of wetlands (see Section 3.4.2), it is likely that upstream development and the cumulative project would result in the permanent loss of wetlands or conversion of wetland types, increased turbidity and sedimentation, changes to wetland values and functions, and increased likelihood of the release of hazardous materials and fuel to wetlands. Despite numerous avoidance and minimization measures, some wetland functions would not be restored; for such functional losses, compensatory mitigation would be proposed.

Implementation of construction BMPs and permitting mitigation requirements (e.g., as imposed through the USACE's Section 404 permitting process) would offset impacts on wetlands during construction and operation of the upstream development and cumulative actions. For example, measures such as winter construction (e.g., the use of ice roads) and placement of pipelines on VSMs would reduce the impacts on wetlands from North Slope oil and gas activities. These measures notwithstanding, cumulatively, the projects would result in significant impacts due to the permanent loss of wetlands.

4.20.2.5 Vegetation

Upstream development associated with the Alaska LNG Project could contribute to impacts on vegetation resources where other past, present, or reasonably foreseeable actions occur on the North Slope. These projects, along with the Alaska LNG Project, could result in a cumulative effect on a diverse assemblage of vegetation communities.

Upstream development activities discussed within this **Final** SEIS would have the potential to impact additional areas of land and associated vegetation. For example, the PBU MGS Project CGF Pad expansion would result approximately 5 acres of ground disturbance and clearing of existing vegetation. The projects identified in Table 4.20-1 would impact vegetation, for example, the Nanushuk Project would impact vegetation due to construction of drill pads, central processing facility, operations center, and pipelines. Cumulatively, however, impacts to vegetation are not anticipated to be significant due to the existing developed oil and gas infrastructure within the ROI and the likely locations of proposed activities within and directly adjacent to existing pads and pipeline ROW.

In addition, operators of upstream development and cumulative projects could minimize construction and operational impacts to vegetation through the implementation of the mitigation measures and plans (e.g., the post-construction monitoring, Revegetation Plans and Noxious/Invasive Plant and Animal Control Plans).

4.20.2.6 Wildlife Resources

Upstream development associated with the Alaska LNG Project could contribute to cumulative impacts on wildlife resources where other past, present, or reasonably foreseeable actions occur on the North Slope.

Construction and operation of upstream development activities on the North Slope could affect wildlife resources, including terrestrial species and avian resources. Effects could include the disturbance, displacement, injury, or mortality of wildlife, as well as the temporary or permanent alteration or reduction in suitable habitat. Cumulative impacts on terrestrial wildlife could result from activities such as clearing and grading, noise, vehicle traffic, and trenching during construction of the upstream development and other cumulative projects occurring within the analysis area. Upstream development would generally involve clearing vegetation for facility construction in winter to the extent practicable, which would avoid impacts on nesting birds. Many small mammals would be in nests or burrows in the winter, however, and could be injured or killed from clearing activities, particularly smaller species such as shrews, voles, and mice. Winter clearing and grading additionally could uncover denning bears or run over hibernating ground squirrels. Other projects requiring clearing or grading in winter, such as the Smith Bay Oil and Gas Exploration Project, National Petroleum Reserve-Alaska Oil Development Projects, and the Mustang Oil Development Project could result in similar impacts on wildlife.

Upstream development activities and the cumulative projects discussed within this **Final** SEIS would have the potential to impact additional areas of land which may support existing wildlife populations and associated habitat. However, due to the existing developed oil and gas infrastructure within the ROI and the likely locations of proposed activities within and directly adjacent to existing pads and pipeline ROW with ongoing human activity, high-quality habitat is not anticipated to be affected during construction and operation.

In addition, operators of upstream development and cumulative projects could minimize construction and operational impacts to vegetation through the implementation of the mitigation measures and plans (e.g., the post-construction monitoring, Revegetation Plans, Noxious/Invasive Plant and Animal Control Plans, Lighting Plans, and Migratory Bird Conservation Plans).

4.20.2.7 Aquatic Resources

Upstream development associated with the Alaska LNG Project could contribute to cumulative impacts on fisheries resources where other actions occur on the North Slope. Impacts on fisheries could result from waterbody crossings, dredging, infrastructure encroachment, and degradation of water quality.

Construction and operation of upstream development activities in the North Slope could affect aquatic resources, including fisheries and EFH. Effects could include the disturbance, displacement, injury, or mortality of fish, as well as the temporary or permanent alteration or reduction in EFH.

Ground disturbance located near waterbodies has the potential to increase erosion and sedimentation to nearby freshwater and marine waterways. For example, upstream development would involve ground disturbance due to the PBU MGS Project use of heavy machinery for the 5-acre CGF Pad expansion and to construct the pipeline and any ground disturbance required to emplace VSMs.

Upstream development activities and the cumulative projects discussed within this **Final** SEIS would have the potential to impact additional aquatic resources. Overall cumulative impacts to aquatic resources would be less-than-significant. Potential impacts would be mitigated through standard BMPs, adherence to project-specific plans, and implementation of mitigation measures (e.g., Preparation of Fugitive Dust Plans, Noxious/Invasive Plant and Animal Control Plans, SPCC Plans, SWPPPs, and Water Use Plans).

4.20.2.8 Threatened, Endangered, and Other Special Status Species

Upstream development associated with the Alaska LNG Project could contribute to cumulative impacts on threatened, endangered, and other special status species where other past, present, or reasonably foreseeable actions occur on the North Slope.

Construction and operation of upstream development activities on the North Slope could adversely affect threatened, endangered, or other special status species, if present. These could include ESA-listed species, NMFS-protected species, and Alaska SGCN. Adverse effects could include the "take" of special status species, or the alteration or destruction of critical habitat. Critical habitat for polar bears occurs along offshore barrier islands and sea ice, as well as terrestrial denning habitat along the Beaufort Sea near Prudhoe Bay and portions of the upstream development for the Alaska LNG Project. The following cumulative projects occur within the geographic scope and polar bear critical habitat: Alaska United Fiber Optic Projects, Alaskan Beaufort Sea and Chukchi Sea Area Oil and Gas Leasing, Badami Unit Restart, BLM Coastal Plain Gas and Oil Leasing, Canadian Beaufort Sea and Chukchi Sea Area Oil and Gas Leasing, Liberty Unit OCS Oil Development, Nanushuk Project (Pikka Unit Oil Development), Nikaitchuq, Nikaitchuq North Eni – Spy Island Oil and Gas Exploration and Development, Nuna Oil Discovery, Oooguruk Unit Oil and Gas Development, Smith Bay Oil and Gas Exploration, and TAPS Maintenance and Upgrade Projects.

Upstream development activities and the cumulative project discussed within this **Final** SEIS would have the potential to impact additional areas of land which may support threatened, endangered, and other special status species. Potential impacts would be mitigated through consultation efforts with appropriate federal and state agencies, surveys for protected species, and avoidance.

4.20.2.9 Land Use, Recreation, and Special Interest Areas

Upstream development associated with the Alaska LNG Project would contribute to cumulative impacts on land use, recreation, and special interest areas where other actions occur on the North Slope.

Upstream development associated with the Alaska LNG Project would incrementally change some existing land uses, converting open land or open water to industrial/commercial land. Among the past, present, and reasonably foreseeable actions identified in Table 4.20-1, some would involve areas of land conversion to industrial/commercial land (e.g., Smith Bay Oil and Gas Exploration, National Petroleum Reserve-Alaska Oil Developments: Greater Mooses Tooth 1, Greater Mooses Tooth 2, Willow [Bear Tooth], and Nanushuk Project [Pikka Unit Oil Development]); some are inactive or in the exploratory phase (e.g., North Slope Shale Oil Development – Greater Alkaid and Talitha Unit); and some involve maintenance/upgrades to existing linear facilities (e.g., highway and Trans Alaska Pipeline System Pipeline Maintenance). Changes would not occur where portions of a project would lie within existing ROWs, roads, or drill pads. Cumulative impacts associated with land use changes would not be significant.

Cumulative impacts could occur if a project is within the vicinity of certain recreational or special interest areas. As discussed in Section 4.9.6, project features located within state lands/North Slope SUA would require necessary permits for motorized vehicle use in the areas in accordance with 11 AAC 96.014.

4.20.2.10 Visual Resources

Visual impacts from any project depend on viewer sensitivity and the degree to which the project would contrast with existing or desired landscape conditions. The visual impacts can vary from low to high depending on location and viewer type.

Overall, significant impacts would not occur from construction and operation of project activities as the setting is heavily industrial in nature and access to the work sites is generally restricted from the general public. Since most of the development of the upstream activities would occur in existing industrial and commercial settings, they would have similar visual characteristics for facilities, structures, and activities. Many of the cumulative projects on the North Slope would occur in an area where oil and gas development is common. The Alaskan Beaufort Sea and Chukchi Sea Area Oil and Gas Leasing Project, Guitar Unit Oil and Gas Exploration Project, and Liberty Unit Outer Continental Shelf Oil Development Project would occur in areas with minimal public access and would therefore have no cumulative visual impact. Temporary impacts on visual resources could occur during construction when large equipment, excavation activities, spoil piles, staging and laydown areas, and artificial nighttime lighting are visible to viewers. Use of temporary ice roads would introduce construction vehicles traveling between loading/staging/source material areas and the work sites. During operation, potential visual impacts could occur from the introduction of new structures and facilities and presence of maintenance/inspection vehicles in a viewshed. Most of the viewers in this area, however, would be the workers associated with industrial facilities on the North Slope, making them less sensitive to changes in the visual landscape and therefore result in less-than-significant adverse impacts.

4.20.2.11 Socioeconomics

Upstream development associated with the Alaska LNG Project and the cumulative projects represent sources of employment, tax revenue, and overall economic growth benefits, which accrue to the entire State of Alaska, and even beyond to the extent that labor, materials, or other items come from out-of-state locations. Negative cumulative effects are possible when multiple projects occur simultaneously in sufficient proximity that housing, transportation networks, and public services become strained. Negative cumulative impacts could also occur if episodic "boom and bust" cycles cause economic hardship to individuals or communities, or strain the commercial environment and public institutions. Table 4.20-1 provides the best current information regarding project status.

As described in Section 4.11.6, upstream development activities discussed within this **Final** SEIS would have the potential to impact socioeconomics, but overall impacts would be beneficial to negligible. Considering potential socioeconomic impacts from upstream development combined with the other current, past, and reasonably foreseeable actions on the North Slope, impacts would be similar to those described in Section 4.11, but greater in magnitude. If the cumulative projects should be constructed simultaneously with the upstream development, the impacts of population growth, including tax revenues, employment, and indirect economic effects of increased spending would be greater than that of the upstream development alone. While construction and operation of the upstream facilities would require some additional temporary and permanent personnel, they would work on a rotational basis and be housed in self-contained work camps while on duty. As a result, personnel living in worker camps would have little opportunity to make purchases within the local economy. This would mean there would not be a substantial change in local residences and spending activity that could affect population, housing stock, the economic base, taxes, or public services.

Impacts on environmental justice populations could include traffic delays and new traffic patterns; visual effects from nighttime lighting or changes to the existing viewshed; interference with subsistence activities or habitats; potential changes to residential property values; and health impacts. Cumulative impacts from an environmental justice perspective are most likely to occur if a cumulative project would occur concurrently with the upstream development associated with the Alaska LNG Project. Given the uncertainty surrounding the final timing and plans of many of the cumulative projects identified in Table 4.20-1 suggests that many of the potential cumulative environmental justice impacts would not occur. As a result, this analysis concludes that cumulative impacts are not expected to have disproportionately high and adverse impacts on environmental justice communities.

4.20.2.12 Transportation

Upstream development associated with the Alaska LNG Project could contribute to cumulative impacts on transportation networks where other cumulative projects would utilize the same roads, railroads, ports, waterways, and airports as the Alaska LNG Project.

The construction and operation of upstream development activities would have the potential to adversely impact transportation resources due to increased traffic volumes of vehicles, marine vessels, and air travel. The increased traffic volumes would primarily occur during the construction phase from the deliveries of equipment, materials, modules, and from the transport of personnel. This increase in volumes could lead to congestion and delays for road, marine, and air transport; additionally, roadways and navigable waters could experience increased safety hazards. The location and magnitude of traffic increases would depend on which projects are under construction at a given time. The largest cumulative impacts on road transportation would occur when multiple projects are under construction more-or-less simultaneously. These impacts are expected to be minimal on the roadway infrastructure as Dalton Highway and the smaller distribution of gravel and ice roads currently experience low traffic volumes and mainly support local industries. Impacts to marine transport resources would be minimized with implementation of Journey Management Plans to ensure a safe and functional marine traffic management and risk mitigation plan during construction. Impacts to air transport would be minimal as the peak demands from workers would be limited to the worker rotation periods and would primarily occur at Deadhorse Airport, a facility mostly used by personnel of the local industries on the North Slope.

4.20.2.13 Cultural Resources

Cumulative impacts on cultural resources would only occur if other past, present, or reasonably foreseeable actions affect the same historic properties as the upstream development associated with the Alaska LNG Project.

This **Final** SEIS considers the APE for direct project effects on historic properties to include the PTU, PBU, and KRU. Only small portions of KRU Oil Production and Development Project, Greater Prudhoe Bay Oil and Gas Developments, Trans Alaska Pipeline System Maintenance and Upgrade Projects, and Alaska United Fiber Optic Projects would overlap within the APE for direct impacts.

As described in Section 4.13.4, construction and operation of upstream development activities could adversely affect historic properties (i.e., cultural resources either listed or eligible for listing in the NRHP), if present. These historic properties could include prehistoric or historic archaeological sites, districts, buildings, structures, or objects, as well as locations with traditional value to federally recognized tribes, Alaska Native Claims Settlement Act village and regional corporations, or other groups. Historic properties must generally possess integrity of location, design, setting, materials, workmanship, feeling, and association, and must meet one or more of the criteria specified in 36 CFR 60.4. Adverse effects could include destruction or damage to all, or a portion, of a historic property; alteration of a property including restoration, rehabilitation, repair, maintenance, or stabilization inconsistent with federal standards; removal of the property from its historic location; change of the character of the property’s use or of physical features within the property’s setting that contribute to its historic significance; and introduction of visual, atmospheric, or audible elements that diminish the integrity of the property’s significant historic features. As discussed in Section 3.13, the AHRS and North Slope Borough databases did not include any cultural sites, including historic properties in proximity to areas identified for potential upstream development activities (0.25-mile buffer from pads and 100-foot buffer from the existing east-west pipeline ROW). The lack of sites within the databases, however, would not necessarily indicate a lack of potential resources. As a large portion of Alaska, including the North Slope, remains unsurveyed, significant cumulative adverse effects could occur to cultural resources if present in the project areas.

Adverse effects would be avoided or mitigated prior to construction activities. Prior to ground disturbance, the project proponent would survey areas within the APEs for cultural resources. If NRHP-eligible resources are identified that cannot be avoided, the project proponent would prepare treatment plans for review and approval by the SHPO and interested tribes, as applicable in accordance with the NHPA. In addition, preparation of Unanticipated Discovery of Cultural Resources and Human Remains Plans would reduce adverse effects due to an unanticipated discovery during construction.

4.20.2.14 Subsistence

Cumulative effects of upstream development and cumulative projects on subsistence considers potential effects on the availability of subsistence resources (wildlife, fish, and vegetation); increased costs and greater travel to harvest resources; a reduction in physical access to resources; increased competition for resources; and contamination (e.g., noxious weeds, invasive species, and dust) of vegetation and wildlife habitat within the ROI which includes PTU, PBU, and KRU.

In general, construction activities could have negative impacts on resource availability. Construction-related disturbances would occur over the construction period for each project. Development of upstream production facilities and infrastructure may also facilitate travel into a community’s subsistence use area by subsistence users from other communities or urban areas, resulting in increased competition for local resources as developed areas could restrict access through placement of fencing. Avoidance of project areas by wildlife, the perception by subsistence users that resources have been contaminated, and changes in access to subsistence areas could also result in competition among subsistence users from the same community. These impacts could also increase competition for the resources necessary to support subsistence. Increases in trip frequency, length, and duration due to the factors described above could deplete a community's reserves of fuel and increase competition for supplies that are necessary for subsistence activities.

While direct habitat loss from cumulative oil and gas development near the upstream development would affect only a small proportion of the total area used by caribou and other wildlife, functional habitat loss could result from long-term displacement of species from the vicinity of the projects listed in Table 4.20-1 and could encompass a much larger area resulting in reduced availability of wildlife resources. Mitigation measures, including consultation with the potentially affected subsistence communities, would be implemented prevent conflicts with subsistence hunting. Nonetheless, the cumulative effects of the upstream development in combination with other cumulative projects on the North Slope could disrupt or delay the distribution of caribou on the North Slope and could negatively affect subsistence harvests of caribou by the Nuiqsut, Kaktovik, Utqiagvik, and Anaktuvuk Pass village residents.

Overall, the cumulative projects and development on the North Slope could increase the area considered to be undesirable by subsistence users, and require subsistence users to travel farther to harvest subsistence foods at a greater cost in terms of time, fuel, wear and tear on equipment, and harvester's lost wages and increased safety risks. Significant adverse impacts could **cumulatively** occur to specific subsistence users in the RO**I**. **These impacts would also be high and adverse to the specific subsistence users and potentially communities as a whole that rely on subsistence.**

4.20.2.15 Air Quality

Past, present and planned actions generally have caused, and may cause, less-than-significant, permanent changes in air quality, assuming that effective regulatory oversight and mitigation efforts occur. The contribution to these impacts by the upstream development would be less-than-significant. The cumulative impacts analysis for air quality considers the potential for long-term increase in emissions of criteria pollutants or hazardous air pollutants that could exceed relevant air quality or health standards and whether actions would cause a negative trend in air quality attainment status related to the NAAQS or state standards.

Construction-related emissions consist of fugitive dust, construction equipment and other stationary sources, and mobile-source combustion emissions, including both criteria pollutants. Given the temporary and localized nature of these dust emissions for projects occurring within the ROI, as well as the ability to mitigate them as needed, these activities are not expected to significantly affect air quality. As a result, contributions from construction activities to cumulative air quality impacts within the ROI from the upstream development and past or reasonably foreseeable future cumulative projects would be less-than-significant.

Operation of the upstream development would make small contributions to cumulative air quality impacts resulting from mobile source emissions during operations and maintenance activities; indirect emissions from electrical power plants; and fugitive emissions at well sites and facilities. The contribution to cumulative air quality impacts from operations of the projects listed in Table 4.20-1 include fugitive emissions from existing and planned oil and gas development including drilling operations, pad construction, pipeline, and other infrastructure; mobile source emissions from use of heavy equipment, trains, vehicles, and aircraft used during operations; and direct and indirect stationary source emissions at operational sites. To reduce emissions, operators could develop a fugitive dust control plan to minimize fugitive dust.

BLM's NS-RAQM Study modeled impacts to air quality in the North Slope from projected oil and gas development in the region (Zephyr Environmental Corporation 2020). The NS-RAQM Study concluded that oil and gas operations would generally have low to moderate impacts to ambient air quality on the North Slope. Modeled oil and gas sources could contribute to increased ambient concentrations of nitrogen dioxide and sulfur dioxide, especially in the vicinity of oil and gas projects. However, these increases would not be likely to lead to any exceedances of applicable air quality standards. Localized exceedances of $PM_{2.5}$ and particulate matter of diameter 10 microns or less air quality standards could occur, but these would be driven primarily by fugitive dust emissions from unpaved roads, rather than emissions from oil and gas operations.

Section 4.19.2.5 of the 2020 EIS discusses in-state gas interconnections along the Mainline Pipeline to allow for future interconnects with lateral pipelines to provide in-state deliveries of natural gas to third-party utility or industrial customers. This includes identification of locations for the following three interconnections based on the execution of binding gas delivery agreements with end-use customers: Fairbanks/North Star Gas Interconnection near Milepost 441; Anchorage/Matanuska-Susitna Gas Interconnection near Milepost 764; and Kenai Peninsula Gas Interconnection near Milepost 806. As stated in the 2020 EIS, other future interconnections could be established during the life of the Alaska LNG Project to accommodate industrial or residential growth that could occur in communities.

At this time, the amount of natural gas that would be consumed within Alaska through future offtakes along the Alaska LNG Mainline is not known. However, it is possible that any such in-state use of natural gas would offset other fuel sources including wood, oil, and coal. Natural gas is a cleaner-burning fuel compared to wood, oil, and coal. Therefore, to the extent that such fuels would be displaced by natural gas supplied from the proposed Alaska LNG Project, there could be long-term, local beneficial impacts to air quality.

4.20.2.16 Noise

The cumulative impacts analysis of noise considers the long-term perceptible increases in ambient noise levels from cumulative projects identified in Table 4.20-1.

Most of the potential impacts from noise associated with the upstream development and cumulative projects would be short term and associated with the construction phase of a project, including construction equipment and vehicles, well drilling, and blasting and directional drilling activities (e.g., new pipelines). Examples of construction noise levels at 50 feet include 84 dBA from ground clearing, 89 dBA from excavation and grading, and 98 dBA from drilling (Bolt et al. 1971).

Construction of upstream development associated with the Alaska LNG Project would result in temporary construction noise, which would dissipate once construction was complete. Similarly, other cumulative projects would produce temporary noise that results in less-than-significant cumulative impacts to nearby receptors for the duration of construction. Although construction noise could be loud from activities resulting in peak noise levels (e.g., drilling), the temporary and intermittent nature of the construction noise would not result in long-term adverse cumulative impacts. Additionally, construction activities are generally managed in conformance with federal, state, and local codes and ordinances, and manufacturer-prescribed safety procedures and industry practices.

For some projects, operations may also cause noise impacts (e.g., oil and gas processing facilities). Potential impacts from noise could include direct impacts to nearby residences, wildlife, recreation areas, and special interest areas. Because noise impacts from projects identified in Table 4.20-1 generally would occur at separate locations, they would not contribute to cumulative impacts in combination with the upstream development. During operations, long-term concerns include perceptible increases in ambient noise levels that exceed regulatory thresholds at sensitive receptors. Typical mitigation measures for noise include avoidance by siting a project away from sensitive receptors and the use of noise barriers and enclosures for noise-emitting equipment (e.g., generators).

The potential for additive cumulative impacts from other past, present, and reasonably foreseeable future projects is negligible. With respect to the upstream development in combination with other past, present and foreseeable projects, permanent changes to noise levels would be negligible assuming that other projects implement effective mitigation measures.

4.20.2.17 Public Health and Safety

Section 4.17 provides an analysis of public health and safety impacts associated with the upstream development activities on the North Slope. Cumulative public health and safety impacts could occur if other cumulative project within these same areas would, when combined with the potential upstream development activities, represent an incremental public health and safety risk.

Additional upstream development activities and cumulative projects listed in Table 4.20-1 would have the potential to generate public health and safety impacts both during construction and operation of new facilities. Construction activities could cause accidents resulting in fatal injuries. This includes increased trucking-related from transportation of materials and construction workers to work sites as well as increased seaborne and airborne transit-related injuries. Operational activities could result in fatal accidents due to leaks, fires, explosions, or other workplace injuries including transit to remote sites. Potential for accidents would be reduced from required training; focusing on a strong safety culture including routine assessment of potential risks and safe practices to mitigate risk; maintenance of equipment; and following systematic approaches to safety.

Construction and operational activities could increase amounts of air emissions including particulate matter in the air from exposed soils and ground disturbance during construction. The increase of air emissions and particulate matter could exacerbate chronic respiratory conditions to sensitive populations on the North Slope.

Increase of construction workers on the North Slope to support upstream development and cumulative projects could increase the transmission of disease by infected resident or non-resident construction workers. As existing rates are much higher than statewide averages, less-than-significant impacts could be anticipated. Construction would temporarily increase the workforce in the North Slope which could place some strain on health care if the workers require medical attention; however, the expected increase in number of workers would be anticipated to generate less-than-significant impacts to health care access.

Overall, the cumulative impacts to public health and safety would not be significant. BMPs for minimizing air quality impacts both during construction and operations would also serve to protect individuals with upper respiratory conditions. In addition, enforcement of required safety training and implementation of safety plans similar to those discussed in Section 4.17.5 would serve to minimize accidents and accident-related fatalities.

4.20.2.18 Reliability and Safety

Cumulative effects of upstream development and cumulative projects on reliability and safety would be similar to those described in Section 4.18. However, the site-specific impacts with respect to a given resource area (soils, biological resources, wetlands, land use, and cultural resources) may differ depending on the location of a potential accident or incidents within the ROI.

As presented in Table 4.20-1, there are numerous contemporaneous existing, recently completed, and planned projects to drill and transport natural gas, oil, and CO_2 via pipeline within the region. When pipelines share the same corridor, as is the case with parallel pipelines or pipelines that cross, there is the potential for cumulative impacts from accidents or incidents to cause releases from multiple pipelines. The impacts of individual spills resulting from separate incidents involving separate pipelines would be additive over time. However, for spills or releases to have a cumulative effect, incidents would need to affect two or more pipelines, and the resulting spills or releases would need to occur near and within timeframes such that the plumes from released product would overlap. While each new well or pipeline would introduce a new potential location of a release, this slight increase in risk represents a negligible adverse impact on cumulative reliability and safety.

4.20.2.19 Greenhouse Gases and Climate Change

Past, present and planned actions generally have caused, and may continue to cause, increases in GHG emissions. The contribution to these impacts by the upstream development would be less-than-significant. The cumulative impacts analysis for GHGs and climate change considers the potential for long-term increase in GHG emissions that could contribute to global climate change.

Construction-related activities, including the combustion of fuel to operate construction equipment and vehicles, can contribute to GHG emissions. Operation of the upstream development would also contribute to cumulative GHG impacts as a result of direct and indirect emissions throughout the natural gas life cycle, including mobile source emissions during operations and maintenance activities; emissions from electrical power plants; and fugitive emissions at well sites and facilities; as well as GHG emissions from natural gas production, processing and liquefaction, transport, and end-use (combustion).

The contribution to cumulative GHG emissions impacts from operations of the projects listed in Table 4.20-1 include fugitive emissions from existing and planned oil and gas development including drilling operations, pad construction, pipeline, and other infrastructure; mobile source emissions from use of heavy equipment, trains, vehicles, and aircraft used during operations; and direct and indirect stationary source emissions at operational sites.

GHG emissions occurring as a result of construction and operations of the proposed Project, as well as other activities in the region, would contribute incrementally to global climate change, which is a significant phenomenon that is inherently cumulative in nature and is occurring as a result of human activities across the globe. Section 3.19.3 of this **Final** SEIS discusses the environmental effects from global and U.S. climate change, including predictions for numerous factors such as changes to temperature and precipitation, ice cover and sea level rise, ocean temperatures and chemistry, land-based ecosystems, extreme weather events, and impacts to human health and society. Cumulative effects of climate change on the North Slope would be similar to those discussed in Section 4.19.7 of this **Final** SEIS and include warming temperatures and changes in precipitation (extreme heat and increases in precipitation), decreasing coverage of sea ice and permafrost, and increasing occurrences of soil liquefaction, wildfires, and coastal and river erosion. These changes could potentially affect construction and operations of projects within the North Slope.

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4.21 INCOMPLETE AND UNAVAILABLE INFORMATION

Under NEPA, federal agencies must disclose incomplete or unavailable information if such information is essential to a reasoned choice among alternatives in an EIS, and must obtain that information if the overall costs of doing so are not exorbitant (40 CFR 1502.21(b)). If the agency is unable to obtain the information because overall costs are exorbitant or because the means to obtain it are not known, the agency must do the following (40 CFR 1502.21(c)):

- Affirmatively disclose that such information is unavailable;
- Explain the relevance of the unavailable information;
- Summarize existing credible scientific evidence that is relevant to the agency's evaluation of significant adverse impacts on the human environment; and
- Evaluate the impacts based upon theoretical approaches or research methods generally accepted in the scientific community.

This section discloses areas where information was unavailable or incomplete during preparation of the **Final** SEIS and discusses its relevance to the range of potential environmental impacts. As stated throughout this document, the additional development activities under Scenarios 2 and 3 provide a basis for the evaluation of representative potential environment effects that could occur on the North Slope due to the proposed Project and are a focus of this **Final** SEIS. These scenarios do not represent specific actions that have been planned or proposed by the Applicant or others but are considered to represent a range of reasonable outcomes for the purpose of environmental impact analysis. Therefore, exact locations of proposed disturbances related to potential upstream development activities are not known at this time. As a result, site-specific field surveys for both natural and cultural resources have not been conducted for the potential upstream development activities analyzed within this **Final** SEIS. Occurrence of regulated floodplains are also not known at this time due to a lack of floodplain mapping within the North Slope.

To account for uncertainties caused by incomplete and unavailable information, DOE developed bounding conditions and assumptions based on the most current and available data and project plans in evaluating the range of potential impacts that could occur under the proposed project, consistent with the regulations cited above. Chapter 4, Impacts of the Proposed Action, provides quantitative information based on the best existing and available information for the purpose of identifying the range of environmental effects that may occur under the Proposed Action. In the absence of specific planning or design information, DOE has also conducted qualitative analysis where appropriate to describe the types and range of impacts anticipated. Due to the uncertainties that remain about project details for upstream development activities, DOE considers that the bounding conditions analyzed in the **Final** SEIS appropriately reflect the upper limits of anticipated impacts. DOE also identified the types of plans and permits that would likely be required for upstream development activities, which include coordination with state and federal regulatory agencies once project proponents determine the exact configuration and specifications for development.

As indicated above, DOE evaluated the potential range of impacts based upon the best available information for the potential upstream development activities within the North Slope and information on affected environment that could reasonably be obtained. In the absence of design data or specific location data for a project feature, DOE developed a range of potential impacts based on conceptual design data, siting criteria, other available project plans and commitments, and available baseline data for each resource area. DOE's analysis was conducted in order to provide a range of potential impacts, including an upper bound, so as to provide decision-makers with information that would support a reasoned choice among the alternatives. DOE concluded that the impacts of and permitting and plan requirements for the potential upstream development activities are appropriately described in this **Final** SEIS and that the range of potential impacts would remain within the upper bounds defined.

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4.22 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS

This section describes the amounts and types of resources that would be irreversibly or irretrievably committed for the potential upstream development activities. A resource commitment is considered irreversible when primary or secondary impacts from its use limit concurrent or future use options. Irreversible commitment applies primarily to nonrenewable resources such as minerals or cultural resources, and to those resources that are renewable only over long-time spans, such as soil productivity or mature forests. A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for use by future generations. Irretrievable commitment applies to the loss of production, harvest, or natural resources. Once consumed, the resource is no longer available for future generations.

The principal resources that would be committed by the upstream development activities are the lands and resources within those lands required for the construction and operation of permanent facilities including pads, wells, and pipelines. Sensitive resources within the ROI include:

- **Geologic storage.** The maximum areal extent of the CO_2 plume after injection throughout the term of authorization would occupy 1.8 square miles of the top layer of the Staines Tongue formation.
- **Permafrost soils.** Loss of permafrost can affect development and land stability within the project footprint and induce thawing on adjacent permafrost soils.
- **Wetlands.** While these features are widespread throughout the ROI, development activities would likely require permanent loss of wetlands where infrastructure is placed.
- **Water.** Hydrostatic testing of new pipelines and project operations involving wells would require water (primarily surface water).
- **Natural habitat.** Construction of the Project, primarily the proposed pads and pipelines, would result in the loss of natural habitat. This could include additional habitats directly adjacent to these features due to permafrost thaw.
- **Sensitive species and species of subsistence importance.** Increased human presence and activity within the ROI could affect species migration patterns and subsistence activities.
- **Cultural resources.** Areas of ground-disturbing activities can threaten the integrity of cultural sites.

Surface lands required for upstream development activities to support the proposed Alaska LNG Project would be irreversibly committed through the operational lifetime of the proposed Project. After this time and upon future decommissioning, proposed project components (e.g., pipelines, wells, and pads) could be removed and the surface lands again made available to be re-used for another purpose.

Other resources that would be committed to the potential upstream development activities include materials and energy resources used for construction and operation. Material and energy resources likely required would include construction materials (e.g., steel, gravel, concrete), electricity, and fuel (e.g., natural gas, diesel, gasoline). All energy used during construction and operation would be irretrievable.

As described above, the potential upstream development activities would result in irreversible (i.e., lost for a period of time) commitments of primarily renewable natural resources. The potential upstream development activities would also result in an irretrievable (i.e., permanently lost) commitment of portions of geologic storage formation, energy, material resources, and fuel.

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4.23 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

This section describes the relationship and tradeoffs between the short-term uses of the environment for the potential upstream development activities and the long-term benefits. Short-term uses of the environment would include the activities and associated impacts during the construction and operational lifespan of the projects to support the Alaska LNG Project. Potential impacts to various resources have been described throughout Chapter 4, Impacts of the Proposed Action. Potential environmental impacts would include:

- Damage to permafrost soils from development and ground disturbance, as described in Section 4.2;
- Impacts to surface water quality and hydrology from erosion and sedimentation during construction and from disturbances to permafrost, as described in Section 4.3;
- Permanent loss of wetlands from construction activities and potential alteration in wetland hydrology from permafrost development, as described in Section 4.4;
- Permanent loss in vegetation and alteration of natural habitat and migration patterns for terrestrial species, as described in Sections 4.5, 4.7, and 4.8;
- Impacts to cultural resources if present within project disturbance footprints, as described in Section 4.13;
- Impacts to subsistence activities from increased human presence and alteration of species migration patterns, as described in Section 4.14;
- Impacts to air quality resulting from fugitive dust emissions, as described in Section 4.15;
- Noise impacts from construction activities and operations, as described in Section 4.16; and
- Contribution to GHG emissions and climate change as described in Sections 3.19 and 4.19.

The potential upstream development activities would use environmental resources, consume products and energy, produce wastes and emissions, and occupy land. The activities would consume resources including surface water and natural and manufactured products during their operational period to support the proposed Alaska LNG Project.

The upstream development activities would enhance short-term productivity in the region through the direct, indirect, and induced creation of construction jobs. In addition, the activities would support the long-term beneficial impact on the state and local economy from increased revenues due to Project operations.

In summary, the short-term uses of the local environment do not represent substantial commitments of resources and would not cause substantial adverse impacts with the likely required plans and permits identified for upstream development activities and coordination with applicable state and federal regulatory agencies.

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5.0 REGULATORY AND PERMIT REQUIREMENTS

CEQ regulations for NEPA found in 40 CFR 1502.24 state that, to the fullest extent possible, agencies shall prepare draft EISs concurrently with and integrated with environmental impact analyses and related surveys and studies required by environmental review laws and E.O.s. It also requires a draft EIS to list all federal permits, licenses, and other entitlements that must be obtained in implementing the proposed project. Table 5-1 identifies relevant regulatory requirements considered within the **Final** SEIS, including federal regulations and E.O.s, state regulations and permitting requirements, and local regulations and permitting requirements.

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Federal Regulations and Permitting	
American Indian Religious Freedom Act of 1978	The American Indian Religious Freedom Act (42 USC 1996) ensures the protection of sacred locations and access of Native Americans to those sacred locations and traditional resources that are integral to the practice of their religions. Although no sacred locations and traditional resources have been identified in any areas that would be affected by the Alaska LNG Project, such locations or resources could be inadvertently discovered during construction activities.
Bald and Golden Eagle Protection Act (BGEPA)	The BGEPA prohibits taking without a permit or taking with wanton disregard any bald or golden eagle or their body parts, nests, chicks, or eggs, which includes collection, molestation, disturbance, or killing. The BGEPA protections include provisions not included in the MBTA, such as the protection of unoccupied nests and prohibition on disturbing eagles. The BGEPA includes limited exceptions to its prohibitions through a permitting process, including exceptions to take bald or golden eagle nests that interfere with resource development or recovery operations. Coordination with USFWS would be required to assess impact and develop avoidance and minimization measures to limit adverse impacts on eagles.
Clean Air Act (CAA)	The CAA (42 USC 7401 *et seq.*) was established “to protect and enhance the quality of the nation’s air resources so as to promote public health and welfare and the productive capacity of its population.” The CAA authorizes USEPA to establish NAAQS to protect public health and the environment. ADEC has the authority to enforce the provisions of the CAA through Alaska’s USEPA-approved programs. ADEC also enforces air quality standards through its USEPA-approved State Implementation Plan. Under the approved State Implementation Plan, ADEC has the authority to issue air construction permits. The USEPA issued a rule in 2010 finalizing GHG reporting requirements for the petroleum and natural gas industry (40 CFR 98). For compliance with the CAA, PSD air quality permits related to Air Quality Control for construction is required to be obtained from ADEC under 18 AAC 50.

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Clean Water Act (CWA)	The CWA is the primary federal statute regulating the protection of *waters of the United States*, the goals of which are to prevent, reduce, and eliminate pollution in the nation's waters in efforts to restore and maintain the "chemical, physical, and biological integrity" of these waters. Both the USEPA and USACE have regulatory authority under this statute. Under the CWA, it is unlawful to discharge any pollutant from a point source into waters of the United States without a permit. • **Section 404.** Regulates the discharge of dredged and/or fill material into *waters of the United States*, including wetlands. USACE has the authority to issue Department of the Army permits for projects that comply with the CWA Section 404(b)(1) guidelines. Proposed activities must demonstrate avoidance and minimization of adverse impacts on *waters of the United States*, including wetlands, to the extent practicable and, if required, provide compensatory mitigation for unavoidable impacts. • **Section 401.** Requires that an applicant for a federal permit who conducts any activity that may result in a discharge to *waters of the United States* must provide the federal regulatory agency with a Section 401 certification. Permits issued under Section 404 require water quality certification under Section 401 to certify that the regulated activity complies with applicable provisions of the act, including state water quality standards. ADEC issues Section 401 certifications that declare that the discharge would comply with applicable provisions of the CWA, including state water quality standards. • **Section 402.** Establishes the National Pollutant Discharge Elimination System permit program to regulate discharges into *waters of the United States*. USEPA has transferred National Pollutant Discharge Elimination System authority to ADEC under the APDES Program for activities within Alaska. APDES permits limit the types and amounts of discharge into *waters of the United States* to protect water quality and human health. If discharge of any pollutants into *waters of the United States* is anticipated, ADEC would determine whether to issue a general or individual APDES permit. • **Section 311.** As amended by the Oil Pollution Act of 1990, this section stipulates that the storage and management of petroleum products is regulated by USEPA under 40 CFR 112 and would require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a SPCC Plan to prevent environmental damage from the discharge of oil.
Endangered Species Act (ESA)	The ESA (16 USC 1531 *et seq.*) establishes a national policy for conserving threatened and endangered species of fish, wildlife, and plants, and the habitat on which they depend. Under Section 7 of the ESA, federal agencies must consult with NOAA Fisheries/NMFS and USFWS when any action the agency carries out, funds, or authorizes may affect either a species listed as threatened or endangered under the ESA, or any critical habitat designated for it. The USFWS and NMFS jointly administer the ESA.

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Fish and Wildlife Coordination Act	The Fish and Wildlife Coordination Act (16 USC 661, *et seq*.) requires consultation with USFWS when any water body is impounded, diverted, controlled, or modified for any purpose. The USFWS and state agencies charged with administering wildlife resources are to conduct surveys and investigations to determine the potential damage to wildlife and the mitigation measures that should be taken. The USFWS incorporates the concerns and findings of state and other federal agencies, including NMFS, into a report that addresses fish and wildlife factors and provides recommendations for mitigating or enhancing impacts to fish and wildlife affected by a federal project.
Magnuson-Stevens Fishery Conservation and Management Act (MSA)	The MSA was enacted to address impacts on fisheries on the U.S. continental shelf. It established U.S. fishery management over fishes within the fishery conservation zone from the seaward boundary of the coastal states out to 200 nautical miles (i.e., boundary of the U.S. Exclusive Economic Zone). The MSA also established regulations for foreign fishing within the fishery conservation zone and issued national standards for fishery conservation and management to be applied by regional fishery management councils. Section 305(b)(2) of the MSA requires federal agencies to consult with National Oceanic and Atmospheric Administration Fisheries/NMFS on any action or proposed action that may adversely affect EFH to identify conservation measures to minimize or avoid adverse impacts. If NMFS identifies conservation measures, the action agency must determine whether it would implement them and provide a formal response if it fails to do so.
Marine Mammal Protection Act (MMPA)	Marine mammals—such as seals, whales, sea otters, and polar bears—are protected under the MMPA. Section 101(a) of the MMPA prohibits persons or vessels subject to the jurisdiction of the United States from taking any marine mammal in waters or on lands of the United States or on the high seas. Sections 101(a)(5)(A) and (D) of the MMPA provide exceptions to the prohibition on take, which requires consultation with NMFS or the USFWS to authorize the incidental but not intentional take of small numbers of marine mammals, provided certain findings are made and statutory and regulatory procedures are met. NMFS has regulatory authority for all marine mammals relevant to this **Final** SEIS with the exception of the sea otter, Pacific walrus, and the polar bear, which are under USFWS authority.
Migratory Bird Treaty Act (MBTA)	The MBTA (16 USC 703 *et seq*.) protects birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. The MBTA regulates the take and harvest of migratory birds. Coordination with the USFWS would be required to determine compliance with the MBTA.
National Environmental Policy Act (NEPA)	This **Final** SEIS **was** prepared to comply with NEPA, the federal law that requires agencies of the federal government to study the possible environmental impacts of major federal actions significantly affecting the quality of the human environment.
National Historic Preservation Act (NHPA)	Section 106 of the NHPA, as amended (54 USC 3001 *et seq*.), requires that federal agencies, in consultation with the SHPO, evaluate the effects of federal undertakings on historical, archeological, and cultural resources and afford the ACHP opportunities to comment on the proposed undertaking. The goal of consultation is to identify historic properties potentially affected by the undertaking, assess effects, and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties. The lead agency must examine whether feasible alternatives exist to minimize or mitigate potential adverse effects. If the proposed action is determined to have an adverse effect on historic properties, the lead federal agency is required to consult further with SHPO and ACHP to develop methods to resolve the adverse effects.

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Natural Gas Act (NGA) **15 USC 717b; 18 CFR 153, 157, 375, and 385**	Section 3(a) of the NGA requires an order of authorization to import or export natural gas. This section also requires that an order be issued, unless it is found to not be consistent with the public interest. Section 3(c) of the NGA states that exportation of natural gas to a nation with which there is a free trade agreement in effect requiring national treatment for trade in natural gas shall be deemed to be consistent with the public interest. Applications should be granted without modification or delay.
Rivers and Harbors Act (RHA)	Section 10 of the RHA requires authorization from the USACE for the construction of any structure in or over any *navigable water of the United* States, the excavation/dredging or deposition of material in these waters or any obstruction or alteration in “navigable water.” Structure or work outside the limits defined as navigable waters of the United States require a Section 10 permit if the structure or work affects the course, location, condition, or capacity of the waterbody.
Safe Drinking Water Act (SDWA)	The SDWA authorizes USEPA to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water and drinking water sources. The USEPA works together with ADEC, which has primacy over drinking water regulations in Alaska. State of Alaska regulations (18 AAC 80) require public water systems to comply with the federal SDWA and amendments for public health protection. The SDWA also requires USEPA to develop minimum federal requirements for UIC programs and other safeguards to protect public health by preventing injection wells from contaminating underground sources of drinking water. **Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146. The USEPA is the permitting authority for the UIC Program in the State of Alaska and primary enforcement authority was granted to Alaska by the USEPA. The USEPA continues oversight of the State primacy program** (Alaska does not have any Class III and Class IV injection wells). • **Class I injection wells**. Used to inject hazardous and non-hazardous wastes into deep, confined rock formations. Class I wells are typically drilled thousands of feet below the lowermost underground source of drinking water. • **Class II injection wells**. Used only to inject fluids associated with oil and natural gas production. Class II fluids are primarily brines (salt water) that are brought to the surface while producing oil and gas. • **Class V injection wells.** Used to inject non-hazardous fluids underground. Most Class V wells are used to dispose of wastes into or above underground sources of drinking water. • **Class VI injection wells.** Used to inject CO_2 into deep rock formations. This process is called geologic sequestration and refers to technologies to reduce CO_2 emissions to the atmosphere and mitigate climate change. USEPA has primacy over Class VI injection wells. .
Executive Orders	
Executive Order 10173 ***Regulations Relating to the Safeguarding of Vessels, Harbors, Ports, and Waterfront Facilities of the United States***	Federal agencies must safeguard against destruction, loss, or injury from sabotage or other subversive acts, accidents, or other causes of similar nature, of vessels, harbors, ports, and waterfront facilities in the United States.

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Executive Order 11514 ***Protection and Enhancement of Environmental Quality***	Federal government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Federal agencies must initiate measures needed to direct their policies, plans, and programs so as to meet national environmental goals.
Executive Order 11988 ***Floodplain Management***	Federal agencies must establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for actions undertaken in a floodplain. Impacts on floodplains are to be avoided to the extent practicable.
Executive Order 11990 ***Protection of Wetlands***	Federal agencies must avoid short-term and long-term adverse impacts on wetlands whenever a practicable alternative exists.
Executive Order 12898 ***Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations***	Federal agencies must develop environmental justice strategies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations, including Native American tribes.
Executive Order 12962 ***Recreational Fisheries***	Federal agencies must improve the quantity, function, sustainable productivity, and distribution of aquatic resources for increased recreational fishing opportunities to the extent permitted by law and where practicable.
Executive Order 13007 and April 29, 1994, Executive Memorandum ***Indian Sacred Sites***	Federal agencies must accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of such sacred sites.
Executive Order 13045 ***Protection of Children from Environmental Health and Safety Risks***	Federal agencies must assess environmental health and safety risks that may disproportionately affect children and to ensure their policies, programs, activities, and standards address the disproportionate risks to children.
Executive Order 13112 ***Invasive Species***	Federal agencies are to prevent the introduction of invasive species, control those that are introduced, and provide for the restoration of native species.
Executive Order 13175 ***Consultation and Coordination with Indian Tribal Governments***	Federal agencies must consult with Indian and Alaska Native tribal governments when considering polices that would affect tribal communities.
Executive Order 13186 ***Responsibilities of Federal Agencies to Protect Migratory Birds***	Federal agencies must avoid or minimize the impacts of their actions on migratory birds and take active steps to protect birds and their habitat.
Executive Order 13212 ***Actions to Expedite Energy-Related Projects***	Federal agencies must take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy.
Executive Order 13783 ***Promoting Energy Independence and Economic Growth***	Federal agencies must review existing regulations that potentially burden the development or use of domestically produced energy resources and appropriately suspend, revise, or rescind those that unduly burden the development of domestic energy resources beyond the degree necessary to protect the public interest or otherwise comply with the law.

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Executive Order 13990 ***Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis***	Federal agencies must review and take action to address federal regulations and other actions taken during the last 4 years that conflict with national objectives to improve public health and the environment; ensure access to clean air and water; limit exposure to dangerous chemicals and pesticides; hold polluters accountable, including those who disproportionately harm communities of color and low-income communities; reduce GHG emissions; bolster resilience to the impacts of climate change; restore and expand our national treasures and monuments; and prioritize both environmental justice and employment.
Executive Order 14008 ***Tackling the Climate Crisis at Home and Abroad***	Federal agencies must place the climate crisis at the forefront of foreign policy and national security planning.
State Regulations and Permitting	
Alaska Air Quality Control; Air Permit Program	Under the authority of AS 46.14 (Air Quality Control) and the Air Permit Program (18 AAC 50), the ADEC and Division of Air Quality issue permits used for the construction, operation, or relocation of a Portable Oil and Gas Operation. "Portable Oil and Gas Operating" refers to an operation that moves from site to site to drill or test an oil or gas well, and that uses drill rigs, equipment associated with drill rigs and drill operations, well test flares, and equipment associated with well test flares. Under these conditions oil and gas drilling rig equipment may be subject to require a Minor General Permit (MG1 or MG2) or a Minor Source Specific permit from ADEC.
Alaska Fishway Act; Anadromous Fish Act	The Anadromous Fish Act (AS 16.05.871- .901) and Fishway Act (AS 16.05.841), requires prior notification and AS Title 16 (Fish Habitat) permit approval from ADF&G for all activities within the limits of ordinary high water of any streams with fish presence to prevent adverse effects on anadromous fish or their habitat and prevent the obstruction of efficient passage and movement of fish. Water withdrawals from fish bearing waterbodies would require an authorization from the ADF&G in accordance with its Title 16 authority.
Alaska Historic Preservation Act (AHPA)	The AHPA (AS 41.35.010–41.35.240) was enacted to locate, preserve, study, exhibit, and evaluate the historic, prehistoric, and archeological resources of Alaska with the intent of preserving and protecting them from loss, desecration, and destruction so that the scientific, historic, and cultural heritage embodied in these resources may pass undiminished to future generations. The AHPA is administered by the ADNR Office of History and Archaeology and SHPO to issue a Cultural Resource Concurrence for development that may affect historic or archaeological sites under the NHPA.
Alaska Land Act	Under Section 850 of this Act (AS 38.05.850, Permits) ADNR is authorized to issue permits for ice construction, including ice roads and ice pads. Under Section 180 of this Act (AS 38.05.180, Oil and Gas and Gas Only Leasing), ADNR is authorized to approve plans of development and plans of operation for oil and gas and gas-only leases.
Alaska Oil and Gas Conservation Act	Under this Act (AS 31.05.090), AOGCC authorizes permits to drill a well for oil or gas in Alaska and requires review/approval from various federal and state agencies (e.g., USFWS under ESA; ADNR for consideration of existing geological strata and resources; and ADNR's Office of History and Archaeology regarding protection of cultural resources).

Table 5-1. Relevant Regulatory and Permit Requirements for Upstream Activities

Statute, Regulation, Order	Description
Alaska Right-of-Way (ROW) Leasing Act	Under this Act (AS 38.35), the State of Alaska reserves the rights, not preempted by federal interstate commerce laws and regulations, in the ROW leasing of any state land for pipeline construction, transmission, or operation within its boundaries. ADNR's Division of Oil and Gas manages lands for oil and gas exploration and development. The State Pipeline Coordinator's section of this division provides regulatory oversite of transportation pipelines authorized under the ROW Leasing Act.
Alaska Water Use Act	Under this Act, ADNR is authorized to issue water use permits for water appropriation on a temporary basis and for operational purposes. A water right is a legal right to use surface or groundwater under the Water Use Act and allows a specific amount of water from a specific water source to be diverted, impounded, or withdrawn for a specific use.
Local Regulations and Permitting	
North Slope Borough Municipal Code (NSBMC)	Under the NSBMC, the North Slope Borough's Permitting and Zoning Division provides administrative approvals and development permits. The Division approves or denies permits and administrative approvals for any construction, operation, or studies conducted in North Slope Borough. The NSBMC 19.50 and 19.60 defines developments that must receive approval prior to commencement to ensure consistency with the Comprehensive Plan. Including issuance of a Certificate of Clearance as a formal approval process to ensure that all sites listed in North Slope Borough's Traditional Land Use Inventory are protected. The NSBMC also establishes Resource Development Districts to address the cumulative impacts of large-scale development (NSBMC 19.40.080).

AAC = Alaska Administrative Code; ACHP = Advisory Council on Historic Preservation; ADEC = Alaska Department of Environmental Conservation; ADF&G = Alaska Department of Fish and Game; ADNR = Alaska Department of Natural Resources; AHPA = Alaska Historic Preservation Act; AOGCC = Alaska Oil and Gas Conservation Commission; APDES = Alaska Pollutant Discharge Elimination System; AS = Alaska Statute; BGEPA = Bald and Golden Eagle Protection Act; CAA = Clean Air Act; CFR = *Code of Federal Regulations*; CO_2 = carbon dioxide; CWA = Clean Water Act; DOD = Department of Defense; DOE = Department of Energy; EFH = Essential Fish Habitat; ESA = Endangered Species Act; et seq. = and what follows; FERC = Federal Energy Regulatory Commission; GHG = greenhouse gas; LNG = liquefied natural gas; MBTA = Migratory Bird and Treaty Act; MG = Minor General Permit; MMPA = Marine Mammal Protection Act; MSA = Magnuson-Stevens Fishery Conservation and Management Act; NAAQS = National Ambient Air Quality Standards; NEPA = National Environmental Policy; NGA = Natural Gas Act; NHPA = National Historic Preservation Act; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NSBMC = North Slope Borough Municipal Code; PSD = Prevention of Significant Deterioration; RHA = Rivers and Harbors Act; ROW = right-of-way; SDWA = Safe Drinking Water Act; SEIS = Supplemental Environmental Impact Statement; SHPO = State Historic Preservation Officer; SPCC = Spill Prevention, Control, and Countermeasure; UIC = Underground Injection Control; U.S. = United States; USACE = U.S. Army Corps of Engineers; USC = United States Code; USEPA = U.S. Environmental Protection Agency; USFWS = U.S. Fish and Wildlife Service

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6.0 MITIGATION MEASURES

This chapter provides a consolidated summary of potential mitigation measures, BMPs, and plans that could apply to each environmental resource area, as identified in Table 2.5-1 and throughout Chapter 4, Impacts of the Proposed Action, of this **Final** SEIS. **DOE believes that these mitigation measures, such as mitigation plans for various specific activities, could reduce potential impacts from upstream development, primarily during construction activities and minimally during production activities in several different resource areas. DOE expects compliance with any such plans that are developed by the project sponsors, to the extent they are additional to those recommended in the 2020 EIS and FERC Order (or extensions of those plans to cover upstream activities), to be the responsibility of the appropriate local or state agencies.** Table 6-1 summarizes the plans and additional mitigation measures discussed in this **Final** SEIS.

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Geologic Resources and Geologic Hazard	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.1.5) • Gravel Sourcing Plan and Reclamation Measures describes material requirements, sources, extraction protocols, transportation logistics, and reclamation measures during construction and reclamation. • Paleontological Resources Management Plan describes the procedures to be used to protect paleontological resources in accordance with NEPA and the Paleontological Resources Preservation Act of 2009. • Paleontological Resources Unanticipated Discoveries Plan describes the procedures to be used to reduce potential for damage to these resources in the event that unanticipated paleontological resources are encountered. **Additional Mitigation Measures and BMPs** (see Section 4.1.5) • Structures should comply with the International Building Code, which requires structures to be designed to withstand ground accelerations expected to occur at the site location based on seismic hazard analysis. • Regarding development of wells for oil and gas exploration and production, submit a Plan of Operations to the state to demonstrate compliance with mitigation measures attached to a lease in order to minimize adverse impacts of exploration and development. ADNR DOG has the authority to impose these mitigation conditions or limitations. Measures help mitigate the potential adverse social and environmental effects on Alaska's resources including areas of high residential, commercial, recreational, and subsistence use, as well as important fish and wildlife habitats, and archeological sites.
Soils and Sediments	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.2.5) • Fugitive Dust Plan describes the procedures to be used to minimize fugitive dust, reducing potential adverse effects of deposition on adjacent areas of permafrost and prevention of permafrost degradation. Measures could include using dust control abatement measures as needed during construction and operation; applying water to affected unpaved roads and staging areas; applying approved dust suppressants such as calcium chloride or water/magnesium chloride mixture; and reducing speed limits on unpaved roads. • Restoration/Revegetation Plan describes the procedures, performance standards, and performance goals for restoring construction areas, including measures to reduce potential for erosion and loss or movement of soil resources. • SPCC Plan addresses prevention of accidental spills and contamination of soils and cleanup of releases of fuels, lubricants, and coolants.

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Soils and Sediments (Continued)	• SWPPP addresses the management of construction sediments and prevention of offsite migration in stormwater discharges. • Winter and Permafrost Construction Plan describes the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan discusses soil stabilization measures to be implemented to limit thermal and erosional degradation of the permafrost. Measures could include constructing in thaw-sensitive permafrost during the winter where possible. **Additional Mitigation Measures and BMPs (see Section 4.2.5)** • **Impacts to permafrost soils in areas of development activities would be avoided wherever possible. This includes placing proposed pipelines in permafrost areas on VSMs. In addition, DOE would consider requiring project proponents to implement monitoring of permafrost down to the depth of the active layer and incorporate adaptive management to minimize thawing and thermokarst development of permafrost soils associated with project construction and operations.** • **Discharge of hydrostatic test water would be conducted in limited and designated areas to prevent thermal erosion or thermokarst development of permafrost.** • **In areas where topsoil would be disturbed, topsoil would be salvaged, wherever practicable, for use to facilitate restoration of temporarily disturbed areas. This would include salvaging frozen topsoil using equipment such as a frozen topsoil cutter specifically designed to remove frozen topsoil.**
Water Resources	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.3.5) • Fugitive Dust Plan addresses procedures to minimize fugitive dust, reducing potential adverse effects of deposition in water resources from ground disturbances during construction. • Restoration/Revegetation Plan addresses measures to reduce potential for runoff and sedimentation into adjacent waters. • SPCC Plan addresses prevention of accidental spills and contamination of soils and cleanup of releases of fuels, lubricants, and coolants prior to reaching adjacent surface water or groundwater resources. • **Preparation of a Project Culvert Design and Maintenance Plan to include provisions for maintaining the floodplain integrity both up and downstream from waterway crossings (e.g., roads) to the greatest extent possible.** • SWPPP addresses measures to reduce pollutants in stormwater discharges into adjacent waters during construction. • Water Use Plan identifies different uses of water during construction and estimated operational water use volumes and sources. The plan would also demonstrate that reuse of water (e.g., for hydrostatic testing) has been considered and applied where practicable. • **Preparation of a Facility Response Plan to demonstrate preparedness for a worst-case oil discharge, and a SPCC Plan to prevent environmental damage from the discharge of oil.** **Additional Mitigation Measures and BMPs** (see Section 4.3.5) • Any project involving disturbance to waters of the United States would require the applicant to obtain a USACE Section 404 Permit containing site-specific waterbody crossing plans and mitigation measures to minimize water resources impacts. **This would include design of upstream development activities such as VSM and HSM pipeline and ice road locations to avoid or minimize impacts to areas prone to flooding along waterways.**

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Wetlands	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.4.5) • Fugitive Dust Plan describes procedures to minimize fugitive dust, reducing potential adverse effects of deposition in wetland resources from ground disturbances during construction. • Restoration/Revegetation Plan addresses restoration of wetland vegetation in areas temporarily disturbed from construction and avoid sedimentation into adjacent wetlands from ground disturbances. • SPCC Plan describes the management procedures for the prevention and cleanup of releases of fuels, lubricants, and coolants, as well as potentially hazardous materials to be implemented, reducing potential accidental discharge into wetlands. • SWPPP describes measures to minimize the pollutants in stormwater discharges into adjacent wetlands during construction. • Wetland Mitigation Plan, prepared in conjunction with the USACE Section 404 permit process, describes measures to minimize unavoidable impacts to wetlands. **Fill placed in wetlands for temporary project needs would be removed to reclaim wetland functions wherever practicable.** • Winter and Permafrost Construction Plan describes procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan would include measures to be implemented to limit thermal and erosional degradation of the permafrost and prevent impacts to wetlands and wetland hydrology. **Additional Mitigation Measures and BMPs** (see Section 4.4.5) • The applicant would file final wetland delineation reports with USACE that document the results of all field delineations completed for proposed project footprints; reports would identify the type, location, and acreage for each wetland and provide impact summaries, indicating if permanent fill (including granular fill and cut fill material) is required in wetlands.
Vegetation	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.5.5) • Fugitive Dust Plan describes procedures to minimize fugitive dust, reducing potential adverse effects of deposition on vegetation from ground disturbances during construction. • Noxious/Invasive Plant and Animal Control Plan describes measures to minimize the introduction and spread of invasive plant species in project work areas. This could include requirements for pre-construction NNIS surveys to identify and manage invasive plant species within or adjacent to project areas. • Restoration/Revegetation Plan addresses restoration of vegetation in areas of temporarily disturbed from construction. This includes establishment of percent vegetation cover restoration goals and monitoring requirements for revegetation success. **As stated in Section 4.2.5, topsoil would be salvaged, wherever practicable, to facilitate restoration of temporarily disturbed areas and recolonization of native species, therefore decreasing impacts associated with slower revegetation (e.g., colonization by invasive non-native species, erosion, maintenance and associated costs, long-term impacts to aesthetic value, reseeding, fertilizing, and slower return of wetland functions).**

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Wildlife Resources	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.6.5) • Lighting Plan describes required measures to provide adequate lighting for the prevention of accidents and compliance with Occupational Safety and Health Administration requirements while reducing visible light disturbance to wildlife, as practicable. • Marine Mammal Monitoring and Mitigation Plan describes measures to be implemented during in-water construction activities (e.g., noise mitigation measures from dredging activities at PTU) in Prudhoe Bay to comply with the MMPA and ESA. • Migratory Bird Conservation Plan describes procedures to be implemented during construction, operation, and maintenance for avian protection. Measures could include requiring vegetation clearing or initial granular fill placement outside of the nesting season within the boundaries of the IBAs. • Noxious/Invasive Plant and Animal Control Plan addresses measures to minimize the introduction and spread of invasive animal species in project work areas. • **Preparation of a SPCC Plan that would address the prevention of accidental spills and contamination of terrestrial and aquatic habitat and address cleanup of releases of fuels, lubricants, and coolants. Measures would include response associated with spills in an iced environment to reduce the extent of impacts to terrestrial and aquatic habitats.** • Restoration/Revegetation Plan addresses restoration of vegetation and related wildlife habitat in areas of temporarily disturbed from construction. • **Preparation of a Winter and Permafrost Construction Plan that outlines the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost. The plan would discuss soil stabilization measures to be implemented to limit thermal and erosional degradation of the permafrost. Measures related to wildlife protection would include avoiding use of synthetic monofilament mesh/netted erosion control materials in, and adjacent to, sensitive wildlife habitat as these materials perpetuate in the environment and can disperse into sensitive areas posing a significant threat to wildlife through ingestion and strangulation.** **Additional Mitigation Measures and BMPs** (see Section 4.6.5) • Perform construction activities during the winter months and localize construction to locations where oil and gas development activities already occur could minimize impacts to wildlife resources. Timing these activities during winter months would avoid impacts during times when wildlife are most active (i.e., migration) or during important life stages (i.e., nesting).
Aquatic Resources	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.7.5) • Fugitive Dust Plan describes procedures to minimize fugitive dust, reducing potential adverse effects of deposition in aquatic resources from ground disturbances during construction. • Noxious/Invasive Plant and Animal Control Plan describes measures to minimize introduction and spread of invasive species into aquatic habitats adjacent to project work areas. • SPCC Plan addresses prevention of accidental spills and contamination of soils and cleanup of releases of fuels, lubricants, and coolants prior to reaching adjacent aquatic habitats. • SWPPP describes measures to reduce the pollutants in stormwater discharges into adjacent aquatic habitats during construction.

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Aquatic Resources (Continued)	• Water Use Plan identifies different uses of water during construction. The plan would identify appropriate water sources and uses to reduce impacts to aquatic resources and habitat. This could include withdrawal rate restrictions to specific surface waters, including waters containing EFH; positioning of water withdrawal pump intakes from the stream bed to avoid the entrainment of eggs or fry from the gravel bed; and use of screen openings on all water withdrawal equipment of 0.25 inch (0.1 inch or less in areas with sensitive life stages, e.g., pink and chum salmon fry, whitefish fry, and arctic grayling fry) to reduce the risk of impingement of small or juvenile fish. • Winter and Permafrost Construction Plan describes the procedures and processes to be implemented to manage summer, winter, and shoulder season construction on permafrost, reducing adverse impacts to aquatic habitats.
Threatened, Endangered, and other Special Status Species	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.8.5) • See also the relevant plans listed under **Wildlife Resources** and **Aquatic Resources**. • Marine Mammal Monitoring and Mitigation Plan describes measures to be implemented during in-water construction activities (e.g., noise mitigation measures from dredging activities at PTU) in Prudhoe Bay to comply with the MMPA and ESA. • Polar Bear and Pacific Walrus Avoidance and Interaction Plan describes measures to avoid or minimize adverse effects on and human interaction with polar bears and Pacific walrus during construction and operational activities on the North Slope and Beaufort Sea. **Additional Mitigation Measures and BMPs** • Prior to ground disturbance, consult with appropriate state and federal agencies, including USFWS, NMFS, and ADF&G to satisfy ESA and MMPA requirements and, if necessary, survey areas within the ROI for the potential presence of protected species and associated critical habitat.
Land Use, Recreation, and Special Interest Areas	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.9.5) • Restoration/Revegetation Plan describes measures to restore temporarily disturbed areas to their prior land use. **Additional Mitigation Measures and BMPs** • New pipeline ROW for the CO_2 pipeline and distribution lines under Scenario 3 would be sited to follow existing ROW and infrastructure to the extent practicable.
Visual Resources	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.10.5) • Lighting Plan describes measures to provide adequate lighting for the prevention of accidents and compliance with Occupational Safety and Health Administration requirements while reducing visible light disturbance to the public and wildlife, as practicable, and reducing the potential for light pollution, including backscatter into the sky. **Additional Mitigation Measures and BMPs** (see Section 4.10.5) • New pipeline ROW for the CO_2 pipeline and distribution lines under Scenario 3 would be sited to follow existing ROW and infrastructure to the extent practicable.
Socioeconomics	**Mitigation Measures and BMPs** (see Section 4.11.5) • Standard construction BMPs and mitigation measures would be implemented to reduce potential impacts to minority and low-income populations through environmental plans and permitting requirements addressing various environmental resources. For example, visual impacts would be managed with a Project Lighting Plan, air permitting to reduce regional haze, and a Transportation Mitigation Plan to reduce potential congestion and damage to roadways.

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Transportation	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.12.5) • Traffic Mitigation Plan addresses measures to minimize traffic congestion and delays from construction-related traffic. • Air Transport Plan details the planned number of project-related aircraft operations at the airports and airstrips to avoid conflicts with existing air traffic. • Journey Management Plan describes the process to be followed for planning and safely undertaking proposed transport activities to avoid conflicts with existing road and marine traffic.
Cultural Resources	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.13.5) • Plan for Unanticipated Discovery of Cultural Resources and Human Remains describes the procedures to be used in the event that previously unreported historic properties or human remains are found. The plan would be approved by the Alaska SHPO and also include procedures for notifying consulting and interested parties, including Alaska Native tribes, in the event of any discovery. **Additional Mitigation Measures and BMPs** (see Section 4.13.5) • Prior to ground disturbance, conduct survey areas within the APEs for cultural resources. If NRHP-eligible resources are identified that cannot be avoided, the project proponent would prepare treatment plans for review and approval by the SHPO and interested tribes, as applicable in accordance with the NHPA.
Subsistence	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1) • See also the relevant plans listed under Soil and Sediments; Water Resources; Wetlands; Vegetation; Wildlife Resources; Aquatic Resources; and Threatened, Endangered, and Other Special Status Species. **Additional Mitigation Measures and BMPs** (see Section 4.14.5) • New infrastructure would be sited within or directly adjacent to disturbed areas or within or directly adjacent to existing ROW for new pipeline construction. • For upstream development activities involving equipment and material deliveries by barge and for dredging at PTU, coordinate with the NMFS and the Alaskan Eskimo Whaling Commission to avoid and minimize impacts on subsistence whaling and marine mammal hunting. • Prepare a site-specific Local Subsistence Implementation Plan, as applicable, which would include measures to coordinate with local communities to identify locations and times where subsistence activities occur, and modify schedules to minimize work, particularly work that could reduce resource availability or user access, to the extent practicable, in those locations and times.
Air Quality	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.15.5) • Fugitive Dust Plan describes measures to minimize adverse impacts to air quality including control of fugitive dust to minimize increases of particulate matter.
Noise	**Mitigation Measures and BMPs** (see Section 4.16.5) • The pipeline ROW for the CO_2 pipeline and distribution lines under Scenario 3 would be sited to follow existing ROW and infrastructure with a similar noise environment. • The future applicant for the PTU Expansion Project (under both Scenarios 2 and 3) would design measures to avoid or minimize noise impacts such as a noise mitigation plan, noise enclosures, exhaust silencers, and acoustic panels

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Public Health and Safety	**Relevant Construction and Restoration Environmental Plans** (see Table 2.5-1 and Section 4.17.5) • Health, Safety, Security, and Environmental Plan outlines requirements for training, safety meetings, accident investigation, and contractor requirements. This would provide project-wide health and safety objectives and performance criteria for construction contractor compliance in developing project-specific Health and Safety Plans. This could include requirements to have worker camps closed to reduce the presence of the outside workforce in communities; providing health education and outreach programs; and requiring construction contractors to have adequate health and medical equipment and staff to respond to and prevent medical emergencies. • Fugitive Dust Plan describes measures to minimize fugitive dust, reducing potential adverse effects of deposition into surrounding populations and adverse effects to respiratory health. • Journey Management Plan describes the process to be followed for planning and safely undertaking transport activities to avoid conflicts with existing marine and vehicle traffic. • SPCC Plan addresses prevention of accidental spills and contamination of soils and cleanup of releases of fuels, lubricants, and coolants, reducing potential accidental release to water resources and general public. • Water Use Plan identifies different uses of water during construction. The plan would identify estimated operational water use volumes and sources and eliminate any potential adverse effects on existing water rights and supplies to the surrounding communities. **Additional Mitigation Measures and BMPs** (see Section 4.17.5) • Prepare an Emergency Plan and perform safety drills for accidents, injuries, or hazardous material release events which would reduce the risk of accidents and increase preparedness. • Prepare a Local Subsistence Implementation Plan, as applicable, would include measures to keep local communities and their leaders informed of the projects by coordinating with local communities, including tribal councils, to identify locations and times where subsistence activities occur, and modify schedules to minimize work. The plan could also include measures to provide community-based participatory monitoring and community engagement to stay aware of and respond to community concerns. This would serve to reduce potential safety concerns for subsistence users during construction activities. • BMPs for minimizing air quality impacts both during construction and operations would also serve to protect individuals with upper respiratory conditions. • Enforcement of required safety training and implementation of safety plans would serve to minimize accidents and accident-related fatalities.
Reliability and Safety	**Mitigation Measures and BMPs** (see Section 4.18.5) • Proposed pipelines would be subject to a prescribed safety program, in accordance with the PHMSA regulations. Pipelines would be regularly inspected for leakage and potential pipeline hazards such as construction activity, encroachments, and evidence of recent unmonitored excavations. • Provide training to all employees responsible for operation and maintenance of the pipelines and other associated facilities, including review of routine and emergency procedures. • Prepare a project-specific Emergency Response Plan outlining emergency procedures, providing protection of personnel and the public, as well as the prevention of property damage that could occur as a result of incidents.

Table 6-1. Summary of Construction and Restoration Environmental Plans and Additional Mitigations

Resource Area	Construction and Restoration Environmental Plans and Additional Mitigations
Greenhouse Gases and Climate Change	**Mitigation Measures and BMPs** (see Section 4.19.5) • Use appropriate BMPs to reduce equipment and vehicle emissions (including GHGs) during construction by such practices as maintaining engines according to manufacturers' specifications, minimizing idling of equipment while not in use, and using electricity from the grid if available to reduce the use of diesel or gasoline generators for operating construction equipment. • **Reduce CH_4 emissions by minimizing operational system upsets, gas flaring and venting, valve leaks, etc.; incorporating innovative technologies in leak detection and continuous monitoring programs for fugitive emissions, such as drones and optical and infrared detectors; and adopting relevant best practices and recommended technologies identified in USEPA's voluntary methane programs - Methane Challenge and Natural Gas STAR.** • **Monitor CO_2 pipelines and sequestration networks to improve safety while also reducing the number of incidents that result in CO_2 leakage, consistent with CEQ's proposed guidance on carbon sequestration.** • **Use energy efficient, lower GHG-emitting equipment and promote sustainable land management practices where applicable.** • Under Scenario 2, develop and implement a USEPA-approved site-specific monitoring, reporting, and verification plan for CO_2 injection wells per Subpart RR of the Mandatory Reporting of Greenhouse Gases Rule. The plan would assure that the GHGs are being sequestered safely and according to design and permit requirements. • **If DOE exercises its authority to reaffirm the Alaska LNG Order, it is recommended that the following measure be included as an environmental condition of any such export authority: Alaska LNG shall submit to DOE, as part of its monthly report, a statement certifying that the natural gas produced for export in the form of LNG did not result in the venting of byproduct CO_2 into the atmosphere, unless required for emergency, maintenance, or operational exigencies and in compliance with the FERC Order.**

ADF&G = Alaska Department of Fish and Game; ADNR DOG = Alaska Department of Natural Resources, Division of Oil and Gas; APE = Area of Potential Effect; BMP = best management practice; CO_2 = carbon dioxide; EFH = Essential Fish Habitat; ESA = Endangered Species Act; GHG = greenhouse gas; IBA = Important Bird Area; MMPA = Marine Mammal Protection Act; NEPA = National Environmental Policy Act; NHPA = National Historic Preservation Act; NMFS = National Marine Fisheries Service; NNIS = non-native invasive species; NRHP = National Register of Historic Places; PHMSA = Pipeline and Hazardous Materials Safety Administration; PTU = Point Thomson Unit; ROI = region of influence; ROW = right-of-way; SHPO = State Historic Preservation Office; SPCC = Spill Prevention, Control, and Countermeasures; SWPPP = Stormwater Pollution Prevention Plan; USACE = U.S. Army Corps of Engineers; USEPA = U.S. Environmental Protection Agency; USFWS = U.S. Fish and Wildlife Service**; VSM = vertical support member**

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Alaska Department of Commerce, Community, and Economic Development

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City of Anaktuvuk Pass

Mr. **Andrew Hopson**, Mayor
City of Anaktuvuk Pass

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City of Anderson

Ms. Heather Fox, Mayor
City of Bettles

Mr. Tim O'Connor, Mayor
City of Craig

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Ms. **Bernice Brown**, City Clerk
City of Golovin

Mr. **Carter Cole**, Mayor
City of Houston

Ms. **Rebecca Rein**, City Clerk
City of Houston

Ms. **Beth McEwen**, Municipal Clerk
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City of Juneau

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City of Kenai

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City of Pelican

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Mr. Gary Dixon, Secretary-Treasurer
Teamsters Local 959

Mr. Cameron Hunt, General Manager
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Mr. Skoey Vergen, President and CEO
The Aleut Corporation

Ms. Susan A. Anderson, President and CEO
The CIRI Foundation

Mr. Steve Cohn, Alaska State Director
The Nature Conservancy in Alaska

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Mr. Daniel Thomas, President
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Mr. Bruce Abraham, Sales Manager
Topper Industries

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Transpac Marinas, Inc.

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Trapper Creek Community Council

Ms. Janet Grelson, Treasurer
Trapper Creek Community Council

Mr. Ralph Kolbeck, Vice-Chairperson
Trapper Creek Community Council

Mr. Levi Miller, Secretary
Trapper Creek Community Council

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Tri-Valley Volunteer Fire Department

Ms. Jennie Frost
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Mr. Doug Johnson, Principal Project Manager
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Mr. Roger Blair
Energy National Business Line Executive
WSP USA

Ms. Catherine E. Stankowitz
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Ms. Theresa Clark, Executive Director
Yukon River Inter-Tribal Watershed Council

Libraries

Anchorage Public Library (Z.J. Loussac Library)

Arctic Interagency Visitor Center

Charles Evans Community/School Library

Noel Wien Public Library

Kenai Community Library

Trapper Creek Library

Tri-Valley Community Library

Wasilla Public Library

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