U.S. Department of the Interior
Bureau of Land Management

Willow Master Development Plan

Environmental Impact Statement

FINAL

Volume 1: Chapters 1 through 5, Glossary, and References

August 2020

Prepared by:
U.S. Department of the Interior
Bureau of Land Management

In Cooperation with:
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Native Village of Nuiqsut
Iñupiat Community of the Arctic Slope
City of Nuiqsut
North Slope Borough
State of Alaska

Estimated Total Costs Associated with Developing and Producing this EIS: $6,668,400

Mission

To sustain the health, diversity, and productivity of the
public lands for the future use and enjoyment of present and
future generations.

Cover Photo Illustration: Caribou in the Alpine Development on Alaska’s North Slope.
Photo by: Wendy Mahan, courtesy of ConocoPhillips.

DOI-BLM-AK-0000-2018-0004-EIS
BLM/AK/PL-19/012+1610+F010

Willow Master Development Plan Final Environmental Impact Statement

Volume 1: Executive Summary, Chapters 1 through 5, Glossary, and References

Prepared by:

U.S. Department of the Interior
Bureau of Land Management
Anchorage, Alaska

In cooperation with:

U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Native Village of Nuiqsut
Iñupiat Community of the Arctic Slope
City of Nuiqsut
North Slope Borough
State of Alaska

August 2020

Estimated Total Costs Associated with Developing and Producing the EIS: $6,668,400

This page intentionally left blank.

FINAL ENVIRONMENTAL IMPACT STATEMENT WILLOW MASTER DEVELOPMENT PLAN PROJECT

Lead Agency:	U.S. Department of the Interior, Bureau of Land Management (BLM)
Cooperating Agencies:	U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, State of Alaska, North Slope Borough, Native Village of Nuiqsut, City of Nuiqsut, and the Iñupiat Community of the Arctic Slope.
Proposed Action:	Construct the infrastructure necessary to allow the production and transportation to market of federal oil resources under leaseholds in the northeast area of the National Petroleum Reserve in Alaska (NPR-A), consistent with the Proponent's (ConocoPhillips Alaska, Inc.) federal oil and gas lease and unit obligations.

Abstract:

The Willow Master Development Plan (MDP) Draft Environmental Impact Statement (EIS) was published on August 23, 2019. The Draft EIS analyzed a No Action Alternative (Alternative A), three action alternatives (Alternatives B, C, and D), and two module delivery options (Options 1 and 2) to support a new development proposed by ConocoPhillips Alaska, Inc. on federal oil and gas leases in the northeast area of the NPR-A. On March 26, 2020, BLM published a targeted Supplement to the Draft EIS that addressed additional analysis for three new Willow MDP Project components added by the Proponent: a third module delivery option (Option 3), a constructed freshwater reservoir, and up to three boat ramps for subsistence access. If the MDP is approved, the Proponent may submit applications to build up to five drill sites, a central processing facility, an operations center pad, gravel roads, ice roads and ice pads, 1 or 2 airstrips (varies by alternative), a module transfer island, pipelines, and a gravel mine site. The Willow MDP Project would have a peak production in excess of 160,000 barrels of oil per day (with a processing capacity of 200,000 barrels of oil per day) over its 30- or 31-year life (varies by alternative), producing approximately 590 million total barrels of oil, and would help offset declines in production from the North Slope oil fields and contribute to the local, state, and national economies. The EIS describes proposed infrastructure and potential effects on the natural, built, and social environments. The action alternative discussion includes existing lease stipulations and best management practices and proposed mitigation measures to avoid, reduce, and minimize the potential effects. BLM and other state and federal agencies will decide whether to authorize the Willow MDP Project, in whole or in part, based on the analysis contained in the Final EIS, as well as other state and federal permit review processes.

The EIS analyzes the following resources in detail: climate and climate change; air quality; soils, permafrost, and gravel resources; contaminated sites; noise; visual resources; water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals; land ownership and use; economics; subsistence and sociocultural systems; environmental justice; and public health.

Further Information: Contact Racheal Jones, BLM Alaska Project Manager, at 907-290-0307 or visit the Willow MDP EIS website at https://www.blm.gov/programs/planning-and-nepa/plans-development/alaska/willow-eis.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Alaska State Office
222 West Seventh Avenue, #13
Anchorage, Alaska 99513-7504
www.blm.gov/alaska

Dear Reader:

I am pleased to present the Willow Master Development Plan (MDP) Final Environmental Impact Statement (Final EIS) for your review. The Final EIS addresses a list of issues and contains three action alternatives for new development proposed by ConocoPhillips Alaska, Inc. (the Proponent) on federal oil and gas leases in the National Petroleum Reserve in Alaska (NPR-A). BLM has identified Alternative B and Module Delivery Option 3 as the preferred alternative. This alternative and module delivery option provides for the protection of surface resources identified through the public scoping and public comments.

The Proponent's proposed project is to construct up to five drill sites, roads, pipelines, and ancillary facilities to support the safe and economic production and transportation to market of oil and gas resources under leaseholds in the NPR-A. The decision to be made from this EIS process is whether BLM will authorize the Willow MDP, in whole or in part, based on the analysis contained in this Final EIS, as well as other state and federal permit review processes.

The analysis of the alternatives and module delivery options was conducted based on public input gathered from the 60-day comment period on the Draft EIS and the 45-day comment period on the Supplement to the Draft EIS. The BLM held public comment meetings on the Draft EIS and subsequently on the Supplement to the Draft EIS. Modifications to the Final EIS were made based on public comment, cooperating agency coordination, tribal and Alaska Native Claims Settlement Act corporation consultation, and the BLM's internal review of the EIS. Consistent with 43 CFR 1503.4, the BLM evaluated all substantive comments received during the public comment period and responses are included in the Final EIS.

The Final EIS may be accessed on the internet at https://www.blm.gov/programs/planning-and-nepa/plans-development/alaska/willow-eis or a digital copy can be requested from Racheal Jones, Project Manager, at (907) 290-0307 or rajones@blm.gov.

A Record of Decision will be signed no sooner than 30 days after publication of the Final EIS Notice of Availability in the Federal Register.

Thank you for your continued interest in the Willow MDP EIS. We appreciate the information and suggestions you contributed to the planning and analyses process. For additional information or clarification regarding this document, please contact Racheal Jones, Project Manager.

Sincerely,

Chad B. Padgett
State Director

Table of Contents

List of Tables

List of Appendices

ACRONYMS

F	Fahrenheit
µPa	micropascal, a unit of pressure
µPa/Hz	micropascal per hertz
2:1	2 horizontal to 1 vertical ratio
AAAQS	Alaska Ambient Air Quality Standards
ACP	Arctic Coastal Plain
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADHSS	Alaska Department of Health and Social Services
ADLWD	Alaska Department of Labor and Workforce Development
ADNR	Alaska Department of Natural Resources
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
APDES	Alaska Pollutant Discharge Elimination System
AQRV	air quality related value
AQTSD	Air Quality Technical Support Document
AR4	fourth assessment report
AR5	fifth assessment report
ASRC	Arctic Slope Regional Corporation
AST	aboveground storage tank
ASTAR	Arctic Strategic Transportation and Resources project
ATV	all-terrain vehicle
BLM	Bureau of Land Management
BMP	best management practice
BO	Biological Opinion
BOEM	Bureau of Ocean and Energy Management
BT1	Bear Tooth drill site 1
BT2	Bear Tooth drill site 2
BT3	Bear Tooth drill site 3
BT4	Bear Tooth drill site 4
BT5	Bear Tooth drill site 5
BTU	Bear Tooth Unit
CAH	Central Arctic Herd
CAMx	Comprehensive Air Quality Model with Extensions
CAPs	criteria air pollutants
cfs	cubic feet per second
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPAI	ConocoPhillips Alaska, Inc.
CPF	central processing facility
CRD	Colville River Delta
CWA	Clean Water Act
cy	cubic yards
DATs	Deposition Analysis Thresholds
dB	decibels
dBA	A-weighted decibels, used to characterize airborne noise, referenced to 20 µPa
DEW	Distant Early Warning

dv	deciviews
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
GHG	greenhouse gas
GMT	Greater Mooses Tooth
GMT-1	Greater Mooses Tooth 1
GMT-2	Greater Mooses Tooth 2
GWP	global warming potential
HAP	hazardous air pollutant
HDD	horizontal directional drilling
HEC	health effect category
HSM	horizontal support member
HUC	hydrologic unit code
Hw/D	headwater-diameter ratio
IAP	Integrated Activity Plan
IBA	Important Bird Areas
IPCC	Intergovernmental Panel on Climate Change
ITR	Incidental Take Regulation
kg N/ha/year	kilograms nitrogen per hectare per year
kg/ha/year	kilogram per hectare per year
km	kilometers
KSOP	Kuukpik Subsistence Oversight Panel
Kuparuk	Kuparuk River Unit
Kuukpik	Kuukpik Corporation
LS	lease stipulation
m	meters
MDP	Master Development Plan
MG	million gallons
mg/L	milligrams per liter
MMT	million metric tons
MTI	module transfer island
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEI	Northern Economics Inc.
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_3^-	nitrate
NOx	nitrogen oxides
NPR-A	National Petroleum Reserve in Alaska
NPRPA	Naval Petroleum Reserves Production Act
NPS	National Park Service
NSB	North Slope Borough
NSBMC	North Slope Borough Municipal Code
NTU	nephelometric turbidity unit
NVN	Native Village of Nuiqsut
O_3	ozone
ODPCP	Oil Discharge, Pollution, and Contingency Plan
OHW	ordinary high water

PAHs	Polycyclic Aromatic Hydrocarbons
Pb	lead
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
Project	Willow Master Development Plan Project
Proponent	ConocoPhillips Alaska, Inc.
PSD	Prevention of Significant Deterioration
Q1	first quarter
Q4	fourth quarter
REL	Reference Exposure Level
RfC	reference concentration
RFFAs	reasonably foreseeable future actions
RMS	Regional Mitigation Strategy
rms	root mean square
ROD	Record of Decision
ROPs	required operating procedures
Secretary	Secretary of the Interior
SDEIS	Supplement to the Draft EIS
SO_2	sulfur dioxide
SO_4^{2-}	sulfate
SPCC	Spill Prevention Control and Countermeasures
SRA	Spill Risk Assessment
SRB&A	Stephen R. Braund and Associates
SS	suspended sediment
State	State of Alaska
SWPPP	Stormwater Pollution Prevention Plan
TAPS	Trans-Alaska Pipeline System
TCH	Teshekpuk Caribou Herd
TLSA	Teshekpuk Lake Special Area
TMT	thousand metric tons
TSS	total suspended solids
U.S. Census	U.S. Census Bureau
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOCs	volatile organic compounds
VRI	Visual Resource Inventory
VRM	Visual Resource Management
VSMs	vertical support members
Willow area	area around the gravel infrastructure and mine site for the Project
WOC	Willow Operations Center
WOUS	Waters of the United States
WPF	Willow Processing Facility
WSE	water surface elevation

This page intentionally left blank.

EXECUTIVE SUMMARY

1.0 INTRODUCTION

The Bureau of Land Management (BLM) received a request from ConocoPhillips Alaska, Inc. (the Proponent) on May 10, 2018, to prepare the Willow Master Development Plan (MDP) Environmental Impact Statement (EIS). The Proponent is proposing the MDP to construct infrastructure components for drill sites, roads, pipelines, and ancillary facilities to support the safe and economic production and transportation to market of oil and gas resources under leaseholds in the National Petroleum Reserve in Alaska (NPR-A) (Figure ES.1). If the development proposal is approved in the Record of Decision (ROD) , the Proponent may submit permit applications for up to five drill sites, a central processing facility, an operations center pad, up to 37.0 miles of gravel roads, up to 699.9 total miles of ice roads during construction and up to 262.5 total miles of resupply ice roads during operations, one to two airstrips, up to 385.5 miles of pipelines (on 94.4 miles of new piperack), and a gravel mine site on federal land in the NPR-A. The Willow MDP Project (Project) would also include the transportation of modules and construction materials via barges to the North Slope of Alaska. In addition, two of the module delivery options would require the Proponent to submit applications to the State of Alaska for a module transfer island (MTI) on State of Alaska submerged lands. Actions on both state and federal lands are considered in the EIS. The Project is anticipated to have a peak production in excess of 160,000 barrels of oil per day (with a processing capacity of 200,000 barrels of oil per day) over its 30- or 31-year life (varies by alternative), producing approximately 586 million barrels of oil.

The Naval Petroleum Reserves Production Act, as amended (NPRPA), requires the Secretary of the Interior to conduct oil and gas leasing in the NPR-A. Congress authorized petroleum production in the NPR-A in 1980 (PL 96-514), but it was not until the 1990s that development on adjacent state lands made exploration in the NPR-A economically feasible. In 1998, BLM completed an Integrated Activity Plan (IAP) that assessed the potential use of the Northeast NPR-A for oil development (BLM 1998). The 1998 IAP was amended in 2005 and supplemented in 2008 (BLM 2005, 2008b). In 2012, BLM completed an IAP/EIS that analyzed development scenarios and related environmental consequences for all BLM-managed federal lands and oil and gas resources within the NPR-A (BLM 2012b). The IAP/EIS ROD was issued in 2013 (BLM 2013a). A revised IAP/EIS was released in 2020 (BLM 2020a), the ROD is forthcoming. The Willow MDP EIS tiers to the 2012 and 2020 IAP/EISs.

2.0 PURPOSE AND NEED

The purpose of the Proposed Action is to construct the infrastructure necessary to allow the production and transportation to market of federal oil and gas resources under leaseholds in the northeast area of the NPR-A, consistent with the proponent's federal oil and gas lease and unit obligations. The need for federal action (i.e., issuance of authorizations) is established by BLM's responsibilities under various federal statutes, including the NPRPA (as amended) and the Federal Land Policy and Management Act as well as various federal responsibilities of cooperating agencies under other statutes, including the Clean Water Act (CWA). Under the NPRPA, BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). BLM is required to respond to the Proponent's requests for an MDP and related authorizations to develop and produce petroleum in the NPR-A.

The U.S. Army Corps of Engineers (USACE), as a cooperating agency on the EIS, develops its own overall purpose for the Project in accordance with its Section 404 CWA regulations. The overall purpose of the Project, as defined by USACE, is to construct infrastructure to safely produce, process, and transport commercial quantities of liquid hydrocarbons to market via pipeline from the Willow reservoir. The overall Project purpose and need allows a robust consideration of alternatives while providing a foundation to determine practicability, which is a key aspect of the Section 404 permitting process. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall Project purposes (40 CFR 230.10(a)(2)).

The purpose and need of the Proposed Action is a key factor in determining a range of alternatives required for consideration in an EIS and assists with the selection of a preferred alternative. The Final EIS presents a reasonable range of alternatives that consists of a No Action Alternative and three action alternatives, together with three sealift module delivery options. The Final EIS analyzes the environmental impacts of these alternatives and informs how well each alternative meets the Project purpose and need.

3.0 DECISION TO BE MADE

BLM and other authorizing cooperating agencies will, in their respective ROD(s), decide whether to approve the Willow MDP and the associated issuance of permits and rights-of-way for the construction of the development plan, in whole or in part, based on the analysis contained in the EIS. The ROD(s) associated with the EIS will not constitute the final approval for all actions, such as approval for subsequent individual applications for permits to drill and rights-of-way associated with the Proposed Action. The EIS analysis does, however, provide BLM and other federal agencies that have regulatory oversight and permitting authorities with information and the National Environmental Policy Act (NEPA) analysis that could be used to inform final approvals for individual Project components, such as specific permits to drill and rights-of-way.

4.0 PROJECT AREA

The Willow MDP area (Project area or Willow area) is located on the North Slope of Alaska, with the majority of the proposed facilities on leased federal lands within the northeastern portion of the NPR-A (Figure ES.2). Supporting infrastructure, including road connections, pipeline tie-ins, MTI, and the gravel mine site would be located on federal and Native corporation–owned lands located in the Greater Mooses Tooth (GMT) Unit, on un-unitized lands within the NPR-A, on private lands owned by Kuukpik Corporation (Kuukpik), and on lands or waters owned and managed by the State of Alaska. None of the facilities would be located on or near Native allotments. Where possible, Project pipelines would be colocated with existing pipelines on federal, State, and Native corporation land.

Elements of the Project would occur within the Teshekpuk Lake Special Area of the NPR-A (as defined in both the 2013 IAP/EIS ROD [BLM 2013a] and the 2020 IAP/EIS [BLM 2020a]), which was designated by the Secretary of the Interior in 1977 for its significant value to waterfowl and shorebirds. The designation has since been expanded to protect caribou and waterbirds, and their habitats.

5.0 SCOPING AND ISSUES

BLM identified substantive issues to be addressed in the Willow MDP EIS through public and agency scoping (including internal BLM scoping) and consultation with Alaska Native tribes (Appendix B.1, *Scoping Process and Comment Summary*). As part of the Project scoping process, the BLM considered public and agency comments received during scoping meetings, and in consultation with Alaska Native Tribes. The original scoping period was 30 days; however, it was extended by 14 days due to public requests and officially ended on September 20, 2018. The community of Nuiqsut was given an additional 8 days to comment, for a total of 52 days. Public scoping meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Fairbanks, Nuiqsut, and Utqiaġvik (Barrow). The scoping summary report is provided in Appendix B.1.

Issues identified during scoping included potential impacts to caribou and other wildlife species, wildlife migration patterns and habitat fragmentation, special areas protected under the IAP (BLM 2012c), subsistence use and traditional ways of life, stakeholder engagement, alternatives development, and the long-term effects of climate change. These and other issues raised are addressed in the EIS.

6.0 CHANGES SINCE THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The Draft EIS comment period began on August 30, 2019. The comment period was open for 45 days and subsequently extended for 15 additional days, ending on October 29, 2019. Meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Fairbanks, Nuiqsut, and Utqiaġvik (Barrow). The Nuiqsut meeting included the public hearing for comments regarding the Project's potential impacts to subsistence resources and activities per Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA). BLM received written comments by mail, fax, email, online comment form via ePlanning, and handwritten and verbal testimony at public meetings.

Following publication of the Draft EIS, and in response to public comments and concerns raised during the public comment period for the Draft EIS, the Proponent presented BLM with design updates to the Project. A Supplement to the Draft EIS (SDEIS) was published on March 20, 2020, with additional analysis for three new Project components that presented substantial changes to the proposed action: a third sealift module delivery option, Option 3: Colville River Crossing, a constructed freshwater reservoir (CFWR), and up to three boat ramps for subsistence access. The Proponent provided additional project design updates; however, the changes were not expected to substantively change the overall analysis or results described in Chapter 3.0 of the Draft EIS and were not addressed in the SDEIS. This Final EIS incorporates all design changes into the Project analyses and considers public comments, feedback received from cooperating agencies, and testimony received during public meetings, for both the Draft EIS and the SDEIS. Key changes since the Draft EIS are summarized in the Final EIS Section 1.9, *Environmental Impact Statement Process and Changes Since Publication of the Draft Environmental Impact Statement.*

Various other clarifications, corrections, additions, and minor revisions to the alternatives considered and the impacts analysis were made throughout the EIS and the appendices to improve the discussion of the affected environment, to improve the analysis of potential impacts, to correct typographical errors, and to address comments and recommendations from the public, cooperating agencies, tribes, and the affected communities.

Details regarding public engagement for all stages of the NEPA process, including the Draft EIS and SDEIS, and responses to substantive comments are included in Appendix B*, Public Engagement and Comment Response*.

7.0 ALTERNATIVES

The range of alternatives developed for detailed analysis in the EIS consists of the No Action Alternative (Alternative A) and three action alternatives (Alternatives B, C, and D) (Figures ES.2 and ES.3); additionally, three sealift module delivery options (Options 1, 2 and 3) are included (Figure ES.2). All action alternatives and options were evaluated for their ability to meet the Project purpose and need and other screening criteria. Chapter 2.0, *Alternatives*, of the EIS describes the action alternatives, module delivery options, and Project features common to all action alternatives. The Project updates were applied to all action alternatives, and are summarized in Appendix D.1, Section 3.1.6, *Updates to Alternatives since the Draft Environmental Impact Statement*. Detailed descriptions of the Project updates are included in Section 4.2, *Project Components Common to All Action Alternatives*, through Section 4.7.3, *Option 3: Colville River Crossing*. A detailed description of the alternatives development process, screening criteria, and alternative elements considered but eliminated from further analysis, as well as each alternative and option, is included in Appendix D.1, *Alternatives Development*.

Activity in the NPR-A is subject to a variety of lease stipulations (LSs) and best management practices (BMPs) intended to reduce effects from development activity. In addition to the 2013 LSs and BMPs (BLM 2013a), BLM is revising the NPR-A IAP (BLM 2020a), including potential changes to required BMPs (described as required operating procedures [ROPs] in BLM 2020a). Updated ROPs adopted in the new NPR-A IAP will replace existing BMPs (BLM 2013a); however, applicable LSs would not change because LSs are fixed at the time of lease issuance. Some requirements may apply as either a LS or BMP/ROP. If the activity is based on lease rights, the LS would govern and could not be superseded by a BMP/ROP; otherwise, the requirement would apply as a BMP/ROP. The terms BMPs and ROPs are used interchangeably throughout this EIS. All projects are subject to BMPs/ROPS that are in place at the time a permit for development is issued. (The reader is referred to Section 2.2.7, *Lease Stipulations, Required Operating Procedures, and Lease Notices*, of the 2020 IAP/EIS for further discussion on this topic.) The Willow MDP ROD will detail which of the measures will be implemented for the Project.

7.1 Alternative A: No Action Alternative

Under Alternative A, the Project would not be constructed; however, oil and gas exploration in the area would continue. Under the NPRPA, BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). Alternative A is included in the analysis for baseline comparison, but BLM does not have the authority to select this alternative because CPAI's leases are valid and provide the right to develop the oil and gas resources therein.

7.2 Alternative B: Proponent's Project

Alternative B would extend an all-season gravel road from the Greater Mooses Tooth 2 (GMT-2) development southwest toward the Project area. Gravel roads would connect to all Project facilities, including the Willow Processing Facility (WPF), Willow Operations Center (WOC), airstrip, and all five drill sites (Bear Tooth [BT] drill sites 1 [BT1], 2 [BT2], 3 [BT3], 4 [BT4], and 5 [BT5]). Additional Project support facilities would include a CFWR, four valve pads, four pipeline pads, two water source access pads (at the CFWR and Lake L9911), eight road turnouts (with subsistence access ramps), horizontal directional drilling (HDD) pipeline pads at the Colville River, and up to three boat ramps for subsistence use (added to the Project by CPAI as mitigation to help offset Project effects on the community of Nuiqsut – see Section 2.5.13, *Boat Ramps for Subsistence Users*). Alternative B would have a 454.1-acre gravel footprint with gravel sourced from the Project-developed Tiŋmiaqsiuġvik Mine Site.

Alternative B would construct 37.0 miles of gravel road and 7 bridges. Infield (multiphase) pipelines would connect individual drill sites to the WPF and export/import pipelines would connect the WPF to existing infrastructure on the North Slope. Diesel fuel would be piped from Kuparuk River Unit (Kuparuk) CPF2 to the Alpine Central Processing Facility and then trucked to the Project area. Seawater would be piped from Kuparuk CPF2 to the WPF. Alternative B would also include a pipeline tie-in pad near the Alpine development's drill site 4N and an expansion of the existing pad at Kuparuk CPF2. Sealift module delivery to the Project area would be required. Details on these options are included in Section 2.6, *Sealift Module Delivery Options*.

The alternative was developed by the Proponent to provide a gravel access road from the existing gravel road network in the GMT and Alpine developments to the Project facilities. The all-season gravel access road connection to the Alpine development would allow for additional operational safety and risk reduction by providing redundancies and additional contingencies for each project and would support potential future development. Alternative B is BLM's preferred alternative.

7.3 Alternative C: Disconnected Infield Roads

Alternative C would include the same gravel access road between GMT-2 and the Project area as Alternative B, but it would not have a gravel road connection from the WPF to BT1. A gravel road would connect BT1 with BT2 and BT4 using the same alignment as Alternative B, for a total of 35.3 miles of gravel roads with six bridges. The WPF, South WOC, and primary Project airstrip would be located approximately 5 miles east of their location in Alternative B, near the eastern Bear Tooth Unit boundary.

A second airstrip, storage and staging facilities, and WOC would be located near BT2 to accommodate the personnel and materials transported between the South WOC and the North WOC and BT1/BT2/BT4.

A 3.6-mile-long annual ice road would be constructed along the Alternative B gravel road alignment for the life of the Project to allow for the movement of large equipment and consumable materials to BT1/BT2/BT4. Infield pipelines would connect all drill sites to the WPF; a diesel pipeline would provide fuel from Kuparuk CPF2 to the North and South WOCs; and export/import lines would connect the WPF to existing infrastructure on the North Slope.

Alternative C Project infrastructure and facilities would require a 507.6-acre gravel footprint and would also include four valve pads (two would be sized to be helicopter accessible at Judy [Iqalliqpik] Creek), four pipeline pads, three water source access pads (at the CFWR and Lakes L9911 and M0235), eight road turnouts (with subsistence access ramps), HDD pipeline pads at the Colville River, one boat ramp, expansion of the existing gravel pad at Kuparuk CPF2, and a sealift module delivery option. Gravel would be sourced from the Project-developed Tiŋmiaqsiuġvik Mine Site.

The intent of Alternative C is to reduce effects to caribou movement and decrease the number of stream crossings required; this is also intended to further reduce impacts to subsistence users of these resources, and reduce impacts to hydrology and wetlands.

7.4 Alternative D: Disconnected Access

Alternative D would colocate the WPF with BT3, construct four additional drill sites, WOC, pipeline and valve pads, CFWR, two water source access road and pads at the CFWR and Lake M0235, gravel roads connecting Project facilities, six bridges, an airstrip, a staging pad near GMT-2, one boat ramp, and an expansion of the existing gravel pads at the Alpine development's drill site 1 and at Kuparuk CPF2. There would be a total gravel footprint of 444.3 acres with gravel sourced from the Project-developed Tiŋmiaqsiuġvik Mine Site. Alternative D would not be connected by an all-season gravel access road to the GMT and Alpine developments; but it would employ the other gravel roads as proposed under Alternative B to connect drill sites with other Project infrastructure. Annual resupply access to the Project area would be provided by ice road connection between GMT-2 and the WPF (12.5 miles) for the life of the Project.

The intent of Alternative D is to minimize the Project's footprint and fill, reduce the number of required bridges (six versus 7), and lessen the length of linear infrastructure on the landscape to decrease effects to caribou movement and subsistence. This alternative's reduction of linear gravel infrastructure in the Project area may also reduce impacts to hydrology (e.g., sheet flow) and wetlands (e.g., direct fill, indirect impacts from dust).

7.5 Sealift Module Delivery Options

A total of nine sealift barges are anticipated for the Project to deliver large, prefabricated modules to the North Slope. Three module delivery options are analyzed (Figure ES.2): Option 1, Option 2, and Option 3. Two options would construct a gravel island (i.e., an MTI) west of the Colville River, and then use ice roads to transport the modules to their gravel pads. The MTI would have a 5- to 10-year design life. A third option would deliver the modules to the existing Oliktok Dock and not require an MTI. This option would use existing Kuparuk gravel roads and Project-specific ice roads to move the modules to the Project area using an ice bridge to cross the Colville River near Ocean Point. Any of the module delivery options could be coupled with any of the three action alternatives. Appendix D.1, *Alternatives Development*, includes additional details for each option.

7.5.1 Option 1: Atigaru Point Module Transfer Island

Option 1 would construct an MTI approximately 2.4 miles offshore in Harrison Bay near Atigaru Point to support sealift module delivery. The MTI would be constructed from gravel sourced from the Tiŋmiaqsiuġvik Mine Site and would provide an approximately 8.3-acre gravel work surface with a 12.8-acre gravel footprint. MTI slopes would be armored with gravel bags and a 200-foot-long sheet pile dock face would facilitate barge offloading. Modules would be barged to the MTI in the summer and stored until the following winter when they would be transported to the Project area via ice road. A total of

110.8 miles of ice road would be needed. The summer following the final sealift module delivery, the island would be abandoned, and all facilities and anthropogenic materials would be removed, including the gravel slope protection. It is anticipated the top of the island would drop below the water surface in 10 to 20 years following abandonment as it is reshaped by ice and waves. The intent of this option is to provide the shortest delivery route without requiring dredging or additional marine impacts.

7.5.2 Option 2: Point Lonely Module Transfer Island

Option 2 would construct a similarly sized (13.0-acre gravel footprint) MTI at Point Lonely, approximately 0.6 mile offshore from the former U.S. Department of Defense site. A total of 225.2 miles of ice roads would be needed to construct the MTI and transport the sealift modules to the Willow area over 3 winter construction seasons. The intent of this option is to move the MTI away from Nuiqsut's high subsistence use area, and to use existing onshore gravel infrastructure at Point Lonely for staging purposes.

7.5.3 Option 3: Colville River Crossing

Option 3 is the Proponent's proposed module delivery option and it would use the existing Oliktok Dock to receive the sealift barges. Modules would then be transported over existing Kuparuk gravel roads to a staging area near Kuparuk drill site 2P (DS2P); 5.0 acres of gravel footprint expansion would be required to accommodate module movement. From Kuparuk DS2P, the modules would then be moved by heavy-haul ice roads to GMT-2, crossing the Colville River on a partially grounded ice bridge near Ocean Point. From GMT-2, the modules would be transported to the Project area over Project gravel roads (Alternatives B and C) or ice roads (Alternative D) to reach the WPF and drill site gravel pads. A total of 80.2 miles of ice road would be needed. This option was developed in response to discussions with stakeholders with the intent of reducing impacts associated with MTI construction and vessel traffic through key marine harvesting areas in Harrison Bay. Option 3 is BLM's preferred module delivery option.

8.0 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Chapter 3.0, *Affected Environment and Environmental Consequences,* of the EIS details the affected environment for social, physical, and biological resources and the potential environmental impacts associated with each of the alternatives and module delivery options. Potential impacts for each resource are described in terms of type, context, duration, and intensity.

Table ES.1 summarizes and compares key potential environmental impacts on resources and uses for each action alternative. Table ES.2 provides a summary comparison of key impacts for sealift module delivery options. For more information on all potential impacts, please refer to Chapter 3.0 of the EIS.

Table ES.1. Summary Comparison of Key Impacts by Action Alternative

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Total Project footprint and gravel fill volume	Soil disturbance and permafrost thaw Consumption of gravel resources Changes to undisturbed characteristic visual landscape including night skies Wetlands lost within fill footprint Habitat loss for fish, birds, caribou, and polar bears in certain areas Disturbance and displacement of birds, caribou, and polar bears Subsistence hunter avoidance	454.1 acres of gravel fill using 4.9 million cubic yards of gravel 607.0 acres of wetlands and 5.2 acres of freshwater waterbodies impacted by gravel fill or excavation (e.g., mine site) 12.1 acres of screeding 18,759.5 acres of disturbance for birds[a] (10,838.9 in high-use areas) Lesser potential for subsistence hunter avoidance due to infrastructure footprint. Lesser direct loss of subsistence use areas due to reduction in overall infrastructure footprint.	507.6 acres of gravel fill using 5.8 million cubic yards of gravel 663.9 acres of wetlands and 5.8 acres of freshwater waterbodies impacted by gravel fill or excavation (e.g., mine site) 12.1 acres of screeding 19,245.1 acres of disturbance for birds[a] (10,867.7 in high-use areas) Greatest potential for subsistence hunter avoidance due to larger infrastructure footprint. Greatest direct loss of subsistence use areas due to increase in overall infrastructure footprint.	444.3 acres of gravel fill using 5.9 million cubic yards of gravel 597.8 acres of wetlands and 7.8 acres of freshwater waterbodies impacted by gravel fill or excavation (e.g., mine site) 12.1 acres of screeding 17,873.3 acres of disturbance for birds[a] (10,110.4 in high-use areas) Least potential for subsistence hunter avoidance due to infrastructure footprint. Least direct loss of subsistence use areas due to reduction in overall infrastructure footprint.
Location of Willow Processing Facility, Willow Operations Center, and airstrip	Perceived differences in air quality effects (Alternative C would be closer to Nuiqsut) Disturbance and displacement of caribou (some Alternative C components would be in an area of lower caribou density)	Near the airstrip and approximately 5 miles east of BT3 The infield road could funnel caribou movement along the west side of the road and toward the airstrip and WPF during fall migration south.	Near the south airstrip and approximately 5 miles east of BT3 Decreased potential for deflection of migrating caribou since it would remove the perpendicular intersection of access and infield roads, which could be a pinch-point for caribou movement. Caribou are less likely to be funneled into the area by the infield road. WPF, WOC, and southern airstrip would be further east, in an area with lower densities of caribou. Because fewer caribou use this area, disturbance and displacement due to noise and human activity from these facilities would affect fewer caribou.	WPF colocated with BT3 Decreased potential for deflection of migrating caribou, especially near the WPF, since it would remove the perpendicular intersection of access and infield roads. Caribou moving south along the east side of the infield roads during southerly movements in the fall would not have to cross a road, which would lower the probability of delays or deflections.

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Ice infrastructure	Potential impoundments during spring breakup Vegetation and soil compaction Habitat alteration for birds, caribou, and marine mammals Increased displacement or mortality of birds, caribou, and other wildlife due to increased subsistence access Changes to subsistence access	Approximately 495.2 total miles (3,590.7 total acres) of ice roads over nine construction seasons No annual resupply ice road 936.6 acres of single season ice pads; 30.0 acres of multi-season ice pads 4,557.3 total acres of ice infrastructure 20.0 acres in polar bear critical habitat Least amount of ice roads for subsistence access	Approximately 650.1 total miles (4,411.6 total acres) of ice roads: 574.5 miles over nine construction seasons 3.6 miles of annual resupply ice road (15.3 acres) (2030 to 2050; 75.6 total miles; 321.3 total acres) 1,166.4 acres of single season ice pads; 30.0 acres of multi-season ice pads 5,608.0 total acres of ice infrastructure 20.0 acres in polar bear critical habitat More ice roads for subsistence access	Approximately 962.4 total miles (5,893.4 total acres) of ice roads: 699.9 miles (4,780.4 acres) over ten construction seasons 12.5 miles (55.7 acres) of annual resupply ice road (2030 to 2051; 262.5 total miles; 1,113.0 total acres) 1,241.4 acres of single season ice pads; 30.0 acres of multi-season ice pads 7,164.8 total acres of ice infrastructure 20.0 acres in polar bear critical habitat Most miles of ice road for subsistence access
Pipelines	Changes to undisturbed characteristic visual landscape including night skies Habitat alteration for birds, caribou, and polar bears Collision potential for birds Delayed or deflected movement of caribou from new linear infrastructure Increased insect relief habitat for caribou Risk of spills	97.5 total miles of pipeline rack 94.4 miles on new VSMs 3.1 miles on existing VSMs 0.9 mile HDD 314.2 total miles of individual pipelines 40.7 miles of pipeline without a parallel road Other pipelines: 64.3-mile seawater pipeline 34.4-mile diesel pipeline Diesel trucked by road: 37.5 miles	98.5 total miles of pipeline rack 95.4 miles on new VSMs 3.1 miles on existing VSMs 0.9 mile HDD 383.7 total miles of individual pipelines 45.5 miles of pipeline without a parallel road Other pipelines: 63.3-mile seawater pipeline 82.0-mile diesel pipeline Diesel trucked by road: 0 miles	98.1 total miles of pipeline rack 95.0 miles on new VSMs 3.1 miles on existing VSMs 0.9 mile HDD 373.9 total miles of individual pipelines 47.9 miles of pipeline without a parallel road Other pipelines: 69.2-mile seawater pipeline 77.0-mile diesel pipeline Diesel trucked by road: 0 miles
Gravel roads	Changes to undisturbed characteristic visual landscape Upslope water impoundment and thermokarst erosion Potential blockage or restriction of sheet flow during spring breakup, that could result in changed flow direction, channel instability, erosion of the tundra or stream channel, or deposition of sediment on the tundra or in the stream channel Disturbance and displacement of birds, caribou, and polar bears Delayed or deflected movement of caribou from new linear infrastructure Changes to subsistence access and resource availability	37.0 total miles (260.2 total acres, including turnouts) Eight turnouts with subsistence/tundra access ramps (3.0 acres total) Most gravel roads for subsistence access	35.3 total miles (243.2 total acres, including turnouts) Eight vehicle turnouts with subsistence/tundra access ramps (3.0 acres total) Fewer gravel roads for subsistence access	27.1 total miles (188.9 total acres, including turnouts) Six turnouts with subsistence/tundra access ramps (2.2 acres total) Fewest gravel roads for subsistence access

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Dust shadow from gravel roads[b]	Soil composition changes, decreased albedo, permafrost thawing, thermokarst development Vegetation damage Wetland composition changes Habitat alteration for fish, birds, caribou, and polar bears	3,472.7 total acres (includes mine site) 3,310.5 acres in wetlands 95.6 acres in freshwater waterbodies 66.6 acres in uplands	3,469.3 total acres (includes mine site) 3,340.4 acres in wetlands 86.9 acres in freshwater waterbodies 42.0 acres in uplands	2,680.9 total acres (includes mine site) 2,542.7 acres in wetlands 80.0 acres in freshwater waterbodies 58.2 acres in uplands
Stream crossings (culverts and bridges)	Hydrologic changes or erosion Perceived potential contamination of fish and thus decreased subsistence resource availability Increased noise during construction Changes to undisturbed characteristic visual landscape Habitat loss for fish in certain areas	18 crossings: 7 bridges 11 culvert batteries 36 bridge piles below OHW (all in anadromous streams) 0 VSMs below OHW	16 crossings: 6 bridges 10 culvert batteries 20 bridge piles below OHW (all in anadromous streams) 10 VSMs below OHW	14 crossings: 6 bridges 8 culvert batteries 36 bridge piles below OHW (all in anadromous streams) 0 VSMs below OHW
Airstrip	Increased noise Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and polar bears	1 airstrip and apron (42.1 acres) near the WOC (approximately 5 miles east of BT3	2 airstrips (87.6 total acres): North airstrip and hangar (43.8 acres) near BT2 South airstrip and apron (43.8 acres), approximately 5 miles east of BT3	1 airstrip and apron (44.7 acres) near BT3/WPF
Total freshwater use	Temporary changes to lake-water chemistry (until spring breakup and recharge) by depleting oxygen and changing pH and conductivity Habitat alteration for fish and birds Special status species: yellow-billed loon nesting lakes	1,662.4 million gallons over the life of the Project (30 years)	1,914.3 million gallons over the life of the Project (30 years)	2,286.3 million gallons over the life of the Project (31 years)
Ground traffic[c, d,]	Increased noise Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and polar bears Injury or mortality of birds, caribou, and polar bears	3,188,910 vehicle trips	4,212,510 vehicle trips	4,376,890 vehicle trips
Fixed-wing air traffic[c, ef]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	12,101 total fixed-wing flights Willow: 11,809 Alpine: 292	19,574 total fixed-wing flights South Willow: 13,201 North Willow: 6,081 Alpine: 292	19,038 total fixed-wing flights Willow: 15,387 Alpine: 3,651

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Helicopter air traffic[c]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	2,421 total flights Willow: 2,321 Alpine: 100	2,910 total flights South Willow: 2,421 North Willow: 357 Alpine: 132	2,503 total flights Willow: 2,403 Alpine: 100
Human activity	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals	30-year Project duration (9 years of construction) 1,168.1 acres of polar bear disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)	30-year Project duration (9 years of construction) 1,188.4 acres of polar bear disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)	31-year Project duration (10 years of construction) 1,250.4 acres of polar bear disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)
Greenhouse gas emissions	Climate change and air quality (GHG emissions for the Project duration are measured as CO_2e in Mt/annual average)	Total GHG emissions are 258,766 Mt of gross CO_2e for 30-year Project duration (using 100-year GWP, IPCC AR4) Annual average total (i.e., sum of direct and indirect) GHG emissions (8,626 Mt CO_2e per year) constitute approximately 0.134% of the 2017 U.S. GHG inventory.	Total GHG emissions are 260,936 Mt of gross CO_2e for 30-year Project duration (using 100-year GWP, IPCC AR4) Annual average total (i.e., sum of direct and indirect) GHG emissions (8,698 Mt CO_2e per year) constitute approximately 0.135% of the 2017 U.S. GHG inventory.	Total GHG emissions are 258,873 Mt of CO_2e for gross 31-year Project duration (using 100-year GWP, IPCC AR4) Annual average total (i.e., sum of direct and indirect) GHG emissions (8,351 Mt CO_2e per year) constitute approximately 0.129% of the 2017 U.S. GHG inventory.

Note:AR4 (Fourth Assessment Report); BT2 (drill site BT2); BT3 (drill site BT3); CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); HDD (horizontal directional drilling); IPCC (Intergovernmental Panel on Climate Change); Mt (thousand metric tons); OHW (ordinary high water); USFWS (U.S. Fish and Wildlife Service); VSM (vertical support members); WOC (Willow Operations Center); WOUS (Waters of the U.S.); WPF (Willow processing facility).

[a] Based on a 656-foot (200-meter) disturbance zone around gravel facilities.

[b] Area potentially altered by dust generated from vehicles or wind on gravel fill extending 328 feet (100 meters) from gravel infrastructure.

[c] Total traffic is for the life of the Project (Alternatives B and C, 30 years; Alternative D, 32 years) and does not include any reclamation activity. Ground-traffic trips are one-way. A single flight is defined as a landing and subsequent takeoff, and a single vessel trip is defined as docking and subsequent departure.

[d] Number of trips includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Construction ground traffic also includes gravel hauling (e.g., B70 or maxi dump trucks).

[e] Flights outlined are additional flights required beyond projected travel to/from non-Project airports (e.g., Anchorage, Fairbanks, Deadhorse); includes C-130, Twin Otter or CASA, Cessna, and DC-6 or similar aircraft.

Table ES.2. Summary Comparison of Key Impacts by Sealift Module Delivery Option

Project Component	Resources Affected	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Total gravel footprint and gravel fill volume	Consumption of gravel resources Changes to undisturbed characteristic visual landscape including night skies Wetlands and/or WOUS lost within fill footprint Habitat loss and disturbance and displacement for fish, birds, and marine mammals in certain areas Subsistence harvester avoidance	12.8 acres of gravel fill using 397,000 cubic yards of gravel in the marine environment 14.5 acres of screeding	13.0 acres of gravel fill using 446,000 cubic yards of gravel in the marine environment 14.5 acres of screeding	5.0 acres of gravel fill using 118,700 cubic yards of gravel (4.9 acres in wetlands) No additional screeding beyond that needed for the action alternatives

Project Component	Resources Affected	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Location	Disturbance and displacement of caribou Subsistence harvester avoidance Reduced availability of subsistence resources (Ranked the same for subsistence since there are positive and negative outcomes for each location)	1.9 miles offshore Farther offshore from high-density caribou areas. No onshore activities in summer, 1 multi-season ice pad would remain (12.5 miles from high-density caribou post-calving and 1.9 miles from high-density oestrid fly relief). Greatest potential for offshore avoidance by Nuiqsut hunters. Impacts are most likely to occur for Nuiqsut harvesters (up to 94% directly affected); impacts may occur for Utqiaġvik but are less likely (up to 11% directly affected).	0.4 mile offshore Summer onshore activities in an area of high use by caribou for insect relief (end of June to beginning of August). Closer to Teshekpuk Lake. Could disturb more caribou, especially in July. Closest to or within high-density caribou areas (post-calving 0.9 miles and insect relief 0 miles). Greater potential for indirect impacts to caribou availability for Nuiqsut and Utqiaġvik due to increased disturbance of caribou in critical habitat areas. Greater potential for indirect impacts to caribou, wolf, and wolverine resource availability for Utqiaġvik harvesters. Less potential for offshore and coastal impacts to Nuiqsut harvester access since the MTI would be farther from core Nuiqsut seal, eider, and coastal caribou harvesting areas. Impacts are most likely to occur for Nuiqsut harvesters (up to 94% directly affected); impacts may occur for Utqiaġvik but are less likely (up to 23% directly affected). More likely than Option 1 to cause indirect impacts to Utqiaġvik harvesters because of its proximity to key Utqiaġvik harvesting areas at Teshekpuk Lake.	0.0 mile offshore Farthest away from high-density caribou areas (post-calving 47.1 miles and insect relief 32.4 miles). Impacts are most likely to occur for Nuiqsut harvesters (up to 91% directly affected); impacts may occur for Utqiaġvik but are less likely (up to 15% directly affected). Less potential for offshore and coastal impacts to Nuiqsut harvester access and resource availability since no MTI would be built and associated offshore activities would occur in areas of existing development activity and infrastructure.
Closest proximity of summer construction to high-density caribou areas	Disturbance and displacement of caribou	12.5 miles to high-density caribou post-calving 9.6 miles to high-density caribou mosquito relief 1.5 miles to high-density caribou oestrid fly relief	0.9 miles to high-density caribou post-calving (greater disturbance of caribou during post-calving) 0.0 miles to high-density caribou mosquito relief (greater disturbance of caribou during insect relief) 0.0 miles to high-density caribou oestrid fly relief (greater disturbance of caribou during insect relief)	47.1 miles to high-density caribou post-calving 46.3 miles to high-density caribou mosquito relief 32.4 miles to high-density caribou oestrid fly relief

Project Component	Resources Affected	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Ice roads	Potential impoundments during spring breakup Vegetation and soil compaction Habitat alteration for birds, caribou, and marine mammals Increased displacement or mortality of birds, caribou, and other wildlife due to increased subsistence access. Changes to subsistence access	110.8 total miles (795.0 acres) : Total gravel haul (1 season): 35.2 miles on tundra; 2.4 miles on sea ice Total module transport (over 2 seasons): 68.4 total miles on tundra; 4.8 miles on sea ice 73% in the TLSA 60.3% in polar bear critical habitat Potential for hunter avoidance of infrastructure and impacts to harvester access due to presence of ice roads in key Nuiqsut geese hunting areas along Fish Creek.	229.7 total miles (2,592.6 acres): Total gravel haul (1 season): 77.9 miles on tundra; 0.6 miles on sea ice Total module transport (over 2 seasons): 150.0 miles on tundra; 1.2 miles on sea ice 89% in the TLSA 16.5% in polar bear critical habitat Most forage damage for caribou Potential for hunter avoidance of infrastructure and impacts on harvester access due to presence of ice roads in key Nuiqsut goose hunting areas along Fish (Uvlutuuq) Creek.	80.2 total miles (583.2 acres): Total gravel haul (1 season): all on existing gravel roads Total module transport (over 2 seasons): 80.2 miles on tundra; 0 miles on sea ice 0% in the TLSA 0% in polar bear critical habitat Least forage damage for caribou Summer and fall caribou harvests less likely to be directly affected. Minimal disturbances to the CAH habitat; few CAH caribou present in winter. Overall fewer impacts to terrestrial mammals, including caribou than Options 1 and 2. Greater potential for direct impacts on Nuiqsut winter wolf and wolverine caribou hunters due to location of ice road within core hunting areas. One less winter ice road season (two winters); associated traffic less likely to deflect or disturb subsistence resources and subsistence harvesters from crossing. Least potential for impacts (compared to Options 1 and 2) to Utqiaġvik harvesters because the ice road is on the periphery of Utqiaġvik's subsistence use area (or overlaps use areas for summer/fall activities when winter ice roads would not be present).
Multi-season ice pads	Potential impoundments during spring breakup Vegetation and soil compaction Habitat alteration for birds, caribou, and marine mammals	Three 10.0-acre multi-season ice pads: One at BT1 One near Atigaru Point One midway between Atigaru Point and BT1	Three 10.0-acre multi-season ice pads: One at BT2 Two along ice road between BT2 and Point Lonely More potential to affect caribou in summer because more caribou use the area closer to Point Lonely	0.0-acre multi-season ice pads

Project Component	Resources Affected	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Total freshwater usage	Temporary changes to lake-water chemistry (until spring breakup and recharge) by depleting oxygen and changing pH and conductivity Habitat alteration for fish and birds Special status species: yellow-billed loon nesting lakes	307.9 million gallons	572.0 million gallons	257.2 million gallons
Ground traffic [a]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and polar bears Injury or mortality of birds Impacts to overland harvester access for Nuiqsut subsistence users	2,306,110 trips	3,196,450 trips	535,160 trips
Fixed-wing traffic[b]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	326 total flights (36 to Atigaru Point in summer): Willow: 205 Alpine: 25 Atigaru Point: 96	326 total flights (36 to Point Lonely in summer): Willow: 205 Alpine: 25 Point Lonely: 96 Markedly greater disturbance of caribou during insect relief	70 total flights: Willow: 0 Alpine: 28 Kuparuk: 42 Least amount of disturbance to caribou, marine mammals, and birds
Helicopter traffic	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals and resulting impacts to resource availability for subsistence users Injury or mortality of birds	450 total flights Willow: 435 Alpine: 15	450 total flights Willow 435 Alpine 15	16 total flights to/from Alpine
Vessel traffic	Disturbance and displacement of fish, birds, and marine mammals and resulting impacts to resource availability for subsistence users	Nearshore barge route ~1,100 miles RT, support vessel route ~100 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons	Nearshore barge route ~1,000 miles RT, support vessel route ~200 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons	Nearshore barge route ~1,200 miles RT, support vessel route ~5.2 miles RT 9 barges, 16 tugboats, and 60 support vessels, 2 summer seasons
195-foot-tall communication tower	Injury or mortality of birds	2 towers	3 Towers	0 towers

Project Component	Resources Affected	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Human activity (construction camps with 100-person capacity)	Disturbance and displacement of birds, caribou, and marine mammals and resulting impacts to resource availability for subsistence users Impacts to harvester access for subsistence users due to avoidance and concerns about safety	Camp for winter ice road construction (each season) on a multi-season ice pad Camp for module offload and transport on multi-season ice pad at Atigaru Point Camp for summer construction and module receipt would be located on a barge (i.e., Floatel) at module transfer island	Camp for winter ice road construction (each season) on existing gravel pad Camp for module offload and transport at Point Lonely on existing gravel pad Camp for summer construction and module receipt at Point Lonely on existing gravel pad Markedly greater disturbance of caribou because activity would be onshore in summer in a location with more caribou.	Camp for winter ice road construction (each season) on a single-season ice pad near Kuparuk drill site 2P

Note: BT1 (drill site BT1); BT2 (drill site BT2); CAH (Central Arctic Herd); MTI (module transfer island); WOUS (Waters of U.S.). Traffic trips are defined as one-way; a single flight is defined as a landing and subsequent takeoff; and a single vessel trip is defined as a docking and subsequent departure.

[a] Includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Ground transportation also includes gravel hauling operations (i.e., B70 or maxi dump trucks) and module transportation.

[b] Flights outlined are additional flights required beyond projected travel to/from existing airstrips and include flights to the Alpine and Willow airstrips. Fixed-wing aircraft includes C-130, DC-6, Twin Otter or CASA, Cessna, or similar.

BLM’s evaluation of the effects of the Project and the cumulative effects of current and future activities on subsistence uses and needs, as required under Section 810 of Alaska National Interest Lands Conservation Act (ANILCA) is included in Appendix G, *Alaska National Interest Lands Conservation Act Section 810 Analysis*. BLM’s findings conclude that the Project is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. However, the evaluation concludes that the Project may significantly restrict uses for the community of Nuiqsut due to a reduction in the availability of resources caused by alteration of their distribution and limitation on subsistence user access to the area.

BLM’s findings conclude that the cumulative effects of past, present and reasonably foreseeable future activities, including those outside of NPR-A, may significantly restrict uses for Nuiqsut, Utqiaġvik, Anaktuvuk Pass, Atqasuk, and Wainwright due to a reduction in abundance of caribou caused by alteration of their distribution and degradation of habitat; Nuiqsut, Utqiaġvik, Wainwright, and Point Lay due to a reduction in availability of marine mammals caused by alteration of their distribution; and Nuiqsut due to a reduction in the availability of caribou and limitations on subsistence user access to the area.

A preliminary ANILCA Section 810 evaluation was published concurrent with the Draft EIS and a revised Section 810 was published concurrent with the SDEIS; public hearings were held to collect testimony from affected communities with a “may significantly restrict” finding during the Draft EIS and SDEIS public comment periods. Dates of public hearings are included in Appendices B.2 (*Draft Environmental Impact Statement Comments and BLM Responses*) and B.3 (*Supplement to the Draft Environmental Impact Statement Comments and BLM Responses*).

9.0 COLLABORATION AND COORDINATION

The BLM is the lead agency for this EIS. Cooperating agencies include the USACE, U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Native Village of Nuiqsut (NVN), the Iñupiat Community of the Arctic Slope (ICAS), City of Nuiqsut, North Slope Borough, and State of Alaska. The Federal Aviation Administration, Bureau of Ocean and Energy Management, National Marine Fisheries Service (NMFS), U.S. Coast Guard, and U.S. Department of Transportation (Pipeline and Hazardous Materials Safety Administration) were invited to be cooperating agencies but declined to participate.

As the lead federal agency, the BLM consulted with federally recognized tribal governments during preparation of the EIS. The BLM initiated the government-to-government consultation and Alaska Native Claims Settlement Act (ANCSA) corporation consultation with the following tribes and ANCSA corporations whose members could be substantially affected by the Project:

- NVN
- Naqsragmiut Tribal Council
- ICAS
- Kuukpik
- Arctic Slope Regional Corporation

The BLM offered these entities the opportunity to participate in formal consultation, to participate as cooperating agencies, or simply to receive information about the project, prior to public dissemination.

The BLM is consulting with the Alaska State Historic Preservation Office, in accordance with Section 106 of the National Historic Preservation Act of 1966. This is to determine if and how the Project could affect cultural resources listed in or eligible for listing in the National Register of Historic Places.

To comply with Section 7(a)(2) of the Endangered Species Act of 1973 (ESA), the BLM is consulting or has consulted with the USFWS and NMFS as appropriate, for species listed under the ESA. Both agencies provided input on issues, data collection and review, and alternatives development. Consultation with USFWS is occurring parallel to the NEPA process and will be completed prior to the issuance of any Record of Decision. Section 7 consultation with NMFS is completed and a letter of concurrence from NMFS was received July 15, 2020.

BLM's evaluation of the effects of the Project and the cumulative effects of current and future activities on subsistence uses and needs, as required under Section 810 of ANILCA is included in Appendix G, *Alaska National Interest Lands Conservation Act Section 810 Analysis*. A preliminary ANILCA Section 810 evaluation was published concurrent with the Draft EIS and a revised Section 810 was published concurrent with the SDEIS; public hearings were held to collect testimony from affected communities during the Draft EIS and SDEIS public comment periods. Dates of public hearings are included in Appendices B.2 (*Draft Environmental Impact Statement Comments and BLM Responses*) and B.3 (*Supplement to the Draft Environmental Impact Statement Comments and BLM Responses*).

This page intentionally left blank.

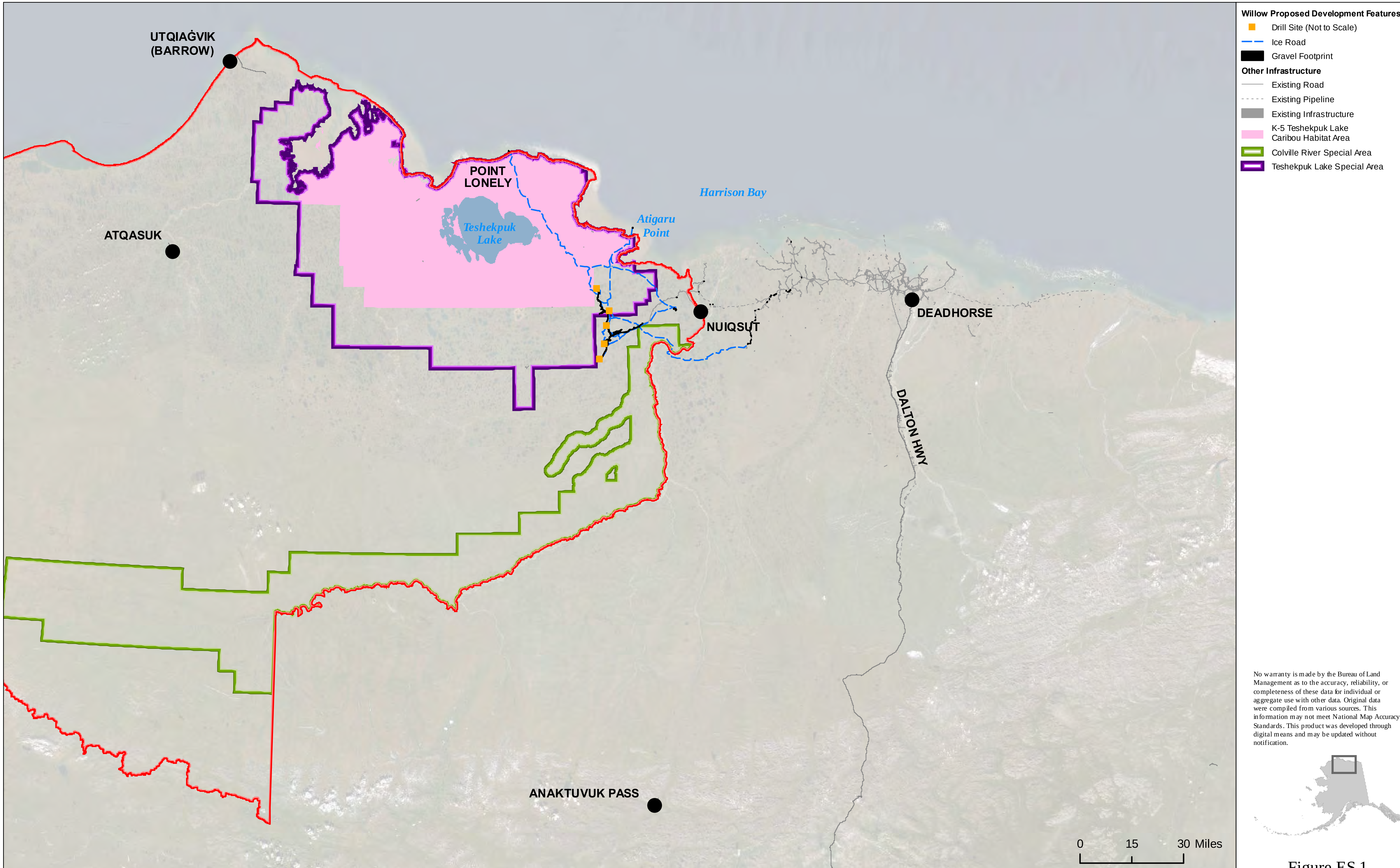
UTQIAĠVIK
(BARROW)
ATQASUK
POINT
LONELY
Teshekpuk
Lake
Harrison Bay
Atigaru
Point
NUIQSUT
DEADHORSE
DALTON HWY
ANAKTUVUK PASS
Willow Proposed Development Features
Drill Site (Not to Scale)
Ice Road
Gravel Footprint
Other Infrastructure
Existing Road
Existing Pipeline
Existing Infrastructure
K-5 Teshekpuk Lake
Caribou Habitat Area
Colville River Special Area
Teshekpuk Lake Special Area
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.
0
15
30 Miles

Figure ES.1

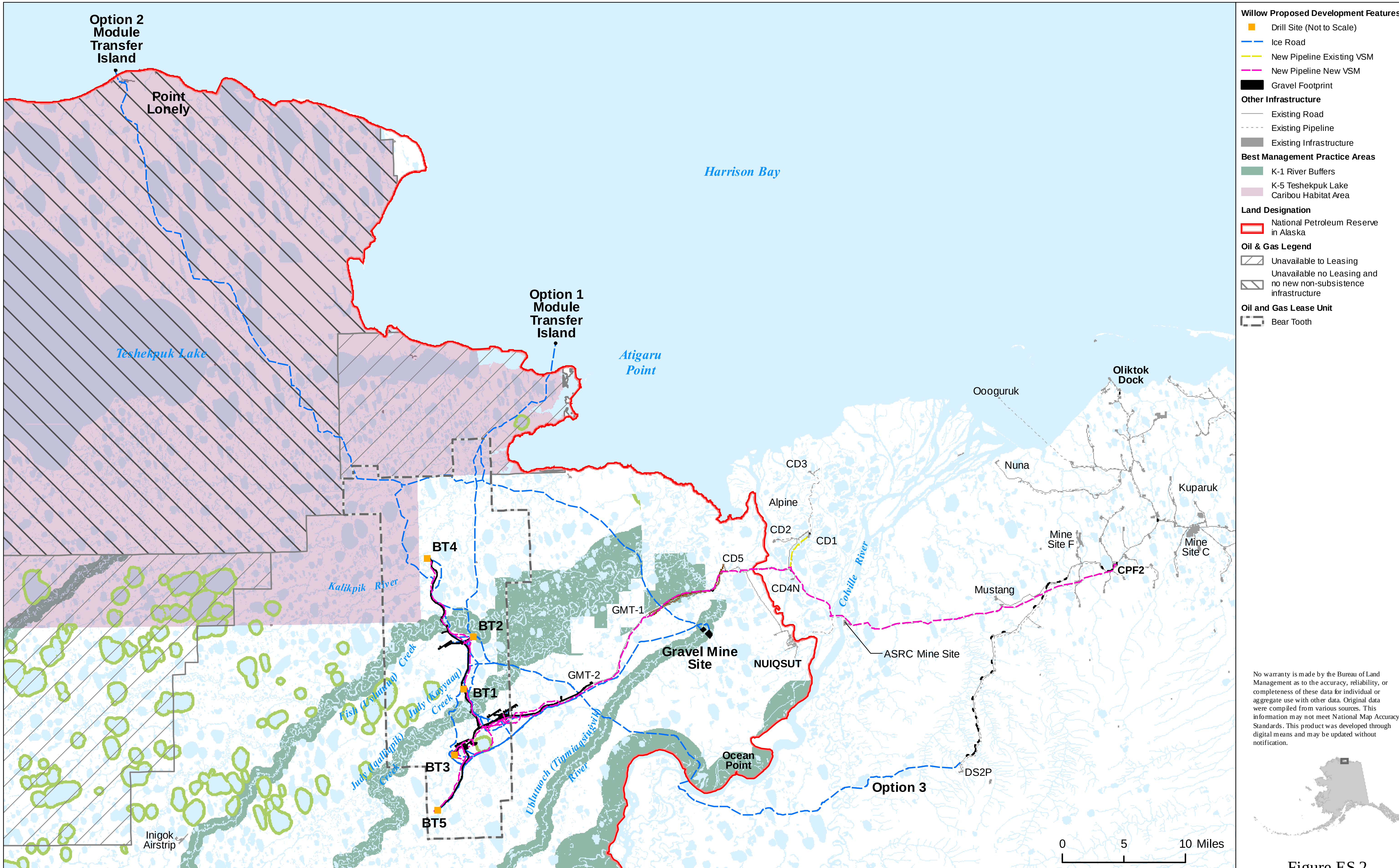
Willow Proposed Development Features
Drill Site (Not to Scale)
Ice Road
New Pipeline Existing VSM
New Pipeline New VSM
Gravel Footprint
Other Infrastructure
Existing Road
Existing Pipeline
Existing Infrastructure
Best Management Practice Areas
K-1 River Buffers
K-5 Teshekpuk Lake Caribou Habitat Area
Land Designation
National Petroleum Reserve in Alaska
Oil & Gas Legend
Unavailable to Leasing
Unavailable no Leasing and no new non-subsistence infrastructure
Oil and Gas Lease Unit
Bear Tooth
Option 2 Module Transfer Island
Point Lonely
Harrison Bay
Option 1 Module Transfer Island
Atigaru Point
Teshekpuk Lake
Oooguruk
Oliktok Dock
Nuna
Kuparuk
CD3
Alpine
CD2
CD1
CD5
CD4N
Colville River
Mine Site F
Mine Site C
CPF2
Mustang
BT4
Kalikpik River
BT2
GMT-1
Gravel Mine Site
NUIQSUT
ASRC Mine Site
GMT-2
BT1
Fish (Uvlutuuq) Creek
Judy (Kayyaaq) Creek
Judy (Iqalliqpik) Creek
Ublutuoch (Tinmiaqsiugvik) River
BT3
BT5
Ocean Point
Option 3
DS2P
Inigok Airstrip
0
5
10 Miles
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

Figure ES.2

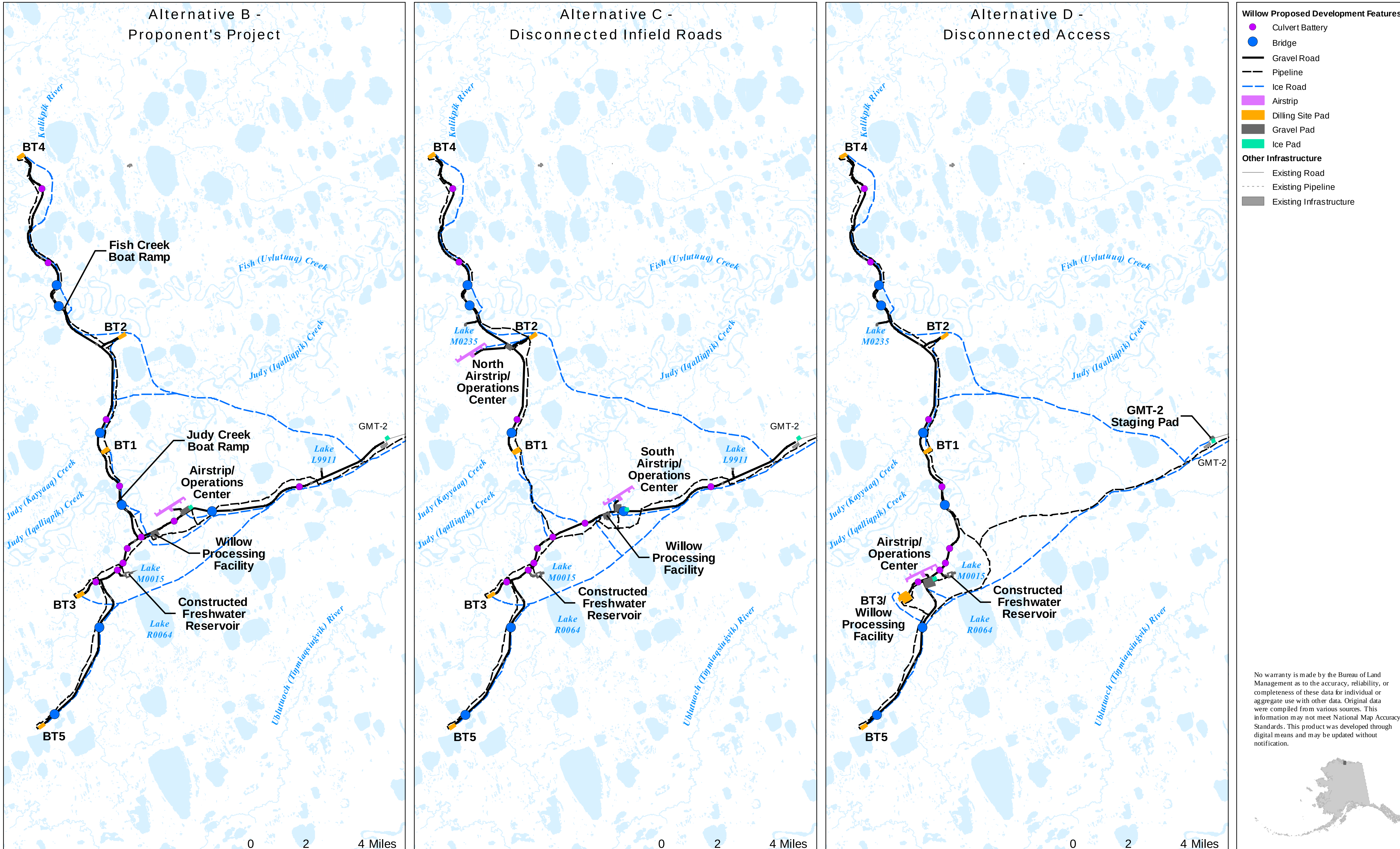
Alternative B - Proponent's Project
Alternative C - Disconnected Infield Roads
Alternative D - Disconnected Access
BT4
BT2
BT1
BT3
BT5
GMT-2
Fish Creek Boat Ramp
Judy Creek Boat Ramp
Airstrip/ Operations Center
Willow Processing Facility
Constructed Freshwater Reservoir
North Airstrip/ Operations Center
South Airstrip/ Operations Center
GMT-2 Staging Pad
BT3/ Willow Processing Facility
Kalikpik River
Fish (Uvlutuuq) Creek
Judy (Iqalliqpik) Creek
Judy (Kayyaaq) Creek
Ublutuoch (Tiŋmiaqsiuġvik) River
Lake L9911
Lake M0015
Lake R0064
Lake M0235
0 2 4 Miles
Willow Proposed Development Features
Culvert Battery
Bridge
Gravel Road
Pipeline
Ice Road
Airstrip
Dilling Site Pad
Gravel Pad
Ice Pad
Other Infrastructure
Existing Road
Existing Pipeline
Existing Infrastructure
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

Figure ES.3

This page intentionally left blank.

1.0 INTRODUCTION AND PURPOSE AND NEED

This Environmental Impact Statement (EIS) has four volumes:

- Volume 1: Executive Summary and Chapters 1 through 5, Glossary, and References
- Volume 2: Appendix A.1 – Figures 1.4.1 – 3.13.6
- Volume 3: Appendix A.2 – Figures 3.14.1 – 4.3.5
- Volume 4: Appendices B through E.2
- Volume 5: Appendix E.3 through E.7
- Volume 6: Appendices E.8 through E.16
- Volume 7: Appendices E.17 through J

Appendix E contains the technical information for all resource sections in Chapter 3 and is numbered in the same order as the resource sections (e.g., Appendix E.2 is the technical appendix for Section 3.2 of the EIS). All glossary terms are bolded upon first use. A full glossary follows the EIS.

1.1 Introduction

The Bureau of Land Management (BLM) received a request from ConocoPhillips Alaska, Inc. (the Proponent, or CPAI) on May 10, 2018, to prepare the Willow Master Development Plan (MDP) EIS. The EIS would facilitate the permitting process for the proposed development of hydrocarbon resources from federal oil and gas leases in the northeast area of the National Petroleum Reserve in Alaska (NPR-A). The MDP addresses infrastructure components that would be constructed for the purpose of oil and gas development. If the MDP is approved, the Proponent may submit permit applications for up to five drill sites, a central processing facility (CPF), an operations center pad, up to 37.0 miles of gravel roads, up to 699.9 total miles of ice roads during construction and up to 262.5 total miles of resupply ice roads during operations, one to two airstrips, up to 385.5 miles of pipelines (95.4 miles of new pipeline rack), and a gravel mine site on federal land in the NPR-A. The Willow MDP Project (Project) would also include the transportation of modules for hauling project materials via sealift barge to the North Slope. The Project is anticipated to have a peak production in excess of 160,000 barrels of oil per day (with a processing capacity of 200,000 barrels of oil per day) over its 30- or 31-year life (varies by alternative), producing approximately 586 million barrels of oil.

As the federal manager of the NPR-A, BLM is responsible for land use authorizations and compliance with the requirements of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.). Additionally, the U.S. Army Corps of Engineers (USACE), a cooperating agency, also has authority over the Project through its authority to issue or deny permits for the placement of dredge or fill material in **Waters of the United States** (WOUS), including wetlands. The eight cooperating agencies for the Project and their roles and expertise are described below.

The Proponent's stated purpose for the Project is to construct drill sites, roads, pipelines, and ancillary facilities to support the safe and economic production and transportation to market of oil and gas resources under leaseholds in the NPR-A. The Project would help offset declines in production from North Slope oil fields and contribute to local, state, and national economies.

1.2 National Petroleum Reserve in Alaska

The Naval Petroleum Reserve Number 4 was created by President Warren G. Harding in 1923 to protect a future oil supply for the U.S. Navy. In 1976, the Naval Petroleum Reserves Production Act (NPRPA) renamed the Reserve the NPR-A and transferred its management to the Secretary of the Interior (Secretary). The NPRPA (as amended) requires the Secretary to conduct oil and gas leasing in the NPR-A and provides the Secretary with the authority to implement such regulations as deemed necessary for the protection of important surface resources and uses.

Congress authorized petroleum production in the NPR-A in 1980 (PL 96-514), but it was not until the 1990s that development on adjacent state lands made exploration in the NPR-A economically feasible. In 1998, BLM completed an Integrated Activity Plan (IAP) that assessed the potential use of the Northeast NPR-A for oil development (BLM 1998). The 1998 IAP was amended in 2005 and supplemented in 2008 (BLM 2005, 2008b). In 2012, BLM completed an IAP/EIS that analyzed development scenarios and related environmental consequences for all BLM-managed federal lands and oil and gas resources within the NPR-A (BLM 2012b). The IAP/EIS Record of Decision (ROD) was issued in 2013 (BLM 2013a). A revised IAP/EIS was released in 2020 (BLM 2020a), the ROD is forthcoming. The Willow MDP EIS tiers to the 2012 and 2020 IAP/EISs.

1.3 Purpose and Need

The purpose of the Proposed Action is to construct the infrastructure necessary to allow the production and transportation to market of federal oil and gas resources under leaseholds in the northeast area of the NPR-A, consistent with the proponent's federal oil and gas lease and unit obligations. The need for federal action (i.e., issuance of authorizations) is established by BLM's responsibilities under various federal statutes, including the NPRPA (as amended) and the Federal Land Policy and Management Act as well as various federal responsibilities of cooperating agencies under other statutes, including the Clean Water Act (CWA). Under the NPRPA, BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). BLM is required to respond to the Proponent's requests for an MDP and related authorizations to develop and produce petroleum in the NPR-A.

USACE, as a cooperating agency on the EIS, develops its own overall purpose for the Project in accordance with its Section 404 CWA regulations. The overall purpose of the Project, as defined by USACE, is to construct infrastructure to safely produce, process, and transport commercial quantities of liquid hydrocarbons to market via pipeline from the Willow reservoir. The overall Project purpose and need allows a robust consideration of alternatives while providing a foundation to determine practicability, which is a key aspect of the Section 404 permitting process. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall Project purposes (40 CFR 230.10(a)(2)).

The purpose and need of the Proposed Action is a key factor in determining a range of alternatives required for consideration in an EIS and assists with the selection of a preferred alternative. The Final EIS presents a reasonable range of alternatives that consists of a No Action Alternative and three action alternatives, together with three sealift module delivery options. The Final EIS analyzes the environmental impacts of these alternatives and informs how well each alternative meets the Project purpose and need.

1.3.1 Decision to be Made

BLM and other authorizing cooperating agencies will, in their respective ROD(s), decide whether to approve the Willow MDP and the associated issuance of permits and rights-of-way for the construction of the development plan, in whole or in part, based on the analysis contained in the EIS. The ROD(s) associated with the EIS will not constitute the final approval for all actions, such as approval for subsequent individual applications for permits to drill and rights-of-way associated with the Proposed Action. The EIS analysis does, however, provide BLM and other federal agencies that have regulatory oversight and permitting authorities with information and NEPA analysis that could be used to inform final approvals for individual Project components, such as specific permits to drill and rights-of-way.

1.4 Development Location (Project Area)

The Willow MDP area (Project area or Willow area) is located on the North Slope of Alaska, with the majority of the proposed facilities on leased federal lands within the Bear Tooth Unit (BTU) in the northeastern portion of the NPR-A (Figure 1.4.1). Supporting infrastructure, including road connections, pipeline tie-ins, the module transfer island (MTI), and the gravel mine site would be located on federal and Native corporation–owned lands in the Greater Mooses Tooth (GMT) Unit, on non-unitized lands within the NPR-A, and on lands or waters owned and managed by the State of Alaska. None of the facilities would be located on or near Native allotments. Where possible, Project pipelines would be colocated with existing pipelines on federal, State, and Native corporation land.

Elements of the Project would occur within the Teshekpuk Lake Special Area of the NPR-A (as defined in both the 2013 IAP/EIS ROD [BLM 2013a] and the 2020 IAP/EIS [BLM 2020a]), which was designated by the Secretary of the Interior in 1977 for its significant value to waterfowl and shorebirds. The designation has since been expanded to protect caribou and waterbirds, and their habitats.

1.5 Cooperating Agencies

BLM is the lead agency for the EIS. Eight federal, tribal, state, regional, or local government entities are participating as cooperating agencies (Table 1.5.1).

Table 1.5.1. Cooperating Agencies and Their Authorities and Expertise

Agency	Authority/Expertise
U.S. Army Corps of Engineers	Permit authority for Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act
U.S. Environmental Protection Agency	Responsibilities under the Clean Air Act, the Clean Water Act, and the Oil Pollution Act

Agency	Authority/Expertise
U.S. Fish and Wildlife Service	Responsibilities under the Endangered Species Act, expertise in fish and wildlife
Native Village of Nuiqsut	Expertise in sociocultural, wildlife, subsistence, and economic resources
Iñupiat Community of the Arctic Slope	Expertise in sociocultural, subsistence, and economic resources
City of Nuiqsut	Expertise in sociocultural and economic resources
North Slope Borough	Responsible for land use planning and regulation; permit authority for rezone; expertise in sociocultural, wildlife, subsistence, and economic resources
State of Alaska (Departments of Fish and Game; Environmental Conservation; Natural Resources; Health and Social Services; and Commerce, Community, and Economic Development)	Responsible for adjudicating requests or applications for permits, easements, and leases on state land (including state submerged land within 3 miles of the coast). Authority for air, water use, and wastewater permits; expertise in sociocultural, human health, wildlife, subsistence, economic resources, off-road travel, and ice road construction.

1.6 Other Agencies

The Federal Aviation Administration (FAA), Bureau of Ocean and Energy Management (BOEM), National Marine Fisheries Service (NMFS), U.S. Coast Guard, and U.S. Department of Transportation (Pipeline and Hazardous Materials Safety Administration) were invited to be cooperating agencies but declined to participate.

1.7 Permitting Authorities

All action alternatives and module delivery options in the EIS would require federal authorization by BLM, USACE, U.S. Coast Guard, and potentially the U.S. Department of Transportation (Pipeline and Hazardous Materials Safety Administration).

The State of Alaska, the North Slope Borough (NSB), Kuukpik Corporation (Kuukpik), the Native Village of Nuiqsut (NVN), and the Arctic Slope Regional Corporation (ASRC) are responsible for land management decisions, easements, leases, authorizations, and permits on their respective lands. The State of Alaska also has authority for state waters within 3 miles of the shore.

Appendix C, *Regulatory Authorities and Framework*, provides a full list of anticipated permits, approvals, and consultations as well as a list of applicable federal laws and executive orders.

1.8 Scoping and Substantive Issues

BLM identified substantive issues to be addressed in the Willow MDP EIS through public and agency scoping (including internal BLM scoping) and consultation with Alaska Native tribes (Appendix B.1, *Scoping Process and Comment Summary*). The original scoping period was 30 days; however, it was extended by 14 days due to public requests and officially ended on September 20, 2018. The community of Nuiqsut was given an additional 8 days to comment, for a total scoping period of 52 days. Public scoping meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Fairbanks, Nuiqsut, and Utqiaġvik (Barrow).

During scoping, 1,430 comment submissions were received, with 377 comments being unique. Comments were categorized as issues associated with resource topics, issues associated with BLM policy (and therefore not addressed in the EIS), or out-of-scope comments. Substantive issues were identified as those that could potentially have significant effects, are necessary to make a reasoned choice among alternatives, or are needed to address points of disagreement, debate, or dispute regarding an anticipated impact from the Project. Substantive issues within the scope of the EIS that were identified through scoping are addressed in the EIS in Chapter 3.0, *Affected Environment and Environmental Consequences*.

Resources and topics that were considered but dismissed from detailed analysis in the EIS are listed in Table 1.8.1, along with the rationale for dismissal.

Table 1.8.1. Resources and Topics Dismissed from Detailed Analysis

Resource or Topic	Rationale for Dismissal from Detailed Analysis
Wildland fire	The Project is located above the latitudinal tree line, in a predominantly wetland environment where wildland fire is rare.
Sand resources	Sand resources would not be used for the Project and thus would not be affected.
Physiography and geomorphology	The dominant physiographic feature near the Project is the Arctic Coastal Plain; the Project would not alter its geography or geomorphology. The only geomorphic feature that could be affected is permafrost, which is included in detailed analysis.
Cultural and paleontological resources	The Project area was surveyed for cultural and paleontological resources (Reanier 2017, 2018, 2019a, 2019b, 2020). All known sites would be avoided; the Proponent routed all Project components (including ice roads and pads) 500 feet or farther from known resources to avoid adversely impacting any such areas. To ensure appropriate treatment of inadvertent discoveries, the Proponent maintains a Fossil and Artifact Finds Standard Operating Procedure and requires awareness training as required under BMP I-1 of the NPR-A IAP/EIS (BLM 2013a, 2020a). Although increased access to cultural resources has been documented to correlate strongly with increased instances of vandalism and looting of cultural resources sites (Hedquist, Ellison et al. 2014; Spangler, Arnold et al. 2006), these impacts are improbable due to conditions specific to the Project area and the Project timeline. Ice roads and pads would only be used during winter construction seasons, during which time any nearby cultural resources would be inaccessible due to snow cover. Access to cultural resources areas via gravel infrastructure in the summer months, while possible, would be complicated by the surrounding terrain. Additional supporting detail is provided in Appendix F, *Cultural Resources Findings: Process and Analysis*.
Recreation	Current recreation use is very low, and prospective future use of this area for recreation is also low.
Wild and Scenic Rivers	There are no rivers eligible for designation as wild and scenic near the Project.

Note: BMP (best management practice); IAP/EIS (Integrated Activity Plan/Environmental Impact Statement); NPR-A (National Petroleum Reserve in Alaska); Project (Willow Master Development Plan Project).

1.9 Environmental Impact Statement Process and Changes Since Publication of the Draft Environmental Impact Statement

The Draft EIS comment period began on August 30, 2019, with the publication of a Notice of Availability in the Federal Register. The comment period was open for 45 days and subsequently extended for 15 additional days, ending on October 29, 2019. A total of 266 people attended the public meetings for the Draft EIS in September and October 2019. Meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Fairbanks, Nuiqsut, and Utqiaġvik. The Nuiqsut meeting included the public hearing for comments regarding the Project's potential impact to subsistence resources and activities per Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA). BLM received written comments by mail, fax, email, online comment form via ePlanning, and handwritten and verbal testimony at public meetings. BLM received a total of 935 submissions during the Draft EIS public comment period. Of the submissions, 490 were unique (i.e., original submissions that did not have identical or almost identical wording as another submission). About 56% of the submittals received were part of organized letter writing campaigns.

Following publication of the Draft EIS, and in response to public comments and concerns raised during the public comment period for the Draft EIS the Proponent presented BLM with design updates to the Project. A Supplement to the Draft EIS (SDEIS) was published on March 20, 2020, with additional analysis for three new Project components that presented potentially substantial changes to the proposed action: module delivery Option 3, a constructed freshwater reservoir (CFWR), and up to three boat ramps for subsistence access. Additional Project design updates were provided by the Project proponent; however, the changes were not expected to substantively change the overall analysis or results described in Chapter 3.0 of the Draft EIS. This Final EIS incorporates all design changes into the Project analyses and considers public comments, feedback received from cooperating agencies, and testimony received during public meetings, for both the Draft EIS and the SDEIS. Key changes since the Draft EIS include the following:

- A third module delivery option using the existing Oliktok Dock, existing gravel roads, and task-specific ice roads was developed (assessed in the SDEIS).
- A CFWR was added at Lake M0015 (assessed in the SDEIS).
- Up to three boat ramps intended to support subsistence users from Nuiqsut were added to the Project by CPAI as voluntary mitigation (assessed in the SDEIS).
- Production from the neighboring Greater Mooses Tooth 2 (GMT-2) development, which is currently under construction, may shift from the Alpine CPF to the Willow Processing Facility (WPF).

- Additional water sources were identified to support Project drilling and operations under all action alternatives; water sources vary by alternative.
- The Willow Operations Center (WOC), WPF, and airstrip were relocated approximately 2.5 miles to the northeast under Alternative B.
- Refinements were made to reduce the overall size of the Tiŋmiaqsiuġvik Mine Site and adjust the layout of the mine cells and ice pads; and a Mine Site Plan describing mining activity and reclamation plans was developed (included as Appendix D.2, *Willow Mine Site Mining and Reclamation Plan*, of the Final EIS).
- The overall Project footprint (under all action alternatives) was refined, including changes to drill site pads, the WOC pad, the WPF pad, and the airstrip(s); changes to Project gravel and ice road widths; and the addition of new pads to support Project construction and operations. The refinements marginally decreased the overall Project footprint for some alternatives and marginally increased them for others.
- Total traffic and freshwater use estimates were updated; the updates decreased the estimates for some alternatives and increased them for others.
- New Project facilities (e.g., Project-supporting equipment and modules) were added; depending on the pad and alternative, some facilities would be accommodated on existing gravel pads and others would expand existing gravel pads or construct new gravel pads in Alpine and Kuparuk.
- Ice road design, including task-specific ice road widths, were updated; the updates decreased the widths for some ice-road classes and increased them for others.
- The Project schedule and construction sequencing were updated (Alternatives B and C would last 30 years [until 2050] and Alternative D would last 31 years [until 2051]).

Various other clarifications, corrections, additions, and minor revisions to the alternatives considered and the impacts analysis were made throughout the EIS and the appendices to improve the discussion of the affected environment, to improve the analysis of potential impacts, to correct typographical errors, and to address comments and recommendations from the public, cooperating agencies, tribes, and the affected communities.

BLM held an additional 45-day comment period for the SDEIS. This comment period began on March 20, 2020, with the publication of a Notice of Availability in the Federal Register, and ended on May 4, 2020. In April 2020, BLM held eight virtual public meetings to receive comments on the SDEIS. Because of state and local mandates regarding COVID-19 that restricted travel and in-person meetings, BLM conducted virtual public meetings to reach audiences across the state using Zoom, Facebook Live, and a telephone call-in number. Public participation in the SDEIS virtual public meetings was substantially greater than public participation for the Draft EIS in-person public meetings, notwithstanding the narrower scope of the SDEIS and the COVID-19 epidemic. Approximately 400 attendees participated in these meetings via Zoom, of which about 10 people registered and attended by phone only. More than 2000 people viewed some or all of the meeting through Facebook Live. BLM received a total of 31,015 submissions during the SDEIS public comment period. Of the submissions, 456 were unique (98% of the submittals received were part of organized letter writing campaigns). Further details regarding public engagement for all stages of the NEPA process and responses to substantive comments are included in Appendix B, *Public Engagement and Comment Response*. BLM will not issue its decision on the Project until at least 30 days after the Notice of Availability of the Final EIS is published by EPA in the Federal Register.

1.10 Consultation and Coordination

1.10.1 Endangered Species Act Consultation

Consultation under Section 7 of the Endangered Species Act (ESA) is ongoing between federal authorizing agencies and the U.S. Fish and Wildlife Service (USFWS) as appropriate, for species listed under the ESA. Consultation is occurring parallel to the NEPA process.

Section 7 consultation with NMFS is completed. A letter of concurrence from NMFS was received July 15, 2020 concurring with BLM's determination that the Project may affect, but is not likely to adversely affect the bowhead whale, blue whale, fin whale, North Pacific right whale, Western North Pacific stock gray whale, Western North Pacific distinct population segment (DPS) or Mexico DPS humpback whale, sperm whale), Arctic subspecies ringed seal, Beringia DPS bearded seal, the Western DPS Steller sea lion, North Pacific right whale critical habitat, or Steller sea lion critical habitat.

1.10.2 Magnuson-Stevens Fishery Conservation and Management Act Coordination

Coordination under the Magnuson-Stevens Fishery Conservation and Management Act regarding Essential Fish Habitat (EFH) is occurring between federal authorizing agencies and NMFS, parallel to the NEPA process.

1.10.3 National Historic Preservation Act Section 106 Consultation

Consultation under Section 106 of the National Historic Preservation Act was initiated on November 23, 2018, and BLM has attempted continued formal and informal Section 106 consultation through the March 2019 NPR-A working group meeting. To date, no North Slope Tribal, municipal, corporation representative, North Slope community members, or non-governmental organizations have elected to consult with BLM regarding places of historic or cultural importance or traditional use. BLM's consultation efforts did not result in any responses indicating specific concerns for documented or undocumented places of historic or cultural importance or traditional use. BLM is seeking concurrence with the Alaska State Historic Preservation Officer on a Section 106 finding of No Adverse Effect to Historic Properties.

1.10.4 Native Consultation

BLM initiated the government-to-government consultation and Alaska Native Claims Settlement Act (ANCSA) corporation consultation with the following tribes and ANCSA corporations whose members could be substantially affected by the Project:

- NVN
- Naqsragmiut Tribal Council
- Iñupiat Community of the Arctic Slope
- Kuukpik
- ASRC

Government-to-government consultation meetings have been held regularly with the NVN. The NVN also participates in regularly scheduled working group meetings for the NPR-A. Kuukpik and the ASRC have engaged in regular consultation with BLM during the NEPA process.

1.11 Compliance with Section 810 of the Alaska National Interest Lands Conservation Act

BLM's evaluation of the effects of the Project and the cumulative effects of current and future activities on subsistence uses and needs, as required under Section 810 of ANILCA is included in Appendix G, *Alaska National Interest Lands Conservation Act Section 810 Analysis*. A preliminary ANILCA Section 810 evaluation was published concurrent with the Draft EIS and a revised Section 810 was published concurrent with the SDEIS; public hearings were held to collect testimony from affected communities during the Draft EIS and SDEIS public comment periods. Dates of public hearings are included in Appendices B.2 (*Draft EIS Comments and BLM Responses*) and B.3 (*Supplement to the Draft EIS Comments and BLM Responses*).

2.0 ALTERNATIVES

2.1 Introduction

This chapter describes Willow MDP Project components and the alternatives under consideration in the EIS. A more detailed description of Project components and alternatives, including the alternatives development process, is available in Appendix D.1, *Alternatives Development*.

2.2 Alternatives Development

Following Project scoping, BLM convened a series of alternatives development meetings with the EIS cooperating agencies. These meetings identified a range of options for the Project or its constituent components; the Project components that options were identified for include access, airstrips, module transport, mine site, gravel pads, and processing facility. This process and the initial range of alternatives are detailed in Appendix D.1. Alternative B (Section 4.3, *Alternative B: Proponent's Project*) was developed by CPAI, and Alternatives C and D (Sections 4.4, *Alternative C: Disconnected Infield Roads*, and 4.5, *Alternative D: Disconnected Access*) were developed by BLM and EIS cooperating agencies.

This chapter describes the range of alternatives developed for detailed analysis in the EIS, including the No Action Alternative (Alternative A) and three action alternatives (B, C, and D); additionally, three options are included for sealift module delivery. All action alternatives were evaluated for their ability to meet the overall Project purpose and need (Section 1.3, *Purpose and Need*); are "practical or feasible from a technical and economic standpoint and using common sense" (CEQ 1981); address resource impacts or conflicts; and do not substantially have the same impacts of other alternatives being considered.

2.3 Alternative Components Considered but Eliminated from Further Analysis

The alternatives development meetings held with cooperating agencies resulted in consideration of several alternative components to the Proponent's Project. Alternative components were evaluated against screening criteria, including how well they meet the purpose and need, their ability to reduce impacts or resource conflict (particularly for key resources and issues raised during scoping), feasibility (technological, logistical, and economical), practicability (as defined by CWA Section 404 regulations), and common sense (as provided by Council on Environmental Quality guidelines). These terms, as defined under the NEPA and CWA Section 404 regulations, are further explained in Appendix D.1. The alternative elements considered but eliminated from further analysis in the EIS are described in Appendix D.1.

2.4 Reasonable Range of Alternatives

The range of alternatives was developed to address the resource impact issues and conflicts identified during internal scoping with the BLM Interdisciplinary Team and external scoping with the public and cooperating agencies. Four alternatives are analyzed in detail in the EIS:

- Alternative A: No Action
- Alternative B: Proponent's Project (Figure 2.4.1)
- Alternative C: Disconnected Infield Roads (Figure 2.4.2)
- Alternative D: Disconnected Access (Figure 2.4.3)

Action alternatives (B, C, and D) presented in the EIS include variations on specific Project components (e.g., Project access) and include updates to the design proposed by CPAI after the DEIS was published. These Project updates were applied to all action alternatives, and are summarized in Section 1.9, *Environmental Impact Statement Process and Changes Since Publication of the Draft Environmental Impact Statement*. Detailed descriptions of the Project updates are included in Appendix D.1, Section 4.2, *Project Components Common to All Action Alternatives*, through Section 4.7.3, *Option 3: Colville River Crossing*.

In addition to the three action alternatives, three options are presented for how sealift modules (required for all action alternatives) would be delivered to the Project (Section 2.6, *Sealift Module Delivery Options*); any one of the module delivery options could be paired with any action alternative:

- Option 1: Atigaru Point Module Transfer Island (Figure 2.4.4)
- Option 2: Point Lonely Module Transfer Island (Figure 2.4.5)
- Option 3: Colville River Crossing (Figure 2.4.6)

2.4.1 Alternative A: No Action

Under the No Action Alternative, the Project would not be constructed; however, oil and gas exploration in the area would continue. Under the NPRPA, BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). The No Action Alternative would not meet the Project's purpose and need but is included in the analysis for baseline comparison; BLM does not have the authority to select this alternative because CPAI's leases are valid and provide the right to develop the oil and gas resources therein.

2.4.2 Alternative B: Proponent's Project

Alternative B would extend an all-season gravel road from the GMT-2 development southwest toward the Project area (Figure 2.4.1). Gravel roads would connect to all Project facilities, including the Willow Processing Facility (WPF), Willow Operations Center (WOC), airstrip, and all five drill sites (Bear Tooth [BT] drill sites 1 [BT1], 2 [BT2], 3 [BT3], 4 [BT4], and 5 [BT5]). Additional Project support facilities would include a CFWR, four valve pads, four pipeline pads, two water source access pads (at the CFWR and Lake L9911), eight road turnouts (with subsistence access ramps), horizontal directional drilling (HDD) pipeline pads at the Colville River, and up to three boat ramps for subsistence use (added to the Project by CPAI as mitigation to help offset Project effects on the community of Nuiqsut – see Section 2.5.13*, Boat Ramps for Subsistence Users*).

A gravel infield road would extend from BT3 north, crossing Judy (Iqalliqpik) Creek before reaching BT1. From BT1, the road would continue north, crossing Judy (Kayyaaq) Creek, to reach BT2 before crossing Fish (Uvlutuuq) Creek and ending outside the eastern boundary of the K-5 Teshekpuk Lake Caribou Habitat Area at BT4. Alternative B would construct 7 bridges. Infield (multiphase) pipelines would connect individual drill sites to the WPF, and export/import pipelines would connect the WPF to existing infrastructure on the North Slope. Diesel fuel would be piped from Kuparuk River Unit (Kuparuk) CPF2 to the Alpine CPF and then trucked 37.5 miles to the Project area. Seawater would be piped from Kuparuk CPF2 to the WPF. Alternative B would also include a pipeline tie-in pad near Alpine Colville Delta drill site 4N (CD4N) and an expansion of the existing pad at Kuparuk CPF2.

Sealift module delivery to the Project area would be required. More details on these options are included in Section 2.6, *Sealift Module Delivery Options*.

The access road alignment would provide direct gravel-road access from the existing gravel road network in the GMT and Alpine developments to the Project facilities. The full, all-season gravel road access connection to Alpine would allow for additional operational safety and risk reduction by providing redundancies and additional contingencies for each project and would provide support for reasonably foreseeable future actions (RFFAs) described in Table E.19.1 in Appendix E.19, *Cumulative Effects Technical Appendix*. Alternative B is BLM's preferred alternative. The identification of a preferred alternative does not constitute a commitment or decision; if warranted, BLM may select a different alternative than the preferred alternative in its ROD.

2.4.3 Alternative C: Disconnected Infield Roads

Alternative C would have the same gravel access road between GMT-2 and the Project area as Alternative B, but it would disconnect gravel road access between the WPF to BT1 (Figure 2.4.2). Thus, there would be no gravel road between these facilities or a bridge across Judy (Iqalliqpik) Creek; however, a gravel road would connect BT1 with BT2 and BT4 using the same alignment as Alternative B.

A second airstrip, storage and staging facilities, and WOC would be located near BT2 to accommodate the personnel and materials transported among the South WOC and the North WOC and BT1/BT2/BT4. A 3.6-mile-long annual ice road would be constructed along the Alternative B gravel road alignment for the life of the Project to allow for the movement of large equipment and consumable materials to BT1/BT2/BT4. Infield pipelines would connect all drill sites to the WPF; a diesel pipeline would provide fuel from Kuparuk CPF2 and to the North and South WOCs; and export/import lines (e.g., sales oil, seawater) would connect the WPF to existing infrastructure on the North Slope.

Additional Project infrastructure and facilities would include six bridges, the CFWR, four valve pads (two would be sized to be helicopter accessible at Judy [Iqalliqpik] Creek), four pipeline pads, three water source access pads (at the CFWR and Lakes L9911 and M0235), eight road turnouts (with subsistence access ramps), HDD pipeline pads at the Colville River, one boat ramp, expansion of the existing gravel pad at Kuparuk CPF2, and construction of one of the sealift module delivery options described in Section 2.6.

Under Alternative C, the WPF, South WOC, and primary Project airstrip would be located similarly to their locations in Alternative B, near the GMT and BT Unit boundaries. Alternative C (unlike Alternative B) would require a diesel pipeline connection from Kuparuk CPF2 to Alpine to the Project area due to the need to regularly supply fuel to the three disconnected drill sites; piped diesel fuel would be made available to support the Project at the WPF and South and North WOCs.

The intent of Alternative C is to reduce effects to caribou movement and decrease the number of stream crossings required; this is also intended to further reduce impacts to **subsistence** users of these resources. This alternative removes a portion of the road (versus Alternatives B and D) that would cross Judy (Iqalliqpik) Creek which could impede caribou movement across linear features (i.e., this alternative would avoid the junction of two roads, which could be a pinch point that deflects caribou movement). This alternative would also reduce linear gravel infrastructure in the Project area, which may reduce impacts to hydrology (e.g., sheet flow) and wetlands (e.g., direct fill, fugitive dust).

2.4.4 Alternative D: Disconnected Access

Alternative D would colocate the WPF with BT3, construct four additional drill sites, the WOC, pipeline and valve pads, CFWR, two water source access road and pads at the CFWR and Lake M0235, gravel roads connecting Project facilities, an airstrip, a staging pad near GMT-2, one boat ramp, and an expansion of the existing gravel pads at Alpine Colville Delta drill site 1 (CD1) and Kuparuk CPF2. However, Alternative D would not be connected by an all-season gravel access road to the GMT and Alpine developments (Figure 2.4.3); but it would employ the other gravel roads as proposed under Alternative B connecting drill sites and other Project infrastructure. Annual resupply access to the Project area would be provided by ice road connection between GMT-2 and the WPF (12.5 miles) for the life of the Project.

The lack of a gravel access road connection to Alpine would reduce the degree to which the Project could leverage existing Alpine infrastructure. As a result, additional facilities would be required in the Project area, duplicating some facilities currently at Alpine, including warehouse space; valve and fleet shops; emergency response equipment; and chemical storage tanks. The addition of these facilities in the Project area would require additional gravel pad space at the WOC and WPF. Additionally, Alternative D would require a diesel pipeline connection from Kuparuk CPF2 to the WOC (similar to Alternative C) as fuel could not be trucked to the Project area throughout the year. Alternative D would require sealift module delivery to the Project area (Section 2.6).

The intent of Alternative D is to minimize the Project's footprint and fill, reduce the number of required bridges, and lessen the length of linear infrastructure on the landscape to decrease effects to caribou movement and subsistence. This alternative's reduction of linear gravel infrastructure in the Project area may also reduce impacts to hydrology (e.g., sheet flow) and wetlands (e.g., direct fill, indirect impacts from dust).

2.5 Project Components Common to All Action Alternatives

Components that are common to all action alternatives are described below; additional details on Project components are available in Appendix D.1, *Alternatives Development*.

2.5.1 Project Facilities and Gravel Pads

The Project would include multiple gravel pads to support Project infrastructure, as described in the following sections. Pads would be a minimum of 5 feet thick (with an average thickness greater than 7 feet) to maintain a stable thermal regime and protect underlying permafrost. Pad thickness and the gravel fill volume needed for each pad would vary due site-specific topography and design criteria (e.g., flat gravel surface). Embankment side slopes would be 2 horizontal to 1 vertical ratio (2:1). Erosion potential would be evaluated on a pad-specific basis and embankment erosion protection measures would be designed and employed as necessary.

2.5.1.1 Willow Processing Facility

The WPF would include the main plant facilities needed to separate and process multiphase production fluids and deliver sales-quality crude oil. Produced water would be processed at the WPF and reinjected to the subsurface as part of reservoir pressure maintenance/water flood for secondary recovery. Produced natural gas would be used to fuel plant and facility equipment, be reinjected into a producing reservoir formation to maintain reservoir pressure and increase recovery, and used for **gas lift.** Under plant startups, shutdowns, and upset conditions, natural gas may be flared to maintain safe operations.

The processing equipment at the WPF would include emergency shutdown equipment, power generators, compressors, gas treatment facilities, heat exchangers, separators, a flare system, pumps, **pigging** and metering facilities, warm storage buildings, and a tank farm. Additional equipment planned for the WPF, including equipment needed to accommodate production from GMT-2 (Appendix D.1, Section 3.1.6.1, *Greater Mooses Tooth 2 Processing at Willow*) is provided in Appendix D.1.

2.5.1.2 Drill Sites

The Project would construct five drill sites (at the same locations under all action alternatives). Each drill site has been designed and sized to accommodate all drilling and operations facilities, wellhead shelters, drill rig movement, and material storage. Each drill site would be sized to accommodate 40 to 70 wells at a typical 20-foot wellhead spacing; the Project would have a total of 251 wells. Additional facilities typical for drill sites would include emergency shutdown equipment, well test and associated measurement facilities, pig launchers and receivers, spill response equipment, operations storage and stand-by tanks, and communications infrastructure.

2.5.1.3 Willow Operations Center

The base of operations for the Project would be the WOC (South WOC under Alternative C), which would be located near the WPF (but separated by approximately 1 mile for safety reasons; Figures 2.4.1, 2.4.2, and 2.4.3). The WOC location would minimize the risk to Project personnel by placing permanently occupied buildings (e.g., living quarters) away from potential blast hazards associated with the WPF, which is consistent with current best safety practices and standards. The WOC would be adjacent to the Project airstrip.

The WOC would contain utility buildings and storage facilities, including Willow operations camp (living quarters, offices, dining facilities, medical clinic), water and wastewater treatment plants, Class I underground injection control (UIC) disposal wells, spill response shop, hazardous waste storage, shop space, municipal solid waste incinerator, and helipad. (Alternative C would include a second WOC [North WOC] that would have similar infrastructure as described above.)

2.5.1.4 Valve Pads

Isolation valves would be installed on each side of pipeline crossings at Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek to minimize the potential spill impact in the event of a leak or break. To support valve infrastructure, gravel pads would be constructed on each side of the two crossings (four valve pads total).

2.5.1.5 Pipeline Pads

Four pipeline pads would be constructed to support pipeline construction and operations:

- One pipeline crossing pad would be located along the import/export pipelines near GMT-2 to allow north to south ice road crossings.
- Two new HDD pipeline pads would be constructed near the existing Alpine Sales Pipeline HDD Colville River crossing.
- The Willow Pipeline (Section 2.5.2.2, Willow Pipeline) would tie into existing pipeline infrastructure at a new tie-in pad located along the Alpine Pipeline near Alpine CD4N. One or more truckable modules would be installed on this pad to support pigging, provide overpressure protection, and meter fluids as well as infrastructure to facilitate warm-up or de-inventory of the Willow Pipeline and seawater pipeline.

2.5.1.6 Water Source Access Pads

Freshwater access would vary by action alternative. All action alternatives would include construction of a water source access pad to provide access to the CFWR near Lake M0015. The water source access pad at the CFWR would be connected to other infrastructure via a gravel access road from the road east of BT3. Alternatives B and C would also include a water source access pad at Lake L9911 connected to a short gravel spur road from the Project access road between GMT-2 and the Project. Alternatives C and D would include a water source access pad at Lake M0235, northwest of BT2. Access would be provided via a gravel spur road connected to the gravel road segment between BT2 and BT4. All pads would be sized to minimize the gravel footprint while maintaining adequate space for vehicles to access the water sources and safely maneuver.

2.5.1.7 Communications Tower Pad

To avoid potential interference with the airstrip and comply with FAA requirements, the WOC communications tower (South WOC under Alternative C) would be constructed on a separate pad. For Alternatives B and C, the gravel pad would be located adjacent to the WOC and South WOC, respectively. For Alternative D, the gravel pad would be located approximately 1,250 feet south of the WOC along the gravel road to BT5. The communications tower pad would house communications infrastructure, including a communications tower up to 200 feet tall.

2.5.1.8 New Project Facilities on Existing Gravel Pads

The Project would include installation of additional modules and equipment on existing gravel pads at Kuparuk CPF2 and the Alpine CPF (located at CD1). The Kuparuk CPF2 pad would be expanded 1.0 acre to accommodate these new facilities. The Alpine CPF pad would be expanded 1.3 acres under Alternative D.

2.5.2 Pipelines

The Project would include infield and import/export pipelines (Figures 2.4.1, 2.4.2, and 2.4.3). Infield pipelines would carry a variety of products, including produced fluids, produced water, seawater, miscible injectant, and gas, between the WPF and each drill site. Import/export pipelines would include the Willow Pipeline, a seawater pipeline, and a diesel pipeline, described further in Appendix D.1, Section 4.2.2, *Pipelines*. The Willow Pipeline would carry sales-quality crude oil processed at the WPF to a tie-in with the existing Alpine Sales Pipeline near Alpine CD4N.

Pipelines would rest on common horizontal support members (HSMs) atop vertical support members (VSMs) placed approximately 55 feet apart, with an estimated 80% of VSMs being singular and 20% being installed as pairs. VSMs would have a typical diameter of 12 to 24 inches (approximately 75% and 25% of VSMs, respectively) and a disturbance footprint of 18 to 32 inches (up to 5.6 square feet).

2.5.2.1 Infield Pipelines

Infield pipelines would carry produced fluids (oil, gas, water), injection water, gas, and miscible injectant (for enhanced oil recovery) between the WPF and each drill site. Infield pipelines would be designed to allow for inspection and maintenance (e.g., pigging). Manifold and/or pipe rack piping would combine individual wellhead piping into a common gathering line through which all produced fluids would be transported to the WPF.

2.5.2.2 Willow Pipeline

The Willow Pipeline (sales oil transport pipeline) would carry sales-quality crude oil processed at the WPF to a tie-in with the Alpine Pipeline near Alpine CD4N. From CD4N, sales-quality oil would be transported via the existing Alpine Sales Pipeline to the Kuparuk Pipeline and onward to the Trans-Alaska Pipeline System (TAPS) near Deadhorse, Alaska. Between the WPF and the tie-in pad near CD4N, vertical lops or isolation valves would be installed on each side of the Ublutuoch (Tiŋmiaqsiuġvik) River and on each side of the segments crossing the Niġliagvik Channel, the Niġliq Channel, and Lakes L9341 and L9323.

2.5.2.3 Other Pipelines

Other Project pipelines would include a seawater import pipeline, a diesel import pipeline, a freshwater pipeline, a treated water pipeline, and a fuel gas pipeline. The seawater pipeline would import seawater from Kuparuk CPF2 to the WPF for injection into the target reservoirs. The U.S. Department of Transportation–regulated diesel pipeline would transport diesel fuel and other refined hydrocarbon products to power drilling support equipment, well work operations, and vehicles and equipment. The seawater and diesel pipelines would cross beneath the Colville River and would be installed using HDD. The Colville River crossing would be near the existing Alpine Sales Pipeline HDD crossing, approximately 400 feet downstream (north). Further details on these pipelines can be found in Appendix D.1, Section 4.2.2.3, *Other Pipelines*.

2.5.3 Access to the Project Area

Access to the Project area from Alpine, Kuparuk, or Deadhorse would occur via ground transportation on ice roads, fixed-wing aircraft, and helicopter. Construction material (e.g., pipeline, VSMs) may be delivered to the North Slope and Project area by ground transportation and barge. Small modules and bulk materials would be delivered by barge to Oliktok Dock and transported to the Project area via the annual Alpine Resupply Ice Road (Section 2.5.3.4, *Sealift Barge Delivery to Oliktok Dock*). The larger sealift modules comprising the processing facilities at the WPF and the drill sites would also be delivered to the North Slope by sealift barge; however, these modules would be too large to cross the Colville River ice bridge used by the Alpine Resupply Ice Road. As a result, three different options for the sealift module deliveries are described in Section 2.6. Anticipated ground, air, and marine traffic is detailed by alternative (Appendix D.1, Sections 4.3 through 4.5).

2.5.3.1 Ice Roads

Ice roads would primarily be used during Project construction to support gravel infrastructure and pipeline construction, for lake access, and gravel mine site access. Separate ice roads would be used for pipeline construction, gravel placement, and general traffic to address safety considerations. The usable ice road season for the Project area is expected to be shorter than that of Kuparuk and Alpine operations due to the logistical challenges of constructing a remote ice road. The annual Project ice-road season is expected to be 90 days (January 25 through April 25). A typical ice road would be at least 6 inches thick with a 35- to 70-foot-wide surface, depending on its use. All ice road routes in the EIS are estimated; final alignments would be determined through optimization and impact minimization prior to construction.

Sealift modules would be transported via ice road (combination of sea ice and over tundra) to the Project area. During drilling and operations, seasonal ground access from Deadhorse and Kuparuk to the Project area would be provided via the annually constructed Alpine Resupply Ice Road and then via existing Alpine and GMT gravel roads; under Alternative D, an annual ice road would be constructed from GMT-2 to the Project area. Alternative C would require the construction of an annual ice road between the WPF and BT1 to resupply drill sites BT1, BT2, and BT4.

2.5.3.2 Gravel Roads

All-season gravel roads would connect the Project drill sites to the WPF and to the existing GMT and Alpine developments (with some exceptions under Alternatives C and D). Gravel roads would be designed to maintain the existing thermal regime and would be a minimum of 5 feet thick (average 7 feet thick due to topography) and have 2:1 side slopes. The roads to BT3 (except under Alternative D), BT4, BT5, the airstrip(s), and the water source access road(s) would be 24 feet wide at the surface. All other Project roads would be 32 feet wide (crown width). CPAI would limit 24-foot-wide Project roads to 25 miles per hour (mph) (32-foot-wide roads would have 35 mph speed limits). Roads would include subsistence tundra access ramps (at road turnouts) generally every 2.5 to 3 miles with final locations based on community input.

When possible, roads would be constructed at least 500 feet from pipelines to minimize caribou disturbance and prevent excessive snowdrifts, but no more than 1,000 feet to aid in visual pipeline inspection from the road.

2.5.3.2.1 <u>Bridges</u>

Bridges would be designed to maintain bottom chord clearance of 4 feet above the 100-year design-flood elevation or at least 3 feet above the highest documented flood elevation, whichever is higher. Bridges crossing Judy (Iqalliqpik) and Fish (Uvlutuuq) creeks would be designed to maintain a bottom chord clearance of at least 13 feet above the 2-year design flood elevation (open water) to provide vessel clearance. Final design analysis would be based on observations, measurements, and modeled conditions (e.g., ice and snow effects), and would vary from crossing to crossing based on site-specific conditions. Shorter, single-span bridges would be designed to avoid placement of piers in main channels. Multi-span bridges would be constructed on steel-pile pier groups, positioned approximately 40 to 70 feet apart with sheet-pile abutments located above ordinary high water (OHW). Each bridge would be designed to accommodate drill rig movement. Bridges would range from 40 to 420 feet in length. (Specific bridge crossings details are in Appendix D.1, Sections 4.3 through 4.5.)

2.5.3.2.2 <u>Culverts</u>

Culverts would be placed in roads to maintain natural surface drainage patterns; culverts at swale crossings would be placed perpendicular to the road, where feasible. Culvert size, design, and layout would be determined based on site-specific conditions to pass the 50-year flood event with a headwater elevation not exceeding the top of the culvert. Fish-passage culverts meeting Alaska Department of Fish and Game (ADF&G) fish passage design requirements would be placed where required (as designated by the ADF&G). The estimated spacing of cross-drainage culverts is one every 1,000 feet. Culverts would be installed per the final design prior to breakup of the first construction season, but additional culverts may be placed after breakup as site-specific needs are further assessed with regulatory agencies.

2.5.3.3 Airstrip and Associated Facilities

Year-round access to the Project area from Alpine, Kuparuk, Deadhorse, or other locations would be provided by aircraft. Aircraft would support transportation of work crews, materials, equipment, and waste to and from the Project. Air access would be supported by a 6,200-foot-long gravel airstrip located near the WOC under Alternatives B and D and near the South and North WOC under Alternative C, which would include two airstrips. Additional airstrip facilities would include a traffic advisory center and approach lighting with airstrip module lighting pads. Aircraft would maintain altitudes consistent with Best Management Practice (BMP) F-1 (BLM 2013a), except during takeoffs and landings and unless doing so would endanger human life or violate safe flying practices. Aircraft flight paths would be routed north of Nuiqsut to the extent practicable.

2.5.3.4 Sealift Barge Delivery to Oliktok Dock

Sealift barges would be used to deliver the processing and drill site modules during four open-water (summer) seasons, as well as other bulk materials, to the North Slope. Barge transit routes would follow existing, regularly used marine transportation routes. To facilitate module delivery, CPAI would use a 9.6-acre offshore barge lightering area approximately 2.3 nautical miles (2.6 miles) from Oliktok Dock, where the water is approximately 10 feet deep. Lightering is the process of transferring cargo between vessels to reduce a vessel's draft, which allows it to enter a dock or port with shallower waters. The water depth at Oliktok Dock is too shallow (approximately 8 feet deep) to accommodate the draft depth of a fully loaded sealift barge. As a result, a portion of the load on each barge would be lightered onto an empty barge to allow transport to the dock.

During the lightering process, barges would be grounded on the seabed, which would require **screeding**, which is the redistribution or recontouring of the existing seafloor to provide a level surface for the barges to be grounded on during load transfers. Following sealift barge grounding and cargo transfer, each barge with a lightened load would be grounded in front of Oliktok Dock and off-loaded. To prevent pressure points on the barge hull during the grounded off-load at the dock, approximately 2.5 acres of marine area in front of the dock would also be screeded immediately before the first barge delivery each year. Grounding barges would require intaking seawater as ballast and then discharging seawater to refloat the barges. Ballast water intake and discharge would occur at the lightering area and the at the dock face; ballast water to ground barges would not be transported. Barge ballast tanks would be stripped of water and dried before departing the fabrication site for the North Slope.

2.5.4 <u>Other Infrastructure and Utilities</u>

2.5.4.1 Ice Pads

Single-season and multi-season ice pads would be used to support construction. Single-season ice pads are built and used for a single winter construction season, and they would be used during all years of construction to house construction camps, stage construction equipment, and support construction activities. Single-season ice pads would be used during construction at the gravel mine site during gravel mining activities (Appendix D.1, Section 4.2.6, *Gravel Mine Site*), on either side of bridge crossings during gravel road and pipeline construction, at the Colville River HDD pipeline crossing, and at other locations as needed near proposed infrastructure within the Project area.

Multi-season ice pads would be used on a limited basis to stage construction materials between winter construction seasons; this avoids the need to place gravel fill to support temporary activities. Multi-season ice pad construction uses a base layer of ice with structural insulated panels above and rig mats on the surface. Once the multi-season pad is no longer needed, the rig mats and insulated panels would be removed, and the ice would be excavated to within 12 inches of the tundra surface.

Three 10.0-acre multi-season ice pads would be used during Project construction: near GMT-2, near the WOC (South WOC under Alternative C), and at the Tiŋmiaqsiuġvik Mine Site. These pads would allow ice road, gravel mining, and other equipment to be stored on-site over the summer, which would support earlier construction starting dates the following winter, while minimizing gravel fill.

2.5.4.2 Camps

Camps required to support Project construction include temporary construction camps within the Project area at the WOC (for Alternatives B and D; at the North and South WOCs under Alternative C) as well as other existing camp space at Alpine (Alpine Operations Camp), the Kuukpik Pad (near the intersection of the Nuiqsut Spur Road and Alpine CD5), and the Sharktooth Camp in Kuparuk. Housing of construction workers at the Kuukpik

Hotel in Nuiqsut is also possible. Camps to support drilling would be located at each drill site. The Willow Camp would support operations and be located at the WOC pad (for Alternatives B and D; at the North and South WOCs under Alternative C).

2.5.4.3 Power Generation and Distribution

Electrical power for the Project would be generated by a 98-megawatt power plant at the WPF, equipped with natural gas-fired turbines. Power would be delivered to each drill site and the WOC(s) via power cables suspended from pipeline VSMs using messenger cables attached to the HSMs. Following WPF startup, the power plant would also be used to power drill rigs, except during periods when power from the WPF is unreliable.

During construction and drilling, prior to completion of the permanent power supply, portable generators would provide temporary power at various locations. Once fuel gas is available, upon startup of the WPF, diesel-fired emergency backup generators would be installed at the WPF and Willow Camp. Portable diesel-fired emergency backup generators would be available to provide emergency power at drill sites. Permanent electric power generator sets would be fully enclosed or acoustically packaged to abate noise.

2.5.4.4 Communications

Communications infrastructure would be provided by fiber-optic cables suspended from pipeline VSMs. Permanent communications towers would be located on the communications tower pad near the WOC and at each drill site (six towers total). The communications towers would be up to 200 feet tall and would not use guywires. Temporary towers would be pile supported and may require guywire supports. Guywires would include devices to mitigate bird strikes. All towers would have warning lights, as required by FAA for aircraft safety. Bird nesting diversion equipment may be installed on towers consistent with BLM NPR-A BMP E-9 (BLM 2013a), as is practicable given the equipment layout and potential for snow and ice loading and associated concerns.

2.5.4.5 Potable Water

The CFWR adjacent to Lake M0015 (also called R0056) would be the primary source of freshwater for domestic use under all action alternatives. Additional freshwater sources include Lake L911 (Alternatives B and C) and Lake M0235 (Alternatives C and D). The freshwater intake infrastructure at the CFWR and Lakes L9911 and M0235 would be accessed by water source access roads and pads.

The water from the CFWR and Lakes L9911 and M0235 would be treated in accordance with State of Alaska Drinking Water Regulations (18 AAC 80), as required for any potable drinking water system. Prior to operation of the freshwater intake system, potable water for construction and drilling camp use would be withdrawn using temporary equipment and trucked to the water plant at the temporary construction camp. Additional freshwater withdrawals from other local permitted lakes would be needed during the construction phase (e.g., ice road and pad construction, hydrostatic pipeline testing, HDD), the drilling phase (e.g., drilling support), and the operations phase (e.g., dust control); these are described in Appendix D.1, Section 4.2.5, *Water Sources and Use*.

2.5.4.6 Domestic Wastewater

Domestic wastewater treatment infrastructure would be located at the WOC (North and South WOCs under Alternative C). Sanitary waste generated from camps would be hauled to the wastewater treatment facility. The treated wastewater would be disposed of in the Class I UIC disposal well located at the WOC(s), hauled to and disposed of at another approved disposal site (e.g., Alpine), or in an emergency, discharged under the Alaska Pollutant Discharge Elimination System (APDES) General Permit (AKG 33-2000).

Prior to the establishment of the UIC well at the WOC, domestic wastewater would be treated and either hauled to Alpine or Kuparuk (winter only) for injection in an existing UIC disposal well or, in instances where weather or conditions at Alpine prevent disposal, discharged to tundra per APDES permit conditions.

2.5.4.7 Solid Waste

Domestic waste (e.g., food, paper, wood, plastics) would either be incinerated (to prevent attracting animals) on-site or at Alpine or, if non-burnable, would be recycled or transported to a landfill facility in Deadhorse (NSB landfill), Fairbanks, or Anchorage. Incinerator ash would be stored on-site until it could be transported to a landfill for disposal. Other hazardous and solid waste from the Project would be managed under Alaska Department of Environmental Conservation (ADEC) and EPA regulations, as well as BLM BMPs.

2.5.4.8 Drilling Waste

Drilling waste (e.g., drilling mud, cuttings) would be disposed of on-site through annular disposal (i.e., pumped down the well through the space between the two well casing strings) and/or transported to an approved disposal well (e.g., Class I UIC disposal well at the WOC). The Project would not use reserve pits. A temporary storage cell (typically a lined, wooden structure) may be constructed for staging drilling muds and cuttings prior to disposal. Produced water would be processed at the WPF and reinjected to the subsurface through injection wells as part of reservoir pressure maintenance and waterflood for secondary recovery. Well work waste materials would be managed according to the *Alaska Waste Disposal and Reuse Guide* (CPAI and BP n.d.). In addition to regulations governing waste handling and disposal, the Project would also be managed under BLM BMPs.

2.5.4.9 Fuel and Chemical Storage

Fuel and other chemicals would primarily be stored at the WPF, with additional storage at drill sites. Diesel fuel would be stored in temporary tanks on-site during construction under all action alternatives. During the drilling and operations phases, the WPF would include a fuel supply storage tank(s) and an associated fueling station as well as a tank farm to store methanol, crude oil flowback, corrosion inhibitor, biocide, scale inhibitor, emulsion breaker, and other chemicals, as required. Jet fuel would be stored on the airstrip apron for helicopter use; jet fuel would be delivered to airplanes by fuel trucks supplied by storage tanks located at the WPF.

Drill sites would have temporary tanks to support drilling operations, including brine tanks, cuttings and mud tank, and a drill rig diesel fuel tank (built into the drill rig structure). Production operations storage tanks at drill sites would include chemical storage tanks that may contain any of the following (depending on operational needs): corrosion inhibitor, methanol, scale inhibitor, emulsion breaker, anti-foaming agent, and ultra-low sulfur diesel fuel. Portable oil storage tanks to support well and pad operational activities and maintenance (i.e., well work, well testing) may be present on an as-needed basis.

Fuel and oil storage would comply with local, state, and federal oil pollution prevention requirements, according to the Oil Discharge Prevention and Contingency Plan (ODPCP) and Spill Prevention Control and Countermeasures (SPCC) Plan. Secondary containment for fuel and oil storage tanks would be sized as appropriate to the container type and according to governing regulatory requirements (18 AAC 75 and 40 CFR 112). Fuel and chemical storage for the Project would be managed under BLM BMPs (BLM 2013a).

2.5.5 Water Sources and Use

2.5.5.1 Constructed Freshwater Reservoir

CPAI would construct a CFWR (Figure 2.5.1) to ensure a reliable source of freshwater for the Project while minimizing the need for water withdrawal from Project-area lakes. The CFWR would be sized for an estimated winter withdrawal volume of 55 million gallons (MG). The CFWR would be accessed by a gravel access road from the road to BT3, and would consist of an 800-foot-long by 700-foot-wide by 50-foot-deep pit with 6 horizontal to 1 vertical ratio (6:1) side slopes and a 7-foot-high permanent berm. An approximately 1,325-foot-longconnection channel would connect the CFWR to Lake M0015 to support initial reservoir flooding and facilitate annual recharge. The excavation footprint for the CFWR would be 16.3 acres. The channel connection would include a sheet-pile weir with a screen to limit fish access to the CFWR and a flow control gate to allow CPAI to restrict flow into the CFWR based on the monitoring of Lake M0015 water levels and the lake's outlet to Willow Creek 3. Water would be withdrawn using a submerged pump (screened per ADF&G design standards). At times of low flow in Willow Creek 3, the flow control gate could be closed so that water is not diverted into the CFWR.

2.5.5.2 Other Water Sources

CPAI would also construct gravel access roads to connect to Lake L9911 (Alternatives B and C) and/or Lake M0235 (Alternatives C and D) to supply water for the Project's drilling and operations phases. Lake L9911 has an estimated total lake volume of 1,586 MG and Lake M0235 has an estimated total lake volume of 327 MG. Water intake infrastructure at these lakes would consist of a triplex pump (housed within secondary containment) sitting on the water source access pad. Water for construction and the maintenance of ice roads and ice pads would be withdrawn from lakes near the construction activities as allowed by State of Alaska temporary water use authorizations and fish habitat permits (where necessary).

Seawater for hydraulic fracturing and well injection would come from the existing Kuparuk Seawater Treatment Plant at Oliktok Point and would be shipped to the Project area from Kuparuk CPF2 via a new seawater pipeline.

2.5.5.3 Water Use

Freshwater would be required for domestic use at remote construction camps and for construction and maintenance of ice roads and ice pads. Potable water requirements are based on a demand of 100 gallons per day per person. Freshwater would also be used for hydrostatic testing.

Depending on the use, ice road widths would be 35 feet, 50 feet, or 70 feet; the volume of freshwater required to construct these ice roads would be approximately 1.0 MG, 1.4 MG, and 2.0 MG, respectively. Multi-season ice pads require approximately 0.25 MG of water per acre, per foot of thickness; Project multi-season ice pads would typically be between 5 to 7 feet thick (including insulation and rig mats), depending on site-specific topography. Multi-season ice pads are individually engineered based on geographic and seasonal variables. Water use for module delivery is described in Appendix D.1, Section 4.7, *Sealift Module Delivery Options*.

Freshwater would be required for domestic use at the drilling camp and during drilling activities. Prior to WPF startup, freshwater would be used for drilling water and hydraulic fracturing. Drilling water requirements are estimated to be 1.4 MG per rig per month and hydraulic fracturing would require approximately 1.0 MG of water per well. Following WPF startup, freshwater needs for drilling water would drop to approximately 0.4 MG per well; the remaining drilling and all of the hydraulic fracturing water would then be seawater. Freshwater for drilling may be withdrawn from lakes near the Project using temporary triplex pump and truck connections, as allowed by temporary water use authorizations and fish habitat permits.

During construction, seawater would be used for ballast water by sealift barges making deliveries to Oliktok Dock. Following WPF startup, seawater would be used for the hydraulic fracturing of production and injection wells, drilling, and for reservoir injection to support enhanced oil recovery. Enhanced oil recovery would require approximately 2.1 to 3.8 MG of seawater per day.

2.5.6 Gravel Mine Site

The amount of gravel required for the Project varies by alternative and module delivery option (approximately 5.0 to 6.4 million cubic yards [cy] depending on the alternative and module delivery option). Gravel would be obtained from a new gravel source in the Tiŋmiaqsiuġvik area, approximately 4 to 5 miles southeast of Greater Mooses Tooth 1 (GMT-1) (Figures 2.4.1, 2.4.2, and 2.4.3). The mine site footprint would overlap the Ublutuoch (Tiŋmiaqsiuġvik) River 0.5-mile setback (137.8 acres); however, mine development is allowed in the setback area (BMP K-1 in BLM 2013a).

2.5.6.1 Mine Site Description

CPAI proposes to develop two mine site cells (Area 1 and Area 2) located on BLM-managed lands in the Tiŋmiaqsiuġvik area (Figure 2.5.2). Further geotechnical investigation has reduced the anticipated mine site footprint from 230.0 acres (total), as described in the Draft EIS (BLM 2019c). Current CPAI estimates are that Mine Site Area 1 would have a 109.3-acre excavation footprint and Mine Site Area 2 would have a 40.4-acre footprint (149.7 total acres). Both mine sites would be needed in order to fulfill Project gravel needs.

The gravel mine site would be accessed seasonally via ice road; no permanent gravel road to the mine site would be constructed. There would be no activity at the mine site outside of the winter construction season. Gravel mining operations would occur over six to seven winter construction seasons (varies by alternative).

The layout of the mine site areas would be designed to maximize access to the most suitable construction materials while minimizing overall surface disturbance at the site. Overburden removal and gravel mining would proceed as material is needed. To support gravel mining, a 10.0-acre multi-season ice pad and approximately 188.0 total acres of single-season ice pads would be used for storing equipment and stockpiling overburden. Pumping would be necessary to maintain a lowered water level throughout mining operations. Pumped water would be discharged through a diffuser onto tundra.

Inorganic overburden material would be used to create water diversion berms (approximately 5 feet tall and 15 feet wide at the top) as needed around the perimeter of the mine site cells. These berms would be placed directly on the surrounding tundra to prevent surface water flow into the mine site, help maintain thermal stability of permafrost adjacent to the mine footprint, safeguard the stability of the mine walls during mine operation, and provide a protective physical barrier around the mine site for local residents.

2.5.6.2 Mine Site Rehabilitation

Mine site reclamation would begin once excavation has progressed enough to provide room within the excavated area to safely perform both mining and reclamation activities concurrently. Reclamation materials would include overburden removed during mining and soils generated during Project construction (e.g., CFWR excavation). The material stockpiled on the adjacent ice pads would be placed back into the excavated area. It is anticipated the overburden generated in Mine Area 2 would remain stockpiled through one summer before being used for mine site reclamation. Following the removal of the overburden stockpiles, monitoring and treatment of the underlying tundra would be completed as needed. All subsequent overburden removed during mining operations would then remain in the excavated mine site. Performing reclamation during the same season as mining would minimize the overall disturbance footprint by eliminating the ongoing need to stockpile overburden outside of the mine site excavation.

When the mine site is no longer needed as a gravel source and reclamation efforts are complete, the mine site walls would have 3:1 slopes. The mine site cells would be allowed to naturally fill with water (e.g., precipitation, meltwater) to potentially provide waterfowl and shorebird habitats. It is anticipated it will take a decade or longer to fill the excavation sites with water. The Willow Mine Site Mining and Reclamation Plan is included as Appendix D.2, *Willow Mine Site Mining and Reclamation Plan*.

2.5.7 Erosion and Dust Control

The Project would follow a Facility Erosion Control Plan, which would outline procedures for the operation, monitoring, and maintenance of various erosion control methods. A Stormwater Pollution Prevention Plan (SWPPP) would describe management of surface water drainage for Project gravel pads. Both plans would be based on the existing Alpine Facility Erosion Control Plan and Alpine SWPPP.

CPAI would implement a Project Dust Control Plan to minimize the incidence of fugitive dust. The Dust Control Plan would identify Project sources for fugitive dust, dust control methods and measures to be used for each source, and monitoring and record keeping parameters. Dust control would include watering gravel roads to minimize dust impacts to the tundra and to maintain gravel road integrity. The Willow Dust Control Plan can be found in Appendix I.3, *Dust Control Plan.*

2.5.8 Spill Prevention and Response

Facilities would be designed to mitigate spills with spill prevention measures and spill response capabilities. CPAI would implement a pipeline maintenance and inspection program and an employee spill prevention training program to further reduce the likelihood of spills occurring. CPAI's design of production facilities would include provisions for secondary containment of hydrocarbon-based and other hazardous materials, as required by state and federal regulations. If a spill occurs on a pad, the fluid would remain on the pad unless the spill is near a pad edge or exceeds the pad's retention capacity. In addition to regulations governing spill prevention and response, the Project would be managed under the BLM BMPs described for solid waste, fuel, and chemical storage (BLM 2013a). Additional details on spill prevention and response are in Appendix H, *Spill Summary, Prevention, and Response Planning*.

2.5.8.1 Spill Prevention

Spill prevention and response measures that would be used during construction, drilling, and operations would be outlined in Project ODPCP and SPCC Plan, which will outline CPAI's capability to prevent oil spills from entering the water or land and to ensure rapid response in the event a spill occurs.

CPAI would design and construct pipelines to comply with state, federal, and local regulations and would use two methods of leak detection for the seawater and diesel pipeline HDD crossings under the Colville River: leak detection by mass balance (primary) and optical leak detection (secondary and within the pipeline carrier casing). To further prevent a pipeline leak under the Colville River, the diesel and seawater pipelines would be installed inside high-strength casing pipe.

There would be an increased potential for pipeline spills where pipelines would cross under roads due to corrosion of the buried portion of the pipelines. The likelihood of corrosion occurring would be reduced through design and monitoring. CPAI would maintain corrosion control and inspection programs that include ultrasonic inspection, radiographic inspection, coupon monitoring, metal loss deflection pigs and geometry pigs (applicable to pig-capable pipelines), and infrared technology.

2.5.8.2 Spill Response

The Project's ODPCP would demonstrate readily accessible inventories of fit-for-purpose oil spill response equipment and personnel at Project facilities. In addition, a state-registered primary response action contractor would provide trained personnel to manage spill response. Spill response equipment would be pre-staged at strategic locations across the Project area as outlined in the ODPCP for an initial response. This strategy would facilitate the rapid deployment of equipment by personnel. The effective response time would be enhanced with pre-staged equipment, which would expedite equipment deployment to contain and recover spilled oil, reducing the overall affected area.

2.5.8.3 Spill Training and Inspections

CPAI provides regular training for its employees and contractors on the importance of preventing oil or hazardous material spills. The CPAI Incident Management Team participates in regularly scheduled training programs and conducts spill response drills in coordination with federal, state, and local agencies.

CPAI is required to conduct visual examinations of pipelines and facility piping with a frequency defined under 49 CFR 195.412 and 18 AAC 75.055 during operations at a minimum interval not exceeding 3 weeks. CPAI would provide aerial overflights as necessary to allow inspection both visually and with the aid of infrared technology, when required.

2.5.9 Abandonment and Reclamation

The abandonment and reclamation of Project facilities would be determined by the BLM Authorized Officer at or before the time of abandonment. The abandonment and reclamation plan would be subject to input from federal, state, and local authorities and private landowners. Abandonment and reclamation may involve removal of gravel pads and roads or leaving these in place for use by a different entity. Revegetation of abandoned facilities could be accomplished by seeding with native vegetation or through natural colonization. Reclaimed gravel could be used for other development projects. To assist with abandonment and reclamation, BLM holds bonds from any company conducting development activities within the NPR-A to cover the cost of reclamation. CPAI also sets aside money to cover asset retirement obligations.

2.5.10 Schedule and Logistics

Timing of the Project is based on several factors including permitting and other regulatory approvals, Project sanctioning, and purchase and fabrication of long-lead time components. CPAI proposes to construct the Project over approximately 9 to 10 years (depending on the alternative) beginning in the first quarter (Q1) of 2021. The WPF is anticipated to come online the fourth quarter (Q4) of 2025 (first oil) for Alternatives B and C, and in Q4 of 2026 for Alternative D. Operations would run to the end of the Project's field life, which is estimated to be 2050 (Alternatives B and C) or 2051 (Alternative D).

2.5.10.1 Construction Phase

Gravel mining and placement would be conducted almost exclusively during winter. Prepacking snow and constructing ice roads to access the gravel mine site and gravel road and pad locations would occur in December and January, with ice roads assumed to be available for use by February 1. Gravel for the infrastructure associated with the initial construction (access road [Alternatives B and C], BT1, BT2, BT3, connecting roads, WPF, WOC, and airstrips) would be mined and placed during winter for the first 4 to 5 years of construction (varies by alternative). Two additional winter seasons of gravel mining and placement would occur to construct BT4, BT5, and associated roads. Gravel haul and placement to modify Oliktok Dock would occur during the 2022 summer season (Alternatives B and C) or 2023 (Alternative D).

Culvert locations would be identified and installed per the final design during the first construction season prior to breakup. Bridges would be constructed during winter from ice roads and pads. Once gravel pads are completed, on-pad facilities would be constructed. Modules for the WPF and drill sites BT1, BT2, and BT3 would be delivered by barge to the MTI during summer. Modules for drill sites BT4 and BT5 would be delivered via a second sealift 2 years after the first delivery and moved to the Project area in the same manner as modules for BT1, BT2, and BT3.

The CFWR would be constructed during Q1 and the second quarter of 2023 (under all action alternatives).

Pipeline installation would take from 1 to 4 years per pipeline, depending on pipeline length and location. The HDD Colville River pipeline crossing would be completed during the winter construction season of 2024.

2.5.10.2 Drilling Phase

Drilling is planned to begin in 2024 (Alternatives B and C) or 2025 (Alternative D) at BT1. It is assumed the wells would be drilled consecutively, from BT1 to BT5; however, CPAI would determine the final timing and order of drilling based on economics and drill rig availability. Drilling is anticipated to take 6 years and would be conducted year-round with an anticipated progress rate of approximately 15 to 30 days per well.

2.5.10.2.1 Hydraulic Fracturing

Project drilling would include hydraulic fracturing, which is a process used to increase the flow of fluids from a reservoir into the wellbore and to establish a connection between oil-bearing formation layers. Each production well would receive a multistage hydraulic fracturing operation similar to those employed at other North Slope developments. It is anticipated that each well would be hydraulically fractured one time with approximately 12 to 20 individual fracturing locations within the well. Hydraulic fracturing operations would last approximately 6 days per well with six wells per pad per year being fracture stimulated. Hydraulic fracturing would only be used during the initial stage of drilling to stimulate flows at the production wells; it would not be needed for continued production over the life of the Project. The Alaska Oil and Gas Conservation Commission (AOGCC) maintains jurisdiction over the subsurface fracturing process (20 AAC 25.283), and all hydraulic fracturing activities would comply with AOGCC regulations.

2.5.10.3 Operations Phase

Following initial well drilling and WPF startup, typical operations would consist of well operations and production and transportation of produced hydrocarbons. Well maintenance operations would occur intermittently throughout the life of the Project. CPAI's standard operations and maintenance practices would be implemented for this Project phase. Table D.4.4 (Appendix D.1, Section 4.2.10.3, *Operations Phase*) summarizes the anticipated daily production profile for each action alternative; these production values include fluids produced at GMT-2 and processed at the WPF.

2.5.11 Project Infrastructure in Special Areas

All action alternatives would include Project infrastructure in BLM-identified Special Areas, including the Colville River Special Area (CRSA) and the TLSA. Designation of Special Areas does not provide specific restrictions on activities but does require such activities be conducted in such a way as to ensure the protection of surface values while being consistent with the NPRPA for exploration and production activities (BLM 2013a, 2020a).

2.5.12 Compliance with Bureau of Land Management Lease Stipulations and Best Management Practices

Activity in the NPR-A is subject to a variety of existing **lease stipulations** (LSs) and BMPs intended to reduce effects from development activity. In addition to the 2013 LSs and BMPs (BLM 2013a), BLM is revising the NPR-A IAP (BLM 2020a), including potential changes to required BMPs (described as required operating procedures [ROPs] in BLM 2020). Updated ROPs adopted in the new NPR-A IAP will replace existing BMPs (BLM 2013a); however, applicable LSs would not change because LSs are fixed at the time of lease issuance. Some requirements may apply as either a LS or BMP/ROP. If the activity is based on lease rights, the LS governs and could not be superseded by a BMP/ROP; otherwise the requirement would apply as a BMP/ROP. The terms BMPs and ROPs are used interchangeably throughout the EIS. (The reader is referred to Section 2.2.7, *Lease Stipulations, Required Operating Procedures, and Lease Notices*, of the 2020 IAP/EIS for further discussion on this topic.) The Willow MDP ROD will detail which of the measures will be implemented for the Project. Many of the previously identified LSs and BMPs are readily incorporable into the Project, although some LSs and BMPs may require exceptions or deviations due to Project constraints and would be evaluated by BLM on a case-by-case basis. Deviations and exceptions from LSs and BMPs are discussed further in the relevant sections for each action alternative in Appendix D.1. Table 2.5.1 lists LSs and BMPs from the 2013 NPR-A IAP/EIS ROD (BLM 2013a) and proposed ROPs from 2020 NPR-A IAP Final EIS anticipated to be applicable to the Project.

Table 2.5.1. Applicable Lease Stipulations and Best Management Practices

Category	2013 Lease Stipulations and Best Management Practices	2020 Proposed Revisions to Best Management Practices
Waste handling and disposal	A-1, A-2, A-7	A-1, A-2; *BMP A-7 withdrawn*
Fuels and hazardous materials handling and storage; spill prevention and spill response	A-3, A-4, A-5	A-3, A-4, A-5
Health and safety	A-8, A-11, A-12	A-8, A-13; *BMPs A-11 and A-12 have no similar requirement*
Air quality	A-9, A-10	A-10, A-14; *BMP A-9 withdrawn*
Water use	B-1, B-2	B-1, B-2
Winter overland moves	C-1, C-2, C-3, C-4	C-1, C-2, C-3, C-4
Facility design and construction	E-1, E-2, E-3, E-4, E-5, E-6, E-7, E-8, E-9, E-10, E-11, E-12, E-13, E-14, E-17, E-18, E-19	E-1, E-2, E-3, E-5, E-6, E-7, E-8, E-10, E-11, E-12, E-13, E-17, E-18, E-19, E-21; *BMP E-4 withdrawn*; *BMPs E-9 and E-14 combined or incorporated into other ROPs*
Aircraft use	F-1	F-1, F-2, F-3, F-4
Oil field abandonment	G-1	G-1
Subsistence	H-1, H-3	H-1, H-3, H-4, H-5, K-15, K-16
Worker orientation	I-1	I-1
Biologically sensitive areas	K-1, K-2, K-4, K-5, K-6, K-7, K-9, K-10	E-23, K-1, K-2, K-5 (formerly K-6), K-6 (formerly K-4), K-7 (formerly K-4), K-9 (formerly K-5), K-10 (formerly K-9), K-11 (formerly K-10), K-12 (formerly K-7)
Summer vehicle tundra access	L-1	L-1
General wildlife and habitat protection	J, M-1, M-2, M-3, M-4	M-1, M-2, M-3, M-4, M-5

Source: BLM 2013a, 2019c
Note: BMP (best management practice).

2.5.13 Boat Ramps for Subsistence Users

CPAI proposes to construct up to three boat ramps (number varies by action alternatives) for subsistence use as part of its effort to mitigate Project effects on the community of Nuiqsut (Figure 2.5.3). CPAI proposes to construct one boat ramp (all action alternatives) to access the Ublutuoch (Tiŋmiaqsiuġvik) River along the existing gravel road between Alpine CD5 and GMT-1 during the first year of construction. Two additional boat ramps could be constructed along Judy (Iqalliqpik) Creek and/or Fish (Uvlutuuq) Creek under Alternative B, pending further community input; these boat ramps would be accessed via short gravel roads connected to Project roads near Project bridges. The two additional boat ramps would not apply to Alternatives C and D as there would be no gravel road connection to these locations from Nuiqsut; they would be constructed within two years of constructing the BT1 and BT4 access roads after site visits and input from local stakeholders.

Preliminary locations and boat ramp design have been determined, but CPAI is seeking community feedback on the preferred location(s) that would best serve the needs of the community. The boat ramps would include a gravel pad with space for vehicles to turn around and provide parking space for approximately 10 vehicles with trailers.

2.6 Sealift Module Delivery Options

CPAI proposes to use large prefabricated modules for Project components like the WPF and drill site facilities. These large modules would be fabricated at an off-site location and transported to the North Slope via sealift barge. Modules for the WPF and drill sites are anticipated to weigh between 3,000 and 4,000 tons and up to 1,000 tons, respectively. Because these large modules are too heavy to be transported across the Colville River on the annual resupply ice road, the following module delivery options are presented for detailed analysis in the EIS:

- Option 1: Atigaru Point Module Transfer Island
- Option 2: Point Lonely Module Transfer Island
- Option 3: Colville River Crossing

The first two options would deliver the large modules to an MTI west of the Colville River (eliminating this required crossing) and then use ice roads to transport the modules to their gravel pads. Based on concerns from stakeholders, CPAI developed a third option to deliver the large modules to the Project area that would use the existing Oliktok Dock and not require an MTI

Sealift delivery of the large WPF and drill site modules would occur during two open-water seasons. Under Alternatives B and C, the modules would be delivered during the summers of 2024 and 2026; under Alternative D, the modules would be delivered during the summers of 2025 and 2027. The three module delivery options are described below.

2.6.1 Option 1: Atigaru Point Module Transfer Island

Option 1 would construct an MTI in Harrison Bay near Atigaru Point to support sealift module delivery (Figure 2.4.4). Appendix D.1, includes additional details regarding island construction, maintenance, and decommissioning; ice road and ice pad requirements; water use; anticipated traffic volumes; and schedule.

2.6.2 Option 2: Point Lonely Module Transfer Island

Option 2 would construct an MTI at Point Lonely, a former U.S. Department of Defense site, to support sealift module delivery (Figure 2.4.5). Appendix D.1 includes additional details regarding island construction, maintenance, and decommissioning; ice road and ice pad requirements; water use; anticipated traffic volumes; and schedule.

2.6.3 Option 3: Colville River Crossing

Option 3 is the Proponent's proposed module delivery option and it would use the existing Oliktok Dock to receive the sealift barges. The modules would be transported over existing Kuparuk gravel roads using self-propelled module transporters (SPMTs) from Oliktok Dock to Kuparuk Drill Site 2P (DS2P). From Kuparuk DS2P, the modules would then be moved by heavy-haul ice roads to GMT-2, crossing the Colville River on a partially grounded ice crossing near Ocean Point (Figure 2.4.6). From GMT-2, the modules would be transported to the Project area over Project gravel roads (Alternatives B and C) or ice roads (Alternative D) to reach the WPF and drill site gravel pads.

2.7 Comparison of Action Alternatives and Module Delivery Options

Table 2.7.1 and Figure 2.7.1 provide a comparison of action alternatives. Table 2.7.2 provides a comparison of module delivery options.

Table 2.7.1. Summary Comparison of Action Alternatives

Project Component	Alternative B – Proponent's Project	Alternative C – Disconnected Infield Roads	Alternative D – Disconnected Access
Drill site gravel pads	Five pads (79.8 acres total) Three 17.0-acre pads (51.0 acres total): BT1, BT2, and BT3 Two 14.4-acre pads (28.8 acres total): BT4 and BT5	Five pads (88.3 acres total): BT1 (23.3 acres), BT2 (18.1 acres), BT3 (17.0 acres), BT4 (15.5 acres), and BT5 (14.4 acres)	Five pads (62.8 acres total): Two 17.0-acre pads (34.0 acres total): BT1 and BT2 Two 14.4-acre pads (28.8 acres total): BT4 and BT5 BT3 (colocated with WPF; acreage accounted for under WPF pad)
WPF gravel pad	22.8-acre pad	22.8-acre pad	64.7-acre pad (colocated with BT3)
WOC gravel pad	31.3-acre pad	Two WOC pads (50.2 acres total): South WOC (33.4 acres) North WOC (16.8 acres)	62.2-acre pad
Constructed freshwater reservoir	16.3-acre excavation (reservoir and connecting channel) and 3.9-acre perimeter berm	16.3-acre excavation (reservoir and connecting channel) and 3.9-acre perimeter berm	16.3-acre excavation (reservoir and connecting channel) and 3.9-acre perimeter berm
Water source access gravel pads	Two water source access pads (2.6 acres total) at the CFWR (1.3 acres) and Lake L9911 (1.3 acres)	Three water source access pads (3.9 acres total) at the CFWR (1.3 acres) and Lakes L9911 (1.3 acres) and M0235 (1.3 acres)	Two water source access pads (2.6 acres total) at the CFWR (1.3 acres) and Lake M0235 (1.3 acres)
Other gravel pads	Four valve pads (1.3 acres total); two pads at Judy (Iqalliqpik) Creek pipeline crossing and two pads at Fish (Uvlutuuq) Creek pipeline crossing Two HDD pipeline pads at Colville River crossing (1.5 acres total) Tie-in pad near Alpine CD4N (0.7 acre) Pipeline crossing pad near GMT-2 (0.5 acre) Communications tower pad (0.5 acre) Kuparuk CPF2 pad expansion (1.0 acre)	Four valve pads (1.7 acres total); two helicopter accessible pads at Judy (Iqalliqpik) Creek pipeline crossing and two pads at Fish (Uvlutuuq) Creek pipeline crossing Two HDD pipeline pads at Colville River crossing (1.5 acres total) Tie-in pad near Alpine CD4N (0.7 acre) Pipeline crossing pad near GMT-2 (0.5 acre) Communications tower pad (0.5 acre) Kuparuk CPF2 pad expansion (1.0 acre)	Four valve pads (1.3 acres total): two pads at Judy (Iqalliqpik) Creek pipeline crossing and two pads at Fish (Uvlutuuq) Creek pipeline crossing Two HDD pipeline pads at Colville River crossing (1.5 acres total) Tie-in pad near Alpine CD4N (0.7 acre) Pipeline crossing pad near GMT-2 (0.5 acre) Communications tower pad (0.5 acre) GMT-2 staging pad (5.9 acres) Kuparuk CPF2 pad expansion (1.0 acre) Alpine CD1 pad expansion (1.3 acres)
Single-season ice pads	Used during construction at the gravel mine site, bridge crossings, the Colville River HDD crossing, and other locations as needed in the Project area (936.6 total acres)	Used during construction at the gravel mine site, bridge crossings, the Colville River HDD crossing, and other locations as needed in the Project area (1,166.4 total acres)	Used during construction at the gravel mine site, bridge crossings, the Colville River HDD crossing, and other locations as needed in the Project area (1,241.4 total acres)
Multi-season ice pads	Three 10.0-acre pads (30.0 acres total): 10.0-acre multi-season ice pad near GMT-2 (Q1 2021 to Q2 2025) 10.0-acre multi-season ice pad near WOC (Q1 2021 to Q2 2022) 10.0-acre multi-season ice pad at the Tiŋmiaqsiuġvik Gravel Mine Site (Q1 2021 to Q2 2023)	Three 10.0-acre pads (30.0 acres total): 10.0-acre multi-season ice pad near GMT-2 (Q1 2021 to Q2 2025) 10.0-acre multi-season ice pad near the South WOC (Q1 2021 to Q2 2022) 10.0-acre multi-season ice pad at the Tiŋmiaqsiuġvik Gravel Mine Site (Q1 2021 to Q2 2023)	Three 10.0-acre pads (30.0 acres total): 10.0-acre multi-season ice pad at GMT-2 (Q1 2021 to Q2 2025) 10.0-acre multi-season ice pad at the WOC (Q1 2021 to Q2 2022) 10.0-acre multi-season ice pad at Tiŋmiaqsiuġvik Gravel Mine Site (Q1 2021 to Q2 2023)

Project Component	Alternative B – Proponent's Project	Alternative C – Disconnected Infield Roads	Alternative D – Disconnected Access
Infield pipelines	43.4 total segment miles: BT1 to WPF (4.3 miles) BT2 to BT1 (4.7 miles) BT3 to WPF (4.2 miles) BT4 to BT2 (10.2 miles) BT5 to WPF (9.8 miles) GMT-2 to WPF (10.2 miles)	47.0 total segment miles: BT1 to WPF (6.0 miles) BT2 to BT1 (4.5 miles) BT3 to WPF (5.9 miles) BT4 to BT2 (9.9 miles) BT5 to WPF (11.5 miles) GMT-2 to WPF (9.2 miles)	46.5 total segment miles: BT1 to WPF (10.0 miles) BT2 to BT1 (4.7 miles) BT4 to BT2 (10.2 miles) BT5 to WPF (6.5 miles) GMT-2 to WPF (15.1 miles)
Willow export pipeline	33.3 total miles (WPF to tie-in pad near Alpine CD4N)	32.2 total miles (WPF to tie-in pad near Alpine CD4N)	38.2 total miles (WPF to tie-in pad near Alpine CD4N)
Other pipelines	64.3-mile seawater pipeline (Kuparuk CPF2 to WPF); includes Colville River HDD crossing 34.4-mile diesel pipeline (Kuparuk CPF2 to Alpine CD1); includes Colville River HDD crossing 2.8-mile fuel gas pipeline (WOC to WPF) 4.9-mile freshwater pipeline (CFWR to WPF to WOC) 2.8-mile treated water pipeline (WOC to WPF)	63.3-mile seawater pipeline from Kuparuk CPF2 to WPF; includes Colville River HDD crossing 82.0-mile diesel pipeline from Kuparuk CPF2 to South WOC to WPF to North WOC 1.7-mile fuel gas pipeline (WPF to South WOC) 5.6-mile freshwater pipeline (CFWR to WPF to South WOC) 12.9-mile treated water pipeline (South WOC to WPF to North WOC)	69.2-mile seawater pipeline from Kuparuk CPF2 to WPF; includes Colville River HDD crossing 77.0-mile diesel pipeline from Kuparuk CPF2 to Alpine CD1 to WOC; includes Colville River HDD crossing 1.5-mile fuel gas pipeline (WPF to WOC) 2.2-mile freshwater pipeline (CFWR to WOC to WPF) 1.5-mile treated water pipeline (WOC to WPF)
Total miles of pipeline alignment without a parallel road (i.e., greater than 1,000 feet of separation)	40.7	45.5	47.9
VSMs	Approximately 13,000 total VSMs with a 0.8-acre disturbance footprint	Approximately 13,000 total VSMs with a 0.8-acre disturbance footprint	Approximately 13,700 total VSMs with a 0.9-acre disturbance footprint
Pipeline VSMs below ordinary high water (number)	0	10 at Judy (Iqalliqpik) Creek	0
Gravel roads	37.0 miles (260.2 total acres, including vehicle turnouts) total connecting drill sites to the WPF, WOC, airstrip access road, water source access roads, and GMT-2 Eight vehicle turnouts with subsistence/tundra access ramps (3.0 acres total)	35.3 miles (243.2 total acres, including vehicle turnouts) total connecting: BT5, BT3, CFWR, South Airstrip access road, and South WOC to the WPF; and WPF to GMT-2 BT1, BT2, and BT4, water source access road, North Airstrip access road, and the North WOC Eight vehicle turnouts with subsistence/tundra access ramps (3.0 acres total)	27.1 miles (188.9 total acres, including vehicle turnouts) total connecting four drill sites to BT3/WPF, WOC, airstrip access road, and water source access roads; there would be no gravel road connection to GMT-2 Six vehicle turnouts with subsistence/tundra access ramps (2.2 acres total)
Bridges	Seven total bridges: Judy (Iqalliqpik) Creek, Judy (Kayyaaq) Creek, Fish (Uvlutuuq) Creek, Willow Creek 2, Willow Creek 4, Willow Creek 4A, and Willow Creek 8	Six total bridges: Judy (Kayyaaq) Creek, Fish (Uvlutuuq) Creek, Willow Creek 2, Willow Creek 4, Willow Creek 4A, Willow Creek 8	Six total bridges: Judy (Iqalliqpik) Creek, Judy (Kayyaaq) Creek, Fish (Uvlutuuq) Creek, Willow Creek 4, Willow Creek 4A, and Willow Creek 8

Project Component	Alternative B – Proponent's Project	Alternative C – Disconnected Infield Roads	Alternative D – Disconnected Access
Bridge piles below ordinary high water (number)	36 total: 16 at Judy (Iqalliqpik) Creek 4 at Judy (Kayyaaq) Creek 16 at Fish (Uvlutuuq) Creek	20 total: 4 at Judy (Kayyaaq) Creek 16 at Fish (Uvlutuuq) Creek	36 total: 16 at Judy (Iqalliqpik) Creek 4 at Judy (Kayyaaq) Creek 16 at Fish (Uvlutuuq) Creek
Culverts or culvert batteries (number)	11	10	8
Cross-drainage culverts (number)	195	186	143
Airstrip	6,200 × 200–foot airstrip and apron (42.1 acres total); would require airstrip access road	Two airstrips (87.6 acres total): North Airstrip: 6,200 × 200–foot airstrip and apron (43.8 acres total); would also require an airstrip access road South Airstrip: 6,200 × 200–foot airstrip and apron (43.8 acres total); would require an airstrip access road	6,200 × 200–foot airstrip and apron (44.7 acres total); would require an airstrip access road
Boat ramps	Three boat ramps (5.9 acres total): 1.8 acres at Ublutuoch (Tiŋmiaqsiuġvik) River 2.0 acres at Judy (Iqalliqpik) Creek 2.1 acres at Fish (Uvlutuuq) Creek	1.8 acres at Ublutuoch (Tiŋmiaqsiuġvik) River	1.8 acres at Ublutuoch (Tiŋmiaqsiuġvik) River
Oliktok Dock modifications	Modifications to the existing dock include adding structural components and a gravel ramp within the existing developed footprint 2.5 acres of screeding at Oliktok Dock 9.6 acres of screeding at the barge lightering area	Modifications to the existing dock include adding structural components and a gravel ramp within the existing developed footprint 2.5 acres of screeding at Oliktok Dock 9.6 acres of screeding at the barge lightering area	Modifications to the existing dock include adding structural components and a gravel ramp within the existing developed footprint 2.5 acres of screeding at Oliktok Dock 9.6 acres of screeding at the barge lightering area
Ice roads	Approximately 495.2 total miles (3,590.7 total acres) over nine construction seasons (2021 through 2029)	Approximately 650.1 total miles (4,411.6 total acres) 574.5 miles (4,090.3 acres) over nine construction seasons (2021 through 2029) 3.6 miles (15.3 acres) of annual resupply ice road (2030 to 2050; 75.6 total miles; 321.3 total acres)	Approximately 962.4 total miles (5,893.4 total acres) 699.9 miles (4,780.4 acres) over 10 construction seasons (2021 to 2030) 12.5 miles (55.7 acres) of annual resupply ice road (2030 to 2051; 262.5 total miles; 1,113.0 total acres)
Total footprint and gravel fill volume[a]	454.1-acre gravel footprint using 4.9 million cy of gravel fill and 25,000 cy of native fill 149.7-acre gravel mine site excavation 16.3-acre excavation at the CFWR 12.1-acre screeding area	507.6-acre gravel footprint using 5.8 million cy of gravel fill and 25,000 cy of native fill 149.7-acre gravel mine site excavation 16.3-acre excavation at the CFWR 12.1-acre screeding area	444.3-acre gravel footprint using 5.9 million cy of gravel fill and 25,000 cy of native fill 149.7-acre gravel mine site excavation 16.3-acre excavation at the CFWR 12.1-acre screeding area
Gravel source	Two mine site cells (149.7 total acres) in Tiŋmiaqsiuġvik area (Mine Site Area 1 would be 109.3 acres and Mine Site Area 2 would be 40.4 acres)	Two mine site cells (149.7 total acres) in Tiŋmiaqsiuġvik area (Mine Site Area 1 would be 109.3 acres and Mine Site Area 2 would be 40.4 acres)	Two mine site cells (149.7 total acres) in Tiŋmiaqsiuġvik area (Mine Site Area 1 would be 109.3 acres and Mine Site Area 2 would be 40.4 acres)
Total freshwater use	1,662.4 MG over the life of the Project (30 years)	1,914.3 MG over the life of the Project (30 years)	2,286.3 MG over the life of the Project (31 years)

Project Component	Alternative B – Proponent's Project	Alternative C – Disconnected Infield Roads	Alternative D – Disconnected Access
Ground traffic (number of trips)[b,c]	3,188,910	4,212,510	4,376,890
Fixed-wing air traffic[b,d]	12,101 total flights Willow: 11,809 Alpine: 292	19,574 total flights South Willow: 13,201 North Willow: 6,081 Alpine: 292	19,038 total flights Willow: 15,387 Alpine: 3,651
Helicopter air traffic[b,e]	2,421 total flights Willow: 2,321 Alpine: 100	2,910 total flights South Willow: 2,421 North Willow: 357 Alpine: 132	2,503 total flights Willow: 2,403 Alpine: 100
Marine traffic (number of trips)[b,f]	319 total trips Sealift barges: 24 Tugboats: 37 Support vessels: 258	319 total trips Sealift barges: 24 Tugboats: 37 Support vessels: 258	319 total trips Sealift barges: 24 Tugboats: 37 Support vessels: 258
Project duration	30 years (9 years of construction)	30 years (9 years of construction)	31 years (10 years of construction)
Infrastructure in special areas	Colville River Special Area: 1.0 mile (8.1 acres) of gravel road; 1.4 miles of pipeline Teshekpuk Lake Special Area: 10.8 miles of gravel road and gravel pads (106.3 acres total); 11.4 miles of pipeline	Colville River Special Area: 1.0 mile (8.1 acres) of gravel road; 1.4 miles of pipeline Teshekpuk Lake Special Area: 12.5 miles of gravel road and gravel pads (179.7 acres total); 12.2 miles of pipeline	Colville River Special Area: 0.5 acre of gravel infrastructure; 1.4 miles of pipeline Teshekpuk Lake Special Area: 11.1 miles of gravel road and gravel pads (108.4 acres total); 11.4 miles of pipeline
Fish-bearing waterbody setback overlap (LS E-2)	56.0 acres of gravel footprint, 5.5 miles of gravel road, and 5.5 miles of pipelines 23.1 acres of gravel mine site	Less than 50.1 acres of gravel footprint, 4.0 miles of gravel road, and 4.0 miles of pipelines 23.1 acres of gravel mine site	Less than 37.2 acres of gravel footprint, 4.2 miles of gravel road, and 4.2 miles of pipelines 23.1 acres of gravel mine site
Less than 500-foot pipeline-road separation (BMP E-7)	15.7 miles of pipelines and road with less than 500 feet of separation	17.1 miles of pipelines and road with less than 500 feet of separation	17.9 miles of pipelines and roads with less than 500 feet of separation
Yellow-billed loon setback overlap (BMP E-11)	60.0 acres of gravel infrastructure and 7.7 miles of pipelines within 1 mile of a nest 25.8 acres of gravel infrastructure and 3.3 miles of pipelines within 1,625 feet of lakes with nests	41.2 acres of gravel infrastructure and 7.7 miles of pipelines within 1 mile of a nest 13.5 acres of gravel infrastructure and 3.3 miles of pipelines within 1,625 feet of lakes with nests	58.0 acres of gravel infrastructure and 7.7 miles of pipelines within 1 mile of a nest 15.3 acres of gravel infrastructure and 3.3 miles of pipelines within 1,625 feet of lakes with nests
River setback overlap (BMP K-1)	Colville River: 0.0 acres of gravel infrastructure and 0.0 miles of pipelines Fish (Uvlutuuq) Creek: 12.3 acres of gravel infrastructure and 5.5 miles of pipelines Judy (Iqalliqpik) Creek: 18.7 acres of gravel infrastructure and 2.3 miles of pipelines Ublutuoch (Tiŋmiaqsiuġvik) River: 0.0 acres of gravel infrastructure and 0.0 mile of pipelines; 137.8 acres of gravel mine site	Colville River: 0.0 acres of gravel infrastructure and 0.0 miles of pipelines Fish (Uvlutuuq) Creek: 12.9 acres of gravel infrastructure and 5.4 miles of pipelines Judy (Iqalliqpik) Creek: 1.1 acres of gravel infrastructure and 2.3 miles of pipelines Ublutuoch (Tiŋmiaqsiuġvik) River: 0.0 acre of gravel infrastructure and 0.0 miles of pipelines; 137.8 acres of gravel mine site	Colville River: 0.0 acres of gravel infrastructure and 0.0 miles of pipelines Fish (Uvlutuuq) Creek: 12.6 acres of gravel infrastructure and 5.4 miles of pipelines Judy (Iqalliqpik) Creek: 16.7 acres of gravel infrastructure and 2.3 miles of pipelines Ublutuoch (Tiŋmiaqsiuġvik) River: 0.0 acre of gravel infrastructure and 0.0 mile of pipelines; 137.8 acres of gravel mine site

Project Component	Alternative B – Proponent's Project	Alternative C – Disconnected Infield Roads	Alternative D – Disconnected Access
Deepwater lake setback overlap (BMP K-2)	3.2 acres of gravel infrastructure and 0.0 mile of pipelines; 14.5 acres of the constructed freshwater reservoir would be within the setback and 1.4 acres of the reservoir connection would be within the lake	3.2 acres of gravel infrastructure and 0.0 mile of pipelines; 14.5 acres of the constructed freshwater reservoir would be within the setback and 1.4 acres of the reservoir connection would be within the lake	3.2 acres of gravel infrastructure and 1.5 mile of pipelines; 14.5 acres of the constructed freshwater reservoir would be within the setback and 1.4 acres of the reservoir connection would be within the lake

Note: BMP (best management practice); BT1 (Bear Tooth drill site 1); BT2 (Bear Tooth drill site 2); BT3 (Bear Tooth drill site 3); BT4 (Bear Tooth drill site 4); BT5 (Bear Tooth drill site 5); CD1 (Alpine CD1); CD4N (Alpine CD4N); CFWR (constructed freshwater reservoir); GMT-2 (Greater Mooses Tooth 2); HDD (horizontal directional drilling); LS (lease stipulation); MG (million gallons); MTI (module transfer island); Q1 (first quarter); Q2 (second quarter); VSM (vertical support member); WPF (Willow Processing Facility); WOC (Willow Operations Center). Ground trips are defined as one-way; a single flight is defined as a landing and subsequent takeoff; and a single vessel trip is defined as a docking and subsequent departure.

[a] Values may not sum to totals due to rounding.

[b] Total traffic is for the life of the Project (Alternative B and C, 30 years; Alternative D, 31 years) and does not include any reclamation activity.

[c] Number of trips includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Construction ground traffic also includes gravel hauling (e.g., B-70/Maxi Haul dump trucks).

[d] Flights outlined are additional flights required beyond projected travel to/from non-Project airports (e.g., Anchorage, Fairbanks, Deadhorse); includes C-130, Twin Otter/CASA, Cessna, and DC-6 or similar aircraft.

[e] Typical helicopters include A-Star and 206 Long Ranger models, although other similar types of helicopters may be used. Includes support for ice road construction, pre-staged boom deployment, hydrology and other environmental studies, and agency inspection during all phases of the Project

[f] Includes crew bats, tugboats supporting sealift barges, screeding barges, and other support vessels.

Table 2.7.2. Summary Comparison of Module Delivery Options

Component	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Gravel footprint (acres)	12.8	13.0	5.0
Gravel fill volume (cubic yards)	397,000	446,000	118,700
Screeding footprint	14.5 total acres 4.9 acres adjacent to dock face 9.6 acres at the barge lightering area	14.5 total acres 4.9 acres adjacent to dock face 9.6 acres at the barge lightering area	No additional screeding needed beyond activity for action alternatives described in Section 2.5.3.4, *Sealift Barge Delivery to Oliktok Dock*
Ice roads	110.8 total miles (795.0 total acres) Gravel haul: 35.2 miles on tundra; 2.4 miles on sea ice Module delivery: 68.4 total miles on tundra; 4.8 miles on sea ice over two module delivery seasons[a]	225.2 total miles (1,551.9 total acres) Gravel haul: 77.4 miles on tundra; 0.6 mile on sea ice Module delivery: 146.0 total miles on tundra; 1.2 miles on sea ice over two module delivery seasons[a]	80.2 total miles (583.2 total acres)[b]
Single-season ice pads	118.9 total acres	195.2 total acres	83.4 total acres
Multi-season ice pads	Three 10.0-acre multi-season ice: One at BT1 One near Atigaru Point One midway between Atigaru Point and BT1	Three 10.0-acre multi-season ice pads: One at BT1 Two along ice road between BT1 and Point Lonely	NA
Sealift delivery schedule (years)	Alternative B: 2024 and 2026 Alternative C: 2024 and 2026 Alternative D: 2025 and 2027	Alternative B: 2024 and 2026 Alternative C: 2024 and 2026 Alternative D: 2025 and 2027	Alternative B: 2024 and 2026 Alternative C: 2024 and 2026 Alternative D: 2025 and 2027
Module mobilization (years)	Alternative B: 2025 and 2027 Alternative C: 2025 and 2027 Alternative D: 2026 and 2028	Alternative B: 2025 and 2027 Alternative C: 2025 and 2027 Alternative D: 2026 and 2028	Alternative B: 2025 and 2027 Alternative C: 2025 and 2027 Alternative D: 2026 and 2028
Total freshwater usage (MG)	307.9[a]	572.0[a]	257.2[b]
Total seawater usage (MG)	376.0	185.0	8.0

Component	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Ground traffic (number of trips)[c]	2,306,110	3,196,450	535,160
Fixed-wing traffic (number of trips)[d]	326 total flights Willow: 205 Alpine: 25 Atigaru: 96	326 total flights Willow: 205 Alpine: 25 Point Lonely: 96	70 total flights Alpine: 28 Kuparuk: 42
Helicopter traffic (number of trips)[e]	450 total flights Willow: 435 Alpine: 15	450 total flights Willow: 435 Alpine: 15	16 total flights to/from Alpine
Marine traffic (number of trips)[f]	284 total trips Sealift barges: 9 Tugboats: 16 Support vessels: 259	284 total trips Sealift barges: 9 Tugboats: 16 Support vessels: 259	85 total trips Sealift barges: 9 Tugboats: 16 Support vessels: 60
Construction camps (100-person capacity)	Camp for winter ice road construction (each ice road year) on a multi-season ice pad Camp for module off-load and transport on a multi-season ice pad at Atigaru Point Camp for summer construction and module receipt would be located on a barge (i.e., Floatel) at the module transfer island	Camp for winter ice road construction (each ice road year) on the existing gravel pad Camp for module off-load and transport at Point Lonely on the existing gravel pad Camp for summer construction and module receipt at Point Lonely on the existing gravel pad	Camp for winter ice road construction (each ice road year) on a single-season ice pad

Note: BT1 (Bear Tooth drill site 1); MG (million gallons); NA (not applicable). Traffic trips are defined as one-way; a single flight is defined as a landing and subsequent takeoff; and a single vessel trip is defined as a docking and subsequent departure.

[a] Alternative D would require an additional 2.7 miles of 60-foot-wide heavy-haul ice road to reach the Willow Processing Facility gravel pad for each year of module mobilization. This additional ice road would require an additional 6.7 MG of freshwater for each year of module mobilization (13.4 MG of freshwater).

[b] Alternative D would require an additional 13.1-mile-long, 60-foot-wide heavy-haul ice road for module transport between the Project area and Greater Mooses Tooth 2. This ice road would require an additional 32.7 MG of freshwater for each year of module mobilization (65.4 MG of total additional freshwater).

[c] Includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Ground transportation also includes gravel hauling operations (i.e., B-70/Maxi Haul dump trucks) and module delivery (i.e., self-propelled module transporters).

[d] Flights outlined are additional flights required beyond projected travel to/from non-Project airports (e.g., Anchorage, Fairbanks, Deadhorse) and include flights to the Alpine and Willow airstrips. Fixed-wing aircraft includes C-130, DC-6, Twin Otter/CASA, Cessna, or similar.

[e] Includes support for ice road construction, pre-staged boom deployment, hydrology and other environmental studies, and agency inspection during all phases of the Project. Typical helicopters include A-Star and 206 Long Ranger models, although other similar types of helicopters may be used.

[f] Includes crew boats, tugboats supporting sealift barges, and other support vessels.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction and Analysis Methods

This chapter describes the existing condition of resources and uses in the Project area and the effects of the Project on those resources and uses. The chapter was developed using the best available data for each resource, which was gathered from a variety of sources.

The scope of the impact analysis is commensurate with the level of detail of the actions presented in Chapter 2.0, *Alternatives*, the importance of particular resources and uses and their potential to experience significant impacts, and the availability or quality of data necessary to assess impacts. All figures referred to in the analysis are in Appendix A, *Figures*. The analysis area for each resource is described at the beginning of each resource section; this is the area in which direct, indirect, or cumulative effects to the resource could occur. Analysis areas differ by resource because the geographic extent of effects varies by resource.

Some readers may better recognize locations, and common plant and animal names by their Iñupiaq or scientific names. These are provided in Appendix E.1 (*Iñupiaq and Scientific Names Technical Appendix*) and are not described in the resource sections.

3.1.1 Past and Present Actions

Past and present actions in each resource's analysis area are included as part of the existing conditions of the affected environment for all resources analyzed in Chapter 3.0. West of the Colville River, these actions include existing oil and gas infrastructure (e.g., gravel and ice roads, pipelines, processing facilities) in the Alpine and GMT oil fields (Figure 3.1.1), which are regularly serviced by aircraft. East of the Colville River, the Kuparuk oil field includes similar but more extensive development, with existing mine sites, airstrips, reservoirs, a dock (Oliktok Dock), and a seawater treatment facility. The Kuparuk oil field experiences more ground and air traffic than the developments west of the Colville River; ground traffic also travels at higher speeds. In addition to Kuparuk, several smaller oil and gas developments occur: Nuna, Oooguruk, and Mustang (Figure 3.1.1).

There are several former (decommissioned) U.S. Department of Defense sites with gravel pads, roads, or airstrips near the Beaufort Sea coast. There is no existing marine infrastructure at Atigaru Point or Point Lonely. There is existing marine infrastructure at Oliktok Point and at Oooguruk Island, including a pipeline to the 6-acre constructed gravel island. The shoreline around Oliktok Point has been armored or altered with sheet pile and other revetment (e.g., gravel bags).

The community of Nuiqsut (approximately 347 people, described in Section 3.16, *Subsistence and Sociocultural Systems*) would be approximately 27 miles from BT1 and about 7 miles from the Tiŋmiaqsiuġvik Mine Site. The community has an airstrip, roads, a power plant, and other infrastructure. Seasonal snow trails and roads occur across the North Slope for community access (NSB 2018b).

Other past and present actions in the Project area are subsistence and research (not associated with oil and gas activities), which contribute additional vehicle, boat, air, foot, and off-road vehicle traffic.

Climate change is occurring across the North Slope and is part of the existing condition of the affected environment for all resources analyzed in Chapter 3.0. Observed and projected climate change trends are described in detail in Section 3.2, *Climate and Climate Change*, and considered for all resources analyzed in the EIS.

RFFAs in the Project area are described in Section 3.19, *Cumulative Effects*.

3.1.2 Analysis Methods

Potential impacts are described in terms of type, context, duration, and intensity. Quantitative data are used to provide additional detail where possible and appropriate and the geographic extent of impacts is described.

The environmental analysis considers existing LSs and BMPs described in the 2013 NPR-A IAP/EIS ROD (BLM 2013a). BLM is currently revising the NPR-A IAP (BLM 2020a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated BMPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs; however, applicable LSs would not change because LSs are fixed at the time of the lease issuance. The terms BMPs and ROPs are used interchangeably throughout the EIS. All projects are subject to the

BMPs/ROPs that are in place at the time the permit for development is issued. (The reader is referred to Section 2.2.7, *Lease Stipulations, Required Operating Procedures, and Lease Notices*, of the 2020 IAP/EIS for further discussion on this topic.) The Willow MDP ROD will detail which of the measures will be implemented for the Project. Existing BMPs that relate to each resource are listed in the resource sections in Chapter 3.0, as is a summary of new or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to resources. Where 2020 IAP changes to requirements are mentioned in the tables throughout the resource sections below, they apply to the measure as a BMP/ROP because the LSs are fixed at the time of lease issuance. In other words, some requirements may apply as either a LS or BMP/ROP. If the activity is based on lease rights the LS governs and cannot be superseded by a BMP/ROP; otherwise the requirement in the tables would apply as a BMP/ROP along with any relevant changes to it in the 2020 IAP. Deviations to existing or proposed BMPs that would be required for the Project are detailed in Appendix D.1, *Alternatives Development*, and discussed in the relevant resource sections in Chapter 3.0. Additional suggested BMPs or mitigation measures to further avoid, reduce, or compensate for impacts from the Project are discussed in the relevant resource sections in Chapter 3.0 and are summarized in Table I.1.3 in Appendix I.1, *Avoidance, Minimization, and Mitigation.* The proponent's design features to avoid and minimize impacts are also detailed in Table I.1.2 in Appendix I.1 and considered in the Chapter 3.0 analysis.

The likelihood and types of spills that could occur from the Project are detailed in Chapter 4.0, *Spill Risk Assessment*. The effects of these potential spills on resources and uses are described in the resource sections in Chapter 3.0.

3.1.3 Traditional Knowledge

Traditional knowledge was considered during the EIS preparation. A review of available traditional knowledge relevant to the NPR-A is provided in Appendix J, *Traditional Knowledge*. The review is based on 80 sources that had been documented in the six North Slope communities of Anaktuvuk Pass, Atqasuk, Nuiqsut, Point Lay, Utqiaġvik (Barrow), and Wainwright since 1976. The focus was on traditional knowledge applicable to the nature of development and relevant to impacts and mitigation associated with the IAP or that contained traditional knowledge about the environment in and around the NPR-A. Local observations and information from residents provided their physical, biological, and social environment experiences.

3.2 Climate and Climate Change

The analysis area for climate change is the **Arctic**, with a focus on the North Slope of Alaska. However, climate change occurs on a global scale; hence, the spatial extent of potential impacts is global. The temporal scale for analysis may extend from decades to an indefinite time period. This analysis examines the potential effects of the Project on climate change and the effects of climate change on the Project.

3.2.1 Affected Environment

Climate change is a global phenomenon caused by the release of **greenhouse gases** (GHGs) into the atmosphere. The effects of climate change in the analysis area are evident currently. Climate in the analysis area is described in Section 3.2.3.1, Climate and Meteorology of BLM (2018a, 61) and Section 3.5.5.1, Meteorology and Climate of USACE (2018, 3-84). Climate change is "a change in the state of the climate that can be identified … by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" (IPCC 2014). Natural internal processes, such as solar cycles or volcanic eruptions, or external forcing, such as persistent **anthropogenic** changes in the composition of the atmosphere or land use, can lead to climate change. GHGs warm the atmosphere by absorbing infrared radiation emitted from the Earth's surface. Major GHGs from oil and gas development include carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). GHG emissions are reported in units of **carbon dioxide equivalent** (CO_2e) to account for the varying global warming potential (GWP) of pollutants. More information on GWP is provided in Appendix E.2A, *Climate and Climate Change Technical Appendix*. GHGs are produced both naturally (e.g., volcanoes) and through anthropogenic activities (e.g., burning of fossil fuels). Anthropogenic emissions have driven atmospheric concentrations of GHGs to levels unprecedented in the last 800,000 years (IPCC 2014). **Black carbon**, a byproduct of incomplete combustion, affects climate directly by absorbing and scattering solar radiation and indirectly by altering cloud properties (AMAP 2015; Xu, Martin et al. 2017). When black carbon settles on top of snow or ice, it decreases the **albedo** (i.e., reflectivity) of the surface, causing increased melting and warming. In cloud droplets, black carbon decreases the cloud albedo, which heats and dissipates the clouds. There is considerable uncertainty regarding the effect of black carbon on climate, as black carbon can warm or cool the atmosphere, but the net effect is believed to be one of warming at +1.1 Watts per square meter (Bond, Doherty et al. 2013).

3.2.1.1 Observed Climate Trends and Impacts in the Arctic and on the North Slope

Impacts related to a warming climate that are observed globally and nationally are amplified in the Arctic. Over the past 60 years, average annual air temperatures in the region have increased by 3 degrees Fahrenheit (F), and average winter temperatures have increased 6 degrees F (Melillo, Richmond et al. 2014). Snow cover extent in 2017 was the lowest on record for April and May in the North American Arctic (Derksen, Brown et al. 2017). The decreased extent and duration of snow cover leads to more of the sun's energy being absorbed by the dark land surface, and warmer surfaces lead to additional reduced snow cover (Melillo, Richmond et al. 2014). Winter maximum sea ice extent in 2017 was the lowest on record (Richter-Menge, Overland et al. 2017). Summertime sea ice has been decreasing throughout the twenty-first century, with a total loss of summertime sea ice expected by 2050 or earlier (Gunsch, Kirpes et al. 2017; Kolesar, Cellini et al. 2017).

Rising temperatures result in permafrost thawing, which releases CO_2 and CH_4 into the atmosphere, accelerating climate feedback effects (Markon, Trainor et al. 2012). A recent study (Voigt, Marushchak et al. 2017) suggests that thawing permafrost could also lead to the release of large amounts of N_2O. Warmer temperatures combined with reduced ice cover has led to greening of the tundra and increases in soil moisture and the amount of snow water available. This has led to an increase in **active layer** depth and changes in herbivore activity patterns (Clement, Bengtson et al. 2013; Epstein, Bhatt et al. 2017). Measurements by the U.S. Geological Survey (USGS) climate and permafrost observing network show that near-surface permafrost has warmed by 3 to 4 degrees Celsius (C) since the 1980s, and the warming is ongoing (Urban and Clow 2016). Air temperatures across the Arctic Slope have been warming by approximately 1 degree C per decade during summer/autumn. Active layer temperatures are warming by about 1 degree C (1.8 degrees F) per decade during all seasons, and the active layer is refreezing approximately 2 to 3 weeks later in autumn (from mid-November in 1998 to late December in 2017). Annual average temperatures on the North Slope would be -11.2 degrees F to -9.0 degrees F by 2019, 2.3 degrees F higher than the annual average from 1961 to 1990 (SNAP 2018). The North Slope has shown substantial increases in tundra greenness from 1982 to 2016 (Richter-Menge, Overland et al. 2017). Long-term permafrost temperature monitoring shows a warming trend over the past 25 years, with the greatest warming near the Arctic coast. Soil temperatures increased 3 degrees F to 5 degrees F between 1985 and 2004 (USFWS 2015b). Permafrost observational sites had record high temperatures at 20 meters (m) (65 feet) depth in 2016 on the North Slope. As in the wider Arctic region, the snow and ice albedo feedback from black carbon is magnified on the North Slope. Black carbon on the North Slope can arise due to a variety of sources, including international transport (Matsui, Kondo et al. 2011; Stohl 2006; Xu, Martin et al. 2017), shipping (Corbett, Lack et al. 2010; Lack and Corbett 2012), oil and gas exploration and production (Ault, Williams et al. 2011), and residential combustion (Stohl, Klimont et al. 2013).

3.2.1.2 Projected Climate Trends and Impacts in the Arctic and on the North Slope

The warming in Alaska is projected to continue, with average annual air temperatures increasing 2 degrees F to 4 degrees F between 2021 and 2050 (Melillo, Richmond et al. 2014). Temperatures on the North Slope would be expected to increase by 10 degrees F to 12 degrees F by the end of the century if global emissions continue to increase. Annual precipitation in Alaska is also projected to increase, with 15% to 30% more precipitation by late this century, if global GHG emissions continue to increase (Melillo, Richmond et al. 2014). However, based on historical data, precipitation may be more variable on the North Slope. Although the statewide average precipitation in Alaska between 1949 and 2005 increased by 10%, precipitation in Utqiaġvik decreased by 36% from 1949 to 1998 (Markon, Trainor et al. 2012). Snow cover duration in Alaska is expected to decrease due to earlier snowmelt and later first snowfall dates (Markon, Trainor et al. 2012). Correspondingly, increases to the Alaskan growing season are also projected to continue (Melillo, Richmond et al. 2014). This change will reduce water storage and increase the risk and extent of wildland fires and insect outbreaks in the region. Warmer temperatures, wetland drying, and a growing number of summer thunderstorms have also increased the number of wildland fires in Alaska. The annual area burned is projected to double by midcentury, releasing more carbon to the atmosphere (Melillo, Richmond et al. 2014). Warmer temperatures will lead to a deeper active layer, which would affect plant communities (BLM 2014). Permafrost thawing could lead to **thermokarsting** or slumping, causing more nutrient loading and suspended sediment in lakes and rivers. Warmer temperatures may lead to an increase in the frequency of **lake-tapping** events (sudden drainage) as degrading ice wedges integrate into drainage channels at a lower elevation.

3.2.1.3 Trends in U.S. and Alaska Greenhouse Gas Emissions

The Intergovernmental Panel on Climate Change (IPCC) Special Report *Global Warming of 1.5°C* (2018) estimates with high confidence that in order to limit global warming to 1.5 degrees C, global GHG emissions in 2030 would need to be 40% to 50% lower than 2010 emissions. Based on the IPCC (2018) findings, the United Nations Environment Programme *Emissions Gap Report* (2019) estimates global GHG emissions in 2030 would need to be 55% lower than 2018 to limit global warming to 1.5 degrees C. GHG emissions in the U.S. are tracked by the EPA and documented in the *Inventory of U.S. Greenhouse Gases and Sinks: 1990–2017* (EPA 2019b). The Willow MDP EIS reports GHG emissions for Alaska and the U.S. to provide context for Project-level direct and indirect GHG emissions and to support a qualitative analysis of impacts.

In 2017, 6,457 million metric tons (MMT) of CO_2e were emitted in the U.S. This was a 1.3% increase in emissions from 1990 levels, down from the 15.7% increase observed in 2007. The major economic sectors contributing to GHG emissions in the U.S. in 2017 were transportation (29%), electricity generation (28%), industry (22%), and agriculture (9%) (EPA 2019b). Emissions of CO_2 accounted for 82% of all GHG emissions in the U.S. in 2017. As the largest source of U.S. GHG emissions, CO_2 emissions from fossil fuel combustion has accounted for approximately 77% of GHG emissions since 1990. From 1990 to 2017, CO_2 emissions from fossil fuel combustion increased by 3.7%, and in 2016, the U.S. accounted for 15% of global fossil fuel emissions (EPA 2019b).

In 2015, approximately 40 MMT CO_2e were emitted in Alaska, which was a decrease of approximately 8% from 1990 levels and an approximately 23% decrease from the peak emissions observed in 2005 (ADEC 2018b). The industrial sector, including oil and gas industries, is the major contributor to GHG emissions in Alaska. This is followed by the transportation, residential and commercial, and electrical generation sectors (ADEC 2018b). When considering just CO_2 emissions, Alaska was the 11th lowest state in the U.S. in terms of total energy-related GHG emissions in 2015, and the 4th highest in terms of per capita emissions (USEIA 2018). GHG emissions in Alaska represent less than 0.7% of the total U.S. GHG inventory for 2015, as reported by the EPA (2019b).

The USGS has estimated GHG emissions and carbon sequestration on federal lands for the 10-year period from 2005 to 2014 (Merrill, Sleeter et al. 2018). GHG emissions (when considering just CO_2) associated with the combustion and extraction of fossil fuels from U.S. federal lands increased from 1,362 MMT CO_2e in 2005 to 1,429 MMT CO_2e in 2010 and then decreased to 1,279 MMT CO_2e in 2014. CH_4 and N_2O emissions from federal lands also decreased over the same 10-year period. Less than 1% of the federal lands' CO_2 and CH_4 emissions were associated with fuel produced in Alaska. When the federal lands' fossil fuel extraction and combustion emissions are combined with ecosystem emissions and sequestration estimates, the net carbon emissions from Alaska range from -14.1 MMT CO_2e to -16.8 MMT CO_2e, indicating a net carbon sequestration from Alaska federal lands.

3.2.2 Environmental Consequences: Effects of the Project on Climate Change

Direct GHG emissions due to the Project were quantified and are reported in Section 3.2.2.3, *Alternative B: Proponent's Project*, and in Appendix E.2A. It is not currently possible to determine the impact of a single project on global climate change and the EPA has not set specific thresholds for GHG emissions. Current scientific knowledge cannot associate particular actions with specific climate effects, and a single project of this size cannot significantly impact global GHG emissions; however, all projects may cumulatively have a significant impact on global climate change. See Appendix E.2A for a description of the method used to estimate GHG emissions. The Social Cost of Carbon, a measure used to assess the economic cost of a project's or action's climate change effects, was not used in the EIS; the reasons for this are detailed in Appendix E.2A, Section 2.4, *Social Cost of Carbon*. For this Project, black carbon emissions were not explicitly quantified, but black carbon is a component of particulate matter less than 2.5 microns in aerodynamic diameter (**$PM_{2.5}$**) and is included in $PM_{2.5}$ emissions. See Appendix E.2A, Section 3.1.2.3, *Black Carbon Effects on Climate*, for details regarding black carbon's effects on climate. Direct and indirect GHG emissions due to the Project are assessed as a proxy for understanding the potential effects of the Project on climate change. Direct GHG emissions are those generated by construction and operations of the Project and indirect emissions are those that are generated by transport, refining, and burning of the produced and sold oil.

3.2.2.1 Avoidance, Minimization, and Mitigation

3.2.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.2.1 summarizes existing applicable NPR-A IAP BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate climate change impacts from development activity (BLM 2013a). The BMPs would reduce impacts to climate change associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP, including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.2.1 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate climate change impacts. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.2.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.2.1. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Climate Change

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring (preconstruction and throughout the life of the project), emissions inventory, emissions reduction plan, air quality modeling, additional emission control strategies as necessary, and possibly mitigation measures	Added text: Provide the North Slope Borough, local communities, and tribes publicly available reports on air quality baseline monitoring, emissions inventories, and modeling results developed in conformance with this BMP.
ROP A-14	Reduce air emissions and protect human health	No similar requirement	All permanent camps (and temporary camps where feasible under alternative E), are required to provide vehicle plug-ins for engine warming systems (e.g., block heaters and oil pan heaters). Alternative E only: reduce extended vehicle idling when practical. In the winter, when vehicles are not in use for extended periods, they should be powered off and plugged in where plugs are available.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize the compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. The location of ice roads shall be designed and located to minimize the compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in subsequent years.	– Ground operations would only be allowed when the frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23°F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the National Petroleum Reserve in Alaska. – Snow survey and soil freeze-down data collected for ice road or snow trail planning and monitoring shall be submitted to the BLM. – Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; maintain populations of, and adequate habitat for, birds, fish, and caribou; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.

Source: BLM 2013a, 2020a
Note: F (Fahrenheit); BLM (Bureau of Land Management); BMP (best management practice); IAP (Integrated Activity Plan); LS (lease stipulation); ROP (required operating procedure).

No deviations to the LSs and BMPs described in Table 3.2.1 would be required.

3.2.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1. CPAI's design measures related to climate change meet or exceed to federal and state regulations and NPR-A IAP/EIS BMPs and would help reduce GHG emissions. These measures include capturing and injecting produced gas in a closed process to enhance oil recovery.

3.2.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

No additional BMPs or mitigation measures are recommended.

3.2.2.2 Alternative A: No Action

Under Alternative A (No Action), the Project would not be developed and direct and indirect GHG emissions from the Project would not occur and hence not contribute to climate change. Current trends in global, U.S., and Alaska GHG emissions would continue, unaffected by the Project. Energy demand would continue to be satisfied by non-Project sources, varying from other oil sources to renewable sources. BOEM report (Appendix E.2B, *Market Substitutions and Greenhouse Gas Downstream Emissions Estimates*) presents an estimate of GHG emissions from these replacement ("displaced substitute") energy sources using the BOEM Market Simulation Model (BOEM 2019). These are representative of emissions from substitute energy sources for the Project and are described in Table 3.2.2 in the discussion on action alternatives.

The absence of the Project itself would not lead directly to emissions. Therefore, for ease of comparison to the action alternatives, GHG emissions in the No Action Alternative are assigned a baseline value of zero in the EIS, reflecting the status quo and current GHG emissions trends in the absence of the Project.

3.2.2.3 Alternative B: Proponent's Project

The direct, indirect, and total GHG emissions over the life of the Project for Alternatives B, C, and D are shown in Table 3.2.2. These do not include emissions due to the module delivery options; those are reported separately in Section 3.2.2.6, *Module Delivery Options*. The calculation of the direct and indirect GHG emissions is summarized in Appendix E.2A. The gross indirect GHG emissions were calculated using BOEM's Greenhouse Gas Lifecycle Model (BOEM 2020; Appendix E.2B) and represent the emissions that would result from the processing and consumption of Project oil if no market effects were considered. The emissions, in CO_2e, produced from energy sources, are also shown in Table 3.2.2. These emissions were derived from the displaced substitutes' emission values from the Market Simulation Model (BOEM 2019). The assumptions in both BOEM models are discussed in BOEM (2019), and references are cited therein. The net CO_2e change shown in Table 3.2.2 is the difference between the previous columns and reflects the net change in CO_2e under each alternative with respect to the baseline No Action Alternative (Alternative A).

Tables 3.2.2, 3.2.3, and 3.2.4 report GHG emissions in CO_2e based on three different sets of GWPs (see Appendix E.2A for additional information):

- 100-year time horizon GWPs from the IPCC fourth assessment report (AR4) (IPCC 2007)
- 100-year time horizon GWPs from the IPCC fifth assessment report (AR5) (IPCC 2014)
- 20-year time horizon GWPs from the IPCC AR5

Emissions calculated with the IPCC AR4 GWPs are provided, as these are used in the U.S. national GHG inventory (EPA 2019b). Emissions calculated with the IPCC AR5 GWPs are also provided, as they reflect more recent science (IPCC 2014).

Table 3.2.2. Total (Gross and Net) Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 100-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fourth Assessment Report

Alternative	GHG Emissions Type	Gross CO_2e Resulting from Project[a]	CO_2e from Energy Sources Displaced by Project[b]	Net CO_2e Change from Baseline CO_2e[c]
B: Proponent's Project	Direct	23,108	NA	+23,108
B: Proponent's Project	Indirect	235,658	223,624	+12,034
B: Proponent's Project	**Total**	**258,766**	**223,624**	**+35,142**
C: Disconnected Infield Roads	Direct	25,278	NA	+25,278
C: Disconnected Infield Roads	Indirect	235,658	223,624	+12,034
C: Disconnected Infield Roads	**Total**	**260,936**	**223,624**	**+37,312**
D: Disconnected Access	Direct	23,215	NA	+23,215
D: Disconnected Access	Indirect	235,658	222,934	+12,724
D: Disconnected Access	**Total**	**258,873**	**222,934**	**+35,939**

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); NA (not applicable). Project duration would be 30 years for Alternatives B and C, and 31 years for Alternative D. The global warming potential values used are carbon dioxide = 1; methane = 25; nitrous oxide = 298.
[a] Indirect gross CO_2e is from the Willow Project's indirect GHG emissions modeled by Bureau of Ocean and Energy Management (BOEM) (2019). Numbers may not match exactly due to rounding.
[b] CO_2e from Energy Sources Displaced by Project is from the displaced substitutes GHG emissions values modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

Table 3.2.3. Total (Gross and Net) Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 100-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fifth Assessment Report

Alternative	GHG Emissions Type	Gross CO_2e Resulting from Project[a]	CO_2e from Energy Sources Displaced by Project[b]	Net CO_2e Change from Baseline CO_2e[c]
B: Proponent's Project	Direct	23,133	NA	+23,133
B: Proponent's Project	Indirect	235,641	223,638	+12,003
B: Proponent's Project	**Total**	**258,774**	**223,638**	**+35,136**
C: Disconnected Infield Roads	Direct	25,303	NA	+25,303
C: Disconnected Infield Roads	Indirect	235,641	223,638	+12,003
C: Disconnected Infield Roads	**Total**	**260,944**	**223,638**	**+37,306**
D: Disconnected Access	Direct	23,240	NA	+23,240
D: Disconnected Access	Indirect	235,641	222,949	+12,692
D: Disconnected Access	**Total**	**258,881**	**222,949**	**+35,932**

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); NA (not applicable). Project duration would be 30 years for Alternatives B and C, and 31 years for Alternative D. The global warming potential values used are carbon dioxide = 1; methane = 28; nitrous oxide = 265.
[a] Indirect gross CO_2e is from the Willow Project's indirect GHG emissions modeled by Bureau of Ocean and Energy Management (BOEM) (2019). Numbers may not match exactly due to rounding.
[b] CO_2e from Energy Sources Displaced by Project is from the displaced substitutes GHG emissions values modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

Table 3.2.4. Total (Gross and Net) Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 20-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fifth Assessment Report

Alternative	GHG Emissions Type	Gross CO_{2e} Resulting from Project[a]	CO_{2e} from Energy Sources Displaced by Project[b]	Net CO_{2e} Change from Baseline CO_{2e}[c]
B: Proponent's Project	Direct	23,628	NA	+23,628
B: Proponent's Project	Indirect	236,367	224,532	+11,835
B: Proponent's Project	**Total**	**259,995**	**224,532**	**+35,463**
C: Disconnected Infield Roads	Direct	25,803	NA	+25,803
C: Disconnected Infield Roads	Indirect	236,367	224,532	+11,835
C: Disconnected Infield Roads	**Total**	**262,170**	**224,532**	**+37,638**
D: Disconnected Access	Direct	23,732	NA	+23,732
D: Disconnected Access	Indirect	236,367	223,843	+12,524
D: Disconnected Access	**Total**	**260,099**	**223,843**	**+36,256**

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); NA (not applicable). Project duration would be 30 years for Alternatives B and C, and 31 years for Alternative D. The global warming potential values used are carbon dioxide = 1; methane = 84; nitrous oxide = 264.
[a] Indirect gross CO_2e is from the Willow Project's indirect GHG emissions modeled by Bureau of Ocean and Energy Management (BOEM) (2019). Numbers may not match exactly due to rounding.
[b] CO_2e from Energy Sources Displaced by Project is from the displaced substitutes GHG emissions values modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

When applying the 100-year GWPs from the IPCC AR4 (Table 3.2.2), Alternative B's annual average direct GHG emissions (770 thousand metric tons [TMT] of CO_2e per year) over the 30-year Project life are approximately 1.925% of the 2015 Alaska GHG inventory. The annual average total gross (i.e., sum of direct and gross indirect) GHG emissions of 8,626 TMT of CO_2e per year represents approximately 0.134% of the 2017 U.S. GHG inventory. When applying the 100-year GWP from the IPCC AR5 (Table 3.2.3), Alternative B's annual average direct GHG emissions (771 TMT of CO_2e per year) are approximately 1.928% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions are again 8,626 TMT of CO_2e per year; they constitute approximately 0.134% of the U.S. GHG inventory. When applying the 20-year GWPs from the IPC AR5 (Table 3.2.4), Alternative B's annual average direct GHG emissions (787 TMT of CO_2e per year) are approximately 1.968% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,667 TMT of CO_2e per year represent approximately 0.134% of the 2017 U.S. GHG inventory. In all three cases, over 90% of the total gross GHG emissions from the Project are from indirect emissions.

Overall, the choice of GWPs has little impact on the total gross CO_2e emissions because the total is dominated by indirect emissions of CO_2, which always has a GWP of one. Over the life of the Project, there would be a net increase of up to 35,463 TMT of CO_2e from the No Action Alternative (Alternative A) to Alternative B, with the highest increase estimated using the 20-year GWPs from IPCC AR5. GHG emissions due to Alternative B would contribute to climate change impacts, as described in Section 3.2.1.2, *Projected Climate Trends and Impacts in the Arctic and on the North Slope*.

3.2.2.4 Alternative C: Disconnected Infield Roads

Tables 3.2.2, 3.2.3, and 3.2.4 provide the direct, indirect, and total GHG emissions for Alternative C.

Direct GHG emissions over the life of the Project calculated with the IPCC AR4 100-year GWPs are 9.40% higher than Alternative B due to the increased air travel and two operations centers and are 8.89% higher than Alternative D. The annual average direct GHG emissions (843 TMT of CO_2e per year) over the 30-year Project life are approximately 2.108% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,698 TMT of CO_2e per year constitute approximately 0.135% of the 2017 U.S. GHG inventory. When applying the 100-year GWPs from the IPCC AR5, direct GHG emissions over the life of the Project (843 TMT of CO_2e per year) represent approximately 2.108% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,698 TMT of CO_2e per year again represents approximately 0.135% of the 2017 U.S. GHG inventory. Thus, when applying either AR4 or AR5 100-year GWPs, total gross GHG emissions of the Project duration for Alternative C are 0.84% higher than Alternative B and 0.79% higher than Alternative D.

When applying the 20-year GWPs from the IPCC AR5, direct GHG emissions over the 30-year Project life are 9.21% higher than Alternative B and 8.73% higher than Alternative D. The annual average direct GHG emissions (860 TMT of CO_2e per year) over the Project life are approximately 2.150% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,739 TMT of CO_2e per year constitute approximately 0.135% of the 2017 U.S. GHG inventory. Total gross GHG emissions over the Project life for Alternative C calculated with 20-year AR5 GWPs are 0.83% higher than Alternative B and 0.79% higher than Alternative D.

Over the Project duration for Alternative C, there would be a net increase of up to 37,638 TMT of CO_2e from the No Action Alternative (Alternative A) to Alternative C, with the highest increase estimated with the 20-year GWPs. Regardless of the choice of GWPs, the annual average total gross GHG emissions due to the Project under Alternative C would constitute approximately 0.14% of the total U.S. GHG inventory. GHG emissions from Alternative C would contribute to the climate change impacts described in Section 3.2.1.2.

3.2.2.5 Alternative D: Disconnected Access

Tables 3.2.2, 3.2.3, and 3.2.4 provide the direct, indirect, and total GHG emissions for Alternative D, respectively.

When applying the 100-year GWPs from the IPCC AR4, direct GHG CO_2e emissions over the 31-year Project life of Alternative D are 0.46% higher than Alternative B due to increased air travel. The annual average direct GHG emissions (725 TMT of CO_2e per year) over the Project duration are approximately 1.813% of the 2015 Alaska GHG inventory. The annual average total GHG emissions of 8,351 TMT of CO_2e per year constitute approximately 0.129% of the 2017 U.S. GHG inventory. The 100-year GWPs from the IPCC AR5 direct GHG CO_2e emissions over the Project life are 0.46% higher than Alternative B. The annual average direct GHG emissions (726 TMT of CO_2e per year) over the Project life are approximately 1.815% of the 2015 Alaska GHG inventory. The annual average total GHG emissions are again 8,351 TMT of CO_2e per year; they represent approximately 0.129% of the 2017 U.S. GHG inventory. Thus, when applying the 100-year GWPs from either AR4 or AR5, total gross GHG emissions over the Project life for Alternative D are 0.04% lower than Alternative B and 0.79% lower than Alternative C.

When applying the 20-year GWPs from the IPCC AR5, direct GHG CO_2e emissions over the Project life are 0.44% higher than Alternative B. The annual average direct GHG emissions (742 TMT of CO_2e per year) over the 31-year Project life are approximately 1.855% of the 2015 Alaska GHG inventory, and the annual average total GHG emissions of 8,390 TMT of CO_2e per year constitute 0.130% of the 2017 U.S. GHG inventory. Total gross GHG emissions over the Project duration for Alternative D calculated with 20-year IPCC AR5 GWPs are 0.04% higher than Alternative B and 0.79% lower than Alternative C.

Over the 31-year life of the Project for Alternative D, there would be a net increase of up to 36,256 TMT of CO_2e from the No Action Alternative (Alternative A) to Alternative D, with the highest increase estimated using the 20-year IPCC AR5 GWPs. The annual average total gross GHG emissions due to the Project under Alternative D represent 0.13% of the total U.S. GHG inventory. GHG emissions due to Alternative D would contribute to climate change impacts, as described in Section 3.2.1.2.

3.2.2.6 Module Delivery Options

3.2.2.6.1 <u>Option 1: Atigaru Point Module Transfer Island</u>

Direct project module delivery emissions for Option 1 would be 140.25 TMT CO_2e when the calculation is based on the IPCC AR4 100-year GWPs, 140.25 TMT when using the IPCC AR5 100-year GWPs, and 140.59 TMT when using the IPCC AR5 20-year GWPs. The MTI would not produce oil or natural gas directly but instead supports Project construction, so there would be no associated indirect GHG emissions for the module delivery options.

3.2.2.6.2 <u>Option 2: Point Lonely Module Transfer Island</u>

Direct project module delivery emissions for Option 2 would be 340.79 TMT CO_2e when the calculation is based on the IPCC AR4 100-year GWPs, 340.81 TMT when using the IPCC AR5 100-year GWPs, and 341.65 TMT when using the IPCC AR5 20-year GWPs. The emissions from Option 2 are approximately 170 TMT of CO_2e more than Option 1 due to the considerable increase in required ground traffic equipment and mileage associated with longer ice road routes to the Point Lonely MTI location.

3.2.2.6.3 Option 3: Colville River Crossing

Direct project module delivery emissions for Option 3 vary based on the action alternative that it is paired with. For Alternatives B and C, direct emissions with Option 3 would be 39.97 TMT CO_2e when the calculation is based on the IPCC AR4 100-year GWPs, 39.98 TMT when using the IPCC AR5 100-year GWPs, and 40.08 TMT when using the IPCC AR5 20-year GWPs. GHG emissions from Option 3 for Alternatives B and C are approximately 100 TMT of CO_2e less than Option 1 and approximately 300 TMT less than Option 2 because Option 3 would make use of the existing Oliktok Dock for module delivery.

For Alternative D, direct emissions with Option 3 would be 43.14 TMT CO_2e using the IPCC AR4 100-year GWPs, 43.15 TMT when using the IPCC AR5 100-year GWPs, and 43.25 TMT when using the IPCC AR5 20-year GWPs. GHG emissions from Option 3 when paired with Alternative D are approximately 97 TMT of CO_2e less than Option 1 and approximately 297 TMT less than Option 2 because Option 3 would use the existing Oliktok Dock for module delivery.

3.2.2.7 Oil Spills and Accidental Releases

The EIS considers the potential effects of accidental spills. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste or hazardous materials (e.g., diesel, gasoline, other chemicals) during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. These types of spills would potentially result in CH_4 emissions from the spill itself, as well as CO_2, CH_4, and N_2O emissions associated with equipment used for containment, transportation, and cleanup (including burning), and thus would potentially contribute incrementally to climate change.

3.2.3 Effects of Climate Change on the Project

Key changes to anticipate as a result of a changing arctic climate are permafrost thawing, shorter ice road seasons, and changes to precipitation. Permafrost thawing and uneven settlement could cause damage to infrastructure such as gravel pads, roads, and pipelines. A shorter ice road season would affect the transport of materials and personnel that depend on ice roads; consequently, the impacts due to climate change would be more substantial for Alternatives C and D due to their reliance on annual ice roads to connect the Project area to existing development during winter. More precipitation could increase surface runoff, and the design of gravel surface elevations would consider more extreme precipitation events.

CPAI would accommodate these considerations in the Project's design using the following measures:

- Gravel roads would be a minimum of 5 feet thick (averaging 7 feet thick due to local topography) to maintain the existing thermal regime and protect underlying permafrost from melting.
- Gravel pads would be a minimum of 5 feet thick (averaging more than 7 feet thick due to local topography) to maintain the existing thermal regime and protect underlying permafrost from melting.
- If localized thaw penetration and subsidence at the gravel surface begin to occur, CPAI would perform maintenance as needed to increase the insulative value of the infrastructure, through additional gravel or other techniques, in the problem area(s). CPAI would adaptively manage gravel road and pad maintenance in response to potentially changing climatic conditions. Specific areas where subsidence may occur is unknown due to site complexity and uncertainties inherent in any model or projection.
- The targeted deployment of thermosiphons to help maintain the existing thermal regime in areas where permafrost degradation would be likely due to local conditions or Project facilities (e.g., on drill pads).
- Design flow for crossings of North Slope streams would be controlled by breakup flood magnitude, which is significantly larger than summer and fall rain induced flood events.
- Infrastructure would be designed to account for increases in winter precipitation due to climate change that could result in larger spring breakup events due to potentially increased snowfall amounts. Bridge and culvert designs would account for larger breakup events than river or stream design flow magnitude by providing 4 feet of freeboard above the 100-year floodwater surface elevation (for bridges) and providing a headwater-diameter ratio (Hw/D) of less than 1.0 for a 50-year flood event for culverted stream crossings.
- Typical bridge design practice in the U.S. per the Federal Highway Administration Project Development and Design Manual is 2 feet of freeboard over the 50-year design water-surface elevation. Per Federal Highway Administration, culverts designed for a "high-standard road" (the most stringent design criteria) are to be designed for a 50-year flow capacity with a Hw/D between 1.2 and 1.5 (Hw/D less than 1.0 means

the inlet of the culvert would not be submerged; an Hw/D greater than 1.0 means the culvert inlet would be submerged), depending on culvert size.

- For both bridges, the Project's design criteria would be more conservative than Federal Highway Administration criteria and would be able to accommodate future increases in flows from potential climate change.
- CPAI evaluated ice road season duration (which has natural variability) over the last 20 years to consider the potential effects of climate change on ice road construction. Because the duration of the Alpine Ice Road season has not changed substantially over the last 20 years (CPAI 2020d) despite climate change occurring, the design uses the existing ice-road season. The Alpine Ice Road has remained open for an average of 92 days for the last 21 years and 99 days for the last 10 years; there is no apparent trend in increasing or decreasing duration. The Lower Foothills Tundra Opening Area has been open an average of 100 days since 2002 and the Western Coastal Tundra Opening Area has been open an average of 130 days since 2002 (ADNR 2020). There appears to be a slight decrease over time in the Western Coastal Tundra Opening Area season duration (would not appreciably affect the Project), and a decrease in the Lower Foothills Tundra Opening Area season duration. The Option 3 ice road would be in the Lower Foothills Tundra Opening Area, but would only construct an ice road for 2 seasons and would be complete by 2028. Ice roads within the NPR-A would not be on state lands and thus would be subject to BLM jurisdiction, for which data regarding ice road season duration are not available (due to the lesser amount of development and activity in the area compared to state lands).
- The MTI design water levels and wave conditions are based on the 100-year event as presented in Resio and Coastal Frontiers Corporation (2019). This hindcast assessment of extreme water level and wave conditions indicates that storm surge and wave conditions have not changed appreciably in the recent past. Twenty westerly and twenty easterly storms that occurred from 1954 through 2014 were selected for inclusion in that study based on their potential to generate large waves. Only five of the westerlies and eight of the easterlies occurred after 2000, and only one westerly and three easterlies after 2010. Furthermore, the highest water level ever recorded at the Prudhoe Bay tide gauge, which was established in 1990, occurred in August 2000 (based on the station information available at: https://tidesandcurrents.noaa.gov/stationhome.html?id=9497645).
- The MTI design considered the effects of declining ice cover in the Beaufort Sea. Because the predominant directions for storm winds are coast-parallel (easterly and westerly), the retreat of the pack ice to the north does not materially increase the **fetch** length. The fetch width (perpendicular to the wind direction) is indeed increasing, but the impact of fetch width on surge and wave generation is relatively minor compared to that of fetch length. As a result, the severity of nearshore surge and wave has not changed substantially. Coastal erosion rates are increasing due to higher air temperatures (thermal erosion of ice-bonded coastal bluffs) and longer open-water seasons (more wave energy), but these factors would not impact an armored structure such as Oliktok Dock or the MTI.

3.2.4 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Project GHG emissions and their contribution to cumulative GHG levels and climate change are unavoidable and irretrievable throughout the life of the Project. Cumulative climate change impacts may be irreversible, depending on what future steps are taken to address future cumulative GHG emissions worldwide. Impacts on the long-term sustainability of area resources is dependent on those steps.

3.3 Air Quality

The near-field analysis area for air quality is the region within approximately 50 kilometers (km) (31 miles) of the Project (Figure 3.3.1), which is the distance the near-field model is generally considered to be applicable (40 CFR 51 Appendix W). The far-field (i.e., regional) analysis area is the region within approximately 300 km[1] (186 miles) of the Project (Figure 3.3.1), which is expected to characterize the maximum long-range impacts on air quality and air quality related values (AQRVs) and is consistent with previous EISs (BLM 2014). The temporal scale of the analysis ranges from acute (1 hour) to the life of the Project (approximately 30 years).

[1] South of the Project, the far-field modeling domain extends approximately 250 km (155 miles).

3.3.1 Affected Environment

Existing air quality in the analysis area is described in this section through a review of the regional climate and meteorology, existing emission sources, and monitoring data; Appendix E.3A, *Air Quality Technical Appendix*, contains additional details.

3.3.1.1 Regulatory Framework

The Clean Air Act (CAA) requires EPA to establish National Ambient Air Quality Standards (NAAQS) for six common pollutants referred to as criteria air pollutants (CAPs): carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), $PM_{2.5}$, and PM less than or equal to 10 microns in aerodynamic diameter (**PM_{10}**), and sulfur dioxide (SO_2). In Alaska, the EPA has delegated authority to ADEC for the implementation and enforcement of the Alaska Air Quality Control Regulations (18 AAC 50) through an EPA-approved State Implementation Plan. The Alaska Ambient Air Quality Standards (AAAQS) were promulgated in 18 AAC 50.010 and include additional standards beyond the NAAQS. The NAAQS and AAAQS are provided in Appendix E.3A (Section 1.1.1, *Regulatory Framework*) and the analysis of impacts assesses both standards. The analysis area for air quality is designated as "attainment/unclassifiable" for all CAPs. The only nonattainment area (for $PM_{2.5}$) in Alaska is in Fairbanks, over 600 km (373 miles) from the Project.

The Prevention of Significant Deterioration (PSD) provisions of the CAA protect air quality in geographic areas designated as attainment/unclassifiable by requiring that new major emission sources, or existing emission sources receiving major modifications, do not result in a violation of the NAAQS or exceed maximum allowable increases in air quality (PSD increments) (40 CFR 52.21). Areas that are in attainment of the NAAQS are categorized as Class I, Class II, or Class III, which determines the increment of air quality deterioration allowed, with Class I areas being the most protected. The PSD program includes special protections for Class I areas federally designated as part of the 1977 CAA amendments and Class II areas. The program requires Federal Land Managers to protect AQRVs, such as visibility and deposition (NPS 2011a), in Class I areas (40 CFR 51.166). There are no Class I areas in the analysis area. AQRVs are assessed in the EIS at three federally managed areas with receptor locations of interest (referred to hereafter as the three assessment areas): Arctic National Wildlife Refuge (ANWR), Gates of the Arctic National Park, and Noatak National Preserve (Figure 3.3.1).

Visibility impairment (i.e., haze), occurs when sunlight is absorbed or scattered by particles and gases (EPA 2017a). Visibility impacts are assessed by comparing the source's impact in units of delta deciviews (dv). The dv scale is nearly zero for a pristine atmosphere, and each dv change corresponds to a small but perceptible scenic change that is observed under either clean or polluted conditions. For example, a source that exceeds 0.5 dv (5% change in light extinction) is considered to contribute to visibility impairment, while a source that exceeds 1.0 dv (10% change in light extinction) is considered to cause visibility impairment (FLAG 2010).

Deposition is the transfer of pollutants from the atmosphere to soil, waterbodies, and other surfaces via dry or wet processes. There are currently no federal standards for deposition. Federal Land Managers use critical loads (cumulative deposition flux below which no harmful effects to an ecosystem are expected) and Deposition Analysis Thresholds (DATs) (below which single-source impacts are considered negligible) to assess cumulative and source-specific deposition impacts, respectively. The critical load range for the Alaska tundra ecoregion is 1.0 to 3.0 kilograms nitrogen per hectare per year (kg N/ha/year) (NPS 2018), and the nitrogen and sulfur DATs for western Federal Land Manager areas are 0.005 kilogram per hectare per year (kg/ha/year) (FLAG 2010).

The CAA also mandates that EPA regulate 187 hazardous air pollutants (HAPs) that are known or suspected to cause serious health effects or adverse environmental effects (42 USC 7412). EPA established National Emission Standards for Hazardous Air Pollutants to regulate specific categories of stationary sources that emit one or more HAPs (40 CFR 63).

There are other federal and state air quality regulations that may apply to the Project, including, but not limited to, the New Source Performance Standards (40 CFR 60), the Title V Operating Permit program (40 CFR 70, 71), the Mandatory Reporting of Greenhouse Gases (40 CFR 98), and ADEC minor source permitting (18 AAC 50.502–560). The specific regulatory requirements applicable to the Project would be determined during permitting.

3.3.1.2 Characterization of Climate, Meteorology, and Air Quality in the Analysis Area

Meteorological conditions such as wind speed, wind direction, temperature, and relative humidity affect air quality conditions. The Project area is classified as a northern polar climate with long and cold winters, short and cool summers, and low annual precipitation. There is generally snow cover from October to May. Average monthly temperatures and precipitation rates at the National Weather Service monitoring station in Nuiqsut are provided in Table 3.3.1. The annual wind rose in Figure 3.3.2 shows the distribution of wind direction and speed at the CPAI monitoring station in Nuiqsut from 2013 to 2017. The prevailing wind direction was from the northeast with wind speeds averaging 5 meters per second (11.2 mph). Seasonal winds patterns at Nuiqsut and additional data from other meteorological monitors are provided in Appendix E.3, *Air Quality Technical Appendix*.

Table 3.3.1. Average Temperature and Precipitation at the Nuiqsut National Weather Service Monitor

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Max Temp (F)[a]	-7.1	-9.6	-8.4	10.0	29.6	51.1	58.2	51.6	40.1	21.8	5.1	-2.5	20
Min Temp (F)[a]	-22.9	-23.3	-21.5	-6.0	18.2	35.4	41.6	38.7	31.5	14.2	-8.7	-15.7	6.8
Total Precip (in)[b]	0.08	0.05	0.02	0.18	0.19	0.27	0.74	0.88	0.38	0.04	0.05	0.13	2.74

Note: F (degrees Fahrenheit); in (inch); Max (maximum); Min (minimum); Precip (precipitation); Temp (temperature).
[a] Source: National Oceanic and Atmospheric Administration National Centers for Environmental Information (https://www.ncdc.noaa.gov/cdo-web/datatools/normals); period of record is 1981 to 2010.
[b] Source: U.S. Department of Agriculture Natural Resources Conservation Service (http://agacis.rcc-acis.org/?fips=02185). Values are based on averages over the period 1998 to 2017. Months within each year with > 1 missing day are omitted from averages. Annual data with > 1 missing day is also omitted from averages. Due to this, the sum of monthly averages does not equal the annual average.

There are several existing emissions sources, both onshore and offshore, on the North Slope and adjacent waters area, resulting in air emissions that affect air quality. Overall, onshore oil and gas sources comprise the largest fraction of existing emissions for all CAPs except PM_{10} and $PM_{2.5}$, for which dust from unpaved roads comprise the largest fraction. The largest existing sources of HAPs are onshore oil and gas activity, other nonroad vehicles and equipment, on-road gasoline-powered trucks, waste incineration, combustion, and landfills (Fields Simms, Billings et al. 2014).

Air concentrations of CAPs measured at the CPAI Nuiqsut monitoring station are provided in Table 3.3.2. The monitored concentrations are all well below the NAAQS; thus, the existing air quality in the analysis area is acceptable with respect to the NAAQS. Measurements of HAPs are reported for six HAPs that are commonly emitted during oil and gas development. The measured concentrations during the 2014 through 2018 period at the CPAI Nuiqsut monitoring station are presented in Table. 3.3.3 (SLR 2019). The measured HAP concentrations are well below corresponding Reference Exposure Level (RELs) and Acute Exposure Guideline Levels (AEGLs) (EPA 2018), as shown in Table 3.3.3.

Table 3.3.2. Measured Criteria Air Pollutant Concentrations at the Nuiqsut Monitoring Station

Pollutant (units)	Averaging Period	Rank	2015	2016	2017	Average	NAAQS/ AAAQS	Below NAAQS/ AAAQS?
CO (ppm)	1 hour	2nd highest daily max	1	1	1	1	35	Yes
CO (ppm)	8 hours	2nd highest daily max	1	1	1	1	9	Yes
NO_2 (ppb)	1 hour	99th percentile of daily max	23.6	18.0	27.4	23.0	100	Yes
NO_2 (ppb)	Annual	Annual average	2	1	2	2	53	Yes
SO_2 (ppb)	1 hour	99th percentile of daily max	1.2	3.2	3.5	2.6	75	Yes
SO_2 (ppb)	3 hours	2nd highest daily max	1.2	3.4	3.5	2.7	500	Yes
SO_2 (ppb)	24 hours	2nd highest	1.1	3.1	3.4	2.5	139	Yes
SO_2 (ppb)	Annual	Average	0.1	0.8	0.9	0.6	31	Yes
PM_{10} (µg/m^3)	24 hours	2nd highest	98.5	128.8	48.8	92.1	150	Yes
$PM_{2.5}$ (µg/m^3)	24 hours	98th percentile	10.0	5.5	6.9	7.5	35	Yes
$PM_{2.5}$ (µg/m^3)	Annual	Average	2.8	1.3	1.6	1.9	12	Yes
O_3 (ppb)	8 hours	4th highest daily max	46	43	45	44	70	Yes

Note: AAAQS (Alaska Ambient Air Quality Standards; CO (carbon monoxide); max (maximum); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); O_3 (ozone); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); ppb (parts per billion); ppm (parts per million); SO_2 (sulfur dioxide); µg/m^3 (micrograms per cubic meter). NAAQS/AAAQS for O_3 were converted from ppm to ppb, and AAAQS SO_2 24-hour and annual standards were converted from µg/m^3 to ppb.

Table 3.3.3. Measured Hazardous Air Pollutants Concentrations at the Nuiqsut Monitoring Station (2014 through 2018)

Pollutant	Average of measurements (μg/m³)[a]	Maximum of measurements (μg/m³)[a]	Acute REL or AEGL (μg/m³)[b]
Benzene[c]	0.86	0.89	27
Ethylbenzene[c]	0.78	0.78	140,000[d]
Formaldehyde	NA	NA	55
n-hexane	1.27	1.27	10,000,000[d]
Toluene	3.81	6.41	37,000
Xylene[e]	2.47	3.47	22,000

Source: SLR 2019
Note: AEGL (Acute Exposure Guideline Level); NA (not available); REL (Reference Exposure Level); μg/m³ (micrograms per cubic meter).
[a] Values converted from parts per billion to μg/m³ at standard temperature and pressure.
[b] Source of REL and AEGL data: Table 2 in *Acute Dose-Response Values for Screening Risk Assessments* (EPA 2018).
[c] Benzene and ethylbenzene measurements reported from the Toxic Organics (TO) method TO-12, n-hexane by the TO-15 method.
[d] AEGL specified for these two pollutants (ethylbenzene and n-hexane) as RELs are not available; RELs are specified for the other pollutants in the table.
[e] Xylene measurement reported equals the sum of o-xylene and m/p-xylene by the TO-12 method.

As shown in Figure 3.3.1, AQRV monitoring site locations are located far from the Project and are beyond the Project's far-field modeling domain boundaries. The Denali monitoring station is located at the park headquarters near Healy, Alaska, which is approximately 470 miles south of the Project. The Gates of the Arctic National Park and Preserve monitoring station is located on the south side of the Brooks Range in Bettles, Alaska, which is approximately 230 miles south of the Project. Poker Creek is located 24 miles from Fairbanks, Alaska, and is approximately 380 miles south of the Project. Due to the large distance between the Project and available AQRV measurement locations, AQRV measurements are in different airsheds than the Project. As a result, AQRV conditions and trends in proximity to the Project could differ from results reported for the Denali, Gates of the Arctic, and Poker Creek AQRV monitoring sites.

Monitored visibility at the Gates of the Arctic National Park and Denali National Park is presented in Appendix E.3A, Figures E.3.8 and E.3.9, respectively. Data are shown for the 20% haziest and 20% clearest days. The 20% haziest days include anthropogenic and natural influences following the EPA (2013) algorithm as revised by IMPROVE in December 2019 and is influenced by natural emission sources such as wildland fires. The haze index on the haziest days shows a downward trend at both sites, with the maximum value of approximately 22 dv occurring in 2004 at Denali National Park and approximately 13 dv occurring in 2010 at Gates of the Arctic National Park. The haze index on the clearest days has been slightly higher than natural conditions and is approximately 2 to 3 dv in Denali National Park since 2000 and between 3 to 4 dv in the Gates of the Arctic National Park since monitoring began in 2010.

Trends in the wet deposition fluxes of ammonium (NH_4^-), nitrate (NO_3^-), and sulfate (SO_4^{2-}) at the National Atmospheric Deposition Program's National Trends Network (NADP 2018) monitors in Poker Creek, Denali National Park, and Gates of the Arctic National Park are shown in Appendix E.3A, Figures E.3.10, E.3.11, and E.3.12, respectively. Most values are below 1.0 kg/ha/year, with no apparent trend in most cases. However, wet deposition fluxes of NH_4^- at Poker Creek and Denali National Park, and NO_3^- at Poker Creek, have shown an upward trend in recent years. The estimated total deposition flux of nitrogen and sulfur at Denali National Park (1999 to 2017) is provided in Appendix E.3A, Figure E.3.13. The estimated total (i.e., wet plus dry) deposition flux of nitrogen at Denali National Park is well below the critical load of the analysis area (1.0 to 3.0 kg N/ha/year) in all years.

3.3.2 Environmental Consequences

3.3.2.1 Avoidance, Minimization, and Mitigation

3.3.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.3.4 summarizes existing NPR-A IAP BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to air quality from development activity (BLM 2013a). The BMPs would reduce impacts to air quality associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.3.4 summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to air quality. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.3.4 only includes changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.3.4. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Air Quality

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-3	Minimize pollution through effective hazardous materials contingency planning	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-9	Reduce air quality impacts	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use “ultra-low sulfur” diesel.	BMP withdrawn: No similar requirement; duplicative with U.S. Environmental Protection Agency standard under Section 202 of the Clean Air Act amendments.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health	Air monitoring (preconstruction and throughout the life of the Project), emissions inventory, emissions reduction plan, air quality modeling, and possibly mitigation measures will be required.	Added text: Provided to the North Slope Borough, local communities, and tribes publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this BMP.
ROP A-14	Reduce air emissions and protect human health	No similar requirement	All permanent camps (and temporary camps where feasible under alternative E), are required to provide vehicle plug-ins for engine warming systems (e.g., block heaters and oil pan heaters). Alternative E only: reduce extended vehicle idling when practical. In the winter, when vehicles are not in use for extended periods, they should be powered off and plugged in where plugs are available.

Source: BLM 2013a, 2020a
Note: BMP (best management practice); F (Fahrenheit); IAP (Integrated Activity Plan); LS (lease stipulation); ROP (required operating procedure).

No deviations to the LSs and BMPs described in Table 3.3.4 would be required.

3.3.2.1.2 Proponent’s Design Measures to Avoid and Minimize Effects

CPAI’s design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1. CPAI’s design measures would reduce CAP and HAP emissions beyond federal or state regulations and existing NPR-A IAP/EIS BMPs. These measures include capturing and injecting produced gas to enhance oil recovery in a closed process and using hydraulic fracturing equipment that meet nonroad engine EPA Tier 4 emissions standards.

3.3.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

BLM would require that CPAI implement a Fugitive Dust Control Plan to mitigate impacts from fugitive PM emissions from the Project. This plan would require regular watering of pads and unpaved roads, enforcing speed limits on unpaved access and haul roads, and several other measures to reduce fugitive dust emissions and impacts. The Fugitive Dust Control Plan is provided as Appendix I.3. (Though ROP M-5 requires a dust plan for areas of bare soil, it is focused on construction and mining; the Fugitive Dust Control Plan is focused on gravel roads and pads.)

3.3.2.2 Air Emissions Inventory

The emissions inventory for the Project action alternatives was calculated based on equipment types and predicted uses. Equipment and design configurations from other North Slope projects, including the GMT-2 drill site and the Alpine Processing Facility, were used initially for Project emissions estimates and were adapted to include Project-specific design information, where available. Project development would result in air emissions from construction, drilling and completion of new wells, operation and maintenance activities, and processing, storage, and transfer of liquid and gas products. Emissions of CAPs, GHGs,[2] and HAPs come from the installation of wells, the operation of engines and boilers, and the transportation of equipment, materials, and personnel to and within the Project area, mostly due to vehicle engine combustion and vehicle traffic on unpaved roads. After the wells are completed, the processing, transport, and storage of the produced oil and natural gas would result in emissions of CAPs, GHGs, and HAPs.

The total life-of-Project emissions by pollutant under each alternative are provided in Tables 3.3.5, 3.3.6, and 3.3.7, with the emissions for Option 1 (Atigaru Point Module Transfer Island), Option 2 (Point Lonely Module Transfer Island), and Option 3 (Colville River Crossing), respectively. Emissions shown are for all Project sources plus the indicated module delivery option. The HAPs analyzed only include those most commonly emitted from oil and gas development (benzene, toluene, ethylbenzene, xylenes, n-hexane, and formaldehyde); thus, the HAPs column in Tables 3.3.5, 3.3.6, and 3.3.7 represents the sum of only these six HAPs. For all three module delivery options, Alternative C has the highest total Project emissions across all three action alternatives for CAPs and HAPs (1% to 20% more than Alternative B and 2% to 18% more than Alternative D) other than PM_{10} for Alternative D. These increased emissions are primarily due to additional equipment and infrastructure requirements necessitated by the lack of a gravel road between the WPF and BT1 for this alternative. For PM_{10}, Alternative C emissions are 10% higher than Alternative B and 8% lower than Alternative D. Higher PM_{10} emissions from Alternative D are mainly due to higher routine operations traffic activity for Alternative D compared to Alternative B and Alternative C. Under all module delivery options, Alternative D has slightly higher emissions (except volatile organic compounds [VOCs] and HAPs) than Alternative B because of the extended Alternative D Project schedule[3]. Note that air emissions are not equivalent to air quality impacts. As described in the following sections, the air emissions for the action alternatives are used in modeling analyses to estimate air quality impacts. A detailed description of the methods used to calculate CAP and HAP emissions, as well as the activity data for each Project phase under each alternative, are provided in Chapter 2 in Appendix E.3B.

Table 3.3.5. Total Life-of-Project Criteria Air Pollutant and Hazardous Air Pollutant Emissions (tons) due to the Project and Module Delivery Option 1 (Atigaru Point Module Transfer Island)

Alternative	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	HAPs
A: No Action	0	0	0	0	0	0	0
B: Proponent's Project	20,270	19,593	1,364	6,549	2,394	16,626	1,911
C: Disconnected Infield Roads	24,328	23,064	1,458	7,213	2,858	17,139	1,927
D: Disconnected Access	20,694	19,743	1,367	7,883	2,575	16,519	1,897

Note: CO (carbon monoxide); HAPs (hazardous air pollutants); NOx (nitrogen oxides); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); VOCs (volatile organic compounds). Greenhouse gas emissions due to the Project are discussed in Section 3.2, *Climate and Climate Change*.

Table 3.3.6. Total Life-of-Project Criteria Air Pollutant and Hazardous Air Pollutant Emissions (tons) due to the Project and Module Delivery Option 2 (Point Lonely Module Transfer Island)

Alternative	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	HAPs
A: No Action	0	0	0	0	0	0	0
B: Proponent's Project	20,836	20,239	1,365	6,596	2,420	16,719	1,922
C: Disconnected Infield Roads	24,894	23,710	1,460	7,260	2,885	17,233	1,939
D: Disconnected Access	21,260	20,389	1,369	7,930	2,602	16,612	1,909

Note: CO (carbon monoxide); HAPs (hazardous air pollutants); NOx (nitrogen oxides); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); VOCs (volatile organic compounds). Greenhouse gas emissions due to the Project are discussed in Section 3.2, *Climate and Climate Change*.

[2] Note that greenhouse gas emissions are described and presented in Section 3.2, *Climate and Climate Change*.

[3] The emission inventory time period for Alternative D was extended 1 year longer than for Alternative B and Alternative C to account for the delayed production schedule for Alternative D.

Table 3.3.7. Total Life-of-Project Criteria Air Pollutant and Hazardous Air Pollutant Emissions (tons) due to the Project and Module Delivery Option 3 (Colville River Crossing)

Alternative	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	HAPs
A: No Action	0	0	0	0	0	0	0
B: Proponent's Project	19,903	19,131	1,361	6,581	2,382	16,562	1,903
C: Disconnected Infield Roads	23,961	22,601	1,455	7,245	2,846	17,076	1,919
D: Disconnected Access	20,342	19,285	1,364	7,915	2,564	16,457	1,890

Note: CO (carbon monoxide); HAPs (hazardous air pollutants); NOx (nitrogen oxides); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); VOCs (volatile organic compounds). Greenhouse gas emissions due to the Project are discussed in Section 3.2, *Climate and Climate Change*.

3.3.2.3 Air Quality Impact Assessment Summary

The approach for the air quality impact assessment for the Project analysis is described in Chapter 1 of the AQTSD (Appendix E.3B). The objective of the assessment was to assess current air quality conditions and estimate the potential change in future air quality conditions associated with Project development. Air quality and AQRV impacts were assessed within the Project area, at discrete sensitive receptor locations, and at three assessment areas within approximately 300 km (186 miles) of the Project. Specifically, the air quality modeling includes the following:

- An assessment of air quality impacts for the CAPs O_3, $PM_{2.5}$, PM_{10}, NO_2, SO_2, and CO
- An assessment of the HAP impacts of benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX), n-hexane, and formaldehyde[4]
- An AQRV analysis to assess changes in visibility and acidic deposition

Note that the air quality impact analyses include additional planned developments and background air quality concentrations in order to compare total air quality and AQRV conditions to applicable standards. Therefore, results presented in the following sections include a cumulative impact assessment. More information about the planned developments and analysis of the cumulative impacts is presented in Section 3.19.5, *Cumulative Impacts to Air Quality*.

3.3.2.3.1 Near-Field Air Impact Assessment Summary

The near-field air impact assessment was conducted using the EPA regulatory air dispersion model AERMOD to assess CAPs (excluding O_3[5] and Pb[6]) and the HAPs listed above within 50 km (31 miles) (near-field) of the Project. The AERMOD results for air concentrations from the Project were added to the background ambient air concentrations from existing emissions sources to calculate the total air quality concentrations for comparison to the applicable NAAQS and AAAQS (collectively referred to as AAQS; Table 3.3.2). AERMOD results for air concentrations from the Project at Nuiqsut were compared to PSD Class II increments (see Appendix E.3B, Chapter 1 for the PSD increment thresholds). Note that this comparison is not a formal PSD increment consumption analysis which is under the jurisdiction of ADEC and is provided here only for reference. The AERMOD model results for the HAPs were compared to non-carcinogenic acute and chronic pollutant specific threshold levels (see Appendix E.3B, Chapter 1 for the threshold levels). The calculated chronic cancer risks for the analyzed HAPs were compared to a one-in-one-million threshold. The AQTSD (Appendix E.3B, Chapter 3) includes a detailed discussion of the near-field modeling methodology and results.

A summary of the near-field air quality modeling impacts for applicable CAPs and HAPs is provided in Table 3.3.8. Impacts for all pollutants analyzed are below NAAQS/AAAQS, PSD increments, and HAPs thresholds for all action alternatives. The Project impacts at Nuiqsut are well below NAAQS/AAAQS, PSD increments, and HAP thresholds for all action alternatives.

[4] These six HAPs were selected for analysis as BTEX and n-hexane are present in raw natural gas and oil. Formaldehyde is formed from the combustion of small chain alkanes that predominate in natural gas.
[5] O_3 impacts are assessed with the Comprehensive Air Quality Model with Extensions (CAMx) regional model. The AERMOD model is not able to estimate O_3 concentrations.
[6] As described in Chapter 1 in Appendix E.3B, Pb was not assessed due to low levels of Pb emissions from the Project.

Table 3.3.8. Summary of Near-Field Air Quality Modeling Impacts for Action Alternatives and Module Delivery Options

Alternative or Option	Development Scenario	Criteria Air Pollutants	Hazardous Air Pollutants
Alternative A (No Action)	Not applicable	No impacts to CAPs. Pollutant concentrations would be identical to existing background levels.	No impacts to HAPs. Pollutant concentrations would be similar to current levels.
Alternative B (Proponent's Project)	Construction	Impacts would be below all AAQS.	HAPs impacts were not directly assessed with the model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative B	BT1 pre-drilling	Impacts would be below all AAQS. Impacts would be identical to Alternative D.	HAPs impacts were not directly assessed with the model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative B	BT1 and BT2 pre-drilling	Impacts would be below all AAQS. Impacts would be identical to Alternative D.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative B	Developmental drilling	Impacts would be below all AAQS.	HAPs emissions from these activities are comparable to routine operations. Since the HAPs impacts were well below thresholds for routine operations, HAPs were not directly assessed for this scenario.
Alternative B	Routine operations	Impacts would be below all AAQS.	*Non-carcinogenic:* All analyzed HAPs would be below RELs and RfCs. *Carcinogenic:* Cancer risks for individual HAPs and total cancer risk across all pollutants were modeled and results were less than a 1-in-1-million risk for all carcinogenic HAPS analyzed.
Alternative C (Disconnected Infield Roads)	Construction	Impacts would be below AAQS.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative C	BT1 pre-drilling	Impacts would be below all AAQS.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative C	BT1 and BT2 pre-drilling	Impacts would be below all AAQS.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative C	Developmental drilling	Impacts would be below all AAQS.	HAPs emissions from these activities are comparable to the routine operations development scenario. Since the HAPs impacts were well below thresholds for routine operations, HAPs were not directly assessed for this scenario.
Alternative C	Routine operations	Impacts would be below all AAQS.	*Non-carcinogenic:* All analyzed HAPs would be below respective RELs and RfCs. *Carcinogenic:* Cancer risks for individual HAPs and total cancer risk across all pollutants were modeled and results were less than a one-in-one-million risk for all carcinogenic HAPs analyzed.
Alternative D (Disconnected Access)	Construction	Impacts would be below all AAQS.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative D	BT1 pre-drilling	Impacts would be identical to Alternatives B, and below all AAQS.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative D	BT1 and BT2 pre-drilling	Impacts would be below all AAQS. Impacts would be identical to Alternative B.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative D	Developmental drilling	Impacts would be below all AAQS.	HAPs emissions from these activities are comparable to the routine operations development scenario. Since the HAPs impacts were well below thresholds for routine operations, HAPs were not directly assessed for this scenario.

Alternative or Option	Development Scenario	Criteria Air Pollutants	Hazardous Air Pollutants
Alternative D	Routine operations	Impacts would be below all AAQS.	*Non-carcinogenic:* All analyzed HAPs would be below respective RELs and RfCs. *Carcinogenic:* Cancer risks for individual HAPs and total cancer risk across all pollutants were modeled and results were less than a one-in-one-million risk for all carcinogenic HAPS analyzed.
Option 1: Atigaru Point MTI	Atigaru Point MTI	Onshore impacts would be lower than Option 2 and below all AAQS.	HAPs impacts were not directly assessed with a model because HAPs emissions from MTI activities would be substantially lower than routine operations under Alternatives B, C, and D.
Option 2: Point Lonely MTI	Point Lonely MTI	Onshore impacts would be below all AAQS and higher than Option 1.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than routine operations under Alternatives B, C, and D.
Option 3: Colville River Crossing	Colville River crossing	Onshore impacts would be below all AAQS. Impacts would be higher or lower than Option 2, depending on the pollutant.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than routine operations under Alternatives B, C, and D.

Note: AAQS (ambient air quality standards); BT1 (Bear Tooth drill site 1); BT2 (Bear Tooth drill site 2); CAPs (criteria air pollutants); HAPs (hazardous air pollutants); MTI (module transfer island); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); RELs (Reference Exposure Levels); RfCs (reference concentrations); WOC (Willow Operations Center).

The Project would be below all applicable air quality thresholds under all action alternatives and scenarios, whether Project roads have 25 or 35 mile per hour roads; this is discussed in Appendix E.3B, Section 3.8, *Speed Limit Change Analysis*).

3.3.2.3.2 Regional (Far-Field) Air Impact Assessment Summary

The regional (far-field) air impact assessment was conducted using the Comprehensive Air Quality Model with Extensions (CAMx) modeling system to assess CAPs (except Pb[7]), PSD increments, and AQRVs for Alternatives B and C, as well as cumulative effects from current sources and reasonably foreseeable developments, including three assessment areas within approximately 300 km (186 miles) of the Project. Regional air quality impacts were assessed using regional emissions and the emissions inventory developed for the Project as described in the Draft EIS (Appendix E.3B, Chapter 2). Cumulative impacts were derived from the total concentrations estimated in the cumulative action alternative scenario (i.e., a CAMx simulation with all Project and regional sources included). The Project impacts were obtained from the difference between the cumulative action alternative scenario and a scenario without the Project (the cumulative no action scenario). Regional air quality was not remodeled using the emissions inventory developed for the Project in this Final EIS because the regional air impact assessment for the Draft EIS showed that cumulative and Project-specific impacts were found to be below all applicable thresholds throughout the modeling domain. Additionally, Project emissions of CAPs are small relative to regional emissions (up to 6.0 % of regional emissions, depending on the pollutant) and changes to Project emissions between the Draft EIS and the Final EIS are an even smaller fraction of regional emissions (up to 4.3%, depending on the pollutant). AQTSD Chapters 4 and 5 (Appendix E.3B) provide additional modeling details, including the model configuration and assessment methods. Regional air quality impacts are quantified and discussed in detail in Chapter 5 of the AQTSD (Appendix E.3B).

Modeled regional impacts were similar for Alternatives B and C for air quality and AQRVs, with Alternative C typically showing slightly higher impacts. Alternative D was not modeled but was qualitatively assessed instead because its emissions (and therefore impacts) would be between the other two action alternatives or lower than either of them.

Impacts due to the Project would be higher near the Project and drop off rapidly with distance from the Project. Although mainly impacting the immediate Project vicinity, in general, Alternative C has a larger impact across the analysis area than Alternative B. The most noticeable difference would be expected NO_2 and $PM_{2.5}$ emissions as the larger total annual nitrogen oxides (NOx) emissions under Alternative C would lead to larger impacts to both NO_2 and particulate nitrate. The modeled spatial maximum for O_3 under Alternative C was higher than Alternative B by 0.3 parts per billion across the analysis area, but the spatial distribution was very similar. The three assessment areas

[7] As described in Appendix E.3B, Chapter 1, Pb was not assessed due to low levels of Pb emissions from the Project and the analysis area is in attainment for the Pb standards.

are far from the Project, and modeled deposition and visibility impacts due to the Project at these areas were small and below applicable thresholds.

A summary of the regional air quality modeling impacts is shown in Table 3.3.9.

Table 3.3.9. Summary of Regional Air Quality Modeling Impacts

Metric	Impact
NAAQS and AAAQS	Impacts for $PM_{2.5}$ and NO_2 in the analysis area would be typically higher for Alternative C than for Alternative B. Impacts for Alternative D for the criteria air pollutants other than PM_{10} would be lower than Alternative C and higher than Alternative B because the emissions of Alternative D are typically between these two alternatives. In the case of PM_{10}, Alternative D would have the least emissions (and therefore impacts) across all alternatives. Alternatives B and C show generally similar impacts for O_3, and Alternative D is expected to be similar as well. Alternative C would have slightly higher (0.3 parts per billion) O_3 than Alternative B. All criteria air pollutants analyzed would be below the NAAQS and AAAQS for all action alternatives.
PSD Increments	All pollutants analyzed would be below the PSD increment thresholds for Alternative B and Alternative C. Impacts for Alternative D would be higher than Alternative B but lower than Alternative C (or lower than both alternatives in the case of PM_{10}), and thus would also be lower than the PSD increment thresholds.
Deposition	Nitrogen deposition would be higher for Alternative C than Alternative B. Nitrogen deposition for Alternative D is anticipated to be lower than Alternative C and higher than Alternative B. Sulfur deposition for all action alternatives would be similar. The nitrogen and sulfur depositions from all action alternatives would be below the Deposition Analysis Thresholds. The cumulative nitrogen deposition for all action alternatives would not exceed the range of critical load of atmospheric deposition.
Visibility	Impacts for Alternatives B and C at the three assessment areas would be comparable (with Alternative C showing slightly higher impacts during the most impaired days at Gates of the Arctic National Park and the Noatak National Preserve), and the impact for Alternative D is anticipated to be similar. Impacts would be well below 0.5 delta deciview haze index threshold, so none of the action alternatives would contribute to visibility impairment.

Note: AAAQS (Alaska Ambient Air Quality Standards); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); O_3 (ozone); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); PSD (Prevention of Significant Deterioration).

3.3.2.4 Near-Field Air Quality Modeling Results

The following sections provide an overview of the near-field air quality modeling results by action alternative. Additional detail can be found in Appendix E.3B, Chapter 3.

3.3.2.4.1 Alternative A: No Action

Under the No Action Alternative, the Project would not occur. BLM and/or other federal permitting agencies would not issue authorizations for the Project. No oil in the Project area would be produced in the near future and no new roads, airstrips, pipelines, or other oil facilities would be constructed. Therefore, there would be no direct Project emissions under the No Action Alternative. However, existing oil and gas exploration and development, as well as air, ground, and marine traffic, would continue to contribute to air emissions. The No Action Alternative is used as a baseline to aid in comparison of the anticipated local impacts among the action alternatives.

3.3.2.4.2 Alternative B: Proponent's Project

Under Alternative B, the Project would consist of five development scenarios which were analyzed for near-field impacts: construction, BT1 pre-drilling, BT1 and BT2 pre-drilling, developmental drilling, and routine operations. The emissions that would come from these activities were estimated for CAPs, VOCs, and HAPs. Tables 3.3.5 through 3.3.7 show the total Project life emissions, including module delivery emissions. As reported in the AQTSD (Appendix E.3B, Chapter 2), HAP emissions from construction and drilling activities would be substantially lower than routine operations and thus only HAP impacts for routine operations were modeled. The near-field impact analyses were based on the maximum emissions for the individual development scenarios. All CAP impacts for the construction, BT1 pre-drilling, BT1 and BT2 pre-drilling, developmental drilling, and routine operation development scenarios would be below AAQS. Table 3.3.10 provides a summary of the maximum cumulative CAP impacts (modeled impacts with background concentrations added) for the modeling domain and at Nuiqsut for each Alternative B development scenario.[8] CAPs impacts at Nuiqsut would be below the PSD increments. In addition, HAP emission impacts for routine operations would be below the respective RELs and reference concentrations (RfCs). The cancer risks for modeled individual HAPs, as well as total cancer risks across all HAPs, would be less

[8] Results from the BT1 and BT2 pre-drilling scenario are in Appendix E.3B (and are below relevant standards) and are not presented here.

than a one-in-one-million risk for all carcinogenic HAPs analyzed. HAP impacts from the construction, BT1 pre-drilling, BT1 and BT2 pre-drilling, and developmental drilling scenarios were not directly modeled as HAP emissions from these activities would be comparable to or lower than the results obtained for routine operations. Maximum HAP impacts in the analysis area and estimated cancer risk at Nuiqsut from routine operations are shown in Table 3.3.11. A detailed description of the modeling results can be found in the AQTSD (Appendix E.3B, Chapter 3).

3.3.2.4.3 Alternative C: Disconnected Infield Roads

Alternative C would have the same gravel access road between GMT-2 and the Project area as Alternative B, but it would not include a gravel road connection from the WPF to BT1, BT2, and BT4. With no gravel road between these facilities, there would be a second airstrip and North WOC, and a seasonal ice road would be constructed to support annual resupply for these facilities. As shown in Tables 3.3.5 through 3.3.7, the direct emissions would be higher than Alternative B due to increased air travel and two WOCs. Overall, the near-field CAP impacts from Alternative C would be below the applicable NAAQS and AAAQS for all scenarios: construction, BT1 pre-drilling, BT1 and BT2 pre-drilling, developmental drilling, and routine operations. Table 3.3.12 provides a summary of the maximum cumulative CAP impacts (modeled impacts with background concentrations added) for the modeling domain and at Nuiqsut for each Alternative C development scenario.[9] Impacts under Alternative C would be higher or lower than Alternatives B and D, depending on the pollutant.

The modeled Alternative C CAP concentrations at Nuiqsut were below the PSD increments. Impacts during Alternative C routine operations would be below all AAQS. Impacts under Alternative C during routine operations would be higher than Alternatives B and D for all pollutants except 24-hour $PM_{2.5}$, which is highest under Alternative B. As with Alternative B, HAP emission impacts for routine operations would be below the respective RELs and RfCs. The modeled cancer risks for individual HAPs, as well as total cancer risk across all HAPs, were less than a one-in-one-million risk for all carcinogenic HAPs analyzed. HAP impacts from construction, BT1 pre-drilling, BT1 and BT2 pre-drilling, and developmental drilling scenarios were not directly modeled as HAP emissions from these activities would be comparable to or lower than those results obtained for routine operations. Maximum HAP impacts in the analysis area and estimated cancer risk at Nuiqsut from routine operations are shown in Table 3.3.13. A detailed description of the modeling results can be found in the AQTSD (Appendix E.3B, Chapter 3).

3.3.2.4.4 Alternative D: Disconnected Access

Under Alternative D, there would be no all-season gravel access road connection to the GMT and Alpine developments; however, it would employ the same gravel infield roads as proposed under Alternative B. With this change, the CAP emissions, other than PM_{10}, would be higher than Alternative B due to increased air travel but lower than Alternative C. Table 3.3.14 provides a summary of the maximum cumulative CAP impacts (modeled impacts with background concentrations added) for the modeling domain and at Nuiqsut for each Alternative D development scenario. Alternative D would have lower PM_{10} emissions (i.e., impacts) than both Alternatives B and C due to the absence of the gravel access road. Alternative D development drilling has the highest predicted impacts of any other scenario and alternative except for 24-hour $PM_{2.5}$, which is highest under Alternative B development drilling. Peak 1-hour NO_2 impacts for Alternative D developmental drilling occur at the combined WPF/BT3 pad. The near-field impacts under Alternative D would be below the AAQS for all CAPs. CAPs at Nuiqsut under Alternative D would be below the PSD increments. As with Alternatives B and C, all analyzed HAPs for routine operations would be below their respective RELs and RfCs. The cancer risks for individual HAPs, as well as total cancer risk across all HAPs, were modeled and found to be less than a one-in-one-million risk for all carcinogenic HAPs analyzed. HAP impacts were not analyzed for construction, BT1 pre-drilling, BT1 and BT2 pre-drilling, or developmental drilling as their impacts would be comparable to or less than routine operations. Maximum HAP impacts in the analysis area and estimated cancer risk at Nuiqsut from routine operations are shown in Table 3.3.15. A detailed description of the modeling results can be found in the AQTSD (Appendix E.3B, Chapter 3).

[9] Results from the BT1 and BT2 pre-drilling scenario are in Appendix E.3B (and are below relevant standards) and are not presented here.

Table 3.3.10. Ambient Air Quality Standards Impacts (and Percentage of Ambient Air Quality Standards) – Alternative B

Pollutant	Averaging Period	NAAQS/ AAAQS (µg/m³)	Construction Activity Domain Maximum[a]	Construction Activity Nuiqsut[a]	BT1 Pre-Drilling Activity Domain Maximum[a]	BT1 Pre-Drilling Activity Nuiqsut[a]	Developmental Drilling Activity Domain Maximum[a]	Developmental Drilling Activity Nuiqsut[a]	Routine Operations Domain Maximum[a]	Routine Operations Nuiqsut[a]
CO	1 hour	40,000	1,823.1 (5%)	1,341.9 (3%)	2,780.0 (7%)	1,322.8 (3%)	2,686.2 (7%)	1,327.1 (3%)	2,686.2 (7%)	1,326.4 (3%)
CO	8 hours	10,000	1,686.7 (17%)	1,311.9 (13%)	2,400.6 (24%)	1,300.1 (13%)	2,218.4 (22%)	1,306.1 (13%)	2,218.4 (22%)	1,306.4 (13%)
NO_2	1 hour	188	133.1 (71%)	47.4 (25%)	87.2 (46%)	26.6 (14%)	156.1 (83%)	40.0 (21%)	156.1 (83%)	39.9 (21%)
NO_2	Annual	100	20.2 (20%)	3.6 (4%)	14.0 (14%)	3.2 (3%)	28.1 (28%)	3.4 (3%)	28.1 (28%)	3.3 (3%)
SO_2	1 hour	196	10.5 (5%)	7.6 (4%)	11.1 (6%)	7.0 (4%)	24.8 (13%)	7.7 (4%)	24.8 (13%)	7.8 (4%)
SO_2	3 hours	1,300	14.2 (1%)	9.5 (1%)	12.6 (1%)	9.1 (1%)	25.6 (2%)	9.6 (1%)	25.6 (2%)	9.6 (1%)
SO_2	24 hours	365[b]	10.1 (3%)	9.0 (2%)	10.9 (3%)	8.9 (2%)	19.0 (5%)	9.0 (2%)	19.0 (5%)	9.0 (2%)
SO_2	Annual	80[b]	2.5 (3%)	2.4 (3%)	2.6 (3%)	2.4 (3%)	3.3 (4%)	2.4 (3%)	3.3 (4%)	2.4 (3%)
PM_{10}	24 hours	150	81.9 (55%)	11.0 (7%)	46.7 (31%)	10.5 (7%)	85.7 (57%)	11.4 (8%)	85.6 (57%)	11.4 (8%)
$PM_{2.5}$	24 hours	35	19.3 (55%)	8.5 (24%)	17.8 (51%)	8.2 (24%)	30.4 (87%)	8.4 (24%)	30.4 (87%)	8.4 (24%)
$PM_{2.5}$	Annual	12	4.5 (38%)	2.0 (17%)	3.9 (33%)	2.0 (16%)	6.2 (51%)	2.0 (17%)	6.2 (51%)	2.0 (17%)

Note: AAAQS (Alaska Ambient Air Quality Standards); BT1 (Bear Tooth drill site 1); CO (carbon monoxide); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); µg/m³ (micrograms per cubic meter).
[a] Total concentration in micrograms per cubic meter (percentage of ambient air quality standards).
[b] There are no NAAQS for SO_2 24-hour and annual averaging times.

Table 3.3.11. Routine Operations Activity Hazardous Air Pollutants Impacts – Alternative B

Pollutant	Max 1-hour in Analysis Area (µg/m³)	Acute Reference Exposure Level (µg/m³)	Max 8-Hour in Analysis Area (µg/m³)	Acute Exposure Guideline Level (µg/m³)	Max Annual in Analysis Area (µg/m³)	Reference Concentration (µg/m³)	Cancer Risk at Nuiqsut
Benzene	8.8	27.0	6.0	29,000	0.2	30.0	3.25×10^{-9}
Ethylbenzene	230.7	140,000	155.4	140,000	5.0	1,000	4.27×10^{-9}
Formaldehyde	1.4	55.0	0.8	1,100	0.0	9.8	2.07×10^{-9}
n-hexane	562.9	10,000,000	379.1	10,000,000	12.1	700	NA
Toluene	25.7	37,000	17.3	250,000	0.6	5,000	NA
Xylene	454.5	22,000	306.2	560,000	9.8	100.0	NA
Total cancer risk	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	$\mathbf{9.6 \times 10^{-9}}$

Note: max (maximum); NA (not applicable); µg/m³ (micrograms per cubic meter).

Table 3.3.12. Ambient Air Quality Standards Impacts (and Percentage of Ambient Air Quality Standards) – Alternative C

Pollutant	Averaging Period	NAAQS/ AAAQS ($\mu g/m^3$)	Construction Activity Domain Maximum[a]	Construction Activity Nuiqsut[a]	BT1 Pre-Drilling Activity Domain Maximum[a]	BT1 Pre-Drilling Activity Nuiqsut[a]	Developmental Drilling Activity Domain Maximum[a]	Developmental Drilling Activity Nuiqsut[a]	Routine Operations Domain Maximum[a]	Routine Operations Nuiqsut[a]
CO	1 hour	40,000	1,940.0 (5%)	1,341.8 (3%)	2,768.2 (7%)	1,322.8 (3%)	2,604.7 (7%)	1,332.6 (3%)	2,604.7 (7%)	1,330.3 (3%)
CO	8 hours	10,000	1,784.8 (18%)	1,311.9 (13%)	2,424.9 (24%)	1,300.1 (13%)	2,227.6 (22%)	1,309.3 (13%)	2,227.6 (22%)	1,308.1 (13%)
NO_2	1 hour	188	152.2 (81%)	50.6 (27%)	85.7 (46%)	26.8 (14%)	169.0 (90%)	38.3 (20%)	169.0 (90%)	38.3 (20%)
NO_2	Annual	100	38.5 (39%)	3.7 (4%)3	15.9 (16%)	3.2 (3%)	27.3 (27%)	3.4 (3%)	27.2 (27%)	3.4 (3%)
SO_2	1 hour	196	11.2 (6%)	7.7 (4%)	11.1 (6%)	7.0 (4%)	26.2 (13%)	7.7 (4%)	26.1 (13%)	7.7 (4%)
SO_2	3 hours	1,300	14.2 (1%)	9.6 (1%)	13.2 (1%)	9.1 (1%)	25.9 (2%)	9.6 (1%)	25.9 (2%)	9.6 (1%)
SO_2	24 hours	365[b]	10.2 (3%)	9.0 (2%)	11.1 (3%)	8.9 (2%)	19.3 (5%)	9.0 (2%)	19.3 (5%)	9.0 (2%)
SO_2	Annual	80[b]	2.7 (3%)	2.4 (3%)	2.6 (3%)	2.4 (3%)	3.4 (4%)	2.4 (3%)	3.4 (4%)	2.4 (3%)
PM_{10}	24 hours	150	120.4 (80%)	11.0 (7%)	28.0 (19%)	10.5 (7%)	111.4 (74%)	11.5 (8%)	127.8 (85%)	11.5 (8%)
$PM_{2.5}$	24 hours	35	24.4 (70%)	8.5 (24%)	19.1 (55%)	8.2 (23%)	26.8 (76%)	8.4 (24%)	26.8 (76%)	8.4 (24%)
$PM_{2.5}$	Annual	12	7.4 (61%)	2.0 (17%)	4.2 (35%)	2.0 (16%)	6.9 (57%)	2.0 (17%)	6.9 (57%)	2.0 (17%)

Note: AAAQS (Alaska Ambient Air Quality Standards); BT1 (Bear Tooth drill site 1); CO (carbon monoxide); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); $\mu g/m^3$ (micrograms per cubic meter).

[a] Total concentration in micrograms per cubic meter (percentage of ambient air quality standards).

[b] There are no NAAQS for SO_2 24-hour and annual averaging times.

Table 3.3.13. Routine Operations Activity Hazardous Air Pollutants Impacts – Alternative C

Pollutant	Max 1-hour in Analysis Area ($\mu g/m^3$)	Acute Reference Level Exposure ($\mu g/m^3$)	Max 8-Hour in Analysis Area ($\mu g/m^3$)	Acute Exposure Guideline Level ($\mu g/m^3$)	Max Annual in Analysis Area ($\mu g/m^3$)	Reference Concentration ($\mu g/m^3$)	Cancer Risk at Nuiqsut
Benzene	8.7	27.0	5.9	29,000	0.2	30.0	3.45×10^{-9}
Ethylbenzene	226.8	140,000	152.5	140,000	4.8	1,000	4.27×10^{-9}
Formaldehyde	1.4	55.0	0.8	1,100	0.0	9.8	2.12×10^{-9}
n-hexane	553.3	10,000,000	372.0	10,000,000	11.6	700	NA
Toluene	25.3	37,000	17.0	250,000	0.5	5,000	NA
Xylene	446.8	22,000	300.4	560,000	9.4	100.0	NA
Total cancer risk	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**9.8×10^{-9}**

Note: max (maximum); NA (not applicable); $\mu g/m^3$ (micrograms per cubic meter).

Table 3.3.14. Ambient Air Quality Standards Impacts (and Percentage of Ambient Air Quality Standards) – Alternative D

Pollutant	Averaging Period	NAAQS/AAAQS (µg/m³)	Construction Activity Domain Maximum[a]	Construction Activity Nuiqsut[a]	Developmental Drilling Activity Domain Maximum[a]	Developmental Drilling Activity Nuiqsut[a]	Routine Operations Domain Maximum[a]	Routine Operations Nuiqsut[a]
CO	1 hour	40,000	1,824.8 (5%)	1,342.0 (3%)	2,832.2 (7%)	1,327.2 (3%)	2,832.2 (7%)	1,326.4 (3%)
CO	8 hours	10,000	1,686.8 (17%)	1,311.9 (13%)	1,896.4 (19%)	1,305.6 (13%)	1,862.7 (19%)	1,304.4 (13%)
NO_2	1 hour	188	133.3 (71%)	47.4 (25%)	174.6 (93%)	30.1 (16%)	161.7 (86%)	33.6 (18%)
NO_2	Annual	100	18.8 (19%)	3.6 (4%)	26.8 (27%)	3.3 (3%)	25.3 (25%)	3.3 (3%)
SO_2	1 hour	196	10.5 (5%)	7.6 (4%)	24.9 (13%)	7.8 (4%)	24.8 (13%)	7.8 (4%)
SO_2	3 hours	1,300	14.3 (1%)	9.5 (1%)	24.7 (2%)	9.6 (1%)	24.2 (2%)	9.6 (1%)
SO_2	24 hours	365[b]	10.1 (3%)	9.0 (2%)	21.1 (6%)	9.0 (2%)	20.7 (6%)	9.0 (2%)
SO_2	Annual	80[b]	2.5 (3%)	2.4 (3%)	3.3 (4%)	2.4 (3%)	3.2 (4%)	2.4 (3%)
PM_{10}	24 hours	150	122.8 (82%)	11.0 (7%)	96.6 (64%)	11.4 (8%)	93.9 (63%)	11.4 (8%)
$PM_{2.5}$	24 hours	35	16.9 (48%)	8.5 (24%)	28.8 (82%)	8.4 (24%)	26.3 (75%)	8.3 (24%)
$PM_{2.5}$	Annual	12	4.3 (36%)	2.0 (17%)	7.1 (59%)	2.0 (17%)	5.8 (49%)	2.0 (17%)

Note: AAAQS (Alaska Ambient Air Quality Standards); CO (carbon monoxide); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); µg/m³ (micrograms per cubic meter).
[a] Total concentration in micrograms per cubic meter (percentage of ambient air quality standards).
[b] There are no NAAQS for SO_2 24-hour and annual averaging times.

Table 3.3.15. Routine Operations Activity Hazardous Air Pollutants Impacts – Alternative D

Pollutant	Max 1-hour in Analysis Area (µg/m³)	Acute Reference Exposure Level (µg/m³)	Max 8-hour in Analysis Area (µg/m³)	Acute Exposure Guideline Level (µg/m³)	Max Annual in Analysis Area (µg/m³)	Reference Concentration (µg/m³)	Cancer Risk at Nuiqsut
Benzene	8.8	27.0	5.9	29,000	0.2	30.0	3.35×10^{-9}
Ethylbenzene	232.3	140,000	155.4	140,000	5.0	1,000	4.26×10^{-9}
Formaldehyde	1.4	55.0	0.8	1,100	0.0	9.8	2.07×10^{-9}
n-hexane	566.7	10,000,000	379.1	10,000,000	12.1	700	NA
Toluene	25.9	37,000	17.3	250,000	0.6	5,000	NA
Xylene	457.7	22,000	306.2	560,000	9.8	100.0	NA
Total cancer risk	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**9.7×10^{-9}**

Note: max (maximum); NA (not applicable); µg/m³ (micrograms per cubic meter).

3.3.2.4.5 Module Delivery Options

Option 1 (Atigaru Point Module Transfer Island), Option 2 (Point Lonely Module Transfer Island), or Option 3 (Colville River Crossing) could be selected by BLM and paired with an action alternative to support module delivery. Air emissions from Option 1, Option 2, and Option 3 are included in the Project emissions shown in Tables 3.3.5, 3.3.6, and 3.3.7, respectively. CAP and HAP emissions from Option 2 are roughly twice those of Option 1 (Appendix E.3B, Attachment D). Thus, CAP impacts were modeled for Option 2 and are discussed in the AQTSD (Appendix E.3B, Attachment D). Option 3 was also modeled explicitly to analyze impacts from sealift barge delivery without an MTI. A summary of the maximum cumulative CAP impacts under Option 2 is shown in Table 3.3.16. A summary of the maximum cumulative CAP impacts under Option 3 is shown in Table 3.3.17. Impacts would be below all AAQS for Option 2 and Option 3. Impacts from Option 1 would therefore also be below all AAQS because emissions are much lower than Option 2, as discussed above. Modeled impacts diminish rapidly with distance from both the MTI and Oliktok Dock and are negligible 25 km (16 miles) away. Impacts for HAPs were not directly modeled for the module delivery options because HAP emissions (and thus impacts) from these activities would be substantially lower than the routine operations scenario due to the Project in all action alternatives that were modeled and found to be lower than relevant thresholds, as discussed in Section 3.3.2.4, *Near-Field Air Quality Modeling Results*.

Table 3.3.16. Ambient Air Quality Standards Impacts (and Percentage of Ambient Air Quality Standards) – Option 2: Point Lonely Module Transfer Island Operations Activity

Pollutant	Averaging Period	NAAQS/AAAQS ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$), % of AAQS
CO	1 hour	40,000	1,770.7 (4%)
CO	8 hours	10,000	1,403.5 (14%)
NO_2	1 hour	188	138.6 (74%)
NO_2	Annual	100	3.8 (4%)
SO_2	1 hour	196	8.4 (4%)
SO_2	3 hours	1,300	10.1 (1%)
SO_2	24 hours	365[a]	9.1 (2%)
SO_2	Annual	80[a]	2.4 (3%)
PM_{10}	24 hours	150	25.1 (17%)
$PM_{2.5}$	24 hours	35	9.9 (28%)
$PM_{2.5}$	Annual	12	2.0 (17%)

Note: AAQS (ambient air quality standards); AAAQS (Alaska Ambient Air Quality Standards); CO (carbon monoxide); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); $\mu g/m^3$ (micrograms per cubic meter).
[a] There are no NAAQS for SO_2 24-hour and annual averaging times.

Table 3.3.17. Ambient Air Quality Standards Impacts (and Percentage of Ambient Air Quality Standards) – Option 3: Colville River Crossing

Pollutant	Averaging Period	NAAQS/AAAQS ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$), % of AAQS
CO	1 hour	40,000	1,552.3 (4%)
CO	8 hours	10,000	1,414.3 (14%)
NO_2	1 hour	188	121.8 (65%)
NO_2	Annual	100	6.5 (6%)
SO_2	1 hour	196	8.3 (4%)
SO_2	3 hours	1,300	10.1 (1%)
SO_2	24 hours	365[a]	9.3 (3%)
SO_2	Annual	80[a]	2.5 (3%)
PM_{10}	24 hours	150	63.4 (42%)
$PM_{2.5}$	24 hours	35	14.0 (40%)
$PM_{2.5}$	Annual	12	2.3 (19%)

Note: AAQS (ambient air quality standards); AAAQS (Alaska Ambient Air Quality Standards); CO (carbon monoxide); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen dioxide); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); $\mu g/m^3$ (micrograms per cubic meter).
[a] There are no NAAQS for SO_2 24-hour and annual averaging times.

3.3.2.5 Regional Air Modeling Results

The following sections provide an overview of the far-field (regional) modeling results by alternative. Far-field modeling was performed using Project emissions inventories developed for Alternatives B, C, and D, as described in the Draft EIS (Appendix E.3B, *Air Quality Technical Support Document*, Section 2.1, *Willow Alternatives Emissions Inventories*). This was not remodeled using the emissions inventories developed for the Final EIS, the reasons for which are described in Section 3.3.2.3.2, *Regional (Far-Field) Air Impact Assessment Summary*. The AQTSD (Appendix E.3B) provides additional detail on the model configuration and assessment methods in Chapter 4 and regional air quality impacts are quantified and discussed in Chapter 5.

3.3.2.5.1 Alternative A: No Action

No Project emissions would occur under the No Action Alternative. However, existing oil and gas exploration and development, as well as air, ground, and marine traffic, and other regional sources would continue to contribute air emissions.

3.3.2.5.2 Alternative B: Proponent's Project

The modeling results show the Project and cumulative regional impacts for all pollutants would be well below the AAQS, with very small contributions from the Project to regional cumulative air quality concentrations, except in the immediate vicinity of the Project. The CAP impacts relative to the AAQS are quantified and discussed in detail in Chapter 5 of the AQTSD (Appendix E.3B).

The maximum Project increments for all pollutants analyzed (NO_2, PM_{10}, $PM_{2.5}$, and SO_2) throughout the modeling domain and at the three assessment areas would be well below the PSD increments (Appendix E.3B, Chapter 5). Overall, the PSD increments indicate the Project impacts would be very small and unlikely to deteriorate air quality values at the three assessment areas.

The nitrogen and sulfur deposition impacts from the Project would be below the DATs (Appendix E.3B; Chapter 5). The cumulative nitrogen deposition would be below or within the critical load range at all three assessment areas.

The Project impacts on visibility, when compared to natural background conditions, indicate that the visibility impacts would be small and Alternative B would not contribute to or cause visibility impairment in the three assessment areas. The visibility impacts for Alternative B are quantified and discussed in detail in Chapter 5 of the AQTSD (Appendix E.3B).

3.3.2.5.3 Alternative C: Disconnected Infield Roads

As with Alternative B, the Project and cumulative impacts for all pollutants would be well below the AAQS, with negligible contributions from the Project to the cumulative air quality concentrations, except in the immediate vicinity of the Project. Each of the CAP impacts relative to the AAQS are quantified and discussed in detail in Chapter 5 of the AQTSD (Appendix E.3B).

The Alternative C maximum Project increments for all pollutants analyzed (NO_2, PM_{10}, $PM_{2.5}$, and SO_2) would be well below the PSD increments in the analysis area and three assessment areas (Appendix E.3B; Chapter 5). Overall, the PSD increments indicate that the Project impacts would be very small and unlikely to deteriorate the air quality values in the three assessment areas.

The nitrogen and sulfur deposition impacts from the Project would be below the DATs (Appendix E.3B; Chapter 5). The nitrogen deposition cumulative impacts would be below or within the critical load range at all three assessment areas.

The analysis of the visibility effects from Alternative C at the three assessment areas would be similar to those of Alternative B. The Project impacts on visibility when compared to natural background conditions indicate that the visibility impacts would be small and Alternative C would not contribute to or cause visibility impairment in the three assessment areas. The regional air impacts of Alternative C are quantified and discussed in detail in Chapter 5 of the AQTSD (Appendix E.3B).

3.3.2.5.4 Alternative D: Disconnected Access

Alternative D was not assessed with the regional model because its CAP emissions (and therefore regional air quality impacts) would be typically lower than Alternative C and higher than Alternative B, or lower than both

Alternative B and C in the case of PM_{10}. Therefore, all CAPs would be below the AAQS under Alternative D. The Project impacts related to PSD increments for Alternative D would be higher than Alternative B but lower than Alternative C, or lower than both alternatives in the case of PM_{10}. The Project impacts would be below the PSD increment thresholds for all CAPs in all three assessment areas. Visibility impacts would be between those for Alternatives B and C and would be well below the 0.5-dv threshold based on the emissions, so Alternative D would not contribute to or cause visibility impairment in the three assessment areas. Nitrogen deposition for Alternative D is anticipated to be lower than Alternative C and higher than Alternative B based on the projected emissions. Sulfur deposition for Alternative D would be similar to the other action alternatives. The Project-specific nitrogen and sulfur deposition under Alternative D would be below the DATs and the cumulative nitrogen deposition would be below or within the critical loads for nitrogen deposition.

3.3.2.5.5 Module Delivery Options

The module delivery options were not included in the regional modeling; the regional air impacts of the module delivery in all three options would be small because the near-field modeling showed impacts that were all below the AAQS within approximately 25 km (16 miles) of the module delivery sites. Impacts to air quality and AQRVs at the three assessment areas would be even lower because those areas are over 100 miles away from the module delivery option locations.

3.3.2.6 Oil Spills and Accidental Releases

Although oil spills and other accidental releases are not a planned activity, there are potential risks related to air emissions should a spill or accidental release occur. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste or hazardous materials (e.g., diesel, gasoline, other chemicals) during all Project phases would likely be contained on gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would potentially result in VOC emissions from the spill itself as well as NOx, SO_2, and PM emissions associated with equipment used for containment, transportation, and cleanup (including burning); thus, they would contribute incrementally to increased air concentrations of VOCs, NO_2, SO_2, $PM_{2.5}$, PM_{10}, and HAPs.

3.3.3 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Although Project air emissions would occur, with the BMPs and other measures listed in Section 3.3.2.1, *Avoidance, Minimization, and Mitigation*, in place, the Project would meet all air quality standards. Project emissions and their impacts on air quality and air quality related values are unavoidable and irretrievable throughout the life of the Project. At the end of the Project's life, emissions would cease, and thus impacts on air quality and air quality related values would not be irreversible.

3.4 Soils, Permafrost, and Gravel Resources

The analysis area for soils, permafrost, and gravel resources is the area within 328 feet (100 m) of proposed ground disturbances and ice infrastructure during construction or operations (Figure 3.4.1). This area represents the extent of potential direct and indirect affects to soils, permafrost, and gravel resources resulting from the Project. In the Arctic, permafrost is sensitive to disturbance and thaw induced by changes to vegetation cover or soils from the alteration of drainage patterns, soil pH, albedo, or changes in snow cover, all of which can decrease the thickness of permafrost for decades (Jorgenson, Ver Hoef et al. 2010). Consequently, the temporal scale for impacts to permafrost could be finite (decades) or permanent.

3.4.1 Affected Environment

The analysis area is located in the Arctic Coastal Plain (ACP) physiographic subprovince. The ACP soils are composed of poorly drained, unconsolidated sediments transected by fluvial deposits of rivers and streams flowing northward from the foothills to the south (Wahrhaftig 1965). The fine-grained, unconsolidated sediments typically consist of **eolian** (windblown) deposits and are normally frozen with a high ice content and are about 100 feet thick. Alluvial and fluvial deposits, including active, braided channels, terraces, and deltaic deposits, bisect the eolian sand deposits (Jorgenson, Kanevskiy et al. 2015).

The entire analysis area is underlain by continuous permafrost to depths between 650 to 2,130 feet (SNAP 2019). Permafrost is ground that has been frozen for two or more consecutive years and is created by freezing temperatures maintaining water in a solid state (i.e., ice) (Jorgenson, Kanevskiy et al. 2015); the active layer (the top layer of ground subject to annual thawing and freezing) is generally between 1 and 4 feet thick (SNAP 2019). Active layer thickness can vary from year to year and depends on such factors as ambient air temperature, aspect, gradient, vegetation, drainage, snow cover, water content, and soil type. Long-term permafrost temperature monitoring shows a warming trend over the past 25 years, with the greatest warming near the coast. Available climate data indicates warming trends in soils across the ACP with a 0.15 degree Celsius increase per year approximately one meter below the ground surface (Urban and Clow 2018; Wang, Jafarov et al. 2018). Polygonal, patterned ground (created when ice wedges form in the upper few feet of the ground surface) is indicative of ice-rich soils and is a common surface feature in the analysis area, especially in lowlands; polygons may be less apparent in drained upland areas, where vegetation can mask these surface features (Rawlinson 1993).

Gravel resources in the analysis area west of the Colville River occur near the Ublutuoch (Tiŋmiaqsiuġvik) River, where a new Project mine site is proposed. Gravel resources are relatively scarce in the NPR-A, especially west and north of the Colville River (BLM 2012b). The southern portion of the NPR-A contains more abundant sand and gravel resources. The source of these sediments is the Brooks Range, from which the wind- and water-transported materials were originally eroded. However, as one moves north away from the Brooks Range sediment sources, the materials become finer grained and thus less suitable for use as construction materials. Coarser grained sediments (including gravel) are typically found along the larger rivers in the southern NPR-A (BLM 2012b). The Clover mine site is a BLM-approved 65-acre undeveloped gravel source within the NPR-A (BLM 2004b), Figure 3.4.1. The only existing or previously used sand and gravel sites within the NPR-A are located around villages.

East of the Colville River, there are several existing mine sites, such as Mine Sites E and C in Kuparuk (proposed for use in Option 3).

There is little existing infrastructure in the analysis area, although ice and snow infrastructure occur across the North Slope. Past and present actions in the broader Project area are described in Section 3.1.1, *Past and Present Actions*. Climate change is occurring on the ACP, as described in Section 3.2, *Climate and Climate Change*. Increasing air temperatures (summer and winter) are likely leading to a deepening of the active layer and degradation of permafrost, which may result in changes in vegetation communities and could affect soils in the region given that vegetation plays a major role in the chemical properties and weathering of soil (Ping, Bockheim et al. 1998).

3.4.2 Environmental Consequences

3.4.2.1 Avoidance, Minimization, and Mitigation

3.4.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.4.1 summarizes existing NPR-A IAP LSs and BMPs that apply to Project actions on BLM-managed lands and are intended to mitigate impacts to soil, permafrost, and gravel resources from development activity (BLM 2013a). The LSs and BMPs would reduce the development footprint size and impacts related to soil compaction, permafrost, soil hydrology, fugitive dust and prohibit activities associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.4.1 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to soils, permafrost, and gravel resources. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.4.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.4.1. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Soils, Permafrost, and Gravel Resources

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-2	Minimize impacts on the environment from nonhazardous and hazardous waste generation.	Prepare and implement a comprehensive waste management plan for all phases of development.	Changes do not affect text as described.
BMP A-3	Minimize pollution through effective hazardous materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before the transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on the environment, including wetlands and marshes, as a result of fuel, crude oil, and other liquid chemical spills.	Develop a comprehensive spill prevention, control, and countermeasure plan.	Develop a comprehensive spill prevention, control, and countermeasure plan, if oil storage capacity is 1,320 gallons or greater.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4 feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.	The withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during winter and the withdrawal of water from lakes during summer may be authorized on a site-specific basis, depending on water volume and depth, the fish community, and connectivity to other lakes or streams.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize the compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	Added text: – Specifications given for when ground operations would only be allowed when frost and snow cover are at a sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the National Petroleum Reserve in Alaska. – Snow survey and soil freeze-down data collected for ice road or snow trail planning and monitoring shall be submitted to the BLM. – Avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. Ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-5	Minimize the impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Changes do not affect text as described.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure the free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural streamflow.	Added text: – Stream and marsh crossings will be designed on at least 1 year of relevant hydrologic data. Additional years of hydrologic data collection may be required by the BLM if more information is needed to design the crossing structure in order to attain the BMP. – The crossing structure design shall account for permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment. – Snow survey and soil freeze-down data collected for ice road or snow trail planning and monitoring shall be submitted to the BLM. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. Ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the BLM and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.	Added text: – The plan shall consider locations outside the active floodplain or design gravel mine sites within active floodplains to serve as water reservoirs, if environmentally beneficial. – Incorporate as much as practicable the storage and reuse of sod or overburden for the mine site or at other disturbed sites on the North Slope. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on the streamflow, fish, turbidity, and integrity of the river bluffs, if present. – Mine pit design and methods shall be engineered to minimize permafrost regime disturbance and protect surface stability. – Geotechnical data collected for materials source reconnaissance (gravel exploration) shall be submitted to BLM.
LS G-1	Ensure the long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.	Changes do not affect text as described. See ROP M-5 for additional requirements to reduce areas of bare soil.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-1[a]	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality and the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas.	Permanent oil and gas facilities are prohibited in the streambed and adjacent to the rivers listed, at the distances identified. Rivers in the Project area that are listed include the Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and the Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	No surface occupancy or new infrastructure, except essential road and pipeline crossings in the following setbacks: Colville River (2- to 5-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). Gravel mines may be located within the active floodplain, consistent with BMP E-8.
LS/ BMP K-2 [a]	(Deepwater Lakes) Minimize the disruption of natural flow patterns and changes to water quality as well as the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes.	Permanent oil and gas facilities are prohibited on the lake or lakebed and within .25 mile of ordinary high water.	Changes do not affect text as described.
BMP L-1	Protect stream banks and water quality; minimize the compaction and displacement of soils; and minimize the breakage, abrasion, compaction, or displacement of vegetation.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.
ROP M-5	Minimize bare soil Reduce areas of bare soil that can contribute to dust emission to protect human health and subsistence resources.	No similar requirement.	Alternatives B, C, and D: permittees will use appropriate measures to control dust (e.g. dust palliatives and watering), as outlined in dust control plans submitted to ADEC pursuant to 18 AAC 50.045(d). All action alternatives: areas of bare soil resulting from operations will be revegetated with native species within 48 months of abandonment, unless otherwise specified in the abandonment and reclamation plan.

Source: BLM 2013a, 2020a

Note: BLM (Bureau of Land Management); BMP (best management practice); F (Fahrenheit); IAP (Integrated Activity Plan); LS (lease stipulation); ROP (required operating procedure).

[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect soil, permafrost, and gravel resources would include those to BMPs K-1 and K-2. All action alternatives include road and pipeline crossings of waterbodies (including one or more of the waterbodies protected in BMP K-1), a CFWR connected to Lake M0015, and freshwater intake pipelines at Lakes L9911 and/or M0235 (varies by alternative), previously identified deepwater lakes protected by BMP K-2 (Figure 3.10.2 in Section 3.10, *Fish*). As a result, some effects to soils in these locations may be unavoidable.

3.4.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.4.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

The following additional, suggested mitigation measures could reduce impacts to frozen soils, as related to the design of embankments and roads:

1. Separate native soils from Project fill using geotextiles or fabrics
2. Use thick embankments and shallow slopes
3. Monitor thermokarsting, the depth of the active layer, and the compression of soil and vegetation in the annual resupply ice road footprint, for footprints that are used consecutively each year

3.4.2.2 Alternative A: No Action

Under the No Action Alternative, no direct or indirect impacts to soils, permafrost, or gravel resources would occur; however, exploration for resources, including gravel and hydrocarbons, would continue in the area.

3.4.2.3 Alternative B: Proponent's Project

3.4.2.3.1 Thawing and Thermokarsting

Degradation of permafrost can be affected by ice content, soil or vegetation removal, and ground disturbances, with ice-rich and thaw-unstable soils and hillsides being the most sensitive to thawing (ADNR 2018). Thawing, ice-rich, permafrost soils create thermokarst features (periglacial topography resembling karst due to the selective melting of permafrost) that transform the landscape by subsidence, erosion, and changes in drainages, including channelization and ponding (USFWS 2015b). Changes in landforms due to erosion and thermokarst, such as slumping and channelization, affect the vegetation and water characteristics of the area (USFWS 2015b).

Placement of gravel fill can cause heat transfer to underlying soils beneath pads, which could cause thermokarst development and thaw settlement. Gravel pads would be a minimum of 5 feet thick to maintain a stable thermal regime and to protect underlying permafrost. The average pad thickness would be 7 feet (details provided in Appendix D.1). Thermosiphons would be installed in specified areas (e.g., near well house shelters and on maintenance shop or warehousing facilities that are at grade) based on North Slope industry standard best engineering practices to protect the permafrost and prevent subsidence.

Placement of gravel fill can also change surface drainage and cause permafrost thawing, subsidence, and the accumulation of water. Project pads would be sited and oriented to minimize wind-drifted snow accumulations and alleviate ponding. Gravel fill would cover soils and kill existing vegetation, altering the thermal active layer indefinitely (USACE 2018, pg. 3-54). Alternative B would fill 454.1 acres with gravel infrastructure using 4,921,200 cy of gravel (Table 3.4.2).

Use of gravel infrastructure by vehicles and aircraft would create dust that would settle onto surrounding vegetation and snow. This could increase soil alkalinity, decrease albedo, increase thermal conductivity, promote earlier spring thaw than in surrounding areas, and lead to ground subsidence from the melting of ice-rich sediments (Everett 1980; Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987). Where road dust increases soil alkalinity, it can reduce plant vigor in acidic tundra (Walker and Everett 1987). The majority of soils in the Project area have a pH between 5.5 and 7.4 (Raynolds, Walker et al. 2006); thus, the impacts may be less compared with other areas of the ACP that have more acidic tundra, which is more vulnerable to dust disturbance (Auerbach, Walker et al. 1997). Road dust has the greatest impact within 35 feet of a road because this is where a majority of the dust is deposited, but it can have impacts up to 328 feet (100 m) of a road's surface (Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987). Impacts may occur at greater distances, but the intensity of the impact decreases with the distance from the road. Where dust deposition leads to the melting of massive ice wedges, thermokarsting can occur. The melted ice wedges typically form flooded low spots, which exacerbate and spread the melting. This leads to the melt area extending laterally from the road and may lead to melting beyond the area immediately adjacent to the road (Walker, Raynolds et al. 2014). Under Alternative B, 3,351.9 acres of **dust shadow** would be created, including at the Tiŋmiaqsiuġvik Mine Site.

During winter, the deposition of airborne dust reduces the albedo of roadside snow, which initiates earlier melting in spring and increases cumulative heat absorption of the active layer, creating a deeper active layer and making the permafrost more prone to thermal erosion (NRC 2003; Walker and Everett 1987).

Ice roads and pads would compact vegetation and organic soil layers, which could reduce the insulating properties and increase the potential for thermokarsting (Jorgenson, Ver Hoef et al. 2010; USFWS 2014). The magnitude of impacts would depend on the type of vegetation affected, the snow depth, and the depth of the active layer.

Properly constructed and maintained ice roads and pads built for a single season would have minimal impacts to soils and permafrost; however, when ice roads are constructed in the same footprint in consecutive years, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Use of seasonal ice infrastructure during construction would reduce the need for gravel infrastructure, which has a greater impact on soils and permafrost. Alternative B would create 4,557.3 acres of ice infrastructure during construction.

Soils and vegetation can also be compressed by off-road travel, which can cause changes and disturbance to the insulating surface vegetation layer and result in increased active layer thickness, thawing of the permafrost, and development of thermokarst structures. Thermokarsts change the surface topography by increasing water accumulation, changing the surface water drainage patterns, and increasing the potential for soil erosion and sedimentation (BLM 2018a, 252; Jorgenson, Ver Hoef et al. 2010). These effects could occur in the footprint of off-road travel. Details on vegetation damage from off-road travel, including the duration of vegetation recovery, are in Section 3.9, *Wetlands and Vegetation*.

Pipeline VSMs could introduce heat and displace and disturb soils around the VSM. Heat from auguring VSMs would likely dissipate within 1 week; heat gain through the VSM itself would be nominal if designed appropriately. VSM installation would occur from temporary ice infrastructure; no residual or indirect impacts would be expected from the sidecasting of cuttings because they would be removed from the ice pad and would not be allowed to reach the ground surface.

Piles driven for bridge abutments would be installed from ice infrastructure and would have minimal surficial disturbance and displacement of soil and permafrost outside the diameter of the pile.

Installation of culverts for stream crossings would change the airflow and thermal dynamics of the soils where culverts are placed. As culverts allow for air flow below road embankments, a deeper active layer would form below the exposed culvert than where the road or pad embankment is placed. If enough thaw is introduced at the culvert crossing, settlement may occur at that location. Conversely, if the soils thaw, heaving may occur; seasonal and differential movement may cause the failure of the culvert and road embankment. Alternative B would install approximately 195 cross-drainage culverts and 11 culvert batteries.

Well casings from production and injection wells would transfer heat to the surrounding soils and could change the thermal regime of the permafrost and create areas of deep thaw. Heat transfer could also occur from warm production fluids (subsurface injections of water, drilling waste, or miscible-injectant), which can create areas of deep thaw or changes in the thermal regime. Approximately 50 boreholes per drill pad are anticipated; vertical settlement of thawed soils can occur and cause instability of the pad. Effects would likely occur in a 20- to 30-foot radius around the borehole. Thaw around the boreholes could continue to widen in radius during operation of the well and would refreeze several years after operations cease (Kutasov 2006).

The Colville River HDD crossing would be bored below the river and would have entry and exit locations set back at least 300 feet from the riverbanks. The HDD pipeline crossing would be approximately 70 feet below the center of the river channel and a bentonite slurry would be used to flush drill cuttings and to hold the hole open. While the majority of the HDD pipeline would be buried below the riverbed, surficial impacts similar to those at culvert crossings may occur at the pipeline entry and exit locations, such as thaw settlement and ponding where soils and vegetation are disturbed.

Approximately 149.7 acres would be excavated for the gravel mine site and the CFWR, which would disturb frozen soils and change thermal conditions at the mine and CFWR sites. This can impact groundwater characteristics immediately adjacent to the excavation and change the movement of groundwater through soils. Material will be excavated from the gravel mine and the CFWR during winter while soils are frozen; however, as the rate of gravel extraction slows or ends at the end of a mining season, the **taliks** and water bearing zones would be reestablished as the pit fills with water to create a pond or lake and the soils of the pit walls are exposed to surface temperatures and allowed to thaw. Seasonal mine dewatering during mining (years 1 through 3) would cause changes in the thermal regime because the ponded water in the pit would create **thaw bulbs**, or taliks. The geographic and temporal extents of thaw would vary depending on the depth and size of the pond and local soil conditions. Installation of soil berms around the perimeter of the mine site and the CFWR would help maintain the thermal regime of frozen soils adjacent to the excavation. The berms would act as insulation and cause the active layer to rise into the berm, thereby protecting the frozen soils below (near the crest of the pit) (Andersland and Ladanyi 2003)).

Several thermal and erosional factors contribute to slope instability, and various methods can be used to limit or reduce slope movement within cuts made in ice-rich soils. These methods include soil retention structures, protective surface coverings, moderate to flat cut slopes (1.5:1 to 3:1) (Andersland and Ladanyi 2003, Chapter 8.5). The 3:1 side slopes of the mine pit would help reduce the thermal impact of impounded water and stabilize slopes (Andersland and Ladanyi 2003, Chapter 9.5); the thawing of lower angle slopes will result primarily in soil settlement with little or no lateral movement (Andersland and Ladanyi 2003, Chapter 8.5).

Stockpiles of overburden material associated with gravel mining would be stored on ice pads prior to construction and returned to the excavated mine pit prior to spring breakup. No effects to soils or permafrost are expected from stockpiled material.

The *Willow Mine Site Mining and Reclamation Plan* (including reclamation activities) has been coordinated with agencies and is provided as Appendix D.2 (*Willow Mine Site Mining and Reclamation Plan*). Upon closure, the mine site would slowly fill with surface water from precipitation and snowmelt, which would accelerate permafrost thaw. Water impounded in a flooded pit would likely remain unfrozen indefinitely near the bottom, creating a thaw bulb around and beneath the pit, which may cause the excavation walls to slough and deposit material into the pit (BLM 2018a, 250). After approximately 10 years, the pit would be full and could crest the banks of the pit during periods of high sheet flow (expected only at spring runoff). Each mine cell would have a low point in the mine perimeter berm (see Figure 3 in Appendix D.2) that would allow drainage from the pit at high water. Although the mine site would not be connected to adjacent streams, water from the pit could flow over the tundra to the Ublutuoch (Tiŋmiaqsiuġvik) River during spring breakup. Such maximum flows would occur once per year during spring breakup; significant releases are not expected during other times of the year. Summer releases would be infrequent or insignificant due to low summer precipitation on the North Slope. Seasonal flow over or inundation of the tundra could cause the thawing of soils and thermokarsting below the flow path.

At the CFWR, the presence of water in the pond would disturb frozen soils; in addition, as the soils of the CFWR walls are exposed to surface temperatures and water, they would likely thaw; thus, the thermal regime of the area immediately adjacent to the disturbed ground soils and vegetation may change. The walls of the CFWR would have 6:1 side slopes, which would be flatter than the slope criteria described in Andersland and Ladanyi (2003) to limit or reduce slope movement, generally flatter slopes are more stable. The 6:1 slopes would also help to reduce the lateral extents of thaw beyond the boundary of the CFRW by drawing thaw bulb, or talik, further into the lake. The CFWR is designed similar to Lake K2014 at CPF2 in Kuparuk. Although there has been no formal monitoring of the thaw bulb or shoreline at Lake K2014, there have been no observations or operational issues regarding stability of the lakeshore or the reservoir that have arisen since the reservoir was constructed.

Excavated material from the CFWR would be placed around the CFWR as a 7-foot-tall berm. Gravel would be placed on top of the berm to provide a driving surface. Placement of fill can change surface drainage and cause permafrost thawing near the toes of the berm slopes, subsidence, and the accumulation of water, as described above regarding placement of fill for roads and pads. Fill would cover soils and kill existing vegetation, altering the thermal active layer indefinitely (USACE 2018, pg. 3-54).

3.4.2.3.2 Gravel Resource Depletion

Little information is available regarding the extent of gravel resources throughout the NPR-A. Some gravel exploration has occurred in the northeastern portion of the NPR-A and known gravel sources do exist, such as the approved (but not yet permitted or developed) Clover Mine Site. The Project would permanently decrease gravel sources near the Ublutuoch (Tiŋmiaqsiuġvik) River and further reduce the availability of gravel resources at Kuparuk Mine Sites C and E.

Table 3.4.2. Impacts to Soils, Permafrost, and Gravel Resources by Action Alternative and Module Delivery Option

Component	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 2: Colville River Crossing
Acres of gravel fill	454.1	507.6	444.3	12.8[a]	13.0[a]	5.0
Volume of gravel fill (cubic yards)	4,921,200	5,822,200	5,908,200	397,000	446,000	118,700

Component	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 2: Colville River Crossing
Acres of excavation (mine site and CFWR)	166.0	166.0	166.0	0	0	0
Acres of dust shadow[b]	3,351.9	3,348.4	2,560.3	0	0	27.5
Acres of freshwater ice infrastructure	4,557.3	5,608.0	7,164.8	859.6	1,756.1	666.6
Number of culvert batteries	11	10	8	NA	NA	NA
Number of cross-drainage culverts	195	186	143	NA	NA	NA
Number of VSMs	13,000	13,000	13,700	0	0	0

Note: CFWR (constructed freshwater reservoir); NA (not applicable); VSMs (vertical support members).
[a] Fill for module transfer islands is in the marine area and would not affect permafrost.
[b] Area potentially altered by dust generated from vehicles or wind on gravel fill extending 328 feet (100 meters) from gravel infrastructure; Alternatives B, C, and D include full mine site development.

3.4.2.4 Alternative C: Disconnected Infield Roads

Impacts to soils, permafrost, and gravel resources under Alternative C would be the same as identified under Alternative B, with the following differences: Alternative C would require 53.5 more acres of gravel fill (507.6 total acres), 901,000 more cy of gravel, 1,050.7 more acres of ice infrastructure (that would have a longer duration since it would occur seasonally throughout operations), 9 fewer cross-drainage culverts, and 1 less culvert battery. It would also have 3.5 less acres of dust shadow (Table 3.4.2). The annual ice road (3.6 miles) that would be required for Alternative C could be constructed in the same footprint in consecutive years throughout the life of the Project, which would result in more compaction and thawing of soils. For these types of ice roads, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Thus, Alternative C would have incrementally more impacts to soils, permafrost, and gravel resources than Alternative B.

3.4.2.5 Alternative D: Disconnected Access

Impacts to soils, permafrost, and gravel resources under Alternative D would be the same as identified under Alternative B, with the following differences: Alternative D would require 9.8 less acres of gravel fill (444.3 total acres), 987,000 more cy of gravel, 2,607.5 more acres of ice infrastructure (that would have a longer duration because it would occur seasonally throughout operations), 52 fewer cross-drainage culverts, and 3 fewer culvert batteries (Table 3.4.2). (A larger fill volume is needed for Alternative D due to topography and depth of fill. Different alternatives require different pad thicknesses to achieve a level pad surface.) It would also have 791.6 fewer acres of dust shadow. The annual ice road (12.5 miles) that would be required for Alternative D could be constructed in the same footprint in consecutive years throughout the life of the Project, which would result in more compaction and thawing of soils. For these types of ice roads, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Overall, Alternative D would have slightly fewer impacts to soils, permafrost, and gravel resources than Alternative B.

3.4.2.6 Module Delivery Options

3.4.2.6.1 Module Delivery Option 1: Atigaru Point Module Transfer Island

Option 1 would require 397,000 cy of gravel fill from the Tiŋmiaqsiuġvik Mine Site (Table 3.4.2). Gravel extraction would change landforms and decrease gravel resources, as described under Alternative B, Section 3.4.2.3.1, *Thawing and Thermokarsting*. Option 1 would also require 859.6 acres of onshore ice infrastructure, which would compact soils and contribute to thaw and thermokarst, as described above for Alternative B.

3.4.2.6.2 Module Delivery Option 2: Point Lonely Module Transfer Island

Option 2 would require more gravel fill (446,000 cy) from the Tiŋmiaqsiuġvik Mine Site and more onshore ice infrastructure (1,771.1 acres) (Table 3.4.2). Both of these types of effects are described for Option 1 and Alternative B.

3.4.2.6.3 Module Delivery Option 3: Colville River Crossing

Option 3 would require 118,700 cy of gravel fill and 666.6 acres of onshore ice infrastructure. Option 3 would also add 5 acres of gravel fill onshore along existing Kuparuk roads and extend the dust shadow 27.5 acres beyond the existing dust shadow (Table 3.4.2). Effects of gravel fill on soils and permafrost are described under Alternative B, Section 3.4.2.3.1.

3.4.2.7 Oil Spills and Other Accidental Releases

The EIS addresses accidental spills that could occur from the Project. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste or hazardous materials (e.g., diesel, gasoline, other chemicals) during all Project phases would likely be contained on gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would not be expected to impact soils, permafrost, or gravel resources.

If a spill were to occur off a gravel pad or road, the likelihood and magnitude of the impact would be influenced not only by the spill's size but also by the season in which it occurs. If a spill were to occur during winter, the contaminant may not infiltrate into the substrate and cleanup would be possible by isolating the contaminant and removing the contaminated ice and snow for proper disposal. If a spill were to occur during summer, the contaminant may infiltrate through the active layer before encountering permafrost. In this scenario, all sediment and contaminated soil above the permafrost may need to be treated or removed and replaced with clean material, depending on the nature of the materials. In either case, the affected area would be limited to the area of the spilled contaminant and the response efforts. A spill occurring in a body of water would have a higher potential for migration and distribution of the contaminant.

Accidental releases of diesel or glycol would not likely migrate into frozen soils, but some substances that would not freeze, such as glycol, have the potential to affect the thermal properties of soils, resulting in thawing if released beyond gravel infrastructure. The greatest impacts to soil and permafrost resources from spills would be from cleanup activities, as these would likely require the excavation or disturbance of soils to remove the contamination.

Seawater spills on nonfrozen soil would have effects that could potentially last many years by killing plants, which would reduce their insulating properties. These types of spills could change the chemical composition of soils and the presence of saline conditions would depress the freezing temperature and cause soils to thaw at lower temperatures and potentially increase the likelihood of thermokarsting.

3.4.3 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Even with LSs, BMPs, and mitigation measures, some unavoidable impacts to soils would occur but may be reduced below a level that would be irreversible or that would result in long-term decreases in soil function in the analysis area. Soil impacts would be irretrievable during the life of the Project and until Project closure and reclamation is completed. If reclamation of permanent infrastructure did not occur, effects would be irreversible. Unavoidable impacts to permafrost would be irreversible, such as water impoundments at the gravel mine site and the CFWR because, because they would permanently change the thermal regime of the underlying soils.

3.5 Contaminated Sites

This chapter describes contaminated sites and spill locations and provides context to understand the likelihood of encountering existing contamination during Project construction and operations. Project handling of hazardous materials and management of hazardous wastes are described in Chapter 2.0. Unintentional releases of oil, produced water, and seawater are discussed in Chapter 4.0.

3.5.1 Affected Environment

Records of existing contaminated sites and spills within 0.5 mile of the Project were reviewed to identify the locations, characteristics, and quantities of existing contamination. The search results are summarized below and in Figure 3.5.1; results are detailed in Appendix E.5, *Contaminated Sites Technical Appendix*.

- The ADEC Contaminated Sites database (ADEC 2019a) identified 13 contaminated sites within 0.5 mile of potential Project elements. All sites have been categorized as cleanup complete and are located at Point Lonely and Oliktok Point, making them only applicable to module delivery options.
- The ADEC Statewide Oil and Hazardous Substance Spills Database (ADEC 2019c) did not identify any documented spills greater than 5 gallons within 0.5 mile of any potential Project elements.

- The BLM NPR-A *Legacy Wells Summary Report* (BLM 2013b) indicates one **legacy well** (West Fish Creek site) is within 0.5 mile of the ice road route for Option 1 (Atigaru Point Module Transfer Island). Because ice infrastructure would not be ground disturbing and because the site is classified as a low surface and subsurface risk, it is not discussed further in the EIS. (Low surface risk means that minor solid waste is present, no known contaminants are present, and there is minimal impact to visual resources; low subsurface risk means that the well penetrated oil or gas stratigraphy, but the producible oil and gas formations are isolated or diesel is present within the wellbore but is contained with no risk of release.)
- The EPA Superfund Enterprise Management System database (EPA 2019c) did not identify any Superfund sites within 0.5 mile of the Project.

3.5.2 Environmental Consequences

It is very unlikely that the Project would encounter existing contamination during Project construction or operations. The only known sites or spills are at Point Lonely, Oliktok Point, or along the Atigaru Point ice road route, all of which would only be used during construction and would not experience excavation.

3.5.2.1 Avoidance, Minimization, and Mitigation

3.5.2.1.1 Applicable Lease Stipulations and Best Management Practices

It is unlikely the Project would encounter existing contaminated sites during construction or operations; therefore, there are no NPR-A IAP LSs or BMPs that would apply.

3.5.2.1.2 Additional Suggested Avoidance, Minimization, or Mitigation

No additional measures are recommended to avoid or reduce the likelihood that the Project would encounter existing contamination.

3.5.3 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Since it is unlikely that the Project would encounter existing contamination sites during construction or operations, there would be no unavoidable adverse, irretrievable, and irreversible effects.

3.6 Noise

The analysis area for noise represents the maximum distance required for most noise levels generated during construction or operation to attenuate to ambient levels (Figure 3.6.1): 0.4 to 33.2 miles, depending on the activity. The analysis area also includes areas beyond 33.2 miles, where there would be very short-term or instantaneous noise events (i.e., **impulsive noise** such as blasting, pile driving) that are perceptible at greater distances than the longer term, more continuous **non-impulsive noise** sources. Specifically, this larger analysis area includes the community of Nuiqsut and surrounding subsistence areas. Impulsive noises are quantified separately in the analysis because their intensity, persistence, onset, and attenuation are different than other noise events. Because air traffic can be one of the loudest non-impulsive noise events for a North Slope project, the analysis area includes the typical flight paths for Willow air traffic. Because the Kuparuk area has a higher ambient noise level and existing daily air traffic, the effects analysis for Willow is focused on the area west of Mine Site F, which has a lower intensity of industrial activity and is the area where meaningful effects from noise could occur. The temporal scale for construction-related impacts is the duration of construction (7 to 9 years), after which construction equipment and activities would no longer produce noise. The temporal scale for drilling and operational impacts is the life of the Project, a period of approximately 25 years. Noise from industrial activities is a common concern for Nuiqsut residents that was noted during public scoping (Appendix B.1, *Scoping Process and Comment Summary*).

The EIS section focuses on human **noise-sensitive receptors** in the analysis area. The effects of noise on fish and wildlife are discussed in Sections 3.10 through 3.13.

3.6.1 Affected Environment

The acoustic environment is a composite of all noise sources, both natural (e.g., wildlife, wind, water) and human-made (e.g., traffic, construction, oil production, aircraft, hunting). Noise has the potential to affect people in the analysis area by interfering with activities such as sleeping or conversation, or by disrupting or diminishing one's quality of life. Table 3.6.1 provides examples of typical noise levels and human responses for context of how Project noise (described below) may be perceived by people.

As noted in Table 3.6.1, sound levels of 80 to 90 A-weighted decibels[10] (dBA) typically elicit annoyance. Annoyance describes a reaction to sound based on its physical nature as well as its emotional effect (Lamancusa 2000). Although subjective, annoyance is routinely used as a basis of evaluating environmental noise effects. The level of annoyance is affected by the persistence of the sound, whether it is impulsive versus steady, the frequency and magnitude of its fluctuation, and whether the receiver finds the sound to be pleasant or unpleasant. In general, annoyance increases with the persistence of the sound, its impulsivity, and more frequent and greater fluctuations.

Noise-sensitive receptors in the analysis area are the community of Nuiqsut and subsistence users. Section 3.16 describes **subsistence use areas**. The EIS does not analyze occupational noise exposure for oil field workers because it is regulated separately by the Occupational Safety and Health Administration.

Ambient sound levels around Nuiqsut and the lower Colville River, including the analysis area, were documented by Stinchcomb (2017) from June through August 2016 (a period of peak subsistence use) to quantify natural ambient sound and aircraft noise levels. Natural ambient sound levels ranged from 25 to 47 dBA, with a median level of 35 dBA. The median sound exposure level of aircraft ranged from 55 to 69 dBA (Stinchcomb 2017).

High winds are common in the analysis area. Wind is the primary natural noise source in Nuiqsut (BLM 2004a). The community of Nuiqsut and the Alpine and GMT oil field developments also contribute human-made noise (daily air and ground traffic) to the ambient soundscape in the analysis area. The analysis area also contains the ASRC Mine Site, which contributes impulsive and non-impulsive noise events during winter operations. The far eastern analysis area contains the Kuparuk oil field, which is larger and has more infrastructure (including more drilling and processing facilities), mine sites, dock facilities, and airstrips, and thus produces more ground and air traffic than the Alpine and GMT oil fields. Thus, the ambient soundscape in the eastern analysis area is likely higher than in the NPR-A

Table 3.6.1. Typical Noise Levels with Associated Human Perception or Response

Noise Source	Noise Level (dBA)	Human Perception or Response
Air raid siren	140	Painfully loud
Thunderclap	130	Painfully loud
Jet takeoff (200 feet)	120	Maximum vocal effort
Pile driver; rock concert	110	Extremely loud
Firecrackers	100	Very loud
Heavy truck (50 feet)	90	Very annoying
Hair dryer	80	Annoying
Noisy restaurant, freeway traffic	70	Telephone use difficult
Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room; bedroom	40	Quiet
Library; soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	Extremely quiet

Source: Noise Pollution Clearinghouse 2019
Note: dBA (A-weighted decibels).

3.6.2 Environmental Consequences

Propagation of sound in air is affected by distance, ground absorption or reflection, meteorological conditions, the character of the noise, intervening topography or structures, foliage, and atmospheric absorption. An overview of acoustic principles is provided in Appendix E.13, *Marine Mammals Technical Appendix*. Of these factors, distance and the presence of intervening structures or topography tend to have the greatest effect on reducing sounds far from the source. The noise level estimates presented in the EIS were calculated based on distance attenuation alone and provide a conservative estimate for the analysis. The EIS assessed the distance needed for a noise source to attenuate to the ambient level of 35 dBA and also identified potential sound levels in Nuiqsut.

Both impulsive and non-impulsive noise were analyzed. These noises are different in their origin, intensity, persistence, onset, and decay. Impulsive noise is short-term, instantaneous noise with a high intensity, short persistence, abrupt onset, and rapid decay; impulsive noise bursts may occur in rapid succession. This type of noise is typically created when one object strikes another object, such as a hammer striking a pile. Non-impulsive

[10] Airborne sound levels are quantified using A-weighted decibels, where the decibel is a unit of sound pressure referenced to 20 micropascals (μPa). A-weighting is a system for weighting measured airborne sound levels to reflect the frequencies that people hear best.

noise has a steady intensity and longer persistence, such as noise created by dump trucks, bulldozers, compaction rollers, and other construction equipment. Sound levels generated by impulsive noise, such as pile driving or blasting, may significantly exceed the ambient sound level for a very short duration. Non-impulsive, more continuous noise sources typically emit lower levels of noise and are less likely to be audible at a distance (described in detail below).

Multiple individual noise sources can combine to result in higher noise levels, but the combined noise is not directly additive. Combined noise sources that differ more than 10 dBA from one another are dominated by the louder source. For example, if blasting or pile driving is occurring, adding truck traffic would likely not increase noise levels noticeably from blasting or pile driving alone.

3.6.2.1 Avoidance, Minimization, and Mitigation

3.6.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.6.2 summarizes existing NPR-A IAP LSs and BMPs that apply to Project actions on BLM-managed lands and are intended to mitigate noise impacts from development activity (BLM 2013a). The LSs and BMPs would reduce noise impacts to wildlife and human populations from mobile and stationary equipment associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.6.2 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts from noise. Although many of the BMPs have proposed minor language revisions, Table 3.6.2 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.6.2. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts from Noise

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: Where aircraft traffic is a concern, balance gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM special status species, from direct or indirect interaction with oil and gas facilities.	Aerial surveys for species will be conducted prior to construction. The applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats and address management of high noise levels.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP F-1, ROPs F-2 and F-3	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft use plans are required. Aircraft shall maintain a specified minimum altitude in specified locations, generally at least 1,500 feet above ground level and at least 3,000 in some places.	Text moved from F-1 to ROPs F-2 and F-3. F-2: Aircraft Use Plan Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. F-3: Minimum Flight Altitudes Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the Teshekpuk Caribou Herd Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude agl throughout NPR-A. F-4: Reduce Impacts of Air Traffic on Subsistence Resources. – Minimize helicopter flights during peak caribou hunting within 2 miles of important subsistence rivers. The current peak dates are July 15 through August 15, but these dates may be revised periodically in consultation with affected communities and the NSB. – Minimize aircraft use near known subsistence camps and cabins and during sensitive subsistence hunting periods (spring goose hunting, summer and fall caribou and moose hunting) by adhering to the following guidelines: – Arrange site visits and flight schedules to conduct required activity near subsistence areas early in the season, on weekdays, and as early in the morning as possible; avoid holidays. – Note whether activities overlap heavily used subsistence rivers and determine if a potentially affected community should be notified. -Compare the proposed landing sites with the NSB camps and cabins map. If activities near camps or allotments cannot be avoided, contact the camp or allotment owner to discuss the timing of the visit.
LS/ BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat; (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears and the summer shoreline habitat for walrus and seals.	Facilities prohibited in coastal waters designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites.	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.

Source: BLM 2013a, 20120a
Note: agl (above ground level); BLM (Bureau of Land Management); BMP (best management practice); DEW (distant early warning); IAP (Integrated Activity Plan); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy); ROP (required operating procedure); USFWS (U.S. Fish and Wildlife Service); USGS (U.S. Geological Survey).

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect noise would include those to BMP E-11. All action alternatives would require a deviation from BMP E-11 due to the proximity of Steller's eiders to the Project area.

3.6.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.6.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

Additional suggested measures to reduce noise impacts could include the following:

1. Alter flight paths to avoid sensitive areas (such as Nuiqsut); this could be part of the aircraft use plan required in BMP F-1
2. Limit blasting to the hours of 10 a.m. to 8 p.m.

3.6.2.2 Alternative A: No Action

Under the No Action Alternative, new construction noise in the Willow area would not occur. Existing human-made noise sources from oil and gas exploration and development; subsistence activities; and air, ground, and marine traffic would continue to affect the soundscape.

3.6.2.3 Alternative B: Proponent's Project

Noise levels and effects related to various elements of Alternative B are summarized in Table 3.6.3. General non-impulsive construction equipment would occur in various locations (near gravel and ice infrastructure) through the construction period. Blasting would be used intermittently to fracture and displace rock. Gravel mining would occur during the winter months during construction. Impact pile driving for bridge construction would produce substantial levels of impulsive noise for relatively short periods (days or weeks) at bridge locations.

Most non-impulsive noise sources listed in Table 3.6.3 would attenuate to ambient sound levels prior to reaching Nuiqsut and would not affect people in the community. Aircraft activity could potentially be audible in Nuiqsut if planes traveled within 20.3 miles of the community or helicopters traveled within 33.2 miles, but the sound levels of most aircraft activity would be less than 39 dBA, which is typically considered protective of residential uses.

Impulsive noise during construction would have farther-reaching effects, but the effects would be short-lived and instantaneous compared to other construction activities. Blasting would be very annoying near the source and intrusive to conversation in Nuiqsut. However, these noise events would be very short-lived and instantaneous. Impact pile driving would be annoying near the source and quiet locations (similar to a living room) in Nuiqsut.

Table 3.6.3. Summary of Potential Noise for All Project Phases

Noise Source	Project Phase: Duration	Estimated Sound 1,000 Feet from the Source (dBA)	Nearest Distance from Project Action to Nuiqsut (miles)	Distance to 35 dBA[a] (miles)	Estimated Sound at Nuiqsut (dBA)	Data Source
Tugboats, marine vessels, barges	Construction: All Alts: 4 yrs	40	33 (Oliktok Dock)	0.3	0	TORP Terminal LP 2009
General construction[b] (bulldozers, loaders, cranes, etc.)	Construction: Alt B: 7 yrs Alt C: 8 yrs Alt D: 9 yrs	62	6.8	4.0	31	BLM 2018
Gravel mining at Tiŋmiaqsiuġvik mine site[b] (bulldozers, loaders, crushers, screens, etc.)	Construction: Alt B: 5 yrs Alts C and D: 6 yrs	62	6.8	4.0	31	BLM 2018

Noise Source	Project Phase: Duration	Estimated Sound 1,000 Feet from the Source (dBA)	Nearest Distance from Project Action to Nuiqsut (miles)	Distance to 35 dBA[a] (miles)	Estimated Sound at Nuiqsut (dBA)	Data Source
Gravel mine blasting at Tiŋmiaqsiuġvik mine site, Lmax	Construction: Alt B: 5 yrs Alts C and D: 6 yrs	90	6.8	101.9	59	Ramboll US Corporation 2017
Impact pipe pile driving, Lmax	Construction: Alt B: 5 yrs Alts C and D: 4 yrs	84	24.0	50.9	42	WSDOT 2015
Helicopter (B206)	All: 30 years	70 to 80	23.4 to 27.9[c]	10.5 to 33.2	27 to 38[d]	BLM 2004
Fixed-wing aircraft (twin engine)	All: 30 years	69 to 81	23.4 to 27.9[c]	6.4 to 20.3	26 to 39[d]	BLM 2004
Ground traffic	All: 30 years	49 to 55	6.8	0.9 to 1.4	18 to 24	BLM 2018
Skiff traffic[e]	Postconstruction: Summer use in perpetuity	63	8.1 (boat ramp on Ublutuoch [Tiŋmiaqsiuġvik] River)	4.7	31	NPS 2011
Drill rig	All: 10 to 11 years total	52 to 66	26.3	1.3 to 6.4	9 to 23	ARCO Alaska 1986
WPF	Operations: ≥ 25 years	52	26	1.3	9	BLM 2018
Flare at WPF	Operations: ≥ 25 years	71	26	11.8	29	USACE 2018

Note: Alt (alternative); ≥ (at least); dBA (A-weighted decibels); Lmax (short-term, maximum sound level), WPF (Willow Processing Facility); yrs (years).
[a] 35 dBA is the ambient sound level in the analysis area.
[b] Assumes five pieces of heavy diesel equipment in operation concurrently.
[c] Alternative B: 23.7 miles, Alternative C: 23.4 miles, and Alternative D: 27.9 miles.
[d] Distance calculated from the Willow airstrip. Sound levels when aircraft are directly over Nuiqsut could range from 69 to 81 dBA if flying at a height of 1,000 feet. Typical flight paths from Kuparuk or Alpine to Willow would pass approximately 8 miles north of Nuiqsut.
[e] Skiffs from subsistence users of boat ramps on the Ublutuoch (Tiŋmiaqsiuġvik) River, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek.

Drilling and operational noise would dominate the local soundscape but would dissipate to ambient levels as one moves farther from the source.

Subsistence users could be affected by noise if they are within the attenuation zone for noise sources, which are described in Table 3.6.3 and Figure 3.6.1. It is likely that subsistence users would avoid construction areas and areas of persistent operational noise (such as the WPF) and thus physical effects from noise on subsistence users would be minimal. The effects of avoidance of subsistence use areas, as well as effects to subsistence resources and harvest, are described in Section 3.16.

3.6.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be the same as described under Alternative B, with the following differences:

- Elimination of the gravel infield road between the WPF and BT1 would reduce some noise associated with construction and use of the road; however, construction and use of the annual ice road between the WPF and BT1 would generate noise during winter.
- Removal of a bridge crossing over Judy (Iqalliqpik) Creek would eliminate construction related to the bridge, including impact pile driving.
- The WPF, WOC, and airstrip would be slightly east of the Alternative B locations by approximately 0.2 mile, 0.5 mile (South WOC), and 0.3 mile (South Airstrip), respectively. This would result in slightly increased noise levels in Nuiqsut throughout the duration of the Project.
- Establishment of a second airstrip near BT2 would introduce construction and air traffic to another location; however, traffic at the BT2 airstrip would originate from the South WOC and would not be heard in Nuiqsut.
- Only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed because there would not be gravel road access to the other rivers. Though the number of potential users of each boat ramp is unknown, if only one ramp at the Ublutuoch (Tiŋmiaqsiuġvik) River were constructed, use could be concentrated on that river and effects could be higher. The Ublutuoch (Tiŋmiaqsiuġvik) River is closest to Nuiqsut, but sound at the boat ramp would attenuate to ambient levels and not be audible in Nuiqsut.

Although there are differences in the locations of some noise sources under Alternative C, any resulting differences in noise received in Nuiqsut would not be noticeable.

3.6.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be the same as described under Alternative B, with the following differences:

- Elimination of the gravel access road between GMT-2 and the WPF would reduce some noise associated with construction and use of the road; however, construction and use of the annual ice road between GMT-2 and the WPF would generate noise during the winter.
- The reduction of gravel roads would result in greater volumes of air traffic during both construction and operation and thus more incidents of aircraft-related noise.
- The location of the WPF, WOC, and airstrip would be 3.2, 3.5, and 2.3 miles west of Alternative B locations, respectively, and thus would result in less noise in Nuiqsut.
- Only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed because there would not be gravel road access to the other rivers. Though the number of potential users of each boat ramp is unknown, if only one ramp at the Ublutuoch (Tiŋmiaqsiuġvik) River were constructed, use could be concentrated on that river and effects could be higher. The Ublutuoch (Tiŋmiaqsiuġvik) River is closest to Nuiqsut, but sound at the boat ramp would attenuate to ambient levels and not be audible in Nuiqsut.

Although there are differences in the locations of some noise sources under Alternative D, any resulting differences in noise received in Nuiqsut would not be noticeable.

3.6.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

Construction of an MTI at Atigaru Point would produce similar noises as described under Alternative B, except without drilling or processing facilities. Additional noise would arise from pile removal (Table 3.6.4). Impact pile driving would produce substantial levels of impact noise for relatively short periods (days or weeks) and would be 31.1 miles from Nuiqsut, 7.1 miles farther than Alternative B. Air traffic would originate from Alpine (year 1 only) or Willow (years 2 through 6) and when landing at Atigaru Point would produce a noise level of 26 to 27 dBA (similar to that of Alternative C) in Nuiqsut. Barge traffic and screeding would occur at Atigaru Point, which is 31.1 miles from Nuiqsut (approximately 2 miles closer than Oliktok Dock). Support vessels would originate from Oliktok Dock. Vessel traffic from either location would attenuate to ambient sound levels within 0.3 mile and would not be heard in Nuiqsut. Ice road equipment and vehicles would be 7.9 miles from Nuiqsut at their closest point (the same as Option 2 and 4.6 miles closer than Option 3 at its closest point).

Table 3.6.4. Construction Noise Unique to Module Delivery Options 1 and 2

Noise Source	Estimated Sound 1,000 feet from the Source (dBA)	Nearest Distance from Project Action to Nuiqsut (miles)	Distance to 35 dBA[a] (miles)	Estimated Sound at Nuiqsut (dBA)	Data Source
Pile removal: Vibratory method	75	31.1 to 72.2[b]	18	23.4 to 30.7 dBA	WSDOT 2015

Note: dBA (A-weighted decibels).
[a] 35 dBA is the ambient sound level in the analysis area.
[b] Proponent's MTI is 31.1 miles from Nuiqsut; Point Lonely MTI is 72.2 miles from Nuiqsut.

3.6.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

Option 2 would produce the same types and levels of noise as Option 1 except most of the noise would be farther away from Nuiqsut (Table 3.6.4 and Figure 3.6.1), except for the gravel mine site. Thus, impact pile driving would not be heard in Nuiqsut since the action would be over 72 miles from the community and noise would attenuate to ambient levels within 50.9 miles (Table 3.6.3). Similarly, air traffic landing at Point Lonely would not be heard in Nuiqsut, since the fixed-wing aircraft sound would attenuate to background levels at 20.3 miles and helicopter traffic would attenuate at 33.2 miles. Point Lonely also has a slightly lower level of subsistence use than Atigaru Point and thus noise in this area would have a lower impact on subsistence users. Barge traffic and screeding would occur at Point Lonely, which is 72.2 miles from Nuiqsut (approximately 65 miles further away than Oliktok Dock). Support vessels would originate from Oliktok Dock. Vessel traffic from either location would attenuate to ambient sound levels within 0.3 mile and would not be heard in Nuiqsut. Ice road equipment and vehicles would be 7.9 miles from Nuiqsut at their closest point (the same as Option 1 and 4.6 miles closer than Option 3 at its closest point).

3.6.2.8 Module Delivery Option 3: Colville River Crossing

Option 3 would produce similar types and levels of noise as Option 1 except there would be no screeding, or impact pile driving or removal. Air traffic would originate from Alpine or Kuparuk and when landing would produce a noise level of 26 to 27 dBA (similar to that of Alternative C) in Nuiqsut. Barge traffic would occur at Oliktok Dock, which is 33.2 miles from Nuiqsut (approximately 2 miles farther away than Atigaru Point). Ice road equipment and vehicles would be 12.5 miles from Nuiqsut at their closest point (4.6 miles further than Options 1 or 2 at their closest point). Gravel mining would occur at Kuparuk Mine Sites C and E, which are existing mine sites that are approximately 33 miles from Nuiqsut (26 miles farther away than Options 1 or 2).

3.6.2.9 Oil Spills and Accidental Releases

Oil spills would not be a planned Project activity but were considered in the effects analysis for the Project. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Depending on the time of year (as well as the type and size of spill), boats, aircraft, trucks, and/or heavy equipment could be used to respond to the incident. Noise effects related to the cleanup of very small to small spills, if they occur, would be similar to those of construction noise described above and occur mainly near the vicinity of the release. Noise effects related to clean up of a large spill, if one were to occur, could be greater, occur over a longer duration, and occur over a larger area.

3.6.3 Unavoidable Adverse, Irretrievable and Irreversible Effects

The LSs, BMPs, and mitigation measures would reduce, but not eliminate, potential noise impacts. Noise impacts from construction and operation would be unavoidable. Such impacts would be irretrievable during the life of the Project but would not be irreversible, as they would cease at Project end. Accordingly, this short-term use would not have noise-related impacts on the long-term sustainability of natural and human resources in the analysis area.

3.7 Visual Resources

Visual resources are visible features of the landscape and **scenic quality** is the measure of the visual appeal of a unit of land. Visual resources and scenic quality of the NPR-A are managed through the BLM **Visual Resource Management (VRM) system** (BLM 1984, 1986); VRM is not applicable on non-BLM managed lands outside of the NPR-A (e.g., Kuparuk, State of Alaska offshore waters).

Qualitative indicators and quantitative measures of impacts used in this analysis focus on disclosure of impacts to scenery and to viewers. BLM **Visual Resource Inventories** (VRIs) were used to describe the baseline affected environment. The BLM **VRM classes** were used to assess Project conformance with BLM visual management objectives in the analysis area. This conformance was determined through the completion of Visual Contrast Rating Worksheets (Appendix E.7B, *Visual Contrast Rating Worksheets*).

The analysis area for visual resources is the area within line-of-sight from ground-eye-level to the tallest components of the Project (drill rig and communications tower lighting). For this Project, that area (also known as the **viewshed**) is 30 miles and includes the 0- to 5-mile **foreground-middleground distance zone** and the 5- to 15-mile **background distance zone** (Figure 3.7.1). The Project viewshed includes all areas from which the facilities would be visible based on topographical obstruction and distance. The temporal scale of visual resource impacts would be the life of the Project, until anthropogenic materials have been removed and reclamation activities are complete; recovery time of disturbed vegetation would be greater than 20 to 30 years (Everett 1980), as described in Section 3.9. If reclamation of gravel infrastructure does not occur, impacts would be permanent.

3.7.1 Affected Environment

The analysis area is characterized by slight topographic relief, 540 feet overall, and thermokarst ponds (USGS 2018). Harrison Bay (of the Beaufort Sea), the Colville River, numerous streams, and hundreds of ponds are the dominant visual features of the ACP (Fenneman 1946). Vegetation is dominated by tundra grasses and shrub willows and the foreground-middleground landscape has few visually distinct features. Additionally, there is visible human infrastructure within the foreground-middleground landscape. The village of Nuiqsut, population 347 (U.S. Census 2018a), is in the analysis area (Figure 3.7.1). Other human development includes ice roads, snow and all-terrain vehicle (ATV) trails, as well as existing land disturbances and facilities associated with the GMT and Alpine developments, approximately 10 miles east of the proposed drill sites and pads. Besides oil and gas exploration and development, subsistence hunting and fishing are the dominant human activities in the analysis area (CPAI 2018b).

BLM VRI scenic quality classes (Figure 3.7.2), **sensitivity level** analyses (Figure 3.7.3), and **distance zones** (Figure 3.7.4) combine to establish **VRI classes** (Figure 3.7.5). Scenic quality is the relative worth of the landscape from a visual perception. Sensitivity level is the measure of public concern for the maintenance of scenic quality. Distance zones are a subdivision of the landscape as viewed from an observer position (BLM 1986).

VRI classes represent the relative value of visual resources, where VRI Class I is the most valued and VRI Class IV is the least. The analysis area is predominantly VRI Class IV (441,759 acres) and VRI Class III (1,959,963 acres), with VRI Class II present at Teshekpuk Lake and along the Colville River (209,518 acres) (Figure 3.7.5). Scenic quality in the analysis area is predominantly Class C (low quality), with Class A (high quality) present at Teshekpuk Lake and Class B (moderate quality) along the Colville River (Figure 3.7.2). Sensitivity levels throughout the analysis area are high. Distance zone visibility consists of the foreground-middleground (0 to 5 miles), background (5 to 15 miles), and **seldom seen** (greater than 15 miles) viewing situations (BLM 1984) from viewer locations. Viewer locations occur throughout the analysis area and are dependent on seasonality and user; for example, the village of Nuiqsut, at overnight-stay sites, along travel routes, and at hunting and fishing areas.

VRM classes are management decisions on how visual resources are managed in conjunction with other uses in the NPR-A and are also assigned values of VRM Class I to VRM Class IV (Figure 3.7.6). These VRM classes were assigned to these lands by the NPR-A IAP/EIS (BLM 2013a) and have been updated in the 2020 BLM NPR-A IAP Final EIS (BLM 2020a) where four new alternative VRM boundaries are presented (alternatives B, C, D, and E; Alternative A is the same as BLM 2013a). Depending on which VRM boundaries (BLM 2013a, 2020a), Project facilities would be located on BLM lands managed as VRM Class II, III, and IV (Figure 3.7.6 through 3.7.10). BLM 2020 identifies five VRM Class Alternatives (A, B, C, D, and E; Alternative A VRM boundaries are the same as BLM 2013a) associated with BLM managed lands within the analysis area. Each of the VRM alternatives are evaluated for the Project's conformance to VRM Class objectives. Tables E.7.5 in Appendix E.7A, *Visual Resources Technical Appendix*, summarize the acreages and percentages of the analysis area in the respective VRI classes; Tables E.7.6 through E.7.10 summarize the acreages and percentages of the analysis area by VRM class. Appendix E.7A also includes the methods used to assess VRI impacts and VRM conformance descriptions and rationale as described in Section 3.7.2, *Environmental Consequences*.

3.7.2 Environmental Consequences

3.7.2.1 Avoidance, Minimization, and Mitigation

3.7.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.7.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate visual impacts from development activity (BLM 2013a). The LSs and BMPs would reduce adverse visual impacts to the natural environment, from mobile and stationary viewing locations, created by structures, and equipment associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.7.1 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to visual resources. Although many of the BMPs have proposed minor language revisions, Table 3.7.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.7.1. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Visual Impacts

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.	– Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	Added text: - In the spring, provide the BLM with photographs of all stream crossings that have been removed, breached, or slotted.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: – Where aircraft traffic is a concern, balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the Authorized Officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.	Added text: – The Plan shall consider locations outside the active floodplain or designing gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-10	Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.	Flagging of structures shall be required, such as elevated power lines and guy wires, to minimize bird collisions. All facility external lighting, during all months of the year, shall be designed to direct artificial exterior lighting inward and downward or to be fitted with shields to reduce reflectivity in clouds and fog conditions, unless otherwise required by the Federal Aviation Administration.
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM special status species, from direct or indirect interaction with oil and gas facilities.	– Power and communication lines shall either be buried in access roads or suspended on vertical support members except in rare cases. – Communication towers should be located on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers and other similar facilities, should be avoided. – Maintain a 1-mile buffer around all recorded Yellow-billed Loon nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline.	Measures related to bird collisions with infrastructure moved to ROPs E-10 and E-21. Changes do not affect text as described.
BMP E-17	Manage permitted activities to meet Visual Resource Management class objectives.	Submit a plan to best minimize visual impacts. At the time of application for construction of permanent facilities, the lessee/permittee shall submit a plan to best minimize visual impacts, consistent with the Visual Resource Management Class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.	Changes do not affect text as described.
ROP E-21	Minimize the impacts on bird species from direct interaction with aboveground utility infrastructure.	No similar requirement See BMP E-11.	Power and communication lines shall either be buried in access roads or suspended on vertical support members except in rare cases. Communications towers should be located on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers and other similar facilities should be avoided. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low flying birds.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP F-1; ROPs F-2 and F-3	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft shall maintain a specified minimum altitude in specified locations, generally at least 1,500 feet above ground level and at least 3,000 in some places.	Text moved to ROPs F-2 and F-3: Added text: – F-2: Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. – F-3: F-3: Minimum Flight Altitudes. Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the Teshekpuk Caribou Herd Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude above ground level throughout NPR-A.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration to the land's previous hydrological and vegetative condition.	Changes do not affect text as described. – See BMP M-5 for additional requirements to reduce areas of bare soil.
LS/ BMP K-6[a]	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat, minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.

Source: BLM 2013a, 2020a

Note: agl (above ground level); BLM (Bureau of Land Management); BMP (best management practice); F (Fahrenheit); IAP (Integrated Activity Plan); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSO (no surface occupancy); ROP (required operating procedure).

[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

No deviations to the LSs and BMPs described in Table 3.7.1 would be required.

3.7.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.7.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

The follow additional measures could reduce impacts to visual resources:

1. Include the following in the plan to minimize visual impacts (plan is required as per BMP E-17):
   A. Ensure structures are a color that blends in with the background colors of the natural landscape. All colors would be pre-approved by the BLM.
   B. ROP E-7 and CPAI's design measure 58 (Appendix I.1, Table I.1.2) state that a non-reflective coating would be used on pipelines; that could be expanded to all metal structures not otherwise painted, including but not limited to communications towers and drill rigs.
2. Minimize light visible from outside of Project facilities *at all times of the year* by using lighting fixtures with lamps contained within the reflector and shading externally facing windows on buildings. This will minimize impacts on visual aesthetics (i.e., reduce contrast from glare and artificial lighting).
3. Implement lighting controls to turn off exterior lighting at satellite pads and other unoccupied facilities when personnel are not present, between August 1 and October 31.

3.7.2.2 Alternative A: No Action

Under Alternative A, the Project would not be constructed, although oil and gas exploration and development would continue to occur in the analysis area. Effects from existing development to visual resources (as described in Section 3.7.1, *Affected Environment*) would continue.

3.7.2.3 Impacts to Scenery Common to the Action Alternatives and Module Delivery Options

Project facilities and lighting under all action alternatives would affect scenery and people by impacting the undisturbed characteristic landscape (including night skies). Visual contrast from Project facilities (drill rigs and supporting infrastructure) as well as light sources during operations would cause the greatest visual impacts in foreground-middleground views due to the broad, panoramic landscape and lack of intervening land features. Impacts to scenic quality are based on estimated visual contrasts resulting from Project facilities and activities, including nighttime lighting, with VRI scenic quality ratings. A summary of how Project elements affect scenic quality is provided in Table 3.7.2.

Table 3.7.2. Impacts to Scenery Based on Visual Change to the Characteristic Landscape and Night Skies

VRI Scenic Quality Rating	Roads	Infrastructure and Pads	Drill Rigs and Module Transport Infrastructure[a]	Nighttime Lighting
Class A	Strong contrasts	Strong contrasts	Strong contrasts	Strong contrasts
Class B	Moderate contrasts	Moderate contrasts	Strong contrasts	Strong contrasts
Class C	Weak contrasts	Weak contrasts	Strong contrasts	Strong contrasts

Note: VRI (Visual Resources Inventory). Impact definitions: strong contrasts (Project element is dominant to the landscape and demands attention); moderate contrasts (Project element begins to attract attention); weak contrasts (Project element can be seen but does not attract attention). See Bureau of Land Management Manual 8431 (BLM 2012a) for detailed contrast definitions.

[a] Drill rigs would be present throughout drilling and operations; module delivery infrastructure would be present only during construction.

Impacts to people are determined based on the estimated contrasts caused by Project facilities, including nighttime lighting, with VRI sensitivity levels and distance zones (0 to 5 miles [foreground-middleground] and greater than 5 miles [background]). A summary of how Project elements affect people based on proximity is provided in Table 3.7.3.

Table 3.7.3. Impacts to People Based on Visual Change to the Characteristic Landscape and Night Skies

High Sensitivity-Visibility-Distance	Roads	Infrastructure and Pads	Drill Rigs and Module Transport Infrastructure[a]	Nighttime Lighting
0 to 5 miles	Moderate contrasts	Moderate contrasts	Strong contrasts	Strong contrasts
Greater than 5 miles	Weak contrasts	Weak contrasts	Moderate contrasts	Strong contrasts

[a] Drill rigs would be present throughout drilling and operations; module delivery infrastructure would be present only during construction.

3.7.2.4 Alternative B: Proponent's Project

3.7.2.4.1 Impacts to Existing Visual Conditions

Due to the flat terrain in the analysis area, Project facilities and activities would impact subsistence users and visitors who would experience observable changes and contrasts to the characteristic landscape for the life of the

Project. Project facilities and activities with visual impacts would include lighting, structural features, drill rigs, communications towers, gravel roads, ice roads, bridges, a mine site, pipelines, stream crossings, pilings, water intakes, flares, vehicle activity, and air and ground traffic (Appendix E.7B). These strong contrasts to scenery would reduce the scenic quality rating of Class A landscapes (161,765 acres), Class B landscapes (20,508 acres), and Class C landscapes (1,720,473 acres) (Figure 3.7.2). This would impact a total of 1,902,746 acres of BLM-managed land (42.0% of Project viewshed) in the currently undisturbed high sensitivity area (including 182,273 acres [4.1% of Project viewshed] inventoried as VRI Class II; 1,377,831 acres [30.7% of Project viewshed] inventoried as VRI Class III, and 344,123.3 acres [7.7% of Project viewshed] inventoried as VRI Class IV) (Figure 3.7.5).

In summary, the Project would result in moderate to strong contrasts to the landscape for viewers in foreground-middleground distance zones and weak to strong contrasts in background distance zones throughout the analysis area. The level of impact has the potential to impact visual sensitivity and reduce the scenic quality in approximately 182,273 acres of BLM lands within the NPR-A that are currently inventoried as VRI Class II (Figure 3.7.5).

3.7.2.4.2 Conformance with Visual Resource Management

Conformance with BLM VRM Class objectives where Project facilities would be located is based on the Project's visual contrasts of forms, lines, colors, and textures (including nighttime lighting), with the characteristic landforms in the viewshed (Appendix E.7B). BLM's (2020) IAP Final EIS identifies four new VRM Class alternatives (B, C, D, and E; Alternative A is the 2013a VRM boundaries). Tables E.7.2 through E.7.6 (in Appendix E.7A) provide the acreages and percentages of sensitivity classes and distance zones based on direct line-of-sight viewing conditions for facilities, activities, and night-sky conditions, as well as the total acres and percentages of VRI and VRM classes. Additional information regarding Project conformance with VRM Class objectives is provided in the Visual Contrast Rating Worksheets 1, 2, 3, and 4 in Appendix E.7B.

VRM Class objectives (BLM 2012d) are summarized as:

- VRM Class II is intended to retain the existing landscape character and while activities may be visible, they should not attract attention. VRM Class II allows for low levels of change from the existing viewshed.
- VRM Class III is intended to partially retain the existing character of the landscape and activities may attract viewer attention, but they should not dominate the view. VRM Class III allows for a moderate change from the existing viewshed.
- VRM Class IV is intended to provide for management activities which would require major modification of the existing landscape character and activities may attract viewer attention or dominate the view, but activities should still be mitigated to reduce impacts to the viewshed. VRM Class IV allows for a high level of change from the existing viewshed.

Table 3.7.4 summarizes each action alternative's conformance to VRM Class objectives by IAP alternative. Figures 3.7.6 through 3.7.10 show the VRM classes for BLM 2013a and 2020. Acreages of impacts by VRM Class for BLM 2013a and 2020 are shown in tables E.7.6 through E.7.10 of Appendix E.7.

Table 3.7.4. Conformance with Visual Resource Management Class Objectives

Willow Project Alternative	2013a IAP Objectives[a]	2020 IAP Objectives: Alternative B	2020 IAP Objectives: Alternative C	2020 IAP Objectives: Alternative D	2020 IAP Objectives: Alternative E
Alternative B: Proponent's Project	In conformance: all visible Project facilities would be located on VRM Class IV areas. No facilities in either VRM Class II or Class III areas.	In conformance in VRM Class IV areas. Non-conformant in VRM Class II areas. No facilities in VRM Class III areas.	In conformance in VRM Class IV areas. Non-conformant in VRM Class II areas. No facilities in VRM Class III areas.	In conformance in VRM Class IV areas. Non-conformant in VRM Class II areas. No facilities in VRM Class III areas.	In conformance in VRM Class IV areas. Non-conformant in VRM Class II areas. No facilities in VRM Class III areas.
Alternative C: Disconnected Infield Roads	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic

Willow Project Alternative	2013a IAP Objectives[a]	2020 IAP Objectives: Alternative B	2020 IAP Objectives: Alternative C	2020 IAP Objectives: Alternative D	2020 IAP Objectives: Alternative E
Alternative D: Disconnected Access	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic	Similar to Proponent's Project with additional air traffic

Note: IAP (Integrated Activity Plan); VRM (Visual Resource Management)
[a] Also described as Alternative A in BLM 2020a.

3.7.2.5 Module Delivery Options

Impacts to visual resources from module delivery options would be similar to those described above for the action alternatives in Tables 3.7.2 and 3.7.3 though the impact duration and intensity would be short-term as a result of the module mobilization schedule occurring over two or three non-consecutive years (varies by module delivery option). Module delivery options do have some impacts that would be unique to the marine area, including barge and support vessel traffic, creation and abandonment of MTIs (Options 1 and 2), and onshore support which would also be short-term in duration and intensity during two non-consecutive year for Sealift operations. These impacts are described below.

3.7.2.5.1 Option 1: Atigaru Point Module Transfer Island

Effects to visual resources from Option 1 would include strong contrasts to the Beaufort Sea viewing environment due to the otherwise uniform forms, lines, colors, and textures of offshore and coastal views. Both the MTI and supporting ice infrastructure (e.g., ice roads, multi-season ice pad) at Atigaru Point would occur in a VRM Class IV area under BLM 2013a (Alternative A in BLM 2020) and would conform with BLM management objectives. MTI construction and operations would occur in VRM Class II for IAP (BLM 2020) alternatives B, C, D, and E, and would not conform to VRM Class II objectives during construction and use resulting from elements of form, line, color, and texture that are not consistent with the characteristic environment. Nonconformance would be short term and conclude following the cease in activity, removal of temporary Project facilities, and the abandonment of the MTI. There would be approximately 37 miles of ice roads constructed each year (for 3 non-consecutive years) to support MTI construction and module hauling. Ice road use in the NPR-A would meet VRM objectives for all IAP (BLM 2020) VRM Alternatives.

3.7.2.5.2 Option 2: Point Lonely Module Transfer Island

Effects to visual resources from this option would be similar to those from Option 1 but would be greater in magnitude. Option 2 would have approximately 75 miles of ice roads, nearly double the length of ice roads as Option 1, constructed over 3 non-consecutive winter seasons. The ice roads would meet VRM objectives for the BLM (2013a) and BLM (2020) alternatives (A, B, C, D, and E) within the NPR-A. Option 2 would have more air traffic, with approximately a third of that air traffic occurring at Point Lonely. Ground and air traffic are detailed by season and option in Appendix D.1, Section 5.0. The MTI for Option 2 would also be more visible to viewers onshore because it would be 0.6 mile from shore, whereas the MTI for Option 1 would be 1.9miles from shore (though the sea ice road would be 2.4 miles), though both still occur within the 0- to 5- mile foreground area. Additionally, the onshore camp (on existing gravel pads), including communications towers, and some ice infrastructure at Point Lonely, would occur in VRM Class II areas (BLM 2013a and all alternatives in BLM 2020) and would not conform to VRM Class II objectives during construction and use resulting from elements of form, line, color, and texture that are not consistent with the characteristic environment. Nonconformance would be short term and conclude following the cease in activity, removal of temporary Project facilities, and the abandonment of the MTI. However, because the IAP allows for "construction, renovation, or replacement of facilities on the existing gravel pads at Camp Lonely and Point Lonely … if the facilities will promote safety or environmental protection," and limits VRM Class II application to those areas where new non-subsistence infrastructure is prohibited (BLM 2013a), Option 2 would be in conformance with the IAP.

3.7.2.5.3 Option 3: Colville River Crossing

Effects to visual resources from Option 3 would be less than Options 1 and 2. The use of the existing Oliktok Dock and staging area (approximately 2 miles south of the Oliktok Dock), as well as the use of existing gravel roads between the staging area and Kuparuk DS2P, would not introduce new delivery infrastructure or light sources as compared to Options 1 and 2 that occur within the NPR-A. There would also be less ground, air, and sea traffic compared to Options 1 and 2 (Appendix D.1, Section 5.0). The 100-person camp for winter ice road construction located near Kuparuk DS2P would be similar to ice road camps associated with Options 1 and 2 and have similar visual impacts. Option 3 would have approximately 3.5 miles more ice road length than Option 1 and approximately 33.5 miles less ice road length than Option 2 (on a per-season basis during module delivery). The construction and use of the ice road west of Kuparuk DS2P to GMT-2 would have similar visual impacts as ice roads associated with Options 1 and 2. There would be 40.1 miles of ice roads associated with Option 3 module delivery over 2 non-consecutive construction seasons with approximately 13.8 miles occurring on BLM-managed lands within the NPR-A. The ice road would meet VRM objectives under the BLM (2013a) and BLM (2020) VRM alternatives (A, B, C, D, and E) within the NPR-A (Appendix E.7B, VCRW Worksheets 4, 5, and 6).

3.7.2.6 Oil Spills and Accidental Releases

Oil spills would not be a planned Project activity but were considered in the effects analysis for the Project. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Depending on the time of year (as well as the type and size of spill), boats, aircraft, trucks, and/or heavy equipment could be used to respond to the incident. Visual resource impacts to scenery and to people related to cleanup of very small to small spills, if they occur, would be similar to those of construction described above and occur mainly near the vicinity of the release. Effects related to cleanup of a large spill, if one were to occur, could be greater, occur over a longer duration, and over a larger area.

In the very unlikely event that a **reservoir blowout** occurred at one of the drill sites (likelihood approaching zero as described in Chapter 4.0), the extent of the accidental release could be much larger and could distribute an aerial mist of oil over tundra vegetation as described in Chapter 4.0. A blowout could reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay, due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

Because oil, diesel fuel, and seawater spills on nonfrozen plants or soil could kill plants, effects may be visible on the landscape for many years. Seawater spills on salt-tolerant plants may be less visible on the landscape.

3.7.3 Unavoidable Adverse, Irretrievable and Irreversible Effects

The LSs, BMPs, and mitigation measures would reduce, but not eliminate, potential impacts. Visual impacts from construction and operation would be unavoidable and irretrievable throughout the life of the Project. Impacts on BLM-managed lands would not be irreversible, nor would they impact long-term sustainability of visual resources in the analysis area if reclamation was completed. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.8 Water Resources

The analysis area for surface water resources is the watersheds in which Project activities or infrastructure would occur (Figure 3.8.1), as well as the groundwater aquifers contained therein, and the nearshore area of Harrison Bay near Atigaru Point, Point Lonely, and Oliktok Point. This encompasses all waterbodies and aquifers potentially affected by the Project, including potential downstream effects. The temporal scale for construction-related impacts is the duration of construction activities. The temporal scale for infrastructure created during construction would be the life of the infrastructure until it is removed.

3.8.1 Affected Environment

The analysis area is in the ACP, which drains to the Beaufort Sea. It is characterized by low relief, continuous permafrost, and numerous lakes (Stuefer, Arp et al. 2017).

3.8.1.1 Surface Waters

Surface water (rivers, shallow streams, lakes, and ponds) hydrology is influenced by low precipitation, relatively flat topography, and the poorly drained tundra underlain by continuous permafrost. The surface waters in the analysis area generally begin to freeze in September or October and thaw in late May or early June. The annual hydrologic cycle is dominated by an approximately 3-week spring breakup characterized by snowmelt runoff, **overland flow**, higher than average stream flows, and overbank flooding in about half the years.

Existing development and infrastructure in the analysis area occur from oil and gas developments (GMT, Alpine, Nuna, Oooguruk, and Kuparuk), decommissioned Distant Early Warning (DEW) Line sites, and the community of Nuiqsut. More gravel infrastructure occurs on the east side of the Colville River, where there are roads, mine sites, airstrips, reservoirs, pipelines, processing facilities, a dock (Oliktok Dock), and seawater treatment facility.

On the west side of the river, gravel infrastructure is focused in the lower reaches of the Ublutuoch (Tiŋmiaqsiuġvik) and Fish (Iqalliqpik) Creek basins and in the Colville River Delta (CRD) (Figure 3.8.2). The existing infrastructure and development activities (traffic, dust suppression, drilling, processing, etc.) have constructed structures in waterbodies, contribute dust and sediment to waterbodies, withdraw freshwater for use throughout the year, and increase the potential for spills entering waterbodies. Seasonal ice infrastructure and associated water withdrawal occur annually to support oil and gas exploration. The freshwater and marine areas are used for subsistence and research and have a relatively minor amount of associated boat, foot, air, and off-road vehicle traffic.

Climate change is occurring on the ACP, which could contribute to degradation of permafrost and alter the hydrologic regime across the region through melting of ground ice, which affects development of drainage features (e.g., the melting of ice wedges within patterned ground polygons, the expansion in number or size of thaw lakes).

3.8.1.1.1 Rivers

The largest rivers in the Willow area are the Colville River, the Kalikpik River, Fish Creek (Uvlutuuq and Iqalliqpik channels), Judy Creek (Kayyaaq and Iqalliqpik channels), and the Ublutuoch (Tiŋmiaqsiuġvik) River (Figures 3.8.1 and 3.8.2). Streamflow in these rivers is seasonal, with the highest **discharge** occurring during spring snowmelt (late May to mid-June). Flows are usually lowest (at or near 0 cubic feet per second [cfs]) from November through April for the largest rivers and for even longer periods for the smaller streams. Snow and ice blockage at the time of peak **stage** and peak discharge can influence **water surface elevations** (WSEs) in these streams and rivers. The riverbeds in all channels of Fish and Judy creeks are highly mobile when compared to the riverbeds of similarly sized streams east of the CRD and thus may have deeper scour depths (i.e., riverbed erosion). Table 3.8.1 summarizes existing conditions of the largest rivers in the Willow area. Appendix E.8A, *Water Resources Technical Appendix*, provides details of large rivers and small streams, including (where available) descriptions of the locations at which monitoring has occurred, descriptions of the snow and ice conditions at breakup (including cross-sections showing the magnitude of the impact), spring-peak-discharge and spring-peak-stage measurements, summer stage and discharge measurements, riverbed movement measurements, and median riverbed material size. Modeling of the floodplain at the Project stream crossings indicates that for most of the streams in the Willow area, the floodplain is limited to a very narrow area (Figures 3.8.3 and 3.8.4); the floodplains for Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek are wider.

Almost all of the tributary streams on the east side of the Colville River freeze to the bottom in winter, except for the lower reaches of the Itkillik River and one unnamed stream and lake complex near Ocean Point. These waterbodies have documented unfrozen water in winter (i.e., overwintering fish habitat, detailed in Section 3.10). The Itkillik River is different than other eastside tributaries of the lower Colville River in that it originates in the Brooks Range and thus is longer and drains a larger area than the other tundra rivers. It is one of the largest tributaries of the Colville River on its east side (Figure 3.8.2). Details of small waterbodies crossed by ice infrastructure are not described in the EIS because exact ice road routes are not yet determined and there are numerous small waterbodies on the North Slope.

The Colville River is the largest waterbody in the analysis area, and the ice infrastructure used to cross it would be substantial, and thus this waterbody is detailed in the EIS. The Colville River drains approximately 30% of the North Slope of Alaska and is summarized in Table 3.8.1. There is no gaging station on the Colville River at Ocean Point; the closest gaging stations are at Umiat (RM 117) and at Monument 1 (RM 26.5); Figure 3.8.2. Although neither of these existing gages measures winter flow at Ocean Point, Umiat is more closely representative of Ocean Point than Monument 1 because Umiat is upstream of the influence of saltwater intrusion and tidal backwatering from the CRD and Monument 1 is not. The average monthly mean discharge at Umiat in winter (December through April) ranged from 84 to 3.1 cfs from 2002 to 2019 (USGS 2020b), as shown in Table E.8.1 in Appendix E.8A. (The range of mean monthly discharge for December through April was 132.2 to 0.0 cfs; Table E.8.1 in Appendix E.8A.) Note that the Colville River is more than 2,000 feet wide at Umiat and that by late winter the flow is contained to a very small channel within that width. In other words, the ice across 99% of the channel is frozen to the bottom, but somewhere within that width there is a very small channel with flow.

Downstream from Umiat the probability of having flow in every month of the year increases as the drainage area increases. Similarly, the magnitude of the flow is likely to increase roughly proportional to the drainage area increase. Thus, when the average monthly mean April flow is 3.1 cfs at Umiat, where the drainage area is approximately 13,860 square miles, the average monthly mean April flow may be 1.5 times than that near Nuiqsut

(4.7 cfs), where the drainage area is 20,670 square miles. Therefore, flow at Ocean Point is likely higher than flow at Umiat.

More data and a description of the Colville River at Ocean Point are provided in Appendix E.8A and Appendix E.8B, *Ocean Point Technical Memorandum*.

3.8.1.1.2 Lakes and Ponds

Lakes are the most common hydrologic surface water feature in the analysis area (Figure 3.8.5). Shallow lakes and ponds (<7 feet deep) dominate the analysis area, but lakes up to 27 feet deep also exist. Shallow waterbodies freeze to the bottom in winter and thaw by the end of June. Deeper lakes generally have free water under the ice and provide a source of water year-round. Lakes in the analysis area recharge through three mechanisms: snowmelt, overbank flooding from nearby streams, and rainfall (BLM 2014).

Lakes in the Willow area were sampled in the summers of 2017 (31 lakes) and 2018 (47 lakes) to identify possible sources of freshwater (McFarland, Morris et al. 2017b; McFarland, Morris, Moulton et al. 2019b). Lake volume varied from 22 to 3,209 MG, and maximum depth varied from 4.2 to 29.9 feet. Lake M0015 (R0056) is proposed to be connected to the CFWR and Lake L9911 and/or M0235 are proposed as potable water sources (varies by alternative). Lake L9911 has an estimated volume of 1,585.8 MG, and at the time of sampling in July 2004, a maximum depth of 8.0 feet, turbidity of 0.7 to 1.0 nephelometric turbidity unit (NTU), and pH of 7.9 to 8.2 units. Lake M0235 has an estimated volume of 237.0 MG, a maximum depth of 7.7 feet, and at the time of sampling in August 2002, a turbidity of 1.2 NTU and pH of 7.7 units (CPAI 2019a, 2020b).

3.8.1.1.3 Freshwater Water Quality

Most freshwaters in the NPR-A are considered pristine (BLM 2012b). Limited data on surface water quality in the analysis area (McFarland, Morris et al. 2017a, 2017b; McFarland, Morris, Moulton et al. 2019b; McFarland, Morris, Moulton, Moulton et al. 2019) indicate it is generally good and meets **Alaska water quality standards**. Water quality data for freshwaters in the Willow area are summarized in Table 3.8.2. No fresh waterbodies are listed as impaired by Alaska Department of Environmental Conservation on its CWA Section 303(d) list (ADEC 2018a), though absence of listing does not indicate that a waterbody meets water quality standards since data may not be available for all waterbodies. The CWA Section 303(d) list includes waterbodies in which one or more **water quality criteria** are not attained or waterbodies that are impaired for at least one **designated use**.

Turbidity in lakes and streams is naturally high during spring breakup but otherwise is generally low. Lakes in the ACP generally have lower pH values in the winter months, due in part to the **ice exclusion process** (that occurs during freeze-up). This natural process causes pH to be seasonally below water quality standards even in natural conditions. It may also cause turbidity to increase with depth in winter. Both conditions typically cease with spring breakup. During summer, turbidity may be higher in shallower lakes than deeper lakes due to wind mixing.

North Slope freshwater can also be naturally high in barium (Guay and Falkner 1998). Ponds and local streams are often colored from dissolved organic matter and iron, and most fresh waterbodies in the NPR-A have low turbidity and dissolved oxygen near saturation.

Fecal contamination above Alaska water quality standards may naturally occur in areas with dense avian, caribou, and lemming populations. Cold water temperatures tend to prolong the viability of fecal coliform.

During spring breakup, and to a lesser extent during summer rainfall-driven high-water events, the Colville River carries suspended sediment (SS) from the foothills of the Brooks Range and has higher turbidity than any of the smaller rivers originating within the ACP. Most of the annual sediment load is carried between May and October, with approximately 62% flowing to the CRD during 13 days in spring breakup (May and June) (Walker and Hudson 2003). For example, sediment transport at Nuiqsut can range from 467,000 tons per day in June to less than 100 tons per day during the low-flow period in July (USGS 2016). For the majority of the year, most flowing freshwaters have low SS concentrations and therefore low turbidity. From midsummer through freeze-up, SS concentrations decrease to as low as 3 parts per million in the Colville River at Nuiqsut (USGS 2016) with measured turbidity as low as 0.7 NTU.

Ocean Point on the Colville River is upstream of the saltwater intrusion influence, which can reach at least 30 miles upstream from Harrison Bay in winter (Arnborg, Walker et al. 1962), and is thought to be just upstream from the Itkillik River. Thus, measurements of winter flow and water surface elevation at Ocean Point are more reliable than locations downstream. Table 3.8.2 shows water quality data for the Colville River at Umiat.

Table 3.8.1. Summary of Largest Rivers Near the Willow Area

Characteristic	Kalikpik River	Fish Creek (Uvlutuuq and Iqalliqpik)	Judy Creek (Kayyaaq and Iqalliqpik)	Ublutuoch (Tiŋmiaqsiuġvik) River	Colville River
Drainage area (square miles)	264	215[a]	385	236	13,860 at Umiat, 20,670 at Nuiqsut
Receiving waters	Harrison Bay	Harrison Bay	Fish (Iqalliqpik) Creek at RM 26	Fish (Iqalliqpik) Creek at RM 10	Harrison Bay
Headwaters	Arctic Coastal Plain	Brooks Range foothills	Brooks Range foothills	Arctic Coastal Plain	De Long Mountains, Brooks Range
Channel character in Project area	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Low gradient; at Ocean Point reach, channel transitions from upstream multiple serpentine meanders to downstream single meandering channel
Tributaries that intersect Project's gravel infrastructure or mine site	None	Judy (Kayyaaq and Iqalliqpik) Creek[a], Ublutuoch (Tiŋmiaqsiuġvik) River[a], and Willow Creek 8	Judy (Kayyaaq) Creek, Willow Creek 1, 2, 3, and 4	Bills Creek	None
Primary flood-event driver	Spring breakup	Spring breakup	Spring breakup	Spring breakup	Spring breakup
Observed conditions affecting annual peak WSEs and WSE at time of annual peak discharge	Snow and ice in channel and on floodplain.	Snow and ice in channel and on floodplain, and ice jams	Snow and ice in channel and on floodplain, and ice jams	Snow and ice in channel and on floodplain	Snow and ice in channel and on floodplain
Bank erosion	NA	Undercutting and sloughing observed along the outside of meander bends	Undercutting and sloughing observed along the outside of meander bends	NA	Sloughing and eroding bluff on south (right) bank at Ocean Point (transect 6 in Michael Baker International 2019)
Spring breakup monitoring record	RM 21.8 (Kal 1): 1 season of stage data; no observed peak discharge information available	RM 32.4: 17 seasons of stage and discharge data, median observed spring peak discharge 3,370 cfs RMs 11.7, 12.6, 18.4, 25.1, 32.4, 43.3, and 55.5: 1–5 seasons of stage (and sometimes discharge) data	RM 7: 17 seasons of stage and discharge data, median observed spring peak discharge 4,770 cfs RMs 13.8, 16.5, 21.4, and 31.1: 1–7 seasons of stage (and sometimes discharge) data	RM 13.7: 17 seasons of stage and discharge data, median observed spring peak discharge 1,700 cfs RMs 6.8, 8.0, 13.5, 14.5, and 15.5: 1–8 seasons of stage (and sometimes discharge) data	Nuiqsut (RM 26.5, Monument 1): 28 seasons of stage and discharge data (MBI 2019) Umiat (RM 90): 17 seasons of stage and discharge data, median observed spring peak discharge is 188,000 cfs
Summer monitoring record	RM 21.8 (Kal 1): 1 season of stage data	RM 32.4: 17 seasons of stage and discharge data RM 55.5: 1 season of stage data	RM 7: 17 seasons of stage and discharge data RM 21.4: 1 season of stage data	RM 13.7: 17 seasons of stage and discharge data	Umiat: 17 seasons of stage and discharge data from (USGS 2020b) Ocean Point: 2 discharge measurements from September 2019 (Michael Baker International 2019)
Winter monitoring record	None	None	None	None	Umiat: 17 seasons of discharge data (USGS 2020b) Ocean Point: 1 measurement from 2007 and 2 measurements from winter 2019/2020 (including average floating ice thickness, average water under ice, and average velocity)

Characteristic	Kalikpik River	Fish Creek (Uvlutuuq and Iqalliqpik)	Judy Creek (Kayyaaq and Iqalliqpik)	Ublutuoch (Tiŋmiaqsiuġvik) River	Colville River
Water quality record[b]	Just upstream of BT4: 2 summers of data	Uvlutuuq channel just upstream of proposed road crossing: 2 summers of data	Judy (Kayyaaq) Creek near BT1: 2 summers of data	Bills Creek: 2 summers of data	Umiat: 6 summers of data Ocean Point: 2 transects sampled September (Michael Baker International 2019), December 2019 (CPAI 2019d), and February 2020 (CPAI 2020b; Michael Baker International 2020))
Existing infrastructure in basin	None	GMT-1, GMT-2	None	GMT-1, GMT-2, and Alpine CD5	Nuiqsut, Umiat, Alpine oil field, Nuna development, ASRC Mine Site

Note: ASRC (Arctic Slope Regional Corporation); BT1 (Bear Tooth drill site 1); BT4 (Bear Tooth drill site 4); CD (Colville Delta); cfs (cubic feet per second); GMT (Greater Mooses Tooth); Kal 1 (Kalikpik gauging station at RM 21.8); NA (not applicable); RM (river mile); WSE (water surface elevation). Source data and detailed information on the rivers in this table are provided in Appendix E.8A, *Water Resources Technical Appendix*. Data for Colville River at Umiat are from USGS gaging station 15870000 (USGS 2020b).
[a] Drainage area does not include the tributary basins of Judy (Kayyaaq and Iqalliqpik) Creek and Ublutuoch (Tiŋmiaqsiuġvik) River, which are calculated separately, as shown in Figure 3.8.1. The drainage area for all three hydrologic unit codes is 836 square miles.
[b] Water quality data are described in Section 3.8.1.1.3, *Freshwater Water Quality*.

Table 3.8.2. Water Quality Data for Rivers, Streams, and Lakes in and near the Willow Area

Waterbody	Water Temperature (degrees Celsius)	Turbidity (NTU)	pH Range
Colville River at Umiat[a]	0.2 to 18.3	2	7.2 to 8.0
Colville River at Ocean Point[b]	0.1 to 10	Not taken	Not taken
Kalikpik River	2.7 to 18.9	2.1 to 14.9	7.7 to 8.1
Fish (Uvlutuuq) Creek	3.2 to 18.4	2.5 to 31.9	7.6 to 8.0
Judy (Kayyaaq) Creek	3.5 to 16.9	1.4 to 12.8	6.9 to 8.1
Judy (Iqalliqpik) Creek	3.7 to 17.9	2.7 to 34.1	7.3 to 8.4
Ublutuoch (Tiŋmiaqsiuġvik) River, Bills Creek	2.7 to 17.0	0.43 to 5.0	7.4 to 7.9
Willow Creek 1	3.4 to 18.1	0.7 to 11.6	6.8 to 8.3
Willow Creek 2	3.0 to 18.0	0.4 to 28.2	7.2 to 8.1
Willow Creek 3 (July only)	11.0 to 13.9	1.3 to 33.3	7.7 to 8.2
Willow Creek 4	3.7 to 17.8	0.5 to 4.3	7.0 to 8.3
Willow Creek 4A	3.6 to 18.7	0.7 to 25.7	7.2 to 7.7
Willow Creek 8	3.9 to 18.3	0.7 to 19.0	7.0 to 7.9
Lakes[c]	6.6 to 17.7	0.5 to 8.1	6.9 to 8.4

Note: NTU (nephelometric turbidity units). Data collected in summer 2017 and 2018.
Source: MBI 2020; McFarland, Morris, Moulton, and Moulton 2017a, 2017b, 2019; McFarland, Morris, Moulton, Moulton et al. 2019; USGS 2020
[a] Water temperature data at Umiat from 1969, 1975, 1978, 2005, and 2007. Turbidity measurement is from 1975 and thus is reported in Jackson Turbidity Units not NTU.
[b] Based on three measurements taken in September and December 2019 and February 2020, detailed in Appendix E.8A, *Water Resources Technical Appendix*.
[c] Lake volume ranged from 22 to 3,209 million gallons and maximum depth varied from 4.2 to 29.9 feet.

3.8.1.1.4 Marine Waters

Harrison Bay spans approximately 62 miles of coastline between Oliktok Point and Cape Halkett. The bay contains the receiving waters for most freshwaters in the analysis area. Sediments on the nearshore Beaufort Sea continental shelf consist primarily of mud, with some coarser material. Sediments tend to be coarser grained closer to shore and in shallower water depths due to wave and current winnowing, with finer grained sediment farther from shore and at deeper water depths (Carey, Ruff et al. 1981). The nearshore waters are most influenced by river input but are also affected by processes offshore in the deep basin, such as currents. During the open-water season, surface currents are primarily wind driven close to shore. Coastal upwelling contributes to the high productivity of such environments (Bakun 1973). Ice covers the sea for up to 9 months of the year, generally from September to May (North Pacific Fishery Management Council 2009). The thickness of **bottom-fast ice** near the CRD at the end of the winter season averages about 5.2 feet (Dodds and Richmond 2017 as cited in Michael Baker International 2017). Ice movement onto shore during wind-driven events causes scouring and trenching and can seasonally alter the shoreline. Sea ice pressure ridges scour and gouge the seafloor and move sediments, creating natural, seasonal disruptions of the seafloor.

Harrison Bay has an average tidal range of 0.5 foot, which is generally overshadowed by storm surges and wind-induced waves (USACE 2018). During open-water season, water circulation is dominated by prevailing northeasterly winds. In winter, ice becomes bottom-fast in water less than 5 feet deep (Weingartner, Danielson et al. 2017).

The shelf of the Beaufort Sea in Harrison Bay at the mouth of the Colville River is shallow. The Colville River is the dominant discharge to this bay, discharging warmer freshwater and sediment during spring and summer. In the Oliktok Point area, 10 miles east of the mouth of the East Channel of the Colville River, outflow from the CRD and coastal erosion transport significant amounts of SS (Dunton, Weingartner et al. 2006). From Oliktok Point eastward, a chain of barrier islands form Simpson Lagoon. Simpson Lagoon has a relatively shallow nearshore shelf that provides a mixing environment for turbid, sediment-bearing, freshwater inflows, such as the Colville, Kuparuk, Sagavanirktok, and other smaller rivers. Freezing and thawing sea ice and river runoff during the summer melting season significantly affect coastal water mass characteristics and decrease salinity. The nearshore areas of the Beaufort Sea are fresher and more turbid compared to the deeper offshore areas, which are clearer, colder, and more saline. Harrison Bay is sheltered from wave energy from the northwest. The area near Atigaru Point is influenced by the sediment released by coastal erosion and the sediment load from the Colville River. Sediment transport by the longshore current is relatively low. The coastline of Harrison Bay is predominantly erosional (Gibbs and Richmond 2015). Although a shoal occurs near Atigaru Point, it has had little deposition (0.06 foot/year) in the last 65 years (CPAI 2019b).

No marine waterbodies in the analysis area are listed as impaired by Alaska Department of Environmental Conservation on its CWA Section 303(d) list (ADEC 2018a). During most of the winter season, when ice covers the sea surface and river discharge is negligible, background levels of total suspended solids (TSS) in the nearshore Beaufort Sea typically range from 0.1 to 0.5 milligrams per liter (mg/L) (Trefry, Rember et al. 2004). During the spring freshet, however, when river discharge occurs prior to breakup of the sea ice, substantial increases in TSS occur. Measurements obtained in 2001 and 2006 documented mean values of 343 and 785 mg/L, respectively, in the Colville River (Trefry, Trocine et al. 2009). During the open-water season, nearshore TSS values in the Beaufort Sea are governed primarily by the wave conditions, which in turn are governed by the wind conditions. Concentrations tend to range from 5 to 15 mg/L when wind speeds range from 10 to 20 knots (11.5 to 23 mph) and 50 to 100 mg/L when the wind speeds exceed 20 knots (23 mph) (Trefry, Trocine et al. 2009). Wind data obtained at the mouth of the Colville River during the 2001 open-water season indicate that speeds of 10 to 20 knots (11.5 to 23 mph) occur about 49% of the time, while those greater than 20 knots (23 mph) occur about 8% of the time.

Existing marine infrastructure in the analysis area occurs at Oliktok Point, where there is a commercial sheet-pile dock, shoreline armoring, and a saltwater treatment plant. In addition, Oooguruk Island, a 6-acre constructed gravel island with a pipeline to shore, is located near the mouth of the Colville River. Screeding occurs with seasonal regularity at Oliktok Dock prior to barge arrival.

3.8.1.2 Groundwater

The availability of groundwater in the analysis area is limited due to the presence of continuous permafrost on the North Slope (BLM 2014). The groundwater is confined to shallow zones near large surface waterbodies such as lakes, streams, and rivers. The areas that contain groundwater, predominantly taliks (i.e., layers of unfrozen ground occurring in permafrost), are recharged primarily with snowmelt.

Deep groundwater, although present, generally is not connected to the surface water system because permafrost acts as a barrier (NRC 2003). Some sub-lake taliks extend through permafrost, but no connection between sub-permafrost groundwater and surface water has been demonstrated (Hinkel, Arp et al. 2017). Deep groundwater on the North Slope is saline (Kharaka and Carothers 1988; Sloan 1987) and is not a source of potable water.

3.8.2 Environmental Consequences

3.8.2.1 Avoidance, Minimization, and Mitigation

3.8.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.8.3 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate water resource impacts from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to human health and safety, fish, waterfowl and invertebrate habitat and subsistence hunting and fishing areas associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.8.3 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to water resources. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.8.3 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2019c).

Table 3.8.3. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Water Resources

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive Waste Management Plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or state permit.	Changes do not affect text as described.
BMP A-3	Minimize pollution through effective hazardous materials contingency planning.	Prepare and implement a hazardous materials emergency contingency plan before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes, and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive Spill Prevention, Control, and Countermeasures Plan.	Develop a comprehensive Spill Prevention, Control, and Countermeasure Plan, if oil storage capacity is 1,320 gallons or greater.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
ROP A-13	Prevent the release of poly- and perfluoroalkyl substances associated with the use of aqueous film-forming foam, a firefighting foam designed to extinguish flammable and combustible liquids and gases.	No similar requirement.	At facilities where fire-fighting foam is required, use fluorine-free foam unless other state or federal regulations require aqueous film-forming foam use. If aqueous film-forming foam use is required, contain, collect, treat, and properly dispose of all runoff, wastewater from training events, and, to the greatest extent possible, from any emergency response events.
BMP B-1	Maintain populations of, and adequate habitat for, fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.	Changes do not affect text as described.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	The withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4 feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during winter and withdrawal of water from lakes during summer may be authorized on a site-specific basis depending on water volume and depth, the fish community, and connectivity to other lakes or streams. BLM must be notified within 48 hours of any observation of dead or injured fish on water source intake screens, in the hole being used for pumping, or within any portion of ice roads or pads. If observed at a particular lake, pumping must cease temporarily from that hole until additional preventive measures are taken to avoid further impacts on fish.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize the compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation is prohibited. Vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	Revised text: – Ground operations would only be allowed when frost and snow cover are at a sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative) . For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	The crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	Added text: – Permittee shall provide to BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of road/trail construction. – In spring, provide BLM with photographs of all stream crossings that have been removed, breached, or slotted.
BMP C-4	Avoid additional freeze-down of deepwater pools harboring overwintering fish and invertebrates used by fish.	Travel up and down streambeds is prohibited unless demonstrated that there will be no additional impacts to overwintering fish or the invertebrates they rely on.	Some travel up and down streambeds would be allowed by the individual vehicles collecting snow from river drifts or ice aggregate from the channel (where ice is grounded).
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.	Added text: Permittees shall construct a subsistence pullout and boat ramp at crossings of heavily used subsistence rivers as determined by consultation with the community.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet of fish-bearing waterbodies. Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and encouraged.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A postconstruction monitoring program, developed in consultation with appropriate federal, state, and North Slope Borough agencies, shall be required to track circulation patterns, water quality, and fish movements around the structure.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.	Added text: – Stream and marsh crossings will be designed on at least 1 year of relevant hydrologic data. Additional years of hydrologic data collection may be required if more information is needed to design the crossing structure in order to attain the BMP. – The crossing structure design shall account for permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment. – A minimum of 1 year of hydrologic data sampling is required at stream and marsh crossings. Additional years of hydrologic data collection may be required if more information is needed to design the crossing structure in order to attain the BMP objective and meet requirements. – All proposed crossing designs would adhere to the standards outlined in fish passage design guidelines developed by the U.S. Fish and Wildlife Service Alaska Fish Passage Program (USFWS 2019b), USFWS Culvert Design Guidelines for Ecological Function (USFWS 2020a), Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (USFS 2008), and other generally accepted BMPs prescribed by BLM.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the BLM and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies. The plan must consider the following: a. Locations outside the active floodplain. b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use. c. Potential use of the site for enhancing fish and wildlife habitat. d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.	Added text: – The plan shall consider locations outside the active floodplain or design gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. - – Incorporate as much as practicable the storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present. – Mine pit design and methods shall be engineered to minimize permafrost regime disturbance and protect surface stability.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before the approval of facility construction	In addition to 2013 requirements, develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments (for alternatives B, C, D: based on LiDAR or other high-accuracy surface imaging).
BMP E-14	Ensure the passage of fish at stream crossings.	To ensure that crossings provide for fish passage, all proposed crossing designs shall collect at least 3 years of hydrologic and fish data.	Similar requirement is BMP E-6.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration to the land's previous hydrological and vegetative condition.	Changes do not affect text as described.
LS/ BMP K-1[a]	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or overwintering fish habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in stream beds and adjacent to the rivers listed. Rivers in the Project area that are listed include the Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	No surface occupancy or new infrastructure, except essential road and pipeline crossings in the following setbacks: the Colville River (2- to 7-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), the Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). Gravel mines may be located within the active floodplain, consistent with BMP E-8.
LS/ BMP K-2[a]	(Deepwater Lakes) Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change of vegetative and physical characteristics of deepwater lakes; minimize the loss of spawning, rearing, or overwintering fish habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within one quarter mile mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).	Changes do not affect text as described.
BMP K-4a[a]	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins.	Changed to Stipulations K-6 and K-7. Some alternatives allow leasing. Some alternatives allow new infrastructure with limitations. Within the Goose Molting Area, no permanent oil and gas facilities, except for pipelines, would be allowed within 0.5 mile of the shoreline of selected lakes. Lakes were selected based on the 85% distribution of black brant within the Goose Molting Area.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-6[a]	(Coastal Area Setback) Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. For permanent oil and gas facility in the coastal area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain adequate habitat for birds, fish, and terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.

Source: BLM 2013a, 2020a

Note: BLM (Bureau of Land Management); BMP (best management practice); DEW (Distant Early Warning); F (Fahrenheit); IAP (Integrated Activity Plan); LiDAR (Light Detection and Ranging); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSO (no surface occupancy), ROP (required operating procedure); USFWS (U.S. Fish and Wildlife Service); USGS (U.S. Geological Survey).

[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, Alternatives Development. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect water resources would include those to LS E-2 and BMPs K-1 K-2, and K-6. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMP K-1), a CFWR connected to Lake M0015, and freshwater intake pipelines at Lakes L9911 and/or M0235 (varies by alternative) (Figure 3.8.3). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would intake and discharge ballast water to ground barges at Oliktok Dock and the barge lightering area; Options 1 and 2 would intake and discharge ballast water at the MTIs and the lightering areas. These ballast water exchanges would occur within 3 miles of the coastline (see BMP K-6), but intake and discharge would occur in the same location and ballast water would not be transported.

Option 3 may require management of water under the partially grounded ice bridge over the Colville River at Ocean Point. If water from the river needs to be pumped around the bridge during the 2 winters of ice bridge use, this may require a deviation to BMP B-1.

3.8.2.1.2 <u>Proponent's Design Measures to Avoid and Minimize Effects</u>

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.8.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

Appendix E.8A provides detail about culvert, bridge, and pipeline design and how that influences potential effects to water resources. Additional suggested measures to reduce impacts created by culvert, bridge, and pipeline crossings, could include the following:

1. Unless a more appropriate method is available, when estimating flood-peak discharge at locations within the Fish (Iqalliqpik) Creek, Judy (Iqalliqpik) Creek, and Ublutuoch (Tiŋmiaqsiuġvik) River basins, use a weighted average from a single station analysis of the BLM long-term monitoring station data on each of these streams and the Shell regression equations (Appendix E.8A). Weight the results of the two computations based on the uncertainty associated with each estimate.
2. As appropriate, consider both 1) snow- and ice-impacted conditions and 2) ice-free conditions in the hydraulic design of bridges, culverts, and pipeline river crossings. Cross-section data at the time of the peak stage and peak discharge that are available for many rivers and streams indicate that the WSE was affected by snow and/or ice blockage. Based on the available information, develop designs that would perform satisfactorily during the design event considering both the possibility of open-water conditions and the possibility that snow and ice blockage is occurring at the time of the design event. At a minimum, the magnitude of the blockage used in the designs should be similar to the magnitude of the blockage that has been observed.
3. At a minimum, design culverts to perform satisfactorily for all flood events up to and including the 50-year event. The headwater-to-diameter ratio at the maximum design condition should be no greater than 1.0.
4. Identify the locations requiring cross-drainage culverts during spring breakup prior to construction by noting all locations where water is flowing over the proposed alignment. This is necessary because it is often not possible to determine where water flowing in polygon troughs will cross the alignment during a summer or fall inspection. At the same time, identify the ends of the proposed culverts and the invert elevation of the ends of the culvert in order to maintain the flow in the historic flow path.
5. At a minimum, design road bridges to pass the 50-year flood-peak discharge with a minimum of a 3-foot freeboard (assuming snow and ice conditions have been considered in estimating the design water surface elevation). Design for bridge foundation scour equal to the maximum scour depth produced by floods up through a magnitude equal to the 100-year flood event and a geotechnical design practice safety factor of from 2 to 3. Check the bridge design using a superflood and a geotechnical design practice safety factor of 1. The superflood is defined as the 500-year event, 1.7 times the magnitude of the 100-year event, or the overtopping flood, whichever is the least. These are standard criteria used by Alaska Department of Transportation and Public Facilities for bridges on the North Slope in nondesignated flood hazard areas.
6. At a minimum, design pipeline river crossings to perform satisfactorily for all floods up to and including the 200-year event (including crossings on bridges or VSMs). This is the magnitude of the design event that has typically been used for common carrier pipelines on the North Slope and a higher level of design than is being proposed for the Project.
7. Start bridge and culvert hydraulic computations sufficiently downstream so that the downstream boundary assumptions do not affect the performance of the proposed design. Consider the USACE (1986) report *Accuracy of Computed Water Surface Profiles* in determining the location of the downstream boundary for hydraulic computations.
8. If the highest observed WSE or high-water mark is higher than the predicted 50-year WSE at a culvert, bridge, or pipeline, reevaluate the design water surface elevation to confirm that snow and ice blockage and other details of the computation are accurate. Given the conditions on the North Slope, it is unlikely that high-water marks from a 50-year flood or greater would be recognizable unless it occurred in the last 10 to 20 years. Additionally, it is improbable that a 1- to 5-year field program would experience a 50-year flood. It is more likely that snow and ice blockage greater than accounted for in the model used to predict the 50-year WSE or an error in the downstream boundary condition used in the model has occurred.
9. Use a freeboard at bridges and pipeline crossings, which considers the uncertainty in the magnitude of the design flood, the uncertainty in the hydraulic computations, and the height of the ice and debris that may be carried by the flood but is not less than 3 feet.
10. Where an aboveground pipeline crossing is *immediately* upstream from a road, backwater from the road during the pipeline design event should be considered when setting the bottom of the pipe elevation. Additionally, if the road is designed for a smaller flood than the pipeline, the changes in hydraulic conditions at the pipeline as a result of the road washout should be considered (i.e., changes in location of the concentrated flow and the impact on erosion at the VSM).

11. Where an aboveground pipeline crossing is immediately downstream from a road, the impact of the road on where water would be flowing and the velocity of the water at the pipeline VSM should be considered. Additionally, if the road is designed for a smaller flood than the pipeline, the changes in hydraulic conditions at the pipeline as a result of the road washout should be considered (i.e., changes in the location of the concentrated flow and the impact on erosion at the VSM).
12. Breach ice road crossings sufficiently that ice from the crossing would not contribute to ice jams or increase snow and ice blockage during spring breakup.
13. Avoid placing multi-season ice pads in floodplains (e.g., construction pads at the mine site).
14. Prior to HDD construction, provide a monitoring and response plan for determining if drilling mud is being lost to formation or making it to the river or groundwater during drilling.
15. Should any spills occur on the MTI, the affected gravel would be addressed immediately and removed prior to MTI abandonment.
16. If Option 1 or 2 is selected, place and maintain appropriate navigation aids on the MTI after it is decommissioned (the top of the MTI is expected to drop to or below the water surface).
17. Provide annual surveillance of bridge, culvert, and pipeline river crossings to confirm that structures are functioning properly and provide maintenance as required.
18. Continue to collect baseline data regarding discharge, ice conditions, and bank conditions on the Colville River near Ocean Point throughout winters every year until ice bridge construction so that an ice bridge plan can be drafted that would include the exact crossing location for bridge and ramps, plans for flow and fish passage management (should they be needed), actions to be taken at the end of ice bridge use (such as slotting or culvert removal, if needed). Prepare an adaptive management plan that provides detail regarding how any unanticipated surface water flow blockages would be identified and corrected as quickly as possible, to avoid lasting environmental impacts.
19. Include erosion mitigation features or options in the engineering design of boat ramp(s) to prevent or minimize erosion potential at the boat ramp(s) and along adjacent riverbanks.
20. Develop a maintenance plan for the boat ramps to ensure long-term viability and use of the site(s) while minimizing impacts to the adjacent waterbodies. Include the following points at a minimum:
    a. Identify entity responsible for site maintenance;
    b. Annual maintenance (grading) of parking pads, turning pads, access ramps, and road access;
    c. Maintain a gravel supply (off-site) to reinforce boat ramps and pads when necessary; and
    d. Regular clean-up of pads and surroundings, including back-haul of trash to suitable disposal site.
21. Before construction and continuing through operations, test and monitor freshwater sources that intersect the Project for hydrocarbons

3.8.2.2 Alternative A: No Action

Under the No Action Alternative, ice infrastructure and associated water withdrawals in the analysis area could continue to occur to support oil and gas exploration. Effects from the existing gravel infrastructure in the Alpine and GMT oil fields would continue, as described in Section 3.8.1.1, *Surface Waters*. No new infrastructure would be constructed for the Project.

3.8.2.3 Alternative B: Proponent's Project

Project activities with the potential to affect water resources would include gravel mining; construction and use of ice and gravel infrastructure; construction and use of in-water structures (bridges, culverts, and water intakes) and pipelines; water withdrawals; the CFWR; and wastewater disposal. Effects of these activities on water resources are discussed below.

3.8.2.3.1 <u>Gravel Mining</u>

Water resources could be impacted by gravel mine excavation and dewatering. Gravel mining at the Tiŋmiaqsiuġvik Mine Site adjacent to the Ublutuoch (Tiŋmiaqsiuġvik) River would occur in winter over several construction seasons. The mine site consists of two distinct areas separated by the Ublutuoch (Tiŋmiaqsiuġvik) River. Perimeter berms constructed of excavated overburden would be placed around the excavated areas to prevent surface flows into the mine areas and minimize the amount of dewatering that is necessary while the mine site is open. When gravel extraction for a season is complete, the overburden would be placed back in the mined area, leaving a depression. The depression would impound precipitation and meltwater from adjacent seasonally thawed permafrost. Dewatering the mine areas would be required while the mine site is open. Discharge water would be pumped to the tundra through a diffuser to mitigate erosion.

Thermokarst erosion from ponded water may increase SS and turbidity in surface water in the mine pits, which would be likely to settle within several years after the sites have stopped filling (Ott, Winters et al. 2014). Stormwater runoff during mine development could also increase SS and turbidity; however, runoff would be contained in the mine pits and the pits would be dewatered in the fall preceding the winter in which mining would occur. Potential pollutants in gravel mine dewatering effluent include SS and petroleum hydrocarbons. Tundra areas that receive the discharged water may act to filter some turbidity from the water. Mine dewatering would be covered under APDES General Permit AKG332000, which authorizes wastewater discharges to tundra, freshwaters, and marine waters from oil- and gas-related facilities. The permit requires development and implementation of BMPs to avoid and minimize impacts to water quality.

Damage to the permafrost from mining would be permanent, and so would the resulting impoundment of water. After mining has ceased, the mine pit is expected to slowly fill with water from precipitation and snowmelt. After approximately 10 years, the pit would be full and could crest the banks of the pit during periods of high sheet flow (expected at only at spring runoff). The mine pit would have perimeter berms to provide thermal stability (described in Section 3.4.2.3.1). Each mine cell would have a low point in the mine perimeter berm (see Figure 3 in Appendix D.2, *Willow Mine Site Mining and Reclamation Plan*), that would allow drainage from the pit at high water. Although the mine pits would not be connected to adjacent streams, water from the pits could flow over the tundra to the Ublutuoch (Tiŋmiaqsiuġvik) River during spring breakup. Such maximum flows would occur once per year during spring breakup; significant releases are not expected during other times of the year. Summer releases would be infrequent or insignificant due to low summer precipitation on the North Slope. The estimated total volume of overflow during spring breakup is 28.7 acre-feet for Area 1 and 8.6 acre-feet for Area 2.[11] The gradient of the Area 1 runoff area is estimated at 0.5% to 2% for the first 400 feet and gradually increases to 4% slope thereafter; the distance from the pit outlet to the stream is approximately 700 feet. The runoff area gradient for Area 2 is estimated between 0.5% and 2.5%; the distance from the pit outlet to the stream is approximately 1,200 feet. Both runoff areas consist of undisturbed tundra. The deepwater areas in the pit would function as sedimentation ponds; thus, sediment in water flowing into the pit is expected to settle out. Based on the volume of runoff and the gradient of the runoff area, surface erosion between the mine pits and the stream would occur. The flow would likely erode a channel in the tundra, which could lead to permafrost erosion and sediment transport. As a result, the mine site could add an annual slight increase in water quantity and sediment to the Ublutuoch (Tiŋmiaqsiuġvik) River; the increase in water quantity would likely be nondistinguishable from baseline spring high-flow conditions. Increases in turbidity and SS may also be nondistinguishable initially during spring breakup. However, rates of erosion and sediment transport may increase as the gully networks increase with permafrost degradation (Godin, Fortier et al. 2014). Headward gully erosion would have the potential to lower the elevation of the pit low point, increasing the amount of water and sediment released during spring breakup

3.8.2.3.2 Ice Infrastructure

Seasonal ice roads and pads would be used for 7 years during construction. Alternative B would construct a total of 4,557.3 acres of ice infrastructure (495.2 miles of ice roads). Ice infrastructure can block or restrict the flow of surface water during spring breakup if located on or near natural drainage paths, diminishing their capacity to convey water, and potentially lead to impoundment of flow, changes in channel stability and alignment, and erosion. Three multi-season ice pads would be used during construction (10.0 acres each) at GMT-2, the WOC, and the mine site. The duration of effects of these pads would be longer than single-season ice pads. The multi-season ice pads would be located outside the floodplain.

Ice road construction over lakes that do not freeze to the bottom could affect dissolved oxygen concentrations. Many of these lakes are just a foot to a few feet deeper than the minimum 6-foot depth necessary to maintain some unfrozen bottom water in winter (BLM 2004a). An ice road across a lake with such an intermediate depth could freeze the entire water column below the road, isolating portions of the lake basin and restricting circulation. As a result, mixing would be reduced and isolated pools with low oxygen could occur. Dissolved oxygen concentrations could be reduced below the 5 mg/L criterion needed to protect resident fish (18 AAC 70), but concentrations

[11] These values are derived from U.S. Department of Agriculture SNOTEL (snow telemetry) information for Site 1177 in Deadhorse and assumes that all precipitation between October 1 and May 31 is snow. This estimate does not account for **sublimation** or evaporation losses, or any changes due to snow drifting.

would increase to above that criterion after surface ice thaws in the spring. Ice roads across lakes shallower than 5 feet or greater than 8 feet would not be expected to have effects since the shallower lakes freeze to the bottom regardless of road presence and the water under the ice in deeper lakes would remain unfrozen.

Depending on the source of ice and water used to create ice roads and pads, the meltwater in the spring could have a temporary localized effect on specific conductance, alkalinity, and pH in the surrounding waterbodies. Water quality effects would be temporary and would likely return to existing conditions after spring recharge.

3.8.2.3.3 Gravel Infrastructure

Alternative B would construct 454.1 acres of gravel infrastructure in winter, when waterbodies would be frozen. Gravel infrastructure could increase turbidity and SS in surface waters surrounding the gravel fill during the spring thaw and summer rainfall events when runoff may entrain fine-grained fill material. Runoff would be localized and minimally increase the quantity of runoff and sediment to any single receiving drainage (may not be noticeable compared to background turbidity during breakup or rainfall events). Runoff would be sporadic and would occur over the life of the Project.

Use of the gravel infrastructure would create dust, the vast majority of which would settle within 328 feet (100 meters) of roads and pads. Dust from vehicle traffic would increase turbidity in waterbodies directly adjacent to gravel roads and pads. Dust would also settle onto surrounding vegetation, snow, and ground. This could decrease albedo, increase thermal conductivity, promote earlier spring thaw than in surrounding areas, and lead to ground subsidence from the melting of ice-rich sediments (Everett 1980; Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987). The dust shadow is detailed in Section 3.4, *Soils, Permafrost, and Gravel Resources* and would occur throughout the life of the Project.

Gravel infrastructure could result in upslope water impoundment and thermokarst erosion next to areas covered by gravel fill (Walker, Webber et al. 1987). Thermokarst erosion caused by both the disturbance of tundra and by the thermal effect of dust blown off the gravel onto the tundra can result in water features with high turbidity and SS. Thermokarst erosion could cause the water quality criteria to be temporarily exceeded within and downgradient of thermokarst features throughout the life of the Project.

Gravel infrastructure would be permanently located in the 50- or 100-year floodplains of Fish (Uvlutuuq) Creek, Judy (Kayyaaq) Creek, Judy (Iqalliqpik) Creek, Willow Creek 2, Willow Creek 4, Willow Creek 4A, Willow Creek 8, and the Ublutuoch (Tiŋmiaqsiuġvik) River (Figures 3.8.3 and 3.8.4). Although the floodplain at most of the stream crossings is limited to a very narrow area (barely visible in the figures), the floodplains of Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek are wider and would encompass the gravel road on either side of the crossing. These two streams would also have boat ramps constructed in their floodplains. If gravel roads, pads, or boat ramps block or restrict the flow of surface water during spring breakup, they may 1) increase the depth and duration of water impoundment, 2) increase thermokarsting, 3) cause a change in flow direction, 4) cause channel instability or a change in alignment, 5) result in erosion of the tundra or a stream channel, or 6) result in deposition of sediment on the tundra or in a stream channel. Effects 1 through 3 would occur on the upstream side of the road or pad; Effects 4 through 6 could occur on either the upstream or the downstream side of the road or pad. If the blockages were fixed within the year in which they were first observed, did not overtop the road or pad, and did not drain along the upstream side of the road, the resulting impact of the blockage would be measurable but would not require rehabilitation. However, thermokarsting due to water impoundments resulting from blockages would create a depression that would last indefinitely. If the blockage caused a change in flow direction, channel instability, or erosion of the tundra or stream channel, or resulted in deposition of sediment on the tundra or in the stream channel, the impact would be measurable and require rehabilitation. The impact could be visible for many years, even with rehabilitation.

3.8.2.3.4 In-Water Structures (bridges, culverts, water intakes, boat ramps)

Hydrologic changes to surface waters could result from the installation and use of culverts and bridges. Alternative B would construct 11 culvert batteries and 7 bridges, with 56 bridge piles below OHW, see Figure 3.8.6. The installation of culverts and bridges may cause temporary increases in SS and turbidity. The increases in SS and turbidity would likely be indistinguishable from background conditions during high-flow events. Piles would be driven in winter through bottom-fast ice, thus minimizing the potential for water quality impacts. During the life of a bridge or culvert, possible impacts to the stream include increased backwater on the upstream side of the structure; increased riverbed erosion within the bridge opening; increased riverbed and bank erosion downstream of the structure; increased sediment deposition downstream from the structure; increased sediment transport downstream from the structure; and a change in channel morphology downstream from the bridge. Appendix E.8A provides more details about the likelihood and extent of these effects, including a discussion about the flood event to which structures were designed and the probability of exceedance of that event. If one of these effects were to occur, it would occur immediately upstream and downstream of the structure.

The boat ramps on Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek would be in areas that contain eolian sand beds, which are highly mobile. Boat ramps in these locations could cause annual scour due to adding an area of hard substrate to an area of soft substrates and from loading and unloading boats (revving boat motors to load and unload boats from trailers as well as the tow vehicle's rear tires) and result in routine long-term in-water maintenance (Wilson 1996).

Construction of the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would occur in winter in an area with overwintering fish habitat, which means the ice may not be grounded during construction. If the construction occurs in water, two potential effects could occur. First, if the river ice surface was used as a work platform, the insulating snow cover would need to be removed, which could super cool the water immediately around the construction site and lead to the formation of slush throughout the entire water column, as observed at the Sagavanirktok River Bridge in 2009 (Morris and Winters 2009). Second, in-water work would increase SS and turbidity in the water column, which could persist for an extended period of time due to the lack of flow (as has been documented on similar winter construction projects in the Kuparuk River (Bill Morris, personal communication to L. Arsan [DOWL], January 16, 2020).

Water intakes would be installed at the CFWR at Lake M0015 and at Lake L9911 (an additional water source lake) and could temporarily increase SS and turbidity during installation.

3.8.2.3.5 Pipelines

All of the pipeline waterbody crossings would be aboveground on VSMs except for the HDD crossing of the Colville River, which would be installed 70 feet below the river channel using HDD.

VSM installation would occur in winter and thus would not affect water quality. Once installed, the VSMs would increase water velocity immediately adjacent to the VSMs, and scour holes would likely form around the VSMs during high water. The scour hole would not compromise pipeline integrity as long as the design properly considers the depth of the scour hole. Additionally, the material from the scour hole would be transported and deposited downstream. Appendix E.8A provides more details about VSMs and pipeline stream crossings.

The pipeline crossing of the Colville River would be located just north of the existing ASRC Mine Site (Figure 3.8.1). Drill cuttings and drilling fluids (also called mud) from the HDD process would not be discharged to surface water or the tundra but would be transported to an existing permitted UIC well for disposal or would be temporarily stored until an on-site Class I UIC disposal well is operational. During installation, there is a potential that the drilling fluid used to bore the pipeline below the streambed could be released into the stream through fractures, a process called a **frac-out**. If a frac-out occurs, the sediment load of the stream would increase. The magnitude of the impact would depend upon how fast the frac-out is recognized and the characteristics of the flow in the stream at the time of the frac-out. Drilling fluids would consist of a slurry of naturally occurring nontoxic materials (typically bentonite clay and water) and would not cause other water quality effects.

No other impacts to surface or ground waters are anticipated if current BMPs are followed.

3.8.2.3.6 Water Withdrawal and Diversion

Alternative B would withdraw 1,662.4 MG of freshwater from lakes over the life of the Project. Water would be used for four primary uses: 1) ice roads and pads during winter construction, 2) hydrostatic testing of pipelines (once at the end of construction), 3) dust suppression throughout the Project, and 4) as a potable water source during operations. Lake M0015 and Lake L9911 would be used as potable water sources. Lake M0015 has an estimated volume of 643 MG, with a maximum recommended winter withdrawal volume of 8.85 MG, and Lake L9911 has an estimated volume of 1,585.8 MG with a maximum recommended winter withdrawal volume of 59.0 MG, as per Alaska Department of Natural Resources' (ADNR's) water withdrawal calculation guidelines (ADNR n.d.).

Winter water withdrawal from lakes would gradually lower the water levels through each winter of construction. More than a decade of monitoring water levels in lakes used for water withdrawal for ice infrastructure has demonstrated that lakes are being recharged during spring breakup (Michael Baker International 2007, 2014a, 2014b, 2014c, 2015a, 2015b; Michael Baker Jr. Inc. 2002a, 2002b, 2007a, 2007b, 2008, 2009, 2011, 2012, 2013a, 2013b). Exceptions could occur in dry years, when a lake might require a year or longer to recover. Water withdrawal in the winter would potentially alter lake-water chemistry temporarily (until spring breakup and recharge) by depleting oxygen and changing pH and conductivity. Summer potable water withdrawal would have no effect on water quality since ice exclusion would not be occurring (Section 3.8.1.1.2, *Lakes and Ponds*).

The Project would also divert water for the CFWR. Excavation of the CFWR would temporarily increase SS in the CFWR connection channel during construction. Temporary increased sedimentation could occur during the connection of the reservoir to Lake M0015. To prevent erosion or a **head cut** in the connection channel while initially filling the CFWR, water would be transported from the intake through a pipe or other water conveyance system.

After the CFWR is excavated, it would be filled with water from Lake M0015 during the first year's breakup (a period of high flow). The volume of water required to fill the CFWR (80 MG) accounts for less than 4% of water volume storage within the Willow Creek 3 basin (which contains both Lakes M0015 and R0064, which are hydraulically connected, Figure 3.8.6). However, the amount of water available for use would be 55 MG, which is the total volume of the CFWR minus the volume of water below the pump (settling area) as well as an assumed ice thickness at the surface during the winter months. The estimated annual recharge volume of the basin exceeds that of the volume of the CFWR. Thus, the Willow Creek 3 annual peak flood flow, which naturally varies year to year but generally occurs during breakup, would be reduced during the filling of the CFWR. In early June 2019, two discharge measurements, 5 cfs and 16 cfs, were made at the Willow Creek 3 W3S monitoring location. These flow rates are equivalent to 3.23 MG a day and 103 MG a day, respectively. Opening the flow diversion gate to fill the CFWR would reduce the channel discharge during the 1- to 3-week period immediately following breakup before the summer low-flow regime occurs. However, widespread meltwater from snow cover on the surrounding tundra would contribute to drainage downstream of Lake M0015 and the CFWR, either in the Willow Creek 3 channel or in adjacent swales.

Minimal effects are anticipated to either Lakes M0015 or R0064 or to Willow Creek 3. The CFWR would be refilled as needed annually during breakup. Summer stage measurements at the Willow Creek 3 W3S monitoring station indicated water levels remained well below spring breakup peak stage, with minimal stage fluctuations associated with summer precipitation events. However, refill of the CFWR would not occur during periods of low flow. Thus, impacts to the summer flow regime of Willow Creek 3 would be minimal.

The CFWR would be separated from Lake M0015 and Willow Creek 3 (its inlet and outlet creek). Flow into the CFWR would be controlled using a manually controlled flow control gate; this would control water inflow and ensure sufficient outflow from Lake M0015 into Willow Creek 3. At times of low flow in Willow Creek 3, the flow control gate can be closed so that water is not diverted into the CFWR. Additionally, perimeter berms around the CFWR would prevent surface drainage from entering the basin.

3.8.2.3.7 Wastewater Disposal

Several types of wastewater would be produced during the Project: domestic wastewater, hydrostatic test water, runoff to secondary containment areas that must be dewatered, and drilling fluids and wastes. Most wastewater would be disposed into a Class 1 UIC disposal well. (Wastes allowed for injection include treated domestic wastewater, drilling muds and cuttings, well workover fluids, melt and stormwater, produced water, and other exempt and nonexempt nonhazardous fluids. The UIC permitting process requires CPAI to provide supporting information beyond what is included in the EIS, including, but not limited to, data regarding topography, geology, hydrogeology, nearby wells, well construction, well operation, monitoring, aquifer exemptions, and waste description.) Hydrostatic test water would be filtered, tested, and discharged to the tundra under the guidelines of APDES General Permit AKG332000. The purpose of hydrostatic testing is to test for leaks in the newly constructed pipelines prior to use; thus, test water would be from clean pipes and would not be expected to affect water quality.

Domestic wastewater (sewage) would be treated at the Project's wastewater treatment facility (at the WOC) and disposed into a Class 1 UIC disposal well. Domestic wastewater generated prior to UIC well completion (i.e., during construction) would be transported by tanker truck to an existing permitted UIC site at Alpine or Kuparuk (in winter only). In instances where weather or conditions at Alpine prevent transport to or disposal at the site, treated domestic wastewater would be discharged to the tundra, per the conditions of APDES General Permit

AKG572000. This permit (which authorizes wastewater discharges to tundra, freshwaters, and marine waters) stipulates effluent limits for pH, chlorine, dissolved oxygen, biochemical oxygen demand, solids, and bacteria. Monitoring is required for ammonia as nitrogen. After the Class I UIC well is established, discharge of treated domestic wastewater to the tundra or surface water is not proposed under normal operating conditions. If this is not possible, such as during maintenance or equipment malfunction, treated wastewater would be trucked to Alpine, or in emergency situations only, discharged to the tundra.

Transferring domestic wastewater to and from tanker trucks could result in the accidental release of domestic wastewater. Potential pollutants in domestic wastewater include total residual chlorine, dissolved oxygen, biochemical oxygen demand, solids, fecal coliform and enterococci bacteria, and nitrogen, which may potentially impact water quality. Such spills are not likely to have concentrations of pollutants that are toxic or hazardous to the environment, but they could cause exceedances of water quality criteria. Domestic wastewater spills are usually small (less than 20 gallons) and would typically occur on ice or gravel infrastructure during pumping or transferring or could result from frozen lines rupturing.

Other wastewater that would be transported by tanker truck to the Class I UIC well for disposal are runoff to secondary containment areas that must be dewatered, and drilling fluids and wastes. Accidental releases from these trucks could contain sediment and petroleum products. Spills of this type are usually small (less than 20 gallons) and would occur on ice or gravel infrastructure during pumping or transferring or could result from frozen lines rupturing.

Wastewater disposed into the Class I UIC well could interact with deep groundwater within the bedrock formations in which the wastewater would be injected; however, no negative effects would be anticipated. It would be highly unlikely that deep groundwater injected with waste fluids would travel laterally or vertically and intersect surface waters. The bedrock units in which waste fluids would be injected are thousands of feet deeper than the ocean floor, and often deeper than the hydrocarbon producing zones of the bedrock, making such an occurrence improbable (NRC 2003). If such an occurrence were possible, it likely would have been previously observed in numerous locations offshore from existing major oil fields (NRC 2003).

The Project’s Class I disposal wells would not impact a source of potable groundwater because the aquifers beneath the permafrost are saline and are not sources of drinking water. All waste injection would be in compliance with UIC permit stipulations.

3.8.2.3.8 Stormwater Runoff

Runoff may occur from stormwater (which includes rainfall and snowmelt) on structures, gravel infrastructure, and from water applied to gravel roads and pads for dust suppression. Stormwater discharges may contain sediment and residues or contaminants from equipment or vehicle drips and leaks (Chapter 4.0) on pads and roads. Pads and roads would be designed to limit point sources of runoff to the surrounding tundra: both snowmelt and rainwater on the pad would primarily seep directly through the gravel.

Stormwater discharges from the Project would be authorized and regulated under APDES General Permit AKG332000. As required under this permit, the Project includes development and implementation of a SWPPP for runoff from Project facilities. Under implementation of the SWPPP, water quality effects (increased turbidity, decreased dissolved oxygen, and increased levels of contaminants) would be minimized. Effects would occur primarily surrounding Project infrastructure.

The boat ramps would create stormwater runoff directly into their receiving waterbodies, which could increase contaminants in the channel near the ramps. The boat ramps would be included in the Project’s National Pollutant Discharge Elimination System permit.

3.8.2.3.9 Watercraft in Rivers

The boat ramps would increase access and use of the Ublutuoch (Tiŋmiaqsiuġvik) River, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek in the areas where they are navigable. Likely use would be by small skiffs (subsistence users). These personal watercraft would increase the potential for gas spills into waterbodies, both up- and downstream of the ramps. Boat wakes could also increase bank erosion both up and downstream of the ramps. The extent and magnitude of erosion would depend on the extent of boat use.

All three boat ramps could be constructed under Alternative B; only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed under Alternatives C and D because there would not be gravel road access to the other rivers. Although the number of potential users of each boat ramp is unknown, if only one ramp were constructed, use could be concentrated on that river and thus effects could be slightly higher there.

3.8.2.3.10 Screeding

Approximately 12.1 acres would be screeded at Oliktok Dock and barge lightering to recontour sediments prior to barge landings (Figure 3.8.7). Screeding would occur twice during construction. There is a significant amount of SS in the Oliktok Point area, due to outflow from the CRD and coastal erosion transport (Dunton, Weingartner et al. 2006). Sea-ice pressure ridges scour and gouge the seafloor and move sediments, creating natural, seasonal disruptions of the seafloor. Bottom disturbance is a natural and frequent occurrence in this nearshore region (Carey, Boudrias et al. 1984). In addition, Oliktok Dock is an existing industrial facility that is seasonally screeded before the arrival of barges. Screeding could temporarily increase turbidity in the screeding area.

3.8.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences (Table 3.8.4): there would be 1 fewer bridged stream crossing, 1 less culvert battery, 16 fewer piles below OHW and only one boat ramp; thus, there would be fewer structures below OHW to cause changes to hydrology and water quality. Only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed because there would not be gravel road access to the other rivers; therefore, there would be less fill in rivers. Although the number of potential users of each boat ramp is unknown, if only one ramp at the Ublutuoch (Tiŋmiaqsiuġvik) River were constructed, use could be concentrated on that river, and effects could be higher. There would be an annual ice road required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative C would have 1,050.7 more acres of ice infrastructure (5,608.0 acres total) and 251.9 MG more water withdrawals (1,914.3 MG total) that could cause changes to water quality in water source lakes and changes to hydrology around the compacted ice and snow. Alternative C would also require the use of ice roads throughout operations, so effects would last throughout the life of the Project. In addition, it would have the most miles of diesel pipeline (on the same VSMs as the Willow Pipeline) of the action alternatives, so it would have more infrastructure from which a spill could occur.

Table 3.8.4. Effects to Water Resources from Action Alternatives

Project Component	Effect to Water Resources	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Gravel fill	Increased suspended sediment and turbidity Upslope water impoundment and thermokarst erosion Blockage or restriction in flow of surface water during spring breakup	454.1 acres of fill 22.5 acres of dust shadow in streams 28.6 acres of dust shadow in lakes	507.6 acres of fill 10.2 acres of dust shadow in streams 32.5 acres of dust shadow in lakes	444.3 acres of fill 14.5 acres of dust shadow in streams 28.9 acres of dust shadow in lakes
Excavation at mine site and constructed freshwater reservoir	Thermokarst erosion Increased suspended sediment and turbidity Gully or channel formation from thermoerosion	166 acres excavated	Same as Alternative B	Same as Alternative B
In-water structures	Increased SS and turbidity Increased backwater on the upstream side of the structure; increased riverbed erosion within the bridge opening; increased riverbed and bank erosion downstream from the structure; increased sediment deposition downstream from the structure; increased sediment transport downstream from the structure; and a change in channel morphology downstream from the bridge	36 pipe piles 0 VSMs 11 culvert batteries 195 cross-drainage culverts 7 bridges	20 pipe piles 10 VSMs 10 culvert batteries 186 cross-drainage culverts 6 bridges	36 pipe piles 0 VSMs 8 culvert batteries 143 cross-drainage culverts 6 bridges
Water withdrawal or diversion	Reduced water quantity Changes in lake chemistry	1,662.4 MG of freshwater	1,914.3 MG of freshwater	2,286.3 MG of freshwater

Project Component	Effect to Water Resources	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Freshwater ice infrastructure	Blockage or restriction in flow surface water during spring breakup	495.2 miles of onshore ice road 4,557.3 acres of onshore ice roads and ice pads	650.1 miles of onshore ice road 5,608.0 acres of onshore ice roads and ice pads	962.4 miles of onshore ice road 7,164.8 acres of onshore ice roads and pads
Pipelines	Increased SS and turbidity during HDD if drilling mud is lost to stream Increased spill-risk differences among alternatives	4,490-foot-long HDD crossing, 70 feet below the river channel bottom 34.4 miles of diesel pipeline[a]	Same as Alternative B 82.0 miles of diesel pipeline[a]	Same as Alternative B 77.0 miles of diesel pipeline[a]
Watercraft in streams	Increased potential for gas spills Bank erosion	Boat ramps on up to 3 streams	Boat ramp on 1 stream	Boat ramp on 1 stream
Wastewater disposal	Spills of domestic wastewater	Waste would be trucked during construction	Same as Alternative B	Same as Alternative B
Screeding	Temporary suspended sediment	12.1 acres, 2 occurrences	Same as Alternative B	Same as Alternative B

Note: HDD (horizontal directional drilling); MG (million gallons); VSMs (vertical support members).
[a] The Project would include other petroleum product pipelines (e.g., infield multiphase pipelines, sales oil pipeline); there is only a nominal difference in the overall lengths of these pipelines.

3.8.2.5 Alternative D: Disconnected Access

Effects on water resources under Alternative D would be similar to those under Alternative B, with the following differences (Table 3.8.4): there would be one fewer bridge and three fewer culvert batteries and thus fewer structures below OHW to cause changes to hydrology and water quality. Like Alternative C, only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed because there would not be gravel road access to the other rivers; therefore, there would be less fill in rivers. There would be one additional season of ice roads and water withdrawal during construction as well as an annual ice road required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative D would have 2,607.5 more acres of ice infrastructure (7,164.8 total acres) over the life of the Project and use 623.9 MG more freshwater (2,286.3 MG total), which could cause changes to water quality in water source lakes and changes to hydrology around the compacted ice and snow. Alternative D would also require the use of ice roads throughout operations, so effects would last throughout the life of the Project. Alternative D would also have additional miles of diesel pipeline (on the same VSMs as the Willow Pipeline), so it would have more pipelines from which a spill could occur.

3.8.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

Effects to water resources from module delivery options are summarized in Table 3.8.5. Some of the types of effects are similar to those described above for the land-based alternatives.

Gravel fill for Option 1 would be placed during winter through a hole cut in the bottom-fast ice. The Atigaru Point area has no human development and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). Mobilization of fine-grained material in the MTI fill into the water column or from in-water work (screeding or recontouring of the MTI slopes) would occur during the summer construction season. A turbidity plume of about 11 to 15 acres is expected based on wind and currents (Coastal Frontiers Corporation 2018b). The duration of the plume would depend on the quantity of fines in the fill and could last 0.5 hour to 55 days (Coastal Frontiers Corporation 2018b).

Approximately 14.5 acres in front of the MTI dock and barge lightering area would be screeded two times over the life of the MTI. A temporary increase in turbidity during and immediately after screeding would occur. Pile and sheet pile driving for MTI construction would occur in winter through bottom-fast sea ice; thus, they would not increase turbidity during installation.

Based on data for western Harrison Bay, current speeds are too low to cause significant, permanent scour of the sea bottom surrounding the MTI (Coastal Frontiers Corporation 2018a). Average rates of shoaling in the area are low (CPAI 2019b). Other human-made islands in the Beaufort Sea experience small amounts of shoaling on the leeward side. Similar amounts would be expected at the MTI and would not affect the stability of the MTI or the coastal processes around it. No accretion or further shallowing of the MTI area would be expected to occur.

Table 3.8.5. Effects to Water Resources from Module Delivery Options

Project Component	Effects to Water Resources	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Gravel fill onshore	Increased SS and turbidity Upslope water impoundment and thermokarst erosion Blockage or restriction in flow of surface water during spring breakup	None	None	5.0 acres filled along existing Kuparuk roads (no fill in waterbodies)
Gravel fill in marine area	Temporary increase in SS or turbidity Changes to sediment transport and deposition Scour or accretion	12.8 acres of fill 11- to 15-acre sediment plume lasting ~55 days No significant scour or accretion	13.0 acres fill 11- to 15-acre sediment plume lasting ~55 days No significant scour or accretion	None
Pile and sheet pile installation and removal	Temporary localized increase in SS or turbidity No effects to hydrodynamics	Vibratory pile and sheet pile installation and removal	Same as Option 1	None
Screeding	Temporary increase in SS or turbidity	14.5 acres, 2 occurrences	Same as Option 1	No additional screeding beyond what is described for Alternatives B, C, or D
Freshwater ice roads and ice pads[a]	Water withdrawal (water quality or quantity changes) Flow changes from compacted ice on overland ice road	307.9 MG of water 103.6 miles of onshore ice road 859.6 acres of onshore ice roads and ice pads	572 MG of water 223.4 miles of onshore ice road 1,756.1 acres of onshore ice roads and ice pads	257.2 MG of water 80.2 miles of onshore ice road 666.6 acres of onshore ice roads and pads Approximately 2,000-foot-long ice bridge across the Colville River with 700 feet spanning the active winter channel Additional 850 feet (total) of ice ramps

Note: ~ (approximately); MG (million gallons); SS (suspended sediment).
[a] No effects are anticipated from the sea ice road.

The MTI sea ice road would span approximately 2.4 miles through shallow, nearshore areas. Sea ice in the area is typically bottom-fast in water less than 5 feet deep. Areas in which ice was not naturally bottom-fast would be made bottom-fast to construct the ice road by applying seawater on the surface and weighing down the ice. Neither seawater withdrawal nor making ice bottom-fast would affect water quality or coastal processes. Effects of freshwater withdrawal for onshore ice roads are described under Alternative B.

After the 5-year design life, armoring and other anthropometric material for the MTI would be removed. The island is expected to be reshaped by waves and ice within 10 to 20 years, similar to Resolution and Goose islands, two Beaufort Sea exploratory islands constructed at water depths similar to the Proponent's MTI. Resolution Island is in the Sagavanirktok River Delta and was abandoned in 2003, and Goose Island is in Foggy Island Bay and was abandoned in 1990. The tops of these two islands are now at or below the water surface, and their shape resembles natural barrier islands in the Beaufort Sea. The top of the MTI would likely drop to or below the water surface sometime within the 10- to 20-year natural reshaping period. The fines contained by the inner material of the island that had not been winnowed by wave action would likely be resuspended once in contact with the water. Any spills of hazardous material that have been contained by the fill in the island throughout its use may also be released into the coastal waters when the island is reclaimed.

3.8.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

All of the effects to water resources described for Option 1 would apply to Option 2. The main difference is Option 2 would require almost double the water withdrawal for ice roads (Table 3.8.5), which could cause more effects in lakes used for withdrawal. In addition, the reshaping of the MTI after decommissioning may be faster at Point Lonely than at Atigaru Point because the ambient erosion and sediment transport at Point Lonely is likely higher than at the Sagavanirktok River Delta and Foggy Island Bay, where two historical exploratory islands have been decommissioned. Point Lonely is further north, with no land mass to shelter it from longshore transport.

3.8.2.8 Module Delivery Option 3: Colville River Crossing

The gravel fill used for road widening along Oliktok Road would have effects described in Section 3.8.2.3.3, *Gravel Infrastructure*. Effects from ice roads and associated freshwater withdrawal are described in Section 3.8.2.3.2, *Ice Infrastructure*. The ice road from DS2P to the Willow area would cross the Colville River near Ocean Point. A single transect surveyed at Ocean Point in late December 2019 and February 2020 provided measurements of average floating ice thickness, average water under ice, and average velocity. The data is described in Section 3.8.1.1.1, *Rivers*, and in Appendix E.8A.

At the crossing location, an engineered partially grounded ice bridge would be constructed to provide sufficient load-carrying capacity to support the weight of the sealift modules and the SPMTs. It is anticipated that the ice crossing for the Colville River would be primarily frozen fast to the riverbed; however, there may be one or more low-flow channels present near the bed, carrying the winter discharge beneath the ice. These small channels are narrower than the length of the SPMT. The engineered ice bridge would be built up to required specifications to support module moves approximately 24 hours prior to crossing, then allowed to rest prior to moving a module across, allowing for potential water movement under the ice. After a module crosses, the ice crossing would be built up to required specifications approximately 24 hours before the next module crosses the bridge. However, ice bridges are constructed by adding ice material at the surface of the bridge. The low-flow channels beneath the bridge are dynamic, as is any river channel, and dimensions may vary from year to year.

If there was flow in the river when the ice bridge was constructed, the bridge could partially block the flow. While it is possible that some of the flow might pass through the low-flow channels or under the partially grounded ice bridge sections in the riverbed, it is possible that at least a portion of the flow could be blocked. If some of the surface flow did pass through the low-flow channels or under the bottom-fast ice bridge, the increased velocity of the flow in the riverbed could lead to erosion of the riverbed under the ice bridge, in which case some sections of the ice bridge may become ungrounded. However, if the **hydraulic conductivity** of the bed material was low, flow within the bed materials may be restricted to some degree as well. If subsurface routes (low-flow channels or drainage through bed materials) were restricted or blocked, the pressure of confined water under the ice cover will increase, and surface flow would likely emerge. Depending on the flow rate, the blocked water could be difficult to manage. Downstream from Umiat, the magnitude of the flow is likely to increase roughly proportional to the drainage area increase. When the mean monthly April flow is 5.0 cfs at Umiat (Table E.8.1 in Appendix E.8A), where the drainage area is approximately 13,860 square miles, the mean monthly April flow may be 1.48 times that near Ocean Point, where the drainage area is 20,580 square miles. Thus, the estimated April mean monthly flow at Ocean Point is 7.4 cfs (Appendix E.8B), which is equivalent to 3,320 gallons per minute. Also, there is a 50% chance that in any given year the mean monthly April flow will be greater than described above. During the 17 years of monitoring, the April mean monthly flow at Umiat has been reported as being as high as 20.0 cfs. Between January and March, the next lowest flow months, the mean monthly flow at Umiat varied from 24.0 to 3.9 cfs.

If there was flow at the time of ice bridge construction and the low-flow channels are insufficient in capacity to carry the flow, the partially grounded ice bridge would act as an ice dam, and effects would be similar to a grounded ice jam: backwatering and out-of-bank flooding upstream of the bridge. If the bridge becomes entirely ungrounded, higher velocities than normal would flow under the bridge and could cause minor scour downstream and associated temporary increases in sediment transport and turbidity.

Naturally occurring overflow events on the Colville River have been noted near Ocean Point and are most likely to occur between January and April (Ice Design & Consult 2020). Observed overflow flooding in March 2020 created unsafe conditions at the CWAT snow bridge near Ocean Point that led to the temporary closure of that bridge (Ice Design & Consult 2020). The presence of a constructed ice bridge is likely to exacerbate the frequency and duration of occurrence and discharge rate of winter overflow in the vicinity.

It is anticipated that the ice bridge near Ocean Point would be needed for 5 weeks; transport of module loads would be spaced out over that time, providing time for ice bridge settling and maintenance. Instrumentation would be installed in the Colville River near Ocean Point to monitor water levels in real time for the duration of the ice road season. If flows are higher than expected or the low-flow channels are smaller than expected, water would be managed with pumps and/or surface pipes across the ice bridge if needed. Industrial-use arctic-rated large-capacity pumps would be required to manage the estimated flows. Gasoline- or diesel-powered pumps would require on-ice refueling and may be difficult to start or maintain in very cold weather. Electric pumps can be powered by a generator located in an enclosure on the bank, which would require a long power cable for power to reach the pumps. Overflow is expected and would be managed both passively with snow berms, ice slots, or other diversion structures or in combination with high-volume pumps and/or rapid response heavy equipment to clear new pathways for water to flow away from the ice structure. Observation, maintenance, and potential cleanup efforts would be required for overflow management actions and equipment during and following overflow events.

CPAI will be collecting flow and ice data at Ocean Point for several more years before the start of module transport (ice bridge first needed in 2025). Once more data are collected, a plan for water management and fish passage at the ice bridge will be coordinated with BLM and the permitting agencies.

An ice road and ice bridge across the Colville River could also affect ice jam flooding that occurs downstream in the Colville River. Even if the ice road and bridge are slotted, the added ice may cause ice jam flooding within the CRD or other locations along the river to be worse than it would have been. Ice conditions in the lower Colville River are described in the Nanushuk EIS (USACE 2018, 3-144 to 3-145 and Figure 3.6.4 therein). Based on that description, ice jams occur regularly at and downstream of Ocean Point all the way to the delta; it appears that ice jam flooding is having a substantial impact on flood elevations within the delta and may control design flood elevations at some locations. It is unknown to what extent the construction of ice bridges is currently influencing ice jam flooding conditions.

3.8.2.9 Oil Spills and Other Accidental Releases

The EIS evaluates the potential impact of accidental spills. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur and provides context for spills that have occurred on the North Slope.

Under all action alternatives, spills and other accidental releases could occur. Spills associated with the discharge of oil from leaking wellheads, facility piping, process piping, or aboveground storage tanks (ASTs) would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. These types of spills would be unlikely to affect the tundra or waterbodies adjacent to facilities or structures. Spills not on gravel infrastructure would likely extend to the area immediately adjacent to a facility or structure where the spill occurred.

In the very unlikely event that a reservoir blowout occurs at one of the drill sites (likelihood approaching zero, as described in Chapter 4.0), the extent of the accidental release could be much larger and potentially reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a). (These low-probability, catastrophic events are described in Chapter 4.0.)

Spills originating along pipelines would be expected to be detected and responded to quickly. However, they would potentially have a larger geographic extent than spills on pads. In the very unlikely event that a pipeline spill occurred at a river crossing during high water flow, the extent of the accidental release could be much larger and may reach the channels of Fish Creek (Iqalliqpik or Uvlutuuq) or the Kalikpik River, particularly during periods of flooding. As described in CPAI (2018a), the relatively low flow and highly sinuous nature of streams in the Fish Creek (Iqalliqpik or Uvlutuuq) and Kalikpik River basins may preclude a spill into one of these rivers from reaching Harrison Bay. Pipeline spills would probably not result in changes to the physical hydrology of the area, but the containment and cleanup response to such a spill may result in damage to the tundra, stream banks and channels, or lakeshores and lake bottoms. The extent of the physical hydrology impact would be from the area where the spill occurred downstream along flow paths to a place where the spill was contained or sufficiently dissipated.

The primary effect of an oil spill on water quality would be the toxicity of petroleum hydrocarbons on and reduced dissolved oxygen for aquatic organisms; even small spills of oil into surface water could make water toxic for some aquatic life. Spills into small streams, tundra waters, and ponds would have a greater toxic effect on aquatic plants and animals than spills into larger waterbodies due to the lower relative volume of water and/or flow rate and would have direct toxic impacts in the water column and the sediments. Long-term toxicity (up to a decade) can result from a small spill (Hobbie 1982) and would be more likely to occur in smaller waterbodies.

Tundra ponds and small slow-moving waterbodies could have decreases in dissolved oxygen concentrations due to the impermeable nature of the oil slick, which decreases the influx of oxygen from the air, coupled with the high rate of oxygen use by the sediments. These effects are not as likely in flowing water, where dilution of the oil and dispersion of oil slicks would occur before there could be effects on dissolved oxygen concentrations.

Due to the design criteria for pipelines and storage tanks, the limited number of opportunities for spills to reach surface waters, and the monitoring, leak detection, and spill response provisions incorporated into the action alternatives through a Project-specific ODPCP, large spills into water would be unlikely.

The HDD crossing of the Colville River with diesel and seawater pipelines could also create a potential risk of a spill. However, the risk would be very low (approaching zero) since the pipelines will be insulated and placed within an outer pipeline casing, which will inhibit heat transfer to permafrost, contain fluids in the event of a leak or spill, and provide structural integrity. The existing HDD crossing of the Colville River by the Alpine Sales Oil Pipeline has had no spills to date; it was constructed in 1998 and 1999 and is similar in design and size as that proposed for Willow. Any unintended releases from the diesel pipeline within the outer pipeline casing would be detected and responded to quickly. It would be very unlikely that fluids would reach the Colville River or the delta and expose marine mammals. If they did, pre-staged spill response materials located throughout the CRD would allow a quick response and increase the likelihood of containment

Seawater spills over unfrozen waterbodies would increase the salinity and conductivity of the waterbody, which could last for several seasons depending on the size of the spill, the size of the waterbody, and the amount of freshwater input to the waterbody.

Most spills to the marine environment would have a low to very low likelihood and occur during construction of the MTI or originate from small support vessels. These very small to small spills would be localized to the immediate area of the MTI. A larger spill from a barge would have a very low likelihood and would only occur if a tug or barge transporting modules were to run aground or sink, or if its containment compartment(s) were breached and the contents released (USACE 2012). The geographic extent of these spills would vary and may or may not reach land depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Seabirds and, potentially, shorebirds could be affected.

3.8.2.9.1 Use and Storage of Hazardous Materials

The Project would require the transport of diesel, gasoline, and other hazardous substances from Alpine to support construction. During operations, hazardous materials would primarily be stored at the WOC, with additional fuel and chemical storage at each drill site as needed. A diesel pipeline would also connect to Kuparuk. Spills of hazardous materials could introduce contaminants directly to surface waters or indirectly to surface or groundwater. However, potential impacts to water resources due to mishandling of hazardous materials would be reduced by the Project's compliance with current state and federal oil pollution and contingency requirements as well as existing BMPs detailed in Section 3.8.2.1.1, *Applicable Lease Stipulations and Best Management Practices*.

3.8.3 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Implementation of these LSs, BMPs, and mitigation measures would not prevent all impacts to water resources but would prevent irreversible impacts on water quality and quantity. Irretrievable impacts to water quality and quantity would continue for the life of the Project, but those impacts would not impact the long-term sustainability of water resources in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible. Water impoundments due to impacts to permafrost (from gravel mining and CFWR) would be irreversible because the mine pit and the reservoir would fill with water and would permanently change the thermal regime of the underlying soils.

3.9 Wetlands and Vegetation

The analysis area for **wetlands** and vegetation encompasses the watersheds in which wetlands and vegetation would be directly or indirectly affected by the Project (Figure 3.9.1). Watersheds were defined using 10-digit USGS **hydrologic unit codes** (HUCs). The temporal scale of wetland loss or alteration would span construction to reclamation. If reclamation did not occur, effects to wetlands would be permanent (reclamation is described in Appendix D.1, *Alternatives Development*). If reclamation did occur, the duration of vegetated wetland recovery after reclamation is expected to be greater than 20 to 30 years, or until more than 50% aerial cover of the wetland is hydrophytic vegetation and soils are saturated or inundated for more than 10 days during the growing season

(Everett, Murray et al. 1985). The duration of ponded wetland recovery is until inundation has returned. The temporal scale of vegetation damage and soil compaction would span construction to vegetation recovery, expected to be 3 to 5 years postconstruction (as described below and in Roth, Jorgenson et al. [2004]).

3.9.1 Affected Environment

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3(b)). Wetlands are regulated by Section 404 of the CWA, which requires that the placement of fill in WOUS, including wetlands, is evaluated and authorized by USACE.

Wetlands are important because they help reduce impacts from flooding, contribute to water quality and quantity, and provide habitat to support plant and animal biodiversity. The largest expanse of arctic fens and thaw lakes in the world is in the ACP (NRC 2003). The lack of subsurface drainage on the ACP is ideal for sedge- and grass-dominated wetlands and waterbodies. Uplands are uncommon because of the high degree of surface inundation (ADF&G 2006).

Approximately 10,240.8 acres surrounding onshore Project gravel infrastructure in the Willow area and at the HDD crossing of the Colville River was mapped using a combination of the USACE three-parameter method (USACE 1987, 2007) and an ecological unit-based approach. This is referred to as the field-verified portion of the analysis area. Data for this area were derived from multiple years of field data collection and subsequent analysis (Wells, Ives et al. 2018). A complete description of methods used to identify wetlands and vegetation is detailed therein. For the marine area and areas outside the field-verified area, National Wetlands Inventory data (USFWS 2019c) were used. Field-verified data were used to quantify direct and most indirect impacts (those that are quantifiable) from all onshore action alternatives; National Wetlands Inventory data were used to assess the module delivery options and provide context for the relative abundance of wetland and vegetation types in the analysis area. The Project's CWA Section 404 permit process is occurring concurrent with the NEPA process, and although a Jurisdictional Determination has not yet been completed, the EIS analysis assumes that all wetlands and waterbodies described in this section are WOUS and are subject to jurisdiction under the CWA (33 CFR 328.3).

Wetland and vegetation types in the analysis area are detailed in Appendix E.9, *Vegetation and Wetlands Technical Appendix,* and in Figures 3.9.2 and 3.9.3. Table E.9.1 in Appendix E.9 demonstrates that wetland types in the Willow area (the field-verified area) are not unique and occur throughout the analysis area and the ACP.

The field-verified portion of the analysis area is 94% wetlands (Table 3.9.1). Previous disturbance and fill of wetlands in the analysis area is limited to gravel and ice infrastructure from the GMT, Alpine, Oooguruk, Mustang, and Kuparuk oil fields, the community of Nuiqsut, and decommissioned Distant Early Warning Line sites (Figure 3.9.1). The existing infrastructure and development activities have altered some wetlands' functions, contributed dust and sediment to wetlands, and increased the potential for spills entering wetlands.

Table 3.9.1. Extent of Wetlands in the Field-Verified Portion of the Analysis Area (acres)

Wetlands	Uplands	Freshwater WOUS	Total
9,589.5	165.6	485.7	**10,240.8**

Note: NA (not applicable); WOUS (Waters of the United States, including lakes and ponds).

There are no plant species listed as threatened or endangered under the ESA known to occur in the analysis area. However, there are 10 plant species identified as **sensitive** by BLM[12]: alpine draba, fewflower draba, Barneby's locoweed, Eurasian junegrass, false semaphoregrass, pygmy aster, Yenisei River pondweed, cottonball bluegrass, and Alaskan bluegrass (ACCS 2020; Wells, Ives et al. 2018).

The analysis area east of the Colville River contains substantially more development than west of the river; it includes a network of gravel roads and pads, mine sites, reservoirs, an industrial dock, and facilities to support oil-field development and production. The mechanism for **invasive species** introduction or transport remains limited as equipment (e.g., heavy equipment, trucks) is primarily stationed on the North Slope and remains there and fill

[12] BLM designates native wildlife, fish, or plant species occurring on BLM lands when they become at-risk species. Once a species is designated, BLM works cooperatively with other federal and state agencies and nongovernmental organizations to proactively conserve these species and ensure that activities on public lands do not contribute to the need for their listing under the ESA. The sensitive species designation only applies to BLM-managed lands.

material is sourced from local or regional mine sites. However, introductions have occurred in the analysis area, as is demonstrated by the presence of common dandelion and foxtail barley along the Tarn Road near DS2P (Figure 3.9.1) (McEachen and Maher 2016), the nearest location of invasive species reported (ACCS 2020). Foxtail barley was also recorded approximately 45 miles south, near Umiat, in 2015 (Alaska Exotic Plant Information Clearinghouse 2018). Large populations of invasive species are common along the Dalton Highway south of Coldfoot (Alaska Exotic Plant Information Clearinghouse 2018), approximately 200 miles from the Project; the high volume of commercial and private vehicle travel there suggests invasive plant seeds are being imported into the region by these means.

Wetlands and vegetation in the ACP are currently being affected by climate change. Climate change may cause alterations in precipitation patterns, water availability, temperature regimes, permafrost presence and depth, and the growing season—all of which influence vegetation communities and wetland habitats. As a result of changing climate, vegetation communities are experiencing an increase in taller deciduous shrubs (shrubs that lose their leaves seasonally), and wetlands are drying because of thawing permafrost and a change in the hydrologic cycle (Naito and Cairns 2014). Deciduous shrubs respond to warming with increased growth and an expanded range. Such changes in height and extent produce a positive feedback loop for additional shrub growth because the shrubs trap snow, reduce albedo, and mediate winter soil temperature and summer moisture regimes (Settele, Scholes et al. 2014). Tall shrubs protrude above the snow and thus reduce albedo year-round, whereas short shrubs are completely covered by the snowpack for part of the year (Loranty and Goetz 2012). Wetland function is generally decreasing since less hydrophytic vegetation can be supported by a drier environment. Species composition is also changing, leading to changes in processes within the wetland ecosystem (McGuire 2013). The deeper annual thawing and melting of ice wedges is likely to lead to the drainage of wetlands and ponds in some areas, but in other areas, thawing ice may lead to the expansion of ponded areas.

3.9.2 Environmental Consequences

3.9.2.1 Avoidance, Minimization, and Mitigation

3.9.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.9.2 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate wetland and vegetation impacts from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to waters and vegetation from the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.9.2 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to wetlands and vegetation. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.9.2 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.9.2. Summary of Applicable Lease Stipulations and Best Management Practices to Mitigate Impacts to Wetlands and Vegetation

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-4	Minimize the impact of contaminants on the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive SPCC Plan.	Develop a comprehensive SPCC Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment from the disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
ROP A-13	Prevent the release of poly- and perfluoroalkyl substances associated with the use of aqueous film-forming foam, a firefighting foam designed to extinguish flammable and combustible liquids and gases.	No similar requirements.	At facilities where fire-fighting foam is required, use fluorine-free foam unless other State or federal regulations require aqueous film-forming foam use. If aqueous film-forming foam use is required, contain, collect, treat, and properly dispose of all runoff, wastewater for training events, and to the greatest extent possible, from any emergency response events. Training events shall be conducted in lined areas or basins to prevent the release of poly- and perfluoroalkyl substances associated with aqueous film-forming foam.
BMP B-1	Maintain populations of, and adequate habitat for, fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.	Changes do not affect text as described.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during wither and withdrawal of water from lakes during summer may be authorized on a site-specific basis, depending on the water volume and depth, the fish community, and connectivity to other lakes or streams.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	– Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow. – For alternatives B, C, and D: avoid using the same route for multiple trips, unless necessitated by serious safety or environmental concerns and approved by BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach.	Added text: – The permittee shall provide to BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of the road/trail construction. – In the spring, provide BLM with photographs of all stream crossings that have been removed, breached, or slotted
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and protect subsistence use and access to subsistence hunting and fishing areas.	Added text: – Subsistence pullout and access/egress ramps would be constructed in adequate numbers and at appropriate locations on all roads to facilitate access to subsistence use areas. – Permittees shall construct a subsistence pullout and boat ramp at all crossings of heavily used subsistence rivers, as determined by consultation with the community.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from OHW of fish-bearing waterways.	Changes do not affect text as described.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A post-construction monitoring program, developed in consultation with appropriate federal, State, and NSB regulatory resource agencies, shall be required to rack circulation patterns, water quality, and fish movements around the structure.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: – Where the aircraft traffic is a concern, balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations. – For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.	Added text: – Stream and marsh crossings will be designed on at least one year of relevant hydrologic data. Additional years of hydrologic data collection may be required by the BLM if more information is needed to design the crossing structure in order to attain the BMP. – The crossing structure design shall account for permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment. – A minimum of 1 year of fish sampling is required at any stream crossing where flow is channelized, and additional years of fish sampling may be required at sites where the determination of anadromous fish presence is still in question. – A minimum of 1 year of hydrologic data sampling is required at stream and marsh crossings. Additional years of hydrologic data collection may be required if more information is needed to design the crossing structure in order to attain the BMP objective and meet requirements. – All proposed crossing designs would adhere to the standards outlined in fish passage design guidelines developed by the USFWS Alaska Fish Passage Program (USFWS 2019b), USFWS *Culvert Design Guidelines for Ecological Function* (USFWS 2020a), *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USFS 2008), and other generally accepted BMPs prescribed by the BLM.
LS E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the BLM and in consultation with appropriate federal, state, and NSB regulatory and resource agencies.	Added text: – The plan shall consider locations outside the active floodplain or designing gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present. – Mine pit design and methods shall be engineered to minimize permafrost regime disturbance and protect surface stability.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.	Added text: Develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments (for alternatives B, C, D: based on Light Detection and Ranging or other high-accuracy surface imaging).

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration to the land's previous hydrological and vegetative condition.	Changes do not affect text as described. See BMP M-5 for additional requirements to reduce areas of bare soil.
LS/ BMP K-1[a]	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or overwintering fish habitat; minimize the loss of raptor habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in streambeds and adjacent to the rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	– No surface occupancy or new infrastructure, except essential road and pipeline crossings in the following setbacks: Colville River (2- to 7-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). – Gravel mines may be located within the active floodplain, consistent with BMP E-8.
LS/ BMP K-2[a]	Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes; minimize the loss of spawning, rearing, or overwintering fish habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed and within 0.25 mile of the OHW of any deep lake (i.e., depth greater than 13 feet).	Changes do not affect text described. Additional restrictions as described in ROP E-11 may also apply in those habitats.
BMP K-4a[a]	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Within the Goose Molting Area: – No leasing, no permanent oil and gas facilities, except pipelines, would be allowed within 1.0 mile of the shoreline of selected lakes. – Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins.	Changed to Stipulations K-6 and K-7. Some alternatives allow leasing. Some alternatives allow new infrastructure with limitations. Within the Goose Molting Area, no permanent oil and gas facilities, except pipelines, would be allowed within 0.5 mile of the shoreline of selected lakes. Lakes were selected based on the 85% distribution of black brant within the Goose Molting Area.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-6[a]	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.	Changed to Stipulation K-5 (Coastal Area) Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). No leasing is allowed within 1 mile of the coast. The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads; or central processing facility for oil and gas is not allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as a barge landing, a seawater treatment plant, or spill response staging and storage areas, are not be precluded. Nor does this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For a permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain populations of, and adequate habitat for birds, fish, and terrestrial mammals.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.
BMP M-2	Prevent the introduction, or spread, of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed-free prior to transporting them into the NPR-A. Monitor annually for invasive species, and submit a plan detailing methods for cleaning, monitoring, and weed control	Changes do not affect text as described. See BMP M-5 for requirements to reduce areas of bare soil.
BMP M-3	Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.	Conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species that might occur there.	Added text: The results of these surveys would be submitted to BLM with the application for development and the BLM would implement appropriate avoidance and minimization measures. See ROP E-12 for tools to assess habitat.
ROP M-5	Reduce areas of bare soil that can contribute to dust emission to protect human health and subsistence resources.	No similar requirement.	Alternatives B, C, and D: permittees will use appropriate measures to control dust (e.g. dust palliatives and watering), as outlined in dust control plans submitted to ADEC pursuant to 18 AAC 50.045(d). All action alternatives: areas of bare soil resulting from operations will be revegetated with native species within 48 months of abandonment, unless otherwise specified in the abandonment and reclamation plan.

Source: BLM 2013a, 2020a
Note: BLM (Bureau of Land Management); BMP (best management practice); DEW (Distant Early Warning); F (Fahrenheit); IAP (Integrated Activity Plan); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy) OHW (ordinary high water); SPCC (Spill Prevention, Control, and Countermeasures); USFWS (U.S. Fish and Wildlife Service); USGS (U.S. Geological Survey).
[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect wetlands and vegetation would include those to LS E-2 and BMPs K-1 and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMPs K-1 and K-2), a CFWR connected to Lake M0015, and freshwater intake pipelines at Lakes L9911 and/or M0235 (varies by alternative) (Figure 3.10.3). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody.

Option 3 may require management of water under the partially grounded ice bridge over the Colville River at Ocean Point. If water from the river needs to be pumped around the bridge during the 2 winters of ice bridge use, this may require a deviation to BMP B-1.

3.9.2.1.2 Other Required Measures

In accordance with 33 CFR 332.1(c)(3), "compensatory mitigation for unavoidable impacts may be required to ensure that an activity requiring a section 404 permit complies with the Section 404(b)(1) Guidelines." Pursuant to this authority, USACE may require compensatory mitigation for the direct and/or indirect losses of aquatic resources. Mitigation measures required by USACE will be described in its ROD for this Project.

3.9.2.1.3 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.9.2.1.4 Additional Suggested Avoidance, Minimization, or Mitigation

The following additional suggested measures could reduce impacts to wetlands and vegetation:

1. If Alternative C or D is selected, monitor vegetation damage and the compression of soil and vegetation in the annual resupply ice road footprint (footprints that are used consecutively each year). Because wetter landscapes show less impact from multiyear ice roads (Yokel, Huebner et al. 2007) and ADNR monitors only tussock tundra and soil compaction, this suggested measure would focus on non-tussock wetlands (including patterned ground) with a Cowardin water regime class of Temporarily Flooded, Saturated, or Seasonally Flooded Ground by vegetation type (total live cover of graminoid, shrub, forb, moss) and the percentage of bare soil would be monitored with control points and points within ice road footprints to determine changes.
2. Use vehicle and equipment wash stations and inspect vehicles and equipment for organic matter (e.g., invasive species) prior to moving equipment west of the Colville River to reduce the risk of introducing invasive species.
3. Clean tires and wheel wells so they are free from soils, seeds, and plant parts.
4. Provide stations to clean footwear and gear so they are free from soils, seeds, and plant parts.
5. Provide training to employees and contractors in the identification, control, and prevention of known invasive plant species.
6. Confine loading and unloading of soils for gravel stockpiles to the downwind side of the pile; if piles would be on-site for longer periods of time, seed with appropriate vegetation to reduce wind erosion. Wind barriers (such as snow fences) may also be appropriate in some situations.

3.9.2.2 Alternative A: No Action

Under the Alternative A, seasonal ice roads and pads (and associated water withdrawals) could continue to occur in the analysis area to support oil and gas exploration. Effects from the existing gravel infrastructure in the GMT and Alpine oil fields would continue.

3.9.2.3 Alternative B: Proponent's Project

3.9.2.3.1 Direct Loss and Alteration of Wetlands

Project activities that would permanently remove or alter wetlands and wetland function are the placement of gravel fill, excavation for the CFWR, and gravel mining. Under Alternative B, 607 acres of wetlands would be lost due to gravel fill or excavation. Another 30.0 acres of multi-season ice pads (lasting more than 1 full year in a single location) would be considered temporary fill under the CWA and would be subject to USACE jurisdiction. Effects would be similar to those of ice infrastructure and thus are discussed with that topic in the EIS (in Section 3.9.2.3.2, *Direct Vegetation Damage and Soil Compaction*). Tables E.9.2 and E.9.3 in Appendix E.9 detail the types of wetlands that would be filled by action alternative. Approximately 0.4 acre of riverine wetlands would be filled by the Project boat ramps. VSMs would fill a total of 0.8 acre of wetlands and WOUS over the length of the pipeline.

The direct fill would occur in no more than 0.2% of any of the five (10-digit) HUCs in which the fill would occur (Table E.9.4 in Appendix E.9). Schueler et al. (2009) reported a correlation between the increase of impervious cover and a decrease in various watershed functions based on wetland and waterbody characteristics (geomorphology, habitat, water quality, water level fluctuation in wetlands, **benthic** macroinvertebrates, and fish). For the EIS analysis, impervious cover was used as a proxy for gravel fill since both impervious cover and gravel fill decrease the infiltration rate of precipitation and increase surface runoff in a watershed. Wetland conditions in watersheds with less than 5% cover by impervious surfaces are good (i.e., close to reference conditions, which were defined as the average condition of the three least impaired wetlands; Hicks and Larson 1997). Wetland conditions in watersheds with more than 20% cover by impervious surfaces were moderately to severely impaired.

The Project's mine site reclamation plan is provided in Appendix D.2, *Willow Mine Site Mining and Reclamation Plan*. After mining has ceased, the pits would fill with water from ground or surface water, or from permafrost melt, and thus existing wetlands would be converted to **lacustrine**. Work in wetlands would be minimized to the extent possible; however, because of the prevalence of wetlands in the analysis area, some fill or excavation would occur in wetlands.

Excavation would permanently change the thermal regime of the underlying soils and change wetland composition. In addition, some flows over the tundra from the mine pits to the Ublutuoch (Tiŋmiaqsiuġvik) River are expected. After mining has ceased, the mine pit is expected to slowly fill with water from precipitation and snowmelt. After approximately 10 years, the pit would be full and could crest the banks of the pit during periods of high sheet flow (expected at only at spring runoff). The mine pit would have perimeter berms to provide thermal stability (described in Section 3.4.2.3.1). Each mine cell would have a low point in the mine perimeter berm (see Figure 3 in Appendix D.2) that would allow drainage from the pit at high water. Although the mine pits would not be connected to adjacent streams, water from the pits could flow over the tundra to the Ublutuoch (Tiŋmiaqsiuġvik) River during spring breakup. Such maximum flows would occur once per year during spring breakup; significant releases are not expected during other times of the year. Summer releases would be infrequent or insignificant due to low summer precipitation on the North Slope. Both runoff areas consist of undisturbed tundra. Based on the volume of runoff and the gradient of the runoff area, surface erosion between the mine pits and the stream would occur. The flow would likely erode a channel in the tundra, which could lead to permafrost erosion and sediment transport. Wetland composition would change in the runoff areas due to erosion and a change in the thermal regime.

3.9.2.3.2 Direct Vegetation Damage and Soil Compaction

Project activities that would damage vegetation or compact soils are the construction of ice infrastructure and off-road travel.

Approximately 4,557.3 acres of vegetation damage could occur from ice infrastructure (e.g., ice roads, ice pads) for Alternative B (Table E.9.5 in Appendix E.9). Of those acres of vegetation damage, 30.0 acres would be from multi-season ice pads and could have a longer duration of effects than single-season ice infrastructure. Ice infrastructure would potentially damage vegetation by freezing plant tissues, physically damaging plant structures, and causing stress that delays plant development. Delayed plant development can modify vegetation (decrease plant size and cover) in the long term and lead to visible traces on the tundra surface (Guyer and Keating 2005). Effects from ice roads are amplified by repeated use of the same route over multiple seasons (Yokel, Huebner et al. 2007). Ice pads used for multiple seasons allow less time during the growing season for vegetation to recover. The degree of saturation is a key factor in mitigating effects from ice infrastructure; ice roads that cross wetter vegetation result in fewer effects than ice roads that cross drier vegetation (Felix and Raynolds 1989; Yokel, Huebner et al. 2007; Yokel and Ver Hoef 2014). Flooded and wet tundra wetlands generally exhibit few or no effects from ice road construction (Felix and Raynolds 1989; Yokel, Huebner et al. 2007; Yokel and Ver Hoef 2014), while some areas of moist tundra still show signs of disturbance after 12 years (Yokel and Ver Hoef 2014). Flooded and wet tundra wetlands freeze to the surface before the ice road season begins, protecting underlying vegetation. Moist tundra would likely show signs of disturbance after 12 years of the last multi-season ice road being built. Effects on sensitive vegetation would be mitigated by using BMPs for routing and constructing ice roads in accordance with NSB requirements (NSB Code 19.50.030(J), and 19.60.040(O)).

The effects of ice infrastructure on soil are not as severe as they are on plants. Typically, little change in the soil thaw depth and compaction of soil result from ice road construction (BLM 2012b; Walker and Everett 1987; Yokel, Huebner et al. 2007; Yokel and Ver Hoef 2014).

Off-road travel would likely occur in rare instances during emergencies (i.e., vehicle overturns off an embankment). Effects to vegetation and soil from off-road travel vary by season of travel and the size of the vehicle. Off-road travel in the winter by any size vehicle can directly affect shrubs such as diamond-leaf willow, which have a substantial proportion of branches and live tissue remaining above the snow that can be broken. The degree of effects depends on 1) the wetland class, 2) the degree to which the wetland is inundated, 3) the number of passes by the off-road vehicle, and 4) the size/type of the vehicle. Off-road travel in winter on drier tundra is more likely to damage wetlands than travel on flooded tundra because of soil compaction and root wad disturbance.

Winter off-road travel would be expected to result in low to moderate disturbances of tundra vegetation, which would recover within 3 to 5 years. As defined in Roth et al. (2004), low tundra disturbance due to off-road travel is a < 25% decrease in vegetation or shrub cover and < 5% exposed soil visible, where the vehicle trail is evident only within its tracks. Moderate tundra disturbance is a 25% to 50% decrease in vegetation or shrub cover and/or 5% to 15% exposed soil visible, where the vehicle trail may appear wetter than the surrounding area.

Areas affected by off-road vehicles in the summer typically recover to near their original state within 10 years or less on the North Slope, if the organic mat (the upper layer of plant material in which plants grow and form a mat of roots above mineral soil) remains unbroken (Abele, Brown et al. 1984). Unlike winter off-road travel, summer off-road travel compacts saturated soils in wet tundra more than in dry tundra. In general, recovery begins approximately 3 years after the initial traffic impact (Abele, Brown et al. 1984).

3.9.2.3.3 Indirect Change in Wetland Composition

Project activities that could change wetland composition are construction and the use of gravel infrastructure (and associated dust, gravel spray, thermokarsting, impoundments, changes in surface flow, and increased vectors for invasive species introduction) and water withdrawals (and associated changes in water quantity). Several factors could contribute to changes in wetland composition: changes in soil composition, changes in vegetation patterns, changes in local hydrologic systems, and increased mechanisms for introduction or dispersal of invasive species. Each of these effects is discussed below. Effects would generally occur close to gravel fill, potentially both up- and downgradient of the fill (described below).

Dust and gravel spray would be generated during gravel placement and compaction, snow clearing, with vehicle traffic, and equipment operations on gravel roads and pads. Dust control measures would be implemented to reduce deposition of dust on vegetation or snow and to minimize impacts to WOUS; the Project's Dust Control Plan is provided in Appendix I.3. Even with dust control measures in place, dust from traffic throughout the life of the Project would accumulate adjacent to roads and pads. The area of deposition by airborne dust is called the dust shadow. Within the shadow, deposited dust overlays and potentially smothers vegetation before eventually being incorporated into the native soil and altering the soil composition. Road dust has the greatest effect within 35 feet of a road, but deposition may occur over a broader area. Roughly 95% of dust settles within 328 feet (100 m) from a road surface (Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987).

Dust deposited on snowdrifts decreases their albedo, leading to earlier melting (Auerbach, Walker et al. 1997; Klinger, Walker et al. 1983) and increased local soil moisture levels in the spring (Brown, Brockett et al. 1984), which can result in early green-up (Walker and Everett 1987). Dust shadows typically decrease nutrient levels in soils (Auerbach, Walker et al. 1997), decrease soil moisture, increase thaw depth, alter the active layer (the upper layer of soil that is churned through the freeze-thaw cycle), and contribute to thermokarst development (Auerbach, Walker et al. 1997; Walker and Everett 1987). Thermokarsting results from the thawing of near-surface ice and may be accelerated by loss of vegetation cover due to dust deposition, impoundments, or early snowmelt from changes in surface albedo.

Alternative B would create a dust shadow over 3,310.5 acres of wetlands. The dust shadow would occur in no more than 0.1% of any of the six HUCs in which the effects would occur. Tables E.9.6 and E.9.7 in Appendix E.9 detail the effects by wetland type and watershed.

The physical and chemical effects from dust deposition on tundra from gravel infrastructure may reduce photosynthesis or change the soil pH and thus could cause vegetation mortality (Walker 1987) or a reduction in vegetation biomass (Auerbach, Walker et al. 1997). Additionally, the change in albedo from the dust shadow could result in the early green-up of plants (Walker 1987), increased grass and sedge composition (Auerbach, Walker et al. 1997), and decreased sphagnum and other mosses and lichens (Everett 1980; Walker 1987) close to gravel infrastructure.

Snow accumulations downwind of the raised roads and pads would insulate soils, lessening changes in winter soil temperature, and could increase standing water as the snow melts in late spring or early summer. This could cause subsidence adjacent to gravel fill. Plowing may cause increased snowdrift accumulation on the downwind side of roads, as well as adjacent to roads and pads due to blocked windswept snow. Although snowbanks adjacent to gravel roads with heavy winter traffic may be several times deeper than the average snowpack from drifting or plowing, these areas are often the first areas to melt, due to the albedo effect of dust on snow (Klinger, Walker et al. 1983). The deeper snow depth restricts the seasonal frost penetration and the earlier thaw increases heat absorption, which results in a compounding effect of a deeper active layer.

Gravel infrastructure and culverts could alter surface flow and result in ponded water upgradient of the structure (Section 3.8, *Water Resources*); this could induce subsidence, particularly as permafrost temperatures increase with climate change. An increase in water impoundments could delay plant growth or contribute to conversion of vegetated tundra to lakes if the impoundments become permanent (Jorgenson and Joyce 1994). The increased surface water depth and duration of inundation on the upgradient side of gravel fill areas could transform the vegetation community composition into wetter tundra types and thus increase grass and sedge cover and decrease shrub cover. It could also lead to plant mortality if the increased inundation becomes permanent and a potential waterbody is created (Walker 1987). During spring snowmelt, impoundments could occur on the upgradient side of gravel fill, and natural drainage patterns could be interrupted on the downgradient side of fill. The effects may include decreased soil moisture and subsequent changes in vegetation communities, such as an increase in shrub cover and a decrease in grass and sedge cover as well as conversion from a wetland to upland.

Water withdrawals from lakes also may indirectly affect adjacent wetlands by reducing the amount of water available to the wetland community. However, if sufficient recharge occurs in the spring, there would be no effects to wetlands and waterbodies. Because the CFWR is not expected to substantially change water levels in Lake M0015 or Willow Creek 3 (as described in Section 3.8.2.3.6, *Water Withdrawal and Diversion*), water diversion to the CFWR is not expected to indirectly affect adjacent wetlands or reduce the amount of water available to the wetland community.

The Project would increase mechanisms for invasive species introduction or dispersal to the Project area. Invasive plant species would most likely be introduced to the ACP through the Dalton Highway and airports and then be dispersed by vehicle traffic (Ansong and Pickering 2013). Additionally, boat ramps would increase mechanisms for invasive species introduction or dispersal to the Project area by increasing access for people to travel to areas previously less accessible. Established invasive species could alter existing wetland types and functions.

3.9.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences. Alternative C would have 56.9 more acres of wetland loss since there would be a second airstrip and camp located near BT2 (Table E.9.2 in Appendix E.9). Alternative C would also require a 3.6-mile-long annual ice road required for the life of the Project and have 1,050.7 acres more total ice infrastructure than Alternative B (Table E.9.5 in Appendix E.9), which would increase the duration and severity of vegetation damage and soil compaction.. Alternative C would have one fewer bridge crossing, thus fill 0.8 fewer acre of riverine wetlands than Alternative B. There would be 251.9 MG more of freshwater used. VSMs would fill a total of 0.8 acre of wetlands and WOUS over the length of the pipeline.

3.9.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those described under Alternative B, with the following differences. Alternative D would have 9.2 fewer acres of wetland loss (Table E.9.2 in Appendix E.9). However, Alternative D would also require one additional season of ice roads and water withdrawal during construction, as well as the longest (12.5 miles) annual ice road required for the life of the Project, which would increase the duration and severity of vegetation damage and soil compaction. Approximately 2,607.5 more acres would be covered by ice infrastructure than Alternative B, which would damage more vegetation and compress more soils than Alternative B. Alternative D would have one fewer bridge crossing than Alternative B but would have 0.4 fewer acre of fill in riverine wetlands than Alternative B (0.8 acre total). Alternative D would have the same impacts from multi-season ice pad impacts as Alternative B and C; there would be 623.9 MG more of freshwater use. VSMs would fill a total of 0.9 acre of wetlands and WOUS over the length of the pipeline.

3.9.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

3.9.2.6.1 Direct Loss and Alteration of Wetlands

Option 1 would fill 12.8 acres of marine WOUS, approximately 1.9 miles offshore of Atigaru Point at its closest point (though the sea ice road would be 2.4 miles). Although the MTI would be decommissioned within 5 years of construction, fill would not be removed. The island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in 3.8.2.6, *Module Delivery Option 1:Atigaru Point Module Transfer Island*, in Section 3.8).

3.9.2.6.2 Direct Vegetation Damage and Soil Compaction

Option 1 would have 859.6 acres of freshwater ice roads and ice pads that could damage vegetation and compact soil (Table E.9.5 in Appendix E.9); effects of ice roads are described under Alternative B. Option 1 would have 30.0 acres of multi-season ice pads.

3.9.2.6.3 Indirect Change in Wetland Composition

Option 1 would withdrawal 307.9 MG of water from lakes, which may indirectly affect adjacent wetlands by reducing the amount of water available to the wetland community.

3.9.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

Option 2 would fill 13.0 acres of marine WOUS, approximately 0.6 mile offshore of Point Lonely, and have the same decommissioning methods and effects as Option 1. Option 2 would have 1,756.1 acres of freshwater ice infrastructure (896.5 more acres than Option 1) that could damage vegetation and compact soil (Table E.9.5 in Appendix E.9). Option 2 would have the same number of acres of multi-season ice pads (30.0 acres) as Option 1. Option 2 would withdrawal 264.1 MG more water from lakes (572.0 MG total).

3.9.2.8 Module Delivery Option 3: Colville River Crossing

Option 3 would not have any fill in marine WOUS; it would add 5 acres of gravel fill to existing Kuparuk roads and expand the existing dust shadow by 27.8 acres (Table E.9.6 in Appendix E.9). This would contribute to the effects of dust and gravel spray described in Section 3.9.2.3.3, *Indirect Change in Wetland Composition*. Because the gravel fill would occur adjacent to existing gravel roads with existing dust shadows, the effect would be minor. Indirect impacts would total less than 0.1% of any affected watershed. The fill for Option 3 would occur over five 10-digit HUCs that range in size from 77,254 acres to 234,392 acres. Thus, the amount of fill for Option 3 is negligible when compared to the size of the HUCs in which the fill would occur. The fill would not measurably increase the proportion of proposed fill in any of the 10-digit HUCs. Approximately 666.6 acres of vegetation damage could occur from ice infrastructure (Table E.9.5 in Appendix E.9) and 257.2 MG of water would be withdrawn from area lakes.

Because there would be no fill in marine or freshwater WOUS, only 5.0 acres of gravel fill in wetlands, and the least acres of ice infrastructure of any of the module delivery options, effects to wetlands and vegetation from Option 3 would be substantially less than Options 1 or 2.

3.9.2.9 Spills and Other Accidental Releases

Although oil spills and other accidental releases are not a planned activity of the Project under any alternative, effects to water resources should a spill occur are discussed here. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur and provides context for spills that have occurred on the North Slope.

Under all action alternatives, spills and other accidental releases could occur. Spills associated with the discharge of oil from leaking wellheads, facility piping, process piping, or ASTs would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. These types of spills would be unlikely to affect the tundra or waterbodies adjacent to facilities or structures. Spills not on gravel infrastructure would likely extend to the area immediately adjacent to a facility or structure where the spill occurred and could result in direct mortality of vegetation.

In the very unlikely event that a reservoir blowout occurred at one of the drill sites (likelihood approaching zero, as described in Chapter 4.0), the extent of the accidental release could be much larger and could distribute an aerial mist of oil over tundra vegetation as described in Chapter 4.0. A blowout could reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

Effects of potential spills on wetlands and vegetation would vary by season, vegetation type, and substance spilled. Winter spills would have a lesser effect because cleanup is easier (NRC 2003). Oil, diesel fuel, and seawater spills on nonfrozen plants or soil would have effects that could potentially last many years. Even a moderate concentration of oil (about 12 liters per square meter) is enough to kill most plant species (Walker 1987). Saltwater spills can be toxic to many plant species, long lasting, and cause physiological stress, including leaf deterioration and deleafing (Simmons 1983). Documented effects to vegetation have varied by plant species and by the hydrology of a particular site: wetter sites recover more rapidly and show less stress. Willow species and mountain avens have a lower tolerance for salt and are more affected, while grasses and sedges are less affected (Simmons 1983).

3.9.3 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Some loss of wetlands and vegetation would be unavoidable. The function associated with those wetlands would be irretrievably lost throughout the life of the Project until restoration is complete. Prior to final abandonment, land used for infrastructure is expected to be reclaimed, however, if reclamation did not occur, including the removal of gravel fill, the loss would be irreversible. The loss would not be irreversible if restoration occurred, which would also reduce impacts to the long-term sustainability of wetland function in the fill footprint. Water impoundments due to impacts to permafrost (from gravel mining and the CFWR) would be irreversible because the mine pit and the reservoir would fill with water and would permanently change the thermal regime of the underlying soils.

The alteration of marine WOUS would also be irreversible because even if the MTI is abandoned and reshaped, it would still exist.

3.10 Fish

The analysis area for fish includes aquatic habitats adjacent to and downstream of Project infrastructure and nearshore marine waters from Point Lonely to Oliktok Point in the Beaufort Sea (Figure 3.10.1). The main freshwater drainages in the Willow area are the Kalikpik River, Fish (Uvlutuuq) Creek, Fish (Iqalliqpik) Creek, Judy (Iqalliqpik) Creek, Judy (Kayyaaq) Creek, and the Ublutuoch (Tiŋmiaqsiuġvik) River; the main drainages in the eastern analysis area are the Colville River, the Itkillik River, and several smaller tributaries of the Colville River or coastal streams that drain to the Beaufort Sea. The temporal scale for construction-related impacts is the duration of construction activities. The temporal scale for operational impacts is the life of the Project or until reclamation is complete. Reclamation of onshore areas can take many years, depending on the tundra damage. If reclamation of onshore gravel fill did not occur, impacts from that fill would be permanent. Marine substrates that would be screeded would return to pre-screeding condition in approximately one season. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in Section 3.8.2.6, *Module Delivery Option 1: Atigaru Point Module Transfer Island*, in Section 3.8).

3.10.1 Affected Environment

3.10.1.1 Freshwater

Freshwater fish habitats in the Willow area are generally representative of habitats across the ACP. Streams are generally low gradient and slow moving. Large rivers and main streams are typically characterized by unstable banks and substrates dominated by shifting sand, silt, and isolated areas of gravel (CPAI 2018a). Smaller streams and creeks are characterized by incised peat channels, submerged aquatic vegetation, and pools connected by shallow riffles (CPAI 2018a). Gravel beds occur more commonly in the Ublutuoch (Tiŋmiaqsiuġvik) River and streams east of the Colville River. Aside from the major stream corridors (Colville and Itkillik rivers), a complex network of lakes and small streams dominates the aquatic habitat. Habitat suitable to support fish during winter is limited. The only streams with overwintering fish habitat that would intersect the Project are the Ublutuoch (Tiŋmiaqsiuġvik) and Colville rivers (Figure 3.10.1); more details on these streams are provided below. Most streams that would intersect the Project are shallow and likely freeze to the bottom during winter. Surface water typically freezes during September and thaws in late May to June. Peak annual flow is from snowmelt during spring breakup, when large expanses across the ACP become inundated by water. Summer flows typically decline, with some streams becoming intermittent by mid- to late summer. Flows often increase in late summer due to rain events, which allows fish a final opportunity to move to wintering areas. Surface flow connectivity is needed for fish to access important rearing, feeding, spawning, and overwintering habitats. Existing conditions in the Colville River and the marine area near Oliktok Point are described in Section 3.8. As described in Section 3.2 (*Climate and Climate Change*), climate change is occurring, and precipitation levels are projected to increase. A concurrent increase in evapotranspiration may result in a net loss in surface water by the end of the summer. Increases in winter precipitation may affect lake recharge and peak snowmelt runoff in rivers and streams.

Existing development and infrastructure in the analysis area occur from several oil and gas developments (GMT, Alpine, Nuna, Oooguruk, and Kuparuk) and the community of Nuiqsut. More gravel infrastructure occurs on the east side of the Colville River, where there are roads, mine sites, airstrips, reservoirs, pipelines, processing facilities, a dock (Oliktok Dock), and a seawater treatment facility. On the west side of the river, gravel infrastructure is focused in the lower reaches of the Ublutuoch (Tiŋmiaqsiuġvik) River and Fish (Iqalliqpik) Creek basins and in the CRD (Figure 3.10.1). This existing infrastructure and development activities (traffic, drilling, processing, etc.) contribute dust, sediment, noise, and the potential for spills to surrounding waterbodies. Seasonal ice infrastructure and associated water withdrawal occur annually to support oil and gas exploration. The freshwater and marine areas are used for subsistence and research and have a relatively minor amount of associated boat, foot, air, and off-road vehicle traffic.

Fish are widely distributed throughout the network of lakes, ponds, alluvial and beaded streams, and adjacent wetlands. Most common fish species are Arctic grayling, broad whitefish, burbot, least cisco, Arctic cisco, Arctic flounder, round whitefish, humpback whitefish, and ninespine stickleback. A comprehensive list of the 24 fish species documented in the analysis area and their life history characteristics is provided in Table 3.10.1.

Many of these species migrate both locally and extensively between major drainages, particularly **anadromous** species, to access habitats that support various life history stages (Heim, Wipfli et al. 2015; McFarland, Morris et al. 2017a; Morris 2003). Abundant stream-lake networks are often accessible only during the open-water season yet provide important and complex habitats for multiple species of fish (Heim, Arp et al. 2019). Robust populations of broad whitefish throughout the central and western Beaufort Sea coast are at least partially dependent on access to small tundra streams and associated shallow lakes during the open-water season for feeding; they then retreat to suitable wintering habitats each year (Morris 2000, 2003; Morris, Moulton et al. 2006). Seasonal waterbody connectivity and flow regimes influence habitat accessibility and use (Heim 2014). Shallow, nearshore marine habitats are used by multiple age classes of forage fish and provide rearing and foraging habitats for other fish species and life stages (Johnson, Thedinga et al. 2010; Logerwell, Busby et al. 2015).

The Colville River at Ocean Point is anadromous (used for spawning, rearing, or migration; Figure 3.10.1). Overwintering habitat depicted in Figure 3.10.1 was derived from Morris (2003) and may overestimate overwintering habitat in some areas. Channel conditions and thus aquatic habitat at Ocean Point are different than both upstream and downstream reaches in that the active channel at Ocean Point is narrow, the banks are more steeply incised, and few if any channel braids occur in winter.

Table 3.10.1. Fish Species that Use the Analysis Area

Family or Subfamily	Common Name	Scientific Name	Habitat Use	Wintering Habitat
Mudminnows	Alaska blackfish[a]	*Dallia pectoralis*	Freshwater	Freshwater lakes and streams
Smelts	Capelin	*Mallotus villosus*	Marine	Marine
Smelts	Rainbow smelt	*Osmerus mordax*	Anadromous	Marine and brackish waters
Salmonids	Arctic cisco	*Coregonus autumnalis*	Anadromous	Freshwater lakes and streams, brackish waters
Salmonids	Bering cisco	*Coregonus laurettae*	Anadromous	Brackish waters and river mouths
Salmonids	Broad whitefish[b]	*Coregonus nasus*	Anadromous	Freshwater lakes and streams
Salmonids	Humpback whitefish[b]	*Coregonus pidschian*	Anadromous	Freshwater lakes and streams

Family or Subfamily	Common Name	Scientific Name	Habitat Use	Wintering Habitat
Salmonids	Least cisco[b]	*Coregonus sardinella*	Anadromous	Freshwater lakes and streams
Salmonids	Round whitefish[b]	*Prosopium cylindraceum*	Freshwater	Freshwater lakes and streams
Salmonids	Arctic grayling[b]	*Thymallus arcticus*	Freshwater	Freshwater lakes and streams
Salmonids	Pink salmon[c]	*Oncorhynchus gorbuscha*	Anadromous	Freshwater streams[d]
Salmonids	Chum salmon[c]	*Oncorhynchus keta*	Anadromous	Freshwater streams[d]
Salmonids	Sockeye salmon[c]	*Oncorhynchus nerka*	Anadromous	Freshwater streams[d]
Salmonids	Chinook salmon[c]	*Oncorhynchus tshawytscha*	Anadromous	Freshwater streams[d]
Salmonids	Lake trout[b]	*Salvelinus namaycush*	Freshwater	Freshwater lakes and streams
Salmonids	Dolly Varden	*Salvelinus malma*	Anadromous	Freshwater lakes and streams
Cods	Burbot[b]	*Lota lota*	Freshwater	Freshwater lakes and streams
Cods	Arctic cod[c]	*Boreogadus saida*	Marine	Marine
Cods	Saffron cod[c]	*Eleginus gracilis*	Marine	Marine
Sticklebacks	Threespine stickleback	*Gasterosteus aculeatus*	Anadromous	Freshwater lakes and streams
Sticklebacks	Ninespine stickleback[a]	*Pungitius pungitius*	Anadromous	Freshwater lakes and streams
Sculpins	Slimy sculpin	*Cottus cognatus*	Freshwater	Freshwater lakes and streams
Sculpins	Fourhorn sculpin	*Myoxocephalus quadricornis*	Marine	Marine and brackish waters
Right-eye flounders	Arctic flounder	*Liopsetta glacialis*	Marine	Marine

Source: Armstrong 1994; Moulton 2002; Woodward-Clyde Consultants 1983.
Note: Freshwater fish use primarily freshwater habitats; however, many freshwater fish can tolerate low-salinity waters and therefore may move into nearshore areas as conditions allow. Anadromous fish spend a portion of their life cycle in both fresh and marine waters and may move between such habitats for spawning. Marine fish use primarily marine and estuarine waters.
[a] Common in freshwater lakes of the Willow area – considered resistant to changes in water quality per best management practice (BMP) B-2 (Moulton 2002).
[b] Common or known to occur in freshwater lakes of the Willow area – considered sensitive to changes in water quality per BMP B-2.
[c] Species with designated essential fish habitat in the analysis area (Armstrong 1994).
[d] Only egg and alevin overwintering habitat; no known juvenile salmon overwintering habitat has been documented in the analysis area.

Arctic cisco (qaaqtak) move into the CRD each fall or winter under the ice as saltwater moves up the delta channels (Moulton, Seavey et al. 2010). Residents of Nuiqsut fish for the species throughout the delta during early winter, primarily in the Nigliq Channel (within the extent of the saltwater intrusion). Because saltwater does not typically extend far upstream from the CRD (the documented extent of saltwater intrusion is at least 30 miles upstream from Harrison Bay in winter, just upstream from the Itkillik River (Arnborg, Walker et al. 1962)), Arctic cisco are unlikely to be in the vicinity of Ocean Point during winter. Burbot (Tittaaliq) fishing during winter, although only quantified in 2006, is focused in the mainstem of the Colville River east of the Putu Channel divergence (Moulton and Pausanna 2006). Summer and late fall fishing for broad whitefish is focused in the Nigliq Channel and the mainstem of the Colville River upstream to just below its confluence with the Itkillik River (Moulton and Pausanna 2006). The distribution of fishing efforts suggests that these targeted fish species are not common during winter farther upstream (to Ocean Point). Studies of seasonal movements of radio-tagged broad whitefish (Morris 2000, 2003) found that fish that moved into the Colville River in fall or winter did not move upstream from Ocean Point, and most wintered in a side channel of the Colville River at Ocean Point or downstream in reaches around the confluence with the Itkillik River. It is likely that burbot are not moving through Ocean Point during winter, although they are the most likely species to do so when the opportunity is there (i.e., flows are sufficient). Most species aside from burbot are not feeding in the winter and tend to be fairly sedentary once they have reached overwintering locations. Several streams on the east side of the Colville River in the analysis area are anadromous (Kalubik Creek, Miluveach River, Kachemach River, Itkillik River, and one unnamed stream and lake complex near Ocean Point), but none contain known overwintering habitat except potentially near their connections to the Colville River (e.g., the Itkillik River) (Figure 3.10.1). The Itkillik River is different than other eastside tributaries of the lower Colville River in that it originates in the Brooks Range and thus is longer and drains a larger area than the other tundra rivers. It is one of the largest tributaries of the Colville River on its east side and likely contains some overwintering habitat near its confluence with the Colville River.

The Ublutuoch (Tiŋmiaqsiuġvik) River contains overwintering fish habitat from near its confluence with Fish (Iqalliqpik) Creek upstream to approximately 0.25 mile upstream from the proposed boat ramp (Figure 3.10.1). The overwintering habitat depicted in Figure 3.10.1 was derived from Morris (2003) and depth surveys by

Moulton (2004) and may overestimate contiguous overwintering habitat in some areas (as was described for the Colville River). Maximum water depths in the reach (approximately 3 river miles [RMs]) upstream of the boat ramp were over 23 feet in 1999 and ranged from less than 1 foot to 23.6 feet (Moulton 2004). Downstream from the proposed boat ramp, deepwater overwintering habitat is more continuous. Overwintering habitat on the North Slope is typically in water at least 7 to 8 feet deep.

From 2013 through 2016, infections of the ubiquitous water mold *Saprolegnia parasitica* were confirmed in multiple broad whitefish and two humpback whitefish (Sformo, Adams et al. 2017). While the mold is not uncommon on stressed and injured fish, these were the first confirmed infections from the Colville River. All signs of infection were observed during the whitefish spawning period when the species' protective mucous membrane can be compromised potentially increasing their susceptibility to *S. parasitica* (Hoag 2019; Sformo, Adams et al. 2017).

3.10.1.2 Nearshore Marine Area

Existing marine infrastructure in the analysis area occurs at Oliktok Point, where there is a commercial sheet-pile dock, shoreline armoring, and a saltwater treatment plant. In addition, Oooguruk Island, a 6-acre constructed gravel island with a pipeline to shore, is located near the mouth of the Colville River. Screeding occurs with seasonal regularity at Oliktok Dock prior to barge arrival. Near Oliktok Dock, outflow from the CRD and coastal erosion transport significant amounts of SS (Dunton, Weingartner et al. 2006). The open-water season in the nearshore Beaufort Sea is characterized by strong and nearly continuous wind. Nearshore habitats are highly turbid.

Marine and anadromous fish species that use the nearshore marine areas in the analysis area are listed in Table 3.10.1. Fish surveys of the Oliktok Point area using multiple sampling techniques from July through September 1982, found that Arctic cod, fourhorn sculpin, and least cisco were the dominant fish species followed by Arctic cisco, rainbow smelt, Arctic flounder, humpback whitefish, Dolly Varden, and pink salmon (Woodward-Clyde Consultants 1983). Studies in the summer of 1983 (Moulton and Fawcett 1984) documented a higher abundance of broad whitefish, humpback whitefish, Arctic cisco, least cisco, Dolly Varden, Arctic cod, Arctic flounder, and fourhorn sculpin west of Oliktok Point than east of it. Fish diversity of the nearshore Point Lonely and Atigaru Point areas are similar to that of the Oliktok Point area, although possibly less diverse (Schmidt, McMillan et al. 1983). Nearshore marine fish species at Point Lonely are similar to Atigaru Point, with the addition of Bering cisco (*Coregonus laurettae*) (Schmidt, McMillan et al. 1983). Because the coast between Point Lonely and Cape Halkett receives relatively little freshwater input from large river systems, the area is expected to have a lower abundance of most whitefish species (that have a lower salt tolerance).

3.10.1.3 Essential Fish Habitat

EFH, as designated by the Magnuson Stevens Fishery Conservation and Management Act are "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity". Freshwater EFH in Alaska are waters listed as anadromous in ADF&G's Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes (Johnson and Blossom 2017). Marine EFH is identified and described in fishery management plans.

Designated EFH occurs throughout the analysis area (Johnson and Blossom 2017; North Pacific Fishery Management Council 2009, 2012), as depicted in Figures 3.10.1 and 3.10.2 and summarized in Table 3.10.2. Most of the main streams contain freshwater EFH in at least some reaches; streams east of the Itkillik River are not included in Table 3.10.2 since no effects to EFH are anticipated there. Nearshore estuarine and marine waters of the Beaufort Sea are designated as EFH for all five Pacific salmon species, saffron cod, and Arctic cod (North Pacific Fishery Management Council 2009, 2012). Marine EFH for Pacific salmon is limited because chum, Chinook, pink, and sockeye salmon distribution is restricted to relatively low numbers of individuals in a few drainages within the analysis area. Coho salmon have not been identified in the area.

Table 3.10.2. Essential Fish Habitat near Project Gravel or Ice Infrastructure

Stream or Waterbody	Species	Reference
Fish Creek (Uvlutuuq and Iqalliqpik channels)	Pink salmon, chum salmon, Chinook salmon	Johnson and Blossom 2017; McFarland, Morris, and Moulton 2020

Stream or Waterbody	Species	Reference
Willow Creek 8	Pink salmon, chum salmon	McFarland, Morris, and Moulton 2020
Judy (Iqalliqpik) Creek	Pink salmon, chum salmon	Johnson and Blossom 2017
Judy (Kayyaaq) Creek	Chum salmon	McFarland, Morris et al. 2017a
Willow Creek 2	Pink salmon, chum salmon	McFarland, Morris, and Moulton 2020
Willow Creek 4	Pink salmon, chum salmon, sockeye salmon	McFarland, Morris et al. 2017a; McFarland, Morris, Moulton et al. 2019a; McFarland, Morris, Moulton, and Moulton 2020
Ublutuoch (Tiŋmiaqsiuġvik) River	Pink salmon, chum salmon, Chinook salmon	Johnson and Blossom 2017; McFarland, Morris, and Moulton 2020
Bills Creek	Pink salmon, chum salmon	McFarland, Morris, and Moulton 2020
Colville River	Pink salmon, chum salmon	Johnson and Blossom 2017
Colville River Delta	Pink salmon, chum salmon	Johnson and Blossom 2017
Itkillik River	Pink salmon, chum salmon	Johnson and Blossom 2017
Harrison Bay, Beaufort Sea	Pink salmon, chum salmon, Chinook salmon, sockeye salmon, coho salmon, saffron cod, Arctic cod	North Pacific Fishery Management Council 2009, 2012

Note: Locations of Essential Fish Habitat are depicted in Figures 3.10.1 and 3.10.2.

3.10.2 Environmental Consequences

3.10.2.1 Avoidance, Minimization, and Mitigation

3.10.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.10.3 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to fish from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to fish habitat, subsistence hunting and fishing areas, and the environment, associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.10.3 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to fish. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.10.3 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.10.3. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Fish

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive Waste Management Plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or state permit.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-3	Minimize pollution through effective hazardous materials contingency planning.	Prepare and implement a hazardous materials emergency contingency plan before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes, and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of the disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
ROP A-13	Prevent the release of poly- and perfluoroalkyl substances associated with the use of aqueous film-forming foam, a firefighting foam designed to extinguish flammable and combustible liquids and gases.	No similar requirement.	At facilities where fire-fighting foam is required, use fluorine-free foam unless other state or federal regulations require aqueous film-forming foam use. If aqueous film-forming foam use is required, contain, collect, treat, and properly dispose of all runoff, wastewater from training events, and, to the greatest extent possible, from any emergency response events.
BMP B-1	Maintain populations of, and adequate habitat for, fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.	Changes do not affect text as described.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4 feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during winter and withdrawal of water from lakes during summer may be authorized on a site-specific basis, depending on water volume and depth, the fish community, and connectivity to other lakes or streams. BLM must be notified within 48 hours of any observation of dead or injured fish on water source intake screens, in the hole being used for pumping, or within any portion of ice roads or pads. If observed at a particular lake, pumping must cease temporarily from that hole until additional preventive measures are taken to avoid further impacts on fish.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	– Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – Snow survey and soil freeze-down data collected for ice road or snow trail planning and monitoring shall be submitted to the BLM. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	Added text: – Permittee shall provide to BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of road/trail construction – In the spring, provide the BLM with photographs of all stream crossings that have been removed, breached, or slotted.
BMP C-4	Avoid additional freeze-down of deep-water pools harboring overwintering fish and invertebrates used by fish.	Travel up and down streambeds is prohibited unless demonstrated that there will be no additional impacts to overwintering fish or the invertebrates they rely on.	Some travel up and down streambeds would be allowed by the individual vehicles collecting snow from river drifts or ice aggregate from the channel (where ice is grounded).
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.	Added text: Permittees shall construct a subsistence pullout and boat ramp at crossings of heavily used subsistence rivers.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high-water mark of fish-bearing waterbodies.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A postconstruction monitoring program, developed in consultation with appropriate federal, state, and NSB agencies, shall be required to track circulation patterns, water quality, and fish movements around the structure.
BMP E-4	Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.	All pipelines shall be designed, constructed, and operated under a BLM-approved Quality Assurance/Quality Control Plan.	No similar requirement; the State of Alaska enforces pipeline design and construction standards to minimize the potential for leaks.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure the free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.	Added text: – Stream and marsh crossings will be designed on at least one year of relevant hydrologic data. Additional years of hydrologic data collection may be required if more information is needed to design the crossing structure in order to attain the BMP. – The crossing structure design shall account for permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment. – A minimum of 1 year of fish sampling at any stream crossing where flow is channelized, and additional years of fish sampling may be required at sites where the determination of anadromous fish presence is still in question. – A 1 minimum year of hydrologic data at any stream crossings where flow is channelized, and additional years of fish sampling may be required at sites where the determination of anadromous fish presence is still in question. – All proposed crossing designs would adhere to the standards outlined in fish passage design guidelines developed by the USFWS Alaska Fish Passage Program (USFWS 2019b), USFWS *Culvert Design Guidelines for Ecological Function* (USFWS 2020a), *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USFS 2008), and other generally accepted BMPs prescribed by the BLM.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the BLM and in consultation with appropriate federal, state, and NSB regulatory and resource agencies.	Added text: – The plan shall consider locations outside the active floodplain or designing gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction	Added text: Develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments (for alternatives B, C, D: based on LiDAR or other high-accuracy surface imaging).
BMP E-14	Ensure the passage of fish at stream crossings.	To ensure that crossings provide for fish passage, all proposed crossing designs shall collect at least 3 years of hydrologic and fish data.	Similar requirement is BMP E-6, which combines BMPs E-6 and E-14.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure restoration of ecosystem function.	Changes do not affect text as described.
ROP H-5	Make data and summary reports derived from North Slope studies easily accessible.	No similar requirement.	Required monitoring studies, reports, and geographic information system data shall be posted online and available to the public.
LS/ BMP K-1[a]	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or overwintering habitat for fish; the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	No surface occupancy or new infrastructure, except essential road and pipeline crossings in the following setbacks: Colville River (2- to 7-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). Gravel mines may be located within the active floodplain, consistent with BMP E-8.
LS/ BMP K-2[a]	(Deepwater Lakes) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabins and campsites; and the disruption of subsistence activities.	Permanent oil and gas facilities are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high-water mark of lakes deeper than 13 feet.	Changes do not affect text as described. Additional restrictions as described in BMP/ROP E-11 may also apply in those habitats.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-6[a]	(Coastal Areas) Protect coastal waters and their value as fish and wildlife habitat; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). No leasing is allowed within 1 mile of the coast. The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as a barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For a permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; maintain populations of, and adequate habitat for, birds, fish, and caribou; and minimize impacts to subsistence activities.	The BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.

Source: BLM 2013a, 2020a

Note: BLM (Bureau of Land Management); BMP (best management practice); DEW (distant early warning); F (Fahrenheit); IAP (Integrated Activity Plan); LiDAR (Light Detection and Ranging); LS (lease stipulations); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy); ROP (required operating procedure); USFWS (U.S. Fish and Wildlife Service); USGS (U.S. Geological Survey).

[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect fish would include those to LS E-2 and BMPs K-1, K-2, and K-6. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMP K-1 and K-2), a CFWR connected to Lake M0015, and freshwater intake pipelines at Lakes L9911 and/or M0235 (varies by alternative) (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would intake and discharge ballast water to ground barges at Oliktok Dock and the barge lightering area; Options 1 and 2 would intake and discharge ballast water at the MTIs and the lightering areas. These ballast water exchanges would occur within 3 miles of the coastline (see BMP K-6), but intake and discharge would occur in the same location and ballast water would not be transported.

Option 3 may require management of water under the partially grounded ice bridge over the Colville River at Ocean Point. If water from the river needs to be pumped around the bridge during the 2 winters of ice bridge use, this may require a deviation to BMP B-1.

3.10.2.1.2 <u>Proponent's Design Measures to Avoid and Minimize Effects</u>

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.10.2.1.3 <u>Additional Suggested Avoidance, Minimization, or Mitigation</u>

Additional suggested measures to reduce impacts to fish could include the following:

- Identify overwintering fish habitat (maximum water depths, particularly free-water depth under ice cover) in the Itkillik River and other tributaries to the Colville River that might intersect the Option 3 ice road. Avoid crossings of potential overwintering habitat.

The Project could adopt the following BMPs suggested by NMFS for EFH for invasive species (Limpinsel, Eagleton et al. 2017):

1. Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs.
2. Adhere to regulations and use BMPs outlined in the State of Alaska *Aquatic Nuisance Species Management Plan* (ADF&G 2002).
3. Encourage vessels to exchange ballast water in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing invasive estuarine species into similar habitats. Ballast water taken on in the open ocean would contain fewer organisms, and these would be less likely to become invasive in estuarine conditions.
4. Discourage vessels that have not exchanged ballast water from discharging their ballast water into estuarine receiving waters.

3.10.2.2 Alternative A: No Action

Under the No Action Alternative, ice infrastructure and associated water withdrawals in the analysis area could continue to occur to support oil and gas exploration. Effects from the existing gravel infrastructure in the Alpine and GMT oil fields would continue.

3.10.2.3 Alternative B: Proponent's Project

3.10.2.3.1 Habitat Loss or Alteration

Project activities that may remove, or alter fish habitat are as follows:

- New gravel roads, gravel pads, airstrips, VSMs, culverts, bridges, the CFWR, and water intake structures
- Gravel mining and mine site reclamation
- Vehicle traffic on gravel infrastructure
- Ice infrastructure within or crossing waterbodies or floodplains
- New boat ramps and access roads below OHW
- Screeding at Oliktok Dock and the barge lightering area, barge grounding

Gravel fill would permanently remove 1.2 acres of freshwater aquatic habitat within the footprint of the boat ramps (up to three). Roads would avoid crossing known overwintering fish habitat (Figures 3.10.1 and 3.10.2); however, the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would be in overwintering fish habitat, which is described below. Several pads and the airstrip would also place fill in lakes (Table 3.10.4).

Bridge piles in waterbodies could remove habitat in the pile footprint and potentially cause scour around the piles. Alternative B would have 36 piles below OHW in anadromous streams (also designated as EFH). The main habitat functions of these streams are migration and rearing. All stream crossings would be designed to provide season-long fish passage in accordance with all ADF&G requirements. No culverts would occur on streams with documented anadromous fish use. Proper culvert sizing, maintenance, and placement relative to seasonal flows would ensure passage for non-anadromous fish during important migration periods in spring and fall and maintain natural hydrogeomorphic processes and drainage patterns during operations. Piles would not affect migration and rearing.

Gravel excavation at the mine site would occur within 324 feet of Bills Creek and within 326 feet of the Ublutuoch (Tiŋmiaqsiuġvik) River. Both of these streams provide high-use habitat for resident and anadromous fish; the Ublutuoch (Tiŋmiaqsiuġvik) River provides overwintering habitat in a limited reach of the river, which is approximately 3+ miles downstream of the mine site. Because blasting and gravel excavation would occur in winter, when surrounding aquatic habitats are frozen bottom-fast, fish habitat would not be affected. Once mining is complete, the mine pit would fill with water; because it would not be connected to adjacent streams, it would not provide fish habitat.

The boat ramps (and their access roads) would permanently alter approximately 0.4 acre of aquatic habitat for each boat ramp (i.e., the portion of each boat ramp that would be beneath OHW) for a total of 1.3 acres for all three boat ramps. Construction of the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would occur in overwintering fish habitat. If the construction occurs in-water, two potential effects could occur. First, if the river ice surface is used as a work platform, the insulating snow cover would need to be removed, which could super cool the water immediately around the construction site and lead to the formation of slush throughout the entire water column, as observed at the Sagavanirktok River Bridge in 2009 (Morris and Winters 2009). Second, in-water work would increase SS and turbidity in the water column, which could persist for an extended period of time due to the lack of flow, as has been documented on similar winter construction projects in the Kuparuk River (Bill Morris, personal communication to DOWL, January 16, 2020). In-water gravel fill may be transported downstream during high flows. The Ublutuoch (Tiŋmiaqsiuġvik) River contains a substantial amount of overwintering habitat; thus, it is anticipated that effects would be localized to the immediate area (from the boat ramp to a riffle immediately downstream of the existing bridge over the river on the GMT road; Figure 3.10.1), and fish would move to other available overwintering habitat.

The boat ramps on Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek would be in areas that contain eolian sand beds, which are highly mobile. Boat ramps in these locations could cause annual scour from placing hard structures on the unconsolidated bed and stream banks and also from loading and unloading boats (revving boat motors to load and unload boats from trailers as well as the tow vehicle's rear tires) and result in routine long-term in-water maintenance. Boat wakes could also cause bank erosion in the navigable area of the streams where the boat ramps are located. The extent and magnitude of erosion would be influenced by a number of factors, as described in Sections 3.8.2.3.4, *In-Water Structures (bridges, culverts, water intakes, boat ramps)*, and 3.8.2.3.9, *Watercraft in Rivers*. Erosion could alter fish habitat by wearing away banks and adding sediment to the stream. Because Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek serve primarily as migration corridors (not high-quality rearing or spawning habitat), and because there is a large amount of this type of habitat in the area, the effects on fish are not expected to be measurable.

The boat ramps would increase community access and use of the Ublutuoch (Tiŋmiaqsiuġvik) River, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek in the areas where they are navigable. Likely use would be by small skiffs (subsistence users). Use of personal watercraft would increase the potential for gas spills into waterbodies, both up- and downstream of the ramps. The boat ramps would also create stormwater runoff directly into their receiving waterbodies, which could increase contaminants in the channel near the ramps. When the amount of available high-quality fish habitat is considered with the extent of expected use of the boat ramps and associated potential spills, the effects to fish would be relatively small. Up to three boat ramps could be constructed. If only one boat ramp were constructed, use could be concentrated on that river and thus effects could be slightly higher there.

Construction of the channel connecting the CFWR to Lake M0015 would excavate 1.5 acres in Lake M0015 (Table 3.10.4), which provides habitat for resistant and sensitive fish. (As per ADNR and ADF&G water withdrawal permit stipulations, **sensitive fish** are susceptible to changes in water quality, such as reduced dissolved oxygen and increased dissolved solids, whereas **resistant fish** are more resilient to these conditions. Resistant fish are ninespine stickleback and Alaska blackfish, while all other species [e.g., broad whitefish, least cisco, Arctic grayling] are sensitive.) Temporary increased sedimentation could occur during the excavation and connection of the reservoir to Lake M0015. To prevent temporary erosion or a head cut while initially filling the CFWR, water would be transported from the intake through a pipe or other water conveyance system. The reservoir would be isolated by a manually controlled flood control gate valve or other structure so fish would not be able to enter the reservoir from the lake. To prevent fish entrainment or impingement during periods of filling, the structure would be screened and intake water velocities would follow ADF&G guidelines and permit conditions. Additionally, perimeter berms around the CFWR would prevent surface drainage and fish from entering the basin. Temporary alterations to freshwater habitat could also be caused by increased sedimentation from runoff associated with excavation activities. The effects would be temporary and limited to the localized area surrounding the excavation and the connection channel.

Increased sedimentation could occur from unplanned surface water connections to the mine pit either during spring floods or once the site fills with meltwater (Joyce, Rundquist et al. 1980). Temporary alterations to freshwater habitat could also be caused by increased sedimentation from runoff associated with gravel and ice infrastructure. Effects would occur throughout the life of the Project, but each occurrence would be temporary and limited to localized areas surrounding the infrastructure. Sediment mitigation measures would be employed, such as SWPPPs and existing BMPs, to limit pad and road runoff to fish habitat.

Dust deposition from vehicle traffic on gravel roads (including boat ramp access roads and the CFWR perimeter berm) throughout the life of the Project could alter 22.5 acres of river habitat, 20.2 acres of lake habitat that supports fish, and 8.4 acres of lake habitat with unknown fish presence (Table 3.10.4). The dust shadow (the area within 328 feet [100 m] of gravel roads and pads) is detailed in Section 3.4. Even with dust control measures in place, dust deposition would still occur.

Ice roads and pads can also alter fish habitat by temporarily blocking passage or eroding streambeds or stream banks. Fish passage can be blocked when compacted ice, which takes longer to melt, remains bedfast and channel-wide at stream crossings in the spring. Arctic fish populations rely on, and move between, multiple habitats throughout the year (Heim, Arp et al. 2019; McFarland, Morris et al. 2017a; McFarland, Morris, Moulton et al. 2019a; McFarland, Morris, Moulton, Moulton et al. 2020; Morris 2003; Morris, Moulton et al. 2006; Moulton, Morris et al. 2007). These populations have a restricted growth season and are often limited by suitable wintering habitat. Thus, maintaining passage during spring and late fall, when fish naturally move from wintering habitat to preferred spawning or feeding habitats, is important for maintaining productive fish populations. Ice infrastructure over defined stream channels would be removed, breached, and/or slotted before spring breakup to allow flow connectivity, minimize blocked passage, and minimize the potential for stream bank or streambed erosion (as per BMP C-3). Techniques to properly breach and slot ice bridges vary depending on the physical habitat and hydrologic conditions at each site. Improper slotting techniques can alter hydrologic conditions and erode stream banks, which can adversely affect habitat quality and interrupt natural fish movement. Alternative B would have 495.2 miles of ice roads. While individual fish may be affected by ice infrastructure, impacts would not result in population-level effects. Effects from blocked passage and erosion would last through spring breakup, which usually occurs in early June. In extreme and unlikely cases, longer lasting impacts on a local spawning population could occur if blockages caused substantial delays to migrating Arctic grayling during the spring spawning period and reduced fry production from that specific creek. Blocked passage could also affect whitefish species attempting to move upstream in spring and delay or prohibit them from reaching preferred feeding areas. Deposition could also occur at eroded locations if flow is restricted long enough to encounter thawed soils. Effects from ice infrastructure would be geographically limited to specific stream crossing locations and a stream-specific spawning population of fish.

Water withdrawal for ice infrastructure can alter fish habitat by reducing the quantity of water available for fish and changing water quality parameters such as dissolved oxygen, pH, and conductivity. Habitat alterations in withdrawal lakes would be temporary and would last until spring breakup, when lakes recharge. Water withdrawal would follow existing BMP B-2, as well as ADNR and ADF&G permit stipulations, which limit water removal during winter based on whether fish species sensitive to, or resistant to, the potential effects of water withdrawal are present. Resistant fish are ninespine stickleback and Alaska blackfish, while all other species (e.g., broad whitefish, least cisco, Arctic grayling) are sensitive. Alaska blackfish are particularly resistant to low dissolved oxygen and are able to use atmospheric oxygen to survive (Armstrong 1994). Ninespine stickleback can also withstand low dissolved oxygen (Lewis, Walkey et al. 1972), although not the same extent as Alaska blackfish. However, ninespine stickleback can withstand higher levels of dissolved solids and often frequent brackish nearshore waters during summer.

Under Alternative B, 1,662.4 MG from an unknown number of lakes would be withdrawn over the life of the Project for ice infrastructure, construction, domestic use, and dust suppression. Although individual fish may be affected, water withdrawal using existing BMPs and permit stipulations would not cause population-level effects.

Water diversion to the CFWR is not expected to substantially change water levels in Lake M0015 or Willow Creek 3 (as described in Section 3.8.2.3.6). If the reservoir is decommissioned at the end of the Project, the 50-foot-deep CFWR would provide new overwintering fish habitat. Lake M0015 currently supports both sensitive and resident fish (Figure 3.10.2).

Table 3.10.4. Effects to Fish and Fish Habitat from Action Alternatives

Project Component	Effect to Fish or Fish Habitat	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Gravel fill	Habitat loss or alteration Disturbance or displacement during construction if occurs in water[a]	1.2 acres in streams[b] 0.4 acre in EFH 0.4 acre in overwintering habitat 1.4 acres in fish-bearing lakes 0.1 acre in lakes with unknown fish presence	0.4 acre in streams[b] 0.4 acre in EFH 0.4 acre in overwintering habitat 1.4 acres in fish-bearing lakes 0.1 acre in lakes with unknown fish presence	0.4 acre in streams[b] 0.4 acre in EFH 0.4 acre in overwintering habitat 1.4 acres in fish-bearing lakes 0.1 acre in lakes with unknown fish presence
Excavation for CFWR	Habitat loss or alteration	1.5 acres in Lake M0015	1.5 acres in Lake M0015	1.5 acres in Lake M0015
Piles and VSMs below OHM	Habitat loss or alteration	36 piles, 0 VSMs 0.01 acre	20 piles, 10 VSMs < 0.01 acre	36 piles, 0 VSMs 0.01 acre
Culvert batteries	Habitat alteration	11	10	8
Number of lakes within 500 feet of permanent infrastructure (LS E-2)	Habitat alteration	4 fish-bearing lakes (deviations to LS E-2) 11 lakes with unknown fish presence	5 fish-bearing lakes (deviations to LS E-2) 11 lakes with unknown fish presence	4 fish-bearing lakes (deviations to LS E-2) 14 lakes with unknown fish presence
Water withdrawal or diversion	Temporary habitat alteration Injury or mortality from impingement or entrainment	1,662.4 MG of freshwater	1,914.3 MG of freshwater	2,286.3 MG of freshwater
Freshwater ice infrastructure	Habitat alteration from compressed ice	4,557.3 total acres 495.2 miles of ice road	5,608.0 total acres 650.1 miles of ice road	7,164.8 total acres 962.4 miles of ice roads
Onshore traffic[c]	Habitat alteration from dust shadow	22.5 acres in streams 20.2 acres in fish-bearing lakes 8.4 acres in lakes with unknown fish presence 3,188,910 total trips 0 to 14.4 trips per hour in summer or fall (when dust is most prevalent) 2021 through 2030 3.7 trips per hour in summer and fall 2031 through 2050	10.2 acres in streams 24.7 acres in fish-bearing lakes 7.8 acres in lakes with unknown fish presence 4,212,510 total trips 0 to 16 trips per hour in summer or fall (when dust is most prevalent) 2021 through 2030 5.7 trips per hour in summer and fall 2031 through 2050	14.5 acres in streams 20.5 acres in fish-bearing lakes 8.4 acres in lakes with unknown fish presence 4,376,890 total trips 0 to 12.6 trips per hour in summer or fall (when dust is most prevalent) 2021 through 2030 2.9 to 5.8 trips per hour in summer or fall 2031 through 2050
Barge and support vessel traffic[c]	Temporary disturbance or displacement from underwater noise and human activity	24 barges, 37 tugboats, and 258 support vessels 145 to 175 dB rms at 3.28 feet from the source	Same as Alternative B	Same as Alternative B
Screeding	Temporary habitat alteration Disturbance or displacement from underwater noise or human activity Injury or mortality from entrainment	12.1 acres, 2 occurrences 164 to 179 dB rms at 3.28 feet	Same as Alternative B	Same as Alternative B

Note: < (less than); dB (decibels); CFWR (constructed freshwater reservoir); EFH (Essential Fish Habitat); LS (lease stipulation); MG (million gallons); OHW (ordinary high water); rms (root-mean-square); VSMs (vertical support members). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*.

[a] Applies only to boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River.

[b] Assumes 0.4 acre below OHW per boat ramp based on preliminary estimated design.

[c] Traffic is detailed in Tables D.4.8, D.4.16, D.4.24, D.5.5, and D.5.6 in Appendix D.1, *Alternatives Development*.

Screeding at Oliktok Dock and the barge lightering area would temporarily alter 12.1 acres of benthic marine habitat by recontouring sediments prior to barge landings. Screeding would occur twice during construction. In the Oliktok Point area, outflow from the CRD and coastal erosion transport significant amounts of SS (Dunton, Weingartner et al. 2006). Sea-ice pressure ridges scour and gouge the seafloor and move sediments, creating natural, seasonal disruptions of the seafloor. Bottom disturbance is a natural and frequent occurrence in this nearshore region, resulting in benthic communities with patchy distributions (Carey, Boudrias et al. 1984). In addition, Oliktok Dock is an existing industrial facility that is seasonally screeded before arrival of barges. Screeding could temporarily increase turbidity in the screeding area. Because substrate types would not change and the screeded ground would likely resettle to conditions similar to those prior to screeding, fish habitat alteration would be minor, temporary, and of limited geographic extent.

Barges would be grounded in the screeding area after screeding is complete. Grounding would be accomplished by intaking ballast water. Ballast water would be discharged in the same location in which the intake occurred, in order to refloat the barges before departure. Should ballast be needed for the barge transit to the Beaufort Sea from origination points further south, potable water for trim ballast would be used and loaded at the fabrication site. Prior to loading trim ballast and leaving the fabrication site, all barges would have their ballast tanks stripped of water and dried.

Ballast water that is not potable or frequently exchanged can degrade habitat quality for fish by introducing aquatic invasive species, which can impact food webs and outcompete native species. In addition to CPAI's design measures to reduce impacts from ballast water, all vessels that enter State of Alaska or federal waters are subject to U.S. Coast Guard regulations (33 CFR 151), which are intended to reduce the transfer of aquatic invasive organisms. Management of ballast water discharge is federally regulated (33 CFR 151.2025); discharge of untreated ballast water into WOUS is prohibited unless the ballast water has been subject to a mid-ocean ballast water exchange (at least 200 nautical miles offshore). Vessel operators are also required to remove "fouling organisms from the hull, piping, and tanks on a regular basis, and dispose of any removed substances in accordance with local, state, and federal regulations" (33 CFR 151.2035(a)(6)). Adherence to the 33 CFR 151 regulations and CPAI's design measures would reduce the likelihood of Project-related vessels introducing aquatic invasive species.

3.10.2.3.2 Disturbance or Displacement

Project activities that may disturb or displace fish are as follows:

- Vehicle traffic at waterbody crossings
- Construction of the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp, and skiff traffic using any of the three boat ramps
- Marine vessel traffic
- Screeding

Disturbance or displacement of aquatic species is only anticipated to occur at stream crossings when water is flowing and vehicle traffic is present. Fish would be temporarily displaced in the immediate area of the stream crossing, which is a fraction of the available similar quality habitat throughout the analysis area. Localized temporary displacement could occur throughout Project operations. Construction at freshwater stream crossings would occur in winter, when most tundra streams, shallow ponds, and lakes are frozen to the substrate; thus, fish would not be present at any of the stream crossings during construction.

Winter gravel excavation at the new mine site would occur within 266 feet of Bills Creek and within 310 feet of the Ublutuoch (Tiŋmiaqsiuġvik) River, both anadromous streams that would be frozen to their beds during mining activities. The closest overwintering habitat for fish is located in the lower Ublutuoch (Tiŋmiaqsiuġvik) River approximately 3+ miles from the blast sites; thus, fish would not be affected by blasting or gravel excavation.

Noise and human activity from construction of the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp in winter could disturb or displace overwintering fish if in-water construction occurs. However, because there is a substantial amount of mapped overwintering habitat and it extends upstream and downstream of the boat ramp, it is expected that fish would be able to move away from the boat ramp construction and still have access to overwintering habitat (Figure 3.10.1). If at the time of construction, deepwater around the boat ramp site is isolated from up- and downstream deepwater habitats, then some fish would not have access to other areas and could be affected.

Skiffs using the boat ramps in summer and fall could disturb or displace fish along the navigable reaches of the boat-accessible rivers. If only one boat ramp were constructed, use could be concentrated on that river and thus effects could be slightly higher there.

Marine vessel traffic and screeding at Oliktok Dock and the barge lightering area could temporarily disturb and locally displace nearshore marine fish due to noise. Avoidance reactions have been observed in fish such as cod and herring when vessel sound levels were 110 to 130 decibels (dB) re 1 micropascal (µPa) root-mean-square (rms) (Ona and Godø 1990; Ona and Toresen 1988). Vessel sound source levels in the audible range for fish are typically 150 to 170 dB re 1 micropascal per hertz (µPa/Hz) (Richardson, Greene et al. 1995). Screeding could produce the highest sound levels of 164 to 179 dB rms at 3.28 feet from the source. These sound pressure levels would be within the range that could cause behavioral avoidance in fish in the immediate area of the vessel but would fall below levels that would injure or kill fish (Buehler, Oestman et al. 2015). Disturbance or displacement would occur only when vessels or screeding are underway and be limited to the nearshore barge route and Oliktok Dock area. Approximately 24 barge trips, 37 tugboat trips, and 258 support vessel trips would be required over four summer seasons. Individual fish may be affected, but populations would not. Oliktok Dock improvements would occur within the existing dock footprint and no in-water work would be needed; therefore, no effects to fish or fish habitat are anticipated.

3.10.2.3.3 Injury or Mortality

Screeding at Oliktok Dock and the barge lightering areas could also injure or kill bottom-dwelling fish within the screeding footprint if fish were entrained in the screeded material. Up to 12.1 acres would be affected in two screeding occurrences. Benthic infauna abundance and diversity are very low in the Oliktok Dock area, probably due to shallow water depth (less than 13 feet [4 meters]), runoff from adjacent rivers (i.e., high sediment loads from the CRD), and ice-related stress (Carey, Boudrias et al. 1984). Freezing and thawing sea ice and river runoff during the summer melting season significantly affect coastal water mass characteristics and decrease salinity. River outflow and coastal erosion also transport significant amounts of SS (Dunton, Weingartner et al. 2006). Sea ice pressure ridges scour and gouge the seafloor and move sediments, creating natural, seasonal disruptions of the seafloor. These factors will result in a less than favorable habitat for benthic organisms in the action area. Bottom disturbance is a natural and frequent occurrence in this nearshore region, resulting in benthic communities with patchy distributions (Carey, Boudrias et al. 1984). Thus, the number of fish potentially entrained in the screeding footprint would be small to negligible.

Increased subsistence access via boat ramps could result in increased harvest of fish, leading to increases in mortality in areas accessible by boat (streams and lakes along the Ublutuoch [Tiŋmiaqsiuġvik] River, Judy [Iqalliqpik] Creek, and Fish [Uvlutuuq] Creek).

3.10.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences (Table 3.10.4): There would be one fewer bridge, one fewer culvert battery, 16 fewer piles below OHW, and only one boat ramp. Only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed because there would not be gravel road access to the other rivers; therefore, there would be less fill in rivers. Although the number of potential users of each boat ramp is unknown, if only one ramp at the Ublutuoch (Tiŋmiaqsiuġvik) River were constructed, use could be concentrated on that river and effects could be higher. There would be an annual ice road (3.6 miles) required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative C would have 1,320.2 more acres of ice infrastructure over the life of the Project and use 251.9 MG more freshwater (1,914.3 MG total).

3.10.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be the same as described under Alternative B, with the following differences (Table 3.10.4): There would be one fewer bridge and three fewer culvert batteries. Like Alternative C, only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed because there would not be gravel road access to the other rivers; therefore, there would be less fill in rivers. There would be two additional seasons of ice roads and water withdrawal during construction and an annual ice road (12.5 miles) required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative D would have 2,607.5 more acres of ice infrastructure over the life of the Project and use 623.9 MG more freshwater (2,286.3 MG total).

3.10.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

3.10.2.6.1 Habitat Loss or Alteration

Gravel fill for the MTI would permanently remove 12.8 acres of nearshore marine EFH for Arctic cod and Pacific salmon in approximately 8 to 10 feet water depth (Table 3.10.5). The MTI area currently has no human development and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). The MTI would alter existing substrates by adding gravel and gravel bags. The MTI would be decommissioned after construction and the gravel would be naturally redistributed by wind and waves, which would alter the substrate of surrounding habitats. Fish and benthic surveys conducted in the MTI and sea ice road area suggest a relatively low complexity and low productivity natural condition that would likely recover within a few seasons after reclamation (Kinnetic Laboratories Inc. 2018). Construction and reclamation of the MTI is not anticipated to impede fish migration.

During the summer construction season, 11 to 15 acres of nearshore marine fish habitat would be temporarily altered due to increased SS and turbidity (Coastal Frontiers Corporation 2018b). This could occur due to mobilization of fine-grained material in the MTI fill into the water column or from in-water work (screeding or recontouring of the MTI slopes). Effects would be temporary and localized because the disturbance plume would quickly settle and therefore would not affect fish at the population level. The duration of the plume would depend on the amount of fines in the fill and could last 0.5 hour to 55 days (Coastal Frontiers Corporation 2018b).

Based on data for western Harrison Bay, current speeds are too low to cause significant, permanent scour of the sea bottom surrounding the MTI (Coastal Frontiers Corporation 2018a). Average rates of shoaling in the area are low (CPAI 2019b). Other human-made islands in the Beaufort Sea experience small amounts of shoaling on the leeward side. Similar amounts would be expected at the MTI and would not affect the stability of the MTI or coastal processes around it. No accretion or further shallowing of the MTI area would be expected to occur.

The MTI sea ice road would span approximately 2.4 miles through shallow, nearshore EFH, which would be naturally grounded and therefore would not affect fish or fish habitat. Once onshore, the freshwater ice road would be approximately 103.6 miles (total); the effects of ice roads (temporary habitat alteration) are described above under Alternative B (Section 3.10.2.3.1, *Habitat Loss or Alteration*).

Screeding at the MTI and barge lightering areas would temporarily alter benthic marine habitat by recontouring sediments prior to barge landings. Because substrate types would not change and the screeded ground would likely resettle to conditions similar to those prior to screeding, effects to fish habitat would be minor and temporary. Barges would be grounded in the screeding area immediately after screeding. Intake and discharge of ballast water would be required to ground and then refloat barges. Effects would be the same as described for Alternative B, Section 3.10.2.3.1.

3.10.2.6.2 Disturbance or Displacement

In-water work for the MTI would be limited to screeding and contouring the fill, which could disturb or displace fish (cause behavioral avoidance) due to noise and human activity (Hastings and Popper 2005; Ruggerone, Goodman et al. 2008). Ambient underwater sound levels in the Beaufort Sea range from 77 to 135 dB re 1 μPa (Greene Jr., Blackwell et al. 2008; LGL Alaska Research Associates Inc., Greenridge Sciences et al. 2013) with average ambient conditions approximately 120 dB re 1 μPa; the marine underwater acoustic environment is characterized in Appendix E.13. Screeding would be the loudest in-water noise created, estimated at 164 to 179 dB rms at 3.28 feet from the source (Blackwell and Greene 2003). These sound pressure levels would be within the range that could cause behavioral avoidance in fish but would fall below levels that would injure or kill fish (Buehler, Oestman et al. 2015). Other in-water work (contouring of the fill) would be even quieter than screeding. It is anticipated that piles and sheet piles would be installed and removed during winter, when sea ice was bottom-fast, and thus there would be no effects to fish from pile installation or removal.

Increased marine vessel traffic would have the same effects as described for Alternative B. Sealift barges (nine) and accompanying tugboats (16) would travel from Dutch Harbor to the MTI and support vessels (259) would travel between the MTI and Oliktok Dock. Vessel traffic would occur over four seasons and could disturb and locally displace nearshore marine fish due to noise while vessels were underway. Disturbance or displacement would be limited to the nearshore barge route, the MTI area, and the Oliktok Dock area. Individual fish may be affected, but populations would not.

Table 3.10.5. Effects to Fish and Fish Habitat from Module Delivery Options

Project Component	Effect to Fish or Fish Habitat	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Gravel fill onshore	Habitat alteration	None	None	5.0 acres filled along existing Kuparuk roads (no fill in waterbodies) 1.1 acres of dust shadow beyond existing dust shadow in lakes with unknown fish presence
Gravel fill in marine area	Habitat and EFH loss Temporary habitat alteration from sedimentation or turbidity Disturbance or displacement from noise during gravel recontouring in summer Injury or mortality of bottom-dwelling fish in fill footprint	12.8 acres lost 11 to 15 acres altered 125 dB rms at 328 feet from the source	13.0 acres lost 11 to 15 acres altered 125 dB rms at 328 feet from the source	None
Screeding	Temporary habitat alteration Disturbance or displacement from noise or human activity Injury or mortality of benthic species	14.5 acres altered, 2 occurrences 164 to 179 dB rms at 3.28 feet Minimal injury of fish entrained in screeded material	Same as Option 1	No additional screeding beyond what is described for Alternatives B, C, or D
Freshwater ice infrastructure	Habitat alteration from water withdrawal (water quality or quantity changes) Habitat alteration from temporarily blocked passage	307.9 MG of water 103.6 miles of onshore ice road 859.6 acres of onshore ice roads and ice pads	572 MG of water 223.4 miles of onshore ice road 1,756.1 acres of onshore ice roads and ice pads	257.2 MGs of water 80.2 miles of onshore ice road 666.6 acres of onshore ice roads and pads Approximately 2,000-foot-long ice bridge across the Colville River with 700 feet spanning the active winter channel; Additional 850 feet (total) of ice ramps
Barge and support vessel traffic[a]	Disturbance or displacement from noise and human activity	Nearshore barge route ~1,100 miles RT, support vessel route ~100 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons 145 to 175 dB rms at 3.28 feet from the source	Nearshore barge route ~1,000 miles RT, support vessel route ~200 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons 145 to 175 dB rms at 3.28 feet from the source	Nearshore barge route ~1,200 miles RT, support vessel route ~5.2 miles RT 9 barges, 16 tugboats, and 60 support vessels, 2 summer seasons 145 to 175 dB rms at 3.28 feet from the source

Note: ~ (approximately); dB (decibels); EFH (Essential Fish Habitat); MG (million gallons); MTI (module transfer island); rms (root-mean-square); RT (round trip). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*.
[a] Traffic is detailed in Tables D.4.34, D.4.35, D.4.40, D.4.41, D.4.44, D.4.45, D.5.8, D.5.9, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1, *Alternatives Development*.

3.10.2.6.3 Injury or Mortality

Placement of gravel fill in marine waters could bury fish and other bottom-dwelling organisms in the fill footprint. Effects would be limited to the fill footprint and would occur one time during gravel placement. Thus, mortality would not impact any fish at the population level.

Screeding could also injure or kill bottom-dwelling fish within the screeding footprint. Up to 14.5 acres would be screeded at the MTI and the barge lightering area (Figure 3.10.3); screeding would occur two times and would not affect fish at the population level.

3.10.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

All the effects to fish and fish habitat described for Option 1 would apply to Option 2, as shown in Table 3.10.5. Nearshore marine fish species at Point Lonely are similar to Atigaru Point, with the addition of Bering cisco (Schmidt, McMillan et al. 1983). The soft-bottom benthic assemblage offshore of Pitt Point (Carey, Ruff et al. 1981) also appears similar to Atigaru Point benthos. Option 2 would have the same design, size, and water depth as Option 1.

The main difference between the two options is that Option 2 would require double the freshwater withdrawal for about twice the length of ice roads (Table 3.10.5), which might cause more habitat alteration if lakes do not recover to pre-withdrawal levels. The effects of withdrawing more water would cover a larger area (i.e., more lakes would be used for withdrawal) but would not differ in the type, magnitude, or duration. Additionally, Option 2 would have markedly more miles of support vessel traffic to and from Oliktok Point, which would cause more local disturbance and displacement of fish in the vessel route.

3.10.2.8 Module Delivery Option 3: Colville River Crossing

Because Option 3 would not require an MTI, effects to fish would be substantially less than Options 1 or 2 (Table 3.10.5). Option 3 would not require additional screeding beyond what is described for the action alternatives. Barge, tugboat, and support vessel traffic would also occur under Option 3 but would be limited to two summer seasons (fewer than Options 1 or 2). Barges and tugboats would have to travel farther to get to Oliktok Dock than to the MTI locations in Options 1 or 2. However, because support vessels would originate from Oliktok Dock, Option 3 would substantially reduce the miles of support vessel traffic and the number of trips needed (Table 3.10.5). Vessel traffic would disturb and locally displace nearshore marine fish due to noise, as described under Alternative B in Section 3.10.2.3.2, *Disturbance or Displacement*.

Option 3 would require 5.0 acres of gravel fill along existing Kuparuk gravel roads to widen curves (no fill in waterbodies; Table 3.10.5), which would expand the existing dust shadow along the road and affect 1.1 acres of lakes with unknown fish presence that are currently outside the dust shadow. Effects of dust deposition are described in Section 3.10.2.3.1.

Option 3 would require 666.6 acres of ice roads and ice pads over 2 years (2025 and 2027). Ice roads and pads can also alter fish habitat by temporarily blocking passage or eroding streambeds or stream banks, as described in Section 3.10.2.3.1. Ice infrastructure for Option 3 would require 257.2 MG of freshwater. Lakes in the area from DS2P to the Itkillik River are generally shallower and contain only resistant fish species or no fish. Thus, although numerous lakes may be used for water withdrawal, effects to fish are not expected.

Because most of the streams that would be crossed by the Option 3 ice road east of the Colville River freeze to the bottom in the winter, effects to fish would be minimal. However, the Itkillik River has overwintering habitat near its confluence with the Colville River (Figure 3.10.1). Thus, there is potential for isolated overwintering habitat that would need to be avoided during final alignment of the ice road.

As described in Section 3.10.1, *Affected Environment*, fish are not anticipated to be present at or moving through Ocean Point to any large extent during the proposed operational period in winter because the river ice can be naturally grounded, little flow exists, most fish exhibit limited movement during winter, and most fish harvested and detected in research appear to use habitats further downstream (Moulton, Seavey et al. 2006; Moulton, Seavey et al. 2010). In addition, because the entirety of the ice bridge crossing would not be grounded, channels for fish movement would be present. CPAI will monitor ice conditions and flow at the crossing location over the next several winters prior to ice bridge construction in 2025 and 2027. If there are indications that fish may be present in winter, CPAI would work with ADF&G through the permitting process to determine if and how to accommodate fish passage through the ice bridge. It is anticipated that the ice bridge at the Colville River crossing would be needed for 5 weeks.

3.10.2.9 Oil Spills and Other Accidental Releases

The EIS evaluates the potential impact of accidental spills. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste and hazardous materials (such as diesel, gasoline, and other chemicals) during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would not be expected to affect fish or aquatic habitats.

Spills from oil infrastructure could occur during drilling and operations from leaking wellheads, facility piping, process piping, or ASTs but would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. In the unlikely event that a pipeline spill occurs at a river crossing during high water flow, the extent of the accidental release could be larger and affect fish habitat and EFH. A spill from a pipeline crossing streams in the Willow area may reach the channels of Fish (Iqalliqpik) Creek or the Kalikpik River, particularly during periods of flooding. As described in CPAI (2018a), the relatively low flow and highly sinuous nature of streams in the Fish (Uvlutuuq or Iqalliqpik) Creek and the Kalikpik River basin may preclude a spill into one of these rivers from reaching Harrison Bay.

The HDD crossing of the Colville River with diesel and seawater pipelines could also create the potential risk of a spill. However, the risk would be very low (approaching zero) because the pipelines would be insulated and placed within an outer pipeline casing, which would inhibit heat transfer to permafrost, contain fluids in the event of a leak or spill, and provide structural integrity. The existing HDD crossing of the Colville River by the Alpine Sales Oil Pipeline has had no spills to date; it was constructed in 1998 and 1999 and is the same size (both pipeline and borehole) as that proposed for Willow. Any unintended releases from the diesel pipeline within the outer pipeline casing would be detected and responded to quickly. It would be very unlikely that fluids would reach the Colville River or the delta and expose EFH. If they did, pre-staged spill response materials located throughout the CRD will allow a quick response and increase the likelihood of containment.

If a reservoir blowout were to occur, there is the potential for oil to reach nearby freshwater lakes and stream channels; however, a reservoir blowout is unlikely to reach Harrison Bay due to the distance to the drill sites and the sinuous nature of streams in the area (CPAI 2018a).

Seawater spills on nonfrozen waterbodies could have effects that would last for several years depending on the size of the spill and the size of the waterbody. Seawater spills would affect salt-tolerant fish species (e.g., ninespine stickleback) less than more sensitive species, such as Arctic grayling.

3.10.2.10 Effects to Essential Fish Habitat

All the types of effects to habitat described above would apply to EFH. Because not all stream crossings would be in EFH, all action alternatives would fill 0.4 acre of freshwater EFH due to gravel fill. Piles and VSMs below OHW would fill another 0.01 acre of EFH. All the effects to marine habitat described for the module delivery options would be in EFH.

3.10.3 Unavoidable Adverse, Irretrievable, and Irreplaceable Effects

Some unavoidable and irretrievable loss of fish habitat would occur throughout the life of the Project; for all action alternatives and module delivery options, the amount of habitat loss would be small in comparison to the amount of available habitat of similar type and quality. Impacts would not be irreversible and would not affect the long-term sustainability of fish resources. However, irreversible direct mortality to fish and benthic organisms would occur as a result of screeding for any action alternative or module delivery option and as a result of gravel fill required for the MTI (Options 1 and 2). Both the fill footprint and the screeding footprint would be small in relation to the amount of available habitat of similar type and quality. These irreversible impacts would be relatively small and would not impact the population viability of impacted species. The alteration of nearshore habitat would also be irreversible because even if the MTI is abandoned and reshaped, it would still exist.

3.11 Birds

The analysis area for birds, which encompasses the area of direct and indirect effects to birds, is the area within a 3.7-mile (6-km) radius of gravel and ice infrastructure, pipelines, mine sites, module delivery sites, and Project activities (Figure 3.11.1). The 3.7-mile (6-km) radius is based on decreased nest survival of some species within 3.1 miles (5 km) of oil field facilities (Liebezeit, Kendall et al. 2009). Movements of more than 3.7 miles are possible for foraging gulls, ravens, and raptors, which may be attracted to artificial food, **nesting** sites, or perch sites (Engle and Young 1992; Weiser and Gilchrist 2012; White, Clum et al. 2002).

The temporal scale for analysis of impacts to birds is the life of the Project and reclamation. Reclamation of onshore areas is expected to take at least 20 to 30 years (Section 3.9). If reclamation did not occur, effects would be permanent. The temporal scale for construction impacts related to human presence and noise would last only through construction. Marine substrates that would be screeded would return to pre-screeding condition in approximately one season. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in Section 3.8.2.6, *Module Delivery Option 1: Atigaru Point Module Transfer Island*).

3.11.1 Affected Environment

3.11.1.1 Bird Species

Between 80 and 90 bird species may occur in the analysis area and nearshore waters of the Beaufort Sea (BLM 2004a, 2012b); approximately 50 species regularly occur or are common (Appendix E.11, *Birds Technical Appendix*). Ground-nesting shorebirds are the most abundant breeding birds (in terms of number of species and number of breeding individuals) followed by passerines, waterfowl, loons, seabirds, ptarmigan, and raptors. Nearly all species are seasonal migrants using the ACP during the breeding season. The exceptions are rock and willow ptarmigan, gyrfalcon, snowy owl, and common raven, which can be year-round residents (Johnson and Herter 1989).

3.11.1.1.1 Special Status Species

Nine bird species in the analysis area are listed as **sensitive species** by BLM (2019a) and nine species are listed as **birds of conservation concern** by the USFWS (2008a) (two of which are not on the BLM list). All special status species are described in more detail in Appendix E.11.

Two species possibly occurring in the analysis area, spectacled and Steller's eiders, are listed as threatened under the ESA. Low densities of spectacled eiders occur throughout most of the analysis area annually during **pre-breeding** (Figure 3.11.2) (Shook, Parrett et al. 2020), but nesting is only known to occur near the coast (including near the module delivery options) (Frost, Ritchie et al. 2007; Morgan and Attanas 2018; Sexson, Pearce et al. 2014). Spectacled eiders move along the coast through Harrison Bay and westward during post-breeding (Sexson, Pearce et al. 2014). Steller's eiders are rare in the analysis area (Figure 3.11.3) and primarily breed near Utqiaġvik (Johnson, Shook et al. 2018; Quakenbush, Day et al. 2002). The most recent sightings of Steller's eider in the analysis area were during pre-breeding in 2013 (one pair) near Point Lonely, 2006 (one male) near Atigaru Point (USFWS 2016b), and 2001 (one male flying) near GMT-2 (Johnson, Shook et al. 2018). No breeding records for Steller's eiders have been confirmed in the Willow, CRD, and Kuparuk areas for more than 3 decades (Johnson, Shook et al. 2018).

The EIS focuses on three special status species: spectacled eider (a uncommon breeder in coastal portions of the analysis area), Steller's eider (a rare visitor and unlikely breeder in the analysis area), and yellow-billed loon (a common breeder in the analysis area west of the Colville River; Figure 3.11.4), see Table E.11.1 in Appendix E.11. BMPs for these three species are prescribed in the NPR-A IAP/EIS ROD (BLM 2013a) and summarized in Section 3.11.2.1.1, *Applicable Lease Stipulations and Best Management Practices*. Densities of these species in the analysis area and locations recorded on aerial surveys are depicted in Figures 3.11.2 through 3.11.5.

BLM is undergoing ESA Section 7 consultation with USFWS concurrent to the NEPA process for effects to ESA bird species (spectacled and Steller's eider) and their critical habitat.

3.11.1.2 Bird Habitats

Birds typically use the ACP (including the analysis area) during several important life history stages: pre-breeding, nesting, **brood-rearing**, **molting**, and **fall-staging**. Few species winter on the ACP. Generally, higher densities of nesting birds are found in coastal rather than interior ACP areas (Andres, Johnson et al. 2012; Bart, Platte et al. 2013; Johnson, Burgess et al. 2004). The analysis area occurs within five Important Bird Areas (IBAs) (Figure 3.11.1), which are recognized for global and continental significance from their use by large proportions of bird populations during different seasons (Smith, Walker et al. 2014). Two IBAs occupy the marine areas offshore of the transport options and three terrestrial IBAs encompass ice roads and permanent infrastructure for the Project. The Barrow Canyon and Smith Bay IBA, west of Harrison Bay, is of global significance because it is used by 1% or more of the North American populations of arctic terns, black-legged kittiwakes, glaucous gulls, king eiders, long-tailed ducks, red phalaropes, and Sabine's gulls, and it regularly holds significant numbers of yellow-billed loons (Audubon Alaska 2014). The Beaufort Sea Nearshore IBA includes Harrison Bay and is globally significant because it is used by 1% or more of the North American populations of brant, glaucous gulls, king eiders, long-tailed ducks, red-throated loons, surf scoters, white-winged scoters, and yellow-billed loons and is used by significant numbers of black scoters (Audubon Alaska 2014). The terrestrial CRD IBA, which includes the CRD and Fish and Judy creeks, is a potential global site supporting 1% or more of the North American population of yellow-billed loons and significant numbers of black scoters and Steller's eiders. South of the delta is the Lower Colville River IBA, which is globally significant because it is used by yellow-billed loons and continentally important because it supports peregrine falcons and gyrfalcons. Immediately west is the Teshekpuk Lake Area IBA, another global site supporting 1% or more of the North American populations of American golden plovers, black-bellied plovers, dunlin, long-billed dowitchers, pectoral sandpipers, red phalaropes, red-necked phalaropes, semipalmated sandpipers, stilt sandpipers, buff-breasted sandpipers, brant, greater white-fronted geese, yellow-billed loons, red-throated loons, and significant numbers of black scoters and Steller's eiders. The NPR-A also provides non-territorial and juvenile golden eagles from Denali National Park and Preserve and other breeding areas with foraging areas during spring and summer and could be important habitat supporting population recruitment (McIntyre, Douglas et al. 2008; McIntyre and Lewis 2018).

Nesting shorebirds, waterfowl, loons, gulls, and terns favor areas with deep and shallow lakes with low relief shorelines; marshes, patterned wet and moist meadows, and drained lake basins (Cotter and Andres 2000; Johnson, Burgess et al. 2003). Species richness and the occurrence of shorebirds declines west to east across the ACP (Johnson, Lanctot et al. 2007), as does total numbers of shorebirds, waterfowl, loons, grebes, gulls, terns, and jaegers (Bart, Platte et al. 2013). Nesting songbirds and other landbirds (e.g., ptarmigan, raptors) tend to use moist meadows, uplands, river and lake bluffs, and shrub areas (Bart, Brown et al. 2012; Ritchie 2014) and have a less coastal distribution but are still more abundant west of the Colville River than to the east (Liebezeit, White et al. 2011), with the possible exception of Lapland longspurs (Bart, Brown et al. 2012). Available data on habitat use by 71 species that may occur in the analysis area are summarized in Table E.11.1 Appendix E.11. The habitats were ranked by the number of species using them to portray areas with the highest potential for avian occurrence and avian diversity (Figures 3.11.1 and 3.11.6; Table E.11.2 in Appendix E.11). Whereas there is not a documented correlation between species richness and the number of birds using habitats on the ACP, there is an observed trend of increasing numbers of birds in areas and habitats with higher species richness (Bart, Brown et al. 2012; Bart, Platte et al. 2013; Johnson, Burgess et al. 2005; Johnson, Lanctot et al. 2007). The most common habitats in the analysis area are Moist Tussock Tundra, Patterned Wet Meadow, and Moist Sedge-Shrub Meadow (Table E.11.2 in Appendix E.11). Moist Tussock Tundra tends to occur in uplands and side slopes and supports lower densities of breeding birds than does Patterned Wet Meadow, Moist Sedge-Shrub Meadow, and other aquatic and wet habitat types. The highest number of bird species use Patterned Wet Meadow (44 species), which also supported the most nests of large waterbirds on the CRD (Table 7 in Johnson, Burgess et al. 2005) and in the CD5 area (Table 5 in Rozell, Johnson et al. 2020). Nonpatterned Wet Meadow (39 species) was second in species richness and Moist Sedge-Shrub Meadow was third (37 species). Other important habitats to the bird community include the following:

- Old Basin Wetland Complex (27 species), Deep Polygon Complex (25 species), and Young Basin Wetland Complex (21 species), are used for nesting and brood-rearing by high densities of diverse waterfowl, loons, grebes, shorebirds, gulls, terns, and jaegers and preferred by spectacled eiders.
- Sedge Marsh (25 species) and Grass Marsh (15 species) are not very abundant aquatic, emergent types used by shorebirds, loons and grebes, and waterfowl for nesting, feeding, and raising young. Grass Marsh is preferred by pre-breeding and nesting spectacled eiders and both marsh habitats are the most frequent aquatic habitats associated with nesting Steller's eiders (Graff 2016),
- Open Nearshore Water (22 species) is used by large numbers of seabirds, sea ducks (including eiders), waterfowl, and loons, particularly during post-breeding and migration. The marine waters at the three module delivery options have been identified as two global IBAs: the Beaufort Sea Nearshore IBA

(includes Options 2 and 3), and the Barrow Canyon and Smith Bay IBA (includes Option 1) (Smith, Walker et al. 2012),

- Salt Marsh (21 species), Salt-killed Tundra (3 species), and Tidal Flat Barrens (7 species) are used by shorebirds for post-breeding and pre-migratory feeding. Salt Marsh is preferred habitat for brant and snow geese during brood-rearing and fall-staging; Salt Marsh and Salt-killed Tundra are preferred habitat by nesting spectacled eiders,
- Deep Open Water with Islands or Polygonized Margins (14 species), Deep Open Water without Islands (12 species), and Tapped Lake with High-water Connection (10 species) are preferred nesting and brood-rearing habitat for yellow-billed loons and preferred pre-breeding and nesting habitat for spectacled eiders.

Existing development and infrastructure in the analysis area occur from several oil and gas developments (GMT, Alpine, Nuna, Oooguruk, and Kuparuk) and the community of Nuiqsut. More gravel infrastructure occurs on the east side of the Colville River, where there are roads, mine sites, airstrips, reservoirs, pipelines, processing facilities, a dock (Oliktok Dock), and a seawater treatment facility. On the west side of the river, gravel infrastructure is focused in the lower reaches of the Ublutuoch (Tiŋmiaqsiuġvik) River and Fish (Iqalliqpik) Creek basins and in the CRD (Figure 3.11.1). This existing infrastructure and development activities (traffic, drilling, processing, etc.) contribute dust, sediment, noise, and the potential for spills to existing habitats. Seasonal ice infrastructure and associated water withdrawal occur annually to support oil and gas exploration. The area is used for subsistence and research and has a relatively minor amount of associated boat, foot, air, and off-road vehicle traffic.

Climate change is occurring on the ACP, as described in Section 3.2, *Climate and Climate Change*. Warmer temperatures and earlier snowmelt affect bird ecology and habitats by changing seasonal timing (arrival, departure, and life stages), forage availability, habitat, and range expansion. As a result, species assemblages may change at various levels of the food web.

3.11.1.2.1 Special Status Species Habitats

Habitat use by special status species is summarized in Tables E.11.1 and E.11.2 and by spectacled eiders in Table E.11.3 in Appendix E.11. All but two habitat types in the analysis area are used by one or more special status species.

Spectacled eiders have been documented in the analysis area during the pre-breeding (Johnson, Parrett et al. 2019) and nesting seasons (Frost, Ritchie et al. 2007; Morgan and Attanas 2018) and nearshore during post-breeding periods (Fischer and Larned 2004; Sexson, Pearce et al. 2014). Nesting has not been confirmed in the Willow area (where the majority of new gravel infrastructure is proposed) because nest searches have not been conducted in that portion of the analysis area (Figure 8 in Johnson, Shook et al. 2018). Steller's eiders are not known to breed in the analysis area. Yellow-billed loons breed in the Willow area and throughout the CRD and northern NPR-A primarily nest and raise young in Deep Open Lakes with Islands or Polygonized Margins, Deep Open Lakes without Islands, and Tapped Lakes with Low-water Connections. Less frequently, nests occur in shallow lakes or wetlands from which young are moved to adjacent large deep lakes (Johnson, Shook et al. 2019; Shook, Parrett et al. 2020).

Critical habitat for bird species protected under the ESA does not occur in the analysis area and would be avoided by the barge transit route.

3.11.2 Environmental Consequences

3.11.2.1 Avoidance, Minimization, and Mitigation

3.11.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.11.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to birds from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to bird habitat, subsistence hunting and fishing areas, and the environment, associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.11.1 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to birds. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.11.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.11.1 Summary of Applicable Lease Stipulations and Best Management Practices Mitigating Impacts to Birds

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations	Areas of operation shall be left clean of all debris.	Changes do not affect text as described.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive Waste Management Plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or state permit.	Changes do not affect text as described.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment from the disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP Withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement bear-interaction plans to minimize conflicts between bears and humans.	Text expanded to include other species of wildlife: Incorporate into infrastructure design measures to deter ravens, raptors, and foxes from nesting, denning, or seeking shelter. Provide the BLM with an annual report on any instances when, despite use of such measures, the use of infrastructure by ravens, raptors, and foxes did occur.
ROP A-13	Prevent the release of poly- and perfluoroalkyl substances associated with the use of aqueous film-forming foam, a firefighting foam designed to extinguish flammable and combustible liquids and gases.	No similar requirement.	At facilities where fire-fighting foam is required, use fluorine-free foam unless other state or federal regulations require aqueous film-forming foam use. If aqueous film-forming foam use is required, contain, collect, treat, and properly dispose of all runoff, wastewater from training events, and, to the greatest extent possible, from any emergency response events.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4 feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during winter and withdrawal of water from lakes during summer may be authorized on a site-specific basis, depending on water volume and depth, the fish community, and connectivity to other lakes or streams. BLM must be notified within 48 hours of any observation of dead or injured fish on water source intake screens, in the hole being used for pumping, or within any portion of ice roads or pads. If observed at a particular lake, pumping must cease temporarily from that hole until additional preventive measures are taken to avoid further impacts on fish.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	– Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from OHW of fish-bearing waterways.	Changes do not affect text as described.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the BLM and in consultation with appropriate federal, state, and NSB regulatory and resource agencies.	Added text: – The plan shall consider locations outside the active floodplain or designing gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present.
BMP E-9	Avoidance of human-caused increases in populations of predators of ground-nesting birds.	Utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Feeding of wildlife is prohibited.	Requirements combined with ROP A-8 (Wildlife Interaction Plan).

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-10	Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward rather than upward and outward.	Flagging of structures shall be required, such as elevated power lines and guy wires, to minimize bird collisions. All facility external lighting, during all months of the year, shall be designed to direct artificial exterior lighting inward and downward or be fitted with shields to reduce reflectivity in clouds and fog conditions, unless otherwise required by the Federal Aviation Administration.
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM special status species, from direct or indirect interaction with oil and gas facilities.	Before the approval of facility construction, aerial surveys for spectacled and Steller's eiders and yellow-billed loon shall be conducted within any area proposed for development. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction. Roads and facilities shall be sited to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Power and communication lines shall either be buried in access roads or suspended on VSMs except in rare cases. Communication towers should be located on existing pads as close as possible to buildings or other structures and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers and other similar facilities should be avoided. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Maintain a 1-mile buffer around all recorded yellow-billed loon nesting sites and a minimum 1,625-foot (500 m) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.	Bird species with special status are protected under ROPs E-10 and E-21. Measures related to bird collisions with infrastructure moved to ROPs E-10 and E-21. Other changes do not affect text as described.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.	Added text: Develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments (for alternatives B, C, D: based on Light Detection and Ranging or other high-accuracy surface imaging).

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-18	Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or spectacled eider nests.	Activity within 200 m of an occupied nest will be restricted to existing pads and roads from June 1 to August 15; construction is prohibited within 200 m of occupied nests. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 m of occupied Steller's and/or spectacled eider nests will be prohibited.	Revised text to: June 1 through July 31.
ROP E-21	Minimize the impacts on bird species from direct interaction with aboveground utility infrastructure.	See BMP E-11.	Added text: – Power and communication lines shall either be buried in access roads or suspended on VSMs except in rare cases. – Communication towers should be located on existing pads as close as possible to buildings or other structures and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers and other similar facilities, should be avoided. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds.
ROP E-23	Infrastructure Siting Near Teshekpuk Lake. Mitigate the impacts of permanent infrastructure on caribou movement near Teshekpuk Lake	No similar requirement.	Added text: Prior to the permitting of permanent infrastructure within the Teshekpuk Caribou Herd Habitat Area (the 75% parturient calving caribou kernel), a workshop shall be convened to identify the optimal placement of infrastructure to minimize impacts on caribou, birds, and other wildlife.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMPs F-1; ROPs F-2 and F-3	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	– Submit an aircraft use plan that addresses strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility. – Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 15 and an altitude of at least 1,500 feet above ground level when within ½ mile of known gyrfalcon nesting sites from March 15 to August 15. – Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area should be minimized from May 20 through August 20.	Text moved to ROPs F-2 and F-3: Added text: – F-2: Aircraft Use Plan. Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. – F-3: Minimum Flight Altitudes. Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the Teshekpuk Caribou Herd Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude agl throughout NPR-A.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
ROP H-5	Make data and summary reports derived from North Slope studies easily accessible.	No similar requirement.	Required monitoring studies, reports, and geographic information system data shall be posted online and available to the public.
LS/ BMP K-1[a]	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or overwintering fish habitat; minimize the loss of raptor habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in streambeds and adjacent to the rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	– No surface occupancy or new infrastructure, except essential road and pipeline crossings in the following setbacks: Colville River (2- to 7-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). – Gravel mines may be located within the active floodplain, consistent with BMP E-8.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-2[a]	(Deepwater Lakes) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabins and campsites; and the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of OHW of any deep lake (i.e., depth greater than 13 feet).	Changes do not affect text as described. Additional restrictions as described in ROP E-11 may also apply in those habitats.
BMP K-4a[a]	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Within the Goose Molting Area: – No leasing, no permanent oil and gas facilities, except pipelines, would be allowed within 1.0 mile of the shoreline of selected lakes. – Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins. – Between June 15 and August 20, oil and gas facilities shall incorporate features (e.g., temporary fences and siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by BLM. – Aircraft use (fixed-wing and helicopter) shall be restricted from June 15 through August 20.	Changed to Stipulations K-6 and K-7. Some alternatives allow leasing. Some alternatives allow new infrastructure with limitations. Within the Goose Molting Area, no permanent oil and gas facilities, except pipelines, would be allowed within 0.5 mile of the shoreline of selected lakes. Lakes were selected based on the 85% distribution of black brant within the Goose Molting Area. Aircraft use (fixed-wing and helicopter) shall be restricted from June 1 through August 20.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-6[a]	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals); prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.	Changed to Stipulation K-5 (Coastal Area) Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). No leasing is allowed within 1 mile of the coast. The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as a barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For a permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.
BMP J	Endangered Species Act - Section 7 Consultation. Lease areas may now or hereafter contain plants or animals, or their habitats determined to be threatened or endangered or some other special status. The BLM may recommend modifications to development proposals to further its conservation and management objective to avoid activities it has approved that would contribute to the need to list such a species or its habitat. The BLM may require modifications to or may disapprove a proposed activity that is likely to adversely affect a proposed or listed endangered species, threatened species, or critical habitat.	See Objective.	Updated to: Lease Notice 2: Compliance with the Endangered Species Act

Source: BLM 2013a, 2020a

Note: agl (above ground level); BLM (Bureau of Land Management); BMP (best management practice); DEW (Distant Early Warning); F (Fahrenheit); IAP (Integrated Activity Plan); LS (lease stipulation); m (meters); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy); OHW (ordinary high-water); ROP (required operating procedures); USGS (U.S. Geological Survey); VSM (vertical support members).

[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect birds would include those to LS E-2 and BMPs E-11, K-1, K-2, and K-6. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMPs K-1 and K-2), a CFWR connected to Lake M0015, and freshwater intake pipelines at Lakes L9911 and/or M0235 (varies by alternative) (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also cross the standard disturbance setback of 1 mile around recorded yellow-billed loon nest sites and 1,625 feet (500 m) around the shoreline of nest lakes (Figures 3.11.5 and 3.11.6) due to gravel roads and pads, pipelines, and boat ramps on the Ublutuoch (Tiŋmiaqsiuġvik) River and Judy (Iqalliqpik) Creek.

The boat ramps would require a deviation from LS E-2 and BMP K-2 due to gravel infrastructure near fish-bearing waterbodies. Because the intent of a boat ramp is to access a waterbody, it is not possible to avoid encroachment within 500 feet of the waterbody. The ramps at the Ublutuoch (Tiŋmiaqsiuġvik) River and Judy (Iqalliqpik) Creek would likely also cross the standard disturbance setback of 1 mile around recorded yellow-billed loon nest sites and 1,625 feet (500 m) around the shoreline of nest lakes. However, the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would be on Native land and thus LSs and BMPs would not apply in those areas. The boat ramp on Fish (Uvlutuuq) Creek (Alternative B) would be in the TLSA.

All action alternatives would intake and discharge ballast water to ground barges at Oliktok Dock and the barge lightering area; Options 1 and 2 would intake and discharge ballast water at the MTIs and the lightering areas. These ballast water exchanges would occur within 3 miles of the coastline (see BMP K-6), but intake and discharge would occur in the same location and ballast water would not be transported.

3.11.2.1.2 Other Required Measures

Additional measures could arise during BLM's Section 7 consultation with USFWS for the Project, initiated in March 2020. Draft reasonable and prudent measures include the following.

Reasonable and Prudent Measure 1: Contribute to improved understanding of spectacled eider collision risk with Project infrastructure, facilities, and/or vessels.

Observations of collision events in which one or more listed eider, or 3 or more birds of any species, appear to have collided with oil and gas infrastructure (i.e., wires, towers, or buildings), or vessels shall be recorded and reported to the USFWS, Fairbanks Fish and Wildlife Conservation Office in an annual report due by December 31, unless listed eider collisions exceed the number exempted by the incidental take statement. Reports should include: the date, time of day, weather conditions, number and species of birds involved, and other factors considered to be relevant by the observer, and should include photos of dead birds, top and bottom view, with wings spread, and with the bill and feet visible if possible.

3.11.2.1.3 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.11.2.1.4 Additional Suggested Avoidance, Minimization, or Mitigation

The following additional suggested measures could reduce impacts to birds:

1. Locate mast poles away from the pad edge.
2. Minimize light visible from outside of Project facilities *at all times of the year* by using lighting fixtures with lamps contained within the reflector and shading externally facing windows on buildings to minimize the potential for bird strikes.
3. Implement lighting controls to turn off exterior lighting at satellite pads and other unoccupied facilities when personnel are not present, between August 1 and October 31.
4. Minimize the number and height of towers.
5. Limit water withdrawal to lakes without sensitive fish or breeding yellow-billed loons.
6. Route ice roads around identified yellow-billed loon nest sites and nesting lakes to avoid vegetation compaction at nest sites and delayed melt-out of nesting lakes.
7. Restrict speed limits to minimize collision hazard and dust production (35 mph except in areas of congestion, on bridges, and on pads, which should be slower).
8. Haze birds out of the mine site blast area before blasting (if resident birds are present in winter).
9. Minimize noise impacts between June 1 and July 15, when birds on nests would be unable to move away from the disturbance.

10. Minimize air traffic during the nesting period, when the movements of incubating birds are restricted, and the molting period, when birds may be energetically stressed and sensitive to disturbance.
11. Avoid the routine use of helicopters during drilling and operations activities to minimize noise and impacts related to birds.
12. Consider revising the air traffic pattern, altitude, and location to minimize conflicts with molting geese
13. Avoid preferred habitats, where possible.
14. Minimize barge and support vessel speed to reduce the potential for bird strikes.
15. Complete upgrades to the Kuparuk gravel road system involving wetland fill before or after the nesting season (June 1-July 31) if possible.

3.11.2.2 Alternative A: No Action

Under Alternative A, seasonal ice roads and pads (and associated water withdrawals), seismic surveys, and exploratory drilling could continue to occur in the analysis area to support oil and gas exploration. Effects from the existing infrastructure and activities in the Alpine and GMT oil fields would continue.

3.11.2.3 Alternative B: Proponent's Project

3.11.2.3.1 <u>Habitat Loss or Alteration</u>

Project activities with the potential to cause habitat loss or alteration include the following:

- Fill for new gravel roads, pads, an airstrip, and boat ramps
- Excavation at the mine site and CFWR
- Gravel spray and dust deposition from roads and pads
- Altered drainage patterns adjacent to gravel and ice infrastructure
- Delayed melt of snow in drifts, compressed snow, and ice from ice infrastructure
- Vegetation compaction from ice infrastructure
- Water withdrawal from lakes
- Screeding at Oliktok Dock and the barge lightering area

Alternative B would permanently remove 454.4 acres of bird habitat due to gravel fill. Table E.11.4 in Appendix E.11 details loss and alteration by habitat type and alternative. High-value habitats (used by 20 or more species) comprise 42% (188.9 acres) of the area permanently lost. Total habitat loss would be a small fraction of the total area of bird habitat within the analysis area (1,174,832.7 acres). Habitat loss could displace 209.8 nests, primarily of shorebirds and Lapland longspurs, based on average densities of 209.8 nests per square mile from breeding bird plots (Johnson, Burgess et al. 2005); most displaced birds could relocate to similar habitats available in the analysis area (see Section 3.11.2.3.2, *Disturbance or Displacement*).

Excavation at the mine site and CFWR would permanently alter 166 acres of bird habitat, mostly Moist Tussock Tundra and Moist Sedge-Shrub Meadow (Table E.11.5 in Appendix E.11). Although the pits would not be connected to streams, the pits would fill with water (from ground or surface water or from permafrost melt), resulting in a loss of habitat for tundra-nesting birds and a gain in habitat for waterbirds. (Tundra-nesting birds and waterbirds in the analysis area are identified in Table E.11.1 in Appendix E.11.) The mine could displace approximately 49 nests, primarily of ground-nesting shorebirds and passerines, based on average densities from breeding bird plots (209 nests per square mile) (Johnson, Burgess et al. 2005). A mine site reclamation plan is being coordinated with agencies and is included as Appendix D.2. Excavation of the CFWR would also permanently alter tundra habitat to be water habitat. Because the CFWR is not expected to substantially change water levels in Lake M0015 or Willow Creek 3 (as described in Section 3.8.2.3.6), water diversion to the CFWR is expected to have effects similar to those described for withdrawal above.

Alternative B would alter 3,351.8 acres of bird habitat due to gravel spray and dust deposition, which is less than 1% of the analysis area (Table E.11.6 in Appendix E.11). Gravel spray and dust deposition from the use of new gravel roads would alter bird habitat within 328 feet (100 m) of gravel infrastructure (described in Section 3.4). Gravel and dust could displace small numbers of birds to other habitats or reduce the quality of forage or nesting cover in the affected areas throughout the life of the Project. Effects would be both ephemeral (early thaw) and permanent (changes in vegetation composition and structure). However, early snow and ice melt caused by the dust shadow is also attractive to some early spring migrants who would gain access to thawed areas.

Gravel and ice infrastructure could create impoundments and cause changes in drainage patterns that would alter habitats immediately adjacent to infrastructure. Ice roads would be removed, breached, or slotted prior to spring breakup (as per CPAI design measure 19 in Table I.1.2 in Appendix I.1). If the impoundments caused thermokarsting, the effects would likely be permanent. Effects could decrease habitat quality and available forage or nesting habitat. Impoundments could also create new foraging, nesting, and brood-rearing habitat that would be beneficial for some bird species such as Pacific loons (Kertell 1996), although the proximity to roads also may increase the potential for collisions with vehicles.

Alternative B would have 4,557.3 acres of ice infrastructure. Compressed snow and ice from ice infrastructure and snowdrifts from snow cleared off gravel infrastructure might delay snow and ice melt until after birds have initiated nesting, causing an annual temporary loss of nesting habitat for small numbers of birds in these areas. Effects would likely occur in years of late snow and ice thaw. Ice roads across nesting lakes for yellow-billed loons could prolong ice cover on the lake, making them less suitable for nesting or delaying the onset of nesting. Ice infrastructure could compress vegetation, especially standing dead vegetation used for concealment by some nesting birds and alter habitats. Greater white-fronted goose nests were less likely to occur in the footprints of ice roads or pads from the previous winter at the CD5 development in NPR-A (Rozell, Johnson et al. 2020). The severity of impacts from compressed snow and ice are described in Section 3.9. Ice roads could be routed around lakes where yellow-billed loon nests have been recorded to minimize impacts to this species (Earnst 2004; see Section 3.11.2.1.3, *Additional Suggested Avoidance, Minimization, or Mitigation*). Areas covered by ice infrastructure would be temporarily altered. Birds should be able to use similar habitats in the analysis area.

Alternative B would require 1,662.4 MG of freshwater (for ice infrastructure, drilling, and potable water, etc.) (Table 3.11.2). Water withdrawal from lakes could lower water levels if lakes do not fully recharge in spring (Section 3.8). Decreased water levels would alter lake and shoreline habitats for small numbers of nesting waterbirds and shorebirds and could reduce suitability for nesting or expose nests to predation, particularly at small islands and low-lying shoreline areas. Lowered lake levels might also impact bird forage species (invertebrates and fish). The state regulates water withdrawal with restrictions on volumes of water removed (Section 3.10), and BMP B-2 restricts water withdrawal based on depth and types of fish present, which should minimize some or all of the effects of water withdrawals to yellow-billed loons and other waterbirds. Potable water would be withdrawn year-round from Lake L9911 and the CFWR (Figure 3.11.6 for permitted lakes and Table 3.11.2 for withdrawal volumes) for the life of the Project. Lake L9911 supports yellow-billed loon nests and broods; a deviation to BMP E-11 would be needed for this site. Winter water withdrawals for ice infrastructure could occur from any permitted lake in the Willow area during construction. Because yellow-billed loons have high nest-lake fidelity (Johnson, Wildman et al. 2019; Schmutz, Wright et al. 2014), they likely would not move to other lakes and could be impacted by withdrawals if they were to occur at nesting lakes. Because yellow-billed loons nest in large deep, clear lakes (Earnst, Platte et al. 2006) and feed on fish in those same lakes, implementation of BMP B-2 should protect most yellow-billed loon nesting lakes. Impacts to these and other special status species are detailed in Section 3.11.2.9, *Special Status Species*.

Screeding at Oliktok Dock and the lightering area would temporarily alter habitats by increasing turbidity and temporarily decreasing the availability of benthic foods in the area immediately surrounding the screeding footprint. Birds such as long-tailed ducks, eiders, scoters, and red-throated loons that depend seasonally on this habitat for foraging could experience decreased foraging success due to turbidity. Additionally, screeding would temporarily decrease the availability of benthic foods in the screeding footprint, which could be used by seaducks. In the Oliktok Point area, outflow from the CRD and coastal erosion transport significant amounts of SS (Dunton, Weingartner et al. 2006). Sea-ice pressure ridges scour and gouge the seafloor and move sediments, creating natural, seasonal disruptions of the seafloor. Bottom disturbance is a natural and frequent occurrence in this nearshore region, resulting in benthic communities with patchy distributions (Carey, Boudrias et al. 1984). In addition, Oliktok Dock is an existing industrial facility that is seasonally screeded before the arrival of barges. Because of the baseline conditions at Oliktok Dock, and because the screeding footprint would be 12.1 acres and the action would occur in two separate summer seasons, the effects would be temporary, localized, and affect small numbers of birds in an area where a large amount of alternative foraging habitat is available.

Table 3.11.2. Effects to Birds and Bird Habitat from Action Alternatives

Project Component	Effect to Birds or Bird Habitat	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Gravel fill	Habitat loss Habitat alteration from dust shadow, gravel spray, thermokarsting, impoundments Disturbance or displacement from noise and human activity Deviations to BMP E-11 (yellow-billed loon buffer)	454.4 acres lost 3,351.8 acres of dust shadow 7 deviations to BMP E-11	507.6 acres lost 3,348.6 acres of dust shadow 6 deviations to BMP E-11	444.6 acres lost 2,560.3 acres of dust shadow 7 deviations to BMP E-11
Excavation at mine site and constructed freshwater reservoir	Habitat alteration (decrease in tundra habitat and increase in water habitat) Disturbance or displacement from noise and human activity	166.0 acres altered Excavation: 62 dBA at 1,000 feet Mining: 90 dBA at 1,000 feet	Same as Alternative B	Same as Alternative B
Pile installation	Disturbance or displacement from noise (winter only)	84 dBA at 1,000 feet from the source 36 pipe piles	84 dBA at 1,000 feet from the source 20 pipe piles	84 dBA at 1,000 feet from the source 36 pipe piles
200-foot-tall communication tower	Injury or mortality from collision with tower or guy-wires	6 towers: 1 at WOC and 1 at each drill site	Same as Alternative B, tower only at South WOC, no tower at North WOC	Same as Alternative B
Freshwater ice infrastructure	Habitat alteration from water withdrawal (water quantity changes) Habitat alteration from vegetation compaction	1,662.4 MG of water 495.2 miles of onshore ice road 4,557.3 acres of onshore ice roads and ice pads	1,914.3 MG of water 650.1 miles of onshore ice road 5,608.0 acres of onshore ice roads and ice pads	2,286.3 MG of water 962.4 miles of onshore ice road 7,164.8 acres of onshore ice roads and ice pads
Ground traffic[a]	Disturbance or displacement from noise and human activity Injury or mortality from collisions with vehicles	3,188,910 total trips 10,928 to 42,027 trips per summer (2021 through 2030) 30,248 to 237,297 trips per winter (2021 through 2030) 10,928 trips per summer (2031 through 2050) 27,456 trips per winter (2031 through 2050)	4,212,510 total trips 11,060 to 46,748 trips per summer (2021 through 2030) 33,180 to 311,229 trips per winter (2021 through 2030) 16,578 trips per summer (2031 through 2050) 41,652 trips per winter (2031 through 2050)	4,376,890 total trips 3,360 to 36,811 trips per summer (2021 through 2030) 36,855 to 210,521 trips per winter (2021 through 2030) 17,124 trips per summer (2031 through 2050) 46,241 trips per winter (2031 through 2050)

Project Component	Effect to Birds or Bird Habitat	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Air traffic[a]	Disturbance or displacement from noise and human activity Injury or mortality from collisions with vehicles	12,101 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source Per summer 2021 through 2030: 0 to 12 to/from Alpine; 0 to 112 to/from Willow Per summer 2031 through 2050: 105.6 to/from Willow 2,421 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source Per summer 2020 through 2021: 25 to 38 to/from Alpine; 2022 through 2030 25 to 57 to/from Willow; 2031 through 2050 57 per summer to/from Willow	19,574 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source Per summer 2021 through 2030: 0 to 12 to/from Alpine; 0 to 319 to/from Willow[b] Per summer 2031 through 2050: 137.7 to/from Willow[b] 2,910 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source Per summer 2020 through 2021: 25 to 38 to/from Alpine; 2022 through 2030 57 to 104 to/from Willow[b]; 2031 through 2050 59 per summer to/from Willow[b]	19,038 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source Per summer 2021 through 2030: 0 to 20 to/from Alpine; 0 to 121 to/from Willow Per summer 2031 through 2051: 121.3 to/from Willow 2,503 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source Per summer 2020 through 2021: 25 to 38 to/from Alpine; 2022 through 2030 25 to 50 to/from Willow; 2031 through 2051 50 per summer to/from Willow
Barge and support vessel traffic[a]	Temporary disturbance or displacement from noise or human activity	Nearshore barge route (~600 miles) 24 barges, 37 tugboats, and 258 support vessels 145 to 175 dB rms at 3.28 feet from the source	Same as Alternative B	Same as Alternative B
Screeding	Temporary habitat alteration Disturbance or displacement from noise or human activity	12.1 acres, 2 occurrences 164 to 179 dB rms at 3.28 feet	Same as Alternative B	Same as Alternative B
All	Total behavioral disturbance area[c]	18,759.5 acres	19,245.1 acres	17,873.3 acres

Note: BMP (best management practice); dB (decibels); dBA (A-weighted decibels); MG (million gallons); MTI (module transfer island); rms (root-mean-square); WOC (Willow Operations Center). All sound levels are detailed in Section 3.6, *Noise*, or in Appendix E.13, *Marine Mammals Technical Appendix*. Summer is defined as June through September, winter as December through March, and spring as April and May. Total acres of bird habitat loss may differ from total gravel footprint because not all areas that would be filled are used by birds.

[a] Traffic is detailed in Tables D.4.8, D.4.16, D.4.24, D.5.5, D.5.6, D.5.10, and D.5.15 in Appendix D.1, *Alternatives Development*.

[b] Air traffic to/from Willow includes traffic at both North and South airstrips.

[c] Disturbance is calculated using the U.S. Fish and Wildlife Service 656-foot (200-meter) zone around nesting spectacled eiders (during June 1 to 31 July), as described in Section 3.11.2.3.2, *Disturbance or Displacement*. This zone encompasses all effective disturbance distances summarized for related species and families of birds nesting in the analysis area (Livezey, Fernandez et al. 2016) and is used here to estimate the area affected by human activity, noise, traffic, and machinery in summer. Disturbance does not include the mine site since activity since that would occur only in winter.

3.11.2.3.2 Disturbance or Displacement

Project activities that could potentially disturb or displace birds include the following:

- Increased human activity
- Increased noise and visual disturbance from machinery as well as ground, air, and marine traffic
- Increased noise and visual disturbance from flaring and drill rigs or other infrastructure

The area of disturbance (from all summer terrestrial activities listed above) would be 18,759.5 acres, during all Project phases, based on a 656-foot (200-m) disturbance zone around gravel infrastructure and pipelines; 10,838.9 acres, or 58%, would be in habitats used by 20 species or more (Table E.11.7 in Appendix E.11). Bird responses to disturbances vary by disturbance source and bird species, with some raptors reacting at the farthest distances (Livezey, Fernandez et al. 2016). The USFWS established a 656-foot (200-m) zone around nesting spectacled eiders during June 1 to July 31 (USFWS 2018) or June 1 to August 15 (USFWS 2015a) where human activities off gravel pads and roads are prohibited. This zone encompasses all effective disturbance distances (flushing distances) summarized for related species and families of nesting and non-nesting birds (with the exception of the Falconiformes [falcons, hawks, and eagles]) in the analysis area (Livezey, Fernandez et al. 2016) and is used here to estimate the area affected by human activity, noise, traffic, and machinery. Data collected on spectacled eiders on the Colville River and Northeast NPR-A found that nesting spectacled eiders rarely (8% of 84 hens on nests) flush at distances greater than 82 feet (> 25 m) from people on foot, and the greatest distance at which flushing occurred was 131 feet (40 m) (ABR unpublished data 2018). The one species on the ACP reported to exceed the 656-foot disturbance zone is the nesting tundra swan, which reacts at 1,640 to 6,562 feet (500 to 2,000 m) (Monda, Rattie et al. 1994).

Disturbance can increase concealment behaviors, decrease nest attendance (Johnson, Burgess et al. 2003), or interfere with resting, feeding, and brood-rearing activities (Murphy and Anderson 1993). It can also increase energetic costs or lead to displacement of breeding birds, which may increase nest and brood predation, thereby reducing reproductive success (Johnson, Parrett et al. 2008; Stien and Ims 2015). Noise and visual disturbances are often coincidental, as they are with road and air traffic. It is rarely possible to separate and identify which causes responses in field studies. Responses to disturbance vary by species, season, and with the type and distance to the source of disturbance (Livezey, Fernandez et al. 2016; Murphy and Anderson 1993). Studies in New Mexico and Canada found that many songbirds avoided gas compressor noise (Ortega 2012). However, gas compressor noise was found to have no measurable effects on nest density or the reproductive success of Lapland longspurs in the Yukon Territory (Gollop, Goldsberry et al. 1974). Likewise, most species of large waterbirds recorded at a gas compressor plant in Prudhoe Bay were not displaced in relation to noise levels, with the exception of Canada geese during pre-breeding and non-nesting spectacled eiders during the nesting period, which were farther from the plant after operation began (Anderson, Murphy et al. 1992).

Aircraft and vehicle traffic can have adverse effects on some but not all species. Air and ground traffic for the Project are detailed in Tables D.4.8 and D.4.9 in Appendix D.1 (*Alternatives Development*). Among waterfowl, brant appear to be most sensitive to vehicle and air traffic and are more reactive during molting and post-breeding. Over 75% of fall-staging brant flushed from aircraft overflights, with higher proportions reacting to rotary aircraft (51%) than to fixed-wing aircraft (33%); fewer Canada geese (11% or less) responded to both types of aircraft (Ward, Stehn et al. 1999). Nesting brant were recorded farther from roads with higher traffic during construction than pre- or post-construction, and brood-rearing brant were farther from roads with higher traffic during construction and post-construction in the Lisburne Development Area (Murphy and Anderson 1993). Nonetheless, brant reacted more strongly to caribou, people on foot, and Arctic foxes than to aircraft or vehicles. Aircraft disturbance in Yukon Territory temporarily reduced the numbers of waterfowl on lakes (Schweinsburg 1974). However, densities of birds using lakes around the Alpine airstrip varied by month, year, and lake type but were not consistently related to distance from the airstrip, thus showing no clear indication of displacement from the airstrip (Johnson, Burgess et al. 2003). Nesting birds show variable reactions. Songbirds and shorebirds nesting at a range of distances from an airstrip and active drill site at Alpine were not displaced after construction and operations began (Johnson, Burgess et al. 2003). Nesting greater white-fronted geese and tundra swans responded to vehicle and air traffic most often with alert and concealment postures, but geese flushed from aircraft during very close approaches by helicopters, such as during landings (Johnson, Burgess et al. 2003). Brant were observed to flush from nests in response to some aircraft overflights, while nesting common eiders were rarely observed to show any visible reaction in response to such activities (Gollop, Black et al. 1974). Recent studies of greater white-fronted geese and human activity found no displacement, no reduction in nest attendance, or decline in nesting success for geese exposed to helicopter overflights and vehicle traffic (Meixell and Flint 2017). A longer study of pre- and postconstruction effects of the CD5 development found increases in the density of greater white-fronted geese nests after construction despite increasing levels of traffic and human activity and found no effect on nesting success, nest attendance, or distribution related to development phase or distance to infrastructure (Rozell and Johnson 2020). Human activity would be greatest during construction. Effects to birds during construction would be minimized by scheduling the heaviest construction activities during winter, when few birds are present. However, some construction would occur in summer. Improvements to Oliktok Dock (Option 3) would occur over 4 weeks during one summer season. Improvements would be within the existing dock footprint but would create noise and increase human activity at the dock and the road leading to the dock. The density of pre-breeding spectacled eiders is lower at Oliktok Point than at Point Lonely and is similar to that at Atigaru Point (Figure 3.11.2), and the number of nests is likely correlated to pre-breeding densities.

Spectacled eiders are known to nest along Oliktok Road. As described in Appendix E.11 (Section 1.1.1, *Special Status Species*), the Kuparuk oil field (included in the analysis area east of the Colville River) has an average density of 0.17 birds per square mile (Attanas and Shook 2020). Fischer and Larned (2004) recorded fewer spectacled eiders and unidentified eiders in the nearshore zone at Oliktok Point than at Atigaru Point or Point Lonely based on 3 years of aerial survey data (Fischer and Larned 2004, Figure 3, Table 5), but the general movement of adults and juveniles from east to west indicates the entire coast is used. The nearshore zone from the Sagavanirktok River to Point Barrow was identified as an important area for spectacled eiders based on satellite telemetry (Sexson, Pearce et al. 2014).

Noise and visual stimuli from ground and air traffic would disturb or displace birds throughout the life of the Project. Routine aircraft flights could result in bird avoidance of certain areas, abandonment of nesting attempts, or reduced survival of eggs and young. Ground and air traffic would be highest during winter construction (December to April), when the fewest birds would be affected. During this time, there would be 0.2 to 4.0 fixed-wing plane landings per day at Willow (2021 through 2030) and 0 to 0.7 plane landings per day at Alpine (2021 through 2024 (Tables D.5.10 and D.5.12 in Appendix D.1, *Alternatives Development*). There would also be 0 to 0.5 helicopter trips per day at Willow (2022 through 2030) and 0 to 0.4 helicopter trips per day at Alpine (2020 through 2022) (Tables D.5.15 and D.5.17 in Appendix D.1). Additionally, there would be 15.5 to 81.7 ground traffic trips per hour to Willow (2022 through 2029; Table D.5.7 in Appendix D.1). Hazing birds at or near airstrips would temporarily disturb or displace additional individual birds and could avoid mortality and injury to birds from collisions. Hazing, as authorized by state and federal agencies, is required by FAA to ensure human safety.

Disturbance and displacement would be lower in intensity during operations than during construction and drilling because ground traffic would decrease by up to 88% and air traffic would decrease by up to 65% with a proportional decrease in associated noise (Tables D.4.9 and D.4.10 in Appendix D.1). Traffic disturbance to most species of birds would occur within 200 m of gravel infrastructure; impacts would be greatest during summer because more birds are present.

Marine vessel traffic would disturb or displace birds along the nearshore barge route; foraging long-tailed ducks, scoters, eiders, loons, and geese could be temporarily disturbed or displaced due to slow-moving vessels. Effects would occur during two open-water seasons (July 7 through September 30), be localized, and although it could affect multiple species, alternative marine habitats are abundant in the area. A total of 24 barge trips, 37 tugboat trips, and 258 support vessel trips would be needed (Table D.4.9 in Appendix D.1).

Increased subsistence access via gravel roads and boat ramps could also displace or disturb birds and change their distribution or local abundance. Section 3.16, describes estimated changes in subsistence access and potential harvest due to Project infrastructure.

3.11.2.3.3 Injury or Mortality

Birds within the analysis area could be injured or killed due to collisions with vehicles, aircraft, or Project infrastructure and from increased subsistence harvest.

The addition of new roads and airstrips and the increased use of vehicles and aircraft during construction and operation would increase the potential for bird collisions. Dust along roads would cause earlier snowmelt and green-up adjacent to gravel infrastructure, which could attract early-arriving birds while the remaining tundra and wetlands are frozen, increasing the potential for individual bird strikes from vehicles. Collision rates for birds in the Alpine and GMT developments from 2015 to June 2019 ranged from zero to two collisions per year, as reported by CPAI. One of the four total collisions reported was with an aircraft.

Structures such as communication towers, flare towers, buildings, elevated pipelines, and drill rigs would pose collision hazards during periods of poor visibility (MacKinnon and Kennedy 2011). The tallest structures would be communications towers (up to 200 feet tall) and drill rigs (up to about 230 feet tall). There would be one communication tower at the WOC and one at each drill site for a total of six as well as one to two drill rigs operating at any given time during the drilling phase (one drill rig per drill pad). In addition, facility and tower lighting, as well as flaring at the CPF, under low-light conditions, could disorient birds and lead to collisions or exhaustion (Day, Rose et al. 2001; Day, Rose et al. 2015; Ronconi, Allard et al. 2015). Weather conditions such as fog, rain, and low light increase collision mortality of common eiders at towers and transmission lines (MacKinnon and Kennedy 2011). On the North Slope, birds often migrate at low altitudes and in foggy conditions; eiders migrate an average of 40 feet (12 m) above ground level at Point Barrow (Day, Stenhouse et al. 2001) and 30 feet (9 m) above ground level at Northstar Island (Day, Prichard et al. 2005). Collision risk would be lower inland, where the towers would be located, because fewer species migrate in that area and visibility is better. Inland communication towers would be up to 200 feet tall. Permanent towers would be triangular, self-supporting lattice towers and would not use guy-wires. Temporary towers would be pile supported and may require guy-wires, which would increase collision risk; guy-wires would include devices to mitigate bird strikes. Collision risk would be further minimized by shielding lights downward on towers and buildings. Effects could occur to individual or flocks of birds around tall structures throughout the life of the Project. Of the 21 bird mortalities reported at BP facilities on the North Slope in 2013, 3 were known vehicle collisions and 3 were known building collisions (Streever and Bishop 2014). BP facilities are in an area of the North Slope with more structures, more roads, faster vehicle speeds, and more air traffic than the Project would have; thus, collisions from the Project would be less than those at the BP facilities.

Increased subsistence access due to new gravel roads could reduce nest success and adult survival of waterfowl due to hunting and egg gathering. Egg gathering now occurs near Alpine CD5 and the GMT-1 road, in part due to increased access. Section 3.16 describes changes in subsistence access. Increased subsistence access via boat ramps could result in increased harvest of birds, leading to increases in mortality for waterfowl (primarily geese) in areas accessible by boat (lakes and wetlands along the Ublutuoch [Tiŋmiaqsiuġvik] River, Judy [Iqalliqpik] Creek, and Fish [Uvlutuuq] Creek).

3.11.2.3.4 <u>Attraction to Human Activity and Facilities</u>

Some scavenging or predatory bird species, such as glaucous gulls, common ravens, rough-legged hawks, and peregrine falcons would be attracted to tall structures and facilities (such as buildings, elevated pipelines, bridges, towers, drill rigs, and wellheads) that provide perching or nesting habitat. This could lead to increased predation of other birds or bird nests in these areas. Golden eagles are attracted to linear structures during migration, which increases their vulnerability to collisions and electrocution on powerlines (Eisaguirre, Booms et al. 2019), but also increases predation on other birds and their nests. Placement of power and communication cables under pipelines on the pipeline rack would reduce the possibility of electrocutions. Some species of songbirds (snow buntings and redpolls) are also attracted to human structures for nesting sites. The impact of increased nest predation would vary depending on the species attracted and the vulnerability of the nesting species. The effect would extend throughout the analysis area.

Two avian predators, glaucous gulls and common ravens, are attracted to human food (Day 1998; NRC 2003). The populations of these two species have increased in the ACP over the last 26 years that have been analyzed (significantly for gulls, not significantly for ravens) (Wilson, Larned et al. 2018), which may be a result of the increased availability of human foods and, for ravens, nesting sites on human-made structures. Ravens, however, were 16% or less of the subsidized predators (those using human food or nest sites) region-wide, whereas jaegers were 32 to 77% of all predators (Liebezeit, Kendall et al. 2009). At CD5, ravens were only 2% of the predators counted on breeding bird plots, glaucous gulls were 50%, and jaegers were 47% (Rozell and Johnson 2020). Ravens accounted for 10% of attacks on snow goose nests in Canada (Bêty, Gauthier et al. 2001). Thus, ravens, which are efficient nest predators, are not a large component of the nest predator community. Some mammalian predators of birds, such as foxes and bears, are also attracted to human food (Section 3.12, *Terrestrial Mammals*). Human food sources concentrated Arctic foxes in portions of Prudhoe Bay during the 1970s through the 1990s (Burgess, Rose et al. 1993; Eberhardt, Garrott et al. 1983; Eberhardt, Hanson et al. 1982). The attraction of foxes and gulls to recent development with improved waste handling practices is less clear, however, with no increase in foxes and gulls observed at Alpine after construction (Johnson, Burgess et al. 2003). Similar numbers of Arctic foxes were recorded between Prudhoe Bay and undeveloped NPR-A during breeding bird surveys (Bart, Platte et al. 2013), and no difference in total nest predators was recorded on bird plots between Prudhoe Bay and undeveloped Teshekpuk study areas (Liebezeit, White et al. 2011). Effective food and garbage control (described in the Project Waste Management Plan) should minimize the attraction of predators to Project facilities.

3.11.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, but the area affected would be larger and air traffic would increase due to the addition of a second airstrip and lack of a gravel road connection among the drill sites (Table 3.11.2). Under Alternative C, 53.2 more acres of habitat would be lost due to gravel fill; 3.2 fewer acres of habitat would be indirectly impacted by dust and gravel spray; and 485.6 more acres of habitat would be impacted by disturbance associated with people, vehicles, machinery, and aircraft activity. Tables E.11.4 through E.11.7 in Appendix E.11 provide details of habitat types affected and impact comparison tables for action alternatives. Approximately 50.8 more acres of habitats used by 20 or more species would be lost to gravel fill due to a larger gravel footprint. There would be two additional seasons of ice roads and water withdrawal during construction, as well as a 3.6-mile-long annual ice road required for the life of the Project, which could have longer lasting effects on water levels and vegetation compaction and modification. Approximately 1,050.7 more acres would be covered by ice infrastructure and could be altered by vegetation damage and compacted soil under Alternative C, and there would be 251.9 MG more of freshwater used (Table E.11.8 in Appendix E.11). More habitat preferred and used by spectacled eiders would be impacted by Alternative C relative to Alternative B: 41.1 more acres would be directly lost to gravel fill and 153.9 more acres would be affected by disturbance (Table E.11.11). Compared with Alternative B, Alternative C would have one fewer unique nest site of yellow-billed loons, one fewer lake within 1 mile of gravel infrastructure, and the same number of breeding lakes within 1,640 feet. One less deviation to BMP E-11 would be needed for Alternative C than Alternative B. Alternative C would have a fractional increase in the number of yellow-billed loons (0.2) and the same number (1.1) of spectacled eiders in the disturbance zone around infrastructure (Table E.11.9).

Alternative C would have 32% more total ground traffic than Alternative B and 62% more air traffic (Tables D.4.17, D.4.18, D.5.5, and D.5.9 in Appendix D.1). The heaviest traffic would occur during winter construction (2022 through 2030), when there would be up to eight more fixed-wing plane landings per day at Willow and up to 25.5 more ground traffic trips per hour than Alternative B (Tables D.5.10 and D.5.6 in Appendix D.1). Air traffic at Alpine would be the same as Alternative B (Table D.5.12 in Appendix D.1). There would be no helicopter traffic in winter (same as Alternative B; Table D.5.15 in Appendix D.1). Because there are significantly fewer birds in the analysis area during the winter, the heaviest air and ground traffic would not overlap with the greatest number of birds present or the most important bird life history stages. Summer ground and fixed-wing traffic would be substantially less than winter traffic throughout the life of the Project (Table D.4.18 in Appendix D.1). Total air traffic would decrease by 13% during operations (2031 through 2050) and ground traffic would decrease by 35%, with a proportional decrease in associated disturbance and displacement. Marine vessel traffic would not differ by action alternative.

3.11.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those described under Alternative B, but with a slightly smaller footprint, much longer ice roads, and an additional year of construction (Table 3.11.2). Under Alternative D, 9.8 fewer acres of habitat would be lost due to gravel fill; 791.5 fewer acres of habitat would be indirectly impacted by dust and gravel spray; and 886.2 fewer acres of habitat would be impacted by disturbance associated with people, vehicles, machinery, and aircraft activity. Appendix E.11 provides details of habitat types affected and impact comparison tables for action alternatives. Approximately 2.6 more acres used by 20 or more species would be lost to gravel fill, 108.8 fewer acres would be impacted by dust effects, and 728.5 fewer acres would be affected by disturbance effects. Although direct loss of habitat preferred and used by spectacled eiders would be more under Alternative D relative to Alternative B by 2.6 acres, 162.5 fewer acres would be affected by disturbance (Table E.11.11). There would be one additional season of ice roads and water withdrawal during construction, as well as the longest (12.5 miles) annual ice road required for the life of the Project, which could have longer lasting effects on water levels in water-source lakes used by nesting waterbirds. Approximately 2,607.5 more acres would be covered by ice infrastructure than under Alternative B and could be altered by vegetation damage and soil compaction; there would be 623.9 MG more of freshwater use. Alternative D would have 11 unique yellow-billed loon nest sites on seven lakes within 1 mile of gravel fill but would have fewer (four) breeding lakes within 1,640 feet of infrastructure. A deviation to BMP E-11 would be needed for these sites. Compared with Alternative B, Alternative D would have a fractional decrease in the number of yellow-billed loons (5.8) and the same number (1.1) of spectacled eiders in the disturbance zone around infrastructure as under Alternative B (Table E.11.9).

Alternative D would have 37% more total ground traffic and 57% more total air traffic than Alternative B (Tables D.4.16, D.4.17, D.5.5, and D.5.9 in Appendix D.1). The heaviest traffic (trips per day or per hour) would occur during winter construction (2022 through 2030), when there would be up to 1.5 more fixed-wing plane landings per day at Willow and 0.9 more landing per day at Alpine than Alternative B (Table D.5.10 in Appendix D.1). However, there would be up to 9.2 fewer ground traffic trips per hour than Alternative B (Table D.5.6 in Appendix D.1). There would be no helicopter traffic in winter (same as Alternative B, Table D.5.15 in Appendix D.1). Because there are significantly fewer birds in the analysis area during the winter, the heaviest air and ground traffic would not overlap with the greatest number of birds present or the most important bird life history stages. Summer ground and fixed-wing traffic would be substantially less than winter traffic throughout the life of the Project (Table D.4.25 in Appendix D.1). Total air traffic would increase by 21% during operations (2031 through 2051), and ground traffic would decrease by 31%, with a proportional increase or decrease in associated disturbance and displacement. Marine vessel traffic would not differ by action alternative.

3.11.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

Many of the effects described for Alternative B would also apply to the module delivery options; these are summarized in Table 3.11.3.

3.11.2.6.1 <u>Habitat Loss or Alteration</u>

Under Option 1, 12.8 acres of open nearshore water would be permanently filled by gravel for the MTI. The fill footprint is in approximately 8 to 10 feet water depth and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). The surrounding 11 to 15 acres of habitat would also be temporarily altered the summer after the winter placement of fill due to mobilization of fines in the MTI fill material into the water column, which would increase SS and turbidity (Coastal Frontiers Corporation 2018b). The duration of the plume would depend on the amount of fines in the fill and could last 0.5 hour to 55 days (Coastal Frontiers Corporation 2018b). Birds such as long-tailed ducks, eiders, scoters, and red-throated loons that depend seasonally on this habitat for foraging could experience decreased foraging success due to turbidity. However, fish and benthic surveys conducted in the MTI area suggest baseline conditions with relatively low complexity and low productivity for prey species (Kinnetic Laboratories Inc. 2018).

Screeding at the MTI and barge lightering area would also temporarily alter habitats by increasing turbidity in the area immediately surrounding the screeding footprint, as described for Alternative B (Section 3.11.2.3.1, *Habitat Loss or Alteration*). Because the screeding footprint is 14.5 acres and the action would occur in four separate summer seasons, the effects would be temporary, localized, and affect small numbers of birds in an area where a large amount of alternative foraging habitat is available.

Option 1 is within the Beaufort Sea Nearshore IBA (Figure 3.11.1), described in Section 3.11.1.2, *Bird Habitats*; the area is globally important for brant, glaucous gulls, king eiders, long-tailed ducks, red-throated loons, surf scoters, white-winged scoters, yellow-billed loons, and black scoters (Audubon Alaska 2014).

Based on data for western Harrison Bay, current speeds are too low to cause significant, permanent scour of the sea bottom surrounding the MTI (Coastal Frontiers Corporation 2018a). Average rates of shoaling in the area are low (CPAI 2019b). Other human-made islands in the Beaufort Sea experience small amounts of shoaling on the leeward side. Similar amounts would be expected at the MTI and would not affect the stability of the MTI or coastal processes around it. No accretion or further shallowing of the MTI area would be expected to occur.

Gravel needed for the MTI would be mined from the Ublutuoch (Tiŋmiaqsiuġvik) mine site, concurrent with mining for the action alternatives. The mine site footprint and number of seasons required to mine would not change from that described for Alternative B (Section 3.11.2.3.1).

Ice roads from the mine site to the MTI (one winter season) and from the MTI to BT3 (two winter seasons) would compress vegetation and temporarily alter bird habitats; effects would be similar to those described for ice roads under Alternative B (Section 3.11.2.3.1). There would be two multi-season ice pads along the ice road (Figure 2.4.4). Recovery of vegetation would take longer at these locations (as described in Section 3.9).

3.11.2.6.2 Disturbance or Displacement

Birds in the nearshore marine area around the MTI would be disturbed or displaced due to in-water work (screeding and recontouring of the MTI slopes), noise (both airborne and underwater), and human activity. In-water work, with associated airborne and underwater noise, would occur over six summer seasons (one for the recontouring of the MTI slopes, four for screeding, and one for removal of anthropogenic material at decommissioning). Airborne noise would also occur during one winter construction season at the mine site, along the ice roads between the mine and the MTI site, and around the MTI fill footprint. Human activity would occur over several winter and summer seasons through construction and decommissioning of the MTI. Effects of disturbing or displacing birds are described in Section 3.11.2.3.2.

Birds along the nearshore barge and support vessel route (foraging long-tailed ducks, scoters, eiders, loons, and geese) could be temporarily disturbed or displaced due to slow-moving vessels. Effects would occur during four open-water seasons (July 7 through September 30), be localized, and although it could affect multiple species, alternative marine habitats are abundant in the area. A total of 9 barge trips, 16 tugboat trips, and 259 support vessel trips would be needed (Table D.4.35 in Appendix D.1).

Year-round resident birds could be disturbed in winter along the ice roads from the mine site to the MTI (one winter season) and from the MTI to BT3 (two winter seasons). All ground traffic for Option 1 would occur in winter, when fewer birds are in the area.

Air traffic for Option 1 would occur year-round during construction (Table 3.11.3 and Table D.4.35 in Appendix D.1). Summer air traffic would occur at Alpine, Willow, or Atigaru Point, depending on the year, and range from 0 to 16 flights per summer. Alpine has existing scheduled and unscheduled air traffic. Air traffic for Option 1 would be additional but would not likely produce an observable increase in disturbance to birds at Alpine beyond normal operation flights. Because of the low number of flights in the summer, air traffic is expected to have minor, temporary effects on birds.

3.11.2.6.3 Injury or Mortality

Two temporary communication towers (one on the MTI and one on an onshore multi-season ice pad) up to 120 feet tall would be erected at the start of MTI construction (2021) and held in place via guy-wires. Risk of collision with towers would be greatest along the coast, because spectacled eiders (Sexson, Pearce et al. 2014) and other special status species follow the arctic coastline during migration (Day, Prichard et al. 2005; Day, Rose et al. 2001) and because fog and poor visibility are common in that area. Guy-wires significantly increase collision mortality for birds (Gehring, Kerlinger et al. 2011); therefore, guy-wires would be fitted with bird divertors to mitigate potential bird collisions. The temporary tower would remain in place until the first season of module delivery is complete (2023), at which time it would be demobilized until the second season of module delivery (2025). It would then be reinstated until MTI decommissioning. As described in Section 3.11.2.3.3, birds could collide with the communication towers and be injured or die.

3.11.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

All of the effects to birds described for Option 1 would apply to Option 2. The main difference is Option 2 would require almost double the volume of water withdrawals for about twice the length of ice roads (Table 3.11.3), which would cause more habitat alteration from vegetation compression and lower lake levels if lakes do not recover to pre-withdrawal levels. Option 2 would also have markedly more miles of support vessel traffic. Although the number of trips and seasons of use are the same as Option 1, the support vessels would originate from Oliktok Point and thus would have a longer route to Point Lonely than Atigaru Point. This would increase disturbance and displacement to birds using nearshore waters. Both locations have large numbers of sea ducks, loons, and molting and brood-rearing brant and other geese, which could be disturbed or displaced by human activity and loss of benthic forage during summer. Option 2 is within the Barrow Canyon and Smith Bay IBA (Figure 3.11.1), described in Section 3.11.1.2; it is of global significance for arctic terns, black-legged kittiwakes, glaucous gulls, king eiders, long-tailed ducks, red phalaropes, Sabine's gulls, and yellow-billed loons (Audubon Alaska 2014).

Option 2 would also require substantially more ground traffic than Option 1 but the same amount and types of air traffic (Table D.5.5 in Appendix D.1) and thus would have more disturbance and displacement as well as injury or mortality from collisions.

Table 3.11.3. Effects to Birds and Bird Habitat from Module Delivery Options

Project Component	Effect to Birds or Bird Habitat	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Gravel fill onshore	Habitat loss Habitat alteration from expanded dust shadow on existing road	None	None	5.0 acres lost 27.5 acres of dust shadow beyond existing dust shadow
Gravel fill in marine area	Open nearshore water and benthic habitat loss Temporary habitat alteration from sedimentation or turbidity Disturbance or displacement from noise	12.8 acres lost 11 to 15 acres altered	13.0 acres lost 11 to 15 acres altered	None
Screeding	Temporary habitat alteration (increased turbidity, and decreased benthic forage) Disturbance or displacement from noise and human activity	14.5 acres altered, 2 occurrences 164 to 179 dB rms at 3.28 feet	Same as Option 1 164 to 179 dB rms at 3.28 feet	No additional screeding beyond what is described for Alternatives B, C, or D
120-foot-tall communication tower	Injury or mortality from collision with tower or guy-wires	2 towers: 1 on the MTI and 1 on an onshore multi-season ice pad Towers erected from 2021 through summer 2023, and from summer 2025 to MTI decommissioning	3 towers: 1 on the MTI and 2 on an onshore multi-season ice pad. Towers erected from 2021 through summer 2023, and from summer 2025 to MTI decommissioning.	None
Freshwater ice infrastructure	Habitat alteration from water withdrawal (water quality or quantity changes) Habitat alteration from vegetation disturbance	307.9 MG of water 103.6 miles of onshore ice road 859.6 acres of onshore ice roads and ice pads	572.0 MG of water 223.4 miles of onshore ice road 1,756.1 acres of onshore ice roads and ice pads	257.2 MG of water 80.2 miles of onshore ice road 666.6 acres of onshore ice roads and pads
Ground traffic[a]	Disturbance or displacement from noise and human activity Injury or mortality from collisions with vehicles	2,306,110 total trips (2022 through 2027) 0 trips per summer 10,920 to 811,965 trips per winter or spring	3,196,450 total trips (2022 through 2027) 0 trips per summer 10,920 to 1,106,805 trips per winter or spring	535,160 total trips (2023 through 2027) 0 to 4,590 trips per summer (2023 through 2026) 198,736 trips per winter or spring (2025 and 2027)
Air traffic[a]	Disturbance or displacement from noise and human activity Injury or mortality from collisions with vehicles	326 total fixed-wing trips (2022 through 2027) 0 in summer to/from Alpine; 16 in summer to/from Willow (2024); 12 per summer to/from Atigaru Point (2023, 2024, and 2026) 450 total helicopter trips (2022 through 2027); 70 to 80 dBA at 1,000 feet from the source 15 in summer to/from Alpine (2022); 16 to 90 per summer to/from Willow (2023, 2024, and 2026)	326 total fixed-wing trips (2022 through 2027) 0 in summer to/from Alpine; 16 in summer to/from Willow (2024); 12 per summer to/from Point Lonely (2023, 2024, and 2026) 450 total helicopter trips (2022 through 2027); 70 to 80 dBA at 1,000 feet from the source 15 in summer to/from Alpine (2022); 16 to 90 per summer to/from Willow (2023, 2024, and 2026)	70 total fixed-wing trips (2023 through 2027) 0 to 6 per summer to/from Alpine or Kuparuk 16 total helicopter trips (2023 through 2027); 70 to 80 dBA at 1,000 feet from the source 8 per summer (2025 and 2027)

Project Component	Effect to Birds or Bird Habitat	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Barge and support vessel traffic[a]	Temporary disturbance or displacement from noise or human activity along nearshore barge and support vessel routes	Nearshore barge route ~1,100 miles RT, support vessel route ~100 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons 145 to 175 dB rms at 3.28 feet from the source	Nearshore barge route ~1,000 miles RT, support vessel route ~200 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons 145 to 175 dB rms at 3.28 feet from the source	Nearshore barge route ~1,200 miles RT, support vessel route ~5.2 miles RT 9 barges, 16 tugboats, and 60 support vessels, 2 summer seasons 145 to 175 dB rms at 3.28 feet from the source
All	Total behavioral disturbance area[b]	188.5 acres	188.4 acres	16.9 acres

Note: ~ (approximately); dB (decibels); dBA (A-weighted decibels); MG (million gallons); MTI (module transfer island); rms (root-mean-square); RT (round trip). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*. Summer is defined as June through September, winter as December through March, and spring as April and May.

[a] Traffic is detailed in Tables D.4.34, D.4.35, D.4.40, D.4.41, D.4.44, D.4.45, D.5.8, D.5.9, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1, *Alternatives Development*.

[b] Disturbance is calculated using the U.S. Fish and Wildlife Service 656-foot (200-meter) zone around nesting spectacled eiders, as described in Section 3.11.2.3.2, *Disturbance or Displacement*. This zone encompasses all effective disturbance distances summarized for related species and families of nesting and non-nesting birds (with the exception of the Falconiformes [falcons, hawks, and eagles]) in the analysis area (Livezey, Fernandez et al. 2016) and is used here to estimate the area affected by human activity, noise, traffic, and machinery in summer.

Although Option 2 would have the same number of air traffic trips (fixed wing and helicopter) as Option 1 (Table D.5.9 in Appendix D.1), the flights would occur in different locations. Option 2 would be within the Goose Molting Area (Figure 3.11.1) and BMPs F-1 and K-4a would apply. Deviations to these BMPs would not be needed if flights stayed along the coast and not over land. There would be 5 to 12 fixed-wing trips to or from Point Lonely airstrip during the summer, for three summer seasons.

The temporary communication tower for Option 2 would be the same as for Option 1 except that an additional repeater tower would be required (on an onshore multi-season ice pad) due to the distance from Point Lonely to the GMT-2 tower. Thus, risk of mortality or injury would be higher in Option 2 with three towers than from the two towers in Option 1.

3.11.2.8 Module Delivery Option 3: Colville River Crossing

Option 3 would have similar types of effects as Options 1 and 2, except there would be no MTI and fill in the marine area and no additional communication towers (Table 3.11.3). Option 3 would require 5 acres of fill onshore along existing Kuparuk roads. Option 3 would need the fewest miles of ice roads and thus would use the least amount of freshwater of all the module delivery options (Table 3.11.3). Thus, Option 3 would cause the least amount of habitat loss from fill, the least amount of habitat alteration from vegetation compression or water withdrawal, the fewest number of ground and air traffic trips and thus the least amount of vehicle and aircraft disturbance (Tables D.5.5 and D.5.9 in Appendix D.1, *Alternatives Development*). Option 3 would also have the fewest number of communication towers (zero, the lowest risk of tower strike).

Option 3 would not require additional screeding beyond what is described for the action alternatives. Although all module delivery options would require vessel traffic, barges and tugboats would dock at different locations under different options, and the species' use and baseline conditions of the locations are different; thus, the magnitude of effects would be different. Oliktok Point, unlike Point Lonely or Atigaru Point, has existing marine infrastructure and an existing industrial dock, where screeding occurs with seasonal regularity before the arrival of barges. The locations of all three module delivery options have large numbers of sea ducks, loons, and molting and brood-rearing brant and other geese, which could be disturbed or displaced by human activity and loss of benthic forage during summer. However, the density of pre-breeding spectacled eiders is lower at Oliktok Point than at Atigaru Point and is similar to that at Point Lonely (Figure 3.11.2), as described in Section 3.11.2.3.2. In addition to all vessels docking at Oliktok Dock, which is already an industrial site, Option 3 would also require half the number of seasons of barge landings and the least number of support vessel trips compared with Options 1 and 2 (Table 3.11.3). Although the number of sealift barges and seasonality of use are the same as Options 1 and 2, the support vessels under Option 3 would originate from Oliktok Point and thus have the shortest route to travel . The combination of fewer vessels, fewer seasons, and shorter routes would cause the least disturbance and displacement to birds using nearshore waters among the three module delivery options.

Option 3 is within the Beaufort Sea Nearshore IBA (Figure 3.11.2), described in Section 3.11.1.2; it is of global significance for brant, glaucous gulls, king eiders, long-tailed ducks, red-throated loons, surf scoters, white-winged scoters, yellow-billed loons, and black scoters (Audubon Alaska 2014).

Ice road construction for Option 3 would also result in human activity, machinery, traffic, and noise that could disturb or displace birds in winter near the construction areas, as described in Section 3.11.2.3.2. The Option 3 ice road may encounter more wintering birds (willow ptarmigan, and to a lesser degree, rock ptarmigan, congregate in riparian willow thickets during winter) at Ocean Point than other locations, but wintering birds are mobile, fewer in numbers, and less likely to collide with vehicles when compared with summer populations (Hannon, Eason et al. 2020; Montgomerie and Holder 2020). With fewer miles of ice roads and less ground and air traffic, Option 3 would result in fewer collisions and less injury and mortality than Options 1 or 2. Overall, Option 3 winter activities would have minimal impacts on birds because fewer birds are present during winter than in summer.

3.11.2.9 Special Status Species

Steller's eiders, whimbrels, buff-breasted sandpipers, and red knots are unlikely to be much affected by habitat loss, disturbance or displacement, and injury or mortality, because they are rare in the vicinity of the Project. Peregrine falcons are rare breeders in the analysis area and use steep bluffs and human structures as nesting sites. Spectacled eiders, yellow-billed and red-throated loons, bar-tailed godwits, dunlin, and arctic terns, depending on their local occurrence, could be subject to all of the effects described for the action alternatives and module delivery options.

Because yellow-billed loons have high nest-lake fidelity (Johnson, Wildman et al. 2019; Schmutz, Wright et al. 2014), they could be impacted by water withdrawals or human disturbance that occurs at nesting lakes. Impacts would likely occur at the individual level. In a pre- and postconstruction study of breeding territory occupancy on the CRD, Johnson, Wildman et al. (2019) found there was no displacement of nests or broods from lakes within 1 mile or 2 miles of active infrastructure at Alpine, with two nests as close as 1,083 feet and 1,640 feet, respectively, to active roads or drill pads. Although breeding territory lakes were retained at high rates (Uher-Koch, Wright et al. 2019), nest visits by researchers reduced nesting success at lakes in NPR-A (Uher-Koch, Schmutz et al. 2015), which indicates that other types of human disturbance could have similar adverse effects. When satellite-tagged yellow-billed loons were displaced from their breeding lakes, they did not establish breeding territories on other lakes that same year, although most spent time on adjacent and nearby lakes (Schmutz, Wright et al. 2014). Establishment of new territories on unoccupied lakes by displaced breeders was not observed, highlighting the importance of maintaining territory ownership. BMP E-11 stipulates no development within 1 mile from a yellow-billed loons' nest and 1,640 feet from a breeding lake. Lake L9911, one of the Project's potable water sources (in addition to the CFWR, varies by alternative), supports yellow-billed loon nests and broods (Figure 3.11.5). The access road to Lake L9911 is more than 1 mile from the nest sites (which are in wetlands at the north end of the lake) but within the 1,640-foot lake buffer. All action alternatives would also cross the standard disturbance setback of 1 mile around recorded yellow-billed loon nest sites and 1,625 feet (500 m) around the shoreline of nest lakes (BMP E-11; Table 3.11.2, Figures 3.11.5 and 3.11.6) due to gravel roads and pads, pipelines, and boat ramps on the Ublutuoch (Tiŋmiaqsiuġvik) River and Judy (Iqalliqpik) Creek. Winter water withdrawals for ice infrastructure could occur from any permitted lake in the Willow area during construction. Based on average yellow-billed loon density in the Willow area (0.21 loons per square mile), 6.1 yellow-billed loons might be in the 656-foot disturbance zone around new infrastructure for Alternative B (Table E.11.9 in Appendix E.11). Under Alternative B, 11 unique nest sites (each occupied for at least 1 year) on seven lakes are known to occur within 1 mile of the proposed gravel infrastructure for Alternative B from 3 years of aerial surveys; six breeding lakes are known within 1,640 feet (Table E.11.10 in Appendix E.11). Alternative C would have 10 unique nest sites and six nesting lakes within 1 mile of infrastructure. Alternative D would have the same numbers of nests and nesting lakes as Alternative B within 1 mile of infrastructure, but only four shorelines of breeding lakes within 1,640 feet of infrastructure. A deviation to BMP E-11 would be needed for these sites under all alternatives. Construction of infrastructure within the buffer stipulated for BMP E-11 could displace nests or reduce nesting success on up to seven lakes under Alternative B; this level of potential impacts would not result in a population level impact on yellow-billed loons. Site-specific survey data are unavailable for red-throated loons, bar-tailed godwits, dunlin, and arctic terns. Relative impacts would vary among the action alternatives depending on the amount habitat directly lost to gravel fill, indirectly altered, and disturbed (Tables E.11.4 through E.11.6 in Appendix E.11). Impacts of human disturbance and water withdrawal on nesting spectacled eiders are possible, but their density in the Willow area is low (Figure 3.11.2). Johnson, Parrett et al. (2008) reported no displacement or reduction in nesting success related to construction and activity at an airstrip and drill pad at CD3 on the CRD. Since construction in 2005, 22 spectacled eider nests have occurred within 200 m of active infrastructure at CD3, and apparent nesting success was 29% (6 of 21 nests hatched) (summarized from ABR unpublished data 2018; Johnson, Parrett et al. 2008; Seiser and Johnson 2014, 2018), which is within the range of average nesting success for other studies in the area (25% to 38%; Attanas and Shook 2020; Warnock and Troy 1992). Water withdrawal would be restricted to permitted waterbodies and would be unlikely to affect more than a few individual eiders nesting on shorelines and islands of water-source lakes. Approximately 109.4 acres of spectacled eider preferred and used habitats would be permanently lost to gravel fill, and 7,035.5 acres of preferred habitat would be affected in the 656-foot disturbance zone under Alternative B (Table E.11.11 in Appendix E.11.). Based on estimated density from aerial pre-breeding surveys (0.028 eiders per square mile), 1.1 spectacled eiders could occur annually in the area subject to Project-related disturbance (Table E.11.9 in Appendix E.11). Assuming each pair of eiders would nest in the area, 0.55 nests could be affected in the disturbance zone. Appendix E.11 provides more details on effects to special status species. All three action alternatives would have the same number of spectacled eiders within their disturbance zones.

The three module delivery options would have similar types of effects on special status species as terrestrial development, but impacts would be short-term in the marine environment affecting foraging spectacled eiders, yellow-billed loons, and red-throated loons over two to four summer seasons. Spectacled eiders and yellow-billed loons occur in marine areas primarily during post-breeding. Red-throated loons feed in nearshore marine areas throughout the breeding season and migrate in that area post-breeding. Impacts would be greater for Options 1 and 2 because of construction of MTIs that would disturb and displace birds during construction and decommissioning, occupy more benthic habitat, and increase the risk of collisions with two communication towers. Options 1 and 2 have four screeding and barging seasons, compared with two barging seasons under Option 3. Option 3 also avoids construction of an MTI by using existing infrastructure at Oliktok Dock, and further reduces impacts by using existing Kuparuk roads and not requiring additional communication towers. This would reduce collision risk for special status species moving along the coast, including spectacled eiders, yellow-billed and red-throated loons, dunlin, red knots, whimbrels, and bar-tailed godwits. Options 1 and 2 would require screeding (which would alter benthic habitat and cause sediment plumes, thereby interfering with foraging by eiders and loons). Screeding also would result in disturbance and displacement. Two special status species, yellow-billed and red-throated loons, make extensive use of nearshore waters in the western Beaufort Sea (Lysne, Mallek et al. 2004) and failed and post-breeding spectacled eiders move there in transit to molting areas (Sexson, Pearce et al. 2014). Although comparative data on abundance of birds for the three option locations are not available for all species, higher proportions of both species of loon were recorded in the Jones/Return Islands Survey segment (Lysne, Mallek et al. 2004) where Option 3 is located (Oliktok Dock), than in Harrison Bay, where Options 1 and 2 are located (Atigaru Point and Point Lonely). However, Option 3 would require fewer support vessels and shorter trips than Options 1 and 2, and require less ground and air traffic. Higher traffic levels and the addition of two communication towers would result in Options 1 and 2 having increased collision risk over Option 3 for listed and special status species moving along the coast. Option 3 also would have shorter ice roads, use less water from lakes, and require less construction. Impacts to all special status species would be less for Option 3 than Options 1 and 2.

3.11.2.10 Oil Spills or Other Accidental Releases

The EIS describes effects of accidental spills. As described in Chapter 4.0 the risk of a large spill during any phase of the Project would be very low. The risk of a very small to small spill or leak is probable over the life of the Project and most likely to occur over gravel infrastructure, which would be easier to contain and remediate. Effects from oil spills and accidental releases on birds and their habitat would depend on the location and season of the spill. Numerous safeguards are required and would be specified in CPAI's ODPCP. The relatively small amounts of material that could be released under most scenarios, and the ability to detect and respond to spills quickly, would minimize potential effects.

Light to moderate oiling of birds can reduce reproduction (through pathological effects on breeding birds or transfer of oil to eggs) or survival (Albers 1980; Anderson, Newman et al. 2000; Lewis and Malecki 1984). Heavy oiling of birds would be lethal and cause hypothermia or mortality through ingestion and inhalation (Clark 1968; Hartung 1967; Holmes, Cronshaw et al. 1978). The effects of other toxic material spills could be similar or more severe, depending on the material. Oil spills on tundra or in water are extremely rare, as are large spills (greater than 10,000 gallons). Releases to tundra could threaten breeding and non-breeding birds, but such releases would be rare and would not spread widely unless undetected. Spills to waterways (if not frozen) would likely spread farther and faster.

In the very unlikely event of a spill at a pipeline crossing of streams in the Willow area, oil may reach the channels of Fish (Iqalliqpik) Creek or the Kalikpik River, particularly during periods of flooding. The relatively low flow and highly sinuous nature of streams in the Fish (Iqalliqpik) Creek and Kalikpik River basin may preclude a spill into one of these rivers from reaching Harrison Bay. If a reservoir blowout were to occur, there is the potential for oil to reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay because of the distance to the drill sites and the sinuous nature of the streams in the area.

Because many birds use the river channels, marshes, and lakes around river channels, contamination of these areas during spring breakup to fall could affect large numbers of birds. Although the effects of such spills could be severe, the probability of such spills occurring would be unlikely. Their duration would be a few days to weeks, although cleanup could prolong the duration of impacts. Effects from very small to small spills would be probable during the life of the Project but would be minor because they would be restricted to pads and roads or not spread more than 1 or 2 acres on tundra. Effects would be infrequent and last hours to a few days.

Most spills to the marine environment would have a low to very low likelihood and occur during construction of the MTI or originate from small support vessels. These very small to small spills would be localized to the immediate area of the MTI. A larger spill from a barge would have a very low likelihood and would only occur if a tugboat or barge transporting modules were to run aground, sink, or if its containment compartment(s) were breached and the contents released (USACE 2012). The geographic extent of these spills would vary and may or may not reach land, depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Seabirds and, potentially, shorebirds could be affected.

Seawater spills on non-frozen tundra would have effects on plants used by birds for forage or cover that could potentially last many years. Saltwater spills can be toxic to many plant species, long lasting, and can cause leaf deterioration and de-leafing (Simmons 1983). Wetter sites recover more rapidly. Willow species and mountain avens have a lower tolerance for salt and are more affected, while grasses and sedges are less affected (Simmons 1983).

3.11.3 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with BMPs in place, some unavoidable impacts to birds would occur, including direct loss of habitat and disturbance and displacement due to noise, human activity, and visual disturbance. Onshore impacts would be irretrievable throughout the life of the Project but would not be irreversible or affect the long-term sustainability of wildlife in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible. The alteration of nearshore habitat would be irreversible because even if the MTI is abandoned and reshaped, it would still exist. Habitat alteration from the CFWR and mine site would be irreversible because the mine pit and the reservoir would fill with water and would permanently change the thermal regime of the underlying soils.

3.12 Terrestrial Mammals

The analysis area for terrestrial mammals is the area within 3.7 miles of construction or operation activities and structures (Figure 3.12.1). This is based on research that documented decreased density of maternal caribou within 0.6 to 3.1 miles (1 to 5 km) of active roads and pads during a 2- to 3-week calving period when cows are giving birth or have young calves with lower mobility (Cameron, Reed et al. 1992; Cronin, Ballard et al. 1994; Dau and Cameron 1986; Johnson, Golden et al. 2019; Lawhead 1988; Lawhead, Prichard et al. 2004; Prichard, Lawhead et al. 2019) and increased caribou densities in areas between 4 to 6 km of roads (Cameron, Reed et al. 1992; Dau and Cameron 1986). The temporal scale for construction-related impacts encompasses the duration of construction activities. However, habitat loss (e.g., fill placement) would be permanent. The temporal scale for operational impacts is the life of the Project.

3.12.1 Affected Environment

At least 19 species of terrestrial mammals use the analysis area (Appendix E.12, *Terrestrial Mammals Technical Appendix)*, and most remain in the analysis area year-round. Because caribou are an important subsistence resource, for which NPR-A provides essential and unique habitats (e.g., TLSA) and because effects to caribou were identified as a key issue in scoping, this section focuses on caribou. Effects to other terrestrial mammals are described in Appendix E.12 but in less detail, as per Council on Environmental Quality guidance (40 CFR 1500.1(b)). None of the terrestrial mammal species that use the analysis area are listed as endangered or threatened under the ESA or listed as sensitive by BLM.

Caribou exhibit high fidelity to calving grounds and ADF&G identifies caribou herds based on calving grounds used. Two herds of barren ground caribou use the analysis area: the Teshekpuk Caribou Herd (TCH) and the Central Arctic Herd (CAH). The herds differ in their use of seasonal ranges, especially during calving, insect-relief, and winter (Murphy and Lawhead 2000; Person, Prichard et al. 2007). During summer, the TCH generally remains west of the CRD and the CAH generally remains east of the CRD (Murphy and Lawhead 2000; Prichard, Welch et al. 2018) (Figure 3.12.2). Both the TCH and CAH were first identified as separate herds in the 1970s.

The TCH was estimated to be 18,292 animals in 1984; it increased to a peak size of 68,932 animals in 2008, declined to 39,172 animals in 2013 (Parrett 2015), but then increased to 56,255 animals in the most recent photocensus in 2017 (Klimstra 2018). Seasonal distribution of the TCH is depicted in Figure 3.12.3. CPAI has been monitoring caribou distribution and abundance in portions of the northeastern NPR-A annually since 2001. Surveys have covered the CRD and the Alpine and GMT oil fields; most of the Willow area has been surveyed since 2002 (Prichard, Macander et al. 2018, 2019; Prichard, Welch et al. 2018) to estimate the seasonal density of caribou in the area (Figure 3.12.4). Surveys have not included Point Lonely or Atigaru Point. Most TCH caribou remain in the ACP between Wainwright and Nuiqsut during winter; however, approximately one-third of females (Fullman, Parrett et al. 2018) and a disproportionate number of bulls typically winter in the central Brooks Range, and smaller numbers winter in western Alaska during some years (Figure 3.12.3) (Parrett 2015; Person, Prichard et al. 2007; Prichard, Welch et al. 2018).

During spring migration and the early calving season, some TCH caribou migrate through the Willow area, generally from southeast to northwest (Figure 3.12.5). Pregnant females return to the calving ground in late May or early June; barren females typically arrive later; and males arrive in mid- to late June. The highest density of calving and post-calving use occurs southeast of Teshekpuk Lake during most years (Kelleyhouse 2001; Parrett 2007; Person, Prichard et al. 2007; Wilson, Prichard et al. 2012). However, calving distribution has exhibited some annual variability since 2010, with some use of the larger area between Atqasuk and the Ikpikpuk River and other areas farther away from Teshekpuk Lake (Figures 3.12.3, 3.12.5, and 3.12.6) (Parrett 2013; Parrett 2015; Prichard, Welch et al. 2018); calving distribution is generally farther north in years of early snowmelt (Carroll, Parrett et al. 2005).

The CAH herd size was estimated at approximately 5,000 animals in the mid-1970s. The herd grew dramatically until the early 1990s, when it experienced a dip in numbers before increasing again to peak at an estimated 68,442 animals in July 2010. The herd then declined to an estimated 22,630 animals in July 2016 but has recovered modestly to 30,069 as of the July 2019 census (ADF&G 2017; Lenart 2015, 2017, 2018). The decline after 2010 was thought to be due to high adult mortality as well as emigration of some CAH caribou to the Porcupine Herd or TCH (ADF&G 2017).

Most CAH caribou migrate onto the ACP during May, shortly before the calving season (Nicholson, Arthur et al. 2016). The CAH calves from late May to mid-June in two general areas of the ACP: approximately half the herd calves between the Colville and Kuparuk rivers, with highest densities occurring south and southwest of the Kuparuk oil field; the other half of the herd calves east of the Prudhoe Bay oil field, between the Sagavanirktok and Canning rivers in an areas with limited development (Figure 3.12.7) (Arthur and Del Vecchio 2009; Cameron, Smith et al. 2005; Lenart 2015). Calving on the CRD is rare (Lenart 2015; Murphy and Lawhead 2000; Prichard, Macander et al. 2017), and few CAH females calve west of the Colville River (Lenart 2015).

After calving, CAH caribou remain on the ACP during summer, repeatedly moving between inland foraging areas and coastal mosquito-relief habitat in response to weather-mediated fluctuations in insect activity levels (Figure 3.12.6) (Lawhead 1988; Murphy and Lawhead 2000; White, Thomson et al. 1975). Over the last decade, portions of the herd have occasionally moved east nearly to the Canada border during July and then spread out across the eastern coastal plain in late summer, while others remained in the vicinity of the oil fields west of the Sagavanirktok River (Arthur and Del Vecchio 2009; Lenart 2015; Prichard, Macander et al. 2017). Most CAH caribou remain east of the CRD during the summer insect season, although movements onto and west of the CRD by large numbers of CAH caribou occur only periodically, judging from telemetry data and aerial survey observations, likely following periods of west winds. One such movement occurred in July 2001, when approximately 6,000 CAH caribou moved west across the CRD into the NPR-A (Lawhead and Prichard 2002). The CAH typically winters in or near the central Brooks Range, often mixing with Porcupine Herd animals on the winter range (Arthur and Del Vecchio 2009; Lenart 2015; Nicholson, Arthur et al. 2016)

Arctic caribou calve in areas with abundant early-emerging forage plants (especially tussock cottongrass) that are high in protein and highly digestible (Johnstone, Russell et al. 2002; Kuropat 1984). Use of the ACP during summer appears to extend the period when caribou can find forage with adequate digestible nitrogen (Barboza, Van Someren et al. 2018).

Although caribou use a variety of habitats over the course of a year, they have specific site needs during certain seasons and life stages. Thus, although habitat used by caribou may occur throughout the ACP, seasonal site characteristics may be more limited in distribution. Wilson et al. (2012) examined factors related to calving site selection for the TCH and found that there were limited areas available with similar characteristics. However, some high-density calving has occurred to the west of Teshekpuk Lake in areas predicted to have low or moderate probability of use (Figure 3.12.3; Parrett 2015; Prichard, Klimstra et al. 2019).

The TLSA was designated in 1977, pursuant to the NPRPA, and expanded in 2013 (BLM 2013a). The TLSA and its subset, the Teshekpuk Lake Caribou Habitat Area, are critical to caribou calving and insect relief for the TCH (Person, Prichard et al. 2007; Wilson, Prichard et al. 2012; Yokel, Prichard et al. 2009). The BMPs for these areas are detailed in Appendix A of BLM (2013a) and summarized in Section 3.12.2.1.1, *Applicable Lease Stipulations and Best Management Practices*.

Caribou behavior during summer is heavily influenced by harassment from several types of insects. Caribou distribution and behavior differs by type of insect, which vary in abundance during the summer. Insect harassment occurs from late June to mid-August, and TCH and CAH caribou typically exhibit the highest movement rate of the year during this period (Fancy, Pank et al. 1989; Prichard, Yokel et al. 2014). Mosquitoes emerge in mid- to late June and the area between Teshekpuk Lake and the Beaufort Sea coast is the primary mosquito-relief habitat for the TCH (Person, Prichard et al. 2007; Wilson, Prichard et al. 2012) due to generally lower temperatures and higher wind speeds. During this period, caribou repeatedly move through the narrow corridors northwest and east of Teshekpuk Lake (Yokel, Prichard et al. 2009) (Figure 3.12.5), resulting in special protections in these areas under BMP K-9 of the NPR-A IAP/EIS (BLM 2012b). (Parts of the movement corridors that are not protected by BMP K-9 are closed to oil and gas leasing.) The Southern Caribou Calving Habitat Area adjacent to the movement corridor is also protected under stipulation K-10 due to its importance for insect relief. Hence, during the mosquito season, TCH caribou are predominantly found north of the Willow area, but high densities of animals can be present in the northern portion of the analysis area.

From mid-July through early August, caribou disperse inland across the central ACP and select gravel bars, dunes, areas with residual snow, gravel roads and pads, and areas of shade created by human-made structures, including pipelines, for oestrid fly relief (Pollard, Ballard et al. 1996; Prichard, Lawhead et al. 2019). Local residents hunt primarily during this period (SRB&A 2017a) and caribou density near the coast can be high (Prichard, Macander et al. 2019). Caribou movements can be rapid and unpredictable during periods of oestrid fly harassment and large numbers of caribou can be in the area near the proposed gravel roads and pads during some years.

The CRD marks the eastern extent of typical TCH movements during summer (Person, Prichard et al. 2007; Prichard, Welch et al. 2018; Wilson, Prichard et al. 2012). Large groups of mosquito-harassed caribou occasionally move onto the CRD in midsummer, but such occurrences are unpredictable and depend on the interplay between weather conditions and insect activity. The herd disperses inland across the central ACP during the oestrid fly and late summer seasons and forage in order to build reserves for the rut and winter (Murphy and Lawhead 2000; Prichard, Macander et al. 2019; Prichard, Welch et al. 2017). During fall, TCH caribou are widely dispersed, and those TCH wintering in the central Brooks Range could cross the proposed gravel roads and pads while migrating south. Some caribou are also likely to cross the area during non-migratory movements in the summer and winter.

Existing development and infrastructure in the analysis area is limited. Seasonal ice infrastructure occurs annually to support oil and gas exploration; seasonal snow roads also occur annually for community access (NSB 2018b). Some gravel infrastructure in the GMT and Alpine oil fields exists, most of it closer to the CRD (Figure 3.12.1). Existing gravel infrastructure and development activities contribute dust, noise, and daily air and road traffic to the eastern portion of the analysis area, which is used for subsistence activities by local residents and research activities.

The area from the Colville River east to the Kuparuk oil field also contains the Nuna and Oooguruk developments. The Kuparuk oil field area has extensive existing infrastructure (e.g., gravel and ice roads, pipelines, processing facilities) as well as existing mine sites, airstrips, reservoirs, a dock (Oliktok Dock), and seawater treatment facility. The Kuparuk oil field experiences more ground and air traffic than the current developments west of the Colville River; ground traffic also travels at higher speeds.

Climate change is occurring in the ACP, as described in Section 3.2, *Climate and Climate Change*. Warmer temperatures and earlier snowmelt are affecting wildlife by changing seasonal timing, forage availability, and habitats. As described in Section 3.9, *Wetlands and Vegetation*, vegetation communities are experiencing an increase in taller deciduous shrubs, which are not preferred by caribou. Further description of how the Project may interact with these effects is in Section 3.19.10.4, *Terrestrial Mammals*.

3.12.2 Environmental Consequences

3.12.2.1 Avoidance, Minimization, and Mitigation

3.12.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.12.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to caribou from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to caribou habitat, subsistence hunting areas, and the environment associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.12.1 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to caribou. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.12.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.12.1. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Caribou

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	Prepare and implement a hazardous materials emergency contingency plan before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	Revised text: – Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – Snow survey and soil freeze-down data collected for ice road or snow trail planning and monitoring shall be submitted to the BLM. – Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice (“bridges”) shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	Added text: – Provide to BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of road/trail construction. – In spring, provide the BLM with photographs of all stream crossings that have been removed, breached, or slotted.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.	Added text: – Subsistence pullout and access/egress ramps would be constructed in adequate numbers and at appropriate locations on all roads to facilitate access to subsistence use areas. Prior to constructing a road, permittees shall gather input from communities regarding the number and location of pullouts and associated access ramps. – Permittees shall construct a subsistence pullout and boat ramp at all crossings of heavily used subsistence rivers, as determined in consultation with the community. – Permittees must allow subsistence use of permanent gravel roads and appropriate ice roads, consistent with safe operations, and shall provide communities and the BLM with concise policies regarding the use of all roads and hunting prohibitions, if any, along the roads and near facilities. Permittees shall ensure that any road use guidelines and updated road maps are disseminated throughout the communities, including making them available online and through social media. – Before ice road construction begins, permittees associated with ice road construction shall hold community meetings to describe the routes and relevant information on all ice roads that would be constructed.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from ordinary high-water of fish-bearing waterbodies.	Changes do not affect text as described.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.	Added text: – Aboveground pipelines shall have a nonreflective finish. – When laying out oil and gas developments, permittees shall orient infrastructure to minimize impeding caribou migration and to avoid corralling effects. – Before the construction of permanent facilities is authorized, the BLM will require a study of caribou movement for the impacted herd. The permittee may be required to conduct this study, or this requirement may be waived if an acceptable study specific to that herd has been completed within the last 10 years and is approved for use by the BLM.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.	Added text: Develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments (for alternatives B, C, D: based on LiDAR or other high-accuracy surface imaging).
BMP E-19	Provide information to be used in monitoring and assessing wildlife movements during and after construction.	A representation, in the form of ArcGIS-compatible shapefiles, of all new infrastructure construction, shall be provided to the Authorized Officer.	Changes do not affect text as described.
ROP E-23	Infrastructure siting near Teshekpuk Lake. Mitigate the impacts of permanent infrastructure on caribou movement near Teshekpuk Lake	No similar requirement.	Prior to the permitting of permanent infrastructure within the TCH Habitat Area (the 75% parturient calving kernel), a workshop shall be convened to identify the optimal placement of infrastructure to minimize impacts on caribou, birds, and other wildlife. (Applies to IAP Alternatives B, C, and D only.)
BMP F-1, ROPs F-2, F-3, and F-4	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Land user shall submit an aircraft use plan as part of an oil and gas development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including, but not limited to, the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area should be minimized from May 20 through August 20. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as aircraft approach, the aircraft is too close and must break away.	Text moved to ROPs F-2 through F-4: F-2: Aircraft Use Plan. Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. F-3: Minimum Flight Altitudes. Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the TCH Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude agl throughout NPR-A. F-4: Reduce Impacts of Air Traffic on Subsistence Resources. – Minimize helicopter flights during peak caribou hunting within 2 miles of important subsistence rivers. The current peak dates are July 15 through August 15, but these dates may be revised periodically in consultation with affected communities and the NSB. – Minimize aircraft use near known subsistence camps and cabins and during sensitive subsistence hunting periods (spring goose hunting, summer and fall caribou and moose hunting).

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.	Changes do not affect text as described. See ROP M-5 for additional requirements to reduce areas of bare soil.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP K-5[a]	(Teshekpuk Lake Caribou Habitat Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect relief, and migration.	Design, implement, and report a study of caribou movement. The study shall include a minimum of 4 years TCH movements. – Within the Teshekpuk Lake Caribou Habitat Area, the permittee shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. – Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement. – Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. – A number of ground and air traffic restrictions are specified, including, but not limited to, the following: – Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period. – Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter. The permittee shall submit with the development proposal an Aircraft Use Plan that considers these and other mitigation. The Aircraft Use Plan shall also include an Aircraft Monitoring Plan. – Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20.	Changed to Stipulation K-9. Text revised: – Federal mineral estate within 3 miles of Teshekpuk Lake, except for the southern shore, is open to leasing, subject to a no surface occupancy stipulation. Federal mineral estate within 1 mile of the southern shore of Teshekpuk Lake is open to leasing, subject to a no surface occupancy stipulation. – Before authorization of construction of permanent facilities, the BLM will require submittal of information on caribou movement for the TCH. – The information shall include multiple years of seasonal distribution and movement of the TCH. The information must include some recent data and must be sufficient to capture a realistic picture of trends in distribution and movements. –Within the TCH Habitat Area (the 75% parturient calving kernel), permittee shall orient linear corridors when laying out oil and gas field developments to address seasonal distribution and avoid corralling effects from loops of road and/or pipeline that connect facilities. –Off-pad activities shall be suspended within TCH Habitat Area (the 75% parturient calving kernel) from May 20 through June 20, unless approved by the BLM. –Within the TCH Habitat Area (the 75% parturient calving kernel), from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 miles of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, stockpiling equipment and materials, etc., to the extent practicable. The permittee shall submit with the development proposal a vehicle use plan (see ROP M-1) that considers these and any other mitigation. Traffic would be stopped: a) Temporarily to allow a crossing by 10 or more caribou. The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. b) By direction of BLM, traffic may be stopped through the TCH Habitat Area (the 75% parturient calving kernel) for a limited amount of time, and only if necessary to prevent displacement of calving caribou.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-6[a]	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat, minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites.	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). No leasing is allowed within 1 mile of the coast. The following requirements apply to authorized activities within 1 mile of the coast: – Permanent production well drill pads or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
BMP K-9[a]	(Teshekpuk Lake Caribou Movement Corridor) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River.	Within the caribou movement corridors, no permanent oil and gas facilities will be allowed, except for pipelines. Prior to the permitting of permanent oil and gas infrastructure, a workshop will be convened to identify the best corridor for pipeline construction to minimize impacts to wildlife and subsistence resources.	Changed to Stipulation K-10. Changes do not affect text as described.
BMP K-10[a]	(Southern Caribou Calving Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post-calving, and insect relief) in the area south/southeast of Teshekpuk Lake.	Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or other infrastructure associated with offshore oil and gas production, will be allowed.	Changed to Stipulation K-11. No similar requirement. See Stipulation K-9 and ROP E-23.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize vegetation damage ; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.
BMP M-1	Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.	Added text: Permittees will submit a vehicle use plan with their permit application, that will include: – Industry practices to minimize or mitigate delays to caribou movement, vehicle collisions, or displacement during calving, spring migration, fall migration, and post-insect aggregation movement. By direction of BLM, traffic may be stopped throughout a defined area for up to 4 weeks to prevent displacement of calving caribou (alternatives B, C, and D only). – Summary of all planned off-road travel, including the number of vehicles, type, and general routes. – Monitoring may be required as part of the vehicle use plan and could include collection of data on vehicle counts and vehicle interactions with wildlife. – Permittees shall provide an annual report to the BLM reporting roadkill of birds and mammals to help the BLM determine whether preventative measures on vehicle collisions are effective.
BMP M-2	Prevent the introduction, or spread, of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed-free prior to transporting them into the NPR-A. Monitor annually for invasive species and submit a plan detailing methods for cleaning, monitoring, and controlling weeds.	Changes do not affect text as described.

Source: BLM 2013a, 2020a

Note: agl (above ground level); BLM (Bureau of Land Management); BMP (best management practice); DEW (distant early warning); F (Fahrenheit); IAP (Integrated Activity Plan); LiDAR (Light Detection and Ranging); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy); TCH (Teshekpuk caribou herd); USGS (U.S. Geological Survey).

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect caribou would include those to LS E-2 and BMP E-7. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. Lastly, it may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7) due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site or at narrow land corridors between lakes where it is not possible to maintain 500 feet of separation between pipelines and roads without increasing potential impacts to waterbodies. Caribou may experience more delays or deflections while crossing roads and pipelines in these locations where the separation is less than 500 feet.

3.12.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects
CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.12.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation
The following additional suggested measures could reduce impacts to terrestrial wildlife:

1. BMP E-7 describes requirements related to caribou ramps over pipelines or buried pipelines. The Project could designate specific locations for these, such as northeast of the airstrip in Alternative B, or areas where caribou movements could be funneled and where roads and pipelines would be close together. The decision to add a crossing ramp over a buried pipeline should consider potential effects of reduced access to the pipeline for oil spill detection and response and thermokarst or changes in surface flow due to the resulting long, linear ditch that would fill with water.
2. Install game cameras to study the effectiveness of measures used to reduce vehicle traffic impacts, such as stopping traffic or caravanning.
3. Include the following in the vehicle use plan to minimize traffic impacts (plan is required as per ROP M-1):
   A. Require vehicles to stop traffic when 25 or more caribou appear to be approaching the road.
   B. Require vehicles to caravan or require periodic traffic closures when groups of caribou are near a road and the road has traffic rates of more than 15 vehicles per hour. Caravanning has limited ability to lower calving displacement (Lawhead, Prichard et al. 2004), but it may increase crossing success on roads with high traffic levels (more than 15 vehicles per hour) by providing periods without traffic to allow caribou to cross. It may be easier logistically to close the road for a specified number of hours a day (as determined by BLM) rather than caravanning. Spring, fall, and winter would likely be the periods of greatest concern for caribou crossing Project roads.
4. Restrict Q400 airtraffic between Alpine and Willow at certain times of year to reduce impacts to caribou.
5. Require the use of propylene glycol for deicing and for vehicle cooling systems, which is not toxic to wildlife.

3.12.2.2 Alternative A: No Action
Under the No Action Alternative, seasonal ice roads and pads could continue to be built in the analysis area. Effects from the existing development at the Alpine and GMT oil fields would continue, including air and road traffic.

3.12.2.3 Alternative B: Proponent's Project

3.12.2.3.1 Habitat Loss or Alteration
Project activities with the potential to cause habitat loss or alteration include the following:

- Fill for new gravel roads and pads
- Gravel spray and dust deposition from roads and pads
- Altered drainage patterns adjacent to gravel and ice infrastructure
- Delayed melt of snow in drifts, compressed snow, and ice from ice infrastructure
- Excavation for the gravel mine and CFWR, and mine rehabilitation

Alternative B would permanently remove 616.1 acres of terrestrial mammal habitat due to gravel fill and gravel mining. Tables E.12.5 and E.12.6 in Appendix E.12 summarize habitat loss or alteration by habitat type and alternative. The mine pit and the CFWR would permanently fill with water and be unsuitable for terrestrial mammals. Because the habitats lost are not unique and occur throughout the analysis area and the ACP, caribou would likely move to similar habitats nearby.

Vehicle use of gravel infrastructure would result in gravel spray and dust deposition, which would alter 3,401.3 acres of terrestrial mammal habitats within 328 feet (100 m) of gravel infrastructure (3,120.5 acres in high-use habitats). Dust can change plant community composition or structure and is discussed in detail in Section 3.9. These changes to habitat would vary by habitat type and topography and could degrade forage quality for caribou.

Gravel and ice infrastructure could also change drainage patterns and create impoundments that would alter habitats immediately adjacent to gravel infrastructure. Impoundments can be caused by physically blocking drainage and by early snowmelt due to dust deposition adjacent to gravel infrastructure. If impoundments lasted more than one season, they could cause thermokarst and permanently alter habitats adjacent to gravel infrastructure (impoundments are described in Section 3.8).

Compressed snow and ice from ice infrastructure and from snow removal on gravel roads would temporarily alter habitats by delaying snowmelt and damaging vegetation. These changes to habitat (discussed in detail in Section 3.9) would vary by habitat type and topography and could degrade forage quality for caribou.

3.12.2.3.2 Disturbance or Displacement

Project activities that could potentially disturb or displace terrestrial mammals include the following:

- Increased human activity and noise from construction, pile driving, mining, equipment use, flaring, and drill rigs as well as ground and air traffic that could cause avoidance.
- New linear infrastructure and visual disturbance, such as pipelines and roads, that could result in some delays or deflections of movement.
- Increased subsistence access due to Project roads and boat ramps.

Behavioral disturbance can cause immediate responses in caribou, including startle or flight responses (Murphy, Russell et al. 2000; Reimers and Colman 2009; Reimers, Loe et al. 2009). Behavioral disturbance may also result in displacement or long-term reduction of use in areas experiencing constant human activity or noise (Nellemann, Vistnes et al. 2003), especially for females during calving. The degree of behavioral disturbance of caribou can vary depending on season, life stage, mobility of calves, and effectiveness of mitigation (Cronin, Ballard et al. 1994; Murphy and Lawhead 2000). Because caribou have a very low energetic cost of locomotion (Fancy and White 1987), substantial impacts from energetic expenditure following disturbances is unlikely without a high level of exposure to infrastructure (Murphy, Russell et al. 2000).

As previously described (and cited above), the analysis area was selected because a decreased density of maternal caribou has been documented within a zone of localized displacement variously reported to range from 0.6 mile to 3.1 miles (1 to 5 km) of active roads and pads during calving and for 2 to 3 weeks immediately after calving. This body of research indicates a consistent displacement zone of 1.25 to 2.5 miles (2 to 4 km) wide; thus, the area within 2.5 miles (4 km) of new gravel infrastructure was used to calculate caribou displacement from the Project, although the presence of hunting on Project roads adds uncertainty in assessing how similar the effects would be in the analysis area (Paton, Ciuti et al. 2017; Plante, Dussault et al. 2018).

Human activity associated with Alternative B would disturb or displace caribou across 118,838.7 acres. The disturbance zone would be located in areas where the average caribou density during calving is in the low end of the range (~0.1 to 0.6 total caribou per km^2) from 2002 through 2019 based on aerial surveys (Figures 3.12.3, 3.12.4, and 3.12.6). The area within 2.5 miles of Alternative B contains between 0.30% and 1.64% of the seasonal range of the TCH (females only) based on **kernel distribution** (Figure 3.12.3; Table E.12.7 in Appendix E.12). Because caribou move frequently during a season, a much larger percentage of caribou could be within this buffer over the course of a season. Although displacement could occur (Cameron, Reed et al. 1992; Dau and Cameron 1986), complete avoidance of areas with human activity does not appear to occur (Johnson, Golden et al. 2019), and some maternal females are presumably less susceptible to human disturbance. The stimulus for this effect appears to be human activity rather than the presence of infrastructure alone; the effect even occurs along roads with relatively low levels of traffic at or below normal operational levels (Dau and Cameron 1986; Lawhead 1988; Lawhead, Prichard et al. 2004), but caribou exhibit less displacement from areas near infrastructure with no activity (Lawhead, Prichard et al. 2004). Thus, except perhaps for a small proportion of the most tolerant females, maternal caribou do not habituate to road traffic. Displacement would occur during and immediately after the calving season for about 3 weeks in every year throughout the life of the Project. The magnitude of the impact from this displacement would depend on the number of caribou displaced and the availability of alternate suitable habitat. Wilson, Prichard et al. (2012) found a limited availability of calving areas with similar characteristics. However, in recent years, moderately high levels of calving occurred to the west of Teshekpuk Lake, in areas predicted to have low or moderate probability of use (Prichard, Klimstra et al. 2019; Prichard, Lawhead et al. 2019; Figure 3.12.3).

During the mosquito and oestrid fly seasons (late June to mid-August), CAH caribou of all ages and both sexes regularly approach and cross pipeline or road corridors while moving to and from insect-relief habitat (Curatolo and Murphy 1986; Murphy and Curatolo 1987; Prichard, Lawhead et al. 2019). Crossing success at linear pipeline-road corridors is lowest when caribou groups attempt to cross pipelines near roads (within 300 feet) or where traffic rates exceed 15 vehicles per hour (Curatolo and Murphy 1986; Lawhead, Byrne et al. 1993; LGL

Alaska Research Associates Inc. 1994). Deflected movements and delays in crossing of up to several hours are more likely to occur under these circumstances (Johnson and Lawhead 1989; Lawhead, Byrne et al. 1993), although CAH caribou cross roads and pipelines frequently during midsummer; the severity of delays and deflections may be stronger in caribou with less previous exposure to infrastructure (Prichard, Lawhead et al. 2019; Smith, Byrne et al. 1994). Project roads would be 500 to 1,000 feet from pipelines whenever possible. During construction (winter and spring 2022 through 2029), traffic rates would range from 15.5 to 81.7 vehicles per hour (Table 3.12.2 and Tables D.4.9, D.4.10, D.5.6, and D.5.7 in Appendix D.1, *Alternatives Development*); thus, deflections and delays in movement could occur. From 2030 through 2050, traffic rates would be reduced (7.5 to 9.5 trips per hour), and caribou deflections would occur less frequently and be of lower intensity. Summer and fall traffic would be less than winter traffic throughout the life of the Project, ranging from 14.4 vehicles per hour during construction (2022 through 2029) to 3.7 vehicles per hour from 2030 through 2050. Project design also includes elevating pipelines to a minimum height of 7 feet at VSMs, 2 feet higher than has been demonstrated to be adequate to maintain crossing success for CAH caribou during the snow-free season (Lawhead, Parrett et al. 2006). Few TCH caribou would be in the Project area during the mosquito season, lowering the potential for adverse effects on movements during this period.

Caribou tend to follow linear infrastructure when structures are oriented roughly parallel to their main direction of movement (Murphy and Anderson 1993; Smith, Byrne et al. 1993). Large groups of TCH caribou could also move through the analysis area in response to weather conditions during the oestrid fly season. The Alternative B infield road could funnel caribou movement along the east side of the road and toward the airstrip and WPF during fall migration south and non-migratory movements during summer. Allowing road crossings west of the airstrip would be important during these periods.

Noise would be greatest during winter construction, especially near bridges with piles (where impact hammers would be used) and around the mine site, where blasting and gravel hauling would occur. Blasting, although of very short onset and duration, would produce the loudest sound levels of the Project. This human activity and noise would disturb and displace caribou from around the mine site during all periods of human activity. Caribou have been reported to avoid areas within 11 to 14 km of large open-pit diamond mines (Boulanger, Poole et al. 2012), but these mines are very large (9.7 and 29.9 km^2) and have extensive dust deposition extending kilometers from the mine site.

Ground and air (helicopters and fixed-wing aircraft) traffic noise would also disturb or displace caribou throughout the life of the Project. Effects of ground traffic (noise and human activity) along roads are described above. Ground traffic would be highest near the WOC, WPF, and airstrip. Air traffic noise would be greatest at airstrips and when animals are directly under low-flying aircraft. The magnitude of disturbance to caribou would likely be greatest during calving. Low-level aircraft traffic over calving grounds and early post-calving aggregations have been reported to reduce calf survival (Harrington and Veitch 1992), although these results were based on small sample sizes and may have been confounded by herd differences (Reimers and Colman 2009). Miller and Gunn (1979) found that 53.6% of caribou exhibited an extreme response to helicopters flying by at low levels (< 656 feet), but only 16.1% exhibited an extreme response at higher altitudes. A total of 28.6% of muskoxen exhibited extreme responses to helicopters, and the percentage declined for altitudes > 656 feet (Miller and Gunn 1979). The level of reaction increased with circling behavior, but the effect declined with repeated passes during a day. Valkenberg and Davis (1985) also found that habituation appears to lower the response of caribou to aircraft activity. Prolonged exposure to low-level aircraft could increase daily energy expenditure and potentially decrease individual fitness or reproductive capacity; however, caribou can become habituated to aircraft, and as a result, exert minimal additional energy in response to aircraft (Webster and Young 1997). The analysis area experiences existing daily air traffic to and from Nuiqsut, Alpine, and Kuparuk. Flights to or from the Project airstrip would originate from Alpine or Anchorage (Figure 3.6.1) and would not pass over the TLSA calving grounds or high-density post-calving areas. Air traffic would be limited to low- and no-density caribou calving areas (the Alternative B airstrip would be in a low-density calving area; Figure 3.12.6). Fixed-wing traffic rates would be highest during construction; throughout the Project, rates would be highest in winter and lowest in summer. During construction (2021 through 2030), there would be up to 12 fixed-wing trips per summer and up to 81 fixed-wing trips per winter to/from Alpine. To/from Willow, there would be up to 112 fixed-wing trips per summer, and up to 481 trips per winter (4 trips per day). Fixed-wing traffic would decrease from 2031 through 2050, when there would be 105.6 trips per summer and 176.9 trips per winter to/from Willow; there would be no traffic to/from Alpine during that time (Tables D.4.9, D.4.10, D.5.10, and D.5.12 in Appendix D.1). Helicopter traffic would occur to/from Alpine and Willow from 2021 through 2030 and only to/from Willow after that

(Tables D.4.14, D.5.15, and D.5.17 in Appendix D.1). All helicopter traffic would occur in spring and summer; summer would have the highest helicopter traffic rates. From 2021 through 2030, there would be up to 38 helicopter trips per summer to/from Alpine and 57 helicopter trips per summer to/from Willow. From 2031 through 2050, there would be 57 helicopter trips per summer to/from Willow.

Increased subsistence access due to Project roads and boat ramps could change caribou distribution and movements and exacerbate the response of caribou to roads and traffic. Caribou hunting from gravel roads could occur year-round in perpetuity. Skiff traffic and caribou hunting could displace or disturb caribou near the rivers on which the boat ramps would be located in summer and fall in perpetuity and may alter caribou distribution and movements. Caribou density in the boat ramp areas in summer is low (caribou are closer to Teshekpuk Lake or coastal insect-relief areas). Caribou use of the boat ramp areas increases during the late summer and fall migration. Although only a portion of the TCH range would be exposed to increased hunting, if more hunters are in the area, caribou could move farther away from Project infrastructure and may be less likely to habituate to roads and traffic (Paton, Ciuti et al. 2017; Plante, Dussault et al. 2018). The anticipated increased access and harvest is described in Section 3.16.

3.12.2.3.3 Injury or Mortality

Terrestrial mammals could be injured or killed due to collisions with vehicles or from increased subsistence access (and presumably harvest).

The addition of new roads and airstrips and the increased use of vehicles during construction and operation would increase the potential for vehicle strikes. Such accidents could occur during all Project phases but would be greatest during mid- to late summer (July through August), when large numbers of insect-harassed caribou are present; some are attracted to Project infrastructure while seeking oestrid fly relief. At such times, caribou often are less cautious around vehicles. The risk of vehicle strikes would be greatest during the construction and drilling phases, when traffic rates would be highest. Scheduling the heaviest construction-related traffic during winter, employing environmental and safety training, and mandating that all drivers yield the right-of-way to wildlife would help reduce the potential for vehicle strikes. Injury of caribou from collisions would be unlikely to cause population-level effects.

Dust along roads could cause early snowmelt and early green-up on tundra adjacent to gravel infrastructure (Walker and Everett 1987); although this could provide early foraging opportunities, it could also increase the potential for vehicle strikes of caribou that feed in the dust shadow of gravel roads in spring.

Collision rates for terrestrial mammals in the Alpine and GMT developments from 2015 to June 2019 ranged from one to five collisions per year. Collisions were mostly with foxes and one wolverine; no collisions with caribou were reported.

Increased subsistence access and, presumably, harvest due to Project roads and boat ramps could increase mortality of caribou in the analysis area, although some of this harvest may be offset by a decline in harvest in other areas. Although it is unknown how many hunters would use Project roads, just over half of **households** (54%) in Nuiqsut reported using roads in the GMT and Alpine area to hunt caribou in 2018 (as detailed in Section 3.16.2.3.3, *Harvester Access*).

3.12.2.3.4 Attraction to Human Activities and Facilities

During the mosquito season, large groups of caribou may be deflected or delayed when traffic rates are high (i.e., more than 15 vehicles per hour) (Lawhead, Byrne et al. 1993; Lawhead and Flint 1993). However, during oestrid fly harassment, caribou may be attracted to gravel infrastructure (where vegetation and thus insects are fewer) as fly-relief habitat (Curatolo and Murphy 1986; Johnson and Lawhead 1989; Lawhead, Byrne et al. 1993; Noel, Pollard et al. 1998; Prichard, Lawhead et al. 2019). At such times, groups of caribou would likely seek relief (and/or travel) in the elevated Project gravel roads and pads and shaded or sheltered areas (including elevated pipelines, VSMs, buildings, etc.). During these times, groups numbering in the hundreds or even thousands may move onto Project gravel roads and pads until oestrid fly harassment subsides. While caribou would experience relief from fly harassment, there would also be increased risk of vehicle strikes on roads. Alternative B would have 37.4 miles of gravel roads and pads and 94.4 miles of new pipeline racks (on new VSMs) that may be used by caribou for insect relief.

Table 3.12.2. Effects to Caribou from Action Alternatives

Project Component	Effect to Caribou	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Gravel fill, excavation at mine site and constructed freshwater reservoir	Habitat loss[a] Habitat alteration from dust shadow, gravel spray, thermokarsting, impoundments Disturbance or displacement from noise and human activity	616.1 acres lost 3,401.3 acres of dust shadow Excavation: 62 dBA at 1,000 feet Mining: 90 dBA at 1,000 feet	668.5 acres lost 3,397.7 acres of dust shadow Excavation: 62 dBA at 1,000 feet Mining: 90 dBA at 1,000 feet	603.9 acres lost 2,620.5 acres of dust shadow Excavation: 62 dBA at 1,000 feet Mining: 90 dBA at 1,000 feet
Pile installation	Disturbance or displacement from noise (winter only)	52 pipe piles 84 dBA at 1,000 feet from the source	36 pipe piles 84 dBA at 1,000 feet from the source	36 pipe piles 84 dBA at 1,000 feet from the source
Freshwater ice infrastructure	Habitat alteration from vegetation compaction	495.2 miles of onshore ice road 4,557.3 acres of onshore ice roads and ice pads	650.1 miles of onshore ice road 5,608.0 acres of onshore ice roads and ice pads	962.4 miles of onshore ice road 7,164.8 acres of onshore ice roads and pads
Pipelines and gravel roads	Displacement from active linear infrastructure, especially during calving; some delays or deflections of movements Attraction to facilities during periods of oestrid fly harassment	94.4 miles of pipeline rack on new VSMs 37.0 miles of gravel road	95.4 miles of pipeline rack on new VSMs 35.3 miles of gravel road	95.0 miles of pipeline rack on new VSMs 27.1 miles of gravel road
Ground traffic[b]	Disturbance or displacement from noise and human activity Injury or mortality from collisions with vehicles	3,188,910 total trips 2022 through 2029: 15.5 to 81.7 vehicles per hour winter and spring; 14.4 vehicles per hour summer and fall 2030 through 2050: 7.5 to 9.5 vehicles per hour winter and spring; 3.7 vehicles per hour summer	4,212,510 total trips 2021 through 2029: 7.6 to 107.2 vehicles per hour winter and spring; 0 to 16 vehicles per hour summer and fall 2030 through 2050: 14.3 vehicles per hour winter; 5.7 vehicles per hour summer	4,376,890 total trips 2020 through 2030: 8.4 to 72.5 vehicles per hour winter and spring; 0 to 12.6 vehicles per hour summer and fall 2031 through 2050: 15.9 vehicles per hour winter; 5.8 vehicles per hour summer

Project Component	Effect to Caribou	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Air traffic[b]	Disturbance or displacement from noise and human activity	12,101 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source Per summer 2021 through 2030: 0 to 12 to/from Alpine; 0 to 112 to/from Willow Per summer 2031 through 2050: 105.6 to/from Willow Per winter 2021 through 2030: 0 to 81 to/from Alpine; 0 to 481 to/from Willow Per winter 2031 through 2050: 176.9 to/from Willow 2,421 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source Per summer 2020 through 2021: 25 to 38 to/from Alpine; 2022 through 2030: 25 to 57 to/from Willow; 2031 through 2050: 57 per summer to/from Willow 0 helicopter trips in winter	19,574 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source Per summer 2021 through 2030: 0 to 12 to/from Alpine; 0 to 319 to/from Willow[c] Per summer 2031 through 2050: 137.7 to/from Willow[c] Per winter 2021 through 2030: 0 to 81 to/from Alpine; 0 to 1,509 to/from Willow[c] Per winter 2031 through 2050: 230.7 to/from Willow[c] 2,910 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source Per summer 2020 through 2021: 25 to 38 to/from Alpine; 2022 through 2030: 57 to 104 to/from Willow[c]; 2031 through 2050: 59 per summer to/from Willow[c] 0 helicopter trips in winter	19,038 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source Per summer 2021 through 2030: 0 to 20 to/from Alpine; 0 to 121 to/from Willow Per summer 2031 through 2051: 121.3 to/from Willow Per winter 2021 through 2030: 0 to 196 to/from Alpine; 0 to 665 to/from Willow Per winter 2031 through 2050: 51.4 to/from Alpine; 218.1 to/from Willow 2,503 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source Per summer 2020 through 2021: 25 to 38 to/from Alpine; 2022 through 2030: 25 to 50 to/from Willow; 2031 through 2051: 50 per summer to/from Willow 0 helicopter trips in winter
All	Total behavioral disturbance area[d] Disturbance or displacement: closest proximity of summer construction	118,838.7 acres 0.9 mile to high-density caribou calving 3.8 miles to high-density caribou post-calving 6.6 miles to high-density caribou mosquito relief 0 miles to high-density caribou oestrid fly relief	122,410.9 acres 0.9 mile to high-density caribou calving 3.8 miles to high-density caribou post-calving 6.6 miles to high-density caribou mosquito relief 0 miles to high-density caribou oestrid fly relief	105,086.0 acres 0.9 mile to high-density caribou calving 3.8 miles to high-density caribou post-calving 6.6 miles to high-density caribou mosquito relief 0 miles to high-density caribou oestrid fly relief

Note: dBA (A-weighted decibels); VSMs (vertical support members). All sound levels are detailed in Section 3.6, *Noise*, or in Appendix E.13, *Marine Mammals Technical Appendix*. Summer is defined as June through September, winter as December through March, and spring as April and May. Total acres of terrestrial mammal habitat loss may differ from total gravel footprint because not all areas that would be filled are used by terrestrial wildlife.
[a] Gravel roads and pads or areas under pipeline infrastructure would also be used by caribou during insect relief.
[b] Traffic is detailed in Tables D.4.8, D.4.16, D.4.24, D.5.5, D.5.6, D.5.10, and D.5.15 in Appendix D.1, *Alternatives Development*.
[c] Air traffic to/from Willow includes traffic at both the North and South airstrips.
[d] Area within 2.5 miles of new gravel infrastructure.

3.12.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences (Table 3.12.2). Alternative C would locate the WPF, WOC, and South Airstrip farther east to an area with lower densities of caribou. Because fewer caribou use this area, disturbance and displacement due to noise and human activity from these facilities would affect fewer caribou. The alternative would decrease the potential for deflection of migrating caribou, especially near Lake M0015, because it would remove the perpendicular intersection of access and infield roads, which could be a pinch point for caribou movement. The elimination of the section of road near Judy (Iqalliqpik) Creek would make east-west movements of caribou easier when ice roads are not in use.

Because Alternative C would also move the southern airstrip to the east, caribou would be less likely to be funneled into the area by the infield road. The area within 2.5 miles of Alternative C contains between 0.31% and 1.70% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.7

in Appendix E.12), which is a similar proportion of the herd as Alternative B. A much larger proportion of caribou will move through the area at some point.

Alternative C would also remove 52.4 more acres of habitat due to gravel fill and gravel mining and alter 3.6 fewer acres of habitat due to the dust shadow. (Although more acres of fill would occur under Alternative C, there would be fewer acres of dust shadow because dust would disperse over some areas that are not used by terrestrial mammals; see Tables E.12.5 and E.12.6 in Appendix E.12 for details on habitat loss and alteration by habitat type.) Alternative C would have 1,032,600 (or 32%) more ground traffic trips than Alternative B (i.e., more disturbance and potential vehicle strikes) over the life of the Project. It would also have the highest rate of ground traffic (up to 107.2 vehicles per hour) during winter construction, primarily due to the annual ice road that would be required between the South WOC and BT1, and to accommodate for the construction of two WOCs (North and South) and associated infrastructure. Less hunting on the northern infield road could increase the probability of caribou using areas near infrastructure during some seasons, but this effect would be partially counteracted by higher rates of ground traffic.

Alternative C would also have an additional airstrip and personnel camp that would result in 62% more fixed-wing air traffic and 20% more helicopter traffic and more hazing of wildlife at the airstrips, especially in summer, which would disturb or displace caribou over an additional area. Traffic rates are summarized in Table 3.12.2 and detailed in Tables D.5.9, D.5.10, and D.5.12 in Appendix D.1. There would be 3,572.2 additional acres of disturbance under Alternative C. Because the North Airstrip in Alternative C would be located closer to the high-density calving areas for the TCH, aircraft traffic is likely to disturb more caribou during the calving season. During takeoff and landing, air traffic (which could include large aircraft [e.g., Q400, DC-6, C-130]) at the northern airstrip would be perpendicular to the northern infield road, which would likely disturb or displace caribou beyond the 2.5-mile area of displacement from roads and pads. Because the northern infield road would be disconnected from the access road, use of the northern infield road by subsistence hunters would be unlikely in summer. Thus, that area would experience a lesser degree of hunting pressure, which would likely lower the degree of disturbance and displacement of caribou and may result in a higher level of tolerance to the road. However, if caribou are hunted along a nearby road, they may associate all roads with hunting, and this effect would be diluted. Caribou harvest may decline if hunting is allowed on fewer road miles, although some additional harvest may occur elsewhere. Winter ice road access to the northern infield road for subsistence hunting would still occur.

There would also be an annual ice road (3.6 miles) required for the life of the Project, which could have longer lasting effects on disturbance and displacement of caribou in winter.

Alternative C would have 1 more mile of new pipeline racks (on new VSMs) that may be used by caribou for oestrid fly relief.

Because only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed under Alternative C (there would be no gravel road access to the other rivers), subsistence use (and disturbance and hunting of caribou) could be concentrated on that river and thus effects could be slightly higher there.

3.12.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those described under Alternative B, with the following exceptions (Table 3.12.2). Alternative D would have a decreased potential for deflection of migrating caribou, especially near the WPF, since it would remove the perpendicular intersection of access and infield roads. Caribou moving south along the east side of the infield roads during southerly movements in fall would not have to cross a road, which would lower the probability of delays or deflections. The area within 2.5 miles of Alternative D contains between 0.29% and 1.47% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.7 in Appendix E.12), which is a similar proportion of the herd as Alternative B. A much larger proportion of caribou will move through the area at some point.

Alternative D would have 12.2 fewer acres of habitat removed from gravel fill and 780.8 fewer acres of habitat altered by the dust shadow (summarized in Table 3.12.2 and detailed in Tables E.12.5 through E.12.8 in Appendix E.12 by habitat type). Alternative D would have 10.3 fewer miles of gravel roads and thus have 13,752.7 fewer acres of disturbance (acres calculated by gravel road disturbance), but there would be more ground traffic over the life of the Project, in part because there would be 1 more year of construction than Alternative B. Ground traffic rates are detailed in Tables D.5.5, D.5.6, and D.5.7 in Appendix D.1. Alternative D would have the most ground traffic of any action alternative (37% more than Alternative B). Alternative D would also have the highest rate of ground traffic during operations: up to 15.9 vehicles per hour in winter for 20 years, which could make it more difficult for caribou to cross the road. Operations ground traffic for other action alternatives would be below 15 vehicles per hour. Therefore, there would be more disturbance of caribou and potential vehicle strikes over the life of the Project. There would be 57% more fixed-wing air traffic and 3% more helicopter traffic, especially in winter (Tables D.5.9, D.5.10, D.5.12, D.5.14, D.5.15, and D. 5. 17 in Appendix D.1), which would disturb or displace caribou over an additional area. Because the infield road would be disconnected from the access road, use of the infield road in summer and fall by subsistence hunters would be unlikely, although some hunting may occur during winter, when the ice road is in place, and that area may experience a lesser degree of hunting pressure, which would influence caribou distribution and use of areas near roads, as described under Alternative C.

There would also be two additional seasons of ice roads during construction and an annual ice road (12.5 miles) required for the life of the Project, which could have long-lasting effects on the disturbance and displacement of caribou in winter.

Alternative D would have 0.6 fewer miles of new pipeline racks (on new VSMs) that may be used by caribou for insect relief.

Because only the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp would be constructed under Alternative D (there would be no gravel road access to the other rivers), subsistence use (and disturbance and hunting of caribou) could be concentrated on that river and thus effects could be slightly higher there.

3.12.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

3.12.2.6.1 Habitat Loss or Alteration

There would be a total of 210.7 acres of onshore ice infrastructure for Option 1 that would compress vegetation and impact forage for caribou, as described in Section 3.12.2.3.1, *Habitat Loss or Alteration*.

3.12.2.6.2 Disturbance or Displacement

Similar types of disturbance or displacement of caribou, as described in Alternative B (Section 3.12.2.3.2, *Disturbance or Displacement*), would also occur from the MTI due to increased human activity and noise from construction, pile driving, mining, equipment use, and ground and air traffic that could cause avoidance. The magnitude of effects would be less than the action alternatives because the island would be 1.9 miles offshore and caribou do not use offshore habitat (the sea ice road to the MTI would be 2.4 miles). It is possible that individual caribou along the coastline may be disturbed by construction offshore in winter or summer; use of the area by the TCH occurs throughout the year but is highest during mid- to late summer (Figures 3.12.3 and 3.12.6). There would be a multi-season ice pad at Atigaru Point for the storage of equipment, but no ground or air traffic to it during summer (though air traffic would occur to the MTI as described below). Construction activity at the MTI could occur from July 7 through September 30 (although the most activity and loudest noise would occur in winter). The area within 2.5 miles of the MTI contains up to 0.01% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.7 in Appendix E.12). A much larger proportion of caribou will move through the area at some point.

There would be a total of 103.6 miles of onshore ice road (approximately 72% would be within the boundary of the TLSA). This would disturb caribou (effects of ice roads are described under Alternative B). However, disturbance would occur in winter, when displacement is unlikely to be as strong as during the calving season. TCH animals have already been exposed to winter ice roads in this area and may have habituated to some degree. Due to the high volume of traffic expected on the ice roads during 2025 and 2027, TCH caribou may avoid the area and have low crossing success during those winters and springs. Some caribou may cross roads during periodic declines in traffic or when vehicles stop to allow crossings. The resulting decline in available and accessible habitat could potentially result in energetic impacts for some caribou, however the TCH winter range covers a large area, with a substantial portion of the herd wintering in the Brooks Range in most years (Figure 3.12.4), therefore alternative wintering areas are likely to be available. There would also be 25 flights to Alpine, 205 to Willow, and 96 to Atigaru Point (during construction or decommissioning of the MTI and to support module mobilization. Ground and air traffic rates are summarized in Table 3.12.3 and detailed in Tables D.5.5, D.5.8, D.5.9, D.5.11, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1.

3.12.2.6.3 Injury or Mortality

Option 1 would have the potential to injure or kill caribou due to collisions with vehicles or from increased subsistence access (and presumably harvest), as described in Section 3.12.2.3.3, *Injury or Mortality*.

3.12.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

Similar types of effects to caribou as described for Option 1 would occur for Option 2. However, there are stark contrasts in the magnitude and intensity of the effects between the two options.

The location of Point Lonely is closer to Teshekpuk Lake and nearly double the distance to the Willow area. The Teshekpuk Lake area is critical to caribou calving, post-calving, mosquito-relief, and oestrid fly–relief uses. Point Lonely is 0.9 miles from the high-density area for post-calving use and in the high-density area for mosquito- and oestrid fly–relief use (Figures 3.12.3 and 3.12.6). (Point Lonely has low caribou density during calving and winter.)

Point Lonely is an area of high use by caribou for insect relief (end of June to beginning of August). Project activities in summer could occur from July 7 through September 30 and could disturb caribou during this period. The area within 2.5 miles of the Point Lonely MTI (and the existing gravel infrastructure that would be used during construction) contains between < 0.01% and 0.75% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.7 in Appendix E.12). A much larger proportion of caribou will move through the area at some point.

The MTI for Option 2 would also be 0.6 mile from shore, whereas the MTI for Option 1 would be 1.9 miles from shore, so any activity at the Option 2 MTI could disturb more caribou, especially in July.

Due to the Project's distance from the Willow area, it would have double the ice road miles compared to Option 1, with the impacts described above. There would be a total of 223.4 miles of onshore ice road (approximately 89% would be within the boundary of the TLSA). This would result in additional impacts on forage (vegetation damage) and a larger area of caribou disturbance. Some summer activity and helicopter traffic to pick up debris along the ice road route could disturb caribou. The potential disturbance would be greatest in the narrow corridor east of Teshekpuk Lake, although this could be mitigated by conducting the activity outside of the mosquito season.

Disturbance would occur in winter, when displacement is unlikely to be as strong as during the calving season. Option 2 would have 39% more total ground traffic trips than Option 1, with up to 101.4 more vehicles per hour (Table 3.12.3); this level of traffic may make it difficult for caribou to cross the ice road during periods of peak traffic levels. This could limit the available winter habitat for some caribou.

Option 2 would also use existing gravel infrastructure onshore at Point Lonely during construction. Onshore summer activities would include creation of a personnel camp on existing gravel pads, air traffic, onshore beach landings of crew boats to and from the MTI, and equipment use on the airstrip and pads (to distribute additional gravel that would have been transported to the pads in the winter). There would be a total of 96 flights to the Point Lonely airstrip; 36 of these would occur in the summer (Table D.4.42 in Appendix D.1), which would equal 1 to 2 flights per week over 6 to 12 weeks during three summer construction seasons (2023, 2024, and 2026). Option 2 would have the same number of fixed-wing flights as Option 1. Traffic rates are summarized in Table 3.12.3 and detailed in Tables D.5.5, D.5.8, D.5.9, D.5.11, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1. The air traffic for Option 2 would cause more disturbance of caribou than Option 1 due to the location and timing of the traffic.

For these reasons (location in insect-relief habitat, closeness to shore, and human activity and air traffic onshore), Option 2 would result in more disturbance and displacement of caribou than Option 1.

3.12.2.8 Module Delivery Option 3: Colville River Crossing

Similar types effects to caribou as described for Option 1 would occur for Option 3. However, because most of the activity would occur within the range of the CAH and near areas of current development and activity, there are stark contrasts in the magnitude and intensity of the effects between the two options. In addition, Option 3 would be entirely outside of the TLSA.

Option 3 would have 5.0 acres of gravel fill along existing gravel roads with existing dust shadows; the fill would extend the dust shadow incrementally in several locations for a total 25.2 acres of additional dust shadow. Effects of habitat alteration from dust and gravel spray are described in Section 3.12.2.3.1. Habitat alteration could also occur from the 666.6 acres of ice infrastructure (Table 3.12.3) that would compress vegetation. The vegetation impacts of ice roads would result in a decrease in habitat quality for a small area of the summer range of the CAH. Effects of ice infrastructure habitat alteration on caribou is described in Section 3.12.2.3.1.

Vehicle traffic can disturb or displace caribou, as described for Alternative B in Section 3.12.2.3.2. Option 3 would have 80.2 miles of ice road. Option 3 would produce ground traffic year-round over 5 years of construction; traffic rates are summarized in Table 3.12.3 and detailed in Tables D.5.5, D.5.8, D.5.9, D.5.11, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1. Summer traffic would occur for 3 years and produce less than 1 vehicle per hour. Winter traffic would occur for 2 years (2025 and 2027) and produce up to 68.4 vehicles per hour; the potential impacts to caribou from this high volume of traffic are described under Option 1 (Section 3.12.2.6.2, *Disturbance or Displacement*). Air traffic would also occur in 2025 and 2027 to/from Alpine and Kuparuk, although there would be 78% less fixed-wing traffic and 96% less helicopter traffic than Option 1. Additional ground traffic on existing roads in summer could potentially result in additional delays or deflections of CAH caribou movements, primarily during midsummer. Roads with traffic levels above 15 vehicles per hour have been reported to have lower caribou crossing success (Murphy and Curatolo 1987), but a portion of the CAH moves through the Kuparuk oil field repeatedly during summer (Prichard, Lawhead et al. 2019) and can select crossing areas with lower traffic or periods when vehicles stop to allow caribou crossings. Additional traffic could also result in additional vehicle-wildlife collisions, although this is expected to be rare. CAH caribou have been reported to use the area within 1 km of roads at a lower density during the mosquito season (Johnson, Golden et al. 2019), but they also cross roads frequently during that season (Prichard, Lawhead et al. 2019).

Construction for the onshore components of Option 3 would result in human activity, machinery, traffic, and noise in both summer and winter that could disturb or displace caribou near the construction areas, as described in Section 3.12.2.3.2. Because few CAH caribou are present during winter, ice road construction and the associated personnel camp would have minimal impacts on that herd but could affect TCH caribou. Summer activities onshore for Option 3 would include curve widening activity along the existing Kuparuk road network (Appendix D.1, Figure D.4.19. Option 3 Curve Widening), modifying an existing pad where the sealift modules would be staged, and moving sealift modules to the existing staging pad. Because these activities would occur on or near existing roads and pads in an area that is already industrial, there would be minimal disturbance to CAH caribou. Summer construction would not affect TCH caribou because they are farther west near Teshekpuk Lake in summer (i.e., not present in the Oliktok Point or Kuparuk area).

Because of the location of the activity, the lowered level of activity and the shorter ice road length, Option 3 is expected to result in less displacement and disturbance than Option 1. Much of the activity associated with Option 3 is located near current infrastructure and in the range of the CAH, a herd that is not generally present in the area during winter or in areas of lower density for the TCH, which will further decrease the impacts on caribou.

Table 3.12.3. Effects to Caribou from Module Delivery Options

Project Component	Effect to Caribou	Option 1: Atigaru Point MTI	Option 2: Point Lonely MTI	Option3: Colville River Crossing
Gravel fill onshore	Habitat loss[a] Habitat alteration from expanded dust shadow on existing road	None	None	5.0 acres lost 25.2 acres of dust shadow beyond existing dust shadow
Pile installation	Disturbance or displacement from noise (winter only, offshore noise could be heard onshore)	9 pipe piles 200 feet of sheet piles (685 sheet piles) 84 dBA at 1,000 feet from the source	Same as Option 1	None
Freshwater ice infrastructure	Habitat alteration from vegetation disturbance	103.6 miles of onshore ice road (~73% in the TLSA) 859.6 acres of onshore ice roads and ice pads	223.4 miles of onshore ice road (~89% in the TLSA) 1,756.1 acres of onshore ice roads and ice pads	80.2 miles of onshore ice road (~0% in the TLSA) 666.6 acres of onshore ice roads and pads

Project Component	Effect to Caribou	Option 1: Atigaru Point MTI	Option 2: Point Lonely MTI	Option3: Colville River Crossing
Ground traffic[b]	Disturbance or displacement from noise and human activity Injury or mortality from collisions with vehicles	2,306,110 total trips (2022 through 2027) 0 trips per summer 10,920 to 811,965 trips per winter or spring, up to 279.6 vehicles per hour	3,196,450 total trips (2022 through 2027) 0 trips per summer 10,920 to 1,106,805 trips per winter or spring, up to 381.1 vehicles per hour	535,160 total trips (2023 through 2027) 0 to 4,590 trips per summer (up to 1.6 vehicles per hour, 2023 through 2026) 198,736 trips per winter or spring (up to 68.4 vehicles per hour, 2025 and 2027)
Air traffic[b]	Disturbance or displacement from noise and human activity	326 total fixed-wing trips (2022 through 2027) Per summer: 0 to/from Alpine; 16 to/from Willow (2024); 12 to/from Atigaru Point (2023, 2024, and 2026) Per winter and spring: 10 to 15 to/from Alpine (2022); 3 to 37 to/from Willow; 5 to 18 to/from Atigaru Point (2023, 2025, and 2027) 450 total helicopter trips (2022 through 2027) Per summer: 15 to/from Alpine (2022); 16 to 90 to/from Willow (2023, 2024, and 2026) Per winter and spring: 0 to/from Alpine; 10 to 50 to/from Willow	326 total fixed-wing trips (2023 through 2027) Per summer: 0 to/from Alpine; 16 to/from Willow (2024); 12 to/from Point Lonely (2023, 2024, and 2026) Per winter and spring: 10 to 15 to/from Alpine (2022); 3 to 37 to/from Willow; 13 to 18 to/from Point Lonely (2023, 2025, and 2026) 450 total helicopter trips (2022 through 2027) Per summer: 15 to/from Alpine (2022); 16 to 90 to/from Willow (2023, 2024, and 2026) Per winter and spring: 0 to/from Alpine; 10 to 78 to/from Willow	70 total fixed-wing trips (2023 through 2027) Per summer: 0 to 6 to/from Alpine and Kuparuk Per winter and spring: 5 to 9 to/from Alpine and Kuparuk (2025 and 2027) 16 total helicopter trips (2025 and 2027), 8 per summer to/from Alpine, 0 per winter
All	Total behavioral disturbance area[c] Disturbance or displacement: closest proximity of summer construction	NA NA[d] miles to high-density caribou calving 12.5 miles to high-density caribou post-calving 9.6 miles to high-density caribou mosquito relief 1.9[e] miles to high-density caribou oestrid fly relief	NA NA[d] miles to high-density caribou calving 0.9 miles to high-density caribou post-calving 0 mile to high-density caribou mosquito relief 0 miles to high-density caribou oestrid fly relief	22.6 acres 43.5 miles to high-density caribou calving 47.1 miles to high-density caribou post-calving 46.3 miles to high-density caribou mosquito relief 32.4 miles to high-density caribou oestrid fly relief

Note: ~ (approximately); dBA (A-weighted decibels); MTI (module transfer island); NA (not applicable); TLSA (Teshekpuk Lake Special Area). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*. Summer is defined as June through September, winter as December through March, and spring as April and May.

[a] Gravel or areas under pipeline infrastructure would also be used by caribou during insect relief periods.

[b] Traffic is detailed in Tables D.5.5, D.5.8, D.5.9, D.5.11, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1, *Alternatives Development*. Air traffic to Atigaru Point would be for surveillance and monitoring; flights would not land since there is no airstrip there.

[c] Area is within 2.5 miles of new onshore gravel infrastructure.

[d] Summer construction at either module transfer site would not occur during calving. Option 1 would also store materials at a multi-season ice pad at Atigaru Point in the summer (6.1 miles from the high-density caribou calving area), but no activity or traffic would occur on it during the summer.

[e] Option 1 MTI would be 1.9 miles to the shore at its closest point, however, the sea ice road to the MTI would be 2.4 miles.

3.12.2.9 Oil Spills and Accidental Releases

The EIS addresses effects from accidental spills. As described in Chapter 4.0 the likelihood of a large spill during any phase of the Project would be very low. A very small to small spill or leak would be probable over the life of the Project and would most likely occur on gravel infrastructure, where it would be easier to contain and remediate than a spill on undisturbed tundra. Since caribou may use gravel infrastructure during the insect season, effects from spills on gravel may still occur.

Spills that may originate along pipelines would be expected to be detected and responded to quickly, although they would potentially have a larger geographic extent than spills on pads. In the very unlikely event that a pipeline spill should occur at a river crossing during high water flow, the geographic extent of the accidental release could be larger. A spill could alter mammal habitat, and effects would vary depending on the location and size of the spill and the time of year. The spill itself and cleanup activities would disturb and displace mammals due to noise and human activity.

Spills of hydrocarbons and other fluids degrade terrestrial mammal habitats by physically covering vegetation, thawing permafrost, and exerting toxic effects on plants and animals. Exposure to and ingestion of contaminants (including minor incidents of fouling and oiling) in the North Slope oil fields have occasionally resulted in injury and mortality to small numbers of animals (Amstrup, Gardner et al. 1989).

Seawater spills on nonfrozen tundra would have effects on plants used by caribou for forage that could potentially last many years. Saltwater spills can be toxic to many plant species, long lasting, and can cause leaf deterioration and deleafing (Simmons 1983). Wetter sites recover more rapidly. Willow species and mountain avens have a lower tolerance for salt and are more affected, while grasses and sedges are less affected (Simmons 1983).

3.12.3 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with LSs, BMPs, and mitigation measures in place, some unavoidable impacts to caribou would occur, including direct loss of habitat and disturbance and displacement due to noise, human activity, infrastructure, or increased subsistence access. These impacts would be irretrievable throughout the life of the Project but would not be irreversible or affect the long-term sustainability of wildlife in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible. Habitat loss from the CFWR and mine site would be irreversible because the mine pit and the reservoir would fill with water and would permanently change the thermal regime of the underlying soils.

3.13 Marine Mammals

The analysis area for onshore activities for marine mammals is the area within 1 mile of onshore construction and operation activities and for offshore activities it is the area within 1.5 miles of construction, screeding, and the estimated vessel route during construction (Figure 3.13.1). This area represents the maximum distance that underwater or airborne noise or vibration could affect marine mammals and their habitats (based on the USFWS polar bear den disturbance zone). Because the distance from which polar bears may be attracted to facilities (food, waste, etc.) is unknown, it is not used to define the analysis area or quantify potential effects.

The temporal scale for construction impacts is the duration of construction because most construction impacts are related to noise and human activity. The temporal scale for operational impacts is the life of the Project or until reclamation is complete. Reclamation of onshore areas can take many years, depending on tundra damage. If reclamation of onshore gravel fill did not occur, impacts from that fill would be permanent. Marine substrates that would be screeded would return to pre-screeding condition in approximately one season. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in Section 3.8.2.6).

3.13.1 Affected Environment

The analysis area west of the Colville River includes existing oil and gas infrastructure (gravel and ice roads, processing facilities, etc.) as part of the Alpine and GMT oil fields and associated daily aircraft traffic. The area east of the Colville River to Kuparuk contains the Kuparuk oil field as well as the Nuna and Oooguruk developments. Kuparuk has extensive existing infrastructure (e.g., gravel and ice roads, pipelines, processing facilities). The area has existing mine sites, airstrips, reservoirs, a dock (Oliktok Dock), and a seawater treatment facility. The Kuparuk oil field experiences more ground and air traffic than the developments west of the Colville River; ground traffic also travels at higher speeds.

Existing marine infrastructure in the analysis area occurs at Oliktok Point, where there is a commercial sheet-pile dock, shoreline armoring, and a saltwater treatment plant. In addition, Oooguruk Island, a 6-acre constructed gravel island with a pipeline to shore, is located near the mouth of the Colville River. Water quality of the marine environment is detailed in Section 3.8.1.1.4, *Marine Waters*. Screeding occurs with seasonal regularity at Oliktok Dock prior to barge arrival. There is limited marine infrastructure between this area and the southern end of the barge transit route near Dutch Harbor.

Existing marine vessel traffic occurs throughout the Bering Sea and less frequently in the Beaufort Sea. The main port in the action area is Dutch Harbor in the Bering Sea, which has supported moderate year-round vessel traffic since the late 1970s and is the current operations center for the Bering Sea and Aleutian Islands commercial fishing industry (USACE 2019). Most vessel traffic transits northwest from Dutch Harbor toward Russia and

Asia. The number of vessels traveling through the Bering Strait to or from Dutch Harbor comprises approximately 10% of that transiting west (Nuka Research and Planning Group 2016). An average of 393 annual transits occurred in the Bering Strait between 2006 and 2015 (Nuka Research and Planning Group 2016), although vessel traffic has more than doubled since 2008, and more recent years (2015 and 2016) have seen approximately 458 to 470 vessel transits per year (Audubon Alaska 2017). Transits are predicted to grow to 2,000 by 2025 under moderate growth scenarios (International Council on Clean Transportation 2015). Not all traffic transiting the Bering Strait continues to the Beaufort Sea. The areas of the Beaufort with the most vessel use appear to be near Utqiaġvik, Oliktok Point, and Deadhorse (Audubon Alaska 2017).

The ambient airborne acoustic environment of the onshore analysis area is described in Section 3.6, *Noise*. Ambient underwater sound levels in the Beaufort Sea range from 77 to 135 dB re 1 µPa (Greene Jr., Blackwell et al. 2008; LGL Alaska Research Associates Inc., Greenridge Sciences et al. 2013), with average ambient conditions approximately 120 dB re 1 µPa. The Beaufort Sea has a narrow continental shelf that drops off to the north into the Beaufort Sea Plateau, a deep basin with depths of 6,500 to 10,000 feet, allowing for long-range propagation of high-amplitude, low-frequency sounds. Oliktok Point is located in the shallow waters of Harrison Bay. Generally, underwater sound levels in shallow waters increase with increasing wind speed (Wenz 1962). More details on the underwater acoustic environment are in Appendix E.13.

Climate change is occurring in the ACP, as described in Section 3.2, *Climate and Climate Change*. Loss of sea ice is one of the most pronounced changes for marine mammals and is currently occurring at rates higher than predicted; it is projected to continue, possibly resulting in loss of summer sea ice by midcentury (Chapin, Trainor et al. 2014). Arctic sea ice is changing in geographic extent, geographic coverage, thickness, age, and timing of melt. Analyses of long-term data sets show substantial decreases in both extent and thickness of sea ice cover during the past 30 years (Post, Bhatt et al. 2013; Wendler, Moore et al. 2014). The increased frequency with which female polar bears in the Southern Beaufort Sea stock (described below) now den on land rather than on pack ice has been attributed to reductions in stable old ice, increases in unconsolidated ice, and lengthening melt season (Fischbach, Amstrup et al. 2007).

Table 3.13.1 provides a list of species that may be present in or near the analysis area, including species currently listed as threatened or endangered under the ESA or protected by the Marine Mammal Protection Act (MMPA). Because some species may be encountered only along the barge transit route from Dutch Harbor (Figure 3.13.2), Table 3.13.1 notes in which part of the analysis area the species occur and what aspects of the Project may affect them.

Because the majority of the impacts to marine mammals would occur from marine or onshore construction or operations, the EIS is focused on species that would be affected by those actions (polar bears and seals). Other species that would only be affected by the barge transit route are described and analyzed in Appendix E.13. Vessel traffic along the barge transit route would have limited effects on marine mammals and occur for a limited duration (3 months during the summer for 4 years).

3.13.1.1 Species and Habitats Protected by the Endangered Species Act

Three species protected by the ESA in Table 3.13.1 may occur in the analysis area from Point Lonely to Oliktok Point. Other ESA species in Table 3.13.1 may occur along the barge transit route. Only polar bears have designated **critical habitat** in the onshore and marine construction analysis area (Figure 3.13.1). Steller sea lions, sea otters, and North Pacific right whales have critical habitat that may be near or intersect the barge transit route. More information about special status species is found in Appendix E.13.

BLM is undergoing ESA Section 7 consultation with USFWS and NMFS concurrent to the NEPA process for effects to ESA species and their critical habitat.

Table 3.13.1. Marine Mammals Known to Occur in the Analysis Area from Point Lonely to Oliktok Point

Marine Mammal Group	Common Name	Scientific Name	Status	Occurrence in Analysis Area	Part of Analysis to Which Species is Applicable
Baleen whales	Bowhead whale	*Balaena mysticetus*	ESA endangered	Chukchi and Beaufort seas	Barge transit route
Baleen whales	Blue whale	*Balaenoptera musculus*	ESA endangered	Gulf of Alaska, Bering Sea	Barge transit route
Baleen whales	Fin whale	*Balaenoptera physalus*	ESA endangered	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Baleen whales	Gray whale	*Eschrichtius robustus*	ESA endangered	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Baleen whales	Humpback whale	*Megaptera novaeangliae*	ESA endangered and threatened[a]	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Baleen whales	Minke whale	*Balaenoptera acutorostrata*	Protected	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Baleen whales	North Pacific right whale	*Eubalaena japonica*	ESA endangered, critical habitat designated	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Toothed whales	Baird's beaked whale	*Berardius bairdii*	Protected	Gulf of Alaska, Bering Sea	Barge transit route
Toothed whales	Beluga whale	*Delphinapterus leucas*	Protected	Chukchi and Beaufort seas	Barge transit route
Toothed whales	Cuvier's beaked whale	*Ziphius cavirostris*	Protected	Gulf of Alaska, Bering Sea	Barge transit route
Toothed whales	Dall's porpoise	*Phocoenoides dalli*	Protected	Gulf of Alaska, Bering Sea	Barge transit route
Toothed whales	Harbor porpoise	*Phocoena phocoena*	Protected	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Toothed whales	Killer whale	*Orcinus orca*	Protected	Gulf of Alaska, Bering and Chukchi seas	Barge transit route
Toothed whales	Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	Protected	Gulf of Alaska, Bering Sea	Barge transit route
Toothed whales	Sperm whale	*Physeter macrocephalus*	ESA endangered	Gulf of Alaska, Bering Sea	Barge transit route
Toothed whales	Stejneger's beaked whale	*Mesoplodon stejnegeri*	Protected	Gulf of Alaska, Bering Sea	Barge transit route
Pinnipeds	Bearded seal	*Erignathus barbatus*	ESA threatened	Chukchi and Beaufort seas, Oliktok Dock area, MTIs	Barge transit route, marine construction
Pinnipeds	Pacific walrus	*Odobenus rosmarus*	Protected	Bering and Chukchi seas	Barge transit route
Pinnipeds	Ribbon seal	*Histriophoca fasciata*	Protected	Chukchi and Beaufort seas	Barge transit route
Pinnipeds	Ringed seal	*Pusa hispida*	ESA threatened	Chukchi and Beaufort seas, Oliktok Dock area, MTIs, Colville River Delta	Barge transit route, marine construction, construction air traffic
Pinnipeds	Spotted seal	*Phoca largha pallas*	Protected	Bering, Chukchi, and Beaufort seas; Oliktok Dock area; MTIs; Colville River Delta	Barge transit route, marine construction, construction air traffic
Pinnipeds	Steller sea lion	*Eumetopias jubatus*	ESA endangered, critical habitat designated	Gulf of Alaska, Bering Sea	Barge transit route
Other	Northern sea otter	*Enhydra lutris kenyoni*	ESA threatened, critical habitat designated	Bering Sea near Dutch Harbor	Barge transit route
Other	Polar bear	*Ursus maritimus*	ESA threatened, critical habitat designated	Onshore; nearshore Chukchi and Beaufort seas	Barge transit route, marine construction, onshore construction

Note: ESA (Endangered Species Act), Protected (protected under the Marine Mammal Protection Act); MTI (module transfer island).
[a] Western North Pacific distinct population segment is endangered; Mexico distinct population segment is threatened.

3.13.1.1.1 Polar Bears
Polar bears in the onshore and marine construction analysis area are the Southern Beaufort Sea stock. Polar bears in the barge transit route are in both the Southern Beaufort Sea and Chukchi Sea stocks; they spend a majority of the year near the coast and move further offshore to pack ice during the summer (Durner, Amstrup et al. 2004). They use terrestrial habitat for maternity denning, scavenging, resting, and travel between marine habitats (Regehr, Hunter et al. 2010). Potential terrestrial denning habitat is defined as a topographic feature at least 4.3 feet in height and having at least an 8-degree slope, which provides conditions for drifting snow (Durner, Simac et al. 2013). There are approximately 3,126.6 acres of mapped potential terrestrial denning habitat in the analysis area (Figure 3.13.1). (Some parts of the southeast analysis area are not mapped for potential terrestrial denning habitat.) The nearest known polar bear maternal dens are approximately 3 miles from proposed gravel and ice infrastructure (in this case, the HDD pads) for all action alternatives and less than 0.1 mile from the proposed ice road for module delivery options 1 and 2, although this is not necessarily indicative that polar bears would den in the same area (Durner, Fischbach et al. 2010; USGS unpublished data) (Table 3.13.3).

On the North Slope, polar bears typically use areas close to the coast, as is evidenced by the designation of terrestrial denning habitat critical habitat within 5 miles of the coast. Between Utqiaġvik and the Kavik River (east of Prudhoe Bay), 95% of dens occupied by radio-collared bears were located within 5 miles of the coast (Durner, Douglas et al. 2009); historical reports of dens found by other methods demonstrate that some females den farther inland (Durner, Fischbach et al. 2010; Seaman 1981). Polar bear observations documented from existing CPAI operations on the North Slope from 1993 through 2019 are shown in Figure 3.13.3. The figure shows that 90% of observations were 7.7 miles from the coast and 95% of observations were 9.6 miles from the coast. Information on polar bear population is in Appendix E.13.

3.13.1.1.2 Seals
Bearded seals in Alaska are of the Pacific subspecies and members of the Beringia distinct population segment; they are listed as threatened and have no designated critical habitat. They may be present in the analysis area throughout the year in areas of shallow water (less than 650 feet) that are at least seasonally ice covered (Cameron, Bengtson et al. 2010). Ringed seals are listed as threatened, and critical habitat has been proposed but not designated. They are likely to be present in the analysis area in waters between 15 to 115 feet deep (Frost, Lowry et al. 2000) and near bottom-fast ice where they can overwinter (Kelly, Badajos et al. 2010). Ringed seals are frequently observed in Harrison Bay and in waters adjacent to the CRD and Oliktok Point (Brandon, Thomas et al. 2011; Green and Negri 2005, 2006; Green, Hashagen et al. 2007; Hauser, Moulton et al. 2008).

3.13.1.2 Other Species

3.13.1.2.1 Spotted Seals
Spotted seals may be seasonally present in the analysis area along the coast of Harrison Bay and in the CRD (BLM 2012b) during winter and spring near sea ice (Quakenbush 1988), using terrestrial haulouts on mud, sand, or gravel beaches, and on sea ice in the spring where water depth does not exceed 650 feet (Muto, Helker et al. 2018). Spotted seals are frequently observed in Harrison Bay and in waters adjacent to the CRD and Oliktok Point (Brandon, Thomas et al. 2011; Hauser, Moulton et al. 2008; Tetra Tech EC Inc. 2005, 2006, 2007). Numerous haulout sites have been identified in the CRD (Figure 3.11-4 in USACE 2018). During winter and spring, this species is strongly associated with the presence of sea ice (Quakenbush 1988).

3.13.1.3 Protected Species Compliance
In 2013, BLM adopted its ROD for the IAP/EIS for the NPR-A (BLM 2013a). The IAP/EIS ROD allocated lands available and unavailable for oil and gas leasing, exploration, and development and included BMPs and LSs that minimized impacts of these activities. The IAP/EIS (BLM 2012b) and the accompanying ROD (BLM 2013a) include a development scenario, for which NMFS concurred (NMFS 2012) with BLM's determination that the development scenario in the IAP/EIS may affect but was not likely to adversely affect whale and seal species. USFWS also issued a Biological Opinion (BO) concluding that the development scenario in the IAP/EIS was not likely to jeopardize the continued existence of the Alaska breeding population of Steller's eider, spectacled eider, or polar bear (USFWS 2013). The BO also concluded that the action was not likely to destroy or adversely modify critical habitat.

Additional consultations were conducted for the issuance of Incidental Take Regulations (ITRs) for the nonlethal unintentional take of small numbers of polar bears and Pacific walrus incidental to other oil and gas activities. Under the MMPA of 1972, as amended and reauthorized (PL 92-522 and 103-238; 16 USC 1361–1423h), ITRs are the primary means for regulating oil and gas activities that have the potential to impact polar bears and walrus. The current ITRs covering oil and gas activities on the North Slope were issued for a 5-year period beginning in August 2016 and ending on August 5, 2021 (81 FR 52276). Industry is currently working with USFWS for issuance of ITRs for the period of 2021-2026; the Project is included in the list of planned activities during that period.

Each permitted project within the NPR-A must undergo its own NEPA analysis and ESA consultation. The Willow MDP Project is such a project.

The Project would use Mine Site C, which has previously been permitted and for which USFWS concurred the mine expansion is not likely to adversely affect or jeopardize the continued existence of ESA species (USFWS 2015c). That concurrence is conditioned on the proponent of that project (in this case, USACE) following the project plans and minimization measures as outlined in the BO. Therefore, Mine Site C is not included in the Willow ESA consultation.

The Project would also use Mine Site E, which has previously been permitted and for which USFWS concurred the mine expansion is not likely to adversely affect or jeopardize the continued existence of ESA species (USFWS 2019a, 2020b). Similarly, that concurrence is conditioned on the proponent of that project (in this case, USACE) following the project plans, reasonable and prudent measures, and terms and conditions as outlined in the BO. Therefore, Mine Site E is not included in the Willow ESA consultation.

3.13.2 Environmental Consequences

3.13.2.1 Avoidance, Minimization, and Mitigation

3.13.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.13.2 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to marine mammals from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to marine habitat, subsistence hunting areas, and the environment associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.13.2 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to marine mammals. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.13.2 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.13.2. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Marine Mammals

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations.	Areas of operation shall be left clean of all debris.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development.	Changes do not affect text as described.
BMP A-3	Minimize pollution through effective hazardous materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before the transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes, and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement a Bear Interaction Plan to minimize conflicts between bears and humans.	Added text: – Feeding wildlife is prohibited. – Prevent the emission of odors by installing kitchen hood exhaust filtration systems such as cleaners, filters, purifiers, and scrubbers. – Activities not covered under Incidental Take Regulations must include the following in their wildlife interaction plan. – Guidelines for safe and nonlethal deterrence of polar bears from damaging property and endangering the public, as found in the Final Rule of the MMPA Deterrence Guidelines – Other methods of deterring polar bears require authorization by the USFWS Marine Mammals Management Office. – If a polar bear interaction escalates into a life-threatening situation, Section 101(c) of the MMPA allows, without specific authorization, to take (including lethal take) a polar bear. – Any injury or lethal take of a polar bear must be reported to the USFWS and the BLM within 24 hours.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use ultra-low sulfur diesel.	BMP withdrawn: No similar requirement; duplicative with the U.S. Environmental Protection Agency standard under Section 202 of the Clean Air Act amendments.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring (preconstruction and throughout the life of the Project), emissions inventory, emissions reduction plan, air quality modeling, additional emission control strategies as necessary, and possibly mitigation measures.	Added text: Provide to the NSB, local communities, and tribes publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this BMP.
ROP A-14	Reduce air emissions and protect human health.	No similar requirement.	All permanent camps (and temporary camps where feasible under alternative E), are required to provide vehicle plug-ins for engine warming systems (e.g., block heaters and oil pan heaters). Alternative E only: reduce extended vehicle idling when practical. In the winter, when vehicles are not in use for extended periods, they should be powered off and plugged in where plugs are available.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-1	Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.	Cross-country use of heavy equipment is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with the USFWS and/or National Marine Fisheries Service, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.	– Cross-country use of heavy equipment is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. – Cross-country use of vehicles, equipment, and oil and gas activity is prohibited within 1 mile of known or observed polar bear dens, unless alternative protective measures are approved by the BLM and are consistent with the MMPA and the ESA. – Should previously unknown occupied dens be discovered within 1 mile of activities, work must cease and the USFWS must be contacted for guidance. – Polar bear and seal mitigation measures for onshore activities are required. – Operators seeking to carry out onshore activities in known or suspected polar bear denning habitat during the denning season (approximately November to April) must make efforts to locate occupied polar bear dens within and near areas of operation. All observations must be reported to the USFWS prior to the initiation of activities. – Restrict the timing of the activity to limit disturbance around dens. – Limit disturbance of activities to seal lairs in the nearshore area (< 3 meter water depth): – Maintain airborne sound levels of equipment below 100 dB re 20 μPa at 66 feet. If equipment will be used that differs from what was originally proposed, the applicant must inform the BLM. – On-ice operations after May 1 will employ a full-time, trained, protected species observer on vehicles to ensure that all basking seals are avoided by vehicles by at least 500 feet and will ensure that all equipment with airborne noise levels above 100 dB re 20 μPa are operating at distances from observed seals that allow for the attenuation of noise to levels below 100 dB. All sightings of seals will be reported to the BLM using a National Marine Fisheries Service–approved observation form. – Ice paths must not be greater than 12 feet wide. No driving will be allowed beyond the shoulder of the ice path or off planned routes unless necessary to avoid ungrounded ice or for other human or marine mammal safety reasons. On-ice driving routes shall minimize travel over snow/ice/topographical features that could foster the development of birthing lairs. – No unnecessary equipment or operations (e.g., camps) will be placed or used on sea ice.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize the compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. The location of ice roads shall be designed and located to minimize the compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.	Revised text: – Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – Snow survey and soil freeze-down data collected for ice road or snow trail planning and monitoring shall be submitted to the BLM. – Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage; avoid flooding; prevent streambed sedimentation and scour; protect water quality; and protect stream banks.	The crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	Added text: – Provide to BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of road/trail construction. – In the spring, provide the BLM with photographs of all stream crossings that have been removed, breached, or slotted.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A postconstruction monitoring program, developed in consultation with appropriate federal, state, and NSB regulatory and resource agencies, shall be required to track circulation patterns, water quality, and fish movements around a structure.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before the development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.	Added text: Develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments (for alternatives B, C, D: based on Light Detection and Ranging or other high-accuracy surface imaging).

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-19	Provide information to be used in monitoring and assessing wildlife movements during and after construction.	A representation, in the form of ArcGIS-compatible shapefiles, of all new infrastructure construction shall be provided to the Authorized Officer.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP F-1, ROPs F-2 and F-3	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Ensure that aircraft used for permitted activities maintain altitudes specified in guidelines. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Submit an aircraft use plan that addresses strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility. Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) in the Goose Molting Area should be minimized from May 20 through August 20. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away. Fixed wing aircraft along the coast shall maintain minimum altitude of 2,000 feet when within a ½ mile of walrus haulouts. Helicopters used along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts. Aircraft used along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals.	Text moved to ROPs F-2 and F-3: Added text: F-2: Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. F-3: Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level during the dates and in the areas defined, unless doing so would endanger human life or violate safe flying practices or if the purpose of the flight requires constant sight of the ground, such as sight of permitted wildlife or engineering survey flights or ice road planning and cleanup. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the Teshekpuk Caribou Herd Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude agl throughout NPR-A unless doing so would endanger human health and safety or violate safe flying practices, or if the purpose of the flight requires constant sight of the ground, such as sighting of wildlife or for archaeological or engineering survey flights or ice road planning and cleanup. Exceptions to the 1,500-foot agl minimum altitude are listed below: a. Single-engine manned aircraft and unmanned aircraft systems devices should not knowingly fly within 0.5 miles of walrus haulouts; or, if required, then maintain 2,000 feet agl when within 0.5 miles of walrus haulouts. b. Helicopters and multi-engine aircraft should not knowingly fly within 1 mile of walrus haulouts; or, if required, then maintain 3,000 feet agl and a 1-mile buffer from walrus haulouts. c. Aircraft—3,000 feet agl when within 1 mile of aggregation of seals

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS G-1	Ensure the long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure the eventual restoration of ecosystem function.	Changes do not affect text as described.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
ROP H-5	Make data and summary reports derived from North Slope studies easily accessible.	No similar requirement.	Required monitoring studies, reports, and geographic information system data shall be posted online and available to the public.
LS/ BMP K-1[a]	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in streambeds and adjacent to listed rivers. Rivers in the Project area that are listed include the Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and the Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	No surface occupancy or new infrastructure, except essential road and pipeline crossings in the following setbacks: Colville River (2- to 7-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). Gravel mines may be located within the active floodplain, consistent with BMP E-8.
LS/ BMP K-6[a]	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in designated coastal waters; vessels will maintain a 1-mile buffer from the aggregation of hauled out seals and a 0.5-mile buffer from walruses. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). No leasing is allowed within 1 mile of the coast. The following requirements apply to authorized activities within 1 mile of the coast: – Permanent exploratory or production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as a barge landing, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For a permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP M-1	Minimize disturbance and hindrance of wildlife or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited.	Added text: Permittees will submit a vehicle use plan with their permit application, that will include: – Industry practices to minimize or mitigate delays to caribou movement, vehicle collisions, or displacement during calving, spring migration, fall migration, and post-insect aggregation movement. By direction of BLM, traffic may be stopped throughout a defined area for up to 4 weeks to prevent displacement of calving caribou alternatives B, C, and D only). – Summary of all planned off-road travel, including the number of vehicles, type, and general routes. – Monitoring may be required as part of the vehicle use plan and could include collection of data on vehicle counts and vehicle interactions with wildlife. – Permittees shall provide an annual report to the BLM reporting roadkill of birds and mammals to help the BLM determine whether preventative measures on vehicle collisions are effective.
BMP J	Lease areas may now or hereafter contain plants or animals or their habitats determined to be threatened or endangered or some other special status. The BLM may recommend modifications to development proposals to further its conservation and management objective to avoid activities it has approved that would contribute to the need to list such a species or its habitat. The BLM may require modifications to or may disapprove a proposed activity that is likely to adversely affect a proposed or listed endangered species, threatened species, or critical habitat.	See Objective.	Updated to: Lease Notice 2: Compliance with the ESA

Source: BLM 2013a, 2020a
Note: µPa (micropascal); agl (aboveground level); BLM (Bureau of Land Management); BMP (best management practice); dB (decibels); DEW (distant early warning); ESA (Endangered Species Act); F (Fahrenheit); IAP (Integrated Activity Plan); LS (lease stipulation); MMPA (Marine Mammal Protection Act); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy), USFWS (U.S. Fish and Wildlife Service); USGS (U.S. Geological Survey).
[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect marine mammals would include BMPs K-1 and K-6. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in BMP K-1) (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would intake and discharge ballast water to ground barges at Oliktok Dock and the barge lightering area; Options 1 and 2 would intake and discharge ballast water at the MTIs and the lightering areas. These ballast water exchanges would occur within 3 miles of the coastline (see BMP K-6), but intake and discharge would occur in the same location and ballast water would not be transported.

A deviation would be needed for ROP C-1; the sea ice roads for module delivery options 1 (Atigaru Point MTI) and 2 (Point Lonely MTI) would be greater than 12 feet wide to support module transfer.

3.13.2.1.2 Other Required Measures

The current Beaufort Sea ITRs (81 FR 52318; §18.128) for polar bears describe mitigation, monitoring, and reporting requirements for oil and gas operators in the central Beaufort Sea and have been important in mitigating impacts to polar bears from oil and gas activities. BLM would apply these mitigation measures to the Project and support additional mitigation measures included in future ITRs in the analysis area. Additional measures could arise during BLM's Section 7 consultation with USFWS for the Project, initiated in March 2020.

All of the measures described in Appendix E.13 (*Marine Mammals Technical Appendix*) Section 1.4, *Required Measures to Avoid and Minimize Effects to Marine Mammals*, are applicable to the Project.

3.13.2.1.3 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1. Measures in CPAI's 2018 Wildlife Avoidance and Interaction Plan (CPAI 2018c) include adequate lighting; installation of safety gates, fences, and cages for workers, as well as skirting of elevated buildings; careful waste handling and snow management; chain-of-command procedures to coordinate responses to bear sightings; and employee education and training programs (USFWS 2006). All program-related activities would be conducted to minimize the attractiveness of work and facility sites to polar bears and to prevent access to food, garbage, putrescible waste, and other potentially edible or harmful materials. Staff would receive training in North Slope wildlife awareness, and all polar bear sightings would be reported immediately to safety personnel.

3.13.2.1.4 Additional Suggested Avoidance, Minimization, or Mitigation

No additional measures are proposed for marine mammals.

3.13.2.2 Alternative A: No Action

Under Alternative A, there would be no impacts on marine mammals as the result of the Project; however, existing oil and gas activities and exploration in the area would continue, as would existing impacts on marine mammals from air and ground traffic and human presence.

3.13.2.3 Alternative B: Proponent's Project

3.13.2.3.1 Habitat Loss or Alteration

A total of 619.4 acres of polar bear habitat would be permanently lost as a result of gravel infrastructure under Alternative B. This consists of 1.6 acres of terrestrial denning critical habitat, 0.9 acre of potential terrestrial denning habitat, and 616.9 acres of habitat (Figures 3.13.1 and 3.13.4). (Potential terrestrial denning habitat was the mapped by USGS [Durner, Fischbach et al. 2010; USGS unpublished data] using common denning habitat characteristics to describe suitable potential terrestrial denning habitat along the Beaufort Sea coast, as shown in Figures 3.13.1 and 3.13.2.) Project gravel roads and pads would be approximately 8.8 to 27.5 miles inland from the coast. Because the majority of bear observations from CPAI operations have occurred within 9.6 miles of the coast (Figure 3.13.3) and the majority (95%) of bear dens observed in this region have occurred within 5 miles of the coast (Durner, Douglas et al. 2009), most of the permanent habitat loss from the Project would be outside of the area most used by polar bears. Visual and infrared surveys are conducted for polar bear dens prior to the start of each winter season as part of Letters of Authorization issued to operators. If dens are identified, operators would coordinate with USFWS on mitigation measures specific to the den site location and nearest activities. Typical measures include establishment of a 1-mile buffer around the den site to avoid disturbance, which has been shown to be effective at minimizing den disturbance in active industrial areas on the North Slope (Larson, Smith et al. 2020).

Ice infrastructure would cover 4,557.3 acres, which would make the habitat unavailable during winter construction. Multi-season ice pads would remain in place through the summer and second winter. All ice infrastructure for Alternative B would be at least 8 miles inland from the coast, which would minimize the likelihood that those areas would be used for denning. There would be no operational impacts to other marine mammals, as operational actions and facilities would be located inland.

Temporary in-water habitat alteration would also occur from screeding at Oliktok Dock, the barge lightering area (12.1 acres), and the resulting increased turbidity in the area immediately surrounding the screeding footprint. Marine substrates that would be screeded would return to pre-screeding condition in approximately one season.

Oliktok Dock is an active industrial facility that is screeded prior to any barge arrival. Thus, the area has been previously disturbed, and screeding in this area could result in a less novel response from marine mammals than in areas with no human development or activity. Ringed and spotted seals have been observed near Oliktok Dock but in relatively low densities (Brandon, Thomas et al. 2011; Green and Negri 2005, 2006; Green, Hashagen et al. 2007; Hauser, Moulton et al. 2008). Increased turbidity would reduce visibility for seals and potentially impact feeding opportunities. Although increased turbidity has been shown to reduce the visual acuity of harbor seals (Weiffen, Möller et al. 2006), observations of blind harbor and grey seals indicated they were capable of foraging successfully enough to maintain body condition (McConnell, Fedak et al. 1999; Newby, Hart et al. 1970). High levels of turbidity are present in locations where marine mammals that do not use echolocation routinely forage, and laboratory studies have shown that seals are able to use other sensory systems to detect and follow potential prey without using their vision (Dehnhardt, Mauck et al. 2001). Thus, any increases in turbidity are likely to have limited or no direct effects on seals. Because of the shallow waters near Oliktok Dock, whales are not expected to be present or be impacted by screeding.

Barges would be grounded in the screeding area after screeding is complete. Grounding would be accomplished by intaking ballast water. Ballast water would be discharged in the same location in which the intake occurred, in order to refloat the barges before departure. Should ballast be needed for the barge transit to the Beaufort Sea from origination points further south, potable water for trim ballast would be used and loaded at the fabrication site. Prior to loading trim ballast and leaving the fabrication site, all barges would have their ballast tanks stripped of water and dried.

Ballast water that is not potable or frequently exchanged can degrade habitat quality for fish by introducing aquatic invasive species, which can impact food webs and outcompete native species. In addition to CPAI's design measures to reduce impacts from ballast water, all vessels that enter State of Alaska or federal waters are subject to U.S. Coast Guard regulations (33 CFR 151), which are intended to reduce the transfer of aquatic invasive organisms. Management of ballast water discharge is federally regulated (33 CFR 151.2025); discharge of untreated ballast water into WOUS is prohibited unless the ballast water has been subject to a mid-ocean ballast water exchange (at least 200 nautical miles offshore). Vessel operators are also required to remove "fouling organisms from the hull, piping, and tanks on a regular basis, and dispose of any removed substances in accordance with local, state, and federal regulations" (33 CFR 151.2035(a)(6)). Adherence to the 33 CFR 151 regulations and CPAI's design measures would reduce the likelihood of Project-related vessels introducing aquatic invasive species.

3.13.2.3.2 Disturbance or Displacement

All construction and operational activities may result in disturbance or displacement of marine mammals from noise or from the physical presence of equipment or personnel. Construction activities that would occur onshore consist of heavy machinery use, vehicle traffic, air traffic, gravel mining, pile driving, and improvements to Oliktok Dock; construction activities that would occur in-water consist of screeding and vessel traffic. The majority of construction activities would occur in winter and be located 5 to 27.5 miles from the coast, although there would be four summer seasons of vessel traffic and one month of onshore construction at Oliktok Dock (0 miles from the coast) (Figure 3.13.3). Operational activities (ground and air traffic, facility noise, etc.) would all be onshore, occur year-round, and be mostly greater than 10 miles from the coast, except for where routine pipeline maintenance and surveillance would run north into the Alpine facility (which is less than 5 miles from the coast). Routine pipeline maintenance and surveillance activities in this area would add little change to the existing condition since the Willow pipeline would parallel the existing Alpine pipeline (Figure 2.4.1). All of these activities could affect polar bears; seals would be affected by construction air traffic, screeding, and improvements to Oliktok Dock. All species in Table 3.13.1 could be affected by vessel traffic.

Noise may directly affect reproductive physiology or energetic consumption as individual marine mammals incur energetic costs or lose mating or foraging opportunities by repeatedly reacting to or avoiding noise. Animals may also be forced to retreat from favorable habitat in order to avoid aversive anthropogenic noise levels. Under the MMPA, NMFS and USFWS have defined levels of harassment for marine mammals. Level A harassment is defined as the potential to injure and Level B harassment is defined as the potential to disturb. Appendix E.13 details noise thresholds for marine mammal harassment and injury (as per NMFS 2018) and provides general information on noise. Implementation of BMPs would lessen (not eliminate) impacts from disturbance and displacement.

3.13.2.3.2.1 Inland Disturbance or Displacement

Construction of ice and gravel infrastructure, pile driving, and increased ground and air traffic could disturb (and locally displace) polar bears due to airborne noise and the physical presence of humans and equipment. Denning females are more sensitive to disturbance; using the disturbance buffer of 1 mile commonly used by USFWS for identified polar bear dens, 1,168.1 acres would potentially be disturbed. The duration and frequency of impacts from construction would be continuous during construction.

Disturbance from vehicle noise would occur throughout the life of the Project but would be greatest during construction. There would be 30,248 to 237,297 ground traffic trips per winter during construction, 2021 through 2030 (approximately 15.5 to 81.7 trips per hour to Willow, 2022 through 2029; Table D.5.7 in Appendix D.1). That would decrease by up to 88% during operations (2031 through 2050) to 27,456 trips per winter. Air and ground traffic for the Project are detailed in Tables D.4.9 and D.4.10 in Appendix D.1. Because construction would occur in winter and would be the closest activity to the coast (the mine site would be approximately 8 miles from the coast and the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would be 5 miles from the coast), construction vehicle traffic would have a larger impact on bears than operational traffic. Project gravel roads and pads would be approximately 8.8 to 27.5 miles inland from the coast. Pile driving would occur at least 12.2 miles from the coast (closest bridge to the coast would be at Willow Creek 8). This distance would limit some potential vehicle disturbance to polar bears as the majority of bear observations from CPAI operations have occurred within 9.6 miles of the coast (Figure 3.13.3) and the majority (95%) of bear dens observed in this region have occurred within 5 miles of the coast (Durner, Douglas et al. 2009). Thus, it is unlikely that bears would den in the Willow area, as evidenced by historical den locations (Figure 3.13.4).

Exposure of polar bears to aircraft presence near Willow would occur throughout the life of the Project, but the Willow airstrip would be 20 miles inland, which would reduce impacts to polar bears since the majority of bears (95%) observed historically in this region have occurred within approximately 10 miles of the coast (Figure 3.13.3).

3.13.2.3.2.2 Coastal and Marine Disturbance or Displacement

Increased air traffic between Alpine and Willow during construction could cause noise disturbances for polar bears and seals using the CRD if the air traffic is under 1,500 feet and flying over water or haulout sites (including during landing or takeoff). Estimated construction flight paths (Figure 3.6.1) in or out of Alpine (before the Willow airstrip is operational) would enter the CRD near known locations of spotted seal haulouts (see Figure 3.11-4 in USACE 2018). From 2021 through 2030, there would be 0 to 12 fixed-wing aircraft trips per summer to/from Alpine and 0 to 81 flights per winter to/from Alpine (Table 3.13.3). Also, in 2021 and 2022, there would be 25 to 38 helicopter trips to/from Alpine per summer; there would be no helicopter flights to/from Alpine in winter. Flights during winter and early spring would mostly affect polar bears and seals on ice, especially over maternal polar bear denning habitat (Figure 3.13.1). Flights occurring during late spring and the open-water season would affect polar bears and seals using the nearshore region. The portion of the analysis area near the Alpine and GMT developments experiences a higher amount of weekly aircraft traffic than other non-developed areas on the North Slope, and an incremental addition of air traffic there is unlikely to be detected by marine mammals. Exposure of polar bears and seals to aircraft presence near Alpine would occur during construction. Each occurrence of air traffic would be temporary and of short duration and would result in brief behavioral responses. Population-level effects would not occur.

Improvements at Oliktok Dock would occur onshore and would create airborne noise from use of heavy equipment, such as those described in Table 3.6.3 in Section 3.6. Work would occur in summer and be within the existing dock footprint; all work would occur onshore and no pile driving is needed. Airborne sound and the presence of construction machinery could temporarily disturb seals and polar bears during the 4-week construction window. NMFS considers 100 dB re 20 µPa as the airborne disturbance threshold for seals; airborne noise would be below the 100-dB airborne threshold at 21 feet, so only animals transiting in the immediate vicinity (within 21 feet) of Oliktok Dock would be potentially disturbed by airborne noise.

Table 3.13.3. Effects to Marine Mammals from Action Alternatives

Project Component	Effect to Marine Mammals	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Gravel fill onshore	Polar bears: Habitat loss Disturbance or displacement during construction from airborne noise or human activity	619.4 acres 1.6 acres in terrestrial denning critical habitat 0.9 acre in potential terrestrial denning habitat 78 dBA at 50 feet from the source during construction	672.8 acres 1.6 acres in terrestrial denning critical habitat 0.3 acre in potential terrestrial denning habitat 78 dBA at 50 feet from the source during construction	609.6 acres 1.6 acres in terrestrial denning critical habitat 0.6 acre in potential terrestrial denning habitat 78 dBA at 50 feet from the source during construction
Screeding	Polar bears and seals: Temporary habitat alteration (increased turbidity, and decreased benthic forage) Disturbance or displacement from underwater noise or human activity	12.1 acres (in sea ice critical habitat for polar bears), 2 occurrences 164 to 179 dB rms at 3.28 feet from the source (distance to 120 dB rms underwater threshold[a] is 131 to 707 feet for seals and polar bears)	Same as Alternative B	Same as Alternative B
Oliktok Dock improvements	Polar bears and seals: Disturbance or displacement from construction airborne noise or human activity	78 dBA at 50 feet from the source during construction	Same as Alternative B	Same as Alternative B
Pile installation	Polar bears: Disturbance or displacement from noise	101 dBA at 50 feet from the source 36 pipe piles	101 dBA at 50 feet from the source 20 pipe piles	101 dBA at 50 feet from the source 36 pipe piles
Ice infrastructure	Polar bears: Temporary habitat alteration Disturbance or displacement from construction airborne noise or human activity	4,557.3 acres[b] (20.0 acres in critical habitat) 495.2 miles of ice roads 78 dBA at 50 feet from the source during construction	5,608.0 acres[b] (20.0 acres in critical habitat) 650.1 miles of ice roads 78 dBA at 50 feet from the source during construction	7,164.8 acres[b] (20.0 acres in critical habitat) 962.4 miles of ice roads 78 dBA at 50 feet from the source during construction
Air traffic[c]	Polar bears and seals: Disturbance or displacement from construction airborne noise or human activity	12,101 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source 2021 through 2030 trips near the coast: 0 to 12 to/from Alpine per summer, 0 to 81 to/from Alpine per winter 2031 through 2050 trips near the coast: all traffic to/from Willow, 20 miles inland 2,421 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source 2020 through 2021 trips near the coast: 25 to 38 to/from Alpine per summer, 0 to/from Alpine in winter 2022 through 2050 trips near the coast: all traffic to/from Willow, 20 miles inland	19,574 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source 2021 through 2030 trips near the coast: 0 to 12 to/from Alpine per summer; 0 to 81 to/from Alpine per winter 2031 through 2050 trips near the coast: all traffic to/from Willow, 20 miles inland 2,910 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source 2020 through 2021 trips near the coast: 25 to 38 to/from Alpine per summer; 0 to/from Alpine in winter 2022 through 2050: all traffic to/from Willow, 20 miles inland	19,038 total fixed-wing trips; 69 to 81 dBA at 1,000 feet from the source 2021 through 2030 trips near the coast: 0 to 20 to/from Alpine per summer; 0 to 196 to/from Alpine per winter 2031 through 2051 trips near the coast: all traffic to/from Willow in summer, 20 miles inland; 51.4 to/from Alpine in winter 2,503 total helicopter trips; 70 to 80 dBA at 1,000 feet from the source 2020 through 2021 trips near the coast: 25 to 38 to/from Alpine per summer; 0 to/from Alpine in winter 2022 through 2050 trips near the coast: all traffic to/from Willow, 20 miles inland

Project Component	Effect to Marine Mammals	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Onshore traffic[b]	Polar bears: Disturbance or displacement from airborne noise or human activity	3,188,910 total trips 10,928 to 42,027 trips per summer (2021 through 2030) 30,248 to 237,297 trips per winter (2021 through 2030) 10,928 trips per summer (2031 through 2050) 27,456 trips per winter (2031 through 2050)	4,212,510 total trips 11,060 to 46,748 trips per summer (2021 through 2030) 33,180 to 311,229 trips per winter (2021 through 2030) 16,578 trips per summer (2031 through 2050) 41,652 trips per winter (2031 through 2050)	4,376,890 total trips 3,360 to 36,811 trips per summer (2021 through 2030) 36,855 to 210,521 trips per winter (2021 through 2030) 17,124 trips per summer (2031 through 2050) 46,241 trips per winter (2031 through 2050)
Barge and support vessel traffic[b]	All marine mammals: Temporary disturbance or displacement from underwater noise and human activity Injury or mortality from vessel strikes	Nearshore barge route (~600 miles) 24 barges, 37 tugboats, and 258 support vessels 145 to 175 dB rms at 3.28 feet from the source (distance to 120 dB rms underwater threshold is 7,067 feet for all marine mammals)[c]	Same as Alternative B	Same as Alternative B
All	Polar bears: Total acres of offshore disturbance (within 0.5 mile of in-water work, USFWS buffer)[c] Total acres of onshore disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)	1,277.4 acres within 0.5 mile of in-water work 1,168.1 acres within 1 mile of onshore work	1,277.4 acres within 0.5 mile of in-water work 1,188.4 acres within 1 mile of onshore work	1,277.4 acres within 0.5 mile of in-water work 1,250.4 acres within 1 mile of onshore work
All	Distance to nearest known historical polar bear den[d]	3.0 miles to gravel infrastructure 3.0 miles from ice infrastructure	3.0 miles to gravel infrastructure 3.0 miles from ice infrastructure	3.0 miles to gravel infrastructure 3.0 miles from ice infrastructure

Note: ~ (approximately); dB (decibels); dBA (A-weighted decibels); rms (root-mean-square); USFWS (U.S. Fish and Wildlife Service). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*. Summer is defined as June through September, winter as December through March.

[a] Disturbance for underwater noise sources (vessels, barges, screeding) is calculated using the National Marine Fisheries Service underwater disturbance threshold of 120 dB rms assuming transmission loss of 15 log(R) for all marine mammals, including polar bears. It is understood that the USFWS recommends the use of 160 dB rms for disturbance of underwater sounds for polar bears; the underwater threshold of 120 dB rms was used to be consistent in the Environmental Impact Statement and Section 7 consultations. The disturbance area is not quantified for the barge route since the route is estimated.

[b] Includes multi-season ice pads in total.

[c] Traffic is detailed in D.4.8, D.4.16, D.4.24, D.5.5, D.5.6, D.5.10, and D.5.15 in Appendix D.1, *Alternatives Development*. Onshore disturbance calculations are provided with ice infrastructure calculations.

[d] The presence of a historical polar bear den does not necessarily indicate that polar bears would den in the same area.

Screeding at Oliktok Dock and the barge lightering area would occur for 1 week each barge delivery year in summer shortly before the barges arrive and would take approximately 1 week to complete. These activities could generate airborne and underwater noise. Bowhead and beluga whales generally transit outside of the barrier islands and are not observed in the shallow waters near Oliktok Dock; therefore, only polar bears and seals would be in the area during the summer. There have been numerous studies associated with ringed seal responses to industrial activities near Northstar Island, indicating ringed seals tolerate construction noise (Blackwell, Lawson et al. 2004; Moulton, Richardson et al. 2003; Williams, Nations et al. 2006). Screeding at Oliktok Dock would occur 1.2 miles from barrier island critical habitat for polar bears, the closest Project action to this habitat. Potential impacts to polar bears would be limited to the short-term disturbance of small numbers of individuals.

Screeding could also indirectly affect polar bears by displacing prey (primarily ringed seals, but also spotted, bearded, and ribbon seals). Because displacement is expected to be temporary and affect a small proportion of the potential available foraging habitat, only a few ice seals would be affected. Screeding and dock improvements would not impact bears' overall ability to successfully obtain and consume prey (USFWS 2011).

The barge transit route would traverse through the Bering, Chukchi, and Beaufort seas, generally 10 to 40 miles offshore, depending on weather, safety, and accepted transit routes. The barge lightering area and Oliktok Dock would be in the very shallow waters of Harrison Bay.

Vessel noise along the barge transit route from Dutch Harbor to Harrison Bay may result in disturbance to marine mammals in the Bering, Chukchi, and Beaufort seas. The Project includes 24 barge and 37 tugboat round trips over 4 years (2022, 2023, 2024, and 2026) over this approximately 600-mile route. The barge route would be designed to avoid North Pacific right whale critical habitat in the Bering Sea; however, the route would traverse Steller sea lion critical habitat near Dutch Harbor (Figure 3.13.2). The barge transit route would avoid passing within 3 nautical miles of known rookeries or haulouts. Marine mammals within 1.3 miles of the barge transit route may be temporarily disturbed as the individual barges and tugboats transit through the habitat. Given the slow speeds (10 knots [11.5 mph]) and low number of barges trips, potential effects on North Pacific right whale and Steller sea lion would be minimal and temporary. The barge transit route would be in the range of all of the species in Table 3.13.1 and may result in short-term behavioral disturbance of these species. Some baleen and toothed whales, Pacific walrus, Steller sea lion, and sea otters are included in the EIS because of the barge transit route. Vessel noise along the barge route would be temporary and localized, and is expected to have negligible impacts on these species.

The Project would also require approximately 258 support vessels between Oliktok Point and the barge lightering area. Support vessels may disturb polar bears, bearded and ringed seals, and, potentially, bowhead and beluga whales migrating in the spring and fall along the coastline. As described above, seals in this area are known to be tolerant of industrial activity. Potential effects on seals would be temporary during the activity and would not result in population-level effects.

3.13.2.3.3 Injury or Mortality

Noise from construction activities, such as pile driving or blasting at the mine site, may result in Level A harassment (Table E.13.2 in Appendix E.13). Standard mitigation measures would be implemented to reduce the likelihood of Level A harassment, such as shutting down if a marine mammal enters the analysis area. There is a potential for noise and/or physical human presence to cause female bears searching for den locations to be displaced or abandon a den with cubs. The mine site would be approximately 8 miles from the coast, outside of designated critical habitat and near potential terrestrial denning habitat for polar bears. Because 95% of dens in this area of the North Slope are located within 5 miles of the coast (Durner, Douglas et al. 2009), effects to bears would be minimized. Because mining would be one of the closest activities to the coast (8 miles), would occur in the winter when bears would be denning, and would be one of the loudest noise sources of the Project, it could have a larger impact on bears than other activities.

Vessel strikes can injure or kill marine mammals. Most lethal and severe injuries to large whales from ship strikes have occurred when vessels were traveling at 14 knots (16 mph) or greater (Laist, Knowlton et al. 2001), speeds common among large ships. When vessel speeds are greater than 15 knots (17 mph), the probability of a lethal injury (mortality or severe injuries) from a ship strike approaches 100% (Vanderlaan and Taggart 2007). Impacts to marine mammals as a result of injury or mortality from Project vessel collision is not expected because Project vessels would maintain slow speeds in the presence of marine mammals; therefore, vessel strikes are not discussed further in this analysis.

Ground traffic on ice roads poses a collision risk to polar bears; however, data prior to 2001 indicate that no such incidental collisions of polar bears and vehicles have been documented on the North Slope (USFWS 2011). CPAI data from 2015 to June 2019 indicate that collisions of mammals in the Alpine and GMT developments were mostly with foxes and one wolverine; no collisions with polar bears were reported. In general, bears that have not been previously food conditioned to human presence would be expected to avoid close interactions with moving vehicles given their mobility and the noise of the vehicles. Additionally, given that Project ice road traffic would be comprised of slow-moving construction vehicles, bears transiting ice roads would have sufficient time to move out of the way of oncoming traffic. Therefore, impacts to polar bears as a result of injury or mortality from vehicle strike is not expected.

Polar bears are curious and opportunistic hunters that frequently approach and investigate locations where human activity occurs (LGL Ecological Research Associates 1993; Stirling 1988). Proximity to humans poses risks of injury or mortality for both bears and humans and may necessitate nonlethal take through deterrence and hazing or, on rare occasions, lethal take to defend human life (LGL Ecological Research Associates 1993; Perham 2005; Stenhouse, Lee et al. 1988).

As sea-ice cover in the Arctic continues to diminish in the future, the number of encounters between nutritionally stressed bears and humans is expected to increase (DeBruyn, Evans et al. 2010). Despite the increase in human-bear interactions in existing oil fields in recent years, virtually no lethal take or injury of polar bears have been reported (USFWS 2008b, 2009, 2016a).

Air emissions would not exceed the NAAQS, and thus would not be harmful to people and polar bears.

3.13.2.4 Alternative C: Disconnected Infield Roads

The extent and types of impacts to marine mammals under Alternative C would be similar to those described for Alternative B, with the following exceptions (Table 3.13.3). There would be 53.4 more acres of habitat loss and potential for disturbance for polar bears and 1,050.7 more acres covered by ice infrastructure (temporary habitat alteration). Although the total number of air traffic trips would be greater for Alternative C (the largest number of trips of any action alternative), the amount of air traffic near the coast would be the same as for Alternative B. There would be an annual ice road (3.6 miles) required for the life of the Project, which could have longer lasting effects on habitat and would result in more ground traffic and associated noise (disturbance) and collision risk (injury or mortality). Marine vessel traffic would not differ by action alternative.

3.13.2.5 Alternative D: Disconnected Access Road

The extent and types of impacts to marine mammals under Alternative D would be similar to those described for Alternative B but with a slightly smaller footprint, much longer ice roads, an additional year of construction, and more traffic (Table 3.13.3). There would be 9.8 fewer acres of habitat loss due to gravel fill and 2,607.5 more acres would be covered by ice infrastructure (temporary habitat alteration). There would be two additional seasons of ice roads during construction, as well as an annual ice road (12.5 miles) required for the life of the Project, which could have longer lasting effects on habitat and could result in more potential disturbance. There would be substantially more ground traffic under Alternative D (1,187,980 more vehicle trips), and a larger onshore disturbance area for polar bears (1,250.4 acres); however, much of this would occur inland away from the coast where polar bears are more prevalent.

Although the total number of air traffic trips would be greater for Alternative D than for Alternative B, the amount of air traffic near the coast would be only slightly more than for Alternative B (Table 3.13.3). From 2021 through 2030, there would be up to 8 more fixed-wing airplane trips to or from Alpine per summer, and up to 115 more flights to or from Alpine per winter. From 2031 through 2051, there would be 51.4 fixed-wing airplane trips to or from Alpine per winter; there would be no fixed-wing flights to or from Alpine in the summer. The number of helicopter trips near the coast would be the same as Alternative B. Marine vessel traffic would not differ by action alternative.

3.13.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

Some of the types of effects to marine mammals from module delivery options would be similar to those described above for the land-based alternatives.

3.13.2.6.1 Habitat Loss or Alteration

Gravel fill for the MTI would permanently remove 12.8 acres of marine habitat (designated as sea ice critical habitat for polar bears) in approximately 8 to 10 feet water depth. The MTI area currently has no human development and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). The MTI would alter existing substrates by adding gravel and gravel bags. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in Section 3.8.2.6). The gravel would be naturally redistributed by wind and waves, which would alter the substrate of surrounding habitats. Temporary habitat alteration would also occur in summer following winter construction of the MTI from increased SS washing out of the MTI fill (expected to cover approximately 11 to 15 acres).

Immediately prior to barge arrival, approximately 14.5 acres would be screeded in front of the MTI's dock face and at the barge lightering area about 1.6 miles offshore from the MTI (Figure 3.13.5). Effects of screeding on marine mammals are described in Section 3.13.2.3.1, *Habitat Loss or Alteration*. Marine substrates that would be screeded would return to pre-screeding condition in approximately one season. Barges would be grounded in the screeding area immediately after screeding. Intake and discharge of ballast water would be required to ground and then refloat barges. Effects would be the same as described for Alternative B, Section 3.13.2.3.1.

The MTI would not be polar bear denning habitat because the side slopes would not be steep enough (all slopes would be less than 8 degrees).

Ice roads and pads would temporarily make the habitat unavailable to polar bears during winter construction; Option 1 would cover 859.6 acres with freshwater ice infrastructure, of which approximately 60.3% would be in critical habitat for polar bears. Effects of ice infrastructure on marine mammals are described in Section 3.13.2.3.1.

3.13.2.6.2 Disturbance or Displacement

Disturbance and displacement would occur from on-ice work in winter and in-water work in summer, and from vessel traffic. Underwater and airborne noise would be created from equipment and marine vessels. Seals may temporarily be displaced from marine waters during construction, although ringed seals exhibit tolerance to construction (Moulton, Richardson et al. 2003). In-water work, with associated airborne and underwater noise, would occur over six summer seasons (one for recontouring of the MTI slopes, four for screeding, and one for removal of anthropogenic material at decommissioning). Airborne noise would also occur during one winter construction season at the mine site, along the ice roads between the mine and the MTI site, and around the MTI fill footprint. Human activity would occur over several winter and summer seasons through construction and decommissioning of the MTI. NMFS requires that all work in coastal ice habitat start prior to March 1 so that disturbance has already occurred before ice seals create their lairs. Construction of the MTIs would start prior to March 1 per NMFS policy, thus lairs are not expected to be disturbed.

During summer construction, the estimated distance to the NMFS underwater disturbance threshold for seals ranges from less than 600 feet for backhoes or bulldozers (resulting in 2 to 24 acres of disturbed area). The estimated distance to the airborne disturbance threshold is approximately 200 feet, resulting in 2.9 acres of disturbed area. Using a 0.5-mile exclusion zone commonly used by the USFWS for polar bear disturbance in open water, approximately 1,450.5 acres of habitat may be disturbed. The duration and frequency of in-water activity is temporary and intermittent during construction. Marine vessel traffic would increase, as described under Alternative B (Section 3.13.2.3.2.2, *Coastal and Marine Disturbance or Displacement*), sealift barges would travel from southern Alaska, and smaller support vessels would originate from Oliktok Point (Figure 3.13.2). A total of 9 barge trips, 16 tugboat trips, and 259 support vessel trips would be needed (Table 3.13.4).Vessels would have a transitory presence and a limited effect on marine mammals; marine mammals typically avoid vessels in known high-vessel areas. Further, sound levels of vessels are well below the injury thresholds for marine mammals. Bowhead and beluga whales harvested near Utqiaġvik and Nuiqsut in fall and spring would not be disturbed by the increased vessel traffic between Atigaru Point and Oliktok Point because their migration corridor is generally in depths greater than 60 feet and all vessel traffic would occur in shallower water. Marine habitat would recover from noise almost immediately after construction and in-water work ceases.

Onshore construction activities would occur in the winter only and consist of construction and use of ice infrastructure. The majority of construction activities would be located within 8 miles of the coast (Figure 3.13.3). These activities could disturb (and locally displace) polar bears due to noise and the physical presence of humans and equipment, as described in Section 3.13.2.3.2, *Disturbance or Displacement*. Denning females are more sensitive to disturbance; using the disturbance buffer of 1 mile commonly used by USFWS for identified polar bear dens, 935.4 acres would potentially be disturbed. The duration and frequency of impacts from construction would be continuous during winter construction. There would be 43,680 to 1,082,620 ground traffic trips per winter and spring during construction, 2022 through 2027 (up to 279.6 trips per hour).

3.13.2.6.3 Injury or Mortality

Option 1 would require a 100-person camp located on a 10-acre multi-season ice pad near Atigaru Point to support module moves during the winters of 2025 and 2027 (Alternatives B and C; Alternative D would occur during the winters of 2026 and 2028). An additional 10-acre multi-season ice pad would house a variety of support facilities and an emergency camp midway between BT1 and Atigaru Point (Figure 2.4.4). Both multi-season ice pads would be in terrestrial denning critical habitat for polar bears. Polar bears may be attracted to human facilities, as described in Section 3.13.2.3.3, *Injury or Mortality*, which could increase human-bear interactions and increase the risk of injury or mortality of bears.

Vessel traffic is not expected to result in injury or mortality of marine mammals because vessels would travel at speeds slower than 14 knots (16 mph), as described in Section 3.13.2.3.3.

3.13.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

All of the effects to marine mammals described for Option 1 would apply to Option 2 but would occur at Point Lonely instead of at Atigaru Point. In addition, multi-season ice pads would be placed between BT4 and Point Lonely to stage equipment (Figure 2.4.5); the 100-person camp for Option 2 would be located on an existing pad at the Point Lonely Distant Early Warning (DEW) Line site.

The main difference between the options is that Option 2 would require more than double the total length (and acres) of ice roads (Table 3.13.4) and 890,340 more ground traffic trips; thus, Option 2 would have a higher intensity of disturbance or displacement than Option 1. Although Option 2 has more total miles and acres of ice infrastructure than Option 1, fewer of these acres would occur in terrestrial denning critical habitat (Figure 3.13.1); thus, the intensity of habitat alteration from ice roads would be lesser than Option 1. The duration of construction would be the same for both options.

Option 2 would also have double the miles of support vessel traffic. Although the number of trips and seasons of use are the same as Option 1, the support vessels would originate from Oliktok Point and thus would have a longer route to Point Lonely than Atigaru Point. This would increase disturbance and displacement to marine mammals along the vessel route.

3.13.2.8 Module Delivery Option 3: Colville River Crossing

Because Option 3 would not use an MTI but would use the existing commercial dock at Oliktok Point, the amount of in-water work and the amount of gravel fill would be substantially reduced from Options 1 or 2 (Table 3.13.4). The only in-water activity would be the barging of materials and modules. No additional screeding would be required at Oliktok Dock and the lightering area beyond that proposed for the action alternatives. Because fewer seals use the area near Oliktok Point than near Atigaru Point (as evidenced by more overlapping subsistence use near Atigaru Point than near Oliktok Point [SRB&A 2010]), effects from vessels carrying and off-loading modules would be lesser than those from Option 1. In addition, marine mammals (primarily seals) along the nearshore barge route could be temporarily disturbed or displaced due to noise and slow-moving vessels. Effects of vessel traffic are described in Section 3.13.2.3.2.2 and Section 3.13.2.3.3. Because there is existing marine infrastructure at Oliktok Point, barging in this area could result in a less novel response from marine mammals than in areas with no human development or activity. Option 3 would also have 23% of the support vessel traffic of either Options 1 or 2, and the vessels would have to travel only a fraction of the miles required for Options 1 or 2 (Table 3.13.4).

Onshore, sealift modules would be transported from Oliktok Dock south to DS2P on existing gravel roads in Kuparuk. Several curves along the road would need to be widened to accommodate module transport. All 5.0 acres of road improvements would result in a corresponding loss of habitat for polar bears. The nearest known polar bear maternal den is approximately 0.3 mile from the proposed gravel fill, although this is not necessarily indicative that polar bears would den in the same area again (Durner, Fischbach et al. 2010; USGS unpublished data) (Table 3.13.4, Figure 3.13.4).

Ice infrastructure would cover 666.6 acres (all inland from the coast by at least 17 miles), which would temporarily alter polar bear habitat during winter construction. Specifically, the crossing of the Colville River at Ocean Point is located in polar bear potential terrestrial denning habitat (Figure 3.13.4), though part of the Option 3 ice road route east of the Colville River is not mapped for this habitat type. The nearest known polar bear maternal den is approximately 10.3 miles from the Option 3 ice road route (across the Colville River from Nuiqsut), although this is not necessarily indicative that polar bears would den in the same area again (Durner, Fischbach et al. 2010; USGS unpublished data) (Figure 3.13.4). Effects of ice infrastructure on marine mammals are described in Section 3.13.2.3.1. No ice or gravel infrastructure would be constructed in polar bear critical habitat.

Option 3 would have substantially less ground traffic and associated noise than Options 1 or 2, which would result in less disturbance or displacement of polar bears (Table 3.13.4). In addition, most of the winter ground traffic would occur more than 17 miles from the coast, where bears are less likely to be (Figure 3.13.3). Because all ice roads and pads would be inland, there would be no impacts to seals. Some summer traffic would occur on existing Kuparuk roads, including near Oliktok Dock (Table 3.13.4).

Option 3 would also have substantially less air traffic than Options 1 or 2 (Table 3.13.4). However, because Option 3 would be the only option to fly to or from Alpine and Kuparuk, there would be added flight paths through the CRD (Figure 3.6.1). Estimated construction flight paths could traverse near known locations of spotted seal haulouts (Figure 3.11-4 in USACE 2018). This portion of the analysis area near Alpine and Kuparuk experiences a higher amount of weekly (GMT) or daily (Kuparuk) aircraft traffic than other areas on the North Slope, and an incremental addition of air traffic there is unlikely to be detected by marine mammals. Effects from traffic are described in Section 3.13.2.3.2.

Option 3 would require a 100-person camp located on a 15-acre single-season ice pad near the DS2P access road to support module moves during the winters of 2025 and 2027 (Alternatives B and C; Alternative D would occur during the winters of 2026 and 2028). Polar bears may be attracted to human facilities, as described in Section 3.13.2.3.3, which could increase human-bear interactions and increase the risk of injury or mortality of bears.

3.13.2.9 Special Status Species

All the effects described for Alternatives B, C, and D would apply to polar bears. Effects from construction air traffic over the CRD, improvements to Oliktok Dock, and screeding would apply to bearded and ringed seals. Effects from vessel traffic would apply to all ESA species in Table 3.13.1.

All the effects described for Options 1, 2, and 3 would apply to polar bears: habitat loss; habitat alteration from screeding and ice infrastructure; disturbance or displacement from barging, construction, and ground and air traffic; and injury or mortality from attraction to human facilities. Habitat loss would be long term, all other effects would last several years to several weeks (two nonconsecutive summer seasons of barging and screeding; 4 weeks of dock construction over a single summer; two nonconsecutive winters with ice road and ice pad construction; and 5 total years of ground and air traffic). Impacts to bearded and ringed seals could occur from barging, screeding, improvements to Oliktok Dock, and air traffic described for Option 3.

Table 3.13.4. Effects to Marine Mammals from Module Delivery Options

Project Component	Effect to Marine Mammals	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Gravel fill in marine area	Polar bears and seals: Open nearshore water and benthic habitat loss Temporary habitat alteration from sedimentation or turbidity Disturbance or displacement from noise	12.8 acres lost in sea ice critical habitat 11 to 15 acres altered 125 dB rms at 328 feet from the source	13.0 acres lost in sea ice critical habitat 11 to 15 acres altered 125 dB rms at 328 feet from the source	None
Gravel fill onshore	Polar bears: Habitat loss Disturbance or displacement during construction from airborne noise or human activity	None	None	5.0 acres filled along existing Kuparuk roads (0 acres in critical habitat) 78 dBA at 50 feet from the source during construction
Pile and sheet pile installation and removal	Polar bears and ice seals: Disturbance or displacement from noise	101 dBA at 50 feet from the source 9 pipe piles 200 feet of sheet piles (685 total sheet pile)	Same as Option 1	None
Screeding	Polar bears and seals: Temporary habitat alteration (increased turbidity, and decreased benthic forage) Disturbance or displacement from underwater noise or human activity	14.5 acres altered in sea ice critical habitat, 2 occurrences 164–179 dB rms at 3.28 feet from the source	Same as Option 1	No additional screeding beyond what is described for Alternatives B, C, or D
Ice infrastructure	Polar bears: Temporary habitat alteration Disturbance or displacement from construction airborne noise or human activity	Total acres: 943.9[a] (~60.3% in critical habitat) Onshore: 859.6 Offshore: 84.3 78 dBA at 50 feet from the source during construction	Total acres: 1,777.1[a] (~16.5% in critical habitat) Onshore: 1,756.1 Offshore: 21.0 78 dBA at 50 feet from the source during construction	Total acres: 666.6[a] all onshore (0% in critical habitat), 17.2 miles inland at its closest point Approximately 2,000-foot-long ice bridge across the Colville River with 700 feet spanning the active winter channel Additional 850 feet (total) of ice ramps 78 dBA at 50 feet from the source during construction
Ground traffic[b]	Polar bears: Disturbance or displacement from airborne noise or human activity	2,306,110 total trips (2022 through 2027) 0 trips per summer 43,680 to 1,082,620 trips per winter and spring (up to 279.6 trips per hour)	3,196,450 total trips (2022 through 2027) 0 trips per summer 43,680 to 1,475,740 trips per winter and spring (up to 381.1 trips per hour)	535,160 total trips (2023 through 2027) 0 to 4,590 trips per summer (2023 through 2026) 264,988 trips per winter and spring (2025 and 2027) (up to 68.4 trips per hour)

Project Component	Effect to Marine Mammals	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Air traffic[b]	Polar bears and seals: Disturbance or displacement from construction airborne noise or human activity	326 total fixed-wing trips (2022 through 2027); 69 to 81 dBA at 1,000 feet from the source Near the coast: 0 in summer to/from Alpine, 10 to 15 in winter and spring 2022; 0 to 12 per summer to/from Atigaru Point, 5 to 18 per winter and spring 450 total helicopter trips (2022 through 2027); 70 to 80 dBA at 1,000 feet from the source 15 in summer to/from Alpine (2022)	326 total fixed-wing trips (2022 through 2027); 69 to 81 dBA at 1,000 feet from the source Near the coast: 0 in summer to/from Alpine, 10 to 15 in winter and spring 2022; 0 to 12 per summer to/from Point Lonely, 5 to 18 per winter and spring 450 total helicopter trips (2022 through 2027); 70 to 80 dBA at 1,000 feet from the source 15 in summer to/from Alpine (2022)	70 total fixed-wing trips (2023 through 2027); 69 to 81 dBA at 1,000 feet from the source Near the coast: 5 to 9 per winter and spring to/from Alpine (2025 and 2027), 0 in summer and fall; 0 to 6 per summer to/from Kuparuk; 5 to 9 per winter and spring (2025 and 2027) 16 total helicopter trips (2023 through 2027); 70 to 80 dBA at 1,000 feet from the source 8 per summer to/from Alpine (2025 and 2027)
Barge and support vessel traffic[b]	All marine mammals: Temporary disturbance or displacement from underwater noise and human activity Injury or mortality from vessel strikes	Nearshore barge route ~1,100 miles RT, support vessel route ~100 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons 145 to 175 dB rms at 3.28 feet from the source (distance to 120 dB rms underwater threshold is 7,067 feet for all marine mammals)[c]	Nearshore barge route ~1,000 miles RT, support vessel route ~200 miles RT 9 barges, 16 tugboats, and 259 support vessels, 4 summer seasons 145 to 175 dB rms at 3.28 feet from the source (distance to 120 dB rms underwater threshold is 7,067 feet for all marine mammals)[c]	Nearshore barge route ~1,200 miles RT, support vessel route ~5.2 miles RT 9 barges, 16 tugboats, and 60 support vessels, 2 summer seasons 145 to 175 dB rms at 3.28 feet from the source (distance to 120 dB rms underwater threshold is 7,067 feet for all marine mammals)[c]
All	Polar bears: Total acres of offshore disturbance (within 0.5 mile of in-water work, USFWS buffer)[c] Total acres of onshore disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)	1,450.5 acres within 0.5 mile of in-water work 935.4 acres within 1 mile of onshore work	1,450.5 acres within 0.5 mile of in-water work 1,296.3 acres within 1 mile of onshore work	1,277.4 acres within 0.5 mile of in-water work 521.0 acres within 1 mile of onshore work
All	Distance to nearest known polar bear den[d]	3.6 miles to gravel infrastructure < 0.1 mile from ice infrastructure	8.8 miles to gravel infrastructure < 0.1 mile from ice infrastructure	2.8 mile to gravel infrastructure 10.3 mile from ice infrastructure

Note: ~ (approximately); < (less than); dB (decibels); dBA (A-weighted decibels); rms (root-mean-square); RT (round trip); USFWS (U.S. Fish and Wildlife Service). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*.

[a] Includes multi-season ice pads in total.

[b] Traffic is detailed in Tables D.4.34, D.4.35, D.4.40, D.4.41, D.4.44, D.4.45, D.5.8, D.5.9, D.5.13, D.5.14, D.5.16, and D.5.18 in Appendix D.1, *Alternatives Development*.

[c] Disturbance for underwater noise sources (vessels, barges, screeding) is calculated using the National Marine Fisheries Service underwater disturbance threshold of 120 dB rms assuming transmission loss of 15 log(R) for all marine mammals, including polar bears. It is understood that the USFWS recommends the use of 160 dB rms for disturbance of underwater sounds for polar bears, the underwater threshold of 120 dB rms was used to be consistent in the Environmental Impact Statement and Section 7 consultations. The disturbance area is not quantified for the barge route since the route is estimated.

[d] The presence of a historical polar bear den is not necessarily indicative that polar bears would den in the same area.

3.13.2.10 Oil Spills and Accidental Releases

The EIS evaluated potential effects from accidental spills. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste and hazardous materials during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would not be expected to affect marine mammals.

Spills from oil infrastructure could occur during drilling and operations from leaking wellheads, facility piping, process piping, or ASTs but would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. In the unlikely event that a pipeline spill occurs at a river crossing during high water flow, the extent of the accidental release could be larger and affect polar bear terrestrial habitat. A spill from a pipeline crossing streams in the Willow area may reach the channels of Fish (Iqalliqpik) Creek or the Kalikpik River, particularly during periods of flooding. The relatively low flow and highly sinuous nature of streams in the Fish (Iqalliqpik) Creek and Kalikpik River basin may preclude a spill into one of these rivers from reaching Harrison Bay.

If a reservoir blowout were to occur, there is the potential for oil to reach nearby freshwater lakes and stream channels; however, oil is unlikely to reach Harrison Bay due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

If a spill to the marine environment were to occur from vessels used during MTI construction or sealift module delivery, it would be expected to be very small to small, limited to refined products (e.g., diesel, lubricating oil), localized to the immediate area of the vessel route or MTI, and short in duration (less than 4 hours). The expected spill occurrence rates for these spill types would be low to very low and the spills would be expected to occur during construction of the module transport site itself or originate from smaller watercraft (e.g., tugboats that handle the module transport barges, support vessels). It would be possible, although of very low likelihood, that a medium to very large spill could occur along existing marine waterways leading to the sealift module transfer site. This would only occur if a tugboat or barge transporting modules runs aground, sinks, or its containment compartment(s) were breached, and the contents released (USACE 2012). The duration of these spill types would vary from about a day to up to several days, depending on the spill's location and the proximity of the shore-based response. Similarly, the geographic extent of these spills would vary and may or may not reach land, depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Since the duration and frequency of marine vessel use for the Project would be limited, the likelihood of a spill of this nature would be very low.

The HDD crossing of the Colville River with diesel and seawater pipelines could also create a potential risk of a spill. However, the risk would be very low (approaching zero) since the pipelines would be insulated and placed within an outer pipeline casing, which would inhibit heat transfer to permafrost, contain fluids in the event of a leak or spill, and provide structural integrity. The existing HDD crossing of the Colville River by the Alpine Sales Oil Pipeline has had no spills to date; it was constructed in 1998 and 1999 and is similar in design and size as that proposed for Willow. Any unintended releases from the diesel pipeline within the outer pipeline casing would be detected and responded to quickly. It would be very unlikely that fluids would reach the Colville River or the delta and expose marine mammals. If they did, pre-staged spill response materials located throughout the CRD would allow a quick response and increase the likelihood of containment.

If an accidental release occurs and enters a habitat in which polar bears or their prey could be exposed, injury or mortality could occur. Although there have been no documented impacts on polar bears from oil spills on the North Slope, in the unlikely event of a spill, polar bears or other marine mammals could be exposed to toxic substances. Effects on experimentally oiled captive bears have included acute inflammation of the nasal passages, marked epidermal responses, anemia, anorexia, biochemical changes indicative of stress, renal impairment, and death (Øritsland, Engelhardt et al. 1981; USFWS 2006). Oiling could cause significant thermoregulatory problems by reducing the insulation value of the pelt (Hurst and Øritsland 1982; Øritsland, Engelhardt et al. 1981). In experimental oiling, many effects did not become evident until several weeks after exposure to the oil (USFWS 2006).

Oil ingestion by polar bears through consumption of contaminated prey and by grooming or nursing could have pathological effects, depending on the amount of oil ingested and the physiological state of the bear (USFWS 2006). It is likely that polar bears swimming in, or walking adjacent to, an oil spill will inhale petroleum vapors. Inhalation of highly concentrated vapors, such as gasoline in excess of 10,000 parts per million, is typically fatal (Boesch and Rabalais 1987). At lower concentrations, up to 1,000 parts per million, humans and laboratory animals can develop inflammation, hemorrhaging, and congestion of the lungs (Boesch and Rabalais 1987).

Øritsland, Engelhardt et al. (1981) reported that inhalation of hydrocarbons from crude oil in a confined space may have been a factor in the death of two of three captive polar bears exposed to oil in their experiments.

Other marine mammals could be impacted by an accidental release in the following ways: 1) acute toxicity caused by an event such as an oil spill can result in acute mortality or injured animals with neurological, digestive, and reproductive problems, and/or 2) can cause detrimental effects to the population through complex biochemical pathways that suppress the immune system or disrupt the endocrine system of the body causing poor growth, development, reproduction, and reduced fitness (NMFS 2008). Contamination of lower trophic-level prey could also reduce the quality and/or quantity of marine mammal prey in the area of the release. In addition, individuals that consume contaminated prey could experience long-term effects to health (Geraci 1990). Releases would likely be isolated to the immediate area and not affect large areas or important marine mammal foraging sites.

3.13.3 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with BMPs in place, some unavoidable impacts to marine mammals would occur, including direct loss of habitat and disturbance, displacement due to noise, and the physical presence of equipment or personnel. These impacts would be irretrievable throughout the life of the Project. Most impacts would not be irreversible or affect the long-term sustainability of marine mammals in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible. The alteration of nearshore habitat would be irreversible because even if the MTI is abandoned and reshaped, it would still exist.

3.14 Land Ownership and Use

The analysis area for land ownership and use extends from Kuparuk Mine Sites C and E and a portion of the existing Kuparuk gravel road network and Oliktok Point on the east, to Point Lonely on the west, 3 miles offshore into the Beaufort Sea to the north, to 2 miles south of the southernmost Project element (Figure 3.14.1).

The temporal scale for Project impacts would last beyond the construction and operation of the Project and would continue until reclamation is complete. Research on gravel pad restoration on the North Slope indicates that recovery of plant cover to comparable levels to adjacent tundra would be greater than 20 to 30 years (Everett 1980). If reclamation did not occur, effects would be permanent.

Because current and prospective future permitted recreation use in the analysis area is low (BLM 2012b), this land use is not analyzed in detail in the EIS.

3.14.1 Affected Environment

Land ownership in the analysis area differs by surface and subsurface estate, particularly for lands granted to ANCSA corporations. ANCSA regional corporations (e.g., the ASRC typically received both surface and subsurface estates on lands transferred to them. Village corporations (e.g., Kuukpik) typically received surface estate, with subsurface estates granted to their regional corporation. Lands selected by ANCSA corporations but not conveyed (selected lands) remain federal lands managed by BLM.

Within the land use analysis area, approximately 48.1% of the surface estate (Figure 3.14.1) is managed by BLM. The Department of Defense has a land withdrawal at Oliktok Point occupying 591.2 acres. The State owns 636,266.3 acres (26.2%) of the analysis area east of the Colville River. The NSB has two parcels east of the Colville River, one near Kuparuk and one east of the main access road that heads south from Kuparuk DS2M; these make up 0.1% of the analysis area. Other nonfederal surface ownership in the analysis area includes 145,159.7 acres (6.0%) conveyed to the Kuukpik (the ANCSA village corporation for Nuiqsut) and 31,819.4 acres (1.3%) have been selected by ANCSA corporations (selected lands) but not conveyed. There are several Native allotments in the western portion of the analysis area and others along the CRD and near Oliktok Point and Ocean Point, making up 4,233.5 acres or 0.2% of the analysis area. Less than 0.1% of the land in the analysis area is private land. Surface land management in the analysis area is summarized in Table 3.14.1.

The state owns navigable waters subsurface onshore and tidal areas seaward of the Beaufort Sea coast out to 3 miles. BLM manages subsurface rights on federally owned surface lands and on many, but not all, Native allotments, including the subsurface in the BTU, where the subsurface aspects of the Project would occur (Figure 3.14.1).

The land within the analysis area is wildlife habitat and used for subsistence. Within the NPR-A, BLM has authorized several research permits, **special recreation permits**, the NSB Community Winter Access Trail, and winter cross-country rights-of-way. Areas of industrial use (oil and gas exploration and development) occur in the Alpine and GMT developments. Nuiqsut is primarily residential, with some institutional and commercial uses. Oliktok Dock is used for industrial purposes and marine shipping.

Table 3.14.1. Surface Land Management in the Analysis Area

Land Manager	Acreage	Percentage of Total
Bureau of Land Management	1,169,491.6	48.1
U.S. Department of Defense	591.2	< 0.1
Private	157.9	< 0.1
Alaska Native Allotment	4,233.5	0.2
Alaska Native Lands patented or interim conveyed[a]	145,159.7	6.0
Alaska Native Lands (selected)	31,819.4	1.3
State of Alaska	636,266.3	26.1
Local government	1,227.4	0.1
Undetermined (waterbodies)	443,437.5	18.2
Total	**2,432,384.5**	**100.0**

Note: < (less than).
[a] Also referred to as Alaska Native Claims Settlement Act lands.

The NSB regulates land use and development in the borough under the *North Slope Borough Area Wide Comprehensive Plan* (NSB 2005) and the NSB zoning regulations (North Slope Borough Municipal Code [NSBMC] Title 19). Three NSB zoning designations apply to areas within the analysis area:

- Resource Development Districts are designed to address resource impacts early and provide for streamlined permit approvals in each district.
- Conservation Districts are designed to conserve natural resources that residents depend on for subsistence.
- Village Districts govern city limits and coincide with the official boundaries of the City of Nuiqsut.

Conservation District is the default designation for lands outside of village districts that have not been rezoned for development. Conservation Districts allow for some exploration activities, but construction of oil and gas development facilities, such as gravel roads and pads, require lands to be rezoned to Resource Development District.

Rezoning to Resource Development District requires submittal of a detailed MDP and documentation of conformance with other NSB conditions. While a Resource Development District allows for more intensive resource development activities, permitted activities cannot permanently or seriously impair the surrounding ecosystem and its ability to support the plants and animals on which residents depend (NSBMC 2019). In the analysis area, lands owned by Kuukpik that lie outside of city limits are zoned for conservation, where not previously rezoned as part of the Alpine development (Figure 3.14.2).

BLM manages the NPR-A under the plan adopted in the IAP/EIS ROD published in 2013, and currently under revision (BLM 2020a). This plan allows for oil and gas development in most areas of the NPR-A but restricts development within the TLSA, in river setbacks, and in and other key areas to balance development with resource protection and minimize adverse effects on key bird and caribou habitats. Specific LSs and BMPs to be considered for the action alternatives are discussed in more detail in Appendix I.1.

3.14.2 Environmental Consequences

3.14.2.1 Avoidance, Minimization and Mitigation

3.14.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.14.2 summarizes existing NPR-A IAP LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to land ownership and land use from development activity (BLM 2013a). The LSs and BMPs would reduce impacts created by facilities, roads, airstrips, pipelines etc. on floodplains, rivers, streams, subsistence use, and hunting and fishing areas, and would provide opportunities for community involvement in planning to prevent conflicts with subsistence, cultural, and recreation uses. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.14.2. also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate land ownership and use impacts. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.14.2 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.14.2. Summary of Applicable Lease Stipulations and Best Management Practices to Mitigate Impacts to Land Ownership and Use

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.	Added text: – Subsistence pullout and access/egress ramps would be constructed in adequate numbers and at appropriate locations on all roads to facilitate access to subsistence use areas. – Permittees shall construct a subsistence pullout and boat ramp at all crossings of heavily used subsistence rivers, as determined in consultation with the community. – Permittees must allow subsistence use of permanent gravel roads and appropriate ice roads, consistent with safe operations, and shall provide communities and the BLM with concise policies regarding the use of all roads and hunting prohibitions, if any, along the roads and near facilities. – Permittees shall ensure that any road use guidelines and updated road maps are disseminated throughout the communities, including making them available online and through social media. – Before ice road construction begins, permittees associated with ice road construction shall hold community meetings to describe the routes and relevant information on all ice roads that would be constructed. – A Vehicle Use Management Plan shall be developed by the permittee to minimize or mitigate displacement during calving and that would avoid, to the extent feasible, delays to caribou movements and vehicle collisions during the midsummer insect season, with traffic management following industry practices.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Permanent facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high-water mark of fish-bearing waterbodies.	Changes do not affect text as described.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added Text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A post-construction monitoring program, developed in consultation with appropriate federal, State, and NSB regulatory and resource agencies, shall be required to track circulation patterns, water quality, and fish movements around the structure.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added Text: – Where aircraft traffic is a concern, balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations – For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize effects to natural stream flow.	Added text: – The crossing structure design shall account for permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment. – All proposed crossing designs would adhere to the standards outlined in fish passage design guidelines.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.	Changes do not affect text as described. Added text: – Aboveground pipelines shall have a nonreflective finish. – When laying out oil and gas developments, permittees shall orient infrastructure to minimize impeding caribou migration and to avoid corralling effects. – Before the construction of permanent facilities is authorized, the BLM will require a study of caribou movement for the impacted herd. The permittee may be required to conduct this study, or this requirement may be waived if an acceptable study specific to that herd has been completed within the last 10 years and is approved for use by the BLM.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation shall be in accordance with a plan approved by the BLM in consultation with appropriate federal, State, and NSB regulatory and resource agencies.	Added text: – The plan shall consider locations outside the active floodplain or designing gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present. –Mine pit design and methods shall be engineered to minimize permafrost regime disturbance and protect surface stability.
BMP E-11	BMP E-11 Objective: Minimize the take of species, particularly those listed under the ESA and BLM special status species, from direct or indirect interaction with oil and gas facilities.	– Power and communication lines shall either be buried in access roads or suspended on vertical support members except in rare cases. – Communication towers should be located on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. – Maintain a 1-mile buffer around all recorded Yellow-billed Loon nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.	Measures related to bird collisions with infrastructure moved to BMPs/ROPs E-10 and E-21. Other changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	The lessee/permittee shall consult directly with affected communities per required guidelines.	Projects that would occur within 50 miles of a community or fewer than 15 miles from the heavily used subsistence rivers listed in ROP F-4 shall submit a subsistence plan.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
LS/ BMP K-2	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; minimize the loss of spawning, rearing or overwintering habitat for fish; and the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).	Changes do not affect text as described. Additional restrictions as described in BMP/ROP E-11 may also apply in those habitats.
Stipu-lation K-16	Minimize the impact of rapid development on the communities within the NPR-A.	No similar requirement.	For alternatives B and E only: Lease tracts that are surrendered or currently unleased within the deferral area would not be offered for lease for the stated period of time after the signing of the IAP Record of Decision. a. The Teshekpuk Lake deferral area encompasses land on the eastern edge of the NPR-A boundary and land around Teshekpuk Lake and Atigaru Point (see BLM 2020). This lease deferral is valid for 10 years. From the eastern NPR-A boundary, the deferral area includes most of the following townships: • T14N, R1E, U.M. • T14N, R1W, U.M. • T14N, R2W, U.M. • T14N, R3W, U.M. • T14N, R4W, U.M. • T15N, R8W, U.M. • T16N, R8W, U.M. • T17N, R8W, U.M. • T15N, R9W, U.M. • T16N, R9W, U.M. • T17N, R9W, U.M. For alternative B only: The deferral area around Atqasuk extends 3 miles in all directions from land owned by the Atqasuk Corporation This deferral is valid for 5 years.

Source: BLM 2013a, 2020a
Note: BLM (Bureau of Land Management); BMP (best management practice); ESA (Endangered Species Act); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); ROP (required operating procedures).

All action alternatives would require deviations from LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect land use would include those to LS E-2 and BMPs E-7, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2) and the CFWR at Lake M0015

(Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. It may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7) due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site or at narrow land corridors between lakes where it is not possible to maintain 500 feet of separation between pipelines and roads without increasing potential impacts to waterbodies.

The boat ramp(s) would be located near the gravel road crossings of the Ublutuoch (Tiŋmiaqsiuġvik) River (all action alternatives), and Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek (under Alternative B), and due to these locations would require deviations from specific LSs and BMPs related to setbacks, buffers, and special use areas within the NPR-A. The boat ramps would require a deviation from LS E-2 and BMP K-2 due to gravel infrastructure near fish-bearing waterbodies. Because the intent of a boat ramp is to access a waterbody, it is not possible to avoid encroachment within 500 feet of the waterbody. The ramps at the Ublutuoch (Tiŋmiaqsiuġvik) River and Judy (Iqalliqpik) Creek would likely also cross the standard disturbance setback of 1 mile around recorded yellow-billed loon nest sites and 1,625 feet (500 m) around the shoreline of nest lakes. However, the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would be on Native land and thus LSs and BMPs would not apply in those areas. The boat ramp on Fish (Uvlutuuq) Creek (Alternative B) would be in the TLSA.

3.14.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.14.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

An additional suggested mitigation measure to reduce impacts created by Option 3 could include the following:

Develop a coordination plan with other stakeholders who are permitted to use the CWAT snow road (i.e., Nuiqsut residents) by BLM to prevent access conflicts during sealift module movement across the Colville River.

3.14.2.2 Alternative A: No Action

Under Alternative A, there would be no land ownership or land use impacts as the result of the Project; however, existing oil and gas activities and exploration in the area would continue as would existing impacts from development activity, including impacts created by facilities, roads, airstrips, pipelines, etc.

3.14.2.3 Action Alternatives and Module Delivery Options

The Willow MDP would serve as the MDP on which an NSB rezoning application would be based. The differences among the action alternatives and module delivery options are not expected to change NSB rezoning requirements, but the number of acres rezoned may vary by alternative and option. Areas with existing infrastructure around the Alpine and GMT developments, Oliktok Point, and Kuparuk, have been previously rezoned (Table 3.14.3). Most of the land affected under the action alternatives and module delivery options is managed by BLM, with about 4 acres of fill or excavation on ANCSA land and 1 to 2.3 acres on state land (depending on the alternative). No private lands, NSB lands, or Native allotments would be affected.

3.14.2.3.1 Action Alternatives

All action alternatives would be consistent with the restrictions on land use in a Resource Development District and would not permanently or seriously impair the surrounding ecosystem, as discussed in Sections 3.9 through 3.13. There would be no changes in land ownership under any of the action alternatives, and the changes in land use would be the same for all action alternatives. Land use would change from primarily subsistence harvest use and wildlife habitat with areas of oil exploration and development to specific areas of oil industry infrastructure (e.g., gravel pads and roads, WPF, pipelines, CFWR). Effects on subsistence and wildlife habitat land uses are discussed in Section 3.16 and Sections 3.10 through 3.14. The areas proposed for development under the action alternatives are all outside the Nuiqsut city boundaries and would not change land uses in the city.

The action alternatives would require BLM approval of deviations from specific LSs and BMPs related to setbacks, buffers, and special use areas within the NPR-A. BLM can approve these deviations if they achieve the objectives of the LS or BMP, or if the effects of the deviation are evaluated within another EIS, such as this document. Alternative B's access road (1.0 mile) and pipeline (1.4 miles) would cross through the CRSA raptor protection area and through a yellow-billed loon nest buffer. Infield roads and pipelines would also cross through the Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek river setbacks and additional yellow-billed loon nest buffers. Alternative B would also construct an infield road, a pipeline, and two drill sites (BT2 and BT4) within the TLSA (106.3 acres).

Alternative C would require most of the same deviations as Alternative B but would eliminate the road crossing through the Judy (Iqalliqpik) Creek river setback. This alternative would have an additional airstrip, storage, and camp facilities located near BT2 in the TLSA (179.7 acres).

Alternative D would require similar deviations to Alternatives B and C. This alternative would remove the mile of road through the CRSA raptor protection area, but would include 1.4 miles of pipeline in the CRSA. The infrastructure within the TLSA would cover 108.4 acres.

All three boat ramps could be constructed under Alternative B; Alternatives C and D would only construct the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp (due to lack of a gravel road connection to the other streams). The boat ramp on Fish (Uvlutuuq) Creek (Alternative B) would be within the TLSA. The boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River would be on Native land. Each boat ramp varies in size and layout and would add a maximum 5.9 acres of gravel footprint for all three boat ramps.

The CFWR would be constructed under all action alternatives. The reservoir would have a 16.3-acre excavation footprint with the water supply channel connecting to Lake M0015. A 7-foot-high reservoir perimeter berm (3.9-acre footprint) would be constructed from excavation spoils and capped with gravel. Pipelines would connect the CFWR to the WPF and WOC. Unused excavation spoils would be back hauled to the Project's gravel mine site, where the material would be placed in an excavated mine cell and used as backfill material.

Unprocessed oil from GMT-2 may be delivered to the WPF for processing; this would be consistent with restrictions on land use in a Resource Development District and would not create further impacts on the surrounding ecosystem. Connecting GMT-2 to the WPF would require the installation of new pipelines, powerline, and communications cable with the Project's pipelines on proposed VSMs between the WPF and GMT-2. GMT-2, located at the western edge of the GMT Unit, is permitted and currently under construction. The GMT-2 development was analyzed under a separate Supplemental EIS (BLM 2020b).

3.14.2.3.2 Module Delivery Options

Approximately 13 acres of state-submerged lands would be affected by module delivery Options 1 and 2, where the MTIs would be constructed. Module delivery Option 1 (Atigaru Point Module Transfer Island) and Option 2 (Point Lonely Module Transfer Island) would require ice roads from the MTI to the Project area. The ice roads would cross through the Teshekpuk Lake Caribou Habitat Area. Option 1 would affect some river setback areas and a portion of the Teshekpuk Lake Caribou Habitat Area closed to leasing. Option 2 would cross through similar river setback areas but much more of the Teshekpuk Lake Caribou Habitat Area, including areas closed to leasing and development of new non-subsistence infrastructure.

Option 3 (Colville River Crossing) would deliver the modules to the existing Oliktok Dock and transport them over the existing Kuparuk gravel road network to from the dock to DS2P, followed by transport via ice road to the Project area. The existing industrial use of the dock and gravel roads would not change. The ice road route from DS2P to the Project area would cross State of Alaska lands east of the Colville River and enter the NPR-A near Ocean Point. The ice road would cross the CRSA for two winter seasons. The area near Ocean Point is currently used by the NSB for its CWAT and by five other permitted commercial operators for transporting people and cargo. The Project would add additional commercial use to a portion of the route for two seasons.

Option 3 would add approximately 5.0 acres of new gravel footprint along the existing Kuparuk gravel road network, on lands that are owned or managed by the State of Alaska. The gravel for these road improvements would be acquired from an existing Kuparuk mine site (e.g., Mine Site C, E, or F).

The closest Project component to a Native allotment would be the ice road required under Option 3, which would be approximately 0.25 mile away.

3.14.2.3.3 Action Alternative and Module Delivery Option Summary and Comparison

The action alternatives and module delivery options differ in the acreages to be developed (Table 3.14.3). Alternative C would have the greatest footprint due to the elimination of a segment of infield road and the need for a second airstrip and operations center. Alternative D would have the smallest footprint through elimination of the gravel access road. State offshore submerged lands would be temporarily occupied for module delivery Options 1 and 2 which would construct an MTI. Option 3 would use the existing Oliktok Dock, impacting submerged areas around the dock. Given the vast scale of the analysis area, the difference in acreage among alternatives would not result in substantive differences in land use within the analysis area.

Table 3.14.3. Municipal Rezoning Needs and Total Project Footprint (acres) by Alternative or Option

Landowner/Manager	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Road	Alternative D: Disconnected Access Road	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Bureau of Land Management	608.4	662.5	596.3	0.0	0.0	0.0
Department of Defense	0.0	0.0	0.0	0.0	0.0	0.0
Private	0.0	0.0	0.0	0.0	0.0	0.0
Alaska Native Allotment	0.0	0.0	0.0	0.0	0.0	0.0
Alaska Native Lands patented or interim conveyed	4.0	4.0	4.0	0.0	0.0	0.0
Alaska Native Lands (selected)	4.6	4.6	5.9	0.0	0.0	0.0
State of Alaska	1.0	1.0	2.3	12.8	13.0	5.0
Local government	0.0	0.0	0.0	0.0	0.0	0.0
Undetermined (waterbodies)	2.3	1.7	2.0	0.0	0.0	0.0
Total footprint[a]	**620.3**	**673.8**	**610.5**	**12.8**	**13.0**	**5.0**
Acres of footprint zoned for resource development	**8.3**	**8.3**	**12.3**	**0.0**	**0.0**	**4.8**

[a] Total Project footprint includes 149.7-acre mine site footprint.

3.14.3 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with LSs, BMPs, and mitigation measures in place, shifts in land use are unavoidable and irretrievable during the life of the Project. However, these impacts are very small in context of the available lands in the area. These impacts would not be irreversible, nor would they impact long-term sustainability, if reclamation of permanent infrastructure occurs. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.15 Economics

The analysis area for economics is Nuiqsut (local economy), NSB (regional economy), and the State (state economy). Although Project activities are located on the North Slope in proximity to Nuiqsut, the employment generated by the Project and the revenues generated accrue to individuals and entities throughout the state. The temporal scale for the Project is defined as the beyond the life of the Project (30 years) until reclamation is complete (estimated to be greater than 20 to 30 years; Everett et al. 1985), as economic effects of operations would occur throughout this period. If reclamation did not occur, some effects could be permanent.

Information on the relevant economies are summarized below. This discussion incorporates by reference Section 3.4.11, *Economy*, in the BLM Final IAP/EIS (2012b, 2020a), and more detail on the regional and state economy is provided there.

3.15.1 Affected Environment

Key economic information for the three economies is summarized in Table 3.15.1.

Table 3.15.1. Summary of Key Economic Data (2012 through 2016 5-year estimates)

Economic Element	Nuiqsut	North Slope Borough	State of Alaska
Civilian labor force	162	5,990	384,093
Employed	130	5,393	353,954
Unemployed	32	597	30,139
Unemployment rate	19.8%	10.0%	7.8%
Mean/Median household income	$97,495/$84,464	$88,304/$72,027	$92,191/$74,444
Mean/Median family income	$88,604/$74,750	$94,337/$77,330	$103,495/$87,365
Per capita income	$24,312	$49,982	$34,191
Families below poverty level	2.4%	11.8%	7.0%
People below poverty level	6.4%	11.2%	10.1%

Source: U.S. Census 2018b

Note: The American Community Survey report data collected between 2012 and 2014 calculates an average representative of that time period. This is the best national source for small area economic data.

3.15.1.1 Local Economy (Nuiqsut)

Nuiqsut is a small Iñupiat community incorporated as a second-class city under AS Title 29, Municipal Government. Second-class cities may provide local services and levy taxes; Nuiqsut has adopted a bed tax and a tobacco tax (ADCCED 2018a). Most economic activity in Nuiqsut is generated by the borough, city, and tribal governments as well as the ANCSA corporations. Government jobs account for 63% of total employment, and most employed residents work in public administration or educational and health services (U.S. Census 2018b). Construction, transportation, and utilities account for most other employment sectors and are often associated with government, ANCSA corporations, or the oil industry. Although the oil industry is the major private industry employer in the area, most oil industry jobs require specific skillsets and are filled by workers from outside the North Slope. The high unemployment rate (19.8%; Table 3.15.1) reflects the lack of employment opportunities for community residents.

The NSB conducts its own economic census survey periodically and provides estimates for the cities within the borough. The survey report from 2015 notes that the NSB considers unemployment in NSB communities to be underestimated by the U.S. Census Bureau (U.S. Census) and that 36.5% of the Nuiqsut labor force was unemployed (NSB 2016). The NSB also reports that a much higher estimated proportion of Nuiqsut households fall below the poverty level (47%) compared to the 2.4% estimate by the U.S. Census (NSB 2016; U.S. Census 2018b). The NSB survey report cautions that some data, particularly on income, may be unreliable due to a high rate of missing data in some communities, including Nuiqsut.

Nuiqsut households receive approximately half of their income from wages and half from corporation and state permanent fund dividends (NSB 2016). However, some residents in Nuiqsut are not Kuukpik shareholders and therefore do not receive Kuukpik dividends. Nuiqsut has lower per capita and household wage income than most other NSB communities but has higher dividend income than most. This is likely related to the proximity of recent oil and gas exploration and development on lands in the Nuiqsut vicinity. Kuukpik, the ANCSA village corporation for Nuiqsut, owns lands in the vicinity and provides oil field support services, including lodging services in Nuiqsut. Over 61% of household heads in Nuiqsut report receiving village corporation dividends, a decrease from 78% in 2010.

The cost of living in remote Alaskan communities like Nuiqsut is substantially higher (42%) than in Anchorage (Fried 2015; Fried and Robinson 2005). Nuiqsut has experienced some decrease in the cost of living since the development of the Alpine oil field (approximately 4 miles north of the community). Alpine provides natural gas to Nuiqsut for heating, reducing a major household cost component.

The value of subsistence harvests is a substantial part of the local economy. Although not a cash resource, subsistence provides valuable food resources to community members; almost 99% of Nuiqsut households use subsistence food resources, and over 70% of households use subsistence resources for more than half of their diet (NSB 2016). Although subsistence resources are not traded in the cash economy, ADF&G estimates a replacement value of subsistence foods at $6 to $8 per pound (ADF&G 2016b). At that value, 2014 harvest levels would have had an estimated replacement value of $20,664 to $27,552 per household (ADF&G 2016b). Participation in subsistence also involved cash expenses for supplies, vehicles, and fuel used in harvests. Nuiqsut subsistence participants reported that they spent an average of $7,062 on subsistence activities in 2010 (NSB 2015c).

Nuiqsut is primarily a residential community, but it has institutional facilities associated with the city, borough, and tribe. It is the only North Slope community that is connected to the state's gravel road system by ice road for about 4 months of the year. Commercial businesses are limited, but Kuukpik operates a hotel in the city. The city's bed tax is 12% and generated $163,928 in revenue in 2017 (ADCCED 2018a). The city's tobacco tax (100 mills per cigarette) generated another $44,416. Most public infrastructure and services in the community (e.g., drinking water and wastewater, health, police, emergency services) are provided by the NSB (NSB 2015c).

Nuiqsut is eligible for grant funding under the NPR-A Impact Grant Program. The NPR-A Impact Grant Program administers grants from federal royalties, which are used to offset development impacts or improve communities impacted by development, as described in Section 5.3.1, *State of Alaska National Petroleum Reserve in Alaska Impact Grant Program*. BLM shares 50% of revenues generated by oil and gas development in the NPR-A with the state for essential public services and facilities, and the state must give priority to areas most directly or severely impacted by the NPR-A development. Nuiqsut received $6,492,596 in NPR-A mitigation grants over the past 10 years (ADCCED 2018b). These grants supported general government operations, youth center operations and maintenance, a boat ramp, and community center maintenance. The city also received another $289,636 in other grants in the same period (ADCCED 2018b).

3.15.1.2 Regional Economy (North Slope Borough)

The NSB is a home rule borough under Title 29 and provides land use regulation, education, and other government services to residents across the North Slope. Home rule boroughs have broad discretion on providing services and have taxing authority.[13] The only tax levied by the NSB is property tax. The NSB economy is primarily based on oil and gas industry revenues; most NSB revenue is from property taxes on oil and gas infrastructure, such as processing equipment, pipelines, and other facilities. Property taxes provide more than $392 million (72%) of NSB's $542 million in total revenues, and oil and gas properties provide 95% of total property tax revenues (NSB 2017). North Slope oil production peaked in 1988 and then entered a steady decline through 2015 (USEIA 2016). Private investments made in response to state exploration and production incentives reversed the decline, and production increased in 2016 and 2017. NSB enterprise revenues for utility services at Prudhoe Bay decreased in 2017, but oil and gas property tax revenues increased (NSB 2017).

To manage the risks associated with a dependence on natural revenue extraction, the NSB has also invested revenues in an investment fund; this fund had investment earnings of $68.5 million and an asset value of $644.6 million in 2017 (NSB 2015a).

Twenty-six percent (26%) of employees in the NSB were classified as government employees, while 73% were classified as private sector employees for 2012 through 2016, with 27% of employees working in natural resources, primarily oil and gas (U.S. Census 2018b). However, this statistic is skewed as it includes nonresident oil and gas workers listing Prudhoe Bay as their primary place of residence as opposed to their employment location. The Alaska Department of Labor and Workforce Development (ADLWD) reported that in 2016, only about 18% of people working in the NSB were NSB residents (ADLWD 2016). In 2014, an estimated 18,786 non-NSB residents worked in the NSB (ADLWD 2017). These employees work extended schedules, primarily in oil industry–related jobs located at drill sites and processing facilities across the North Slope; they are housed in company facilities during their work shifts and regularly fly in and out of the NSB. About 40% of these workers came from outside Alaska in 2014 and 60% came from elsewhere in Alaska, mostly Anchorage and the Matanuska-Susitna Borough (ADLWD 2016).

The NSB reported that only 11 NSB residents (1% of employed residents) indicated that they worked in the oil and gas industry (NSB 2016). Many of the workers in other sectors, such as local government, construction, retail trade, professional and business, and education and health, are employed by subsidiary companies that provide a variety of services (e.g., hospitality, construction) to the oil and gas industry. Others are employed by the NSB or the State in jobs supported by oil and gas revenues. Total direct and indirect NSB-resident jobs supported by the oil and gas industry was estimated at 1,845 jobs and $105 million in income in 2016 (McDowell Group 2014). Based on this estimate of direct and indirect jobs associated with the oil and gas industry on the North Slope and the total number of employed persons, more than one in three jobs held by NSB residents was directly or indirectly supported by the oil and gas industry (McDowell Group 2014; U.S. Census 2017a).

The major contributors to household income for the NSB are wages (70%), corporation dividends (13%), the Alaska Permanent Fund dividend (9%), and income from other sources (8%) such as pensions, child support, and Social Security (NSB 2016). The U.S. Census reported that the 2012 to 2016 NSB median household income was $72,027; the mean household income was $88,304; and per capita income was $49,982 and that 11.8% of NSB families had income below the poverty level (U.S. Census 2017b).[14] The NSB 2015 socioeconomic survey report provides very different income data: the NSB reported that the 2015 average household income was $62,367; per capita income was $16,782; and 26% of all NSB households were below the poverty level (NSB 2016).

The NSB provides public health and safety; potable water and wastewater service; and transportation infrastructure primarily within village communities and in oil development areas. Most areas within the NSB are remote and uninhabited and have no public infrastructure or services.

The NSB also receives grant funding under the NPR-A Impact Grant Program. As discussed above, the NPR-A Impact Grant Program administers grants from federal royalties, which are used to offset development impacts or improve communities impacted by development (Section 5.3.1). The NSB received $29,748,182 in NPR-A Impact Grant Program funds over the past 10 years (ADCCED 2018b). The NSB used the grants for several services, including school counselors, comprehensive planning for communities, and land management and permitting. The NSB received $20 million in other state grants over this same period (ADCCED 2018b).

[13] Under Title 29, home rule boroughs have the authority to exercise any powers not specifically prohibited by state law. Home rule boroughs adopt a charter that provides the services to be provided and service areas as well as taxing authority for the borough.

[14] U.S. Census Bureau NSB data since 2015 includes 2,174 nonresidents housed at Prudhoe Bay, so these estimates may be high.

3.15.1.3 Alaska's Economy

Alaska's economy is also tied closely to the oil and gas industry, with 72% of general fund revenues coming from oil and gas revenues in fiscal year 2016 (McDowell Group 2017). These revenues are generated by taxes on production, property, and corporate income, royalties, and other minor industry sources. The State supports local governments through a variety of grant programs. The majority of State funding support to local governments over the past 10 years has been associated with the federal royalties provided through the NPR-A Impact Grant Program. NPR-A Impact Grant Program grants accounted for 96% of all grant funds to Nuiqsut over the past 10 years and 59% of total grant funds to the NSB (ADCCED 2018b). Other grants were associated with American Recovery and Reinvestment Act funding or specific legislative funding requests. These annual allocations from these grants are a crucial source of revenue, especially to small, remote communities (Duke University Energy Initiative 2016).

State infrastructure and services on the North Slope are limited. The State owns and maintains an airport in Utqiaġvik and Deadhorse, but most other infrastructure and services on the North Slope are provided by the NSB.

Declining oil production and low oil prices in the last several years resulted in a declining oil revenues and industry activity in Alaska. Oil and gas revenues to the state have decreased from a high of $9.9 billion in fiscal year 2012 to $1.6 billion in fiscal year 2016 (McDowell Group 2017). Decreasing state revenues have resulted in budget deficits that have reduced state savings accounts and resulted in a decrease of 1,691 state jobs between March 2014 and March 2016 (Guettabi 2017). Private-sector jobs in Alaska also fell by 1,518 over that time period. The decline in oil production has been abated more recently, and several new oil fields are currently under exploration and/or development. However, state budget deficits are predicted to continue in the near future, with reduced funding of programs and projects likely leading to a smaller state economy for the near future.

3.15.2 Environmental Consequences

The North Slope communities have a mixed cash and subsistence economy. An assessment of the potential cash economy effects of the Willow MDP alternatives was prepared by Northern Economics Inc. (NEI) and is included as Appendix E.15, *Economics Technical Appendix*. The NEI economic assessment estimates the capital expenditures for the Project using proprietary project capital expenditure data from other developments with processing facilities on the North Slope and a regression model that considers the volume of oil and natural gas liquids produced over the life of the field.

The effects on the subsistence economy are described in detail in Section 3.16 and are not repeated in this section.

3.15.2.1 Avoidance, Minimization, and Mitigation

3.15.2.1.1 Applicable Lease Stipulations and Best Management Practices

There are no NPR-A IAP LSs and BMPs that would apply to the Project to mitigate economic impacts.

3.15.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.15.2.1.3 Additional Suggested Best Management Practices or Mitigation

There are no additional mitigation measures recommended for economic impacts.

3.15.2.2 Alternative A: No Action

Under Alternative A, the Project would not be developed and there would be no increase in employment or wages in Nuiqsut, the NSB, or the state. Employment opportunities in Nuiqsut and the NSB would remain at current levels and oil sector employment in the state would likely decrease. New property tax revenues would not be generated for the NSB and no new oil and gas tax revenues would be added to the Alaska general fund or the NPR-A Impact Grant Program.

3.15.2.3 Alternative B: Proponent's Project

3.15.2.3.1 Construction and Drilling

Construction would result in increased employment locally, regionally, and statewide. Direct construction employment from the Project would have an annual average anywhere from 130 to 1,073 jobs per year for 7 years of full construction (2021 through 2028) and average 26 and 65 jobs for the first and last year of construction (2020 and 2029), respectively. Peak construction employment is anticipated to occur in 2023 with a seasonal peak of 1,650 jobs and an annual average peak of 1,073 jobs. A small portion of these construction jobs would likely be filled by NSB residents, including some Nuiqsut residents. As with most oil field development employment, most of the jobs would be filled by nonresidents of the NSB. Despite the low number of jobs filled by NSB residents, any industry employment would impact the local and regional economy given the limited nongovernment job opportunities. Local residents may also be employed by local industry support companies contracted to provide goods and services during construction. If local oil industry support companies, such as those owned by Kuukpik or ASRC, earn revenues on the Project, this would indirectly affect local incomes through increased dividends. Occupancy of the Kuukpik Hotel would likely increase during construction, increasing tax revenues from the city's 12% bed tax.

Construction effects on local services and infrastructure would be limited given the self-sufficient nature of North Slope oil field construction activities. Oil and gas development on the North Slope does not increase demand for local services, as construction camps are developed to provide lodging, food, utilities, and other services needed by workers.

Alternative B direct construction employment estimates are summarized in Table 3.15.2.

Table 3.15.2. Direct Construction Employment Estimates

Year	Seasonal Peak	Annual Average
2020	40	26
2021	200	130
2022	750	488
2023	1,650	1,073
2024	1,500	975
2025	950	618
2026	350	228
2027	100	65
2028	100	65
2029	100	65
Average annual over the construction phase	NA	373

Source: CPAI direct employment estimates for construction.
Note: NA (not applicable).

In addition to construction employment, drilling activities are estimated to generate 390 North Slope jobs and 10 Anchorage-based jobs (2024 to 2029) but would decline to 99 North Slope jobs and 10 Anchorage-based jobs for the last year of drilling (2030). Construction and drilling employment would result in an additional 2,800 indirect and induced jobs (part and full time) per year. Oil industry wages average $147,584 per year and oil and gas extraction wages average $224,827 (ADLWD 2019).

For 373 direct jobs, wages would average between $56.0 million and $83.9 million. Assuming an average salary of $57,000 for the 2,800 indirect and induced jobs throughout the Alaska economy, indirect and induced wages would total $159.6 million per year (NEI 2020).

While direct employment and wages generated by construction activities on the North Slope would account for only 1 to 2% of total employment in the state, indirect effects would accrue throughout the state, as wages earned on the North Slope would be spent on goods and services in workers' home communities.

3.15.2.3.2 Operations

Once the operations phase begins, the Project would add an estimated 125 to 450 jobs through the life of the Project (Table 3.15.3). Again, most jobs associated with the Project are likely to be filled by non–North Slope residents, but there would be an increase in opportunities for NSB and Nuiqsut residents as well, with the Project directly and with locally owned support service companies. Given the small employment base on the North Slope and the limited job opportunities, these few jobs can substantially affect the local and regional economy.

Table 3.15.3. Direct Operations Employment Estimates

Year	North Slope Based	Anchorage Based
2025	100	25
2026	275	25
2027	400	25
2028	425	25
2029	425	25

Year	North Slope Based	Anchorage Based
2030 through 2050 (per year)	425	25
Average annual over the operations phase	406	25

Source: ConocoPhillips Alaska, Inc. direct employment estimates for operations.

The 431 annual operations jobs (average) would result in an additional 360 to 400 indirect and induced jobs per year. Wages associated with the direct operations jobs would range from $64.7 to $97.0 million per year. Indirect and induced wages would total $20.5 to $22.8 million per year.

Wages associated with operations employment would result in increased incomes locally, regionally, and statewide. NSB and Nuiqsut residents employed by the Project would increase their household wage income. Local industry support companies, such as those owned by Kuukpik and ASRC, would likely earn revenues from the Project, increasing corporation dividends that would contribute to local and regional household incomes.

Most employment and wages associated with operations are likely to go to Alaskans that do not live on the North Slope, and the increase in household incomes would be spread across the state. Although this would be a relatively small increase to the state economy, average wages in the oil industry are more than double the average wage across the state (Fried 2018), so the direct and indirect effects of these wages are still important on a statewide level.

The regional and state economies would gain revenues from Project development and the NSB would receive additional property tax revenues that would offset the declining value of older oil field property assets. The state would receive revenues from disbursement of federal royalties, property taxes, production taxes, and corporate income taxes. Table 3.15.4 summarizes revenues to the NSB, state, and federal government.

Table 3.15.4. Summary of State, Federal, and Borough Revenues from the Project (millions of 2020 U.S. dollars)

Revenue Category	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
State of Alaska tax[a]	$2112.6	$1803.2	$1754.6
State of Alaska oil surcharge	$24.4	$24.4	$24.4
State of Alaska total	**$2,137.00**	**$1,827.60**	**$1,779.00**
Federal government royalty (managed by the State of Alaska)[b]	$2,642.0	$2,642.0	$2,644.1
Federal government royalty	$2,642.0	$2,642.0	$2,644.1
Federal government corporate income tax	$2,317.9	$2,077.0	$2,037.3
Federal government gravel sales	$9.9	$9.9	$10.7
Federal government total	**$7,611.80**	**$7,370.90**	**$7,336.20**
North Slope Borough property tax	$1,233.6	$1,438.4	$1,481.3

Source: NEI 2020
Note: The values shown reflect the estimated total cumulative revenues through the end of the production life of the field.
[a] State of Alaska taxes include property tax, production tax, and corporate income tax.
[b] Royalties managed by the State of Alaska represent 50% disbursement of federal royalties related to the National Petroleum Reserve in Alaska Impact Grant Program.

3.15.2.4 Alternative C: Disconnected Infield Roads

Employment and wage effects as well as tax and royalties from this alternative would be the same as described for Alternative B, except that Alternative C would have larger federal government gravel sales due to the larger gravel footprint required.

3.15.2.5 Alternative D: Disconnected Access

Economic effects of Alternative D would be similar to Alternatives B and C, but employment and wage effects would be somewhat lower. Overall, State and NSB revenues would be higher than Alternatives B and C, while federal revenues would be lower. Differences in taxes and royalties reflect the slightly longer construction and operations duration (31 years versus 30 years for Alternatives B and C).

3.15.2.6 Module Delivery Options

Module delivery Option 1 (Atigaru Point Module Transfer Island) and Option 2 (Point Lonely Module Transfer Island) would both construct an MTI and construct ice roads to the Project area. Option 3 (Colville River Crossing) would not construct an MTI but would use the existing Oliktok Dock, existing gravel roads, and construct tundra-based ice roads to the Project area. None of the three module delivery options would change drilling and operations phase employment effects, but there would be differences in the construction phase employment effects. The potential employment effects of Option 3 would be lower compared to Options 1 and 2. Option 3 would only require workers for module off-load and transport of each sealift and for the winter ice road construction for two seasons. Options 1 and 2 would require additional workers for camp mobilization, winter ice road construction, and for the summer construction at the MTI. The estimated direct employment (average annual number of jobs) for the module delivery options would be as follows:

- Option 1 – 80 jobs
- Option 2 – 90 jobs
- Option 3 – 60 jobs

None of these options would change the alternatives' economics impacts significantly.

3.15.2.7 Oil Spills and Accidental Releases

Most oil spills and accidental releases would be on gravel pads and not require large or extensive responses. Response to oil spills or accidental releases could result in additional employment and wages in the NSB and for Nuiqsut residents if a large and extended response is required. Kuukpik could see increased revenues from providing support services for response activities. Employment regionally and within the state, as well as sales of goods and services, could increase over the response period.

3.15.3 Unavoidable Adverse, Irretrievable, and Irreplaceable Effects

There would not be unavoidable adverse, irretrievable, or irreversible impacts on economics. Similarly, the Project would not adversely impact the long-term economic sustainability of the area.

3.16 Subsistence and Sociocultural Systems

The analysis area for subsistence and sociocultural systems includes all areas used for subsistence activities by the communities of Nuiqsut and Utqiaġvik, which have documented use near the Project and would be most likely to experience direct and indirect effects to subsistence uses. While the Project would not geographically overlap with subsistence use areas for other communities, the indirect subsistence and sociocultural impacts of the Project could extend to other North Slope communities such as Atqasuk and Anaktuvuk Pass if the Project results in large-scale changes in the abundance or availability of subsistence resources such as caribou that are used by those communities. These effects, while unlikely to be apparent from the Willow Project alone, could be magnified when added to other past, present, and RFFAs and are therefore discussed in Section 3.19.

In addition, this section analyzes a **direct effects analysis area**, which includes all subsistence use areas within 2.5 miles of Project infrastructure (uses are detailed in Appendix E.16, *Subsistence and Sociocultural Systems Technical Appendix*). The direct effects analysis area is defined as a 2.5-mile buffer around all action alternatives and module delivery options and is used to characterize the nature of subsistence uses, including timing and transportation methods, within the area of potential direct effects.

The **alternatives analysis area** is the part of the direct effects analysis area around the onshore action alternatives (it excludes the module delivery options). The alternatives analysis area is based on a 2.5-mile buffer of permanent and temporary (e.g., ice roads) infrastructure associated with Alternatives B, C, and D, in addition to the gravel mine site and Oliktok Dock and allows for analysis of potential direct impacts on subsistence. Because the 2.5-mile buffer of the three action alternatives is similar, it was not necessary to develop separate analysis areas for each action alternative. With the similar infrastructure footprints, differences in infrastructure design, infrastructure placement, and operational details determine how and to what level subsistence uses would be affected. These differences are discussed qualitatively, including the differences between the construction and operations phases. The alternatives analysis area does not include areas where activity would occur adjacent to existing infrastructure or activity (e.g., new pipelines that would be colocated with existing pipelines and roads east of GMT-2), nor does it include all areas where development-related activity would occur (e.g., air traffic). These indirect effects are described where applicable. While each action alternative would also include a module delivery option, the three options and associated ice infrastructure are analyzed separately using a separate 2.5-mile buffer. The analysis areas allow for more detailed analysis of the area where subsistence users are most likely to experience direct impacts from the Project. Additional direct and indirect impacts that would occur outside the alternatives analysis area are also addressed.

The analysis in this section summarizes and incorporates by reference subsistence and sociocultural systems impact analyses in the Alpine Satellite Development Plan EIS (BLM 2004a, Section 3.4), GMT-1 EIS (BLM 2014, Sections 3.4.2, 3.4.5, and 4.4.2), GMT-2 EIS (BLM 2018a, Sections 3.4.1, 3.4.3, 4.4.2, and 4.4.5), and the NPR-A IAP/EIS (BLM 2012b, Sections 3.4.3, 3.4.4, 4.4.13, and 4.4.14). The temporal scale for construction impacts is the duration of construction (9 years for Alternatives B and C; 10 years for Alternative D). The temporal scale for operational impacts is the life of the Project or until reclamation is complete. Reclamation of onshore areas can take many years, depending on the tundra damage. If reclamation of onshore gravel fill did not occur, impacts from that fill would be permanent. In marine areas, after abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in Section 3.8.2.6). Other impacts related to long-term changes in subsistence resource availability (e.g., changes in caribou distribution or migration) and subsistence harvesting patterns (e.g., reduced use of traditional harvesting areas) may extend beyond operation.

3.16.1 Affected Environment

3.16.1.1 Community Background and Demographics

The North Slope is a large but sparsely populated area that is inhabited primarily by Iñupiat living in eight small communities, the largest of which is Utqiaġvik, the seat of the NSB government (Figure 3.16.1). The communities of the North Slope share a cultural identity and have close social and kinship ties, both within and between individual communities. The Iñupiat of the North Slope traditionally lived a seminomadic, subsistence-based lifestyle, using trade to acquire goods not readily available in their immediate area. Today, North Slope Iñupiat communities continue to actively engage in traditional subsistence activities, with substantial sharing of traditional foods across the region. Over 98% of all Iñupiat households reported using subsistence foods in a 2015 NSB survey, and a 2014 community snapshot report noted that subsistence foods made up between 50% and 70% of respondents' diets (NSB 2016). Sharing is a key Iñupiaq value that strengthens social ties and promotes the continuation and transmission of cultural values and traditions. Many subsistence traditions, such as the bowhead whale hunt, are centered on the sharing and distribution of subsistence foods across communities and regions (see Section 3.16.1.2, *Definition of Subsistence*).

Sociocultural systems among the Iñupiat of the North Slope underwent various changes following European and American contact. The primary forces of sociocultural change included the introduction of the whaling industry (and a cash economy) in the mid-nineteenth century; compulsory education that facilitated the centralization of people into permanent villages; introduction of modern technologies; conversion of many Iñupiat to Christianity; and oil and gas development. The establishment of the oil and gas industry on the North Slope in the 1970s substantially changed sociocultural systems in the region. The desire to develop oil and gas resources on the North Slope was a major factor in passage of the ANCSA and creation of ANCSA Native corporations, including regional corporations (e.g., ASRC) and village corporations (e.g., Kuukpik) in each community as well as the creation of local municipalities. These corporations control money and land from the settlement agreement and were established with the intent to provide Alaska Natives with opportunities for self-control and self-determination. Alaska Natives were provided with shares in both a regional and a village corporation in 1971, and corporation dividends now make up a substantial portion of household income in the NSB. Shares in ANCSA corporations were originally only transferable by gift or inheritance, meaning some ANCSA corporation shareholders' descendants did not receive shares in ANCSA corporations. In 1988, ANCSA was amended to allow ANCSA corporations to issue new shares to shareholders' descendants. ASRC has a program in place to issue a variety of share types to original shareholders' descendants. Some village corporations have also enrolled shareholders' descendants, while others, such as Kuukpik, have not. This has resulted in a decrease in the percentage of Nuiqsut household heads reporting ownership of village corporation shares from 2010 to 2015; in Nuiqsut, 61% of household heads reported owning village corporation shares in 2015 compared to 78% of household heads in 2010 (NSB 2016).

ANCSA corporations and municipal governments (both borough and city) on the North Slope created new employment opportunities in communities and remain the primary employers in most communities. The NSB in particular was created to capture some of the financial opportunities of oil and gas development and to use the revenues collected to provide facilities and services for residents of the North Slope. NSB services, including health care and education, provide employment opportunities throughout the borough. As the borough seat, Utqiaġvik has a stronger cash economy than most North Slope communities as well as a more diverse population (Table 3.16.1). Tribal governments continue to operate in and provide employment opportunities in each community.

The changes in sociocultural systems resulting from the growth of the cash economy on the North Slope occurred over a relatively short period of time and resulted in the establishment of a mixed subsistence-cash economy, where families invest money from employment into small-scale, efficient technologies to harvest wild foods. The introduction of a cash economy, and differences in participation rates in the cash and subsistence economies between households, has resulted in increased stresses in some communities, where some residents are impacted more from the cash economy than others (Wolfe 2004). Factors affecting the distribution of economic impacts include opportunities for employment with government entities and the oil and gas industry, including support services, and ownership of shares in regional and village corporations. Community tensions associated with the increased cash economy and increased oil and gas industry development include a sense of unequal distribution of financial impacts; conflicting feelings over the cash economy versus the subsistence economy; and general concerns about industry development and its potential for adverse effects on the environment, subsistence resources and access, and human health. The NSB's 2015 economic profile and census report notes that respondents throughout NSB communities reported negative trends in access to subsistence resources, real household incomes, and food security (NSB 2016).

Table 3.16.1. Analysis Area Demographic and Employment Data (2012–2016[a])

Community	Population[a]	Alaska Native (%)[b]	Unemployment Rate (%)
Anaktuvuk Pass	273	90.8	41.5
Atqasuk	167	96.4	9.7
Nuiqsut	347	89.3	19.8
Utqiaġvik (Barrow)	4,316	70.5	16.1
North Slope Borough	9,681	57.4	10.0

Source: U.S. Census 2018a, 2018b
[a] American Community Survey data is a 5-year estimate, not a point data source.
[b] Reported as the only race or in combination with one or more other races.

3.16.1.2 Definition of Subsistence

Subsistence is the cornerstone of the traditional relationship of the Iñupiat people with their environment. Residents of Nuiqsut and Utqiaġvik rely on subsistence harvests of plant and animal resources for nutrition and their cultural, economic, and social well-being. Activities associated with subsistence—processing; sharing; redistribution networks; cooperative and individual hunting, fishing, and gathering; and ceremonial activities—strengthen community and family social ties, reinforce community and individual cultural identity, and provide a link between contemporary Alaska Natives and their ancestors. These activities are guided by traditional knowledge based on a long-standing relationship with the environment.

Like residents in other North Slope communities, Nuiqsut and Utqiaġvik residents participate in a mixed, subsistence-market economy (Walker and Wolfe 1987), where residents invest money to purchase equipment and supplies (e.g., boats, snow machines, gill nets, fuel) to support subsistence activities. Native corporation dividends (Section 3.15) rely heavily on oil and gas development, and many residents invest their dividends and employment income into their subsistence way of life. Sharing subsistence foods with other communities is a major component of the mixed economy and is facilitated by advancements in rural transportation and technology.

Subsistence activities on lands in Alaska, including private lands, are subject to state and/or federal regulations. The Project would be located primarily on federal lands within the NPR-A, although pipelines would cross lands owned by Kuukpik and the state.

3.16.1.3 Overview of Subsistence Uses

This section provides an overview of subsistence use areas, timing of subsistence activities, harvest data, and existing impact levels for Nuiqsut and Utqiaġvik. Appendix E.16 provides details related to Nuiqsut and Utqiaġvik subsistence uses, in addition to subsistence uses within the direct effects analysis area. See Sections 3.10 through 3.13 for details regarding the relative abundance and distribution of subsistence resources.

3.16.1.3.1 <u>Nuiqsut</u>

Subsistence use areas for Nuiqsut are shown on Figures 3.16.1 through 3.16.3 (and Figures E.16.1 through E.16.9 in Appendix E.16). Contemporary Nuiqsut subsistence use areas (Figure 3.16.1) for all resources exist over a large area extending from Utqiaġvik in the west and Anaktuvuk Pass in the south to Kaktovik in the east, and in areas offshore from the CRD and Cross Island. Areas of higher overlapping use occur around the Colville River, in overland areas to the west and south of Nuiqsut, and in the Beaufort Sea. Historical or lifetime use areas for Nuiqsut occur in an a somewhat smaller area than contemporary uses focused around the Colville River, west toward Teshekpuk Lake, east to Prudhoe Bay, and offshore up to 15 miles. More recent subsistence use area data show that those areas extend much farther offshore, occur in a larger overland area (i.e., areas accessed by snow machine), and indicate a shifting away from the Prudhoe Bay development area. The expansion of offshore and overland use areas are likely due to a number of factors, including changes in resource availability and better transportation technologies. In the case of the Prudhoe Bay area, avoidance of industrial development has been documented in a number of studies and has been cited as a primary reason for this shift (SRB&A 2018b). Other reported reasons for the reduced use of the Prudhoe Bay area include changes to hunting regulations in that area, security restrictions, and increased obstacles to overland travel due to the construction of pipelines and roads. The primary differences in historical (Figure 3.16.2) and contemporary (Figure 3.16.1) subsistence uses are a shifting away from the Prudhoe Bay development area in more recently documented use areas and a greater expanse of overland use areas (i.e., those accessed by snow machine).

Use areas vary by resource; the larger overland areas shown on Figure 3.16.1 are those of subsistence activities conducted in the winter months by snow machine, such as hunting wolf, wolverine, caribou, and upland game birds, and conducted in a somewhat smaller area during spring for goose. Summer and fall subsistence activities are generally focused along river systems, in offshore areas, and in smaller overland areas west of the Nuiqsut that are accessible by ATV. Caribou is a resource of specific interest in the EIS because of its importance to the community and the potential impacts of the Project on migration. Caribou subsistence use areas (Figure 3.16.3) show high use of the Colville River and areas west of the community toward Fish (Uvlutuuq) Creek for caribou hunting for the 2008 to 2016 period. Comparison of these use areas to those documented in the past (Figure E.16.2 in Appendix E.16) indicate less use of the middle CRD and Fish (Iqalliqpik) Creek and a smaller extent of overland use areas in recent years. Figures E.16.1 through E.16.9 in Appendix E.16 display additional resource-specific subsistence use areas in Nuiqsut for all study years available.

Nuiqsut subsistence activities occur year-round, with a peak in overall subsistence effort (number of resources harvested) in August and September (Table E.16.7 in Appendix E.16). Waterfowl hunting, which begins in April and peaks in May/June, signals the arrival of spring in Nuiqsut. Breakup occurs as early as May, when residents' primary travel method shifts from snow machine to boat (Table E.16.8 in Appendix E.16). From May through September, residents travel along the Colville River and its tributaries, Fish (Uvlutuuq) Creek, and into the Beaufort Sea to harvest resources such as caribou, waterfowl, seals, fish, and vegetation. Moose hunting occurs in August and September upriver from the community and is often combined with caribou hunting. Bowhead whaling occurs in September from the community's whaling base at Cross Island; preparations for the whaling season begin in August. Harvesters spend October and November on the fall Arctic cisco fishery and harvest caribou in overland areas near the community. Recent years have seen an increase in the use of trucks to access subsistence harvesting areas along the road system (Table E.16.8 in Appendix E.16). During November through April, furbearer hunters travel by snow machine to pursue wolves and wolverines, target caribou and ptarmigan as needed and available, and fish for burbot through the ice.

Available data on Nuiqsut harvest amounts and community participation rates are summarized in Table 3.16.2 and Appendix E.16. On average, Nuiqsut households harvest 679 pounds of subsistence resources per capita annually. In terms of edible pounds, the annual subsistence harvest is made up almost equally of marine mammals, large land mammals, and non-salmon fish, with waterfowl, salmon, and vegetation contributing lesser amounts (Table 3.16.2). The primary species harvested by Nuiqsut households are bowhead whale, caribou, and whitefish (including Arctic cisco and broad whitefish; Table E.16.3 in Appendix E.16). An average of 100% of households use subsistence resources during any given year and 95% attempt harvests of resources (Table 3.16.2). Species that involve the greatest amount of community participation (greater than 50% of households trying to harvest) include caribou, white-fronted goose, cloudberries, and several species of fish (Table E.16.9 in Appendix E.16). A high percentage of households also participate in sharing subsistence resources, with 93% giving and 98% receiving subsistence resources during available study years.

While subsistence harvests in Nuiqsut have remained relatively stable over time in terms of harvest amounts (ADF&G 2016a; SRB&A 2018a), the community has experienced various impacts related to oil and gas development and other activities in the region since resettlement in 1973. Impacts include disruption of subsistence activities from increased air and ground traffic; decreased access to traditional use areas resulting from security restrictions and increased infrastructure (e.g., pipelines, roads, pads); reduced availability of subsistence resources due to disruption from oil and gas activity and infrastructure; avoidance of subsistence foods due to contamination concerns; and avoidance of traditional use areas due to discomfort about hunting around industrial development (SRB&A 2009, 2017b, 2018a). Throughout the 9 years of the Nuiqsut Caribou Subsistence Monitoring Project, between 27% (in Year 9) and 72% (in Year 1) of harvesters reported one or more impacts during individual study years. While impacts related to helicopter traffic have decreased in recent years, impacts related to human-made structures have increased slightly, likely related to increased road infrastructure in the area (SRB&A 2018a). In addition, between 33% and 46% of harvesters reported they avoid developed areas during individual study years (CPAI 2018b).

Table 3.16.2. Selected Nuiqsut Harvest and Participation Data, Average across Available Study Years

Resource Category	Estimated Pounds per Capita	Total Harvest (%)	Households Using (%)	Households Attempting to Harvest (%)	Households Giving (%)	Households Receiving (%)
All resources	679	100	100	95	93	98
Salmon	5	< 1	65	43	31	35
Non-salmon fish	209	30.6	97	81	81	79
Large land mammals	224	32.6	96	77	77	78
Small land mammals	< 1	< 1	45	41	16	12
Marine mammals	226	33.8	97	54	60	97
Migratory birds	13	2.3	85	78	58	52
Upland game birds	2	< 1	54	48	36	15
Bird eggs	< 1	< 1	24	16	8	11
Vegetation	1	< 1	61	52	19	33

Sources: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995); 1994–1995 (Brower and Hepa 1998); 1995–1996, 2000–2001 (Bacon, Hepa et al. 2009); 2014 (ADF&G 2016a)

Note: < (less than). The average represents the mean of all available data. See Tables E.16.2 and E.16.3 in Appendix E.16, *Subsistence and Sociocultural Systems Technical Appendix*, for data by study year.

Approximately 40% of Nuiqsut subsistence use areas occur within the direct effects analysis area (Table E.16.1 in Appendix E.16). Areas located within the direct effects analysis area include overland areas to the west, south, and southeast of the community; coastal boating areas to the west and east of the CRD; and riverine boating areas along the Colville and Itkillik rivers, and along Fish Creek (Uvlutuuq and Iqalliqpik channels). The primary resources harvested by residents within these areas include caribou, wolf, wolverine, moose, goose, and seal (Table E.16.5 in Appendix E.16). A small number of respondents have reported use areas for eiders, broad whitefish, and burbot within the direct effects analysis area. Caribou, wolf, wolverine, and goose are the primary resources harvested by Nuiqsut residents throughout the direct effects analysis area, particularly around the Project area and module delivery option ice roads. In addition, seal and eider hunting occur offshore near the module delivery options and near Oliktok Dock, which would be used under all action alternatives. Residents of Nuiqsut commonly harvest fish (particularly broad whitefish) downstream from the Project in Fish (Uvlutuuq) Creek; in addition, residents conduct much of their fishing for broad whitefish, Arctic cisco, Arctic grayling, and burbot downstream from where the direct effects analysis area crosses the Colville River. Residents commonly hunt for moose along the Colville River at Ocean Point. Other activities such as vegetation harvesting also occur along the Colville River. Across 9 years of the Nuiqsut Caribou Subsistence Monitoring Project, the direct effects analysis area held between 14% and 26% of reported caribou harvests (Table E.16.4 in Appendix E.16). Use of the direct effects analysis area occurs year-round, peaking in winter for resources such as wolf and wolverine, spring for goose and eider, summer for caribou, seal, and fish, and fall for moose (Figure E.16.10 in Appendix E.16). Snow machines and ATVs are the primary methods of travel to the direct effects analysis area, although residents also access areas associated with the module delivery options (marine and coastal areas, in addition to the Colville River) by boat (Figure E.16.11 in Appendix E.16). Of the resources harvested within the direct effects analysis area, caribou, white-fronted goose, and bearded seal are considered resources of major importance in Nuiqsut based on an analysis of selected variables (Table E.16.9 in Appendix E.16).

3.16.1.3.2 Utqiaġvik

Subsistence use areas for Utqiaġvik are shown on Figures 3.16.4 and 3.16.5 (and Figures E.16.12 through E.16.20 in Appendix E.16). Utqiaġvik contemporary subsistence use areas extend from Point Lay in the west to the Kuparuk River in the east, south into the foothills of the Brooks Range, and up to 80 miles offshore (Figure 3.16.4). Areas of higher overlapping use for the 1997 through 2006 time period occur along the Chipp, Meade, and Ikpikpuk rivers; in coastal areas between Dease Inlet and Peard Bay; and up to 20 miles offshore. Although not shown on Figure 3.16.4, a recent global positioning system mapping study (Harcharek 2015) shows Utqiaġvik harvesters using an area similar to that documented in 1997 through 2006, with global positioning system tracks extending west to Wainwright, inland into the Brooks Range as far south as Anaktuvuk Pass, east beyond the Colville River, and to varying distances offshore. Historical and lifetime Utqiaġvik subsistence use areas show a somewhat smaller but still extensive area compared to the same time period (Figure 3.16.5).

Figures E.16.12 through E.16.20 in Appendix E.16 display additional resource-specific subsistence use areas for all available study years in Utqiaġvik. Furbearers, caribou, and waterfowl are harvested in large overland areas south, southwest, and southeast of the community. Certain activities, such as harvesting fish and waterfowl, are more focused around river drainages, as is caribou hunting during the open-water months. Caribou and furbearer hunting involve the greatest overland extent of travel from Utqiaġvik, while marine mammal hunting is generally limited to offshore use areas in the Chukchi and Beaufort seas.

Utqiaġvik subsistence activities also occur year-round but peak in the months of June, August, and September (Table E.16.15 in Appendix E.16). April represents the end of the winter furbearer hunting and trapping season and the beginning of the spring bowhead whale hunt, which also includes incidental eider harvests at whaling camps and overland goose hunting. In June, residents continue to hunt goose by snow machine but also begin to travel by boat in offshore, coastal, and riverine areas to harvest marine mammals (seal and walrus), eiders, caribou, fish, and berries. In summer, residents set nets in lagoons, lakes, and rivers for various fish species, with an emphasis on broad whitefish. Bowhead whaling resumes in offshore waters during September and October, and non-whaling crew members continue to hunt resources such as caribou and fish, with the under-ice fishery peaking in October. Some individuals may travel to the Colville River to hunt moose during the fall months. Residents shift to traveling by snow machine again in November through April and target furbearers, with a secondary emphasis on resources such as caribou, upland birds, fish, and ringed seal.

Available data on Utqiaġvik harvest amounts and community participation rates are summarized in Table 3.16.3 and Appendix E.16. On average, Utqiaġvik households harvest 265 pounds of subsistence resources per capita annually. In terms of edible pounds, most of the annual subsistence harvest consists of marine mammals (63.8%), followed by large land mammals (25.5%) and non-salmon fish (6.6%), with other resources such as migratory birds and salmon contributing lesser amounts (Table 3.16.3).

Table 3.16.3. Selected Utqiaġvik Harvest and Participation Data, Average across Available Study Years

Resource Category	Estimated Pounds per Capita	Total Harvest (%)	Households Using (%)	Households Attempting to Harvest (%)	Households Giving (%)	Households Receiving (%)
All resources	265	100	89	57	63	87
Salmon	7	0.8	69	26	26	55
Non-salmon fish	28	6.6	69	29	37	60
Large land mammals	81	25.5	72	39	39	57
Small land mammals	< 1	< 0.1	8	6	2	4
Marine mammals	144	63.8	71	30	45	70
Migratory birds	8	2.9	53	35	29	35
Upland game birds	< 1	0.1	9	9	4	1
Bird eggs	< 1	0.1	13	7	3	7
Vegetation	1	0.1	43	17	15	35

Sources: 1987–1989 (SRB&A and ISER 1993); 1992 (Fuller and George 1999); 1995–1996, 1996–1997, 2000, 2001, 2003 (Bacon, Hepa et al. 2009); 2014 (ADF&G 2016a).

Note: The average represents the mean of all available data. See Tables E.16.11 through E.16.13 in Appendix E.16, *Subsistence and Sociocultural Systems Technical Appendix*, for data by study year.

Utqiaġvik households primarily harvest bowhead whale, followed by caribou. Species which have frequently contributed substantial amounts over the study years include seal (bearded and ringed), walrus, and broad whitefish (Table E.16.13 in Appendix E.16). An average of 89% of Utqiaġvik households use subsistence resources during any given year and 57% attempt harvests of resources (Table 3.16.3). These estimates include non-Native households and would likely be substantially higher for Native households alone. The highest rates of participation are for marine mammals, migratory birds, large land mammals, and non-salmon fish. A substantial percentage of households also share resources, with 63% giving and 87% receiving subsistence resources during available study years (Table 3.16.3).

A relatively small percentage of Utqiaġvik use areas (3%) occur within the 2.5-mile direct effects analysis area (Table E.16.10 in Appendix E.16). The primary resources harvested by residents within these areas are moose, wolf, wolverine, and caribou (40%, 29%, 29%, and 26% of harvesters, respectively), with a small number of harvesters also reporting use areas for seal and goose (Table E.16.14 in Appendix E.16). Caribou, wolf, and wolverine are harvested throughout the Project area, whereas seal is harvested near the module delivery options. Moose is hunted by some Utqiaġvik residents where the direct effects analysis area crosses the Colville River near Ocean Point. Use of the direct effects analysis area by Utqiaġvik harvesters peaks during March through April, with a smaller peak in July and August (Figure E.16.21 in Appendix E.16). Travel is primarily by snow machine, with some coastal boat hunting and riverine boat hunting along the Colville River (Figure E.16.22 in Appendix E.16). Of the resources harvested within the direct effects analysis area, caribou and bearded seal are resources of major importance to Utqiaġvik, goose and moose are of moderate importance, and wolf and wolverine are of minor importance (Table E.16.17 in Appendix E.16).

3.16.1.4 Existing Conditions

Several factors contribute to the existing condition for subsistence and sociocultural systems, including development-related activities and infrastructure, climate change, harvest regulations, scientific research, sport hunters and recreationists, and economic and technological changes. Impacts related to oil and gas exploration and development are one of the primary concerns voiced by North Slope residents (SRB&A 2009) and include both onshore and offshore impacts. In Nuiqsut, reported impacts have increased as development has moved westward into core subsistence harvesting areas near the CRD. Existing impacts of oil and gas development on North Slope subsistence activities include impacts to access resulting from physical obstructions (pipelines, roads), security restrictions, and harvester avoidance of industry; impacts to resource availability resulting from development-related noise and air, vessel, and ground traffic; changes in resource distribution resulting from development infrastructure; and real and perceived contamination of subsistence foods resulting from spills and emissions. The increasing presence of development infrastructure, particularly in the area of Nuiqsut, has resulted in the loss of some traditional lands and a sense that residents are surrounded by development (SRB&A 2018b). While overall community harvests in Nuiqsut have remained relatively stable over time, impacts on individual success rates, harvest amounts, and harvest effort have been reported by harvesters.

Existing impacts on sociocultural systems include development activities, transportation projects, increased recreation and tourism in the region, government regulations, modernization and technological changes, and changes in demographics and land status. Increased revenue and income associated with oil and gas activities have provided benefits to North Slope communities by contributing to social services and community infrastructure projects. However, changes in income and employment levels have also contributed to income disparities and differences in shareholder status, introducing tensions within and among communities. These impacts have affected social and political organization on the North Slope.

Climate change has affected subsistence harvesting activities through changes in the timing of freeze-up and breakup, ice conditions, the strength and frequency of storms and winds, reduced water levels in lakes and rivers, coastal and river erosion, changes in the timing of resource migrations, and melting permafrost which affects access to ice cellars. Changes in snow, ice, and river conditions can affect residents' ability to travel safely to subsistence harvesting areas at times when resources are available in those areas.

3.16.2 Environmental Consequences

Potential impacts to subsistence are discussed in terms of resource availability, resource abundance, and harvester access. Impacts related to harvester avoidance are addressed under the topic of harvester access; while harvester avoidance is not a physical or legal barrier to access, it is a documented harvester response that results in the reduced availability of traditional use areas and resources for harvesters. The magnitude or intensity of impacts to subsistence uses vary depending on the relative material and cultural importance of the resource being affected; the relative importance of resources is discussed in Section 3.16.1, *Affected Environment*, and Appendix E.16. Other impacts to sociocultural systems are more difficult to quantify or predict (e.g., impacts on cultural practices, values, and beliefs) or result from changes to resource abundance, resource availability, and harvester access (e.g., costs and time, competition). These potential impacts are addressed in Section 3.16.2.3.4, *Other Subsistence and Sociocultural Impacts*, where relevant in the discussion below, and in Section 3.19.

3.16.2.1 Avoidance, Minimization, and Mitigation

3.16.2.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.16.4 summarizes existing LSs and BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to subsistence and sociocultural systems from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to subsistence resource availability and abundance, as well as subsistence use areas, and subsistence access associated with the construction, drilling, and operation of oil and gas facilities. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.16.4 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to subsistence. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.16.4 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.16.4. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Subsistence and Sociocultural Systems

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local law and regulations	Areas of operation shall be left clean of all debris.	Changes do not affect text as described.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Protect the health and safety of the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of exploration and development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or state permit.	Changes do not affect text as described.
BMP A-3	Minimize pollution through effective hazardous materials contingency planning.	Prepare and implement a hazardous materials emergency contingency plan before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes, and marine waters, as a result of fuel, crude oil, and other liquid chemical spills; protect subsistence resources and subsistence activities; protect public health and safety.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement bear interaction plans to minimize conflicts between bears and humans.	Text expanded to include other species of wildlife: Incorporate into infrastructure design measures to deter ravens, raptors, and foxes from nesting, denning, or seeking shelter. Provide BLM with an annual report on any instances when, despite use of such measures, the use of infrastructure by ravens, raptors, and foxes did occur. Added Text: – Feeding wildlife is prohibited. – Prevent the emission of odors by installing kitchen hood exhaust filtration systems such as cleaners, filters, purifiers, and scrubbers.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	Design and implement a monitoring study of contaminants in locally used subsistence foods	No similar requirement.
BMP A-12	Minimize negative health impacts associated with oil spills.	Consider immediate health impacts, long-term monitoring for contamination, monitoring of human health, health promotion activities.	No similar requirement; this describes the BLM's responsibility, and it is not a requirement of a permittee.
ROP A-13	Prevent the release of poly- and perfluoroalkyl substances associated with the use of aqueous film-forming foam, a firefighting foam designed to extinguish flammable and combustible liquids and gases.	No similar requirement.	At facilities where fire-fighting foam is required, use fluorine-free foam unless other state or federal regulations require aqueous film-forming foam use. If aqueous film-forming foam use is required, contain, collect, treat, and properly dispose of all runoff, wastewater from training events, and, to the greatest extent possible, from any emergency response events.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4 feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during winter and withdrawal of water from lakes during summer may be authorized on a site-specific basis, depending on water volume and depth, the fish community, and connectivity to other lakes or streams. BLM must be notified within 48 hours of any observation of dead or injured fish on water source intake screens, in the hole being used for pumping, or within any portion of ice roads or pads. If observed at a particular lake, pumping must cease temporarily from that hole until additional preventive measures are taken to avoid further impacts on fish.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.	Revised text: – Ground operations would only be allowed when frost and snow cover are at sufficient depth, strength, density, and structure to protect the tundra. Soils must be frozen to at least 23 degrees F at least 12 inches below the lowest surface height (e.g., inter-tussock space). Tundra travel would be allowed when there is at least 3 to 6 inches of snow (depending on the alternative). For alternatives B, C, and D: snow depth and snow density must amount to no less than a snow water equivalent of 3 inches over the highest vegetated surface (e.g., top of tussock) in the NPR-A. – Snow survey and soil freeze-down data collected for ice road planning and monitoring shall be submitted to BLM. – Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow. – For alternatives B, C, and D: avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by BLM. This provision does not apply to hardened snow trails or ice roads. – Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types, as much as practicable. For alternatives B, C, and D: ice roads may not use the same route each year; ice roads would be offset to avoid portions of an ice road route from the previous 2 years.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	Added text: – Provide to BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of road/trail construction. – In the spring, provide the BLM with photographs of all stream crossings that have been removed, breached, or slotted.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.	Added text: – Subsistence pullout and access/egress ramps would be constructed in adequate numbers and at appropriate locations on all roads to facilitate access to subsistence use areas. Prior to constructing a road, permittees shall gather input from communities regarding the number and location of pullouts and associated access ramps. – Permittees shall construct a subsistence pullout and boat ramp at all crossings of heavily used subsistence rivers, as determined by consultation with the community. – Permittees must allow subsistence use of permanent gravel roads and appropriate ice roads, consistent with safe operations, and shall provide communities and BLM with concise policies regarding the use of all roads and hunting prohibitions, if any, along roads and near facilities. -Permittees shall ensure that any road use guidelines and updated road maps are disseminated throughout communities, including making them available online and through social media. – Before ice road construction begins, permittees associated with ice road construction shall hold community meetings to describe the routes and relevant information on all ice roads that would be constructed. – A vehicle use management plan shall be developed by the permittee to minimize or mitigate displacement during calving and would avoid, to the extent feasible, delays to caribou movements and vehicle collisions during the midsummer insect season, with traffic management following industry practices. By direction of BLM, traffic may be stopped throughout a defined area for up to 4 weeks to prevent displacement of calving caribou. If required, a monitoring plan could include collection of data on vehicle counts and caribou interaction. – When laying out oil and gas developments, permittees shall orient infrastructure to minimize impeding caribou migration and to avoid corralling effects. – Permittees shall provide an annual report to BLM reporting roadkill of birds and mammals to help BLM determine whether preventative measures on vehicle collisions are effective.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from the ordinary high-water mark of fish-bearing waterways.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A postconstruction monitoring program, developed in consultation with appropriate federal, state, and NSB regulatory and resource agencies, shall be required to track circulation patterns, water quality, and fish movements around a structure.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added text: – For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills. – Where aircraft traffic is a concern, balance gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.	Added text: – Aboveground pipelines shall have a nonreflective finish. – When laying out oil and gas developments, permittees shall orient infrastructure to minimize impeding caribou migration and to avoid corralling effects. – Before the construction of permanent facilities is authorized, BLM will require a study of caribou movement for the impacted herd. The permittee may be required to conduct this study, or this requirement may be waived if an acceptable study specific to that herd has been completed within the last 10 years and is approved for use by BLM.
BMP E-9	Avoid human-caused increases in populations of predators of ground-nesting birds.	Utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Feeding of wildlife is prohibited.	Requirements combined with ROP A-8 (Wildlife Interaction Plan).
BMP E-10	Prevent migrating waterfowl from striking oil and gas and related facilities during low light conditions.	Illumination of all structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.	Flagging of structures shall be required, such as elevated power lines and guy-wires, to minimize bird collision. All facility external lighting, during all months of the year, shall be designed to direct artificial exterior lighting inward and downward or be fitted with shields to reduce reflectivity in clouds and fog conditions, unless otherwise required by Federal Aviation Administration.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.	Added text: Develop a separate map displaying detailed water flowlines and small-scale delineation of drainage catchments based on LiDAR or other high-accuracy surface imaging.
ROP E-23	Mitigate the impacts of permanent infrastructure on caribou movement near Teshekpuk Lake.	No similar requirement.	Prior to the permitting of permanent infrastructure within the TCH Habitat Area (the 75% parturient[1] calving kernel), a workshop shall be convened to identify the optimal placement of infrastructure to minimize impacts on caribou, birds, and other wildlife.

BMP F-1, ROPs F-2, F-3, and F-4	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Ensure that aircraft used for permitted activities maintain altitudes specified in guidelines. – Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Caribou wintering areas will be defined annually by the Authorized Officer. – Submit an aircraft use plan that addresses strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility. – Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum. – Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) in the Goose Molting Area should be minimized from May 20 through August 20. – Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away. – Fixed wing aircraft along the coast shall maintain minimum altitude of 2,000 feet when within a ½ mile of walrus haulouts. Helicopters used along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts. – Aircraft used along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals.	Text moved to ROPs F-2 through F-4: Added text: F-2: Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. F-3: Minimum Flight Altitudes. Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the TCH Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude agl throughout NPR-A. Exceptions to the 1,500-foot agl minimum altitude are listed below: a. Single-engine manned aircraft and unmanned aircraft should not knowingly fly within 0.5 mile of walrus haulouts; or, if required, then maintain 2,000 feet agl when within 0.5 mile of walrus haulouts. b. Helicopters and multi-engine aircraft should not knowingly fly within 1 mile of walrus haulouts; or, if required, then maintain 3,000 feet agl and a 1-mile buffer from walrus haulouts. c. Aircraft—3,000 feet agl when within 1 mile of aggregation of seals F-4: Reduce Impacts of Air Traffic on Subsistence Resources. – Minimize helicopter flights during peak caribou hunting within 2 miles of important subsistence rivers. The current peak dates are July 15 through August 15, but these dates may be revised periodically in consultation with affected communities and the NSB. – Minimize aircraft use near known subsistence camps and cabins and during sensitive subsistence hunting periods (spring goose hunting, summer and fall caribou and moose hunting) by adhering to the following guidelines: – Arrange site visits and flight schedules to conduct required activity near subsistence areas early in the season, on weekdays, and as early in the morning as possible; avoid holidays. – Note whether activities overlap heavily used subsistence rivers and determine if a potentially affected community should be notified. – Compare the proposed landing sites with the NSB camps and cabins map. If activities near camps or allotments cannot be avoided, contact the camp or allotment owner to discuss the timing of the visit.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS G-1	Ensure the long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure the eventual restoration of ecosystem function.	Changes do not affect text as described. See ROP M-5 for additional requirements to reduce areas of bare soil.
BMP H-1	Provide opportunities for participation in planning and decision-making to prevent unreasonable conflicts between subsistence uses and other activities.	Consult with affected communities per guidelines.	Projects that would occur within 50 miles of a community or fewer than 15 miles from the heavily used subsistence rivers listed in ROP F-4 shall submit a subsistence plan.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by the lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
ROP H-4	Notification and consultation with Alaska native groups: Prevent unreasonable conflicts with subsistence access and activities by providing opportunities for consultation and incorporating input into project plans.	No similar requirement.	For projects that require a subsistence plan (ROP H-1), permittees shall prevent unreasonable conflicts with subsistence access, use areas, and schedules by facilitating consultation according guidelines prescribed.
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year. Include information concerning avoidance of conflicts with subsistence users.	Changes do not affect text as described.
LS/ BMP K-1[a]	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or overwintering fish habitat; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed consist of the Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and the Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).	Added text: No surface occupancy or new infrastructure except essential road and pipeline crossings in the following setbacks: the Colville River (2- to 7-mile setback), Judy (Iqalliqpik) Creek (0.5- to 1-mile setback), and the Ublutuoch (Tiŋmiaqsiuġvik) River (0.5- to 1-mile setback). Gravel mines may be located within the active floodplain, consistent with ROP E-8.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-2[a]	(Deepwater Lakes) Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change of vegetative and physical characteristics of deepwater lakes; minimize the loss of spawning, rearing, or overwintering fish habitat; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).	Changes do not affect text as described. Additional restrictions as described in BMP/ROP E-11 may also apply in those habitats.
BMP K-4a[a]	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Within the Goose Molting Area: –No leasing, no permanent oil and gas facilities, except pipelines, would be allowed within 1.0 mile of the shoreline of selected lakes. –Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins. –Between June 15 and August 20, oil and gas facilities shall incorporate features (e.g., temporary fences and siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by BLM. –Aircraft use (fixed-wing and helicopter) shall be restricted from June 15 through August 20.	Changed to Stipulations K-6 and K-7. Some alternatives allow leasing. Some alternatives allow new infrastructure with limitations. Within the Goose Molting Area, no permanent oil and gas facilities, except pipelines, would be allowed within 0.5 mile of the shoreline of selected lakes. Lakes were selected based on the 85% distribution of black brant within the Goose Molting Area. Aircraft use (fixed-wing and helicopter) shall be restricted from June 1 through August 20.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP K-5[a]	(Teshekpuk Lake Caribou Habitat Area) Minimize disturbance and hindrance of caribou or alteration of caribou movements through portions of the Teshekpuk Lake Caribou Habitat Area that are essential for all-season use, including calving and rearing, insect relief, and migration.	Design, implement, and report a study of caribou movement. The study shall include a minimum of 4 years of current data on TCH movements. Within the Teshekpuk Lake Caribou Habitat Area, permittee shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required in the Teshekpuk Lake Caribou Habitat Area, where pipelines potentially impede caribou movement. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. A number of ground and air traffic restrictions are specified, including, but not limited to, the following: Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter. The permittee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1 and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20.	Text moved to Stipulation K-9. Text revised: -Federal mineral estate within 3 miles of Teshekpuk Lake, except for the southern shore, is open to leasing, subject to a no surface occupancy stipulation. Federal mineral estate within 1 mile of the southern shore of Teshekpuk Lake is open to leasing, subject to a no surface occupancy stipulation. –Before authorization of construction of permanent facilities, the BLM will require submittal of information on caribou movement for the TCH. The information shall include multiple years of seasonal distribution and movement of the TCH. The information must include some recent data and must be sufficient to capture a realistic picture of trends in distribution and movements. –Within the TCH Habitat Area (the 75% parturient calving kernel), permittee shall orient linear corridors when laying out oil and gas field developments to address seasonal distribution and avoid corralling effects from loops of road and/or pipeline that connect facilities. –Off-pad activities shall be suspended within TCH Habitat Area (the 75% parturient calving kernel) from May 20 through June 20, unless approved by the BLM. –Within the TCH Habitat Area (the 75% parturient calving kernel), from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 miles of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, stockpiling equipment and materials, etc., to the extent practicable. The permittee shall submit with the development proposal a vehicle use plan (see ROP M-1) that considers these and any other mitigation. Traffic would be stopped: a) Temporarily to allow a crossing by 10 or more caribou. The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. b) By direction of BLM, traffic may be stopped through the TCH Habitat Area (the 75% parturient calving kernel) for a limited amount of time, and only if necessary to prevent displacement of calving caribou.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
LS/ BMP K-6[a]	(Coastal area) Protect coastal waters and their value as fish and wildlife habitat, minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and DEW Line sites. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.	Changed to Stipulation K-5. Added text: NSO. No new infrastructure, except essential coastal infrastructure (see requirement/standard for essential coastal infrastructure). No leasing is allowed within 1 mile of the coast. The following requirements apply to authorized activities within 1 mile of the coast: – Permanent exploratory or production well drill pads or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the NPR-A and the mainland or in inland areas within 1 mile of the coast. Other facilities necessary for oil and gas production, such as barge landing, seawater treatment plant, or spill response staging and storage areas, would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. – For permanent oil and gas facility in the Coastal Area, develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
BMP K-9[a]	(Teshekpuk Lake Caribou Movement Corridor) Minimize disturbance and hindrance of caribou or alteration of caribou movements (that are essential for all-season use, including calving and rearing, insect relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River.	Within the caribou movement corridors, no permanent oil and gas facilities, except for pipelines, will be allowed. Prior to the permitting of permanent oil and gas infrastructure, a workshop will be convened to identify the best corridor for pipeline construction in an effort to minimize impacts to wildlife and subsistence resources.	Changed to Stipulation K-10. Changes do not affect text as described.
BMP K-10[a]	(Southern Caribou Calving Area) Minimize disturbance and hindrance of caribou or alteration of caribou movements (that are essential for all-season use, including calving, post-calving, and insect relief) in the area south/southeast of Teshekpuk Lake.	Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or other infrastructure associated with offshore oil and gas exploration and production, will be allowed.	Changed to Stipulation K-11. No similar requirement. See Stipulation K-9 and ROP E-23.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
Stipu-lation K-15	Minimize disturbance to Native subsistence hunters resulting from development and ensure access to Native allotments.	No similar requirement.	Permanent oil and gas facilities within 3 miles of Native allotments are prohibited, except for essential road and pipeline crossings in areas of overlapping setbacks. Exceptions would be granted with the permission of the owner of the allotment. In cases of overlapping setbacks, the permittee would need the permission of the primary owners of the allotments to develop within the setback. Allotment owners may not waive setbacks defined in Stipulation K-1.
Stipu-lation K-16	Minimize the impact of rapid development on the communities within the NPR-A.	No similar requirement.	For alternatives B and E only: Lease tracts that are surrendered or currently unleased within the deferral area would not be offered for lease for the stated period of time after the signing of the IAP Record of Decision. a. The Teshekpuk Lake deferral area encompasses land on the eastern edge of the NPR-A boundary and land around Teshekpuk Lake and Atigaru Point (see BLM 2020). This lease deferral is valid for 10 years. From the eastern NPR-A boundary, the deferral area includes most of the following townships: • T14N, R1E, U.M. • T14N, R1W, U.M. • T14N, R2W, U.M. • T14N, R3W, U.M. • T14N, R4W, U.M. • T15N, R8W, U.M. • T16N, R8W, U.M. • T17N, R8W, U.M. • T15N, R9W, U.M. • T16N, R9W, U.M. • T17N, R9W, U.M. The deferral area around Atqasuk extends 3 miles in all directions from land owned by the Atqasuk Corporation This deferral is valid for 5 years.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage to vegetation; maintain populations of, and adequate habitat for birds, fish, caribou, and other terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP M-1	Minimize disturbance and hindrance of wildlife or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.	Added text: Permittees will submit a vehicle use plan with their permit application, that will include: – Industry practices to minimize or mitigate delays to caribou movement, vehicle collisions, or displacement during calving, spring migration, fall migration, and post-insect aggregation movement. By direction of BLM, traffic may be stopped throughout a defined area for up to 4 weeks to prevent displacement of calving caribou alternatives B, C, and D only). – Summary of all planned off-road travel, including the number of vehicles, type, and general routes. – Monitoring may be required as part of the vehicle use plan and could include collection of data on vehicle counts and vehicle interactions with wildlife. – Permittees shall provide an annual report to the BLM reporting roadkill of birds and mammals to help the BLM determine whether preventative measures on vehicle collisions are effective.
BMP M-2	Prevent the introduction or spread of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed free prior to transporting them into the NPR-A. Monitor annually for invasive species, and submit a plan detailing methods for cleaning, monitoring, and weed control.	Changes do not affect text as described.

Source: BLM 2013a, 2020a.
Note: agl (above ground level); BLM (Bureau of Land Management); BMP (best management practice); DEW (Distant Early Warning); F (Fahrenheit); IAP (Integrated Activity Plan); LiDAR (Light Detection and Ranging); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); NSO (no surface occupancy); ROP (required operating procedures); TCH (Teshekpuk Caribou Herd); USGS (U.S. Geological Survey).
[a] Revisions to K LSs and BMPs are provided as a range of values reflecting different action alternatives in BLM 2020a.

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect subsistence and sociocultural systems would include those to LS E-2 and BMPs E-7, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMPs K-1 and K-2), a CFWR connected to Lake M0015, and freshwater intake pipelines at Lakes L9911 and/or M0235 (varies by alternative) (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. Lastly, it may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7) due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site or at narrow land corridors between lakes where it is not possible to maintain 500 feet of separation between pipelines and roads without increasing potential impacts to waterbodies. Caribou may experience more delays or deflections while crossing roads and pipelines in locations where the separation is less than 500 feet.

3.16.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1. These are also incorporated into the discussion of potential impacts below, where relevant.

3.16.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

In addition to the applicable LSs and BMPs described above (Section 3.16.2.1.1, *Applicable Lease Stipulations and Best Management Practices*), the following additional suggested measures could reduce impacts to subsistence and sociocultural systems:

1. Inform employees who are North Slope residents of company subsistence leave policies and ensure that leave policies are flexible to account for annual variation in the timing and length of subsistence activities.

2. Employ subsistence representatives who receive daily communications on Project activities and report potential conflicts with subsistence users. Subsistence representatives should be provided with clear communication protocols and training, be local and knowledgeable residents, and be included in field activities the community believes have a high potential of conflicting with subsistence uses (e.g., helicopter-based surveys).
3. In coordination with local organizations, such as the Kuukpik Subsistence Oversight Panel (KSOP) (required in CPAI design measure 68 and BLM [2020a] ROP H-4), ensure communications include the timing and location of development activities such as air traffic, blasting, and other construction activities.
4. Identify areas with high drifted snow accumulation along pipelines after construction and implement a snow management program to clear drifts and create access points (i.e., openings) in areas where drifts accumulate for a long distance (e.g., quarter- and half-mile lengths) along pipelines. Consult with Nuiqsut residents on an appropriate distance for cleared access areas as well as the depth of snowdrifts that impede travel under pipelines.
5. As part of the Subsistence Plan (required in BLM [2020a] ROP H-1) and as part of the Proponent's notification and consultation with Alaska Native groups (required in BLM [2020a] BMP H-4), provide equal opportunities for various local entities (e.g., KSOP, NVN, City of Nuiqsut, Kuukpik), in addition to knowledgeable subsistence users, to provide input.
6. Continue to consult with local subsistence users and community organizations regarding the appropriate design and location of subsistence boat ramps, pullouts, and subsistence tundra access ramps. Consult with other operators regarding other boat ramp projects on the North Slope that may inform future designs. (This would be required as part of BLM [2020a] ROP E-1.)
7. Participate in Conflict Avoidance Agreements with the Alaska Eskimo Whaling Commission to reduce potential impacts on bowhead whale hunting resulting from barge and vessel traffic.
8. Work with community organizations to establish measures to reduce impacts of vehicle traffic on subsistence activities, particularly during the Project's construction phase.
9. Install traffic control signs (e.g., stop signs) to halt industry vehicle traffic at all subsistence access ramps to ensure that subsistence users can cross safely
10. Place development-free buffer around Native Allotment be at least 1 mile to ensure the viability of the allotment for subsistence use. Exceptions would be made for allotment owners who agree to having development closer than 1 mile.

3.16.2.2 Alternative A: No Action

Under Alternative A, the Project would not be constructed. No additional impacts to subsistence and sociocultural systems would occur over existing levels. Nuiqsut would continue to experience impacts to subsistence and sociocultural systems resulting from existing oil and gas development, ongoing exploration, and other activities in the region. Impacts from development infrastructure, traffic, human activity and noise, socioeconomic changes, and increasing interaction with non–Native Alaska businesses, governments, and people would continue to occur.

3.16.2.3 Alternative B: Proponent's Project

Figures 3.16.6 through 3.16.15 show Nuiqsut and Utqiaġvik subsistence use areas by resource and the alternatives analysis area, which is defined as the area surrounding the action alternatives and mine site. Oliktok Dock is also included in the alternatives analysis area, as it would be used under all action alternatives for delivery of bulk Project construction materials. Tables 3.16.5 and 3.16.6 show resource harvests and use within the alternatives analysis area. Because the data are identical across the action alternatives, they are shown in a single column. These data are based on an analysis of available information from subsistence mapping studies in Nuiqsut and Utqiaġvik and are useful for understanding the likelihood and magnitude of direct impacts on subsistence uses. In these mapping studies, a sample of active harvesters in each community identified harvest areas and/or harvesting locations by resource on a map.

Table 3.16.5. Number and Percentage of Nuiqsut and Utqiaġvik Harvesters Using the Alternatives Analysis Area by Resource Category

Resource Category	Number (%) of Nuiqsut Harvester Respondents Reporting Use Areas in the Alternatives Analysis Area	Number (%) of Utqiaġvik Harvester Respondents Reporting Use Areas in the Alternatives Analysis Area
Caribou	27 (84%)	7 (10%)
Wolverine	21 (88%)	7 (23%)
Wolf	20 (87%)	7 (23%)

Resource Category	Number (%) of Nuiqsut Harvester Respondents Reporting Use Areas in the Alternatives Analysis Area	Number (%) of Utqiaġvik Harvester Respondents Reporting Use Areas in the Alternatives Analysis Area
Bearded seal	11 (41%)	0 (0%)
Eiders	11 (39%)	0 (0%)
Goose	12 (36%)	0 (0%)
Ringed seal	8 (35%)	0 (0%)
Moose	3 (10%)	0 (0%)
All resources	30 (91%)	9 (12%)

Source: SRB&A 2010a

Table 3.16.6. Number and Percentage of Nuiqsut Caribou Harvesters and Harvests Using the Alternatives Analysis Area by Study Year

Study Year	Number (%) of Nuiqsut Caribou Harvester Respondent Reporting Use Areas in the Alternatives Analysis Area	Percentage of Reported Caribou Harvests Occurring in the Alternatives Analysis Area
Year 1	26 (72%)	7%
Year 2	25 (47%)	6%
Year 3	33 (58%)	8%
Year 4	26 (45%)	18%
Year 5	25 (44%)	13%
Year 6	20 (35%)	7%
Year 7	33 (55%)	14%
Year 8	23 (40%)	6%
Year 9	23 (37%)	9%

Source: SRB&A 2018

3.16.2.3.1 Resource Abundance

Project activity and infrastructure (e.g., gravel and ice roads, drill sites, mine site) would result in the removal or disturbance of habitat for resources such as fish (e.g., broad whitefish, grayling), waterfowl, and caribou. The Project may also cause direct mortality to individual animals through vehicle and aircraft collisions. Habitat loss and disturbance could reduce calving and nesting rates and survival for caribou and waterfowl in the vicinity of Project infrastructure and activity but would not have population-level effects on subsistence resources harvested within or downstream from the Project area (Sections 3.12.2.3.1, *Habitat Loss and Disturbance*; and 3.12.2.3.3, *Injury and Mortality*). Construction-related impacts would occur in a larger area during a more limited time period. Operational activities and permanent Project infrastructure would be limited to the Project area over the life of the Project. Increased air and ground traffic would occur in a larger area and extend outside the Project area.

3.16.2.3.2 Resource Availability

Construction and operations activities, equipment, and infrastructure have the potential to affect resource availability by displacing and diverting subsistence resources. Noise, traffic, and human activity could deflect subsistence resources from the direct effects analysis area or cause skittish behavior, making them more difficult to harvest. Disturbances may be localized and considered minimal from a biological perspective, but they can have larger impacts on subsistence harvesters who often travel to certain areas at specific times of the year. While the exact time and place of a resource's movement changes annually, harvesters are generally able to apply their knowledge of movement patterns and associated factors to successfully locate and harvest caribou. When resource behavior is less predictable, harvest success declines. Impacts to resource availability would occur year-round. Impacts would be higher during winter construction, when ice roads are present and activities are at their peak. Use of the direct effects analysis area by Nuiqsut and Utqiaġvik harvesters is highest during winter (Figures E.16.10 and E.16.21 in Appendix E.16), although a substantial amount of summer and fall activity occurs in the eastern portion of the analysis area where the mine site is located (SRB&A 2010b, 2018a). A majority of noise and traffic associated with the mine would occur in winter; mining would occur over six to seven winter construction seasons. As the presence of permanent infrastructure grows throughout the construction and operations phases, the sources of impacts may change. For example, air traffic impacts may decrease over the course of the construction phase while ground traffic impacts may increase. Most noise- and human-related impacts would occur in and around the Project area; however, impacts related to air traffic, ice road traffic, and new pipeline construction (in areas of current development to the east of the Project) would occur in larger areas and affect a larger percentage of harvests and harvesters than activities in the alternatives analysis area.

3.16.2.3.2.1 Caribou

Data on harvest amounts within the alternatives analysis area are only available for Nuiqsut caribou harvests (Table 3.16.6). Based on these data, the alternatives analysis area for Alternative B provides between 6% and 18% of annual caribou harvests. Caribou harvesting is more concentrated in the eastern portion of the alternatives analysis area (Figures 3.16.8 and 3.16.9). Caribou hunting activity has been more confined in recent years (2008–2017; Figure 3.16.9), but earlier studies show greater amounts of overland hunting near Project infrastructure (Figure 3.16.8); during years with adequate snow cover, use of this area may be more common. Because current uses are more focused in the eastern portion of the alternatives analysis area, direct impacts to caribou resource availability are more likely to occur near the mine site (Figures 3.16.8 and 3.16.9). Indirect impacts on the availability of caribou are likely to occur if equipment and infrastructure west of key harvest areas block or divert caribou movement into residents' hunting areas west of the community. A larger percentage of Nuiqsut caribou harvests could be indirectly affected (east of the Project area) by construction and operations activities compared to being directly affected. Some residents may use existing and new roads to access hunting areas closer to the Project area, increasing the potential for direct impacts for those users. Utqiaġvik caribou hunting was reported throughout the alternatives analysis area for the 1997–2006 time period but is characterized by low overlapping use (Figure 3.16.14).

Around the mine site, noise associated with gravel mining, including blasting, mining equipment and machinery, and excavation, could cause caribou to avoid the mine site area or to act skittishly. Mining would occur over six to seven construction seasons, primarily during the winter months, when subsistence uses in that area are at their peak but overall caribou hunting activity is low. While caribou hunting activities generally peak in summer and fall, winter can be an important time for hunters when they are low on food or had poor success in the previous season. When caribou are abundant near the community during winter, winter hunting is more common. The presence of the mine site and associated ice roads could deflect movement of caribou through the area, resulting in reduced availability closer to Nuiqsut. The use of ice and gravel roads by Nuiqsut harvesters to access caribou farther from the community could help offset these impacts; however, all gravel haul ice roads would be off limits to subsistence users during construction and therefore could act as a barrier rather than facilitate access. In addition, residents may experience difficulty hunting along existing gravel roads or in overland areas during this time due to safety concerns about shooting in the direction of ice roads with high traffic volumes. The mine site would be allowed to fill with water following construction and may result in some changes to caribou distribution and movement within that area. The CFWR would also remove suitable habitat for terrestrial mammals; however, caribou would likely move to other habitat (Section 3.12.2.3, *Alternative B: Proponent's Project*).

Air traffic, particularly helicopter traffic, has been the most commonly reported impact on caribou hunting (CPAI 2018b; SRB&A 2018a). Throughout the alternatives analysis area, air traffic could cause direct and indirect disturbances to caribou availability both within and outside the Project footprint. During construction, fixed-wing airplanes would be the primary source of air traffic, with helicopters used to support ice road construction, surveying, and monitoring (CPAI 2018b). There would be increased fixed-wing traffic to Alpine for the first 2 years of construction, which could affect resource availability for residents hunting by boat in the CRD. Once the airstrip is constructed, air traffic to the Project area would likely increase to multiple daily flights throughout the life of the Project, although at slightly lower levels during drilling and operations. Helicopter traffic would occur on a more periodic basis throughout the life of the Project. According to Stephen R. Braund and Associates (SRB&A) (2018), the area west of Nuiqsut accounts for a substantial percentage of Nuiqsut's annual caribou harvest, and increased air traffic within that area could affect Nuiqsut harvesting success during the construction and operations phases. Impacts of air traffic to caribou resource availability would be most likely during fall, when caribou migrate in an easterly direction, often crossing through the Project area into areas heavily used by Nuiqsut caribou hunters (Figures 3.16.8 and 3.16.9; Figure E.16.2 in Appendix E.16).

In recent years, reports of ground traffic–related impacts have increased with the construction of gravel roads in the area (SRB&A 2016, 2017a, 2018a). Deflections or delays of caribou movement from roads and associated ground traffic and human activity have been documented both by active harvesters (SRB&A 2010a, 2011, 2012, 2013b, 2014, 2015, 2016, 2017a) and during behavioral studies on caribou, particularly for maternal caribou (displacement of between 1.24 and 2.5 miles [2 and 4 kilometers] from roads) (Section 3.12). Displacement of calving caribou would likely not have direct effects on hunter success, as hunting during the calving season is low. Effects on caribou movement are most likely to occur when linear structures are placed parallel to the herd's primary movement. Perpendicular roads may also intercept caribou and cause delayed crossing (BLM 2018a; CPAI 2018b). All Project roads would likely affect crossing patterns to some extent, and deflections and delays in migration could occur for up to several hours during periods of heavy traffic, resulting in reduced success for hunters traveling overland to the west of the community.

Deflected movements and delays become common where roads and pipelines are close to one another and where traffic rates exceed 15 vehicles per hour. (The effects of roads and pipelines on caribou are detailed in Section 3.12.) Traffic rates would be highest during construction but would exceed 15 vehicles per hour into drilling (through 2029). While traffic rates would be highest in winter, they could still exceed 15 trips per hour during summer, when hunting activities are highest (Section 5.3, *Ground Traffic Comparisons*, in Appendix D.1). Therefore, decreased hunting success resulting from delayed caribou crossings could occur throughout the construction period. It is likely that caribou deflections would continue during drilling and operations but at a lower intensity and frequency than during construction. During operations, traffic rates are not expected to exceed 15 vehicles per hour. Temporary changes in distribution have not been shown to alter overall migration patterns or herd distribution (Section 3.12). However, small changes in caribou distribution and movement can have large impacts on hunter success.

According to CPAI (2018b), the TCH may be less habituated to development activity than caribou from the CAHand thus more prone to disturbance. Impacts would most likely occur during the summer and fall months, when caribou hunting activity is highest (Table E.16.7 in Appendix E.16). During drilling and operations, caribou would continue to be deflected or delayed while crossing Project roads, although ground traffic would decrease somewhat during operations. During the oestrid fly season, groups of caribou could gather on pads and roads for insect relief; this may result in increased availability of caribou for individuals hunting along roads but may also increase the likelihood of vehicle strikes and mortalities. Individuals not using roads to access caribou may experience reduced success closer to Nuiqsut.

Under Alternative B, CPAI would construct a boat ramp specifically for subsistence use on the Ublutuoch (Tiŋmiaqsiuġvik) River, and up to two additional boat ramps at Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek. Increased traffic along these drainages as a result of increased access for subsistence hunters could displace or disturb caribou and alter caribou movement and distribution. Use of these rivers for hunting, in combination with traffic along Project roads to the east, could decrease the availability of caribou within areas directly west of the community of Nuiqsut, where residents frequently hunt during the fall months. However, these impacts to resource availability may be offset by the increased access introduced by Project roads and boat ramps (Section 3.16.2.3.3).

Use and storage of hazardous materials, treatment and disposal of wastewater, solid waste, and drilling waste, and generation of air emissions could also reduce caribou use if individuals perceive or confirm caribou to be contaminated and avoid harvesting caribou that feed near the Project and are harvested elsewhere. Both Nuiqsut and Utqiaġvik harvesters have reported avoiding harvests of subsistence resources in certain years due to concerns about contamination (SRB&A 2009); during a recent BOEM–funded study, 47% of Nuiqsut households reported avoidance in the previous year of certain subsistence foods due to concerns about contamination (SRB&A 2017b).

During operations, drilling noise may affect the availability of caribou. Studies show that caribou, especially females with calves, avoid active drilling sites and caribou that do approach drilling sites spend less time feeding and lying down (Fancy 1983; Lawhead, Prichard et al. 2004). Thus, residents may experience reduced hunting success near Project drill sites.

In summary, the Project could both directly and indirectly affect the availability of caribou to Nuiqsut subsistence users. The alternatives analysis area has provided up to 18% of the total caribou harvest during some years, and harvests are even more concentrated directly east of the Project area. Thus, large deflections of caribou away from the area west of Nuiqsut would have substantial impacts to subsistence users.

3.16.2.3.2.2 Furbearers

Wolf and wolverine are the primary resources harvested by Nuiqsut and Utqiaġvik subsistence users in the Alternative B analysis area (in terms of the percentage of harvesters using the area). Relative to other resources, the availability of furbearers would be most impacted directly around Project activities and infrastructure due to their sensitivity to noise and human activity and tendency to avoid developed areas (SRB&A 2009). As shown on Figure 3.16.10, during the 1995–2006 time period, wolf and wolverine hunters reported high levels of overlapping use throughout a majority of the alternatives analysis area, including areas surrounding the road and the BT1, BT2, BT3, and BT5 drill sites. Drill site BT4 is in an area of low to moderate use for wolf and wolverine hunting. Low to moderate overlapping use for Utqiaġvik wolf and wolverine hunters also occurs in the alternatives analysis area (Figure 3.16.15). During construction and operations, furbearers are likely to avoid areas with equipment and infrastructure and increased levels of human activity, noise, and ground traffic. During the early construction phase, ground traffic would be highest during the winter months, when furbearer harvester numbers are at their highest. Increased air traffic west of Nuiqsut could also affect Nuiqsut and Utqiaġvik wolf and wolverine harvesters. Operations impacts would be similar to construction impacts but would continue throughout the life of the Project at somewhat lower levels.

Noise associated with gravel mining could affect the availability of furbearers by causing them to avoid the mine site or act skittishly. Furbearers may also avoid the mine site and associated ice roads due to the physical presence of construction equipment. Blasting and excavation would occur primarily during the winter months and have the greatest effect on wolf and wolverine hunting, which peaks during the winter months in the direct effects analysis area (Figure E.16.10 in Appendix E.16).

3.16.2.3.2.3 Waterfowl

Nuiqsut waterfowl use areas overlap with the eastern portion of the mainland alternatives analysis area, in addition to a small portion where the analysis area intersects with goose hunting along Fish (Uvlutuuq and Iqalliqpik) Creek and Judy (Iqalliqpik) Creek (Figure 3.16.11). In addition, Nuiqsut eider use areas overlap with the portion of the alternatives analysis area near Oliktok Dock. Eider hunting occurs offshore from Oliktok Dock in Harrison Bay (Figure 3.16.6; Figure E.16.7 in Appendix E.16).

The removal of waterfowl habitat at the mine site (including nesting habitat) would reduce the availability of waterfowl in those areas during the construction phase, although residents generally report low overlapping use at the mine site itself. After mining is complete, the mine pit would fill with water, which may increase harvest opportunities through the creation of suitable waterfowl habitat. Noise associated with gravel mining could also affect the availability of waterfowl by causing them to avoid the mine site area or to act skittishly. Blasting and excavation would occur primarily during the winter months when waterfowl (goose) hunting does not occur; however, if mining extends into the early goose hunting season (April), there could be impacts on waterfowl availability at that time.

Placement of gravel for roads and pads would remove waterfowl habitat and dust deposition from gravel roads would alter or reduce the quality of bird habitat. While the Project would remove a small fraction of total bird habitat in the area, bird displacement would occur, and residents may experience reduced success in formerly successful hunting areas.

Noise; human presence; and ground, vessel, and air traffic during construction and operations may also cause temporary disturbances to or displacement of waterfowl, causing temporary changes to harvester success; however, these disturbances would vary by species and impact source and would not likely affect overall resource availability for Nuiqsut harvesters. Increased barge and vessel traffic in the vicinity of Oliktok Dock, in addition to noise associated with screeding and lightering, could alter habitats and displace eiders in the vicinity of these activities; however, these impacts would be additive to existing impacts near Oliktok Dock rather than introducing impacts into areas that were previously unaffected by development. Operations impacts from noise and traffic would be similar to construction impacts. Impacts on waterfowl availability from ground traffic would occur at reduced levels during operations (less than half the traffic levels experienced during construction and drilling) but would continue throughout the life of the Project. In addition, ground traffic impacts would be most likely during construction, when ice roads cross through areas of high overlapping use for goose hunters. While most construction activity would be complete before goose hunting begins, it is possible the ice road season would overlap with the beginning of the waterfowl hunting season in late April. Air traffic would continue at similar levels throughout the life of the Project. Operational drilling noise could displace waterfowl in the Project area (Section 3.11) but would not affect waterfowl availability for Nuiqsut harvesters, as waterfowl are harvested at a substantial distance from the drill sites.

3.16.2.3.2.4 Fish

Ice road crossings over waterways such as Fish (Uvlutuuq) Creek could temporarily block passage of subsistence resources; however, such displacement would likely not cause changes in resource availability for harvesters downstream, and ice infrastructure would be removed, breached, or slotted before spring breakup to minimize blocked passage of fish (Section 3.10).

Noise and disturbance related to in-water work (e.g., culvert installation) could temporarily displace fish upstream and downstream from construction activities; however, fish availability for Nuiqsut harvesters downstream from stream crossings (e.g., in Fish [Iqalliqpik] Creek) would likely not be affected. Fish are harvested at a substantial distance from stream crossings. In addition, in-water work would be relatively infrequent, as most culverts would be installed prior to breakup of the first construction season (Section 2.5.3.2.2, *Culverts*; Section 3.10).

Construction of the new boat ramps along the Ublutuoch (Tiŋmiaqsiuġvik) River, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek would remove some aquatic habitat, including overwintering habitat at the boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River. However, in most cases, impacts would be localized and fish would move to other wintering habitat. In addition, stormwater runoff from the boat ramps and increased boat traffic along the Ublutuoch (Tiŋmiaqsiuġvik) River, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek may increase the potential for contamination; however, impacts on fish would be relatively small (Section 3.10.2.3.1).

Freshwater withdrawal could potentially affect fish availability in some freshwater lakes. Excavation of the CFWR may cause increased sedimentation in Lake M0015; however, these impacts would be local and temporary, and subsistence fishing has not been reported in this lake. In addition, dust deposition from truck traffic could alter lake habitat for sensitive fish species. Lake use for subsistence within the alternatives analysis area is relatively limited.

Project use and storage of hazardous materials throughout the life of the Project could reduce the use of fish resources if fish or the streams they inhabit are perceived or confirmed to be contaminated, causing some individuals to avoid harvesting fish resources downstream from infrastructure and work areas.

3.16.2.3.2.5 Marine Mammals

The Oliktok Dock portion of the alternatives analysis area overlaps with Nuiqsut seal use areas. Oliktok Dock shows areas of low to moderate use for Nuiqsut seal hunters, with areas of high overlapping use occurring to the west of the dock area in Harrison Bay (Figure 3.16.6; Figure E.16.9 in Appendix E.16). Seals may be temporarily displaced around barge and vessel traffic, or in the vicinity of screeding and lightering activities, which could affect resource availability for Nuiqsut seal hunters during the summer months. However, these impacts would be temporary and additive to the existing impacts at Oliktok Dock. Barge traffic associated with the Project would traverse through the Bering, Chukchi, and Beaufort seas and may temporarily affect the availability of marine mammals, including seals, walrus, and whales, in the vicinity of the barges. Marine mammals within 1.3 miles of barges may experience disturbances or displacement (Section 3.13). While barges would stay 10 to 40 miles offshore in most cases, they would traverse through Harrison Bay before terminating at Oliktok Dock. Harrison Bay is a key seal hunting area for Nuiqsut and thus barge traffic may affect seal availability temporarily.

Barge traffic may also displace bowhead whales and affect whale hunting success, as has been reported by whaling crews in the past (SRB&A 2009). While barges associated with the Project would not traverse through Nuiqsut's whaling grounds near Cross Island, they would traverse whaling grounds for other communities that hunt whales during the open-water months, including Utqiaġvik. Bowhead whale is a key subsistence resource that has unique cultural and social importance to the Iñupiat of the North Slope and around which Iñupiaq social organization is based. Bowhead whale harvests also account for a large proportion of subsistence foods harvested by coastal North Slope communities; in the case of Utqiaġvik, bowhead whales have accounted for between 28.4% and 68.1% of the total subsistence harvest (in terms of edible pounds) during years with available harvest data (Appendix E.16). Thus, any disruption to bowhead whaling activities for whaling crews could have substantial subsistence and sociocultural impacts to the study communities. BMP H-1 would require that permittees proposing barging activities coordinate with the Alaska Eskimo Whaling Commission, community whaling captains' associations, and the NSB to minimize the impacts of barging on subsistence whaling activities.

In addition to vessel and barge traffic, increased air traffic between Alpine and Willow, particularly during construction, could have temporary and localized effects on seals in the vicinity of the CRD; however, these impacts would be localized, temporary, and relatively infrequent. Some isolated impacts on resource availability for seal hunters may occur.

3.16.2.3.3 Harvester Access

Tables 3.16.5 and 3.16.6 summarize the percentage of harvesters using the alternatives analysis area. During an approximately 10-year period between 1995 and 2007, 91% of Nuiqsut harvesters and 12% of Utqiaġvik harvesters reported using the alternatives analysis area (Table 3.16.5). For both communities, wolf and wolverine were the primary resource targeted, followed closely by caribou. Between 2008 and 2016, between 35% and 72% of Nuiqsut caribou harvesters used the alternatives analysis area on an annual basis (Table 3.16.6); 84% used it over a 10-year period (Table 3.16.5). Thus, up to 84% of Nuiqsut caribou harvesters could be directly affected during 1 or more years of the Project, with smaller numbers on an annual basis. In addition to caribou, wolf, and wolverine, Nuiqsut harvesters also use the alternatives analysis area to hunt goose (36% of goose harvesters) and the offshore area near Oliktok Dock to hunt bearded seal (41% of harvesters), ringed seal (35%), and eiders (39%). Limited moose hunting (10% of Nuiqsut moose harvesters) occurs in the alternatives analysis area along Fish Creek and along the coast to Oliktok Dock. A 1,000-foot safety area around all Willow facilities would be in place and would prohibit the discharge of firearms within those areas. In addition, according to CPAI's access guidelines, hunters would be asked to avoid shooting in the direction of people, work crews, equipment, pipelines, or infrastructure. Nuiqsut hunters already observe these guidelines at existing oil and gas facilities out of concern for human safety. The presence of infrastructure and human activity and associated safety considerations further reduces the area in which residents would be able to hunt. The distance at which residents can safely shoot around infrastructure varies depending on the firearm being used, but it could range from 0.5 mile for an AK-47 to 2.5 miles for a .30-06.

During construction and operations, residents would experience physical barriers to access from Project infrastructure, although tundra access ramps and road pullouts at regular distances (every 2.5 to 3 miles) along Project roads would help reduce those impacts. Aboveground pipelines will be elevated a minimum of 7 feet and would be designed to allow for unimpeded passage by subsistence users. Harvesters traveling overland to access use areas for caribou, furbearers, and goose may be diverted around construction areas or operational infrastructure. For Nuiqsut and Utqiaġvik, the direct effects analysis area is primarily accessed by snow machine (Figures E.16.11 and E.16.22 in Appendix E.16), with Nuiqsut caribou hunting also occurring by four-wheeler (Figure E.16.11 in Appendix E.16) (SRB&A 2018a). Boats are also used in the direct effects analysis area but primarily in the marine area and along the Colville River, where module transport ice roads are proposed at a time when no boat travel would occur (Section 3.16.2.8, *Module Delivery Option 3: Colville River Crossing*). Boat hunting occurs along Fish (Iqalliqpik) Creek (Figure 3.8.3) but generally downriver from the action alternatives. Thus, for the action alternatives, physical barriers to access would occur for Nuiqsut and Utqiaġvik wolf, wolverine, and caribou harvesters, with Nuiqsut goose hunters also being affected. Nuiqsut harvesters access the eastern portion of the direct effects analysis and alternatives analysis areas during snow-free months using ATVs; these individuals, and individuals traveling by snow machine in winter, would likely have to divert around the mine site area, which is located within areas of high overlapping use for caribou, wolf, and wolverine (Figures E.16.2 and E.16.5 in Appendix E.16). Residents may also experience reduced access to certain construction areas if work areas are closed to access by local residents. Although Nuiqsut harvesters have generally reported being able to cross under recently built pipelines without difficulty (SRB&A 2019), individuals on snow machines may periodically have to divert around certain areas of the pipeline due to snowdrifts. After mining is complete, the mine pit would fill with water (regardless of if it were connected to adjacent streams during reclamation); reclamation plans would be coordinated with the agencies prior to construction. Caribou harvesters traveling to the west of the community by ATV during the summer and fall months may have to alter their usual routes due to the new waterbody; however, these impacts would be relatively minimal, as harvesters generally do not use a single route when hunting overland.

Nuiqsut caribou hunters increasingly use trucks to access subsistence use areas north and west of the community (BLM 2018a; SRB&A 2018a). This corresponds with construction of the Nuiqsut Spur, Alpine CD5, and GMT-1 roads. Some hunters use gravel and ice roads to access hunting areas for caribou and furbearers west of Nuiqsut and goose hunting areas during the spring. Road use would most likely be from individuals who do not have access to other overland modes of transportation (e.g., snow machines, ATVs). During construction, gravel haul ice roads, including the ice road connecting the mine site to the existing road system, would be off limits to subsistence harvesters and would therefore pose as a barrier to subsistence access. In addition, residents may experience difficulty hunting along existing gravel roads or in overland areas during this time due to safety concerns about shooting in the direction of ice and other roads with high traffic volumes. Winter is generally a low time for caribou harvesting in Nuiqsut, so road use would be more likely for those who experienced reduced harvest success at other times of the year. Some Utqiaġvik harvesters may also access the Project road system in the winter via the NSB's Community Winter Access Trail (a snow trail). During operations, use of the Project area may increase for some individuals because of roads and tundra access ramps. While some hunters have reported difficulty navigating existing tundra access ramps, ramp designs have been modified in response to comments from Nuiqsut hunters. These upgrades, which consist of a more gradual slope, ramps on both sides of the road, and the inclusion of a landing area at the top of each ramp, should increase the usability and safety of the ramps.

The increased use of Project roads for subsistence harvesting may result in increased competition along the road. It may also create a new hunting corridor in the area, causing increased deflection of caribou during their fall migration toward the community's traditional hunting area to the west of Nuiqsut (SRB&A 2018a). This could result in reduced success for individuals who choose not to use Project roads and continue to hunt west of the community.

Nuiqsut harvesters' use of newly built roads has been documented during the Nuiqsut Caribou Subsistence Monitoring Project (SRB&A 2018a). As shown in Table 3.16.7, just over half of households (54%) reported using the road system to hunt caribou in 2018. Use of roads lessened somewhat with distance from the community (e.g., 40% of households used the road between Alpine CD5 and GMT-1 versus 52% of households who used the Spur Road). In addition, the percentage of households using the road east of the Spur Road toward Alpine was substantially lower than other road sections. Thus, it is possible that road use in the Project area would be less common due to the distance from the community and the more concentrated nature of drill sites and roads.

Table 3.16.7. Nuiqsut Household Use of Roads for Caribou Hunting, by Road Area, 2018

Road Area	Percentage of Households Using[a]
Any roads	54
Spur Road (Area 1)	52
East of Spur Road toward Alpine (Area 2)	10
West of Spur Road to CD5 (Area 3)	45
Between CD5 and GMT-1 (Area 4)	40

Note: CD5 (Colville Delta 5); GMT-1 (Greater Mooses Tooth 1).
[a] Total number of households was 70.

Of the households who used roads in 2018, 50% cited the ease of access to hunting areas, while around 25% mentioned the lack of access to non-road methods of transportation (i.e., did not have a boat or snow machine) (Table 3.16.8). A total of 18% of households reported using roads due to the availability of caribou along the road system. Of those households who did not use roads in 2018, 38% cited a preference for non-road modes of transportation (e.g., boats), while 25% indicated that they avoided roads due to industry. A total of 13% cited a general preference for other forms (non-road) of hunting. In summary, 46% of households reported not using roads, and a majority of those households indicated they did not use roads due to general avoidance of industry or personal hunting preferences.

Table 3.16.8. Reasons for Using or Not Using Roads for Caribou Hunting, 2018

Reason	Percentage of Households Using Roads[a]	Percentage of Households Not Using Roads[b]
Ease of use	50	–
Transportation method	26	38
Avoid industry	–	25
Resource availability	18	9
Personal preference	–	13
Security restrictions	–	3
Funds	3	–
No reason specified	16	16

Note: – (no data).
[a] Total number of households using roads was 38.
[b] Total number of households not using roads was 32.

Use of Project roads and/or avoidance of previously used areas could cause an overall shift in hunting areas and incrementally change the way traditional knowledge of hunting methods and areas is imparted and used. This would continue throughout the life of the Project and, in some cases, could continue after the Project ends.

In addition to Project roads, under Alternative B, CPAI would construct a boat ramp specifically for subsistence use on the Ublutuoch (Tiŋmiaqsiuġvik) River and up to two additional boat ramps at Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek. Boat ramps would be accessible from existing Project roads with the addition of short access roads. Travel by boat along the Ublutuoch (Tiŋmiaqsiuġvik) River to the proposed boat ramp location from Fish (Iqalliqpik) Creek (Figure 3.8.3) has occurred during at least some years, although on a limited basis (SRB&A 2010b, 2019). If it is possible for individuals to navigate to Fish (Iqalliqpik) Creek via the Ublutuoch (Tiŋmiaqsiuġvik) River using boats, the boat ramps could have substantial benefits to some users. The use of Fish (Iqalliqpik) Creek for subsistence purposes has declined in recent years, with residents citing fuel costs and difficult travel and navigation conditions (e.g., shallower waters near the mouth of Fish [Iqalliqpik] Creek) for the decline in use. A boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River could facilitate access to this traditionally important subsistence harvesting area. Of the three proposed boat ramps, residents would be most likely to use the Ublutuoch (Tiŋmiaqsiuġvik) River boat ramp, as it is closest to the community and would provide more immediate access to the lower, most heavily used portions of Fish (Iqalliqpik) Creek, where most traditional camps are located.

The boat ramps on Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek are located in areas that are not commonly accessed by boat, according to available subsistence use area data (SRB&A 2010b, 2019). However, these boat ramps could provide a benefit to the community, particularly in the event that the Project reduces the availability of certain resources, such as caribou, near the community. Accessing the upriver areas of Fish (Uvlutuuq) and

Judy (Iqalliqpik) creeks would allow residents to access areas that are currently not frequently used due to the long boat ride from the community, the high costs associated with such travel, and reported difficulties in recent years navigating into the mouth of Fish (Iqalliqpik) Creek by boat. Access to these areas may result in a shift in the community's boat hunting areas but could also provide access to new areas with greater concentrations of caribou in areas that are considered less affected by development (e.g., to the west of the current Prudhoe Bay, Kuparuk, Alpine). Residents may also use the boat ramps to access fishing areas along Fish (Iqalliqpik) Creek. The boat ramps could increase access to waterfowl hunting areas along Fish (Iqalliqpik) Creek, particularly after breakup, when the area is no longer accessible by snow machine. However, a majority of goose hunting occurs by snow machine and therefore use of the boat ramps for waterfowl hunting would likely be limited.

Some harvesters may avoid construction infrastructure due to discomfort hunting and shooting near industrial infrastructure; lack of knowledge about security protocols; concerns about resource contamination; and an assumed lack of resource availability near infrastructure. Harvesters would likely avoid the mine site area when traveling overland out of safety concerns, noise associated with the mine, and assumptions regarding the availability of resources near the mine site. Between 51% and 61% of caribou harvesters reported avoiding a subsistence use area during 4 years of the Nuiqsut Caribou Subsistence Monitoring Project, and between 33% and 46% did so due to development (CPAI 2018b; SRB&A 2018a). As noted above, nearly one-quarter of households cited avoidance of industry as a reason for not using roads in 2018 (Table 3.16.8). On this basis, it is estimated that at least one-third of harvesters who use the alternatives analysis area (95% of all harvesters; Table 3.16.2) may experience avoidance during one or more years of construction. In addition to the mainland portion of the alternatives analysis area, residents may also avoid the Oliktok Dock area, including offshore (seal and eider hunting) and coastal (caribou hunting) areas, during times of increased barge and construction activity. These responses would likely be temporary or additive, as the Oliktok Dock area already experiences barge and development activity, and uses of the area for subsistence hunting are low to moderate (Figures 3.16.6 and 3.16.12).

Although the analysis areas in the Environmental Evaluation Document and the EIS are not identical, CPAI (2018b) notes that while a substantial percentage of Nuiqsut harvesters reported using the Willow area over a 10-year period for all resources, fewer used the area in the 12 months prior to their interview (18% for all resources). The percentage of harvesters using the alternatives analysis area (which includes the mine site) for caribou is higher, at between 35% and 72% annually, but lower than the percentage using the area over a 10-year period (84%). Thus, not all harvesters who have reported using the alternatives analysis area over a 10-year period would experience direct impacts on access during the construction phase or would actively avoid the area. Harvester avoidance generally occurs at a distance larger than development footprints (Pedersen, Wolfe et al. 2000; SRB&A 2009, 2017a). Thus, it is possible that avoidance would occur in an area larger than the alternatives analysis area. Impacts related to avoidance may be temporary (e.g., one hunting season) for some individuals; for other individuals, avoidance may occur throughout the duration of construction. For additional discussion of harvester avoidance and how it has affected Nuiqsut subsistence uses over time, see BLM (2014, 2018a).

During operations, harvester avoidance of the Project area may be reduced from construction levels due to decreased noise and traffic disturbances, although avoidance responses would likely continue throughout the life of the Project for certain individuals. During the drilling and operations phases, most noise-related impacts would occur within the western portion of the alternatives analysis area as well as in other areas affected by Project-related air and ground traffic.

3.16.2.3.4 Other Subsistence and Sociocultural Impacts

Decreased harvester access or subsistence resource availability resulting from the Project (Sections 3.16.2.3.2, *Resource Availability*, and 3.16.2.3.3) would affect sociocultural systems due to the importance of subsistence in Iñupiaq cultural identity, social organization, social cohesion, transmission of cultural values, and community and individual well-being. Harvesting, processing, consuming, and sharing subsistence resources allows cultural values and traditions to be taught to new generations; sharing in particular reinforces social bonds throughout the local community and the region, while participation in subsistence activities allows for the transmission of knowledge about culturally important hunting and harvesting areas, Iñupiaq place names, harvest methods, and cultural values. Reduced participation or success in subsistence harvests affects social health by weakening social bonds. Changes in resource availability can also result in harvesters having to spend greater amounts of time and effort, in addition to spending more on fuel and other supplies, to harvest subsistence resources. If residents travel farther to access subsistence resources due to changes in their migration and distribution, they may take greater safety risks, causing stress to themselves and others in the community. Infrastructure and activities (e.g., air and ground traffic, mining and construction activity) associated with the Project could reduce resource availability, thus decreasing harvester success (Section 3.16.2.3.2, *Resource Availability*). Decreases in harvests resulting from changes in resource availability would also reduce opportunities for engaging in subsistence activities, potentially increasing social problems associated with drugs and alcohol (SRB&A 2009).

Impacts to sociocultural systems resulting from changes to subsistence resource availability and harvester access are most likely to occur for the community of Nuiqsut, as Nuiqsut harvesters most frequently use the potentially affected area and are most likely to experience direct and indirect impacts. However, Utqiaġvik harvesters may also experience changes to sociocultural systems if the Project affects harvesting activities in the vicinity of Teshekpuk Lake or winter furbearer harvesting activities. Given the relationships between communities and the sharing of resources throughout the area, sociocultural effects could extend beyond Nuiqsut and Utqiaġvik. Although this is unlikely due to the Willow Project alone, when added to other past, present, and RFFAs, the likelihood of sociocultural effects could increase, as discussed in Section 3.19. Impacts on sociocultural systems from drilling and operations would be long term, as these changes would affect current residents' use of and relationship to the area, and these changes would be transmitted to the next generation.

In addition to effects on sociocultural systems resulting from decreased resource availability or harvester access, residents may experience impacts to sociocultural systems resulting from increased interactions with non-local workers, changes in income and employment levels, and associated social tensions, During construction, the increase in personnel in Nuiqsut use areas could increase the risk of conflicts between workers and subsistence harvesters, particularly if residents and/or construction personnel are not properly informed of security restrictions and procedures. Implementation of cultural awareness training for all employees would help reduce the potential for such interactions.

Nuiqsut residents are also most likely to receive income from development, through wage employment or Kuukpik dividends. Project construction could result in increased employment opportunities and income for Nuiqsut residents. A majority of construction work would be seasonal or temporary (Section 3.15). Residents may invest the income from construction jobs and Kuukpik dividends into supplies and equipment (e.g., snow machines, fuel, ammunition) to support subsistence activities. Increased cash may help offset some effects by allowing residents to invest in equipment that helps them access more subsistence harvest areas and increases subsistence harvest efficiency. A decrease in subsistence activity by certain households could have a larger impact on the community if these households are particularly active and distribute subsistence foods to less active households. Because most construction activity is in the winter, a generally lower time for subsistence activities (Table E.16.7 in Appendix E.16), subsistence/work conflicts would be fewer.

The availability of jobs for Nuiqsut residents would likely decrease during operations; however, income through increased Kuukpik dividends would continue throughout drilling and operations. A shifting of subsistence roles may occur in certain cases, where particularly active harvesters (e.g., super-harvester households) may no longer have time to provide subsistence foods and may rely on others to fill the subsistence roles they once held. The role of super-harvester households has been documented in a number of studies (Kofinas, BurnSilver et al. 2016; Wolfe 2004). Wolfe (2004) found that in most rural communities, approximately 30% of households (super-harvester households) harvest 70% of a community's total harvest. Kofinas et al. (2016) found that many super-harvester households are often also high-earning households. However, more recent research shows an inverse relationship between household income and subsistence harvests, indicating that harvests may decline as household income increases (Guettabi, Greenberg et al. 2016). Subsistence roles within a community naturally change over time due to household circumstances (e.g., age and number of household members, employment levels), and communities generally adapt to these changes; however, a sudden change in employment levels in the community may cause at least a temporary disruption in social ties and roles within the community of Nuiqsut, which could cause a decline in the distribution of subsistence foods for a period of time and decreased food security for some households. Top reasons for reporting decreased harvests in rural Alaska communities include a lack of harvest effort; reduced resource availability; a lack of time due to work; other personal reasons; and less sharing. Thus, changes in resource availability resulting from the Project, increased local employment rates, and decreased distribution of subsistence resources could all contribute to decreased food security in affected communities (Fall and Kostick 2018). Disruptions to subsistence could come with high costs to social, cultural, and economic well-being, particularly to the more vulnerable low-income, unconnected, and low-harvest households (Kofinas, BurnSilver et al. 2016).

3.16.2.4 Alternative C: Disconnected Infield Roads

The type of effects under Alternative C would be similar to those described for Alternative B, with the differences in magnitude described below.

Under Alternative C, the reduction in infield roads, including no road and bridge crossing Judy (Iqalliqpik) Creek and the removal of a perpendicular intersection of access and infield roads, would potentially reduce the deflection of migrating caribou (Section 3.12), thus reducing impacts to resource availability for Nuiqsut subsistence users. The lack of infield roads would increase the need for air traffic during the ice-free months, increasing potential disturbances to caribou and other resources and Nuiqsut harvesters. Overall, fixed-wing, helicopter, and ground traffic would be slightly higher under Alternative C. Ground traffic would be more concentrated in the winter months, when caribou hunting activity is lower. The need for second airstrips and operations centers may result in air traffic disturbances occurring over a larger area.

Year-round road access for Nuiqsut residents would be less under Alternative C, as residents would not have road access to the areas west of Judy (Iqalliqpik) Creek during the snow-free months. The lack of year-round road access combined with increased air traffic may result in higher rates of harvester avoidance during certain times of the year. Similar to Alternative B, Alternative C would construct a subsistence boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River that could provide access to key hunting areas on the lower portion of Fish (Uvlutuuq) Creek; however, boat ramps would not be constructed on Fish (Uvlutuuq) and Judy (Iqalliqpik) creeks.

The decreased gravel road footprint under Alternative C, including the lack of a bridge crossing over Judy (Iqalliqpik) Creek, could reduce potential impacts to fish availability downstream from the Project (Section 3.10), particularly the perceived contamination concerns of residents harvesting broad whitefish in Fish (Iqalliqpik) Creek, the receiving waters of Judy (Iqalliqpik) Creek. However, because the pipeline crossing would remain, the reduction in perceived contamination concerns under Alternative C would be minimal. Alternative C would include an additional year of mine pit operation that would extend impacts resulting from associated blasting/noise and ice roads.

3.16.2.5 Alternative D: Disconnected Access

The types of effects under Alternative D would be similar to those described for Alternative B, with the differences in magnitude described below.

Under Alternative D, the lack of a year-round road and associated ground traffic between GMT-2 and the Project area would reduce impacts to the fall caribou migration (Section 3.12). There would still be a pipeline between GMT-2 and the Project area. The lack of year-round road access would also increase the need for air traffic during the ice-free months, increasing potential air traffic disturbances to caribou and other resources as well as Nuiqsut harvesters. The increase in air traffic under Alternative D would amount to, on average, approximately one additional fixed-wing aircraft trip per day during construction and drilling, although the increase in air traffic would likely be more concentrated in the ice-free months, when many subsistence activities are at their peak. Overall, Alternative D would result in higher levels of both air and ground traffic; however, ground traffic and infrastructure would be substantially reduced in the fall migration corridor during the peak caribou hunting season, while air traffic would increase only slightly. Because road infrastructure and associated ground traffic have been found to have greater impacts on caribou movement and distribution as compared to air traffic, which generally causes local disturbances, the overall impacts to subsistence in terms of caribou availability would likely be less than under Alternative B.

Year-round road access for Nuiqsut residents would be less under Alternative D, as residents would not have access to areas beyond GMT-2 during the snow-free months. The lack of year-round access in combination with increased air traffic may result in higher rates of harvester avoidance than under baseline conditions during certain times of the year and reduced use of a hunting corridor during the peak hunting season. Similar to Alternative B, Alternative D would construct a subsistence boat ramp on the Ublutuoch (Tiŋmiaqsiuġvik) River that could provide access to key hunting areas on the lower portion of Fish (Uvlutuuq) Creek; however, boat ramps would not be constructed on Fish (Uvlutuuq) and Judy (Iqalliqpik) creeks. The lack of a year-round road between GMT-2 and the Project area under Alternative D may lessen the sense of being boxed in for Nuiqsut residents and reduce the amount of infrastructure within traditional use areas and thus having fewer impacts to sociocultural systems associated with loss of some traditional use areas.

3.16.2.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

Figures 3.16.16 through 3.16.29 show Nuiqsut and Utqiaġvik subsistence use areas by resource. As shown in Tables 3.16.9 and 3.16.10, a majority of Nuiqsut harvesters (94%) reported using the MTI analysis area. Nuiqsut harvesters use the MTI analysis area primarily to harvest caribou, wolverine, wolf (with between 87% and 88% of harvesters using the area for each resource), and goose (55% of harvesters). These resources are harvested primarily in overland areas crossed by ice roads, particularly the ice road to the mine site (Figures 3.16.17 through 3.16.20). Nuiqsut areas of high overlapping use for caribou, wolf, and wolverine occur along the southern portion of MTI ice roads; some of these uses for caribou occur during the summer and fall season, when ice roads would not be present. The ice road to the mine site also crosses areas of high overlapping use for goose on Fish (Uvlutuuq) Creek, although ice roads would likely not be present during the primary goose hunting season in May (Figure 3.16.20). On an annual basis, the MTI analysis area provides between 4% and 11% of caribou harvests, primarily in areas surrounding the ice road crossing Fish (Iqalliqpik) Creek.

Nuiqsut harvesters use the offshore areas surrounding the MTI primarily for harvesting bearded seal (33% of harvesters), ringed seal (26%), and eider (14%) (Figures 3.16.21 and 3.16.22). Some coastal caribou hunting also occurs near the MTI, with Atigaru Point being an important traditional caribou hunting ground (SRB&A 2018a). Some broad whitefish harvesting occurs along Fish (Uvlutuuq) Creek in areas crossed by ice roads, but primarily during the ice-free season (Figure 3.16.23). A small percentage of harvesters report hunting moose in the MTI analysis area (Figure 3.16.24), where it crosses Fish (Iqalliqpik) Creek, but this is outside the core moose harvesting area for Nuiqsut and primarily occurs in fall, when ice roads would not be present (Figure E.16.3 in Appendix E.16).

Utqiaġvik uses the MTI analysis area primarily for hunting wolf (16% of harvesters), wolverine (16% of harvesters), and caribou (7% of harvesters) (Table 3.16.7). These uses are generally in areas of low to moderate overlapping use surrounding the proposed ice roads (Figure 3.16.25 through 3.16.27). In addition, a small percentage (2%) of Utqiaġvik harvesters use the offshore areas near the MTI for hunting bearded seal while traveling along the coast (Figure 3.16.28).

Table 3.16.9. Number and Percentage of Nuiqsut and Utqiaġvik Harvesters, by Module Delivery Option Area, 1996–2007

Resource Category	Nuiqsut: Atigaru Point MTI	Nuiqsut: Point Lonely MTI	Nuiqsut: Colville River Crossing	Utqiaġvik: Atigaru Point MTI	Utqiaġvik: Point Lonely MTI	Utqiaġvik: Colville River Crossing
Caribou	28 (88%)	28 (88%)	29 (91%)	5 (7%)	15 (21%)	5 (7%)
Wolverine	21 (88%)	21 (88%)	23 (96%)	5 (16%)	6 (19%)	5 (16%)
Wolf	20 (87%)	20 (87%)	22 (96%)	5 (16%)	6 (19%)	5 (16%)
Goose	18 (55%)	18 (55%)	15 (45%)	–	1 (1%)	–
Eiders	4 (14%)	1 (4%)	2 (7%)	–	–	–
Broad whitefish	3 (12%)	3 (12%)	4 (15%)	–	–	–
Burbot	1 (3%)	1 (3%)	0 (0%)	–	–	–
Moose	3 (10%)	3 (10%)	29 (94%)	–	–	4 (44%)
Bearded seal	9 (33%)	0 (0%)	0 (0%)	1 (2%)	1 (2%)	–
Ringed seal	6 (26%)	0 (0%)	0 (0%)	–	1 (2%)	–
All resources	31 (94%)	31 (94%)	30 (91%)	8 (11%)	17 (23%)	11 (15%)

Source: SRB&A 2010a
Note: – (no data); MTI (module transfer island).

Table 3.16.10. Number and Percentage of Nuiqsut Caribou Harvesters and Harvests, by Module Delivery Option Area, 2008–2016

Study Year	Total # of Active Harvester Respondents	Atigaru Point MTI Active Harvester Respondents	Point Lonely MTI Active Harvester Respondents	Colville River Crossing Active Harvester Respondents	Atigaru Point MTI Caribou Harvests[a]	Point Lonely MTI Caribou Harvests[a]	Colville River Crossing Caribou Harvests
Year 1	36	28 (78%)	26 (72%)	34 (94%)	6%	5%	11%
Year 2	53	23 (43%)	23 (43%)	47 (89%)	5%	5%	9%
Year 3	57	31 (54%)	31 (54%)	52 (91%)	6%	6%	7%
Year 4	58	29 (50%)	29 (51%)	51 (88%)	8%	8%	8%
Year 5	57	28 (49%)	24 (42%)	48 (84%)	11%	10%	7%
Year 6	57	19 (33%)	19 (33%)	44 (77%)	6%	6%	6%
Year 7	60	29 (48%)	29 (48%)	50 (83%)	6%	6%	8%
Year 8	58	22 (38%)	22 (38%)	48 (83%)	4%	4%	7%
Year 9	63	22 (35%)	21 (33%)	47 (75%)	7%	7%	8%

Source: SRB&A 2018
Note: MTI (module transfer island).
[a] Harvests are a percentage of the total reported harvests by interview respondents during each study year.

Construction and use of ice roads associated with the MTI could affect resource availability and harvester access. While construction activities associated with the MTI, including ice roads, would result in the temporary removal or disturbance of habitat for some resources and may also cause direct mortality to individual animals, these would not have population-level effects on subsistence resources.

Noise and traffic associated with ice roads, and the physical presence of the ice roads themselves, could affect the availability of caribou, wolf, and wolverine for Nuiqsut and Utqiaġvik harvesters. The ice road may still be present in late April, when goose hunting along Fish (Uvlutuuq) Creek intensifies (Figure E.16.10 in Appendix E.16); thus, goose hunters could experience direct impacts on their hunting, although impacts related to ice road traffic would likely not extend into the peak hunting month of May. Helicopter traffic may also extend into early summer along ice road routes for cleanup and "stick picking" purposes.

Some hunters from Nuiqsut may use MTI ice roads, particularly the ice road crossing Fish (Iqalliqpik) Creek (Figure 3.8.3), to access hunting areas; however, gravel haul ice roads would generally be off limits to local residents due to safety considerations. In addition, use of roads lessens somewhat with distance from the community; therefore, use of these ice roads may be limited. Others may avoid ice roads altogether. Because MTI ice roads would not be present during the fall caribou migration, it is unlikely they would cause overall changes in caribou distribution or migration; however, caribou may be deflected from ice roads in winter during times of heavy road traffic, affecting resource availability for caribou harvesters. During construction, peak ground traffic levels associated with the MTI would reach up to 6,710.5 trips daily (in winter 2025), or 279.6 trips per hour in winter (Table D.5.8 in Appendix D.1). Traffic volumes would reach or exceed 15 vehicles per hour, the rate at which caribou show increased disturbance, in 3 out of the 6 winters of construction of the MTI. Some Nuiqsut and Utqiaġvik hunters traveling overland by snow machine may experience reduced access during the winter months if crossing through areas with ice roads. Hunters on snow machines may also avoid ice roads due to noise and human activity or because of a perceived lack of resources in the area.

During construction of the MTI, noise generated from screeding, pile driving, and ice road and related vessel and air traffic could temporarily displace marine mammals and eiders, periodically resulting in reduced harvest success for Nuiqsut seal and eider hunters in the MTI area. MTI construction would occur during both winter and summer (beginning in mid-July). Vessel traffic between the MTI and Oliktok Point would occur during the ice-free open-water season and could cause periodic displacement of seals and eiders for Nuiqsut hunters in Harrison Bay. Air traffic, including fixed-wing aircraft overflights and helicopters, could also cause the temporary disturbance of marine mammals, birds, and caribou along the coast. Noise related to MTI construction would not cause overall impacts to resource availability (Sections 3.11 and 3.13). Impacts to marine mammals would occur during construction due to noise and human activity, and some habitat would be removed (Section 3.13). Some hunters may stay at a distance from the MTI and/or associated barges.

The presence of the MTI could affect the distribution of marine mammals and eiders within the immediate area (Sections 3.11 and 3.13); however, it is unlikely that this local displacement would have overall impacts on resource availability because the MTI is outside the primary seal and eider hunting area for Nuiqsut (Figures 3.16.21 and 3.16.22).

Seal and eider hunters may also temporarily avoid certain areas in Harrison Bay due to the presence of vessel traffic in areas of high overlapping use (Figures E.16.7 and E.16.9 in Appendix E.16). Although the area directly surrounding the MTI is not used as heavily by Nuiqsut harvesters, some individuals hunting along the coast or in offshore areas toward Atigaru Point may avoid the MTI during active construction activity. The presence of construction crews, particularly in summer, would likely increase potential avoidance by Nuiqsut hunters.

A key concern voiced by stakeholders regarding the Atigaru Point MTI is the potential for decreased access to coastal areas based on erosion and sedimentation around the island. Residents of the community of Nuiqsut have reported changes to the coastal area between the mouth of Fish (Iqalliqpik) Creek and Atigaru Point that have resulted in shallower waters and navigation issues. They are concerned that the MTI could contribute to the increasingly shallow waters in Harrison Bay and could further decrease access to coastal hunting areas as well as access into Fish (Iqalliqpik) Creek. Similar to other barrier islands in the Beaufort Sea, small amounts of shoaling may occur on the leeward side of the MTI; however, no additional accretion or further shallowing of the MTI area would be expected to occur (Section 3.8). Besides the MTI itself, no additional navigational hazards are expected for boaters. Whaling crews in Nuiqsut have reported navigational impacts on boat travel to Cross Island, which is perceived to be a result of erosion of human-made islands; crews have observed that the area between the coast and barrier islands has become shallower and more difficult to navigate (SRB&A 2018b). Small changes in coastal conditions can have more substantial impacts to boaters attempting to safely navigate ocean waters. While it is possible that the MTI may be used by some individuals as a stopover point when hunting in Harrison Bay by boat, future use of the island (once abandoned) is unclear. It is expected that the top of the MTI would drop below the water surface within 10 to 20 years and therefore would not be usable as a stopover point. If residents are no longer able to access the coastal areas near Atigaru Point, then they could experience reduced opportunities to teach younger generations about this traditionally important place, which would affect sociocultural systems for Nuiqsut. As discussed in Section 3.16.2.3.4, social organization, social cohesion, and transmission of cultural values would be affected if changes in subsistence resource availability and harvester access and avoidance reduce subsistence participation, sharing subsistence harvests, and passing on subsistence traditions to younger generations.

3.16.2.7 Module Delivery Option 2: Point Lonely Module Transfer Island

The effects of Option 2 would be the same as described for Option 1, with the differences described below.

Option 2 is farther from Nuiqsut and outside the community's core seal and eider hunting areas and key traditional caribou hunting areas near Atigaru Point (Table 3.16.10; Figures 3.16.17 through 3.16.22). Thus, there would be limited impacts on offshore seal and eider and coastal caribou hunting for the community of Nuiqsut compared to Option 1. Ice roads associated with Point Lonely would affect a similar percentage of Nuiqsut wolf, wolverine, caribou, and goose harvesters. While ice roads would occur over a larger area, resulting in a greater area of disturbance for TCH caribou, the additional acreage of ice roads under the Point Lonely option would occur in areas of low overlapping use for Nuiqsut. Thus, winter ice road activity under Option 2 would not have greater direct effects on subsistence harvesters but could have greater indirect effects through the displacement of wintering caribou. Option 2 is closer to critical caribou calving, post-calving, mosquito-relief, and oestrid fly-relief uses north of Teshekpuk Lake (Section 3.12). Summer Project activities at Point Lonely and along the ice road route, including construction noise, stick picking, human presence, and air traffic, could affect caribou during the calving and insect-relief seasons, resulting in alterations to caribou distribution closer to Nuiqsut and increased disturbance of calving and migrating caribou. Compared to Option 1, module delivery Option 2 would require higher levels of ground and fixed-wing traffic closer to shore and would therefore cause more disturbance of caribou than Option 1 (Section 3.12).

Due to its closer proximity to the Teshekpuk Lake area, an important subsistence use area for some Utqiaġvik residents, Option 2 would affect a greater percentage of Utqiaġvik caribou (21%), wolf (19%), and wolverine (19%) harvesters compared to Option 1 (Table 3.16.9; Figures 3.16.26 and 3.16.27). The ice road would be to the east and northeast of moderate overlapping use areas for wolf and wolverine to the south of Teshekpuk Lake (Figure 3.16.27). A small percentage (2%) of Utqiaġvik harvesters hunt offshore from the Point Lonely area for bearded and ringed seal. A single, small goose hunting area was documented for Utqiaġvik at the Option 2 site (Figure 3.16.29).

3.16.2.8 Module Delivery Option 3: Colville River Crossing

Option 3 would not construct an MTI and would instead rely on existing infrastructure at Oliktok Dock, as described under Alternative B, for module delivery. Thus, impacts associated with MTI construction and operations, particularly associated with vessel traffic through key marine harvesting areas in Harrison Bay and construction of the MTI near Atigaru Point, would not occur under Option 3.

Modules would be transported along existing gravel road routes from Oliktok Dock to Kuparuk DS2P, and then from Kuparuk DS2P to GMT-2 over a heavy-haul ice road. Some modifications to the Oliktok Road would be required to ensure adequate turning radii for the SPMTs; however, this area is not regularly used by contemporary Nuiqsut subsistence users and is not included in the analysis area because Project activities would be limited to upgrades to existing infrastructure rather than the construction of new infrastructure. The ice road route under Option 3 would cross through areas somewhat more heavily used by the community of Nuiqsut than those under Options 1 and 2 (Figure 3.16.30). Part of the ice road would intersect with the NSB's Community Winter Access Trail and therefore impacts would be additive in areas of existing impact. The ice road would cross through areas heavily used in winter for hunting furbearers (96% of wolf and wolverine harvesters) and caribou (91% of harvesters) along the Itkillik River, the Colville River near Ocean Point, and to the south and west of Nuiqsut (Figures 3.16.31 through 3.16.33). The Option 3 analysis area accounts for between 6% and 11% of the total caribou harvest during individual study years, compared to between 4% and 11% under Option 1. However, most of those harvests occur during summer and fall, when the ice road would not be present; therefore, a smaller percentage of harvests would likely be directly affected by the ice road. Winter hunting is more important during some years, when caribou are less available during the summer and fall months; therefore, impacts could be greater during these years. The Option 3 ice road occurs in CAH and TCH habitat. Because few CAH caribou are present in the area during winter, there would be minimal disturbances to the CAH from the ice road. Increased traffic along the gravel road from Oliktok Dock would be in areas of existing traffic and development and would be additive to existing impacts on CAH caribou. Traffic along the western portion of the ice road may affect the availability of wintering TCH caribou; however, the ice road is in areas of lower density for the TCH than the ice roads under Options 1 and 2 (Section 3.12.2.8, *Module Delivery Option 3: Colville River Crossing*). Overall, the ice road under Option 3 is expected to have fewer impacts to terrestrial mammals, including caribou, than the ice roads under Options 1 and 2 (Section 3.12.2.8).

During a study for the 1995–2006 time period, nearly all wolf and wolverine harvesters (96%) reported using the ice road area to conduct subsistence hunting. Most of the ice road area occurs in areas of high overlapping subsistence use for Nuiqsut wolf and wolverine hunting (Figure 3.16.33). Wolf and wolverine hunters may cover expansive areas by snow machine in pursuit of these resources, and the ice road overlaps with a small portion of this area. However, subsistence hunters generally do not travel farther than necessary due to the high cost of travel (SRB&A 2010b), and if the ice road increases the area from which furbearers are displaced, residents may have to travel farther than desired in pursuit of this resource. Such impacts would occur over two winter seasons.

The ice road would also cross through areas of moderate overlapping use for waterfowl, in areas used by 45% of goose harvesters; thus, if the ice road season extends into April, then early spring goose hunting could be directly affected (Figure 3.16.34). However, few birds are present in the ice road area during winter (Section 3.11), and hunting activity in April is limited (SRB&A 2010b); therefore, impacts are unlikely. Option 3 activity would occur in an area used by a slightly smaller percentage of goose harvesters than Option 1, and uses occur primarily in May, when the ice road season would be over. While the area where the ice road crosses the Colville River is heavily used by Nuiqsut moose hunters (94%), these activities occur in fall, when the ice road would not be present (Figure 3.16.37). In addition, a majority of moose harvests have been reported farther upriver from the crossing, toward Sentinel Hill, the Chandler River, and Umiat (SRB&A 2010a) The Colville River crossing would be located far enough upstream from the CRD that fish are not anticipated to be present in winter (see Section 3.10.2.8, *Module Delivery Option 3: Colville River Crossing*); winter fishing activities are generally focused downstream from Ocean Point and near the mouth of the Itkillik River (Figure 3.16.36). The further monitoring of ice conditions and fish presence at the ice bridge location would occur prior to ice bridge construction.

Construction of the ice road under Option 3 would result in the community of Nuiqsut being completely encircled to the north, west, south, and east by gravel or ice roads. This encirclement would occur over two winter seasons and would therefore be temporary. While the Community Winter Access Trail also occurs in this area, it is not connected to other development infrastructure in the area and its primary purpose is for travel by North Slope residents. Individuals on snow machines would likely have to cross over roads in order to travel any distances greater than 15 or 20 miles from the community. Nuiqsut wolf and wolverine hunters generally travel by snow machine to the southwest and south of the community (SRB&A 2010b), and the ice road would occur directly in the path of their usual travel routes. Option 3 would require one less winter ice road season (two winters) compared to Options 1 and 2 (three winters); in addition, substantially less ground traffic would be required under Option 3 (approximately one-quarter of that anticipated under Option 1, Table D.5.5 in Appendix D.1) and therefore the ice road and associated traffic are less likely to deflect or disturb subsistence resources and less likely to deter subsistence harvesters from crossing. Option 3 would also require substantially less fixed-wing and helicopter traffic than Option 1, reducing disturbances to wildlife resources and hunters.

With the exception of moose hunting areas, Option 3 would move most activity and infrastructure associated with module delivery farther from Utqiaġvik's primary subsistence use area compared to Options 1 and 2 (Figures 3.16.38 through 3.16.41). While Option 3 overlaps with moose hunting areas for 44% of moose harvesters, these moose hunting activities occur during the summer and fall months, when ice roads would not be present. Because the ice road would be located farther east, impacts on resource availability resulting from disturbances to migrating caribou would be less likely for Utqiaġvik. Overall, Option 3 would be less likely to have direct impacts to Utqiaġvik harvesters than Options 1 and 2.

3.16.2.9 Oil Spills and Accidental Releases

An oil spill or blowout would likely affect the availability of fish, particularly broad whitefish, in Fish (Uvlutuuq) Creek, due to decreased resource abundance (Section 3.10) as well as harvester avoidance related to contamination concerns. Broad whitefish has accounted for between 5.3% and 45% of the total subsistence harvest during available study years (Table E.16.3 in Appendix E.16). A large oil spill or blowout could also affect the availability of birds within a larger area surrounding Fish (Iqalliqpik) Creek due to contamination concerns. Nearly 50% of Nuiqsut households reported avoiding subsistence foods they believed to be contaminated during the 2016 study year (SRB&A 2017b). Contamination concerns are generally more widespread for marine or riverine resources (e.g., broad whitefish) due to the greater potential for contaminants to spread outside of the immediate Project area; however, harvesters may also avoid harvesting caribou and waterfowl that feed in the vicinity of a spill. A large oil spill, although unlikely, could have substantial impacts on Nuiqsut subsistence uses for an extended period, resulting in decreased subsistence harvests and associated sociocultural impacts. Residents may avoid a large area surrounding and downstream from the spill, which could result in a loss of some traditional use areas over time and impacts to sociocultural systems, resulting from decreased opportunities to share subsistence resources, participate in subsistence harvesting activities, and pass on subsistence traditions to the younger generation.

3.16.3 Unavoidable Adverse, Irretrievable, and Irreplaceable Effects

Even with BMPs in place, the subsistence impacts described above would be unavoidable and irretrievable during the life of the Project. Previous analyses have shown that many impacts to subsistence persist despite the implementation of BMPs (SRB&A 2013a, 2018a). Most impacts would not be irreversible if reclamation of permanent infrastructure occurred. However, impacts related to decreased knowledge of and cultural ties to developed areas may be irreversible. The creation of the MTI would be irreversible because even if the MTI is abandoned and reshaped, it would still exist. Multigenerational shifts in subsistence participation may be irreversible, depending on local community response to the development. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.17 Environmental Justice

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to take appropriate and necessary steps to identify and address disproportionately high and adverse effects of federal decisions on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.

This environmental justice analysis evaluates effects on the minority population in Nuiqsut, the community closest to the Project and most likely to be directly affected by social or environmental changes associated with Project development. Income and poverty data on Nuiqsut are inconsistent between data sources (U.S. Census versus NSB data) that provide measures of income and poverty. As noted in Section 3.15, U.S. Census data on mean and median household income and poverty rates show that Nuiqsut has higher incomes and lower poverty rates than the NSB and the state as a whole. Median family and household incomes for Nuiqsut are substantially higher than U.S. Department of Housing and Urban Development low-income limits and U.S. Department of Health and Human Services poverty guidelines (HHS 2019; HUD 2019).

3.17.1 Affected Environment

Nuiqsut residents are considered a minority population as the community is 89% Alaska Native. Nuiqsut's median family income is $74,750 and mean family income is $88,604; these income levels exceed federal poverty and low-income guidelines (HHS 2019; HUD 2019; U.S. Census 2018b). As described in Section 3.15, the cost of living in remote Alaskan communities like Nuiqsut are substantially higher (42%) than in Anchorage (Fried 2015; Fried and Robinson 2005).

As noted by BLM (2018a), climate change can be understood as an environmental justice issue. Alaska Natives living in rural areas also may be especially vulnerable to climate-related effects due to their economic, nutritional, and cultural dependence on subsistence food resources (EPA 2017b). 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 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.

3.17.2 Meaningful Engagement

EPA's 2016 environmental justice guidance stresses the importance of providing minority or low-income populations with meaningful engagement in environmental review processes (EPA 2016). Coordination with and involvement of Nuiqsut residents has occurred through six primary avenues of communication:

- During the initial phase of the Project, BLM invited NVN and the City of Nuiqsut to participate in the environmental review process as cooperating agencies representing expertise in sociocultural, wildlife, and subsistence resources. The NVN was also invited to participate in government-to-government consultation. The NVN and the City of Nuiqsut have participated in cooperating agency meetings, including those pertaining to alternatives development and identification of key issues. They have also been offered opportunities to comment on draft resource analyses and sections of the EIS.

- In addition to agency meetings, BLM consults with the NVN regularly through government-to-government discussion.
- BLM has invited the NVN to participate in regularly scheduled meetings for the NPR-A Working Group (reinstituted in spring 2019).
- BLM also engaged Nuiqsut residents through public meetings in Nuiqsut to solicit input regarding the EIS process and concerns of the community, both through public scoping meetings and from community open house meetings regarding the Project. Iñupiaq translators were present during meetings in Nuiqsut. Public scoping was conducted from August 7, 2018, to September 20, 2018, to solicit input from the public and to inform the EIS. BLM provided the community of Nuiqsut an additional 8 days (52 total days) to comment because many community members were participating in subsistence activities during much of the scoping period. More information on public scoping and comments received are provided Appendix B.1 (*Scoping Process and Comment Summary*).
- BLM engaged Nuiqsut residents through public meetings for the Draft EIS in Nuiqsut to solicit input regarding Project effects and concerns of the community. Iñupiaq translators were present during meetings in Nuiqsut. The public comment period (starting August 30, 2019) was open for 45 days and subsequently extended for 15 additional days, ending on October 29, 2019. The Nuiqsut meeting included the public hearing for comments regarding the Project's potential impact to subsistence resources and activities, as per ANILCA Section 810.
- BLM engaged Nuiqsut residents though eight virtual public meetings to receive comments on the SDEIS. Because of state and local mandates regarding COVID-19 that restricted travel and in-person meetings, BLM delivered virtual meetings to reach audiences across the state. Two of the virtual public meetings gave priority to North Slope residents and two meetings gave priority to Nuiqsut residents. The meetings included public hearings for comments regarding the Project's potential impact to subsistence resources and activities as per the ANILCA Section 810. All meetings were also accessible by phone. A copy of the presentation was translated into Iñupiaq and aired six times on KBRW radio. Hard copies of the presentation were sent to post office boxes in Nuiqsut.

Through BLM's efforts to involve Nuiqsut residents, community members have provided input and expressed environmental justice concerns related to the potential Project impacts (adverse and positive) on human health, subsistence, Nuiqsut socioeconomics, caribou, general wildlife, and pollutants to air quality and water quality. Key points made by comment type are summarized in Table 3.17.1.

Table 3.17.1. Key Points Made by Nuiqsut Residents (minority population) in Scoping Comments

Comment Category	Summary of Comments
Subsistence	Evaluate positive effects of new roads for subsistence hunting and for people without off-road-capable vehicles or snowmobiles. Evaluate adverse effects of air and ground traffic, blasting and mining activities, and Project infrastructure on caribou migration patterns and other species of wildlife, and the resulting impacts to subsistence hunting, fishing, or whaling, especially for the Nuiqsut community. Provide mitigation for adverse impacts to Nuiqsut subsistence hunting. Evaluate both adverse and positive impacts of the access road on caribou, air and water quality, and increased subsistence access. Do not allow the gravel mine to be reclaimed and used as a human-made lake with artificially introduced fish for subsistence use. Give attention to important subsistence areas such as Fish Creek, Judy Creek, and Harrison Bay.
Nuiqsut Socioeconomics	Evaluate potential adverse socioeconomic or environmental justice impacts to the village of Nuiqsut resulting from health impacts and the cost of medical treatment, subsistence impacts and the cost of food subsidies, and the increased use of public resources, including health clinics and emergency response resources as well as evaluating whether Project-created jobs could specifically positively affect Nuiqsut. Some comments stated that BLM should re-evaluate NPR-A royalty distributions and whether royalties are being distributed in a fair and equitable manner, where the number of royalty shares are commensurate with the severity of impacts felt by the community. The Native Village of Nuiqsut requests that any analysis of potential impacts to tribal communities and resources be performed in accordance with their Project and Land Management Evaluation Rubric as well as Section VIII of the Alaska National Interest Lands Conservation Act.

Comment Category	Summary of Comments
Caribou and General Wildlife	Evaluate impacts to caribou and wildlife migration patterns, flora, fauna, fish, aquatic and wildlife habitats, and fragmentation on wildlife. Identify existing protections for flora and fauna in the IAP including special areas protected under the IAP and set aside for their importance to caribou (Teshekpuk Lake and Colville River Special Areas); tundra habitats and species from thermokarst development; caribou migration patterns or avoidance effects from module delivery, aboveground or elevated pipelines, ice roads, winter activities; shorebirds and waterfowl from habitat loss and aircraft flushing; bird species of concern from habitat loss and roads; whales, seals, and other aquatic species from the gravel island in Harrison Bay; and fish species from road crossings and gravel mining. Evaluate impacts of gravel island and vessel traffic on nearshore and aquatic habitats, fish passage, whales and marine mammal movement, polar bear movement, and bird migration. Evaluate an alternative that minimizes impacts to caribou.
Human Health	Evaluate impacts on human health due to air and water pollution, stress, limited access to medical resources, or changes in traditional way of life and diet. Evaluate health concerns: respiratory and cardiovascular diseases, cancer, genetic mutations and endocrine disruption, bioaccumulation of toxins in animals and food, general exposure to toxins in air and drinking water, and reduced access to traditional food sources or inadequate food supply. Consider partnering with local, state, tribal, and federal health officials to determine if an HIA is required. If needed, use a qualified third party to prepare the HIA.
Air Quality	Sources and impacts from Project emissions (fine particulate matter, diesel exhaust, anthrax released from thawing permafrost, benzene, hydrogen sulfide, ozone, smoke, and volatile organic compounds). Perform air quality modeling to support the analysis and identify potential mitigation and control measures.
Water Quality	Identify existing aquatic habitats and water resources in the area and evaluate water quality impacts, including new water pollutants, compliance with water quality standards, downstream impacts, water use during construction or operation, groundwater injections, erosion and sedimentation, wastewater discharges, mercury and anthrax released from thawing permafrost, and xylene and benzene.
Teshekpuk Lake Special Area	Evaluate impacts to wetlands, caribou, other wildlife species and habitats within the TLSA and resulting subsistence impacts to North Slope communities. Describe protections for the TLSA and how the project complies with applicable use or development restrictions.

Note: BLM (Bureau of Land Management); HIA (health impact assessment); IAP (Integrated Activity Plan); NPR-A (National Petroleum Reserve in Alaska); TLSA (Teshekpuk Lake Special Area).

3.17.3 Environmental Consequences

3.17.3.1 Avoidance, Minimization, and Mitigation

3.17.3.1.1 Applicable Lease Stipulations and Best Management Practices

Table 3.17.2 summarizes existing NPR-A IAP BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate environmental justice impacts from development activity (BLM 2013a). The BMPs would help reduce disproportionately high and adverse impacts on the minority population in Nuiqsut, the community closest to the Project that is most likely to be directly affected by social or environmental changes associated with Project development. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.17.2 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate impacts to environmental justice. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.17.2 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.17.2. Summary of Applicable Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Environmental Justice

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local laws and regulations.	Areas of operation shall be left clean of all debris.	Changes do not affect text as described.
BMP A-2	Minimize impacts on the environment from nonhazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.	Changes do not affect text as described.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	Prepare and implement a hazardous materials emergency contingency plan before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 100 feet from any water body.
BMP A-7	Minimize the impacts to the environment from disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP Withdrawn: No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel.	BMP Withdrawn: No similar requirement; duplicative with EPA standard under Section 202 of the Clean Air Act amendments.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring (pre-construction and throughout life of project), emissions inventory, emissions reduction plan, air quality modeling, additional emission control strategies as necessary, and possibly mitigation measures.	Added Text: Provide to the NSB, local communities, and tribes publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this BMP.
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally used subsistence foods.	No similar requirement.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	Consult directly with affected communities per required guidelines.	Added text: Projects that would occur within 50 miles of a community or fewer than 15 miles from the heavily used subsistence rivers listed in ROP F-4 shall submit a subsistence plan.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.	Changes do not affect text as described.

Source: BLM 2013a, 2020a
Note: BLM (Bureau of Land Management); BMP (best management practice); EPA (U.S. Environmental Protection Agency); GIS (geographic information systems); IAP (Integrated Activity Plan); LS (lease stipulation); NSB (North Slope Borough); ROP (required operating procedures).

No deviations to the BMPs described in Table 3.17.2 would be required.

3.17.3.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.17.3.1.3 Measures Taken to Avoid or Minimize Disproportionate and Environmental Justice Impacts

Prior planning documents covering the Project area (BLM 2004a, 2008a, 2012b, 2013a, 2014) have provided opportunities for public involvement for low-income and minority populations. BLM has carefully considered community views when developing and implementing mitigation strategies to reflect the needs and preferences of these populations, to the extent practicable. These planning documents have made some lands unavailable for oil and gas leasing, including a large portion of the ACP within the NPR-A used by Nuiqsut subsistence users.

Following scoping for the Project, BLM conducted a series of alternatives development workshops with cooperating agencies, including the NVN and the City of Nuiqsut. Each agency provided expertise and assisted BLM in identifying alternatives and ways to avoid or minimize potential Project impacts, with a focus on minimizing impacts identified in scoping, such as impacts to caribou and other terrestrial wildlife as well as other subsistence impacts.

As part of the alternatives development process, potential alternatives were evaluated using screening criteria, which included consideration of whether the alternative reduced adverse impacts or resource conflicts. As a result, each alternative's ability to do the following was considered:

- Reduce the overall Project footprint (i.e., direct impacts from facilities)
- Reduce potential human health impacts (especially those relating to air quality and subsistence)
- Reduce impacts to wildlife, subsistence resources (especially caribou), and subsistence use areas
- Reduce risks related to spills or other accidental releases
- Reduce effects to water resources and floodplains, including marine habitat

For more detailed information on alternatives development and avoidance and minimization of impacts, see Chapter 2.0 and Appendix D.1, *Alternatives Development*. The Proponent's design features to avoid and minimize impacts are detailed in Appendix I.1. The Project would increase the amount of funds available to Nuiqsut through the NPR-A Impact Grant Program (described in Section 5.3.1). CPAI provides the City of Nuiqsut access to a grant writer to assist with grant proposals, which could increase the local understanding that mitigation funds are available and decrease some concerns over the impacts of the Project. CPAI also provides funding for accounting support, which is critical to successfully managing grant money.

3.17.3.1.4 Additional Suggested Best Management Practices or Mitigation
Project impacts, particularly on subsistence harvester access or subsistence resource availability, may be highly adverse and would be disproportionately borne by the Nuiqsut population. To address community concerns and further reduce disproportionate impacts, the following additional mitigation measures are recommended:

1. Continue to use the KSOP to maintain meaningful engagement in the Project and identify continuing concerns and specific Project impacts
2. Attend government-to-government meetings between NVN and BLM, as requested by NVN or BLM, to discuss issues and resolution strategies through construction and operations

3.17.3.2 Alternative A: No Action
Under Alternative A, the Project would not be constructed. There would be no environmental justice effects from the No Action Alternative.

3.17.3.3 Alternative B: Proponent's Project

3.17.3.3.1 Subsistence and Sociocultural Systems
The most substantial Project effects are related to subsistence harvest impacts. Subsistence harvests are part of the social, cultural, and economic fabric of Nuiqsut. Adverse effects to subsistence harvests affect social standing in the community, transmission of cultural traditions between generations, and food security for individual households and the community as a whole. Due to the integral role of subsistence, the environmental justice analysis focuses on it.

Project impacts on subsistence are discussed in Section 3.16. These effects would predominately be experienced by Nuiqsut residents, as they are the primary subsistence users of the affected areas.

Resource availability could decrease due to loss or alteration of habitat for birds, fish, caribou and other terrestrial mammals; disturbance or displacement of animals; or direct injury or mortality. However, the decrease would not have population-level effects on subsistence resources harvested within or downstream from the Project area. Caribou and bird availability may be reduced in harvest areas near the Project and furbearer availability may decline near the gravel mine site, while overall fish and waterfowl availability in high-use harvest areas would not be affected.

Harvester access would be adversely affected by the construction of roads through areas used for harvesting wolf, wolverine, caribou, and goose. As noted in Section 3.16, at least one-third of harvesters that use the Project area are likely to avoid the affected area during at least 1 year during construction. During operations, harvester access would be adversely affected by roads through areas used for harvesting. Some Nuiqsut caribou hunters use trucks to access subsistence harvest areas and may use roads constructed under this alternative. This could increase competition along the road and deflect caribou from the community's traditional harvest area, reducing success for those continuing to use traditional areas. Some subsistence harvesters also avoid developed areas due to concerns about security protocols and an assumed lack of resources around these areas.

Decreased harvester access or subsistence resource availability resulting from the Project would adversely affect sociocultural systems due to the importance of subsistence in Iñupiaq cultural identity, social organization, social cohesion, transmission of cultural values, and community and individual well-being. Decreases in harvester access or subsistence resource availability would reduce opportunities for engaging in subsistence activities potentially increasing social problems associated with drugs and alcohol (SRB&A 2009). The poorest residents would bear disproportionate effects.

The effects on subsistence and sociocultural systems may be highly adverse and disproportionately borne by the Nuiqsut population.

3.17.3.3.2 Economics
Construction would result in increased employment locally, regionally, and statewide. A small portion of these construction jobs are likely to be filled by NSB residents, including some Nuiqsut residents. Local residents may also be employed by local industry support companies contracted to provide goods and services during construction. During the operations phase, the Project would add an estimated 350 jobs through the life of the Project. Most of these jobs are likely to be filled by non-NSB residents, but there would be an increase in opportunities for NSB and Nuiqsut residents as well, both with the Project directly and with locally owned support service companies. Given the small employment base on the North Slope and the limited job opportunities, these few jobs could substantially affect the local and regional economy.

Nuiqsut residents are also most likely to receive income from development, through employment wages or Kuukpik dividends. However, not all Nuiqsut residents are shareholders and therefore do not receive Kuukpik dividends. Although oil and gas development on the North Slope does not increase demand for local services, as construction camps are developed to provide lodging, food, utilities, and other services needed by workers, occupancy of the Kuukpik Hotel would likely increase during construction, increasing tax revenues from the city's 12% bed tax. The effects on Nuiqsut economics would not be highly adverse.

3.17.3.3.3 Public Health

The Project would result in additional employment opportunities in Nuiqsut. Although most construction jobs would be filled by non-locals, even a small number of additional jobs would positively impact the community's relatively small labor force. Project construction would increase household incomes for Nuiqsut residents employed with Project, and dividend income would also increase for ASRC and Kuukpik shareholders if these corporations have subsidiaries working on the Project.

Not all Nuiqsut residents would find jobs or receive ANCSA dividends, resulting in the potential for social tensions regarding an uneven distribution of money in the community. The Project would increase air and noise emissions and human activity in Nuiqsut's subsistence use area. This could increase stress in some Nuiqsut residents and lead to or exacerbate mental health issues such as anxiety and depression. As discussed in BLM (2018a), rapid modernization and development, as well as other multiple stressful conditions, including significant changes in diet, housing, and traditional culture, has led to negative health outcomes, including suicide. Suicide was the fifth-leading cause of death in the NSB from 2011 to 2013, and it has remained a leading cause of death in the NSB for over 2 decades (ABVS 2018).

Reduced subsistence harvester access or subsistence resource availability would adversely affect community health by reducing the availability of subsistence foods and increasing dependence on store-bought foods, increasing food insecurity. Between 2003 and 2010, Nuiqsut was the only NSB community that reported an increase in the percentage of households for which subsistence foods accounted for more than half of a household's diet (McAninch 2012). Among all NSB communities, a higher percentage of Nuiqsut households use subsistence resources for more than half of their diet (NSB 2016).

The effects on public health in Nuiqsut may be highly adverse and disproportionately borne by the Nuiqsut population.

3.17.3.4 Alternative C: Disconnected Infield Roads

The types of effects to subsistence, sociocultural systems, and public health under Alternative C would be similar to those described under Alternative B but with different magnitude. Although Alternative C reduces effects to caribou resource availability, it has a larger overall footprint and a higher level of air traffic.

The effects on subsistence, sociocultural systems, and public health may be highly adverse and would be disproportionately borne by the Nuiqsut population.

3.17.3.5 Alternative D: Disconnected Access

The types of effects to subsistence, sociocultural systems, and public health under Alternative D would be similar to those described under Alternative B but with different magnitude. This alternative would have the least impact to caribou availability; however, it would eliminate the potential for subsistence harvesters to access new areas via road and would increase the level of air traffic, adding to the adverse effects.

The effects on subsistence, sociocultural systems, and public health may be highly adverse and would be disproportionately borne by the Nuiqsut population.

3.17.3.6 Module Delivery Option 1: Atigaru Point Module Transfer Island

Option 1 impacts to environmental justice would be similar to those described for Alternative B and would be disproportionately high and adverse for Nuiqsut residents, as they are the minority population located closest to the MTI. Because Atigaru Point is a high subsistence use area for caribou for Nuiqsut residents (Figure 3.16.15) and is an important traditional caribou hunting ground, the most substantial Option 1 impacts are related to subsistence and sociocultural systems.

3.17.3.7 Module Delivery Option 2: Point Lonely Module Transfer Island

Some of the effects for Option 2 would be similar to those of Option 1 because the gravel mine site would be the same under both options. The effects of Option 2 would be substantially less for Nuiqsut than for Option 1, because the MTI and the majority of the ice roads would be outside of the community's core subsistence use area. The subsistence effects from Option 2 would not be highly adverse or disproportionately borne by the Nuiqsut population.

3.17.3.8 Module Delivery Option 3: Colville River Crossing

Module delivery Option 3 would not include an MTI and would eliminate or reduce many of the subsistence impacts associated with Options 1 and 2, including the construction of new offshore marine infrastructure, the overall volume of ground and air traffic, and the number of years of activity. Option 3 would also use gravel from existing mine sites in Kuparuk (Mine Sites C and E), which are farther away from Nuiqsut than the Tiŋmiaqsiuġvik Gravel Mine Site. Effects of Option 3 would be substantially less for Nuiqsut than for Option 1 because no marine infrastructure would be built and the majority of the activity would be outside of the community's core subsistence use area. Option 3 would not be highly adverse or disproportionately borne by the Nuiqsut population.

3.17.3.9 Oil Spills and Accidental Releases

Effects of oil spills and other accidental releases would be disproportionately borne by Nuiqsut residents. Project use and storage of hazardous materials throughout the life of the Project could reduce the use of fish resources if fish or the streams they inhabit are perceived or confirmed to be contaminated, causing some individuals to avoid harvesting fish resources downstream from drill sites and pipelines. The level of avoidance and impacts on the community would vary by individual and their sensitivity to development.

Large spills that escape gravel pads and spread on the tundra or in rivers would have the most adverse effect on Nuiqsut residents and their access to subsistence resources. Although the effect of a large spill would be highly adverse in the immediate aftermath of the spill, there is a low probability of a spill of this extent over the life of the Project. The effects of a large oil spill that travels off gravel pads may be highly adverse and would be disproportionately borne by the Nuiqsut population, but there would be a very low probability of a large spill event occurring.

3.17.4 Unavoidable Adverse, Irretrievable, and Irreplaceable Effects

The environmental justice impacts described above would be unavoidable and irretrievable during the life of the Project. If reclamation did not occur, effects would be irreversible. Effects may not be irreversible in terms of subsistence access and harvest areas if the reclamation of gravel roads and pads occurs and wildlife migration patterns are not permanently changed. However, the incremental addition from the Project to multigenerational shifts in sociocultural values due to shifts in subsistence participation and the passing on of subsistence traditions may be irreversible depending on the extent of changes to harvester access, wildlife availability, and local community response to the Project.

3.17.5 Environmental Justice Determination

All of the action alternatives and module delivery Options 1 and 2 would result in disproportionately high and adverse environmental effects to the minority community of Nuiqsut. There are subpopulations within this minority population that may experience the impacts of the Project differently than the rest of the community. Lower economic status households and households that are more dependent on harvesting subsistence resources from impacted use areas could experience more intense impacts. However, some individuals and households would likely experience positive impacts from the facilitated access provided by Project roads.

The finding of the ANILCA Section 810 subsistence evaluation (Appendix G, *Alaska National Interest Lands Conservation Act Section 810 Analysis*) is that the Project may significantly restrict subsistence uses for the community of Nuiqsut under all action alternatives due to a reduction in the availability of resources caused by alteration of their distribution and a limitation on subsistence user access to the area. An ANILCA Section 810 notice was published concurrent with the Draft EIS and the SDEIS; public hearings were held in Nuiqsut during the public meeting for the Draft EIS and online during the public meetings for the SDEIS.

Reduced subsistence resource availability, as well as reduced harvester access through access restrictions and through avoidance, would adversely affect subsistence and sociocultural systems. Decreased subsistence resource availability and harvester access would also adversely affect sociocultural systems due to the importance of subsistence in Iñupiaq cultural identity, social organization, social cohesion, transmission of cultural values, and community and individual well-being.

3.18 Public Health

The geographic extent of the public health analysis is limited to the community of Nuiqsut, the closest community to the Project, which is approximately 25 miles from the nearest proposed drill site. Nuiqsut residents use the CRD and the NPR-A, including the Project area, for subsistence harvests and other reasons. The temporal scale for Project impacts to public health is defined as the life of the Project or until long-term public health effects are mitigated to their original conditions following Project reclamation.

3.18.1 Affected Environment

The NSB and Nuiqsut residents have expressed concerns about the potential for public health effects associated with oil and gas development on the North Slope, including impacts from air emissions, water quality changes, and the potential for spills to contaminate the environment and subsistence resources that Nuiqsut residents rely on (BLM 2018c). Technical guidance for evaluating health impacts from resource development projects was provided by the following:

- Alaska Department of Health and Social Services (ADHSS), *Technical Guidance for Health Impact Assessment in Alaska* (2015)
- NSB, *Health Impact Assessment in the North Slope Borough: A Guide for Stakeholders, Decision-Makers and Project Proponents* (2015b)
- BLM, *National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement* (2012b) health effects analysis

This analysis uses the eight ADHSS Health Effect Categories (HECs) to evaluate potential health effects on the local population from the Project. These HECs incorporate issues identified in the NSB guidance (2015b) and those factors evaluated in BLM (2012b). HECs are described in Tables E.18.1 and E.18.2 in Appendix E.18, *Public Health Technical Appendix*.

Because Nuiqsut's small population limits the availability of public health data, this analysis uses public health statistics for the NSB, supplemented with data from community health baseline assessment reports in 2012 and 2014 (Habitat Health Impact Consulting 2014; McAninch 2012); these studies rely heavily on 2010 NSB survey data for village-level statistics (NSB 2011). The NPR-A IAP/EISs (BLM 2012b, Section 4.4.21; 2019c, Section 3.4.12) also present a broad-based overview of public health in Nuiqsut and an assessment of potential health effects associated with oil and gas development on the North Slope.

Climate change is part of the existing condition that affects public health of NSB and Nuiqsut residents. According to an ANTHC report on climate change in Nuiqsut, residents are reporting noticeable changes in weather, plants, animals, and the land, and these changes are raising concerns about food and water security, transportation safety, and increased stress affecting mental health (Brubaker, Bell et al. 2014).

3.18.1.1 Health Effect Category 1: Social Determinants of Health

The Health Effect Category 1 components that the Project may affect include employment, economic status, social connections/cultural continuity, mental health, and overall general health.

Employment: Employment opportunities in Nuiqsut are limited and unemployment is high (Section 3.15). U.S. Census statistics provide an unemployment rate in Nuiqsut (19.8%) that is more than twice that of Alaska overall (7.8%) (U.S. Census 2018b). The NSB estimates that unemployment in Nuiqsut is even higher at 36.5% (NSB 2016).

Economic status: The economic status of Nuiqsut is described in Section 3.15. National and local statistics on economic indicators differ substantially, but the consensus is that the cost of living in Nuiqsut is much higher than in urban Alaska. In addition, local challenges related to the availability or costs (or both) of housing, employment, food products, and health services result in the economic status for Nuiqsut residents being more difficult to place in context using state and national statistics.

Social connections/cultural continuity: Cultural continuity includes the continuation of subsistence activities, including harvesting resources and sharing those resources within the community as well as using and teaching the Iñupiaq language. Cultural continuity is strong in Nuiqsut. ADF&G characterizes Nuiqsut as "a highly active, subsistence-based community," with 95% of Nuiqsut households attempting to harvest subsistence resources in 2014 (ADF&G 2016a). The NSB 2010 socioeconomic survey data indicate that 54% of Nuiqsut Iñupiat households had at least one fluent Iñupiaq speaker (NSB 2016). Nuiqsut was the only NSB community that showed an increased percentage of fluent Iñupiaq speakers between 2003 and 2010 (NSB, as reported in Habitat Health Impact Consulting 2014).

Mental health: State 2017 health statistics show that Alaska Natives report more mentally unhealthy days per month (4.3) than Alaskans as a whole (3.9) (ADHSS 2019c). State statistics comparing all North Slope and Alaska Native North Slope residents show Alaska Native residents report 3.5 mentally unhealthy days per month versus 3.2 for all North Slope residents (ADHSS 2019c). Suicide was the fifth-leading cause of death in the NSB from 2011 to 2013, and it has remained a leading cause of death in the NSB for over 2 decades (ABVS 2018). Alaska Natives are at particular risk of suicide, comprising an average of 33% of all suicides in the state from 2013 through 2017 (ABVS 2018).

General health: State health statistics for 2017 show that 16.9% of Alaskans reported poor to fair health compared to 24.8% of Alaska Natives (ADHSS 2019b). On the North Slope, 13.1% of all residents reported poor to fair health in 2017, while 14.2% of Alaska Natives on the North Slope reported poor to fair health (ADHSS 2019b).

3.18.1.2 Health Effect Category 2: Accidents and Injuries

The unintentional injury mortality rate for Alaska Natives in 2016 was 115.1 per 100,000 people, 175% higher than the rate for all Alaskans (61.9) (ADHSS 2019d). NSB mortality rates from unintentional injury from 2012 through 2016 (86.3) also exceeds the comparable statewide rate (65.1) (ADHSS 2019d).

3.18.1.3 Health Effect Category 3: Exposure to Potentially Hazardous Materials

Air quality: As discussed in Section 3.3, *Air Quality*, studies have found that air pollutant concentrations in Nuiqsut were below NAAQS and AAAQS for most measured pollutants (ADHSS 2012; ANTHC 2011). $PM_{2.5}$ and PM_{10} levels have exceeded NAAQS and AAAQS on a few occasions, although this is common in rural Alaska communities during the summer months, when windborne dust is generated from gravel roads and exposed riverbanks. Air quality sampling has indicated no violations of air quality standards or federal agency screening levels for VOCs (ANTHC 2011).

Water quality: As discussed in Section 3.8, a 2011 water quality study evaluated VOC levels in local surface waters, and no samples had concentrations exceeding state water quality standards (ANTHC 2011). Nuiqsut's drinking water supply had detectable levels of xylene in the early 2000s, when a new water storage tank's liner failed to properly cure. Water quality was monitored quarterly as the levels decreased and monitoring returned to an annual basis in 2005. The detected xylene levels are below the EPA limits established for drinking water to protect public health (ADEC 2018c). Overall, water quality near Nuiqsut is good.

Subsistence: As described in Section 3.16, Nuiqsut has a high percentage of subsistence users. NSB studies conducted to date have found that contaminant levels in subsistence resources tested were below levels of concern for human health (NSB 2018a).

3.18.1.4 Health Effect Category 4: Food, Nutrition, and Subsistence Activities

Food and nutrition: The 2015 NSB survey classified households as "food insecure" if they indicated not having enough to eat at times. The survey results indicated that, overall, 24% of NSB Iñupiat households surveyed were food insecure compared to 9% of Iñupiat households in Nuiqsut (NSB 2016).

Subsistence activities: Between 2003 and 2010, Nuiqsut was the only NSB community that reported an increase in the percentage of households for which subsistence foods accounted for more than half of the household's diet (McAninch 2012). Among all NSB communities, a higher percentage of Nuiqsut households use subsistence resources for more than half of their diet (NSB 2016).

3.18.1.5 Health Effect Category 5: Infectious Disease

Infectious disease rates for Alaska Natives are lower than those for all Alaskans for most diseases, but Alaska Natives have higher rates of hospitalization for upper and lower respiratory diseases and cellulitis (Gounder, Holman et al. 2016). Rates of chlamydia (a sexually transmitted disease) are higher in Alaska Natives (2,516 per 100,000) than statewide (770 per 100,000), and rates are highest in southwest and northern Alaska (ADHSS 2019a).

3.18.1.6 Health Effect Category 6: Water and Sanitation

About 90% of Nuiqsut households are connected to sanitary sewage facilities. About 94% of Nuiqsut households are connected to the village drinking water system (NSB 2015c).

3.18.1.7 Health Effect Category 7: Noncommunicable and Chronic Diseases
Nuiqsut residents reported higher levels of heart disease, chronic pain or arthritis, and chronic ear problems, and a lower level of chronic breathing problems (7%) compared to the levels reported in the NSB overall (8%) (McAninch 2012). For breathing problems in children, however, the reported percentage was higher in Nuiqsut (8%) than for the NSB overall (5%) (McAninch 2012). More than two-thirds (69%) of Nuiqsut Iñupiat household heads reported smoking in 2015 compared to 67% in the NSB overall (NSB 2016).

3.18.1.8 Health Effect Category 8: Health Services Infrastructure and Capacity
The NSB and the Arctic Slope Native Association provide health care services in all NSB communities with health aides who are not medical professionals (Habitat Health Impact Consulting 2014). Nuiqsut has a primary care health clinic, but advanced care must be accessed in Utqiaġvik (150 miles), Fairbanks (350 miles), or Anchorage (600 miles) and requires air travel. Therefore, the NSB is characterized as a medically underserved community by the U.S. Health Resources and Services Administration (McAninch 2012).

Nuiqsut had an average of 24.1 **medevacs** per 100 people from 2005 to 2008, which was slightly lower than the average (26) for NSB villages (McAninch 2012).

3.18.2 Environmental Consequences

3.18.2.1 Avoidance, Minimization and Mitigation

3.18.2.1.1 Applicable Lease Stipulations and Best Management Practices
Table 3.18.1 summarizes existing BMPs that would apply to Project actions on BLM-managed lands and are intended to mitigate impacts to public health from development activity (BLM 2013a). The BMPs would reduce or minimize impacts to public health in the areas of environmental exposure, nutrition, diet, and acculturative stress through subsistence consultation, orientation programs, and implementation of Project waste prevention, handling, disposal, and spill response procedures to reduce or eliminate exposure. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table 3.18.1 also summarizes new ROPs or proposed substantial changes to existing NPR-A IAP BMPs that would help mitigate public health impacts. Although many of the LSs (where they are applied as BMPs) and BMPs have proposed minor language revisions, Table 3.18.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

Table 3.18.1. Summary of Applicable Lease Stipulations and Best Management Practices to Mitigate Impacts Public Health

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations	Areas of operation shall be left clean of all debris.	Changes do not affect text as described.
BMP A-2	Minimize impacts on the environment from nonhazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.	Changes do not affect text as described.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.	Changes do not affect text as described.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a Spill Prevention, Control, and Countermeasures Plan.	Develop a Spill Prevention, Control, and Countermeasures Plan if oil storage capacity is 1,320 gallons or greater.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.	Refueling of equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations shall be located at least 100 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.	BMP Withdrawn No similar requirement; discharges of produced fluids are addressed by the State of Alaska under the water quality standards, wastewater discharge, and permitting requirements contained in 18 AAC 70, 18 AAC 72, and 18 AAC 83.
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement bear-interaction plans to minimize conflicts between bears and humans.	Added Text: – Feeding wildlife is prohibited. – Prevent the emission of odors by installing kitchen hood exhaust filtration systems such as cleaners, filters, purifiers, and scrubbers. – Activities not covered under Incidental Take Regulations must include the following in their wildlife interaction plan: – Guidelines for safe and nonlethal deterrence of polar bears from damaging property and endangering the public.
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel.	BMP Withdrawn: No similar requirement; duplicative with U.S Environmental Protection Agency standard under Section 202 of the Clean Air Act amendments.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring, (preconstruction and throughout the life of the Project) emissions inventory, emissions reduction plan, air quality modeling, and possibly mitigation measures.	Added Text: Provide to the NSB, local communities, and tribes publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this BMP.
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally used subsistence foods.	No similar requirement.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.	Added text: – Subsistence pullout and access/egress ramps would be constructed in adequate numbers and at appropriate locations on all roads to facilitate access to subsistence use areas. Prior to constructing a road, permittees shall gather input from communities regarding the number and location of pullouts and associated access ramps. – Permittees shall construct a subsistence pullout and boat ramp at all crossings of heavily used subsistence rivers, as determined in consultation with the community. – Permittees must allow subsistence use of permanent gravel roads and appropriate ice roads, consistent with safe operations, and shall provide communities and the BLM with concise policies regarding the use of all roads and hunting prohibitions, if any, along the roads and near facilities. -Permittees shall ensure that any road use guidelines and updated road maps are disseminated throughout the communities, including making them available online and through social media. – Before ice road construction begins, permittees associated with ice road construction shall hold community meetings to describe the routes and relevant information on all ice roads that would be constructed. – A Vehicle Use Management Plan shall be developed by the permittee to minimize or mitigate displacement during calving and that would avoid, to the extent feasible, delays to caribou movements and vehicle collisions during the midsummer insect season, with traffic management following industry practices. By direction of the BLM, traffic may be stopped throughout a defined area for up to 4 weeks to prevent displacement of calving caribou. If required, a monitoring plan could include collection of data on vehicle counts and caribou interactions. – When laying out oil and gas developments, permittees shall orient infrastructure to minimize impeding caribou migration and to avoid corralling effects. – Permittees shall provide an annual report to the BLM reporting roadkill of birds and mammals to help the BLM determine whether preventative measures on vehicle collisions are effective.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.	Added Text: Permittees shall submit a minimum of 2 years of data on fish, circulation patterns, and water quality with an application for construction. A post-construction monitoring program, developed in consultation with appropriate federal, State, and NSB regulatory and resource agencies, shall be required to track circulation patterns, water quality, and fish movements around the structure.
BMP E-4	Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.	All pipelines shall be designed, constructed, and operated under an BLM-approved quality assurance/quality control plan.	No similar requirement; the State of Alaska enforces pipeline design and construction standards to minimize the potential for leaks.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.	Added Text: – Where aircraft traffic is a concern, balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations – For alternatives B, C, and D, use impermeable liners under gravel pads to minimize the potential for hydrocarbon spills.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.	Added text: – Aboveground pipelines shall have a nonreflective finish. – When laying out oil and gas developments, permittees shall orient infrastructure to minimize impeding caribou migration and to avoid corralling effects. – Before the construction of permanent facilities is authorized, the BLM will require a study of caribou movement for the impacted herd. The permittee may be required to conduct this study, or this requirement may be waived if an acceptable study specific to that herd has been completed within the last 10 years and is approved for use by the BLM.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation shall be in accordance with a plan approved by the BLM in consultation with appropriate federal, State, and NSB regulatory and resource agencies.	Added text: – The plan shall consider locations outside the active floodplain or designing gravel mine sites within active floodplains to serve as water reservoirs if environmentally beneficial. – Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs is prohibited. – Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact on streamflow, fish, turbidity, and the integrity of the river bluffs, if present.
BMP E-9	Avoidance of human-caused increases in populations of predators of ground-nesting birds.	Utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Feeding of wildlife is prohibited.	Requirements combined with ROP A-8 (Wildlife Interaction Plan).
BMP E-10	Prevention of migrating waterfowl, including species listed under the ESA, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.	Flagging of structures shall be required, such as elevated power lines and guy wires, to minimize bird collision. All facility external lighting, during all months of the year, shall be designed to direct artificial exterior lighting inward and downward or be fitted with shields to reduce reflectivity in clouds and fog conditions, unless otherwise required by the Federal Aviation Administration.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP F-1, ROPs F-2, F-3, and F-4	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Ensure that aircraft used for permitted activities maintain altitudes specified in guidelines. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Submit an aircraft use plan that addresses strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility. Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away. Fixed wing aircraft along the coast shall maintain minimum altitude of 2,000 feet when within a ½ mile of walrus haulouts. Helicopters used along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts. Aircraft used along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals.	Text moved to ROPs F-2 through F-4: Added Text: F-2: Aircraft Use Plan. –Permittees shall submit an aircraft use plan 60 days prior to activities. Projects with landings north of 70 degrees North latitude that will occur between June 1 and October 15 must submit estimates of takeoffs and landings no later than April 5. F-3: Minimum Flight Altitudes. Alternatives B, C, and D - Aircraft shall maintain the stated minimum altitudes above ground level. Amended flight altitudes (others remain the same): December 1–May 1—1,500 feet over caribou winter range. May 20–August 20—1,500 feet over the Teshekpuk Caribou Herd Habitat Area. Alternative E: Except for takeoffs and landings, manned aircraft flights for permitted activities (fixed-wing and helicopters, unless specified) shall maintain a 1,500-foot minimum altitude agl throughout NPR-A. Exceptions to the 1,500-foot agl minimum altitude are listed below: a. Single-engine manned aircraft and unmanned aircraft systems devices should not knowingly fly within 0.5 miles of walrus haulouts; or, if required, then maintain 2,000 feet agl when within 0.5 miles of walrus haulouts. b. Helicopters and multi-engine aircraft should not knowingly fly within 1 mile of walrus haulouts; or, if required, then maintain 3,000 feet agl and a 1-mile buffer from walrus haulouts. c. Aircraft—3,000 feet agl when within 1 mile of aggregation of seals F-4: Reduce Impacts of Air Traffic on Subsistence Resources. – Minimize helicopter flights during peak caribou hunting within 2 miles of important subsistence rivers. The current peak dates are July 15 through August 15, but these dates may be revised periodically in consultation with affected communities and the NSB. – Minimize aircraft use near known subsistence camps and cabins and during sensitive subsistence hunting periods (spring goose hunting, summer and fall caribou and moose hunting) by adhering to the following guidelines: – Arrange site visits and flight schedules to conduct required activity near subsistence areas early in the season, on weekdays, and as early in the morning as possible; avoid holidays. – Note whether activities overlap heavily used subsistence rivers and determine if a potentially affected community should be notified. – Compare the proposed landing sites with the NSB camps and cabins map. If activities near camps or allotments cannot be avoided, contact the camp or allotment owner to discuss the timing of the visit.

LS or BMP	Description or Objective	2013 Requirement	Proposed Changes to BMPs per 2020 IAP Revisions
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	The lessee/permittee shall consult directly with affected communities per required guidelines.	Projects that would occur within 50 miles of a community or fewer than 15 miles from the heavily used subsistence rivers listed in ROP F-4 shall submit a subsistence plan. The plan should be submitted as early as possible and no later than an application is submitted to BLM. Information on how the permittee would keep potentially affected individuals and communities up to date on the progress of the activities and locations of possible, short-term conflicts with subsistence activities; such communication methods could include posting information on a website and distributing the link; social media; newsletters and radio and television announcements; community meetings; or workshops.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."	Changes do not affect text as described.
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year.	Changes do not affect text as described.

Source: BLM 2013a, 2020a

Note: agl (above ground level); BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); ROP (required operating procedure).

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.5 in Appendix D.1, *Alternatives Development*. When deviations are granted, they typically are specific to stated Project actions or locations and are not granted for all Project actions. Deviations that would affect public health would include those to LS E-2 BMP E-7. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2) and freshwater intake pipelines at Lakes M0015 and R0064 (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody.

It may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7), due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site or at narrow land corridors between lakes where it is not possible to maintain 500 feet of separation between pipelines and roads without increasing potential impacts to waterbodies.

3.18.2.1.2 Proponent's Design Measures to Avoid and Minimize Effects

CPAI's design features to avoid or minimize impacts are listed in Table I.1.2 in Appendix I.1.

3.18.2.1.3 Additional Suggested Avoidance, Minimization, or Mitigation

Additional suggested mitigation measures to minimize the effects of Project-related changes to health could include the following:

1. Limited health data are available for Nuiqsut. The best data available date from the NSB's 2010 survey. Funding a collection of health information for Nuiqsut and studies of contaminant levels in local subsistence resources would provide better data for evaluation of potential health effects associated with oil field development and operation.

2. Create a public health monitoring program at a regional level to track health indicators that are vulnerable to impacts from oil and gas activities. These indicators should focus on health outcomes and/or determinants of local concern that can be tied to oil and gas activity. Where possible, indicators should include threshold levels and specific actions should be developed for when thresholds are surpassed. The State should be responsible for the development and implementation of the monitoring program; however, the NSB and the Alaska Native Tribal Health Consortium should be consulted in the identification of appropriate indicators, thresholds, and responsive actions.
3. Establish a Nuiqsut public health coordination group to conduct health education and engage the community in the public health monitoring program described above.

3.18.2.2 Action Alternatives and Module Delivery Options

3.18.2.3 Alternative A: No Action

Alternative A would have no new effects on public health in Nuiqsut. Nuiqsut residents are likely to continue to have limited access to advanced medical care and higher rates of some health issues, such as upper and lower respiratory illnesses.

3.18.2.4 Alternative B: Proponent's Project

3.18.2.4.1 Construction Phase

3.18.2.4.1.1 Health Effect Category 1: Social Determinants of Health

Employment: Construction activities would result in additional employment opportunities in Nuiqsut. Although most construction jobs would be filled by non-locals, even a small number of additional jobs would positively impact the community's relatively small labor force. Any increase in the number of jobs would also increase household income and dividends for ASRC and Kuukpik shareholders if these corporations have subsidiaries working on Project construction.

Economic status: Household incomes in Nuiqsut rely heavily on wage income and dividends from ANCSA corporations (Section 3.16). Project construction would increase household incomes for Nuiqsut residents employed with Project construction jobs, and dividend income would also increase for ASRC and Kuukpik shareholders if these corporations have subsidiaries working on Project construction.

Social connections/cultural continuity: Few non-local construction workers would be expected to interact with Nuiqsut residents. If Nuiqsut residents are hired and stay in Project camps, they would have more interaction with non-local workers, decreased connections with their social support network, and potential time conflicts for subsistence activities. Not all Nuiqsut residents would find jobs or receive ANCSA dividends, resulting in the potential for social tensions regarding an uneven distribution of money in the community (McAninch 2012). Cultural continuity would be impacted if subsistence activities were interrupted by construction activities that could restrict access to subsistence harvest areas or decrease subsistence resource availability.

Mental health: Construction activities would result in increased air and noise emissions, including in currently undeveloped areas Nuiqsut residents use or travel through. Development-related noise could cause irritation, annoyance, or sleep disturbance among individuals who experience it (BLM 2012b). This would increase stress in some Nuiqsut residents and could lead to or exacerbate mental health issues such as anxiety and depression. Residents who apply for jobs and are not hired may also experience these conditions. As discussed in BLM (2018a), rapid modernization and development, as well as other multiple stressful conditions, including significant changes in diet, housing, and traditional culture, have led to negative health outcomes, including suicide.

General health: Construction would not affect general health in Nuiqsut.

3.18.2.4.1.2 Health Effect Category 2: Accidents and Injuries

Construction activities could result in an increased potential for accidents and injuries for Nuiqsut residents. Construction activity could result in changes in local travel patterns and use of new travel routes would increase the potential for accidents and injuries, particularly if residents must travel farther or along unfamiliar routes.

3.18.2.4.1.3 Health Effect Category 3: Exposure to Potentially Hazardous Materials

Air quality: Most Project construction activities would occur over 20 miles from Nuiqsut. Prevailing winds would typically blow equipment emissions and dust to the southwest, away from Nuiqsut, so construction activities would not impact air quality in the community. Several isolated construction activities would occur closer to Nuiqsut (such as the mine site approximately 7 miles away) or east to northeast of Nuiqsut (such as the HDD crossing pads along the Colville River). These activities would occur only during construction.

As discussed in Chapter 4.0, Section 4.4, *Hazardous Materials*, Polycyclic Aromatic Hydrocarbons (PAHs) can be generated through the combustion of organic fuels. Combustion fuel for the Project would primarily consist of processed natural gas and ULSD. PAHs are not generally found in natural gas, and they are not expected in the Willow fuel gas due to their high molecular weight and their tendency to remain with crude oil in the liquid phase during separation at the WCF.

Water quality: Contractors working on the Project would be required to develop and comply with SWPPPs to avoid or minimize pollutant discharge to waters. No effects on freshwater water quality are expected.

Subsistence: Section 3.16 discusses the potential effects on subsistence during construction and Chapter 4.0 provides an analysis of potential spills and their likelihood during construction. Construction-related impacts to subsistence resources could occur for a limited time, primarily from potential hazardous material spills. Potential construction spill locations could include marine waters, ice and gravel infrastructure locations, and the Tiŋmiaqsiuġvik Mine Site. Most spills would be expected to be very small to small, localized, and contained quickly. However, because subsistence resources would be displaced, diverted away from, or avoid the construction area (due to the increased human activity, traffic and noise), they would likely not be exposed to hazardous materials.

3.18.2.4.1.4 Health Effect Category 4: Food, Nutrition, and Subsistence Activities

Food and nutrition: Section 3.16 describes potential effects on subsistence and sociocultural systems. Subsistence roles within a community naturally change over time due to household circumstances (e.g., age and number of household members, employment levels), and communities generally adapt to these changes; however, a sudden change in employment levels in the community may cause at least a temporary disruption in social ties and roles within the community of Nuiqsut, which could cause a decline in the distribution of subsistence foods for a period of time and decreased food security for some households. Top reasons for reporting decreased harvests in rural Alaska communities include a lack of harvest effort; reduced resource availability; a lack of time due to work; other personal reasons; and less sharing. Thus, changes in resource availability resulting from the Project, increased local employment rates, and decreased distribution of subsistence resources could all contribute to decreased food security in affected communities (Fall and Kostick 2018). Increased incomes for some households would provide funds to support subsistence activities and allow for the purchase of more store-bought foods, potentially offsetting some effects on food insecurity during Project construction.

Subsistence activities: Section 3.16 describes the potential effects on subsistence, including changes in traditional means of access and potential harvester avoidance of Project construction areas.

3.18.2.4.1.5 Health Effect Category 5: Infectious Disease

Non-local construction workers would have little contact with Nuiqsut residents, and construction would not affect infectious disease levels in the community.

3.18.2.4.1.6 Health Effect Category 6: Water and Sanitation

There would be no effect on drinking water or sanitation for Nuiqsut.

3.18.2.4.1.7 Health Effect Category 7: Noncommunicable and Chronic Diseases

Construction activities would not directly affect noncommunicable or chronic disease levels in Nuiqsut, although construction activities could increase stress levels for some Nuiqsut residents, increasing disease susceptibility.

3.18.2.4.1.8 Health Effect Category 8: Health Services Infrastructure and Capacity

Non-local construction workers would be housed at construction camps and would have access to on-site medical facilities and transportation to an urban area for advanced medical treatment, if needed. There would be no effect on community health services in Nuiqsut.

3.18.2.4.2 Operations and Drilling Phases

Operations and drilling activities would have the same effects described above for construction, except the duration of the effects would continue for the life of the Project (through 2050). If subsistence harvest and sharing activities are disrupted for the long term, effects on cultural connectivity and social connections would last beyond the life of the Project. Similarly, if residents' stress levels increase due to increased concerns about subsistence access and harvests, the increased stress could become chronic and indirectly contribute to poorer overall health for some residents.

3.18.2.5 Alternative C: Disconnected Infield Roads

Effects for this alternative would be the same as described for Alternative B. As noted in Section 3.16, the removal of some roads results in reduced impacts on some subsistence resources and increased impacts on others due to increased flight activity. Overall, the effects on food, nutrition, and subsistence (HEC4) social connections and cultural continuity (HEC1) would be somewhat less but not substantially different than Alternative B. Effects on accidents and injuries (HEC2) may be less given the reduced potential for conflicts with road traffic, but still greater than Alternative D.

3.18.2.6 Alternative D: Disconnected Access

Effects for this alternative would be the same as described for Alternative C. Elimination of the access road may reduce some subsistence impacts but may also result in more flight activity. Overall, the effects on food, nutrition, and subsistence (HEC4) and social connections and cultural continuity (HEC1) would be somewhat less but not be measurably different from Alternatives B and C. With no access road, the potential for accidents and injuries (HEC2) may be reduced compared to Alternatives B and C.

3.18.2.7 Module Delivery Option 1: Atigaru Point Module Transfer Island

Effects on public health related to the construction of an MTI in Harrison Bay near Atigaru Point to support sealift module delivery would primarily result from effects on food, nutrition, and subsistence (HEC4) and related effects on social connections and cultural continuity (HEC1) due to the impacts on subsistence described in Section 3.16. This option would have impacts on Nuiqsut subsistence harvests, particularly of caribou and a lesser effect on Utqiaġvik subsistence harvesters.

3.18.2.8 Module Delivery Option 2: Point Lonely Module Transfer Island

Effects on public health from an MTI at Point Lonely to support sealift module delivery would not be measurably different from Option 1. This option would affect subsistence harvesters from Nuiqsut less and would affect Utqiaġvik subsistence harvesters more, particularly caribou harvesters.

3.18.2.9 Module Delivery Option 3: Colville River Crossing

Module delivery Option 3 would not include an MTI and would eliminate or reduce many of the subsistence impacts associated with Options 1 and 2, including the construction of new offshore marine infrastructure, the overall volume of ground and air traffic, and the number of years of activity. There would be fewer effects on food, nutrition, and subsistence (HEC4) and related effects on social connections and cultural continuity (HEC1) because no marine infrastructure would be built, and the majority of the activity would be outside of the community's core subsistence use area (the impacts on subsistence are described in Section 3.16).

3.18.2.10 Oil Spills and Accidental Releases

Most spills and accidental releases would be small and would occur on gravel pads or other developed areas. These spills would not affect public health in Nuiqsut. Larger spills that could occur and spills that migrate off gravel pads have the potential to contaminate land, water, and subsistence resources such as fish. State and national spill response regulations require oil field operators to have plans for spills that limit exposure to fish and wildlife and limit public exposure to the spill area or hazardous materials associated with cleanup activities. Response activities could also increase air emissions from increased transport of labor and equipment into the spill area and increased use of equipment in cleanup activities. Community concerns about potential spills, contamination of water and subsistence resources, and additional noise and activities associated with spill response could increase stress levels in community residents during and after response activities.

3.18.3 Unavoidable Adverse, Irretrievable, and Irreplaceable Effects

Effective implementation of BMPs for resources that influence public health (air quality, noise, sociocultural systems, subsistence, etc.) would help prevent unavoidable adverse, irretrievable, and irreversible effects to public health. They would also provide for the long-term sustainability of public health in the analysis area.

3.19 Cumulative Effects

3.19.1 Introduction

The cumulative effects analysis considers impacts of a proposed action and its alternatives that may not be consequential when considered individually, but when combined with impacts of other actions, may be consequential (CEQ 1997). A cumulative impact is an "impact on the environment which results from the incremental impact of the action when added to other past, present, and RFFAs regardless of what agency…or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7 and 1508.25[a][2]).

The purpose of this cumulative effects analysis is to determine if the impacts of the Project, together with other past, present, and RFFAs, have the potential to accumulate over time and space, either through repetition or combination with other impacts, and what the effects of that accumulation would be. An RFFA is defined as a project for which there is an existing proposal, a project currently in the NEPA process, or a project to which a commitment of resources (such as funding) has been made.

3.19.2 Background and Methodology

3.19.2.1 Background

The cumulative effects analyses are documented in multiple EISs for similar types of projects and programs on the North Slope: the *Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement, Final* (BLM 2019b, Chapter 3), *Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth Two Development Project – Final Supplemental Environmental Impact Statement* (BLM 2018a, Section 4.6), and *Nanushuk Project Final Environmental Impact Statement* (USACE 2018, Section 3.1.3, and throughout Chapter 3) provide a broad analysis of existing and potential oil and gas-related activities on the North Slope that is applicable to the cumulative impacts analysis for the Willow MDP. The cumulative impacts summaries and conclusions in the above-referenced EISs were reviewed for the applicability of information and methods to the Project; then past and present actions and RFFAs affecting the resources evaluated in the EIS were identified and evaluated.

3.19.2.2 Methodology

The analysis of cumulative impacts follows guidance provided in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997). Past and present actions and RFFAs that may impact the elements of the environment already potentially impacted by the Project were identified and evaluated. Cumulative effects of oil and gas exploration and development action on the North Slope have been extensively evaluated in multiple EISs. The cumulative impacts analytical method for resources analyzed in the EIS was similar in approach to those described in detail by BLM (BLM 2018a, 2019b) and USACE (2018).

BLM considered public and agency input (Appendix B, *Public Engagement and Comment Responses*) and used the technical analyses conducted for the EIS to identify and focus on cumulative effects that are "truly meaningful" in terms of local, regional, or national significance (CEQ 1997). The EIS addresses the direct and indirect effects of alternatives on the range of resources representative of the human and natural environment; for this cumulative effects analysis, similar resources have been grouped. While not all of those resources need to be included in the cumulative effects analysis—just those that are relevant to the decision to be made on the Proposed Action—the grouping provides a summary of cumulative impacts to all resources.

The temporal scope of cumulative impacts analysis is the 1970s (when oil and gas activities began on a large scale on the North Slope) through the anticipated duration of direct and indirect impacts from the Project (assumed to be 30 years after the Project has ended and gravel infrastructure is removed [detailed in Section 3.9]), which would be 2081. The geographic scope of the cumulative impacts analysis for most resources is the analysis area for each resource (Sections 3.2 through 3.19, the resource analysis sections). For caribou, the geographic scope of the cumulative impacts analysis is the annual range extent of the TCH and the CAH. Climate change impacts (as described in Section 3.2) are occurring as a result of factors well beyond the North Slope. Nevertheless, a changing climate affects all resources assessed in the EIS and the effects of climate change are incorporated as a future condition as part of the assessment of affected environment and cumulative effects.

3.19.3 Reasonably Foreseeable Future Actions

Past and present actions are described in Section 3.1.1, *Past and Present Actions*, and in Figure 3.19.1. RFFAs considered in this cumulative impacts analysis are presented in detail in Table 3.19.1 and in Figure 3.19.2. Impacts of RFFAs that are the farthest from BT3 (the center of the Project) would overlap with impacts from the Project in three primary areas: overall subsistence uses, caribou movement, and GHG emissions contributions to climate change.

Past and present actions that were considered were mainly oil and gas exploration and development actions on the North Slope that have environmental impacts within the analysis area of the resources analyzed in this cumulative effects analysis. RFFAs include oil and gas exploration, pipeline development, and transportation projects that are likely to affect resources in similar ways as the Project. Exploration activities by a variety of entities occur throughout the North Slope. The location and frequency of exploration activity changes from year to year, although trends may arise across some years. In recent years, exploration activity in the NPR-A and areas south and east of Nuiqsut (outside of the NPR-A) have seen increased exploration as additional recoverable resources have been discovered in these less developed areas. This trend is likely to continue over the coming years and may increase if changes in the NPR-A IAP (currently underway and listed as an RFFA in Table 3.19.1) open more areas of the NPR-A to oil and gas activity.

For the EIS, exploration activity is grouped as one RFFA due to the disparate and constantly changing details about activities by a wide variety of project proponents and the uncertainty related to any one proponent's exploration plans beyond the currently permitted activity. Exploration activities typically include construction and use of ice roads and pads (and sometimes ice airstrips), heavy equipment operation, traffic, water withdrawal, exploration well drilling, and seismic surveys. These activities have historically occurred across the North Slope and will continue to do so, with concentrated activity likely to occur within the NPR-A and in areas south and east of Nuiqsut (outside of the NPR-A).

Changes to leasing programs (i.e., changes that would open new or additional areas to leasing) are included as RFFAs because they would change the types of activities that could occur in an area. Individual lease sales are not included as RFFAs because of their speculative nature, which is influenced by a number of factors, such as the following: whether or not leases would be approved, the extent and magnitude of lease sales, when and where commercial discoveries of oil and gas occur, if production development would occur, the type and extent of petroleum technology advances, and economic uncertainties related to global oil prices. This is supported by the low probability that commercial production development would occur on a lease tract offering. ADNR reports that half of the tracts (49.7%) offered in state oil and gas lease sales in northern Alaska are actually leased (Kornbrath 1995); of these, approximately 11% have been drilled. About 5% of the tracts leased have been commercially developed for oil and gas production. The percentage is even smaller for tracts offered in federal lease sales in Alaska (Kornbrath 1995).

Table 3.19.1. Reasonably Foreseeable Future Actions That May Interact with the Project

Type	Project	Entity	Description	Unit/ Location	Distance to BT3[a] (miles)
Oil and gas exploration and development	Outer Continental Shelf Leasing Program	BOEM	Revisions to leasing plan in Chukchi and Beaufort seas, could open more areas to offshore leasing. Under 43 USC 1331-1656b, a new plan is under development.	Offshore	Varies
Oil and gas exploration and development	Nanushuk	Oil Search Alaska	New oil and gas development east of the Colville River. USACE published the ROD in May 2019; construction began in late 2019 and will continue for several years.	Pikka Unit	35
Oil and gas development	Nuna DS2	ConocoPhillips Alaska, Inc.	Nuna DS1 gravel infrastructure was constructed 2015 and is included as a present project; a second drill site (DS2) is permitted may be constructed in the future.	Kuparuk River Unit	46
Oil and gas exploration and development	Placer	Arctic Slope Regional Corporation	A new 7-acre gravel pad and 7-mile gravel road with pipeline originating from near the Mustang Pad	Placer Unit	45
Oil and gas exploration	Miscellaneous Seismic Exploration	Multiple	Seismic exploration is ongoing throughout the region; conducted by multiple firms for different operators.	Multiple	Varies

Type	Project	Entity	Description	Unit/ Location	Distance to BT3[a] (miles)
Oil and gas exploration and development	Liberty	Hilcorp Alaska	Proposed artificial island located northeast of Deadhorse. BOEM published the ROD on October 26, 2018.	Liberty	108
Oil and gas exploration and development	Greater Willow 1 & 2	ConocoPhillips Alaska, Inc.	Potential expansion areas to be included in the Willow Master Development Plan	Bear Tooth Unit	8
Oil and gas development	Kuparuk Seawater Treatment Plant Upgrades	ConocoPhillips Alaska, Inc.	Planned upgrades to the existing treatment plant at Oliktok Point	Kuparuk River Unit	61
Oil and gas development	Kuparuk Operational Projects	ConocoPhillips Alaska, Inc.	Routine operational projects with small footprints	Kuparuk River Unit	50+
Oil and gas development	Alpine Infrastructure Upgrades	ConocoPhillips Alaska, Inc.	Proposed expansion of the Alpine airstrip apron, expansion of gas infrastructure on the CD-1 pad, additional gravel pads for staging, and other routine operational projects with small footprints	Colville River Unit	33
Oil and gas development	Oliktok Road Upgrades	ConocoPhillips Alaska, Inc.	Up to 48 acres of road widening from Kuparuk Drill Site 3N to Kuparuk Central Processing Facility 1, Kuparuk Drill Sites 2G and 2M, as well as the access road from Kuparuk Drill Sites 3M to 3I, permitted in 2017	Kuparuk River Unit	50
Oil and gas development	K-Pad expansion	Kuukpik Corporation	5-acre expansion to the existing pad near the Nuiqsut Spur Road	Colville River Unit	27.5
Oil and gas development	Alaska LNG	State of Alaska	Natural gas line from the North Slope to Nikiski; includes compression and liquification facilities	North Slope	89
Oil and gas development	Alaska Stand Alone Pipeline	State of Alaska	Natural gas pipeline for in-state distribution that would follow the Trans-Alaska Pipeline System from the gas conditioning facility in Prudhoe Bay south to a connection with the existing ENSTAR natural gas pipeline system in the Matanuska-Susitna Borough	North Slope	89
Oil and gas exploration and development	Coastal Plain Oil and Gas Leasing Program	BLM	Oil and gas leasing program for the Arctic National Wildlife Refuge in Area 1002	Arctic National Wildlife Refuge	140
Oil and gas exploration and development	NPR-A Integrated Activity Plan Revisions	BLM	Revisions to the IAP for NPR-A, including potentially opening areas to oil and gas leasing and development	NPR-A	0
Mining	Miscellaneous Mine Site Expansions	Multiple	The opening of new cells at existing mine sites on the North Slope, such as Mine Sites E and F and the ASRC Mine Site	Multiple	Varies (32 miles closest)
Transportation	Colville River Access Road	Native Village of Nuiqsut/ North Slope Borough	Proposed gravel road connecting a water source lake to the Colville River; road permitted in 2016	Nuiqsut	28
Transportation	Arctic Strategic Transportation and Resources Project	State of Alaska/ North Slope Borough	Planning-level effort to identify North Slope community needs; includes potential roads (seasonal ice, snow, or all-season gravel) that may connect communities to the Dalton Highway or the development of utilities, fiber-optic networks, or port and shipping facilities	North Slope	Unknown
Transportation	Community Winter Access Trail	North Slope Borough	Overland snow trails to connect Atqasuk, Wainwright, Utqiaġvik, and Nuiqsut to the Dalton Highway	Multiple	Varies

Type	Project	Entity	Description	Unit/ Location	Distance to BT3[a] (miles)
Community development	NPR-A Impact Grant Program Projects	Multiple	Various projects to support essential public services and facilities (such as construction or maintenance of a youth center, a boat ramp, a community center, etc.), priority given to areas most directly or severely impacted by development in NPR-A, such as Nuiqsut	Multiple	Varies

Note: BLM (Bureau of Land Management); BOEM (Bureau of Ocean and Energy Management); BT3 (Bear Tooth drill site 3); DS (drill site); ENSTAR (ENSTAR Natural Gas Company); IAP (Integrated Activity Plan); LNG (liquified natural gas); NPR-A (National Petroleum Reserve in Alaska); ROD (Record of Decision); USACE (U.S. Army Corps of Engineers). A reasonably foreseeable future project is defined as a project for which there is an existing proposal, a project currently in the National Environmental Policy Act process, or a project to which a commitment of resources (such as funding) has been made. For the Environmental Impact Statement, all present projects are assumed to also occur in the future; present projects are not listed in the table.
[a] BT3 is the center of the Project; distances measured from BT3 to closest point of other projects.

3.19.4 Cumulative Impacts to Climate Change

As discussed in Section 3.2.2, *Environmental Consequences: Effects of the Project on Climate Change*, GHG emissions are used as a surrogate for the impacts of climate change. As part of the required Greenhouse Gas Reporting Program, EPA requires all facilities that emit more than 25,000 MT of CO_2e per year to report their annual GHG emissions. This information is collated in EPA's (2019a) Facility Level Information on Greenhouse Gases Tool. The total CO_2e emissions from all major sources on the North Slope in 2018 (the most recent year of data) are listed in Table 3.19.2. As with Alaska as a whole, the industrial sector, including oil and gas industries, is the major contributor to GHG emissions in the North Slope.

Cumulative GHG emissions include Willow direct and indirect emissions, existing GHG emissions sources on the North Slope (which are presented in Table 3.19.2), and GHG emissions from the Greater Willow potential drill sites 1 and 2 (Figure 3.19.2). Together, the cumulative annual average of GHG emissions (comprising approximately 8.8 MMT of Willow direct and indirect emissions and approximately 9.0 MMT of other North Slope emissions) is approximately 0.27% of the 2017 U.S. GHG inventory (6,457 MMT) for all action alternatives.

BLM has disclosed below projected cumulative GHG emissions from all of the cumulative sources described above and potential future development resulting from the BLM Coastal Plain Oil and Gas Leasing Program (BLM 2019b) in the ANWR The projected annual average of CO_2e emissions from the Coastal Plain development range from approximately 0.06 to 0.38 MMT for direct emissions and 0.7 to 5.0 MMT for indirect emissions. The projected annual average direct and indirect Willow CO_2e emissions are approximately 8.8 MMT in Alternative C and lower in Alternative B and Alternative D (see Appendix E.2), while other North Slope emissions are approximately 9 MMT, as shown in Table 3.19.2. Using the higher end of the Coastal Plain range of projected emissions, the cumulative annual average of GHG emissions from Willow, the Coastal Plain, and other North Slope emissions would be approximately 23 MMT (i.e., about 0.36% of the 2017 U.S. GHG inventory) and therefore cumulatively constitute a relatively small fraction of total impacts from U.S. GHG emissions.

Table 3.19.2. North Slope Major Facility Greenhouse Gas Emissions in Year 2018[a]

Facility Name	CO_2e (metric tons)[b]
BPXA Central Compressor Plant	2,892,315
BPXA Central Gas Facility	2,057,255
BPXA Central Power Station	734,150
BPXA Lisburne Production Center	677,233
Endicott Production Facility	594,501
ConocoPhillips Alaska Inc – KRU CPF1	559,896
ConocoPhillips Alaska Inc – KRU CPF2	403,745
ConocoPhillips Alaska Inc – KRU CPF3	326,384
Red Dog Operations Mine Facility	144,916
BPXA Seawater Treatment Plant	103,878
BPXA Seawater Injection Plant	103,283
ConocoPhillips Alaska Inc – KRU Saltwater Treatment Plant	93,078
Trans Alaska Pipeline System Pump Station 3	64,580
Trans Alaska Pipeline System Pump Station 4	63,197
Alyeska Pipeline SE/TAPS Pump Station 1	62,235
TDX North Slope Generating Co/North Slope Generating, Inc.	56,771

Facility Name	CO_2e (metric tons)[b]
Barrow Utilities & Electric	43,455
BPXA Crude Oil Topping Unit, Prudhoe Bay Operations Center, Tarmac Camp	22,241
Trans Alaska Pipeline System Pump Station 7	11,439
Total	**9,014,552**

Note: BPXA (British Petroleum Exploration Alaska, Inc.); CO_{2e} (carbon dioxide equivalent); CPF (central processing facility); KRU (Kuparuk River Unit); TAPS (Trans-Alaska Pipeline System).
[a] U.S. Environmental Protection Agency Facility Level Information on Greenhouse Gases Tool (2019a)
[b] CO_2e calculated using global warming potential values from Table E.2.1 in Appendix E.2, *Climate and Climate Change Technical Appendix*.

The impacts of GHG emissions on climate change would be compounded by impacts from climate change on the environment discussed in Section 3.2.1.2. There would be a synergistic effect of these environmental changes and the cumulative impacts of GHG emissions in the North Slope. For example, warmer temperatures combined with reduced ice cover have led to the greening of the tundra and increases in soil moisture and the amount of snow water available. Section 3.19.6, *Cumulative Impacts to Soils, Permafrost, and Gravel Resources*, further discusses the deepening of the active layer on the ACP, and the degradation of the near-surface permafrost, leading to thermokarst development. The North Slope has experienced increased average temperatures, decreased sea ice and snow cover extent, an expanded growing season, and thawing permafrost. Projected and observed increases in periods of sea-ice-free conditions, as sea ice melts earlier and forms later in the year, particularly in the autumn, when large storms are more common in the Arctic, suggest that Arctic coasts will be more vulnerable to storm surges and wave energy, potentially resulting in accelerated shoreline erosion and terrestrial habitat loss (Gibbs, Snyder et al. 2019). Section 3.19.9, *Cumulative Impacts to Biological Resources*, further discusses the cumulative impacts of climate change on fish, marine mammals, birds, terrestrial mammals, and wetlands and vegetation due to habitat loss.

3.19.5 Cumulative Impacts to Air Quality

As presented in Section 3.3, there are several existing emissions sources, both onshore and offshore, on the North Slope and the adjacent waters area, resulting in air emissions that affect air quality. Overall, onshore oil and gas sources comprise the largest fraction of existing emissions for all CAPs except PM_{10} and $PM_{2.5}$, for which dust from unpaved roads comprises the largest fraction. The concentrations of CAPs at the CPAI Nuiqsut monitoring station are all well below the NAAQS; thus, the existing air quality in the analysis area is not considered harmful to public health or the environment. Section 3.3.2, *Environmental Consequences*, includes additional planned developments and background air quality concentrations in order to compare total air quality and AQRV conditions to applicable standards. Therefore, results presented in that section include a cumulative impact assessment. Table 3.19.3 presents the past and present actions and RFFAs that were considered in the modeling analyses. The analysis included only RFFAs with sufficient data for modeling.

Modeled cumulative impacts to air quality and AQRVs (visibility and deposition) were all below applicable thresholds.

Table 3.19.3. Past, Present, and Reasonably Foreseeable Future Actions Sources Considered for Air Quality Cumulative Impacts Assessment

Name of Facility	Miles from Willow Operations Center[a]	Included in Near-Field Modeling	Included in Far-Field Modeling	Source Type and Notes
TDX Deadhorse Power Plant	77	No	Yes	Modification to an existing source
ExxonMobil Point Thomson Facility Expansion	133	No	Yes	Modification to an existing source Project is already included in the BOEM future year database used in the Willow MDP EIS, so duplicate emissions were not added explicitly to the cumulative far-field modeling analysis.
Nanushuk Pad (proposed)	41	No	Yes	RFFA source
Nanushuk Drill Site 2 (proposed)	37	No	Yes	RFFA source
Nanushuk Drill Site 3 (proposed)	34	No	Yes	RFFA source
Nanushuk Operations Center (proposed)	41	No	Yes	RFFA source

Name of Facility	Miles from Willow Operations Center[a]	Included in Near-Field Modeling	Included in Far-Field Modeling	Source Type and Notes
Eni Nikaitchuq Development	60	No	Yes	RFFA source
Pioneer Oooguruk Development	47	No	Yes	RFFA source
Hilcorp Liberty	106	No	Yes	RFFA source Project is already included in the BOEM future year database used in the Willow MDP EIS, so duplicate emissions were not added explicitly to the cumulative far-field modeling analysis.
CPAI GMT-1	17	Yes	Yes	RFFA source Project is included in the BOEM future year database used in the Willow MDP EIS, so duplicate emissions were not added explicitly to the cumulative far-field modeling analysis.
CPAI GMT-2	11	Yes	Yes	RFFA source
Mustang Pad	44	No	Yes	RFFA source
Greater Willow Potential Drill Site #1	14	Yes	No	RFFA source Source not anticipated to be operational in 2025, the selected analysis year for the cumulative far-field modeling.
Greater Willow Potential Drill Site #2	8	Yes	No	RFFA source Source not anticipated to be operational in 2025, the selected analysis year for the cumulative far-field modeling.

Note: BOEM (Bureau of Ocean and Energy Management); BPXA (BP Exploration Alaska); CPAI (ConocoPhillips Alaska, Inc.); EIS (Environmental Impact Statement); GMT-1 (Greater Mooses Tooth 1); GMT-2 (Greater Mooses Tooth 2); MDP (Master Development Plan); RFFA (reasonably foreseeable future action).
[a] As measured for Alternative B.

3.19.6 Cumulative Impacts to Soils, Permafrost, and Gravel Resources

As described in the affected environment in Section 3.4, past and present actions have impacted soils and permafrost in the areas where ground-disturbing activities and gravel or ice infrastructure have occurred. In some areas, this has resulted in soil and vegetation compaction as well as changes to the thermal regime, permafrost thaw, thermokarst, subsidence, erosion, or ponding. Gravel infrastructure has also created dust that has contributed to changes in soil composition and locally increased albedo. The Project would have effects like those of past and present actions and would contribute to the cumulative effects of past and present actions and RFFAs on soils, permafrost, petroleum, and gravel resources. Given the scope of the Project and that effects would be localized (within 100 m of infrastructure), the Project would not change the cumulative impacts on soils, permafrost, or gravel resources because the availability of soils and permafrost spans the ACP.

Global climate change is a current and reasonably foreseeable future condition affecting soils and permafrost in the analysis area. The depth of the active layer on the ACP within the NPR-A is projected to increase by 37% (an average increase from 1.32 to 1.81 feet across the ACP within the NPR-A) by the end of the century (SNAP 2011). The deepening of the active layer and degradation of the near-surface permafrost could lead to thermokarst development and alteration of ice-related geomorphological landforms from the melting of the ground ice. The magnitude of disturbance and thermokarsting is directly related to the abundance of ground ice (USACE 2012). These effects would occur independent of the RFFA's effects on soils and permafrost.

3.19.7 Cumulative Impacts of Noise

As described in Section 3.6, noise sources in the analysis area are both natural (e.g., wildlife, wind, water) and human made (e.g., traffic, construction, oil production, aircraft, hunting). Ambient sound levels around Nuiqsut and the lower Colville River range from 25 to 47 dBA, with a median level of 35 dBA (Stinchcomb 2017). The median sound exposure level of aircraft ranges from 55 to 69 dBA. The community of Nuiqsut, the Alpine and GMT oil fields, and the ASRC Mine Site also contribute human-made noise to the ambient soundscape in the analysis area. Sound from the Project would create noise in the analysis area and contribute to additive noise in areas where other RFFAs would also contribute noise at the same time. Almost all operational noise from the Project would attenuate to ambient sound levels prior to reaching Nuiqsut and therefore would not affect the largest community in the analysis area. Cumulative operational and construction noise (and the Project's contribution to those cumulative effects) could affect subsistence activities by causing subsistence users to avoid areas impacted by noise (Section 3.19.11, *Cumulative Impacts to the Social Environment (land use, economics, and public health*).

3.19.8 Cumulative Impacts to Visual Resources

As described in Section 3.7, *Visual Resources*, past and present actions have resulted in visible human infrastructure within the foreground-middleground landscape. The community of Nuiqsut, the Alpine and GMT oil fields, and the ASRC Mine Site contribute infrastructure to the landscape, as do ice roads, snow and ATV trails. The RFFAs that would impact the same viewshed as the Project are primarily oil and gas related (Table 3.19.1). These RFFAs would include facilities and infrastructure that would have the same types of impacts to visual resources as described for the Project. These RFFAs would contribute cumulatively with the Project in creating strong to moderate contrasts in scenic quality Class C (low scenic quality) lands that are inventoried as VRI Class III. However, because they would occur in the seldom seen zone (greater than 15 miles distant), these RFFAs would not contribute cumulatively to impacts on scenic Class B (moderate quality) lands on the Colville River that are inventoried as VRI Class II.

3.19.9 Cumulative Impacts to Water Resources

As described in the Affected Environment section in Section 3.8, gravel and ice infrastructure, water withdrawals, and in-water structures (like culverts and bridges) have affected water resources in the analysis area. The existing infrastructure and development activities (traffic, dust suppression, drilling, processing, etc.) have constructed structures in waterbodies, contribute dust and sediment to waterbodies, withdraw freshwater for use throughout the year, and increase the potential for spills entering waterbodies. The Project would have effects like those of past and present actions and would contribute to the cumulative effects of past and present actions and RFFAs on water resources. Given the scope of the Project considered in the context of past and present actions and RFFAs, the Project would not change the cumulative impacts on water resources in the analysis area. When the cumulative effects to hydrology and floodplains are considered in the context of their total abundance, distribution, and quality throughout the region, the incremental effects of the Project would be small. Freshwater waterbodies are abundant and occur throughout the ACP, the total and incremental amount of disturbed area is small compared with the total resource within the region.

Global climate change is a current and reasonably foreseeable future condition affecting water resources in the analysis area. Earlier breakups and thinner river and lake ice will likely occur as the climate continues to warm. The increase in spring temperatures could result in more thermal breakups. A continued warming of the climate could also lead to scenarios in which a cool spring is followed by a sudden warm-up when a large portion of the snowpack melts and enters a river in a short period (Markon, Trainor et al. 2012). In the years in which this occurs, it will intensify the spring breakup processes and generally lead to a larger flood-peak discharge. These effects would occur independent of the RFFA's effects on water resources.

As described in Section 3.2.1.2, *Projected Climate Trends and Impacts in the Arctic and on the North Slope*, predicting the effects of changes in precipitation is difficult. In Alaska, the snow-cover duration dropped by 15 days from 1980 to 2009, and projections for Alaska include a shift in snowfall patterns to a later date of first snowfall and an earlier snowmelt (Clement, Bengtson et al. 2013). Although precipitation levels are projected to increase, the longer warmer summers may increase evapotranspiration. An increase in evapotranspiration may result in a net loss in surface water by the end of the summer season, which could affect the size, depth, and areal extent of thaw lakes. Increases in winter precipitation may have some effect on lake recharge and on peak snowmelt runoff in rivers and streams. The Project may exacerbate climate change effects by withdrawing water from lakes throughout the year. However, permitting requirements should minimize effects as the volume of permittable water withdrawal is regulated to maintain adequate water levels in lakes.

The Project would add vessel traffic to the Beaufort Sea at a time when traffic is expected to continue to increase due to changing climate and reduced sea ice extents. Project vessel traffic in combination with increased shipping and vessel traffic could increase the likelihood of accidental spills from the vessels. The revisions to the NPR-A IAP could also increase vessel traffic, and potential revisions by BOEM to its outer continental shelf leasing plans could result in additional offshore oil and gas development through issuance of offshore leases in areas of the Beaufort and Chukchi seas currently closed to leasing. These activities, in combination with the Project, could cumulatively increase the likelihood of spills in the marine environment.

3.19.10 Cumulative Impacts to Biological Resources

For the purposes of this cumulative effects analysis, biological resources are fish, marine mammals, birds, terrestrial mammals, and wetlands and vegetation. The impacts of past and present actions on biological resources are documented in Sections 3.9 through 3.13. In general, past and present actions across the ACP have impacted biological resources though short-term impacts (e.g., disturbance and displacement) and long-term alteration and loss of habitat. The Project would impact wetlands and vegetation, as well as fish, marine mammals, terrestrial mammals, birds, and habitat for those animals, as further detailed in Sections 3.19.10.1 through 3.19.10.5. Implementation of BMPs and other avoidance, minimization, or mitigation measures would lessen impacts to biological resources and the Project's contribution to cumulative impacts to biological resources.

3.19.10.1 Wetlands and Vegetation

As described in Section 3.9, disturbance and fill of wetlands in the analysis area has been primarily due to gravel and ice infrastructure development of the GMT, Kuparuk, and Alpine oil fields, the community of Nuiqsut, and decommissioned Distant Early Warning Line sites. Existing infrastructure and activities have filled wetlands and altered some wetlands' functions, contribute dust and sediment to wetlands and vegetation, and increase the potential for spills to reach vegetation or wetlands. Past actions have introduced invasive plants into the cumulative effects analysis area in the Kuparuk oil field, and it is likely only a matter of time before existing populations of invasive species expand their range into the NPR-A and the analysis area. Because humans are the primary dispersal mechanism for invasive species, RFFAs would likely contribute to factors that could expand the range of invasive species, mainly from building roads and expanding the range of human activity. Prior to final abandonment, land used for infrastructure is expected to be reclaimed, however, if the gravel fill is not removed at the end of the Project, the abandoned pads and roads would support plants adapted to drier habitats, including invasive species (such as dandelion and foxtail barley), should their range expand from current locations. These invasive species could be a seed source and impact adjacent habitats.

Reasonably foreseeable additional ice and gravel infrastructure would continue to impact wetlands and vegetation in similar ways as past and present development. The Project would impact wetlands and vegetation as described in Section 3.9 and would add to impacts of past and present actions and RFFAs by removing and altering wetlands and disturbing vegetation. Some impacts would be permanent. The Project would fill no more than 0.1% of any of the watersheds in which it would occur, and vegetation impacts would affect less than 0.1% of vegetation in any watershed. Comprehensive mapping data are not available for all the past and present actions and RFFAs to facilitate a meaningful quantitative analysis of the cumulative loss of wetland habitats; however, all developments in Table 3.19.1 will contribute additive impacts to existing and proposed developments in the analysis area. While most direct effects constitute a permanent loss of wetlands or WOUS, wetlands are abundant on the ACP and are not likely to be imperiled.

Indirect effects from the Project, in particular changes in wetland composition and invasive species, may exacerbate long-term changes occurring as a result of climate change. The action alternatives would further lengthen the growing season in areas adjacent to roads and pads (Walker and Everett 1987), where dust would melt snow sooner. This could exacerbate the effects of climate change by further decreasing soil moisture, increasing thaw depth, and altering the active layer in areas adjacent to roads and pads due to the dust shadow. Climate change may increase the potential for nonnative plant species to establish in response to warming temperatures (Markon, Trainor et al. 2012). As the climate warms, some plant species that do not presently thrive north of the Brooks Range are likely to extend their ranges into the ACP. The action alternatives would further increase pathways for invasive species to spread into the Project area through vehicle traffic (Ansong and Pickering 2013).

3.19.10.2 Fish

As described in Section 3.10, existing infrastructure and development activities (traffic, dust suppression, drilling, processing, etc.) in the analysis area contribute dust, sediment, and noise to waterbodies; withdraw freshwater for use throughout the year; and increase the potential for spills entering waterbodies. The RFFAs would have similar types of effects on fish (habitat loss or alteration and disturbance). When combined with the RFFAs, the Project would result in an increase to the demand for water withdrawals from lakes for ice roads, potable uses, oil and gas operations, etc. Because there are permit restrictions on the locations and volumes of water withdrawal, this would be unlikely to impact the availability of water for fish and aquatic resources. In the reasonably foreseeable future, the impacts described for fish, invertebrates, and aquatic habitats in the analysis area are likely to increase in intensity when compared to existing conditions.

Climate change will continue to affect fish throughout the area and could magnify Project impacts on fish by influencing the quantity, quality, and timing of freshwater in fish habitats and thus alter the rate or degree of potential cumulative impacts. Climate change, as described in Section 3.2, could have impacts on fish by influencing changes in precipitation, changes in the timing of ice formation, and changes in water chemistry, temperature, and oxygen levels. Climate change would continue to occur in the ACP, and the Project would produce GHG that could incrementally contribute to climate change and its effects. Increasing temperature is expected to change climate patterns and lengthen the ice-free season, degrade permafrost, and increase evaporation, processes that contribute to surface water hydrology and may reduce surface water connectivity. These reductions in connectivity (e.g., drying of channels or ponds) may in turn reduce colonization opportunities for fish by limiting dispersal pathways and movement between habitats (Laske, Haynes et al. 2016). This could change local species assemblages or species richness. Climate change is also causing lakeshore and riverbank erosion because of the shorter periods of ice cover, permafrost thawing, and bank collapse, leading to higher sediment transport and turbidity (Markon, Trainor et al. 2012).

In nearshore marine waters, increased temperature typically leads to increased primary and secondary productivity, which in turn may lead to more food availability for foraging fish (Reist, Wrona et al. 2006). Warming ocean temperatures may change the composition of lower trophic populations as warmer seas, open water, and increased radiative energy from the sun increases. Climate change may also contribute to potential northern range expansions of fish species, the effects of warming sea surface temperatures on fish biomass, possible changes in fish species assemblages, shifts in prey availability and shifts in food webs, and the particular vulnerability of coastal areas in Alaska (Cheung, Lam et al. 2009; Sherman, Belkin et al. 2009). Shifts in the food web as a result of changing climate could have cascading effects on fish, with some predators forced to eat non-optimal prey items or preferred feeding spots becoming unavailable. Some species may benefit from shifts in a changing climate. Rising ocean acidity also affects the basic functions of fish and other marine species, including detrimental effects on metabolism, respiration, and photosynthesis, which can thwart their growth and lead to higher mortality (Fabry, Seibel et al. 2008). The decrease of the extent of the Arctic ice pack impacts the lower trophic communities, which has impacts on fish communities.

The Project would add vessel traffic to the Beaufort Sea at a time when traffic is expected to continue to increase due to changing climate and reduced sea-ice extents. Project vessel traffic in combination with increased shipping and vessel traffic could increase vectors for invasive species introduction and increase the likelihood for potential oil spills. The revisions to the NPR-A IAP could also increase vessel traffic, and potential revisions by BOEM to its outer continental shelf leasing plans could result in additional offshore oil and gas development through issuance of offshore leases in areas of the Beaufort and Chukchi seas currently closed to leasing. These activities, in combination with the Project, could have cumulative impacts (disturbance, vectors for invasive species, and vectors for oil spills) on fish across the Beaufort Sea. Concurrent to an increasing number of vectors for invasive species introduction, conditions may become suitable for species to expand their ranges or for introduced species to establish. All vessels that enter State of Alaska or federal waters are subject to U.S. Coast Guard regulations (33 CFR 151), which are intended to reduce the transfer of aquatic invasive organisms. Management of ballast water discharge is federally regulated (33 CFR 151.2025); discharge of untreated ballast water into WOUS is prohibited unless the ballast water has been subject to a mid-ocean ballast water exchange (at least 200 nautical miles offshore). Vessel operators are also required to remove "fouling organisms from the hull, piping, and tanks on a regular basis, and dispose of any removed substances in accordance with local, state, and federal regulations" (33 CFR 151.2035(a)(6)). Adherence to the 33 CFR 151 regulations would reduce the likelihood of Project-related vessels introducing aquatic invasive species.

3.19.10.3 Birds

As described in Section 3.11, existing infrastructure and development activities (traffic, dust suppression, drilling, processing, etc.) in the analysis area contribute tall structures, traffic, dust, noise, and vegetation compaction to existing habitats; withdraw freshwater for use throughout the year; increase the potential for spills entering waterbodies or the tundra; and increase subsistence access (and presumably harvest). Birds would be cumulatively affected by other RFFAs in the analysis area, and the Project would contribute to those cumulative effects.

The main RFFAs that could affect birds are the NPR-A IAP revisions, the Arctic Strategic Transportation and Resources (ASTAR) project, other community or oil and gas development projects, and future expansions of the Willow Project. Revisions to BLM's NPR-A IAP that are currently underway may change the land management prescriptions associated with existing special areas, such as the TLSA. The 2020 IAP Final EIS (BLM 2020a) evaluated changes to land management prescriptions in the special areas and those changes vary by alternative; some alternatives provide protections for birds over a larger area within the TLSA than others. Alternatives D and E of the IAP would open all of the land near Teshekpuk Lake to leasing, with impacts from any future development partially mitigated through no surface occupancy stipulations and timing limitations. If either of these alternatives is selected, additional effects to birds could occur. Further development in the NPR-A and new development in the TLSA would impact a major proportion of birds breeding on the North Slope with habitat loss and alteration and increased predation, injury, and mortality. The NPR-A supports the highest numbers and densities of breeding shorebirds and waterbirds (5.4 million birds) on the ACP (7.8 million birds), which is 69% of all aquatic birds on the ACP (Bart, Platte et al. 2013). Within the NPR-A, the TLSA is a major breeding area for waterbirds (Amundson, Flint et al. 2019), supporting 42% of the aquatic birds on the ACP (Bart, Platte et al. 2013) and identified as an IBA of global significance (Audubon Alaska 2015). Development in the TLSA, which was previously off-limits to oil and gas leasing and surface occupancy, would impact large numbers of breeding geese, ducks, and shorebirds, including the *arcticola* dunlin, which, with other shorebirds, concentrate there in unusually high numbers (Andres, Johnson et al. 2012; Liebezeit, White et al. 2011). Development within goose molting areas, where approximately 22% of the Pacific population of brant congregate (Flint, Patil et al. 2020), would increase human disturbance and risk of spills for four species of geese undergoing wing molt, a period when they are flightless and sensitive to human and predator activity. Pipelines, roads, and other facilities would attract predators, which would reduce productivity of nesting birds (Liebezeit, Kendall et al. 2009) and disrupt and displace molting and brood-rearing geese from feeding areas, causing mortality, loss of young, and increasing energetic demands.

The revisions to the NPR-A IAP could also allow 140 to 250 miles of new roads (and 130 to 240 miles of new pipelines), including a community road connecting Nuiqsut and Utqiaġvik that would be routed north of Teshekpuk Lake. The ASTAR project could include additional road construction and intersect the Goose Molting Area north and east of Teshekpuk Lake. New roads could directly kill some birds due to vehicle collisions or increase access for local or non-local hunters. These changes in addition to the use of Project roads and boat ramps would increase access for hunters, which could alter the distribution of hunting activity and the location and levels of harvest. No Project gravel infrastructure is proposed in the Goose Molting Area, though Option 2 would build ice roads through the area during construction. In addition, the Project’s all-season roads with associated pullouts and ramps would increase subsistence access to those areas if they are connected to new development infrastructure related to the NPR-A IAP or the ASTAR project.

Cumulative changes to hunter access from the RFFAs and the Project could impact all game species of birds, although they could be mitigated through hunting regulations or road use limitations. Community roads would also increase disturbance of breeding and molting geese from vehicle traffic and hunting activity and likely increase harvest of geese. The addition of roads that could be used for hunting and possibly connect with Project roads could alter the use of the Project roads by subsistence hunters. Although brant and other North Slope goose populations have been increasing (Wilson, Larned et al. 2018), there is concern that those observed increases in brant may not be compensating for losses occurring on the Yukon-Kuskokwim Delta (Sedinger, Riecke et al. 2019), which may be indicative of a decline in the larger Pacific Brant population. Increases in mortality, predation, and human disturbance related to oil and gas and transportation development could reduce recruitment and survival (Leach, Ward et al. 2017; Pacific Flyaway Council 2018), thereby possibly contributing to an overall decline in the Pacific brant population.

Seismic activity associated with new oil and gas leasing could cause some long-term damage to forage vegetation in some areas and cause snow compaction that could delay the timing of snowmelt. The impact of seismic activity on forage plants would be in addition to the direct loss of forage within the footprint of gravel roads and pads.

Climate change will continue to affect birds throughout the area and could alter the rate or degree of potential cumulative impacts. Climate change, as described in Section 3.2, could have impacts on birds. The impacts of climate change are likely to vary by species, but in general, climate change will introduce substantial uncertainty in predicting the demographic trends of species in the area and will make the predicted impacts of development more difficult to accurately assess. Soil, hydrology, and vegetation change is expected to occur at the scale of decades to millennia (Martin, Jenkins et al. 2009). These habitat changes will increase habitat quality for some songbirds but decrease habitat quality for those shorebirds (Wauchope, Shaw et al. 2017) and Lapland longspurs preferring moist to wet meadows (Thompson, Handel et al. 2016) and for waterfowl, loons, and grebes that rely on lakes and ponds on the tundra.

The warmer spring temperatures and longer ice and snow-free season (SNAP 2011) allows some birds to arrive and nest earlier (Liebezeit, Gurney et al. 2014; Ward, Helmericks et al. 2016), allow production of replacement clutches and double broods in some species (Ely, McCaffery et al. 2018; Grabowski, Doyle et al. 2013; Meltofte, Piersma et al. 2007), and may allow the slow-developing young of loons and tundra swans to stay on breeding grounds longer to reach flight capability. Migrant birds have arrived in the CRD an average of 6 days earlier with increasing May temperatures over a 50-year period (Ward, Helmericks et al. 2016). For some birds, such as geese (Dickey, Gautheir et al. 2008) and shorebirds (Meltofte, Piersma et al. 2007), warmer spring temperatures result in earlier nesting and higher nesting success, although very warm temperatures and very cold temperatures tend to reduce reproductive output (Dickey, Gautheir et al. 2008).

Many factors affect the production of young by tundra-nesting birds, and trends are not consistent across species or years. Arrival and breeding of birds in the arctic may not coincide with peaks in insect production (Saalfeld, McEwen et al. 2019; Senner, Stager et al. 2017; Tulp and Schekkerman 2008) or forage quality in vegetation (Doiron, Gauthier et al. 2014), resulting in mismatches in timing of reproduction with forage conditions (Clausen and Clausen 2013; McKinnon, Picotin et al. 2012), and can reduce chick survival (Senner, Stager et al. 2017). Red knots breeding in the arctic in years of early snowmelt were smaller (due to lack of prey) and had lower survival in non-breeding areas due to shorter bills and a subsequent reduction in foraging success (van Gils, Lisovski et al. 2016). Some species appear to have flexibility in timing arrival and egg laying to adjust to forage production based on local conditions (Ely, McCaffery et al. 2018; Grabowski, Doyle et al. 2013), whereas others do not (Senner, Stager et al. 2017).

3.19.10.4 Terrestrial Mammals

As described in Section 3.12, existing infrastructure and development activities (traffic, dust suppression, drilling, processing, etc.) in the analysis area contribute linear structures, traffic, dust, noise, and vegetation compaction to existing habitats, increase the potential for spills, and increase subsistence access (and presumably harvest). Some terrestrial mammals may also be impacted through attraction to human activities or facilities. Terrestrial mammals would be cumulatively affected by other RFFAs in the analysis area, and the Project would contribute to those cumulative effects.

Many of the RFFAs are in the range of the CAH, a caribou herd that has been exposed to oil and gas infrastructure for approximately 40 years. Development that displaces caribou from calving areas, hinders caribou movements among seasonal ranges, or increases hunter access are likely to have the biggest impact on caribou. The additional projects would result in additional disturbance and displacement during some seasons, but the potential demographics impacts from these projects would depend on the location and type of development. Continued development within the summer range of the CAH would create additional direct habitat loss from gravel placement, indirect habitat loss disturbance and displacement during some seasons, and additional deflections and delays during caribou midsummer movements. Johnson et al. (2019) estimated that CAH caribou density was lower in 12%, 15%, and 17% of important habitat during the calving, post-calving, and mosquito season, respectively, as a result of the partial avoidance of areas near infrastructure. This reported avoidance was for an area that included oil fields constructed without modern mitigation methods (e.g. pipelines elevated less than 5 feet). The additional activity and traffic associated with the Project would be additive to these potential impacts. Murphy, Russell et al. (2000) found that changes in activity budgets of caribou from exposure to development were likely to have demographic impacts only at higher levels of exposure than currently exist. Nellemann and Cameron (1998) found that caribou density during calving declined with increasing road density. Colocating pipelines near existing infrastructure, avoiding development in calving areas, and using BMPs for development design would minimize impacts on caribou. Although the CAH has limited use of the Project area, the additional development would increase the total exposure to development for the herd.

The main RFFAs that could affect the TCH are the NPR-A IAP revisions, the ASTAR project, and future expansions of the Willow Project. Revisions to BLM's NPR-A IAP that are currently underway may change the land management prescriptions associated with existing special areas, such as the TLSA. The 2020 IAP Final EIS (BLM 2020a) evaluated changes to land management prescriptions in the special areas and those changes vary by alternative; some alternatives provide protections for caribou over a larger area within the TLSA than others. Alternatives D and E of the IAP would open all of the land near Teshekpuk Lake to leasing, with impacts from any future development partially mitigated through no surface occupancy stipulations and timing limitations. If leasing and development occurred in the high-density calving area of the TCH, additional effects to the TCH could occur. Development within the high-density calving area would likely result in the displacement of maternal caribou during calving. The demographic impacts of this displacement are difficult to predict but could result in higher calf mortality or reduced calf and adult body condition if alternative calving areas have higher predatory densities or lower forage quality. The development of the Project area would result in a less undeveloped area available for alternative calving areas. The relative value for calving habitat was mapped by Wilson et al. (2012), although in recent years the TCH calving distribution has apparently expanded to areas to the west of Teshekpuk Lake (Parrett 2015; Prichard, Klimstra et al. 2019).

The revisions to the NPR-A IAP could also allow 140 to 250 miles of new roads (and 130 to 240 miles of new pipelines), including a community road connecting Nuiqsut and Utqiaġvik that would be routed north of Teshekpuk Lake. The ASTAR project could include additional road construction through seasonal ranges of the TCH and the CAH. New roads could directly kill some caribou due to vehicle collisions, delay or alter caribou migratory movements (Panzacchi, Moorter et al. 2013; Wilson, Parrett et al. 2016), or increase access for local or non-local hunters. These changes in addition to the use of Project roads and boat ramps would increase access for hunters, which could alter the distribution of hunting activity and the location and levels of harvest.

Cumulative changes to hunter access from the RFFAs and the Project could impact all game species of mammals, although they could be mitigated through hunting regulations or road use limitations. Roads near calving areas would likely result in the displacement of calving caribou unless they are closed during the calving season. Road construction north of Teshekpuk Lake could potentially interfere with the use of narrow corridors of land that are used to access mosquito-relief habitat (Yokel, Prichard et al. 2011).

Seismic activity associated with new oil and gas leasing could disturb wintering caribou of the TCH and other species wintering or denning in the ACP. Seismic trains and camps could cause some long-term damage to forage vegetation in some areas and cause snow compaction that could delay the timing of snowmelt and increase mortality and limit movements of small mammals. The impact of seismic activity on forage plants would be in addition to direct loss of forage within the footprint of gravel roads and pads.

Climate change will continue to affect fish, birds, and wildlife throughout the area and could alter the rate or degree of potential cumulative impacts. Climate change, as described in Section 3.2, could have impacts on birds and terrestrial mammals. The impacts of climate change are likely to vary by species, but in general, climate change will introduce substantial uncertainty in predicting demographic trends of species in the area and will make the predicted impacts of development more difficult to accurately assess.

Climate change appears to be resulting in a northward expansion of some mammal species, such as moose, beaver, and snowshoe hare (Tape, Christie et al. 2016; Tape, Gustine et al. 2016; Tape, Jones et al. 2018). Increasing numbers of red fox due to warming could cause a decline in arctic foxes. Some species with low reproductive output in the arctic, such as grizzly bears, may benefit from increased productivity and a more diverse prey base. Warming could also result in a spread of pathogens (Kutz, Bollinger et al. 2015).

Climate change in the Arctic is predicted to have multiple, sometimes counteracting, effects on caribou (Albon, Irvine et al. 2017; Mallory and Boyce 2017; Martin, Jenkins et al. 2009). Climate change may have been a factor in a 56% decline in populations of migratory caribou and wild reindeer across the arctic over the last 2 decades (Russell, Gunn et al. 2019). A longer snow-free season can increase access to forage (Cebrian, Kielland et al. 2008; Tveraa, Stien et al. 2013), but increasing midsummer temperatures could result in more severe insect harassment (Weladji, Holand et al. 2003) and increase the incidence of parasites and the rate of annual decline in forage quality (Gustine, Barboza et al. 2017). If mosquitos emerge closer to calving, it could result in a higher rate of separation of calves, poorer body quality of maternal caribou, and higher calf mortality. Earlier river breakup could alter the timing or difficulty of caribou migrations (Leblond, St-Laurent et al. 2016; Sharma, Couturier et al. 2009).

During the winter, changes in precipitation could increase energetic demands for cratering through snow to access forage (Fancy and White 1985). Increasing frequency of rain-on-snow events could greatly decrease access to winter forage and change the winter distribution of the TCH (Albon, Irvine et al. 2017; Bieniek, Bhatt et al. 2018; Hansen, Aanes et al. 2011; Loe, Hansen et al. 2016), which could alter the use of the Project area during winter in unpredictable ways and increase mortality (Forbes, Kumpula et al. 2016). Changes in the timing of snowmelt and vegetation growth could mean that the timing of calving and the emergence of highly nutritious forage would no longer overlap (Post and Forchhammer 2008). Gustine, Barboza et al. (2017) found no evidence of a spring nourishment mismatch for caribou in Alaska but suggested that one may occur in fall with increased warming.

Over the longer term, changes in vegetation composition could lower forage quality (Fauchald, Park et al. 2017). Increased moose densities (Tape, Gustine et al. 2016) could increase predator densities and alter predator distributions. Increases in wildland fire could lead to lower lichen availability on the winter range (Joly, Chapin et al. 2010). Calving grounds tend to shift depending on the timing of snowmelt (Carroll, Parrett et al. 2005; Dau 2007; Griffith, Douglas et al. 2002); therefore, climate change could alter the location of calving grounds, and additional development could interact with climate change by limiting the availability of alternative calving areas as conditions change. Impacts on caribou body condition resulting from climate change may also make caribou more susceptible to potential impacts from developments.

Cumulative impacts on biological resources would contribute to impacts to subsistence, as described in Section 3.19.11.

3.19.10.5 Marine Mammals

As described in Section 3.13, existing infrastructure and activities (traffic, screeding, barging, drilling, processing, etc.) in the analysis area contribute human activity, noise, habitat alteration, and increase the potential for spills entering marine waters. Polar bears may also be impacted through attraction to human activities or facilities. Marine mammals would be cumulatively affected by other RFFAs in the analysis area, and the Project would contribute to those cumulative effects through an incremental increase in habitat loss and alteration for marine mammals and disturbance and displacement due to Project noise and human activity and mortality and injury associated with construction, vessel strikes, and human safety concerns. Placement of gravel fill would contribute an incremental loss and alteration of potential denning habitat of polar bears in the ACP.

The Project would add vessel traffic to the Beaufort Sea at a time when traffic is expected to continue to increase due to changing climate and reduced sea ice extents. Project vessel traffic in combination with increased shipping and vessel traffic could increase the likelihood of vessel strikes of marine mammals and increase the likelihood of accidental spills from the vessels. The revisions to the NPR-A IAP could also increase vessel traffic, and potential revisions by BOEM to its outer continental shelf leasing plans could result in additional offshore oil and gas development through issuance of offshore leases in areas of the Beaufort and Chukchi seas currently closed to leasing. These activities, in combination with the Project, could have cumulative impacts (vessel strikes, disturbance and displacement, and increased likelihood of spills) on marine mammals across the Beaufort Sea, including bowhead whales.

Warming global temperatures and associated reductions in the extent and duration of sea ice (Durner, Douglas et al. 2009) that are predicted to occur in the future may have implications for polar bears and their ice-dependent marine prey. The effects of continuing climate change pose challenges to the future well-being of marine mammals and may lead to population declines and range contraction for some ice-dependent marine species. However, the ability of federal agencies to influence the processes thought to be responsible for climate change (such as GHG emissions) is extremely limited at present, absent an effective worldwide response to the problem.

Recent shifts in distribution and habitat use by polar bears in the Beaufort and Chukchi seas are likely attributable to the loss of sea-ice habitat. The greatest declines in optimal polar bear habitat would occur in those areas, where reduced habitat will likely reduce polar bear populations (Durner, Douglas et al. 2009; Regehr, Laidre et al. 2016). Polar bears of the SBS stock experienced twice as many days of reduced sea ice from 2008 to 2011 than did those of the Chukchi Sea stock. Despite similar diets, SBS bears were smaller and in poorer condition, exhibited lower reproduction, and twice as many were fasting in spring (Rode, Regehr et al. 2014). Consuming terrestrial foods is judged to be insufficient to offset the loss of ice-based hunting. The lack of sea ice or the delayed formation of ice also forces bears to spend more time on land, where they have difficulty catching prey and spend longer periods fasting, increasing the chance of interactions with humans and increasing the risk of mortality of bears killed in defense of life or property (Amstrup 2000; Whiteman, Harlow et al. 2015). The Project could exacerbate the effects of climate change by adding development and the chance of human-bear interactions in terrestrial habitats that bears are increasingly forced to use.

As sea-ice cover diminishes with a warming climate, polar bears may spend more time on land and fast more, which would reduce access to prey and negatively affect energy levels, respectively (Molnár, Derocher et al. 2010). It may also mean a higher likelihood of bears encountering human infrastructure and activities on land. The impacts of onshore development would likely affect polar bears through a disturbance in terrestrial denning habitat, especially during construction, but those would be mitigated through the ITRs and Letters of Authorization issued by USFWS (which stipulate mitigation and minimization measures).

A warming climate could also contribute to cumulative effects on other marine mammals, particularly ringed and bearded seals, which are closely associated with sea ice. Warming global temperatures and the associated reductions in extent and duration of sea ice that are predicted to occur in the future may have substantial implications for these species.

Increased subsistence harvest due to increased onshore subsistence access could kill more polar bears or displace them to other habitats to avoid harvest. The combination of increased subsistence user access and bears forced to spend time on shore will likely lead to more harvest of bears.

3.19.11 Cumulative Impacts to the Social Environment (Land Use, Economics, and Public Health)

The effects of past and present actions on the social environment are presented in the Affected Environment section in Sections 3.14, 3.15, and 3.18. Since the 1970s, oil and gas development on the North Slope has substantially changed the social conditions, including economics, land use, and public health. The cumulative effects of past and present actions include the formation of the regional Native corporation, village corporations, and municipal incorporations; employment in the oil and gas industry, supporting sectors, and government; and the provision of health care services. These changes have, in turn, resulted in other changes that have both increased sociocultural stressors and provided improved health care.

RFFAs that would cumulatively affect land use include future oil and gas activities and infrastructure, with the potential land zoning designations, community expansion, and revisions to the NPR-A IAP. All action alternatives under consideration in the 2020 NPR-A IAP would increase the number and density of uses in the NPR-A. Increased development in the NPR-A may increase demand for public services and infrastructure for communities within the NSB. Expansion of community-based infrastructure may increase the demand for new residential, commercial, civic, and industrial land uses in these communities.

Due to increasing oil and gas activity in the NPR-A, many of the RFFAs would have sociocultural and economic effects that would occur throughout the analysis area, but effects could be more substantial in Nuiqsut due to the proximity to activities and subsistence use of the area.

Revisions to the NPR-A IAP as well as other RFFAs, like Nanushuk and BOEM's Outer Continental Shelf Leasing Program, could increase oil and gas activities on- and offshore of the ACP, which would increase oil production; increase TAPS throughput; increase economic activity at the local, regional, and state level due to direct industry spending on labor, materials, and services; increase government revenues from shared royalties, tax payments such as property taxes, corporate income taxes, severance taxes, and other local taxes; increase job opportunities for Alaskans, including residents of communities in the NSB; and increase labor income in regions where industry spending would occur and where the oil and gas workforce would reside. Most direct wages from new employment generated by RFFAs would go to nonresidents of the NSB, but some new wages would accrue in both the local and regional economy.

Increased gravel infrastructure expected from RFFAs in combination with Project gravel infrastructure and boat ramps would increase subsistence access for Nuiqsut residents and likely the subsistence harvest of fish, birds, terrestrial mammals, and marine mammals. This would add to the positive effects to community health of past and present and actions and RFFAs described above.

In addition, if oil and gas development continues westward into the core calving area for the TCH, or if it reduces access to key insect-relief habitats, and the herd experiences a decline in productivity and abundance, subsistence users of the herd (including those from Nuiqsut, Utqiaġvik, Anaktuvuk Pass, Atqasuk, and Wainwright) could be affected. This could have impacts on public health (HEC4: Food, Nutrition, and Subsistence Activities) across the North Slope since subsistence resources are often shared among communities. Such a scenario could occur if BLM selects Alternative D or E in the NPR-A IAP ROD. Alternative D and E would open areas surrounding Teshekpuk Lake to oil and gas leasing and infrastructure development. Under this scenario, any impacts related to the health and abundance of the TCH would likely extend to subsistence users of the herd.

The revisions to the NPR-A IAP could also increase vessel traffic and potential revisions by BOEM to its outer continental shelf leasing plans could result in additional offshore oil and gas development through the issuance of offshore leases in areas of the Beaufort and Chukchi seas currently closed to leasing. These activities, in combination with the Project, could have cumulative impacts on the availability of marine mammals for the North Slope communities of Nuiqsut, Utqiaġvik, Wainwright, and Point Lay. This could have impacts on public health (HEC4: Food, Nutrition, and Subsistence Activities) across the North Slope since subsistence resources are often shared among communities.

Climate change is raising concerns about food and water security, transportation safety, and increased stress affecting mental health of Nuiqsut residents (Brubaker, Bell et al. 2014). The Project would exacerbate those effects by adding more stress about food and water security.

The Project would contribute to the cumulative social impacts of past and present actions and RFFAs. The NPR-A Impact Grant Program (Table 3.19.1) is available to all North Slope communities to help support essential public services and facilities and to offset the direct, indirect, and cumulative effects of oil and gas development in the NPR-A.

3.19.12 Cumulative Impacts to Subsistence and Sociocultural Systems

The effects of past and present actions on subsistence and sociocultural systems are described in Section 3.16. Past and present actions have cumulatively impacted subsistence activities and sociocultural systems in the analysis area. As noted in Section 3.16 regarding the subsistence use areas for Nuiqsut:

> Impacts [of oil and gas development] include disruption of subsistence activities from increased air and ground traffic; decreased access to traditional use areas resulting from security restrictions and increased infrastructure (e.g., pipelines, roads, and pads); reduced availability of subsistence resources due to

disruption from oil and gas activity and infrastructure; avoidance of subsistence foods due to contamination concerns; and avoidance of traditional use areas due to discomfort about hunting around industrial development (SRB&A 2009, 2017b, 2018a). Throughout the 9 years of the Nuiqsut Caribou Subsistence Monitoring Project, between 27% (in Year 9) and 72% (in Year 1) of harvesters reported one or more impacts during individual study years. While impacts related to helicopter traffic have decreased in recent years, impacts related to human-made structures have increased slightly, likely related to increased road infrastructure in the area (SRB&A 2018a). In addition, between 33% and 46% of harvesters reported they avoid developed areas during individual study years (CPAI 2018b).

Changes in subsistence resource availability, harvester access, and the ability to participate in subsistence activities have also affected sociocultural systems, as Iñupiat social organization, cultural values, social ties, and community and individual well-being are inextricably linked with subsistence. Additional changes associated with modernization, the transition from a subsistence economy to a mixed subsistence-cash economy, formation of Native and village corporations and municipal governments, and increasing interaction with non-Iñupiat individuals have affected sociocultural systems in the study communities.

Since 2000, oil and gas development has expanded into highly used Nuiqsut subsistence use areas in the CRD (Alpine and Alpine Satellite developments CD1 through CD4) and toward Fish (Iqalliqpik) Creek (Alpine Satellite development CD5 and the GMT-1 and GMT-2 developments). Exploration continues to occur to the north, west, east, and south of the community, effectively surrounding Nuiqsut with industrial infrastructure and activity. As a result, the frequency of conflicts between subsistence and development activities has increased substantially since the late 1990s and early 2000s (SRB&A 2009, 2019). The Project, in addition to other RFFAs such as the Nanushuk development, would contribute to the cumulative effects of development on subsistence resources and activities because it would represent a net increase in the amount of land used for oil and gas and other development, in addition to a related increase in industrial activity, including air traffic. While development infrastructure has not been introduced to the south of Nuiqsut, leasing and exploration has occurred to the south of the community and may occur in the future. Nuiqsut residents have reported feeling surrounded by infrastructure (as one resident put it, living in a "human corral"), and the Project, when combined with the RFFAs, would contribute to these concerns by further surrounding the community with infrastructure (SRB&A 2018b) (see Section 3.16.1.4. *Existing Conditions*). Even with residents being allowed access to development-related roads and facilities, many view the increasing expansion of development infrastructure as a loss of traditional lands. Once considered part of the community's traditional subsistence use area (SRB&A 2018b), the areas surrounding Prudhoe Bay and Kuparuk are now considered off-limits to subsistence uses. As development has moved closer to Nuiqsut, recent data have shown decreased frequency of use and avoidance behaviors in certain areas such as the Nigliq Channel and Nanuq rather than total abandonment of these areas.

Future development near Native allotments, which were in many cases chosen for their favorable subsistence locations and traditional ties, could affect residents' use of and identification with these allotments, particularly if development affects the availability of resources in these areas. In addition to Nuiqsut's subsistence use areas, development of the Project would also introduce large-scale oil and gas development into the eastern periphery of Utqiaġvik's subsistence use area and, in combination with other RFFAs, may facilitate future developments farther west into the core subsistence use areas for Utqiaġvik and Atqasuk. Future development within traditional subsistence use areas resulting from this facilitated access may result in changes to subsistence land use patterns over time, resulting in decreased opportunities to pass on knowledge about culturally important places and activities. The growing presence of oil and gas infrastructure on the North Slope and the associated risks of oil spills and contamination could contribute to increased avoidance of subsistence foods due to concerns about contaminated food sources. Concerns about the impacts of development on subsistence foods have led to some residents avoiding certain subsistence foods because they believe they are contaminated. As the Project and RFFAs lead to the continued expansion of oil and gas development on the North Slope, concerns about contamination among subsistence harvesters and avoidance of certain subsistence foods will likely grow. Avoidance of subsistence foods could have sociocultural effects by reducing food security and reducing opportunities to engage in the distribution (sharing), processing, and consumption of subsistence foods.

Human activity, ground and air traffic, noise, and infrastructure have the potential to affect the availability of subsistence resources in the analysis area by disturbing or displacing subsistence resources or making them more difficult to harvest. The Project in combination with the RFFAs could affect the availability of caribou to Nuiqsut and Utqiaġvik subsistence users, although a majority of direct and indirect impacts to resource availability resulting from the Project would occur for Nuiqsut, as most Utqiaġvik caribou harvesting areas occur to the west of the Project. If the Project facilitates westward expansion of oil and gas development, then impacts to resource availability would increase for Utqiaġvik.

Access to subsistence harvest areas could be physically restricted during construction, particularly for Nuiqsut; however, new gravel roads and boat ramps associated with the Project and RFFAs would increase harvester access for those who choose to use roads. While data on Nuiqsut caribou hunting have shown the increased use of some areas due to road access, the use of roads varies by location. For example, few hunters report using the road system to the east of the Nigliq Channel, with some noting that they avoid the area due to the higher density of development infrastructure. In addition, the use of roads decreases with distance from the community although the reason for this decreased use is unclear and use of certain roads may increase over time. Thus, increased road infrastructure on the North Slope will likely have varying cumulative effects on subsistence use, with increased use and access in some areas and decreased use and hunter avoidance in others. In addition, some Nuiqsut hunters have reported using industry roads to offset the reduced availability of caribou closer to their community. Thus, roads may mitigate the impacts of development but may not provide a net benefit to communities in regard to subsistence. Regardless of physical access, the Project, combined with the RFFAs, may contribute to harvester avoidance of construction and operations areas on the North Slope due to discomfort hunting and shooting near industrial infrastructure, a lack of knowledge about security protocols, concerns about resource contamination, and an assumed lack of resource availability near infrastructure. During operations, harvester avoidance of the oil and gas development areas may be reduced from construction levels due to decreased noise and traffic disturbances, although avoidance responses would likely continue throughout the life of development projects for certain individuals.

The Project, when combined with the RFFAs, would increase social and economic effects on subsistence through subsistence/work conflicts (for residents who have jobs related to oil and gas development) and a shift in subsistence roles could affect social ties in the community.

Reasonably foreseeable future oil and gas activities (i.e., most of the RFFAs considered in the analysis, Table 3.19.1) would have similar impacts to subsistence as the Project and may occur within the analysis area. Non–oil and gas activities could also occur and would have lesser impacts than the Project. The Project's impacts on subsistence would be additive to the impacts of activities of past and present actions and RFFAs that have cumulatively affected the analysis area. The Project would increase those cumulative effects and would amplify effects to subsistence resource availability such that impacts to other North Slope communities such as Anaktuvuk Pass and Atqasuk would be more substantial.

Increased development infrastructure on the North Slope would continue to cause the alteration and degradation of habitats for key subsistence resources, including caribou, furbearers, fish, and goose. Over time, these changes could affect the health and abundance of different subsistence resources on the North Slope. If development continues westward into the core calving area for the TCH, or if it reduces access to key insect-relief habitats, then the herd could experience an overall decline in productivity and abundance. Such a scenario could occur if BLM selects Alternative D or E in the NPR-A IAP ROD. Alternative D and E would open areas surrounding Teshekpuk Lake to oil and gas leasing and infrastructure development. Under this scenario, impacts related to the health and abundance of the TCH would likely extend to subsistence users of the herd, including those from Nuiqsut, Utqiaġvik, Anaktuvuk Pass, Atqasuk, and Wainwright.

The revisions to the NPR-A IAP could also increase vessel traffic and potential revisions by BOEM to its outer continental shelf leasing plans could result in additional offshore oil and gas development through the issuance of offshore leases in areas of the Beaufort and Chukchi seas currently closed to leasing. These activities, in combination with the Project, could have cumulative impacts on the availability of marine mammals for the North Slope communities of Nuiqsut, Utqiaġvik, Point, Lay, and Wainwright. In particular, bowhead whales are a resource of high importance to the coastal communities of the North Slope, and residents could experience reduced harvest success if increased offshore activity causes deflections or behavioral changes in whales.

In addition to the additive effects of increasing oil and gas infrastructure in the region, increased activity, including oil and gas exploration and seismic activity, air traffic, vessel traffic, scientific research, recreation, and sport hunting and fishing activities, would also contribute to subsistence impacts on Nuiqsut and Utqiaġvik by increasing the frequency of noise and air traffic disturbances, vessel disturbances, and interactions with non-local researchers, workers, and recreationists. Increased noise disturbances would contribute to existing impacts on subsistence resource availability.

Climate change will continue to affect subsistence resources and users through changes in resource health and abundance, as well as changes in weather conditions, which may affect resource abundance, resource availability, and harvester access. Climate change could contribute to increased infrastructure and development activity in the region by affecting the predictability of weather conditions, including the timing of freeze-up and breakup; snow conditions; water depth in lakes and rivers; the frequency and nature of storms and winds; and ice conditions.

Changes in these conditions may affect the ability of residents to travel to and from subsistence harvesting locations safely or successfully. Changes in the timing of resource migrations could also affect harvesting success for certain species, and increased susceptibility of certain resources to disease could affect resource quality and abundance. Climate change could also increase the presence of contaminants in certain species, which would contribute to harvester concerns about impacts of contaminated subsistence foods on human health (AMAP 2017; Richter-Menge, Druckenmiller et al. 2019).

Table 3.19.4 summarizes cumulative effects to subsistence uses for Nuiqsut and Utqiaġvik from past and present actions and RFFAs.

Table 3.19.4. Comparison of Impacts to Subsistence Uses for Nuiqsut and Utqiaġvik

Effects To	Nuiqsut	Utqiaġvik
Resources (importance)	Caribou (major) Furbearers (minor)[a] Waterfowl (major) Fish (major) Seals (major)	Caribou (major) Furbearers (minor)[a]
Resource abundance	Possible impacts to TCH herd abundance resulting from displacement from core calving grounds.	Possible impacts to TCH herd abundance resulting from displacement from core calving grounds.
Resource availability	For all resources, a high likelihood of reduced resource availability resulting from increased impacts from infrastructure, noise, and traffic.	For all resources, a high likelihood of reduced resource availability resulting from increased impacts from infrastructure, noise, and traffic occurring within Utqiaġvik subsistence use areas.
Harvester access	A high likelihood of increased physical and legal barriers to access to traditional subsistence use areas.	Low to moderate likelihood of increased physical and legal barriers to access to traditional subsistence use areas.

Note: TCH (Teshekpuk Caribou Herd).
[a] Despite being characterized as a resource of minor importance based on selected measures, furbearer hunting and trapping is a specialized activity with unique importance to the study communities.

3.19.13 Cumulative Impacts to Environmental Justice

As described in Section 3.17, *Environmental Justice*, Nuiqsut is the minority population affected by the direct and indirect effects of the Project. The communities of Utqiaġvik, Anaktuvuk Pass, Atqasuk, Wainwright, and Point Lay are part of the cumulative effects analysis area due to the overlap of Project effects with potential RFFAs. These minority and low-income populations are described in detail in the NPR-A IAP DEIS (BLM 2019c), page 3-270 and Appendix V.

The area around Nuiqsut has experienced a substantial increase in oil and gas exploration and development over the past few decades. Past developments have had competing effects on the community. These effects include increased wages, a higher standard of living, and improved access to health care. Increased revenue from development for the NSB and ASRC has also beneficially impacted Nuiqsut residents through health and social programs funded by these organizations, more job opportunities associated with programs run by these organizations, and increased dividends for ASRC shareholders.

However, these changes have also given rise to several adverse social and public issues. The adverse effects of past and current development activities include changes in subsistence resource availability, increased concerns about the potential for health impacts from North Slope development (particularly air emissions and the potential for spills and contamination), and increased income disparities in Nuiqsut between ANCSA corporation shareholders and non-shareholders. It is expected these effects would continue to grow as development increases in the area.

Impacts to Nuiqsut's subsistence resources and use areas from RFFAs would be additive to impacts from past and present actions as well as the Project. Gravel roads expected from RFFAs and the Project, as well as Project boat ramps, would increase subsistence access for Nuiqsut residents and likely increase the subsistence harvest of fish, birds, terrestrial mammals, and marine mammals. This would add to the positive effects of the past and present actions and RFFAs described above.

If oil and gas development continues westward into the core calving area for the TCH, or if it reduces access to key insect-relief habitats and the herd experiences a decline in productivity and abundance, subsistence users of the herd (including those from Nuiqsut, Utqiaġvik, Anaktuvuk Pass, Atqasuk, and Wainwright) could be affected. This could have impacts on public health across the North Slope since subsistence resources are often shared among communities. Such a scenario could occur if BLM selects Alternative D or E in the NPR-A IAP ROD. Alternative D and E would open areas surrounding Teshekpuk Lake to oil and gas leasing and infrastructure development. Under this scenario, impacts related to the health and abundance of the TCH would likely extend to subsistence users of the herd.

The revisions to the NPR-A IAP could also increase vessel traffic and potential revisions by BOEM to its outer continental shelf leasing plans could result in additional offshore oil and gas development through issuance of offshore leases in areas of the Beaufort and Chukchi seas currently closed to leasing. These activities, in combination with the Project, could have cumulative impacts on the availability of marine mammals for the North Slope communities of Nuiqsut, Utqiaġvik, Wainwright, and Point Lay. In particular, bowhead whales are a resource of high importance to the coastal communities of the North Slope, and residents could experience reduced harvest success if increased offshore activity causes deflections or behavioral changes in whales.

Climate change is also affecting Nuiqsut residents and is likely to affect the community more in the future. As temperatures increase, snow and ice cover would decrease and vegetation and habitats may change. These changes can affect human health and safety by making travel conditions more unpredictable or by affecting habitat availability, quality, and suitability for Nuiqsut subsistence resources, in particular caribou. These changes would likely create additional stress to Nuiqsut residents with the current, proposed, and reasonably foreseeable development in their subsistence use areas. Climate change effects to the North Slope are, however, experienced by all NSB residents and are not expected to be generally disproportionate for Nuiqsut residents.

The cumulative effects on subsistence, sociocultural systems, and public health may be highly adverse and would be disproportionately borne by populations from Nuiqsut, Utqiaġvik, Anaktuvuk Pass, Atqasuk, Point Lay, and Wainwright. These effects would be long term and of high intensity. As discussed in Section 3.17.1, *Affected Environment*, these communities are also particularly vulnerable to the effects of climate change. This is because they have fewer financial resources to cope with these effects and because of their economic, nutritional, and cultural dependence on subsistence food resources.

4.0 SPILL RISK ASSESSMENT

This chapter provides a qualitative assessment of potential spills and addresses the types of spills that may occur and their likely occurrence, potential size (volume), duration, and geographic extent based on historical data and the Project's design features. These would vary by Project phase and are discussed by phase in the results. Appendix H (*Spill Summary, Prevention, and Response Planning*) describes preventive measures and response planning activities CPAI would implement to minimize potential damage to human health and the environment from oil spills or other accidental releases.

The history of oil spills on the North Slope (e.g., location, type, volume) has been evaluated and analyzed in several recent technical studies and EISs, including those by BLM (1998, 2004a, 2012b, 2014), USACE (2012, 2018), BOEM (2013), and ADEC (2010, 2013). The ADEC Statewide Oil and Hazardous Substance Spills Database (2019c) reported more recent data: seven crude oil spills ranging in volume from less than a gallon up to 50 gallons, and seven process water spills ranging in volume from 200 to 1,263 gallons have occurred since the publication of USACE (2018). None of these spills are unique or change the results or conclusions presented in this analysis.

The Spill Risk Assessment (SRA) uses the historical data and analysis of oil spills on the North Slope (including the NPR-A) to qualitatively evaluate the Project's potential for oil spills. Although Chapter 2.0 presents a range of alternatives for the Project, the number of wells and pipelines, their locations, and overall planned production rates (i.e., volumes) are similar for all action alternatives; consequently, the results of this SRA would be the same for all action alternatives. Potential impacts from spills on specific resources are discussed in Chapter 3.0, *Affected Environment and Environmental Consequences*.

As part of the permitting process with the state, CPAI would be required to provide more detail regarding potential spills, design features and measures to prevent spills, and its spill response and planning measures as part of the Project's ODPCP.

4.1 Spill Risk Assessment Approach

4.1.1 Types of Spills

The types of spills identified in the SRA considered the types of activities that would occur by Project phase and the machinery and fuels associated with them. During construction, potential spill locations could include marine waterways, ice and gravel infrastructure, and the Tiŋmiaqsiuġvik mine site. During drilling and operations, potential spill locations could include gravel pads as well as tundra and waterbodies adjacent to or crossed by pipelines. The type of fluids evaluated in this SRA include produced fluids taken directly from the well and composed primarily of crude oil, water, natural gas, gas condensates (if present), and formation sand; processed sales-quality crude oil; refined products such as diesel and gasoline; produced water; and seawater. Section 4.4, *Hazardous Materials*, addresses the potential occurrence of hazardous material spills.

4.1.2 Spill Likelihood and Size

The likelihood or the expected relative rate of spill occurrence during all phases of the Project is described in six categories: very high, high, medium, low, very low, and would not occur. Spill size categories and their associated volumes are provided in Table 4.1.1.

Table 4.1.1. Spill Size Categories and Spill Volume Ranges

Spill Size Category	Spill Volume (gallons)	Spill Volume (barrels)
Very small	< 10	< 0.24
Small	10 to 99.9	0.24 to 2.4
Medium	100 to 999.9	2.4 to 24
Medium-large	1,000 to 9,999.9	24 to 240
Large	10,000 to 100,000	240 to 2,400
Very large	Over 100,000	Over 2,400

Note: < (less than).

These values adequately define the range of historical spill volumes and are similar to the values used in past assessments and studies of oil spill risk for this region. The above spill size classifications are similar to those used by ADEC when it responds to and evaluates oil spills and are consistent with those used in its 2013 North Slope spill analysis (ADEC 2013).

4.1.3 Duration

Durations noted in the risk assessment describe the duration of the potential release; the duration of the spill response or potential impacts of the release on resources could be much longer.

4.1.4 Geographic Extent

The geographic extent of potential spills considers the spill's location, size, and estimated duration and assumes spill response actions would be consistent with the requirements outlined in CPAI's spill response plans that would be developed and approved for the Project. The analysis assumed typical environmental conditions during a spill event; if a spill occurred during atypical environmental conditions (e.g., periods of high flows or flooding), the geographic extent could be much larger.

4.2 Potential Spills during Construction

Most spills to the marine environment would be expected to be very small to small, limited to refined products (e.g., diesel, lubricating oil), localized to the immediate area of the sealift module transfer location, and short in duration (less than 4 hours). The expected spill occurrence rates for these spill types would be low to very low and the spills would be expected to occur during construction of the module delivery site itself or originate from smaller watercraft (e.g., tugboats that handle the module delivery barges, support vessels). It would be possible, although of very low likelihood, that a medium to very large spill could occur along existing marine waterways leading to the sealift module transfer site. This would only occur if a tugboat or barge transporting modules runs aground, sinks, or its containment compartment(s) were breached and the contents released (USACE 2012). The duration of these spill types would vary from about a day to up to several days, depending on the spill's location and the proximity of the shore-based response. Similarly, the geographic extent of these spills would vary and may or may not reach land, depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Since the duration and frequency of marine vessel use for the Project would be limited, the likelihood of a spill of this nature would be very low.

Spills occurring on ice and gravel roads could result from construction vehicles capable of hauling gravel, bulk fuels, equipment, and other supplies. The likelihood of occurrence for very small to small spills of fuel or refined products is medium to low, and spills could occur in the event of vehicle accidents. Spills of this nature would happen at the time of the accident, last less than an hour, and be limited to the road or to tundra immediately adjacent to the road. It is expected that these spills would be quickly contained in the immediate area of the spill and would not move far from the accident site to tundra or other sensitive habitats. The likelihood of occurrence for medium to medium-large spills of diesel or other refined product is very low, but spills could occur if a large truck accident resulted in the breaching of its fuel tanks. Spills of this nature would also occur at the time of the accident, last less than an hour, and be limited to the road and area immediately adjacent to the road. It is possible this type of spill could reach small areas of tundra or waterbodies immediately adjacent to roads.

The volume of potential spills from a large bulk-fuel tanker truck accident could range from very small to large. A large spill could occur if the entire capacity of the truck's bulk-fuel tank emptied. Spills of this nature would be expected to be of short duration (less than 0.5 day). The likelihood of an event of this nature occurring is considered medium for very small to small spills, low for medium-sized spills, and low to very low for medium-large and large spills because large tanker trucks consist of multiple smaller, segregated tanks, and it is very unlikely that all tanks would be ruptured in a single accident. In the event of a large spill, the geographic extent would likely include roads and adjacent roadside habitats and possibly waterbodies. The geographic extent of a spill of this size would vary, depending on the season; however, the spill would be localized and likely affect an area up to 0.5 acre in size. Very large spills would not be expected to occur from bulk-fuel tanker truck accidents.

Spills occurring on ice or gravel pads could occur at vehicle and equipment storage areas, equipment maintenance and repair facilities, designated refueling areas, and at temporary AST locations. These spills could involve a variety of refined products such as diesel, gasoline, hydraulic fluid, lubricating oil, grease, waste oil, mineral oil, and other products. Spills could occur on gravel pads, inside buildings, or inside secondary containment areas. The likelihood of very small to small spills occurring is very high to high; the likelihood of medium to large spills is medium to high. On-pad spills of all sizes would be of short duration (less than 0.5 day) and would remain on the pad or within secondary containment; damage to areas adjacent to pads would not be anticipated. Very large spills of refined products along ice or gravel pads would not be expected to occur during construction. Consistent with BLM BMP A-5 (BLM 2013a), refueling of equipment within 500 feet of a waterway's active floodplain would be prohibited.

The drilling mud used for the construction of the Colville River HDD crossings (Appendix D.1, *Alternatives Development*, Section 4.2.2.3, *Other Pipelines*) would largely consist of a combination of freshwater and bentonite, a naturally occurring clay. Polymers may be added to the bentonite to increase drilling fluid yield; specific polymers, if needed have not yet been selected. For historical context, the Alpine development's HDD crossing used polyacrylamide, a product commonly used in water and sewage treatment, as well as consumer products such as cosmetics, lotions, and sunscreens. Nontoxic tracer dye may be included to help monitor for inadvertent returns. As with polymers, specific tracer dye(s) have not been selected. The Alpine HDD used Rhodamine WT fluorescent dye, a product certified by the National Sanitation Foundation and proven safe to humans and aquatic life. Drilling waste from the Colville River HDD would be Resource Conservation and Recovery Act nonhazardous at the point of injection into a UIC Class I disposal well. In addition, drilling mud used for the HDD crossing would be limited to materials approved by the EPA as being nonhazardous waste.

Module delivery Option 3 (Colville River Crossing) would use a partially grounded ice bridge to facilitate module movement across the Colville River. Potential oil or hazardous materials associated with construction and use of the ice bridge would include diesel fuel and lubricating oils, hydraulic fluid, and glycols (antifreeze). The likelihood of accidental spills occurring on the bridge or approach ramps is considered very low. Potential spills would be small to very small (less than 100 gallons), would be observed quickly, contained in the immediate vicinity of the spill, and responded to quickly in accordance with CPAI's approved ODPCP. Potential spills associated with the construction and use of the ice bridge would not be expected to affect the adjacent tundra or the Colville River and its resources on either side of the bridge.

4.3 Potential Spills during Drilling and Operations

Spills could occur as a result of blowouts during well drilling activities. A blowout (the uncontrolled release of produced fluids or natural gas or both) after pressure control systems have failed can occur when shallow, high-pressure gas deposits are unexpectedly encountered beneath the surface and above the target oil reservoir depth (**shallow-gas blowout**) or when target oil reservoir pressures are much higher than anticipated and planned for (reservoir blowout or **well blowout**).

Only seven shallow-gas blowouts have occurred on the North Slope since 1974. Although it is conceivable that a shallow-gas blowout could occur during drilling, the expected relative rate of occurrence of such an event would be very low. In the event one did occur, it would likely have a duration of 1 to 2 days and affect approximately 20 to 25 acres of tundra adjacent to the well pad (USACE 2018). Spilled material would include drilling fluids (i.e., mud) but not crude oil.

There have been no reservoir blowouts on the North Slope since drilling began in the late 1960s (approximately 7,000 wells). The expected rate of occurrence for a reservoir blowout to occur as part of the Project would be very low (approaching zero). For response planning purposes, CPAI calculated the potential discharge from a reservoir blowout from any drill pad during drilling (in accordance with 18 AAC 75.434(e)) that resulted in a spill volume of 15,000 barrels per day for 15 days (225,000 barrels [9.5 MG] total release) (CPAI 2019c). The modeling results suggest that up to 10% of the discharged oil would remain airborne as an aerosol and 90% would be expected to reach the ground surface downwind of the well based on typical prevailing wind patterns at the time of the spill. Figures 4.3.1 through 4.3.5 illustrate the modeled reservoir blowout scenario at drill sites BT1 through BT5 under winter and summer conditions. Table 4.3.1 summarizes the approximate extent and volume of oil to reach the ground surface in the event of a reservoir blowout.

Table 4.3.1. Approximate Distance and Width of Oil Fallout from a Reservoir Blowout, Based on Percentage Discharged

Spill Volume in Barrels (percentage of total spill volume)	Distance from Wellhead (feet)	Width of Fallout (feet)
22,500 (10)	213	52
45,000 (20)	223	56
67,500 (30)	282	62
90,000 (40)	361	75
112,500 (50)	492	92
135,000 (60)	623	121
157,000 (70)	1,115	197
180,000 (80)	3,117	574
202,500 (90)	22,310	2,953

Source: CPAI 2019
Note: Spill volume based on a total reservoir blowout of 225,000 barrels.

The radii in Figures 4.3.1 through 4.3.5 demonstrate the 70%, 80%, and 90% extent limits for oil fallout (i.e., oil that would reach the ground) in this scenario; the oil plume trajectories represent prevailing wind conditions and indicate the most likely areas to be impacted in the event of a reservoir blowout. Approximately 10% of the discharged oil would be in aerosol in droplets so small (50 micrometers or less) that they would not reach the ground. If a reservoir blowout were to occur, there is potential for oil to reach nearby freshwater lakes and stream channels; however, a reservoir blowout is unlikely to reach Harrison Bay due to its distance from the drill sites and the sinuous nature of area streams. BT4 is approximately 17.5 RMs from Harrison Bay (via the Kalikpik River) and the other drill sites are at least 50 RMs or more from Harrison Bay (via the Fish [Iqalliqpik] Creek basin). Because the streams are all highly sinuous, flow would be slower than less-sinuous streams, and there would be more shoreline on which the oil could strand and potentially be recovered.

Spills on gravel pads directly associated with petroleum development infrastructure could originate from wellheads (leaks from the wellhead or the well casing during normal operations), facility and process piping, or from ASTs. Based on historical spills data, the expected rate of occurrence of wellhead spills would be very low to low; they would range in size from very small to large, typically last from a few hours to a few days, and be contained within the immediate vicinity of the well itself and not be expected to reach areas beyond the gravel pad.

Facility piping includes pipelines that run from individual wells to pipeline manifolds that then connect to produced fluids pipelines (i.e., infield flowlines) and on-pad piping that connects ASTs to on-pad equipment (e.g., drilling rigs, generators). Process piping includes pipes inside pipeline manifold buildings and crude oil processing modules. Based on historical North Slope spills data, the expected occurrence rate for these spills would range from very high for very small spills to very low for very large spills. The expected duration of these spills could range from very short (less than 4 hours) for very small spills to a few days for large spills; these spills would be expected to be contained inside buildings or on gravel pads.

Based on ADEC data (ADEC 2010, 2013), ASTs associated with petroleum development infrastructure have the second lowest frequency of loss of integrity spills: only 10 spill cases were recorded from July 1995 through 2011, an average of about 0.6 spills per year. There is no indication that any of these spills escaped secondary containment. For this reason, the expected frequency of spill occurrences from ASTs from the Project is expected to be very low to low. Spill volumes from ASTs would be dependent on the size and location of the leak (on the tank) and the overall capacity of the tank itself. Leaks from a large AST would likely be noticed within a day of the leak forming, but securing the leak could take a few days, depending on the leak's location on the tank. Spilled material from an AST would be captured within secondary containment. In the unlikely event that a spill escaped secondary containment, it is expected the spill would be limited to the gravel pad where the tank is located.

Pipeline spills could occur along infield pipelines that transport produced fluids (composed of oil, water, and natural gas, with a general split of 70% oil and 30% water/gas mixture) from drill pads to processing facilities. Leaks from produced fluids pipelines could result in spill sizes ranging from very small spills to medium-large spills. The expected duration of these types of spills could be very short (less than 4 hours) or continue for a period of days to weeks, depending on the type and location of the leak. The expected occurrence rate of these spills would be very low to low (BOEM 2013). Very small spills would be expected to be contained within a small area in the immediate vicinity of the spill; however, large spills that go undetected for a period of time could affect an area a few acres in size before the spill is contained. Estimated discharges from guillotine ruptures of produced fluids pipelines for all crossings of Willow Creek 8, Judy (Kayyaaq) Creek, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek are shown in Table 4.3.2 (also Figures 2.4.1 through 2.4.3 in Chapter 2.0). There have been no documented cases of guillotine failures occurring on the North Slope, mainly because the conditions most likely to cause this type of failure are not present in the region (e.g., active geological faults, landslide-prone topography). The spill's location and time of year would also influence the spill area extent, with larger spill volumes potentially affecting creek and creek shoreline habitat several miles downstream from the leak source. A spill from a pipeline crossing streams in the Project area could reach the channels of Fish (Uvlutuuq) Creek or the Kalikpik River, particularly during periods of flooding. The relatively low flow and highly sinuous nature of streams in the area may preclude a spill into one of these rivers from reaching Harrison Bay.

Table 4.3.2. Produced Fluids Pipeline Estimated Spill Volume at Select Waterway Crossings

Pipeline Section	Section Length (feet)	Total Spilled Volume (gallons)	Volume of Oil Spilled (gallons) (70% of total)[a]	Volume of Oil Spilled (barrels) (70% of total)[a]
Willow Creek 8[b]	34,320	329,299	230,509	5,488
Fish (Uvlutuuq) Creek[c]	2,514	27,934	19,554	466
Judy (Kayyaaq) Creek[b]	75	8,062	5,643	134
Judy (Iqalliqpik) Creek[c]	4,413	108,347	75,843	1,806

Source: CPAI 2019, 2020
Note: Volume spilled is based on crude oil pipeline discharge calculations presented in 18 AAC 75.436 and 49 CFR 194.105(b)(1), where the discharge volume equals the capacity of the pipeline section plus the potential volume of oil discharged during time to detect and time to shutdown (5 minutes to detect and 1 minute to shutdown were used in this table), multiplied by the flow rate based on 21,000 barrels per day from each drill pad.
[a] Produced fluids are composed of oil, water, and natural gas, with a general mixture ratio of 70% oil and 30% water/gas.
[b] The capacity of the pipeline at a stream crossing is based on the hydraulic characteristics of the pipeline due to the terrain profile change at a bridge (i.e., elevation rise), which would limit spill volume to that contained in the section of pipeline along bridges.
[c] The capacity of the pipeline at the stream crossing is based on the volume of the section of pipeline between automated valves.

The Willow Pipeline (export) would transport sales-quality crude oil from the WPF to Kuparuk CPF2. Leaks that could occur along the export pipeline would be expected to result in spills ranging in size from very small to very large. The duration of these types of spills could be very short (less than 1 hour) or continue for a period of days to weeks depending on the size and location of the leak along the pipeline corridor. The expected rate of occurrence of spills from the Willow Pipeline would be very low. Very small spills would be expected to affect a small area in the immediate vicinity of the spill; however, larger spills that go undetected for an extended period could affect an area several acres in size before the leak is stopped. The overall area affected by spills would also be influenced by the location and time of year the spill occurred. Table 4.3.3 provides a summary of potential Willow export pipeline spill volumes by select pipeline segments.

Table 4.3.3. Willow Export Pipeline Estimated Spill Volumes for Select Pipeline Segments

Willow Export Pipeline Segment	Section Length (feet)	Total Spilled Volume (gallons)	Total Spilled Volume (barrels)
Tiŋmiaqsiuġvik River crossing[a]	3,285	231,168	5,504
Nigliq Channel crossing[a]	19,453	376,992	8,976
Longest valve-to-valve segment	157,976	1,626,702	38,731

Source: CPAI 2019, 2020
Note: Volume spilled is based on sales oil pipeline discharge calculations presented in 18 AAC 75.430(c) and 18 AAC 75.436, where the discharge volume equals the capacity of the pipeline section plus the potential volume of oil discharged during time to detect and time to shutdown (30 minutes to detect and 15 minute to shutdown were used in this table).
[a] The capacity of the pipeline at the stream crossing is based on the volume of the section of pipeline between automated valves.

Leaks that could occur along the diesel pipeline would be expected to result in spills ranging in size from very small to medium; medium-large to very large spills would not be expected to occur along the diesel pipeline. The duration of these types of spills could be very short (less than 1 hour) or continue for a period of days to weeks, depending on the size and location of the leak along the pipeline corridor. The expected rate of occurrence of spills from the diesel pipeline would be very low. Very small spills would be expected to affect a small area in the immediate vicinity of the spill; however, larger spills that go undetected for an extended period could affect an area of several acres before the leak is stopped. The area affected by spills would also be influenced by the location and time of year the spill occurred. An estimated 2 barrels (84 gallons) of diesel could be spilled in a guillotine rupture of the diesel pipeline where it crosses Judy (Kayyaaq) Creek (Alternative C; Figure 2.4.2).

The diesel and seawater pipelines would also cross the Colville River using HDD (Appendix D.1, *Alternatives Development*, Section 4.2.2.3, *Other Pipelines*). The pipelines and casing pipes would meet leak detection standards stipulated in 18 AAC 75.047 and 18 AAC 75.055. The pipeline would transition from aboveground to underground approximately 300 feet from the banks of the Colville River at elevated gravel pads that would further protect them against ice and high-water events during spring breakup. The proposed HDD crossing would be similar in design and size to the existing Alpine HDD crossing. There have been no reported spills from pipelines that cross rivers via HDD technology (ADEC 2020). Because the HDD crossing would include built-in secondary containment (i.e., outer casing) and extensive leak detection technology, the potential for a spill or release from the Project HDD crossing of the Colville River is very low.

Estimated discharges from potential guillotine ruptures of produced water injection pipelines for all crossings of Willow Creek 8, Judy (Kayyaaq) Creek, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek (Figures 2.4.1 through 2.4.3) are shown in Table 4.3.4. Produced water is composed of water and residual crude oil, the ratio of which varies over the life of the field; for planning purposes, a ratio of 5% oil and 95% water is used. The location and time of year of the spill would also influence the spill area extent, with larger spill volumes potentially affecting creek and creek shoreline habitat several miles downstream of the leak. The effects of produced water spills on tundra or waterbodies are addressed in appropriate resource sections in Chapter 3.0.

Table 4.3.4. Produced Water Injection Pipeline Estimated Spill Volumes at Select Waterway Crossings

Pipeline Section	Section Length (feet)	Total Spilled Volume (gallons)	Volume of Oil Spilled (gallons) (5% of total)[a]	Volume of Oil Spilled (barrels) (5% of total)[a]
Willow Creek 8	35,376	127,512	6,376	152
Fish (Uvlutuuq) Creek	1,100	9,705	485	12
Judy (Kayyaaq) Creek	75	8,437	422	10
Judy (Iqalliqpik) Creek	420	15,083	754	18

Source: CPAI 2019, 2020

Note: Volume spilled is based on crude oil pipeline discharge calculations presented in 18 AAC 75.436 and 49 CFR 194.105(b)(1), where the discharge volume equals the capacity of the pipeline section plus the potential volume of oil discharged during time to detect and time to shutdown (5 minutes to detect and 1 minute to shutdown were used in this table), multiplied by the flow rate based on 23,000 barrels per day from each drill pad. Automated valves are not planned on produced water injection pipelines. The capacity of the pipeline at a stream crossing is based on the hydraulic characteristics of the pipeline due to the terrain profile change at a bridge (i.e., elevation rise), which would limit spill volume to that contained in the section of pipeline along bridges. Where crossings may not be bridges (Willow Creek 8), hydraulic characteristics are considered zero.

[a] Produced water is composed of water and residual crude oil and has a variable ratio of oil to water over the life of the field; for planning purposes, a ratio of 5% oil and 95% water is used.

Pinhole leaks could occur in seawater lines and would be expected to result in spills ranging in size from very small to large depending on the time it would take to detect the spill and secure the leak. Leaks could occur on gravel pads or tundra and waterbodies between pads or both. The effects of seawater spills on tundra or waterbodies are addressed in the appropriate resource sections in Chapter 3.0.

During drilling and operations, spills that are not specifically associated with petroleum development infrastructure (as discussed above) could also occur. These spills include those associated with warehouse and storage facilities, equipment maintenance and repair activities, and vehicle and equipment refueling activities. These spills would involve a variety of refined products such as diesel, gasoline, hydraulic fluid, lubricating oil, grease, waste oil, mineral oil, and other products. Spills would occur on gravel pads, inside buildings, or inside secondary containment areas. The likelihood of very small to medium spills is high to very high. On-pad spills of this nature would be detected and responded to quickly, be of short duration (less than 0.5 day) and would remain on the pad or within secondary containment; damage to areas adjacent to pads would not be anticipated.

Spills along roadways associated with accidents involving vehicles transporting personnel, equipment, and supplies could also occur during drilling and operations. It is expected that spill events associated with vehicle accidents would be similar to those previously described and discussed in Section 4.2, *Potential Spills during Construction.* Consistent with BLM BMP A-5 (BLM 2013a), refueling of equipment within 500 feet of the waterway's active floodplain would be prohibited.

4.4 Hazardous Materials

In addition to the potential for spills of oil, associated produced water, or seawater to occur, a number of hazardous materials would also be used by the Project under all action alternatives. These include, but are not limited to, the use of biocides (used in the seawater pipeline system in order to kill microorganisms which cause internal corrosion in the pipeline network), corrosion inhibitors, methanol, antifreeze, other glycols, acids, lubrication oils, used oil, and hydraulic fluids. These materials would be predominately used during drilling and operations and are typically stored inside buildings or in ASTs with necessary secondary containment, both of which are located on gravel pads.

Using the ADEC Statewide Oil and Hazardous Substance Spills Database, USACE (2012) identified a total of 9,106 spills that occurred on the North Slope between 1995 and 2009. The spills of commonly used hazardous materials for typical oil drilling and production activities are summarized in Table 4.4.1. Additional data was made available by ADEC (2019b) to cover the 2010 through June 2019 time period and is summarized in Table 4.4.2. A total of 10,086 spills were recorded in the 2 databases.

Table 4.4.1. Summary of Selected Hazardous Material Spills on the North Slope, 1995–2009

Hazardous Material	Number of Spill Records	Average Number of Spills per Year	Largest Spill (gallons)	Total Volume Spilled (gallons)	Average Volume Spilled (gallons)	Percentage of All Spill Records[a]
Hydraulic oil	1,727	115.1	660	23,353	13.5	19.2
Methanol	532	35.5	12,811	57,682	108.4	5.9
Corrosion inhibitors	520	34.7	500	6,999	13.4	5.8
Engine lube oils	519	34.6	650	8,590	16.6	5.8
Antifreeze (ethylene glycol)	443	29.5	5,700	29,182	65.9	4.9
Other glycols	245	16.3	4,074	18,582	75.8	2.7
Acids	148	9.8	211	7,848	53.0	1.6
Used oil	38	2.5	2,020	4,755	125.1	0.4

Source: USACE 2012.
Note: USACE (2012) uses data from the Alaska Department of Environmental Conservation Statewide Oil and Hazardous Substance Spills Database.
[a] Percentage of 9,106 total spill records.

Table 4.4.2. Summary of Selected Hazardous Material Spills on the North Slope, 2010–2019

Hazardous Material	Number of Spill Records	Average Number of Spills per Year	Largest Spill (gallons)	Total Volume Spilled (gallons)	Average Volume Spilled (gallons)	Percentage of All Spill Records[a]
Hydraulic oil	1	0.1	0.4	0.4	0.4	0.1
Methanol	169	16.9	500	10,648	63.0	17.2
Corrosion inhibitors	234	23.4	400	2,882	12.3	23.9
Engine lube oils	1	0.1	0.1	0.1	0.1	0.1
Antifreeze (ethylene glycol)	107	10.7	1,600	6,894	64.4	10.9
Other glycols	120	12.0	1,540	15,956	133.0	12.2
Acids	52	5.2	44	109	2.1	5.3

Source: ADEC 2019b
Note: Used oil was not a category of spill in the data provided by the Alaska Department of Environmental Conservation (ADEC).
[a] Percentage of 980 total spill records.

As shown in Table 4.4.1, average volumes for hazardous materials spills range from small to medium; although some spills were medium-large to large. Based on this historical data, the likelihood of a hazardous material spill occurring over the Project's lifetime is very high.

Once the boat ramps are constructed, skiffs could contribute contaminants (e.g., fuels, lubricants) to the waterways. These releases would likely be very small (less than 10 gallons) and could occur along the navigable reaches of the river(s) accessed from the boat ramps. These small releases would be short in duration and would quickly dissipate in the moving waterbodies.

There would be the potential for Willow crude to contain PAHs. PAHs can also be generated through combustion of organic fuels. Combustion fuel for the Project would primarily consist of processed natural gas and ULSD. PAHs are not generally found in natural gas, and they are not expected in the Willow fuel gas due to their high molecular weight and their tendency to remain with crude oil in the liquid phase during separation at the WCF. Commercially available ULSD may contain PAHs. The Project would follow all regulatory requirements and BMPs as well as CPAI best practices regarding minimization of leaks and spills during fuel transfer, including 110% secondary containment for tanks and the use of duck ponds and "diapers" on vehicles.

The duration of potential hazardous materials spills is expected to be short (typically less than 4 hours), and identified and responded to quickly, as consistent with required spill plans (SPCC Plan, ODPCP, and Facility Response Plan). It is expected that hazardous materials spills would be localized and contained within required secondary containment or contained in the immediate area of the spill on the gravel pad. Hazardous materials spills are not expected to extend beyond gravel or ice infrastructure.

CPAI assumes a non-hazardous water-based mud system would be used for production and injection wells in the surface and intermediate hole sections. In the lateral hole sections, approximately half of the wells would use a water-based mud system with the remainder using a mineral oil-based mud system. Both mud systems for lateral holes would be nonhazardous. The mineral oil-based mud intended for select lateral sections is needed due to the extended nature of the wells.

4.5 Summary

Any North Slope oil and gas development, including the Project, would likely incur spills despite continued improvements in engineering design; a greater emphasis on clean and safe operations; adherence to the use of

BMPs; continued improvements in, and awareness of, spill prevention; and improvements in spill response capabilities. Very small to large spills of refined oils could occur during construction; however, these accidental releases would occur on gravel or ice infrastructure, or into secondary containment structures. These types of spills occurring on gravel or ice infrastructure would be expected to have very limited to no impact to tundra or waterbodies adjacent to these facilities.

Spills along roadways would be limited to the road or tundra immediately adjacent to the road. It is expected that these spills would be quickly contained in the immediate area of the spill and would not move far from the accident site. If a spill occurred from a large bulk-fuel tanker truck accident and the tanker volume was released, the geographic extent would likely include the road and the area adjacent to the road, including waterbodies. The geographic extent of a spill of this size would vary, depending on the location of the accident and the season in which it occurred; however, the spill would be localized and most likely affect an area up to 0.5 acre in size.

Very small to small spills of refined products to the marine environment could during construction of the MTI or originate from smaller watercraft (e.g., tugboats, support vessels, etc.). It would be possible, although of very low likelihood, that a medium to very large spill could occur along the barge or support vessel route in marine waters leading to the MTI site.

During drilling and operations, very small to medium spills may occur. Accidental releases could also occur from leaking wellheads, facility piping, or process piping. Spills of this type would be expected to be contained to and cleaned up on gravel pads and would not be expected to result in damage to adjacent tundra or waterbodies. Spills that originate along produced fluids pipelines or the export/import pipelines (e.g., sales-quality crude oil, seawater, diesel) would be expected to be detected and responded to quickly and would have a limited geographic extent. In the very unlikely event of a large or very large pipeline spill occurring at creek crossings or during periods of high flow, the extent of the accidental release could be much larger. Table H.1.1 in Appendix H provides a summary of spill types, volumes, likelihood, duration, and estimated geographic extent for the action alternatives. Appendix H also describes numerous oil spill prevention and response planning measures that CPAI would implement. The results of this SRA (including Appendix H) suggest that the Project would not present a uniquely or an unusually high likelihood of a large or very large spill event occurring from petroleum development infrastructure. It would have similar likelihood of spills as other petroleum development infrastructure on the North Slope.

4.5.1 Comparison of Action Alternatives

All action alternatives would have similar likelihood of a spill occurring, and similar pipeline routes and waterbody crossings. Although the number and location of drill sites; the number of wells; and the hydrocarbon pipeline diameters, operating pressures, and throughput capacities are the same for each action alternative, there are several subtle differences in pipelines among the alternatives that could influence the potential impacts and risks posed by a potential spill or other accidental release. These characteristics include total pipeline length and distance from roads, which expresses the difficulty of detecting (visual monitoring) and responding to a potential spill. Table 4.5.1 summarizes the pipeline differences among action alternatives.

As shown, Alternative B would truck diesel 37.5 miles from Alpine CD1 to the WPF, while the other two action alternatives would not truck diesel but would have a diesel pipeline along the entire corridor. Because the likelihood of spills from trucking diesel is higher (very low to medium) than the likelihood of spills from a diesel pipeline (very low), Alternative B would have a higher potential for diesel spills.

Table 4.5.1. Summary of Pipeline Differences among Action Alternatives

Pipeline or Characteristic	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Road	Alternative D: Disconnected Access Road
Infield lines (miles)[a]	43.4	47.0	46.5
Willow pipeline (total miles)	33.3	32.2	38.2
Fuel gas pipeline (miles)	2.8	1.7	1.5
Freshwater pipeline (miles)	4.9	5.6	2.2
Treated water pipeline (miles)	2.8	12.9	1.5
Seawater pipeline (miles)	64.3	63.3	69.2
Diesel pipeline (miles)	34.4	82.0	77.0
Diesel pipeline route	Kuparuk CPF2 to Alpine CD1	Kuparuk CPF2 to Alpine CD1 to South WOC to North WOC	Kuparuk CPF2 to Alpine CD1 to WOC
Miles diesel would be trucked by road	37.5 (Alpine CD1 to WPF)	0	0
Total miles of pipeline alignment without a parallel road (i.e., greater than 1,000 feet of separation)	40.7	45.5	47.9

Note: CD (Colville Delta); CPF (central processing facility); WOC (Willow Operations Center); WPF (Willow Processing Facility).
[a] Includes infield line from Greater Mooses Tooth 2.

4.5.2 Comparison of Module Delivery Options

The types of spills that could occur under the module delivery options would be related to construction equipment, support vehicles, and marine vessels. Though the types of spills would be the same for all options, the locations of activity and amount of total traffic would differ. More traffic would increase the potential for a spill could occur. Table 4.5.2 summarizes the transportation differences among module delivery options. As shown, Option 3 would have notably less vehicle traffic and far fewer support vessel trips.

Table 4.5.2. Summary of Transportation Differences among Module Delivery Options

Characteristic	Option 1: Atigaru Point Module Transfer Island	Option 2: Point Lonely Module Transfer Island	Option 3: Colville River Crossing
Total miles of ice road[a]	110.8	225.2	80.2
Number ice road seasons	3	3	2
Total miles of ice road in the TLSA	81.6	201.1	0.0
Total miles of ice road in the CRSA	0.0	0.0	27.5
Total miles of ice road in the K-5 area	34.8	160.6	0.0
Total vehicle trips	2,306,110	3,196,450	535,160
Total support vessel trips	259	259	60
Barge and support vessel routes (miles round trip)	Barge route ~1,100 support vessel route ~100	Barge route ~1,000 support vessel route ~200	Barge route ~1,200 support vessel route ~5.2

Note: ~ (approximately); CRSA (Colville River Special Area); TLSA (Teshekpuk Lake Special Area). Table does not include barge and tugboat trips because all options would have the same number of trips.
[a] Includes miles of sea ice- and tundra-based ice roads.

This page intentionally left blank.

5.0 MITIGATION

5.1 Introduction

NEPA regulations (40 CFR 1508.20) define mitigation as avoiding, minimizing, rectifying, reducing over time, or compensating for impacts of a proposed action. For actions on federally managed land in the NPR-A, BLM has developed a series of protective measures to mitigate potential impacts. These are defined and evaluated in the NPR-A IAP/EIS (BLM 2012b) and adopted in the ROD (BLM 2013a). State of Alaska regulatory standards and permits also have requirements designed to protect environmental health and serve to mitigate impacts from development.

This chapter summarizes the proposed mitigation measures, including a general description of avoidance and minimization measures incorporated into the design, LSs, and BMPs, and compensatory mitigation. Each resource section in Chapter 3.0, *Affected Environment and Environmental Consequences*, describes the specific mitigation measures and BMPs that would reduce impacts to that resource in additional detail.

5.2 Impact Mitigation

5.2.1 Applicable Lease Stipulations and Best Management Practices

The 2013 NPR-A IAP/EIS ROD established performance-based LSs and BMPs that apply to oil and gas activities within the NPR-A. Lease stipulations are specific to oil and gas leases and describe objectives for protection of certain resources and management of certain activities. Best management practices apply to all activities in the NPR-A. Appendix I.1 (*Avoidance, Minimization, and Mitigation*) Table I.1.1 summarizes the existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate Project impacts. BLM is currently revising the NPR-A IAP (BLM 2013a), including potential changes to required BMPs (described as ROPs in BLM [2020a]). Updated ROPs adopted in the new NPR-A IAP will replace existing (BLM 2013a) BMPs. The Willow MDP ROD will detail which of the measures described below will be implemented for the Project. Table I 1.1. also summarizes new or proposed substantial changes to existing NPR-A IAP LSs (when applied as BMPs) and BMPs that would help mitigate Project impacts. Although many of the BMPs have proposed minor language revisions, Table I 1.1 includes only changes that would be apparent in the paraphrased table text. Full text of the changes to BMPs is provided in BLM (2020a).

The Project would require BLM to grant waivers to BMPs due to technical requirements of the Project and physical constraints of the area that would require essential proposed infrastructure to cross identified setbacks. Design deviations that would require waivers from NPR-A BMPs for action alternatives are described in Appendix D.1, *Alternatives Development*, Section 4.2.12, *Compliance with Bureau of Land Management Stipulations, Best Management Practices, and Supplemental Practices*.

5.2.2 Design Features to Avoid and Minimize Impacts

The Project includes design features intended to avoid or minimize impacts that result in environmental harm consistent with BLM's management practices in the NPR-A. The Proponent's design features are listed in Table I.1-2 in Appendix I.1; the measures are part of the Project and were used to evaluate the impacts described in Chapter 3.0. The Proponent may propose additional measures in subsequent permitting phases.

In addition to the measures listed in Appendix I.1, CPAI considered 22 separate gravel-road segment alignments during the preliminary design process, to avoid and minimize Project impacts. As described in Appendix I.2, *ConocoPhillips Road Optimization Memorandum*, these road segments were evaluated based on the following key considerations:

- Minimize the overall gravel footprint (e.g., length of roads, size of pads) and use higher and drier ground where possible to avoid wetlands and other WOUS
- Minimize impacts to caribou migration
- Avoid and minimize encroachments into established waterbody setbacks, particularly Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek setbacks
- Locate waterway crossings to minimize the crossing length and number of bridge piles below OHW
- Avoid and minimize encroachments of yellow-billed loon nest setbacks
- Minimize the Project footprint in the Teshekpuk Lake Caribou Habitat Area

Drill site locations were also optimized using the above considerations. These sites are relatively constrained by the reservoir location, however, CPAI was able to make some minor refinements to avoid and minimize impacts. For example, one of the drill sites (BT4) was initially located in the Teshekpuk Lake Caribou Habitat Area, but after further design refinement, CPAI was able to move that drill site east to avoid this area. CPAI also realigned the road to BT4 to avoid the Teshekpuk Lake Caribou Habitat Area (BLM BMP K-5).

CPAI proposed locating the WPF as far south and west as possible under Alternative B. The intent of this was to construct the WPF in a location where it could potentially be used for future projects CPAI may develop (to the south and west of the Project, where CPAI owns leases though there are no current development plans). This location could minimize future (cumulative) impacts related to further development to the west of the Project area.

5.2.3 Additional Suggested Avoidance, Minimization or Mitigation

In addition to Project design features and BLM LSs and BMPs already applicable to the Project, Chapter 3.0 also considers additional suggested avoidance, minimization, and mitigation measures designed to further avoid, reduce, or compensate for impacts from the Project. These measures are discussed in the relevant resource sections in Chapter 3.0 and are summarized in Table I.1-2 in Appendix I.1. They were developed based on suggestions from cooperating agencies, stakeholders, public comments, tribal consultations, and BLM staff. Except where otherwise eliminated from further consideration, the decision whether to adopt each new measure will be made in BLM's Willow MDP ROD.

Additionally, BLM finalized its Regional Mitigation Strategy (RMS) for the northeastern NPR-A in August 2018 (BLM 2018b). The goal of the RMS was to "serve as a roadmap for mitigating impacts from oil and gas development projects enabled or assisted by the existence of GMT-1." The RMS describes current and potential future mitigation actions or opportunities that should be considered when approving an application for development. The Willow MDP ROD will identify mitigation measures that may incorporate recommendations made in the RMS.

5.3 Compensatory Mitigation

Pursuant to BLM policy (IM No. 2019-018), BLM will not require compensatory mitigation, except where specifically required by law. However, BLM considers other compensatory mitigation programs applicable to the Project and Project area (e.g., voluntary or state-mandated compensatory mitigation), in its determination of mitigation for impacts from the Project, including USACE's compensatory mitigation program under Section 404 of the CWA and the State's NPR-A Impact Grant Program.

5.3.1 State of Alaska National Petroleum Reserve in Alaska Impact Grant Program

The NPR-A Impact Grant Program was created in the early 1980s to provide eligible municipalities with grants to help mitigate significantly adverse impacts related to oil and gas development within the NPR-A. Revenues from oil and gas development within the NPR-A are paid to the U.S. Treasury, which then pays 50% of the revenues to the State of Alaska. The NPR-A Impact Grant Program is managed by the Department of Commerce, Community and Economic Development under AS 37.05.530 and requires annual reports to the Alaska Legislature, including the history of the program and a list of all grantees, projects, and amounts granted by the State since the program began receiving money in fiscal year 1983. The federal government has no ability to influence the management of the fund or State-run grant program. Activities that are eligible to receive NPR-A grant funding from the State are limited to three categories:

1. Planning
2. Construction, maintenance, and operation of essential public facilities
3. Other necessary public services provided by a municipality

Many subsistence projects are funded as "planning" or "other necessary public services." Fund levels change annually as they are based on lease sales and production royalties.

Grant priority is given to the communities most directly or severely impacted by oil and gas development. This has historically meant those communities located within the NPR-A: Utqiaġvik (Barrow), Atqasuk, Nuiqsut, Anaktuvuk Pass, and Wainwright. Because the NSB is an umbrella organization that has received and distributed a significant percentage of this grant money, all NSB communities benefit, including Kaktovik, Point Lay, and Point Hope. Tribal governments are not municipalities and are not authorized to submit applications to the NPR-A Impact Grant Program.

The State Division of Community and Regional Affairs has an application selection committee made up of three people familiar with issues in NPR-A communities. The committee scores and ranks proposals and provides that list to its commissioner to determine which projects to fund.

Examples of North Slope projects funded by the NPR-A Impact Grant Program include:

- Natural gas distribution system in Nuiqsut

- Village power plants and electrical distribution
- Police officers in villages
- Upgrades to search and rescue equipment
- Renovations or additions to community centers

To date, the State has awarded $203 million in funding for such projects. Willow development is anticipated to generate royalties that would significantly increase funds for the NPR-A Impact Grant Program. Total estimated cumulative state royalties range from $2.6 billion to $4.4 billion (NEI 2020).

5.3.2 Compensatory Mitigation for the Fill of Wetlands and Waters of the United States

In accordance with 33 CFR 332.1(c)(3), "compensatory mitigation for unavoidable impacts may be required to ensure that an activity requiring a section 404 permit complies with the Section 404(b)(1) Guidelines." Pursuant to this authority, USACE may require compensatory mitigation for the direct and/or indirect losses of aquatic resources. Mitigation measures required by USACE will be described in its ROD for this Project.

5.4 Other Mitigation

Through agreements with Kuukpik, CPAI provides the following measures to offset impacts from all CPAI developments in the Nuiqsut area.

- Providing natural gas to the community of Nuiqsut.
- Providing funds to support administration of the KSOP.
- Funding of scholarships via the Kuukpikmiut Foundation.

5.5 Proponent's Additional Mitigation

CPAI also provides additional mitigation to offset impacts from all CPAI developments in the Nuiqsut area (not the Willow Project alone). These efforts are summarized below.

- Providing the City of Nuiqsut access to a grant writer to assist with grant proposals, which could increase the local understanding that mitigation funds are available and decrease some concerns over the impacts of the Project.
- Providing funding for accounting support, which is critical to successfully managing grant money.
- Continuing to provide resources, access, or services from CPAI North Slope developments to residents of Nuiqsut through the CPAI outreach program. The program includes:
    - Providing annual grants to support the Alaska Eskimo Whaling Commission (though this does not provide a direct benefit to Nuiqsut residents, the Nuiqsut Whaling Captains Association is affiliated with the Alaska Eskimo Whaling Commission, along with the other 10 Alaskan whaling communities)
    - Providing education and workforce development programs (Nuiqsut Trapper School, Ilisaġvik College, scholarship funds, and more)
    - Funding community projects (such as the Elder's Housing Project, Nuiqsut playground, outdoor basketball court, and early learning center)
    - Making donations to the community (including fire trucks, spill response boats, supplies for the teen center, etc.)
    - Providing emergency response assistance to the community of Nuiqsut

This page intentionally left blank.

GLOSSARY TERMS

Active layer – The top layer of ground subject to annual thawing and freezing in areas underlain by permafrost.

Alaska water quality standards – A level of water quality established by Alaska Department of Environmental Conservation to protect Waters of the State of Alaska from pollutants; includes designated water use, numeric or narrative parameters for designated use (i.e., criteria), and consistency with the state antidegradation policy.

Albedo – A measure of how a surface reflects incoming radiation; a surface with a higher albedo reflects more radiation than a surface with lower albedo.

Alternatives analysis area – The part of the direct effects analysis area around the onshore action alternatives (excludes the module delivery options).

Anadromous – Fish species that begin their life cycle in freshwater, migrate to salt water, and return to freshwater to spawn (e.g., Pacific salmon).

Anthropogenic – Resulting from the influence of human beings on nature.

Arctic – Lands north of the Arctic Circle and all United States territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim Rivers; all contiguous seas, including the Arctic Ocean and the Beaufort, Bering, and Chukchi Seas; and the Aleutian Chain (15 USC 4111).

Background distance zone – Areas visible within 5 to 15 miles from **key observation points**.

Benthic – Referring to the area at the bottom of a body of water (such as an ocean or lake), that includes the sediment surface and some subsurface layers.

Best management practice – Mitigation developed through the BLM planning process or NEPA process that is not attached to an oil and gas lease but is required, implemented, and enforced at the operational level for all authorized (not just oil and gas) activities in the planning area. Best management practices are developed with various mechanisms in place to ensure compliance.

Birds of Conservation Concern - Species that are likely to become candidates for listing under the ESA (as defined by USFWS).

Black carbon – A component of fine particulate matter that is formed from incomplete combustion of fossil fuels and biomass.

Bottom-fast ice – Ice that is attached to the waterbody or sea floor and is relatively uniform in composition and immobile during winter (also known as bedfast, ground-fast, fast, shorefast, or landfast ice).

Brood-rearing – After hatch, the season when young birds grow and develop flight capability and are cared for by one or both parents; this life stage spans June (for some early nesting passerines and goose) through August.

Carbon dioxide equivalent – The amount of greenhouse gases that would have an equivalent global warming potential as carbon dioxide when measured over a specific timescale.

Critical habitat – Geographic areas that contain features essential to the conservation of an endangered or threatened species and may require special management and protection. Critical habitat is federally designated.

Designated use – Uses specified by ADEC as protected for each waterbody or water segment, regardless of whether those uses are being attained.

Direct effects analysis area – All subsistence use areas within 2.5 miles of Project infrastructure.

Discharge – The rate at which a given volume of water passes a given location within a specific period of time (e.g., cubic feet per second or gallons per minute).

Distance zones – The level of visibility and distances from important viewer locations, including travel routes, human use areas, and observation points. Distance zones consist of foreground-middleground (0 miles to 5 miles), background (5 miles to 15 miles), and seldom seen (not visible or beyond 15 miles). The Project's estimated nighttime lighting conditions are determined by the heights of drill rigs and communications towers. The Project would be visible out to 30 miles, based on the direct line-of-sight limits due to the curvature of the earth and regional atmospheric conditions.

Dust shadow – The area of deposition by airborne dust around gravel infrastructure.

Eolian – Produced by the wind.

Fall-staging – Season when birds are feeding to build fat reserves for migratory flights and when many species gather into flocks before migration; for most North Slope species, fall-staging occurs in August and September, although shorebirds may start forming flocks in July.

Fetch - The distance traveled by wind or waves across open water.

Foreground-middleground distance zone – Areas visible within less than 5 miles from key observation points.

Frac-out – An event during horizontal directional drilling when drilling fluids (mud) used to lubricate the borehole below the streambed are unintentionally released into the stream through fractures in the bore hole.

Gas Lift – A method of artificial lift (i.e., process used to increase reservoir pressure and encourage oil to the surface) that uses an external source of high-pressure gas for supplementing formation gas to lift the well fluids.

Greenhouse gases – Gaseous compounds, including carbon dioxide, methane, and nitrous oxide, among others, that block heat from escaping to space and warm the Earth's atmosphere.

Head cut - an erosional feature of some intermittent and perennial streams with an abrupt vertical drop in the stream bed. When the stream is not flowing, the head cut resembles a very short cliff or bluff. A small plunge pool may be present at the base of the head cut due to the high energy of falling water.

Household – One or more individuals living in one housing unit, whether or not they are related.

Hydrologic unit code – A U.S. Geological Survey-based system of organizing watersheds using a sequence of numbers or letters to identify a watershed. As the numbers used to describe a watershed increase, the size of the watershed decreases.

Hydraulic Conductivity - The ease with which a fluid can move through pore spaces or fractures

Ice exclusion process – The process during the growth of ice by which small molecules are retained in the ice and larger molecules are preferentially excluded, thus concentrating dissolved inorganic ions and organic matter in the unfrozen water below the ice.

Impulsive Noise – Short-term or instantaneous noise events with a steep rise in sound level to a high peak followed by a rapid decay.

Invasive species – Species nonnative to a given ecosystem and whose introduction is likely to cause economic or environmental harm or harm to human health (EO 13112).

Kernel distribution – Kernel distribution or density is a statistical way to estimate the probability of density of a given variable in a defined area. In this case, locations of radio-collared caribou were used to estimate the spatial pattern of seasonal caribou distribution based on the location of radio-collared individuals.

Key observation points – One or a series of points on a travel routes or at a use area or potential use area. This includes points with views of the Project that were identified based on areas of high visual sensitivity, angle of observation, number of viewers, public access, length of time the Project is in view, relative project size, season of use, and light conditions.

Lacustrine – Produced or originating from or within a lake.

Lake-tapping – Sudden drainage of lakes caused by ice melting or dislodging and opening up a drainage channel.

Lease stipulations – Mitigation developed through BLM planning process or NEPA process that is specifically attached to a lease.

Legacy well – Exploratory and scientific wells drilled between 1944 and 1982 by the U.S. Navy and U.S. Geological Survey within the NPR-A in which BLM now has the responsibility to asses, plug, and clean up (BLM 2013a).

Medevac – The transport of someone to a hospital via helicopter or airplane.

Molting – Molt is the annual replacement of feathers; it is an important period for waterfowl because they become flightless until wing feathers are replaced. Molt occurs during mid- to late-summer after nesting and during the brood-rearing period.

Nesting – Season when birds are building nests and incubating eggs, which for most birds on Alaska's North Slope, spans from late May through July.

Noise-sensitive receptors – People and areas of human activity that may be particularly affected by high levels of noise (e.g., residences, hospitals, schools, etc.).

Non-impulsive noise – Longer term, continuous, varying, or intermittent noise events.

Overland flow – The flow of rainwater or snowmelt over the land surface toward stream channels.

Permafrost – Ground with subfreezing temperatures for at least two consecutive years.

Pigging – Mechanical devices (i.e., pigs) used in pipeline monitoring and maintenance which are capable of inspecting pipeline conditions and cleaning pipelines.

$PM_{2.5}$ – Particulate matter less than 2.5 microns in aerodynamic diameter in ambient air; this fraction of particulate matter penetrates most deeply into the lungs.

PM_{10} – Particulate matter less than or equal to 10 microns in aerodynamic diameter in ambient air, which causes visibility reduction or potential adverse health effects; a criteria air pollutant.

Pre-breeding – Equivalent to pre-nesting. Period immediately prior to nesting when nesting habitats are becoming available after snowmelt or flooding, and birds are dispersing into nesting areas, generally in late May for early nesting species and in early June for most species in the ACP.

Reservoir blowout – The uncontrolled release of produced fluids or natural gas (or both) when target oil reservoir pressures are much higher than anticipated and planned for (also known as a well blowout).

Resistant fish – Fish that are resistant to the potential changes in water quality, such as reduced dissolved oxygen and increased dissolved solids, as per BMP B-2, as well as ADNR and ADF&G permit stipulations. These species are ninespine stickleback and Alaska blackfish.

Scenic quality – The relative worth of a landscape from a visual perception point of view expressed as a quantitative measure of qualitative criteria associated with landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications (BLM 2012a).

Screeding – A process which recontours sediment on the marine floor but does not remove sediment from the water. The activity often entails dragging a metal plate such as a screed bar across the sediment, thereby smoothing the high spots and filling the relatively lower areas. The amount of material moved is generally small and localized and the result is a flat seafloor within the work area. Screeding is necessary to temporarily ground the sealift barges during module off-loading; a flat seafloor provides stability and prevents damage to the barge hulls during grounding.

Seldom seen – Areas within the foreground-middleground and background distance zones that are not visible, or areas that are visible but are beyond the background zone (more than 15 miles from key observation points).

Sensitive fish – Fish that are sensitive to the potential changes in water quality, such as reduced dissolved oxygen and increased dissolved solids, as per BMP B-2, as well as ADNR and ADF&G permit stipulations. All species documented from the fish analysis area are sensitive except ninespine stickleback and Alaska blackfish.

Sensitive Species - Native species that have a known or predicted downward population trend or depend on rare or specialized habitats that are threatened with alteration (as defined by BLM).

Sensitivity level – The measure of public concern for scenic quality (as determined through the Visual Resource Inventory process).

Shallow-gas blowout – The uncontrolled release of natural gas (and drilling mud) when shallow, high-pressure gas deposits are unexpectedly encountered beneath the surface and above the target oil reservoir depth.

Special Recreation Permits – Permits issued by BLM to businesses, organizations, and individuals to allow the use of specific public land and related waters for commercial, competitive, and organized group use. The permits allow BLM to track commercial and competitive use of public lands, and provide resource protection measures to ensure the future enjoyment of those resources by the public.

Stage – The vertical height of the water above an established but usually arbitrary point. Sometimes zero stage corresponds to the riverbed but more often to just an arbitrary point.

S**ublimation -** When a solid turns into a gas without first becoming liquid first.

Subsistence – A traditional way of life in which wild renewable resources are obtained, processed, and distributed for household and community consumption according to prescribed social and cultural systems and values.

Subsistence use areas – The geographic extent of a resident's or community's use of the environment to conduct traditional subsistence activities.

Talik – A layer of year-round unfrozen ground that lies in permafrost areas and often forms beneath lakes and rivers too deep to completely freeze during the winter; also referred to as a thaw bulb.

Thaw bulb – A layer of year-round unfrozen ground that lies in permafrost areas and often forms beneath lakes and rivers too deep to completely freeze during the winter.

Thermokarst – A land surface with karst-like features and hollows produced by melting of ice-rich soil or permafrost.

Viewshed – The total landscape seen from a point, or from all or a logical part of a travel route, use area, or waterbody.

Visual Resource Inventory – The process of determining the visual value of BLM-managed lands through the assessment of the scenic quality rating, sensitivity level, and distance zones of visual resources within those lands.

Visual Resource Inventory classes – Four visual resource inventory classes into which all BLM-managed lands are placed based on scenic quality, sensitivity levels, and distance zones, as determined through the Visual Resource Inventory process.

Visual Resource Management classes – Categories assigned to public lands based on scenic quality, sensitivity level, and distance zones with consideration for multiple-use management objectives. There are four classes; each class has an objective that prescribes the amount of change allowed in the characteristic landscape. Visual resource management classes are assigned through BLM Resource Management Plans (in this case, the IAP for the NPR-A).

Visual Resource Management system – The system used by BLM to manage visual resources (including in the NPR-A). It includes inventory and planning actions to identify visual values and to establish objectives for managing those values.

Visual resources – Visible features and objects, natural and man-made, moving and stationary, which comprise the character of the landscape observed from a given location or key observation point.

Water quality criteria – Numeric or narrative parameters established to protect designated uses.

Water surface elevation – The elevation of the water surface of a river, lake, or stream above an established reference or vertical datum.

Waters of the United States – Waterbodies and wetlands under jurisdiction of USACE, as defined by 33 CFR 328.3.

Well blowout – See reservoir blowout.

Wetlands – Areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3(b)).

REFERENCES

Abele, G., J. Brown, and M.C. Brewer. 1984. Long-Term Effects of Off-Road Vehicle Traffic on Tundra Terrain. *Journal of Terramechanics* 21 (3):283–294. doi: 10.1016/0022-4898(84)90037-5.

ABR. 2018. Flushing Distance Data from Nest Searches on Colville Delta and NPR-A, Rick Johnson, Data Manager. Fairbanks, AK.

ABVS. 2018. *2013–2017 Alaska Resident Leading Causes of Death*. Anchorage, AK: ADHSS, Division of Public Health, Health Analytics & Vital Records (Formerly the Bureau of Vital Statistics).

ACCS. 2020. Rare Plant Data Portal. University of Alaska Anchorage, Accessed February 7, 2020. https://accscatalog.uaa.alaska.edu/dataset/alaska-rare-vascular-plant-field-guide.

ADCCED. 2018a. *Alaska Taxable 2017 Supplement*. Anchorage, AK: ADCCED, Division of Community and Regional Affairs.

-----. 2018b. *National Petroleum Reserve-Alaska (NPR-A) Impact Mitigation Grant Program: Report to the Second Session of the Thirtieth Alaska Legislature*. Anchorage, AK: ADCCED, Division of Community and Regional Affairs.

ADEC. 2010. *Alaska North Slope Spills Analysis: Final Report on North Slope Spills Analysis and Expert Panel Recommendations on Mitigation Measures*. Fairbanks, AK: Prepared by Nuka Research and Planning Group, LLC, and Pearson Consulting.

-----. 2013. *Alaska North Slope Spills Analysis*. Fairbanks, AK: Prepared by Nuka Research and Planning Group, LLC, and Pearson Consulting.

-----. 2018a. *2014/2016 Final Integrated Water Quality Monitoring and Assessment Report*. Juneau, AK.

-----. 2018b. *Alaska Greenhouse Gas Emissions Inventory: 1990–2015*. Juneau, AK.

-----. 2018c. *Occurrence of Xylene in Nuiqsut's Drinking Water Supply: Memorandum to U.S. Army Corps of Engineers, February 2, 2018*. Juneau, AK.

-----. 2019a. Contaminated Sites Program Databases. Accessed December 31, 2019. https://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/Search.

-----. 2019b. Hazardous Materials Spill Data. Accessed July 25, 2019.

-----. 2019c. Prevention, Preparedness, and Response (PPR) Spills Database Search. Accessed December 31, 2019. http://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch.

-----. 2020. Prevention, Preparedness, and Response (PPR) Spills Database Search. Accessed March 24, 2020. http://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch.

ADF&G. 2002. *Aquatic Nuisance Species Management Plan*. Juneau, AK: ADF&G, Aquatic Nuisance Species Task Force.

-----. 2006. *Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources*. Anchorage, AK.

-----. 2016a. *Harvests and Uses of Wild Resources in Four Interior Alaska Communities and Three Arctic Alaska Communities, 2014*. Technical Paper No. 426. Fairbanks, AK: ADF&G, Division of Subsistence.

-----. 2016b. *Subsistence in Alaska: A Year 2014 Update*. Anchorage, AK: ADF&G, Division of Subsistence.

-----. 2017. *Central Arctic Caribou Herd News: Winter 2016–17*. Fairbanks, AK: ADF&G, Division of Wildlife Conservation.

-----. 2018. Community Subsistence Information System: Harvest by Community. Accessed May 2018. https://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvestCommSelComm.

ADHSS. 2012. Investigation into a Report of Increased Respiratory Illness in Nuiqsut Due to Possible Exposure to Gas from the Repsol Gas Blowout and Smoke from the Alpine Fields Facility 2012. Unpublished memorandum from Michael Cooper, MD, and Ali Hamade, PhD, to ADHSS.

-----. 2015. *Health Impact Assessment Program: Technical Guidance for Health Impact Assessment in Alaska – Version 2.0*. Anchorage, AK: State of Alaska Health Impact Assessment Program.

-----. 2019a. Indicator-Based Information System for Public Health (AK-IBIS): Complete Health Indicator Report of Chlamydia Cases (HA2020 Leading Health Indicator: 18). Accessed May 2018. http://ibis.dhss.alaska.gov/.

-----. 2019b. Indicator-Based Information System for Public Health (AK-IBIS): Complete Health Indicator Report of General Health – Fair/Poor – Adults (18+). Accessed May 2018. http://ibis.dhss.alaska.gov/.

-----. 2019c. Indicator-Based Information System for Public Health (AK-IBIS): Complete Health Indicator Report of Mental Health – Past 30 Days – Adults (18+) (HA2020 Leading Health Indicator: 9). Accessed May 2018. http://ibis.dhss.alaska.gov/.

-----. 2019d. Indicator-Based Information System for Public Health (AK-IBIS): Complete Health Indicator Report of Unintentional Injury Mortality Rate (HA2020 Leading Health Indicator: 16). Accessed May 2018. http://ibis.dhss.alaska.gov/.

ADLWD. 2016. When the North Slope is Home. *Alaska Economic Trends* 36 (9):5–9.

-----. 2017. *Nonresidents Working in Alaska: 2015*. Juneau, AK: ADLWD, Research and Analysis Section.

-----. 2019. Current Quarterly Census of Employment and Wages (QCEW): Preliminary Annual Employment and Wages, 2018. Accessed May 2019. http://live.laborstats.alaska.gov/qcew/.

ADNR. 2018. *North Slope Areawide Oil and Gas Lease Sales. Written Finding of the Director, April 18, 2018*. Anchorage, AK: ADNR, Division of Oil and Gas.

-----. 2020. *Winter Off-Road Travel Opening and Closing Dates by Tundra Opening Area*. Fairbanks, AK: Division of Mining, Land, and Water.

-----. n.d. *North Slope Water Withdrawal Guidelines*. Unpublished guiadance available from ADNR.

Alaska Exotic Plant Information Clearinghouse. 2018. Alaska Exotic Plant Information Clearinghouse Database. Accessed May 2019. http://aknhp.uaa.alaska.edu/apps/akepic/.

Albers, P.H. 1980. Transfer of Crude Oil from Contaminated Water to Bird Eggs. *Environmental Research* 22 (2):307–314. doi: 10.1016/0013-9351(80)90143-7.

Albon, S.D., R.J. Irvine, O. Halvorsen, R. Langvatn, L.E. Loe, E. Ropstad, V. Veiberg, R. van der Wal, E.M. Bjørkvoll, E.I. Duff, B.B. Hansen, A.M. Lee, T. Tveraa, and A. Stien. 2017. Contrasting Effects of Summer and Winter Warming on Body Mass Explain Population Dynamics in a Food-Limited Arctic Herbivore. *Global Change Biology* 23 (4):1374–1389. doi: 10.1111/gcb.13435.

AMAP. 2015. AMAP Assessment 2015: Black Carbon and Ozone as Arctic Climate Forcers. Accessed March 2018. https://www.amap.no.

-----. 2017. *AMAP Assessment 2017: Snow, Water, Ice and Permafrost in the Arctic (SWIPA); Summary for Policy Makers*. Tromso, Norway.

Amstrup, S.C. 2000. Polar Bear. In *The Natural History of an Arctic Oil Field: Development and the Biota*, edited by J. C. Truett and S. R. Johnson, 133–157. San Diego, CA: Academic Press.

Amstrup, S.C., C. Gardner, K.C. Myers, and F.W. Oehme. 1989. Ethylene Glycol (Antifreeze) Poisoning in a Free-Ranging Polar Bear. *Veterinary and Human Toxicology* 31 (4):317–319.

Amundson, C.L., P.L. Flint, R.A. Stehn, R.M. Platte, H.M. Wilson, and W.W. Larned. 2019. Spatio-Temporal Population Change of Arctic-Breeding Waterbirds on the Arctic Coastal Plain of Alaska. *Avian Conservation and Ecology* 14 (1):55–252.

Andersland, O.B. and B. Ladanyi. 2003. *Frozen Ground Engineering*. Reston, VA: John Wiley & Sons.

Anderson, B.A., S.M. Murphy, M.T. Jorgenson, D.S. Barber, and B.A. Kugler. 1992. *GHX-1 Waterbird and Noise Monitoring Program: Final Report*. Fairbanks, AK: Prepared by ABR, Inc. for ARCO Alaska, Inc.

Anderson, D.W., S.H. Newman, P.R. Kelly, S.K. Herzog, and K.P. Lewis. 2000. An Experimental Soft-Release of Oil-Spill Rehabilitated American Coots (*Fulica americana*): Lingering Effects on Survival, Condition and Behavior. *Environmental Pollution* 107 (3):285–294. doi: 10.1016/S0269-7491(99)00180-3.

Andres, B.A., A.J. Johnson, S.C. Brown, and R.B. Lanctot. 2012. Shorebirds Breed in Unusually High Densities in the Teshekpuk Lake Special Area, Alaska. *Arctic* 65 (4):411–420.

Ansong, M. and C. Pickering. 2013. Are Weeds Hitchhiking a Ride on Your Car? A Systematic Review of Seed Dispersal on Cars. *PLOS ONE* 8 (11):e80275. doi: 10.13711journal.pone.0216362.

ANTHC. 2011. *Independent Evaluation of Ambient Air Quality in the Village of Nuiqsut, Alaska*. Anchorage, AK: ANTHC, Division of Environmental Health and Engineering.

ARCO Alaska Inc. 1986. *An Evaluation of the Effects of Noise on Waterfowl in the Vicinity of CPF-3, Kuparuk Field, Alaska. Vol. 1, 1985–1986*. Anchorage, AK: Prepared by Environmental Science and Engineering, Inc.

Armstrong, R.H. 1994. *Alaska Blackfish*. Anchorage, AK: ADF&G.

Arnborg, L., H.J. Walker, and J. Peipo. 1962. Suspended Load in the Colville River, Alaska. *Geografiska Annaler: Series A, Physical Geography* 49 (2–4):131–144.

Arthur, S.M. and P.A. Del Vecchio. 2009. *Effects of Oil Field Development on Calf Production and Survival in the Central Arctic Herd. Final Research Technical Report, June 2001–March 2006*. Federal Aid in Wildlife Restoration Project 3.46. Juneau, AK: ADF&G.

Attanas, L.B. and J.E. Shook. 2020. *Eider Surveys in the Kuparuk Oilfield, Alaska, 2019*. Fairbanks, AK: Draft prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Audubon Alaska. 2014. Important Bird Areas of Alaska. Accessed July, 2020. http://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9.

-----. 2015. Important Bird Areas. Accessed July, 2019. https://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9.

-----. 2017. Human Uses Chapter. In *Ecological Atlas of the Bering, Chukchi, and Beaufort Seas*, Pages 266 through 325. Anchorage, AK.

Auerbach, N.A., M.D. Walker, and D.A. Walker. 1997. Effects of Roadside Disturbance on Substrate and Vegetation Properties in Arctic Tundra. *Ecological Applications* 7 (1):218–235. doi: 10.1890/1051-0761(1997)007[0218:EORDOS]2.0.CO;2.

Ault, A.P., C.R. Williams, A.B. White, P.J. Neiman, J.M. Creamean, C.J. Gaston, F.M. Ralph, and K.A. Prather. 2011. Detection of Asian Dust in California Orographic Precipitation. *Journal of Geophysical Research: Atmospheres* 116 (D16). doi: 10.1029/2010jd015351.

Bacon, J.J., T.R. Hepa, H.K. Brower Jr., M. Pederson, T.P. Olemaun, J.C. George, and B.G. Corrigan. 2009. *Estimates of Subsistence Harvest for Villages on the North Slope of Alaska, 1994–2003*. Barrow, AK: NSB, Department of Wildlife Management.

Bakun, A. 1973. *Coastal Upwelling Indices, West Coast of North America, 1946–71*. Technical Report NMFS–SSRF–671. Seattle, WA: NOAA.

Barboza, P.S., L.L. Van Someren, D.D. Gustine, and M.S. Bret-Harte. 2018. The Nitrogen Window for Arctic Herbivores: Plant Phenology and Protein Gain of Migratory Caribou (*Rangifer tarandus*). *Ecosphere* 9 (1):e02073. doi: 10.1002/ecs2.2073.

Bart, J., S. Brown, B.A. Andres, R.M. Platte, and A. Manning. 2012. North Slope of Alaska. In *Arctic Shorebirds in North America: A Decade of Monitoring*, edited by J. Bart and V. Johnston, 37–96. Berkley, CA: Cooper Ornithological Society and University of California Press.

Bart, J., R.M. Platte, B. Andres, S. Brown, J.A. Johnson, and W. Larned. 2013. Importance of the National Petroleum Reserve–Alaska for Aquatic Birds. *Conservation Biology* 27 (6):1304–1312.

Bêty, J., G. Gauthier, J.F. Giroux, and E. Korpimäki. 2001. Are Goose Nesting Success and Lemming Cycles Linked? Interplay between Nest Density and Predators. *Oikos* 93 (3):388–400.

Bieniek, P.A., U.S. Bhatt, J.E. Walsh, R. Lader, B. Griffith, J.K. Roach, and R.L. Thoman. 2018. Assessment of Alaska Rain-on-Snow Events Using Dynamical Downscaling. *Journal of Applied Meteorology and Climatology* 57 (8):1847–1863. doi: 10.1175/jamc-d-17-0276.1.

Blackwell, S.B. and C.R. Greene. 2003. *Acoustic Measurements in Cook Inlet, Alaska, During August 2001*. Santa Barbara, CA: Prepared by Greenridge Sciences, Inc. for NMFS.

Blackwell, S.B., J.W. Lawson, and M.T. Williams. 2004. Tolerance by Ringed Seals (*Phoca hispida*) to Impact Pipe-Driving and Construction Sounds at an Oil Production Island. *Journal of the Acoustical Society of America* 115 (5):2346–2357.

BLM. 1984. *BLM Manual 8400: Visual Resource Management*. Washington, D.C.

-----. 1986. *BLM Manual H-8410-1: Visual Resource Inventory*. Washington, D.C.

-----. 1998. *Northeast National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement*. Anchorage, AK.

-----. 2004a. *Alpine Satellite Development Plan: Final Environmental Impact Statement*. Anchorage, AK.

-----. 2004b. *Northwest National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement Record of Decision, 2004*. Anchorage, AK.

-----. 2005. *Northeast NPR-A Final Amended IAP/EIS*. Anchorage, AK.

-----. 2008a. *Greater Mooses Tooth Unit (GMTU) Agreement for the Exploration, Development and Operation of the Greater Mooses Tooth Unit Area*. Anchorage, AK.

-----. 2008b. *National Petroleum Reserve-Alaska Final Supplemental Integrated Activity Plan/Environmental Impact Statement*. Anchorage, AK.

-----. 2012a. *Bureau of Land Management Manual 8431 – Visual Resource Contrast Rating*. Washington, D.C.

-----. 2012b. *National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement*. Anchorage, AK.

-----. 2012c. *National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement*. Anchorage, AK.

-----. 2012d. National Petroleum Reserve-Alaska final integrated activity plan/environmental impact statement. Anchorage.

-----. 2013a. *National Petroleum Reserve-Alaska Integrated Activity Plan/Environmental Impact Statement Record of Decision*. Anchorage, AK.

-----. 2013b. *National Petroleum Reserve in Alaska: 2013 Legacy Wells Summary Report*. Anchorage, AK.

-----. 2014. *Final Supplemental Environmental Impact Statement: Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth One Development Project*. Anchorage, AK.

-----. 2018a. *Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth Two Development Project – Final Supplemental Environmental Impact Statement*. Anchorage, AK.

-----. 2018b. Final Regional Mitigation Strategy for Northeastern NPR-A. Accessed May 16, 2019. https://www.blm.gov/programs/planning-and-nepa/plans-in-development/alaska/npr-a_rms.

-----. 2018c. *Willow Master Development Plan Environmental Impact Statement Scoping Summary Report*. Anchorage, AK.

-----. 2019a. *Alaska Sensitive Animal and Plant List*. Anchorage, AK.

-----. 2019b. *Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement, Final*. Anchorage, AK.

-----. 2019c. *National Petroleum Reserve in Alaska Draft Integrated Activity Plan and Environmental Impact Statement*. Anchorage, AK.

-----. 2020a. *National Petroleum Reserve in Alaska Final Integrated Activity Plan and Environmental Impact Statement*. Anchorage, AK.

-----. 2020b. *Willow Master Development Plan Supplement to the Draft Environmental Impact Statement*. Anchorage, AK.

BOEM. 2013. *Oil Spill Occurrence Rates for Alaska North Slope Crude and Refined Oil Spills*. Alaska OCS Study BOEM 2013-205. Seldovia, AK: Prepared by Nuka Research and Planning Group, LLC.

-----. 2019. *Market Substitutions and Greenhouse Gas Downstream Emissions Estimates for BLM's Willow Master Development Project*. Anchorage, AK.

Boesch, D.F. and N.N. Rabalais, eds. 1987. *Long-Term Environmental Effects of Offshore Oil and Gas Development*. New York, NY: Elsevier Applied Science Publishing Co., Inc.

Bond, T.C., S.J. Doherty, D.W. Fahey, P.M. Forster, T. Berntsen, B.J. DeAngelo, M.G. Flanner, S. Ghan, B. Kärcher, D. Koch, S. Kinne, Y. Kondo, P.K. Quinn, M.C. Sarofim, M.G. Schultz, M. Schulz, C. Venkataraman, H. Zhang, S. Zhang, N. Bellouin, S.K. Guttikunda, P.K. Hopke, M.Z. Jacobson, J.W. Kaiser, Z. Klimont, U. Lohmann, J.P. Schwarz, D. Shindell, T. Storelvmo, S.G. Warren, and C.S. Zender. 2013. Bounding the Role of Black Carbon in the Climate System: A Scientific Assessment. *Journal of Geophysical Research: Atmospheres* 118 (11):5380–5552. doi: 10.1002/jgrd.50171.

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. 2012. Estimating the Zone of Influence of Industrial Developments on Wildlife: A Migratory Caribou *Rangifer tarandus groenlandicus* and Diamond Mine Case Study. *Wildlife Biology* 18 (2):164–179.

Brandon, J.R., T. Thomas, and M. Bourdon. 2011. Beaufort Sea Aerial Survey Program Results. In *Marine Mammal Monitoring and Mitigation during Marine Geophysical Surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort Seas, July–October 2010: 90-Day Report*, edited by C. Reiser, Dale W. Funk, R. Rodrigues and D. Hannay. Anchorage, AK: Prepared by LGL Alaska Research Associates, Inc. and Jasco Research for Shell Offshore, Inc., NMFS, and USFWS.

Brower, H.K. and T. Hepa. 1998. *North Slope Borough Subsistence Harvest Documentation Project: Data for Nuiqsut, Alaska for the Period July 1, 1994, to June 30, 1995*. Barrow, AK: NSB, Deparment of Wildlife Management.

Brown, C.L., N.M. Braem, E.H. Mikow, A. Trainor, L.J. Slayton, D.M. Runfola, H. Ikuta, M.L. Kostick, C.R. McDevitt, J. Park, and J.J. Simon. 2016. *Harvests and Uses of Wild Resources in Four Interior Alaska Communities and Three Arctic Alaska Communities, 2014*. Technical Paper No. 426. Fairbanks, AK: ADF&G, Division of Subsistence.

Brown, J., B.E. Brockett, and K.E. Howe. 1984. *Interaction of Gravel Fills, Surface Drainage, and Culverts with Permafrost Terrain*. Report No. AK-RD-84-11. Fairbanks, AK: ADOT&PF.

Brown, W.E. 1979. *Nuiqsut Paisanich: Nuiqsut Heritage, a Cultural Plan*. Anchorage, AK: Prepared for the Village of Nuiqsut and the NSB Planning Commission on History and Culture.

Brubaker, M., J. Bell, H. Dingman, S. Evans, K. Kasak, M. Itta, and R. Drake. 2014. *Climate Change in Nuiqsut, Alaska Strategies for Community Health*. Anchorage, AK: Alaska Native Tribal Health Consortium, Center for Climate and Health.

Buehler, D., R. Oestman, J. Reyff, K. Pommerenck, and B. Mitchell. 2015. *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*. Technical Report No. CTHWANP-RT-15-306.01.01. Sacramento, CA: California Department of Transportation, Division of Environmental Analysis.

Burgess, R.M., J.R. Rose, P.W. Banyas, and B.E. Lawhead. 1993. *Arctic Fox Studies in the Prudhoe Bay Unit and Adjacent Undeveloped Area, 1992*. Fairbanks, AK: Prepared by ABR, Inc. for ARCO Alaska, Inc.

Cameron, M.F., J.L. Bengtson, P.L. Boveng, J.K. Jansen, B.P. Kelly, S.P. Dahle, E.A. Logerwell, J.E. Overland, C.L. Sabine, G.T. Waring, and J.M. Wilder. 2010. *Status Review of the Bearded Seal (Erignathus barbatus)*. NOAA Technical Memorandum NMFS-AFSC-211. Seattle, WA: NMFS and NOAA, Alaska Fisheries Science Center.

Cameron, R.D., D.J. Reed, J.R. Dau, and W.T. Smith. 1992. Redistribution of Calving Caribou in Response to Oil Field Development on the Arctic Slope of Alaska. *Arctic* 45 (4):338–342.

Cameron, R.D., W.T. Smith, R.G. White, and B. Griffith. 2005. Central Arctic Caribou and Petroleum Development: Distributional, Nutritional, and Reproductive Implications. *Arctic* 58 (1):1–9.

Carey, A., M. Boudrias, J. Kern, and R. Ruff. 1984. Selected Ecological Studies on Continental Shelf Benthos and Sea Ice Fauna in the Southwestern Beaufort Sea. In *Outer Continental Shelf Environmental Assessment Program: Final Reports of Principal Investigators*, 1–164. Anchorage, AK: NOAA, OCSEAP Final Report 23.

Carey, A.G., R.E. Ruff, P.H. Scott, K.R. Walters, and J.C. Kern. 1981. The Distribution, Abundance, Composition and Variability of the Western Beaufort Sea Benthos. In *Environmental Assessment of the Alaskan Continental Shelf: Annual Reports of Principal Investigators for the Year Ending March 1981*, Vol II: Receptors - Benthos, 27–324. Anchorage, AK: NOAA and BLM.

Carroll, G.M., L.S. Parrett, J.C. George, and D.A. Yokel. 2005. Calving Distribution of the Teshekpuk Caribou Herd, 1994–2003. *Rangifer* Special Issue No. 16:27–35.

Cebrian, M., K. Kielland, and G. Finstad. 2008. Forage Quality and Reindeer Productivity: Multiplier Effects Amplified by Climate Change. *Arctic Antarctic and Alpine Research* 40 (1):48–54. doi: 10.1657/1523-0430(06-073)[CEBRIAN]2.0.CO;2.

CEQ. 1981. *NEPA's 40 Most Asked Questions*. Washington, D.C.

-----. 1997. *Considering Cumulative Effects under the National Environmental Policy Act*. Washington, D.C.

Chapin, F.S., S.F. Trainor, P. Cochran, H. Huntington, C. Markon, M. McCammon, A.D. McGuire, and M. Serreze. 2014. Alaska. In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by J. M. Melillo, T. C. Richmond and G. W Yohe, 514–536. U.S. Global Change Research Program.

Cheung, W.W.L., V.W.Y. Lam, J.L. Sarmiento, K. Kearney, R. Watson, and D. Pauly. 2009. Projecting Global Marine Biodiversity Impacts under Climate Change Scenarios. *Fish and Fisheries* 10 (3):235–251. doi: 10.1111/j.1467-2979.2008.00315.x.

Clark, R.B. 1968. Oil Pollution and the Conservation of Seabirds. In *Proceedings of the International Conference on Oil Pollution of the Sea*, 76–112. London, UK: British Advisory Committee on Oil Pollution of the Sea, Natural History Museum.

Clausen, K.K. and P. Clausen. 2013. Earlier Arctic Springs Cause Phenological Mismatch in Long-Distance Migrants. *Oecologia* 173 (3):1101–1112. doi: 10.1007/s00442-013-2681-0.

Clement, J.P., J.L. Bengtson, and B.P. Kelly. 2013. *Managing for the Future in a Rapidly Changing Arctic: A Report to the President*. Washington, D.C.: Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska.

Coastal Frontiers Corporation. 2018a. *Memorandum: Potential for Sea Bottom Scour around Module Transfer Island*. Moorpark, CA: Prepared for ConocoPhillips Alaska, Inc.

-----. 2018b. *Suspended Sediment Concentrations During Construction of the Willow Development Module Transfer Island*. Moorpark, CA: Prepared for ConocoPhillips Alaska, Inc.

Corbett, J.J., D.A. Lack, J.J. Winebrake, S. Harder, J.A. Silberman, and M. Gold. 2010. Arctic Shipping Emissions Inventories and Future Scenarios. *Atmospheric Chemistry and Physics* 10 (19):9689–9704. doi: 10.5194/acp-10-9689-2010.

Cotter, P.A. and B.A. Andres. 2000. Nest Density of Shorebirds Inland from the Beaufort Sea. *Canadian Field-Naturalist* (114):287–291.

CPAI. 2018a. *Alpine Field, Satellites, and Pipelines ODPCP*. Anchorage, AK.

-----. 2018b. *Environmental Evaluation Document: Willow Master Development Plan*. Anchorage, AK.

-----. 2018c. *Wildlife Avoidance and Interaction Plan*. Anchorage, AK.

-----. 2019a. *Environmental Evaluation Document (Revision No. 3): Willow Master Development Plan*. Anchorage, AK.

-----. 2019b. *Response to RFI 39: MTI Scour and Accretion. Responses to BLM Questions Posed at 7 February 2019 Meeting*. Anchorage, AK.

-----. 2019c. *Response to RFI 46: Spill Modeling Needs, Willow Development, Worst Case Spill Volume for Drill Pad Blowout and Fish Creek and Judy Creek Pipeline Crossings*. Anchorage, AK.

-----. 2019d. *Response to RFI 82: Colville River Crossing Hydrology for the Willow MDP EIS*. Anchorage, AK: Prepared for BLM.

-----. 2020a. *Response to DOWL RFI 46b: Spill Volume Updates*. Anchorage, AK.

-----. 2020b. *Response to RFI 82b: Lakes L9911 and M0235 Hyrdrology Data*. Anchorage, AK.

-----. 2020c. *Response to RFI 91, Polar Bear Observations. March 5, 2020*. Anchorage, AK: Prepared for BLM Alaska.

-----. 2020d. *Response to RFI 98: Ice Road Season*. Anchorage, AK: Prepared for BLM Alaska.

CPAI and BP. n.d. *Alaska Waste Disposal and Reuse Guide*. Anchorage, AK.

Cronin, M.A., W.B. Ballard, J.C. Truett, and R.H. Pollard. 1994. *Mitigation of the Effects of Oil Field Development and Transportation Corridors on Caribou*. Anchorage, AK: Unpublished report prepared by LGL Alaska Research Associates for the Alaska Caribou Steering Committee.

Curatolo, J.A. and S.M. Murphy. 1986. The Effects of Pipelines, Roads, and Traffic on the Movements of Caribou, *Rangifer tarandus*. *Canadian Field-Naturalist* 100 (2):218–224.

Dau, J.R. 2007. Units 21D, 22A, 22B, 22C, 22D, 22E, 23, 24, and 26A - Caribou Management Report. In *Caribou Management Report of Survey and Inventory Activities, 1 July 2004–30 June 2006*, edited by P. Harper, 174–231. Juneau, AK: ADF&G.

Dau, J.R. and R.D. Cameron. 1986. Effects of a Road System on Caribou Distribution During Calving. *Rangifer* 6 (2):95–101.

Day, R.H. 1998. *Predator Populations and Predation Intensity on Tundra-Nesting Birds in Relation to Human Development*. Fairbanks, AK: Prepared for USFWS, Alaska Region.

Day, R.H., A.K. Prichard, and J.R. Rose. 2005. *Migration and Collision Avoidance of Eiders and Other Birds at Northstar Island, Alaska, 2001–2004: Final Report*. Fairbanks, AK: Prepared by ABR, Inc. for BP Exploration (Alaska), Inc.

Day, R.H., J.R. Rose, B.A. Cooper, and R.J. Blaha. 2001. Migration Rates and Flight Behavior of Migrating Eiders near Towers at Barrow, Alaska. In *Climate Monitoring and Diagnostics Laboratory Summary Report No. 26, 2000–2001*, edited by D. B. King, R. C. Schnell, R. M. Rosson and C. Sweet. Boulder, CO: NOAA.

Day, R.H., J.R. Rose, A.K. Prichard, and B. Streever. 2015. Effects of Gas Flaring on the Behavior of Night-Migrating Birds at an Artificial Oil-Production Island, Arctic Alaska. *Arctic* 68 (3):367–379.

Day, R.H., I.J. Stenhouse, and H.G. Gilchrist. 2001. Sabine's Gull (*Xema sabini).* Account 593. In *The Birds of North America*, edited by A. F. Poole and F. B. Gill. Ithaca, NY: Cornell Lab of Ornithology.

DeBruyn, T.D., T.J. Evans, S. Miller, C.J. Perham, E.V. Regehr, K. Rode, J. Wilder, and L.J. Lierheimer. 2010. Polar Bear Conservation in the United States, 2005–2009. In *Polar Bears: Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, Denmark*, edited by M. E. Obbard, G. W. Thiemann, E. Peacock and T. D. DeBruyn, 179–198. Cambridge, UK: Paper of the IUCN Species Survival Commission.

Dehnhardt, G., B. Mauck, W. Hanke, and H. Bleckmann. 2001. Hydrodynamic Trail-Following in Harbor Seals (*Phoca vitulina*). *Science* 293 (5527):102–104.

Derksen, C., R. Brown, L. Mudryk, K. Luojus, and S. Helfrich. 2017. NOAA Arctic Report Card: Terrestrial Snow Cover. Accessed December 2017. http://www.arctic.noaa.gov/Report-Card.

Dickey, M.-H., G. Gautheir, and M.-C. Cadieux. 2008. Climatic Effects on the Breeding Phenology and Reproductive Success of an Arctic-Nesting Goose Species. *Global Change Biology* 14 (9):1973–1985. doi: 10.1111/j.1365-2486.2008.01622.x.

Dodds, L. and B. Richmond. 2017. *Assessment of Historical Springtime Water Levels at the West Dock STP NOS Tide Gauge*.

Doiron, M., G. Gauthier, and E. Lévesque. 2014. Effects of Experimental Warming on Nitrogen Concentration and Biomass of Forage Plants for an Arctic Herbivore. *Journal of Ecology* 102 (2):508–517.

Duke University Energy Initiative. 2016. North Slope Borough: Huge Revenues, Future Challenges. Accessed October 23, 2016. https://energy.duke.edu/content/north-slope-borough-huge-revenues-future-challenges.

Dunton, K.H., T. Weingartner, and E.C. Carmack. 2006. The Nearshore Western Beaufort Sea Ecosystem: Circulation and Importance of Terrestrial Carbon in Arctic Coastal Food Webs. *Progress in Oceanography* 71 (2–4):362–378.

Durner, G.M., S.C. Amstrup, R.M. Nielson, and T.L. McDonald. 2004. *The Use of Sea Ice Habitat by Female Polar Bears in the Beaufort Sea*. Alaska OCS Study MMS 2004-014. Anchorage, AK: USGS, Alaska Science Center, and MMS.

Durner, G.M., D.C. Douglas, R.M. Nielson, S.C. Amstrup, T.L. McDonald, I. Stirling, M. Mauritzen, E.W. Born, Ø. Wiig, E. DeWeaver, M.C. Serreze, S.E. Belikov, M.M. Holland, M.H. Holland, J. Maslanik, J. Aars, D.A. Bailey, and A.E. Derocher. 2009. Predicting 21st Century Polar Bear Habitat Distribution from Global Climate Models. *Ecological Monographs* 79 (1):25–58.

Durner, G.M., A.S. Fischbach, S.C. Amstrup, and D.C. Douglas. 2010. *Catalogue of Polar Bear (Ursus maritimus) Maternal Den Locations in the Beaufort Sea and Neighboring Regions, Alaska, 1910–2010*. Data Series 568. Reston, VA: USGS.

Durner, G.M., K. Simac, and S.C. Amstrup. 2013. Mapping Polar Bear Maternal Denning Habitat in the National Petroleum Reserve-Alaska with an IFSAR Digital Terrain Model. *Arctic* 66 (2):197–206.

Earnst, S.L. 2004. *Status Assessment and Conservation Plan for the Yellow-Billed Loon (Gavia adamsii)*. Scientific Investigations Report 2004-5258. Reston, VA: USGS.

Eberhardt, L.E., R.A. Garrott, and W.C. Hanson. 1983. Den Use by Arctic Foxes in Northern Alaska. *Journal of Mammalogy* 64 (1):97–102.

Eberhardt, L.E., W.C. Hanson, J.L. Bengtson, R.A. Garrott, and E.E. Hanson. 1982. Arctic Fox Home Range Characteristics in an Oil-Development Area. *Journal of Wildlife Management* 46 (1):183–190.

Eisaguirre, J.M., T.L. Booms, C.P. Barger, S.B. Lewis, and G.A. Breed. 2019. Step Selection Functions on Energy Landscapes Reveal How Linear Features Alter Migration Movement in a Large Soaring Bird. BioRxiv Preprint. doi: 10.1101/805374

Ely, C.R., B.J. McCaffery, and R.E. Gill Jr. 2018. Shorebirds Adjust Spring Arrival Schedules with Variable Environmental Conditions: Four Decades of Assessment on the Yukon–Kuskokwim Delta, Alaska. In *Trends and Traditions: Avifungal Change in Western North America*, Studies of Western Birds no. 3, edited by W. D. Shuford, R. E. Gill Jr. and C. M. Handel, 296–311. Camarilla, CA: Western Field Ornithologists.

Engle, K.A. and L.S. Young. 1992. Movements and Habitat Use by Common Ravens from Roost Sites in Southwestern Idaho. *Journal of Wildlife Management* 56 (3):596–602.

EPA. 2016. *Technical Guidance for Assessing Environmental Justice in Regulatory Analysis*. Washington, D.C.

-----. 2017a. Basic Information about Visibility. Accessed December 2018. https://www.epa.gov/visibility/basic-information-about-visibility.

-----. 2017b. Climate Impacts in Alaska. https://archive.epa.gov/epa/climate-impacts/climate-impacts-alaska.html#Natives.

-----. 2018. Table 2. Acute Dose-Response Values for Screening Risk Assessments. Accessed October 3, 2018. https://www.epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants.

-----. 2019a. Facility Level Information on Greenhouse Gases Tool. Accessed May 2019. https://ghgdata.epa.gov/ghgp/main.do.

-----. 2019b. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017*. EPA 430-P-19-001. Washington, D.C.

-----. 2019c. Superfund Enterprise Management System. Accessed December 31, 2019. https://www.epa.gov/enviro/sems-search.

Epstein, H., U. Bhatt, M. Raynolds, D. Walker, B. Forbes, T. Horstkotte, M. Macias-Fauria, A. Martin, G. Pheonix, J. Bjerke, H. Tommervik, P. Fauchald, H. Vickers, R. Myneni, and C. Dickerson. 2017. NOAA Arctic Report Card 2017: Tundra Greenness. Accessed March 2019. http://www.arctic.noaa.gov/Report-Card.

Everett, K.R. 1980. Distribution and Properties of Road Dust Along the Northern Portion of the Haul Road. In *Environmental Engineering and Ecological Baseline Investigations Along the Yukon River-Prudhoe Bay Haul Road*, edited by J. Brown, 101–128. Hanover, NH: U.S. Army Cold Regions Research and Engineering Laboratory.

Everett, K.R., B.M. Murray, D.F. Murray, A.W. Johnson, A.E. Linkins, and P.J. Webber. 1985. *Reconnaissance Observations of Long-Term Natural Vegetation Recovery in the Cape Thompson Region, Alaska, and Additions to the Checklist of Flora*. Hanover, NH: Army Cold Regions Research and Engineering Laboratory.

Fabry, V.J., B.A. Seibel, R.A. Feely, and J.C. Orr. 2008. Impacts of Ocean Acidification on Marine Fauna and Ecosystem Processes. *ICES Journal of Marine Science* 65 (3):414–432. doi: 10.1093/icesjms/fsn048.

Fall, J.A. and M.L. Kostick. 2018. *Food Security and Wild Resource Harvests in Alaska*. Anchorage, AK: ADF&G, Division of of Subsistence.

Fancy, S.G. 1983. Movements and Activity Budgets of Caribou Near Oil Drilling Sites in the Sagavanirktok River Floodplain, Alaska. *Arctic* 36 (2):193–197.

Fancy, S.G., L.F. Pank, K.R. Whitten, and W.L. Regelin. 1989. Seasonal Movements of Caribou in Arctic Alaska as Determined by Satellite. *Canadian Journal of Zoology* 67 (3):644–650.

Fancy, S.G. and R.G. White. 1985. Energy Expenditures by Caribou while Cratering in Snow. *The Journal of Wildlife Management* 49 (4):987–993. doi: 10.2307/3801384.

Fancy, S.G. and R.G. White. 1987. Energy Expenditures for Locomotion by Barren-Ground Caribou. *Canadian Journal of Zoology* 65 (1):122–128. doi: 10.1139/z87-018.

Fauchald, P., T. Park, H. Tømmervik, R. Myneni, and V.H. Hausner. 2017. Arctic Greening from Warming Promotes Declines in Caribou Populations. *Science Advances* 3 (4):e1601365. doi: 10.1126/sciadv.1601365.

Felix, N.A. and M.K. Raynolds. 1989. The Effects of Winter Seismic Trails on Tundra Vegetation in Northeastern Alaska, U.S.A. *Arctic and Alpine Research* 21 (2):188–202.

Fenneman, N.M. 1946. Physiographic Divisions of the United States. *Annals of the Association of American Geographers* 6 (1).

Fields Simms, P., R. Billings, M. Pring, R. Oommen, D. Wilson, and M. Wolf. 2014. *Arctic Air Quality Modeling Study: Emissions Inventory, Final Task Report*. Alaska OCS Study BOEM 2014-1001. Anchorage, AK: Prepared by Eastern Research Group, Inc., for BOEM.

Fischbach, A.S., S.C. Amstrup, and D.C. Douglas. 2007. Landward and Eastward Shift of Alaskan Polar Bear Denning Associated with Recent Sea Ice Changes. *Polar Biology* 30 (11):1395–1405.

Fischer, J.B. and W.W. Larned. 2004. Summer Distribution of Marine Birds in the Western Beaufort Sea. *Arctic* 57 (2):143–159.

FLAG. 2010. *Federal Land Managers' Air Quality Related Values Work Group (FLAG): Phase I Report, Revised 2010*. Resource Report NPS/NRPC/NRR – 2012/232. Denver, CO: NPS, Natural Resource Program Center.

Flint, P.L., V. Patil, B. Shults, and S.J. Thompson. 2020. *Prioritizing Habitats Based on Abundance and Distribution of Molting Waterfowl in the Teshekpuk Lake Special Area of the National Petroleum Reserve, Alaska*. Open-File Report 2020-1034. Reston, VA: USGS.

Forbes, B.C., T. Kumpula, N. Meschtyb, R. Laptander, M. Macias-Fauria, P. Zetterberg, M. Verdonen, A. Skarin, K.-Y. Kim, L.N. Boisvert, J.C. Stroeve, and A. Bartsch. 2016. Sea Ice, Rain-On-Snow and Tundra Reindeer Nomadism in Arctic Russia. *Biology Letters* 12 (11):20160466. doi: doi:10.1098/rsbl.2016.0466.

Fried, N. 2015. Alaska's Cost of Living. *Alaska Economic Trends* 35 (July):4–13.

-----. 2018. The North Slope Oil Patch. *Alaska Economic Trends* 38 (August):4–8.

Fried, N. and D. Robinson. 2005. The Cost of Living in Alaska. *Alaska Economic Trends* 4 (July):4–18.

Frost, G.V., R.J. Ritchie, and T. Obritschkewitsch. 2007. *Spectacled and Stellar's Eiders Surveys at U.S. Air Force Radar Sites in Northern Alaska, 2006*. Fairbanks, AK: Report for U.S. Air Force, Elmendorf AFB, Anchorage by ABR, Inc.

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2000. Factors Affecting the Observed Densities of Ringed Seals, *Phoca hispida*, in the Alaskan Beaufort Sea, 1996–99. *Arctic* 57 (2):115–128.

Fuller, A.S. and J.C. George. 1999. *Evaluation of Subsistence Harvest Data from the North Slope Borough 1993 Census for Eight North Slope Villages for the Calendar Year 1992*. Barrow, AK: NSB, Department of Wildlife Management.

Fullman, T., L. Parrett, B. Person, and A. Prichard. 2018. Abstract: Individual Variability in Migration Timing and Destination for a Partially Migratory Caribou Herd. Alaska Chapter of the Wildlife Society and Northwest Section of the Wildlife Society 2018 Joint Annual Meeting, March 26–30, 2018: Wildlife Ecology, Management, and Conservation in a Changing Environment, Anchorage, AK.

Galginaitis, M. 2017. *Summary of the 2016 Subsistence Whaling Season at Cross Island*. Anchorage, AK: Prepared by Applied Sociocultural Research for Hilcorp Alaska, LLC.

Gehring, J., P. Kerlinger, and A.M. Manville. 2011. The Role of Tower Height and Guy Wires on Avian Collisions with Communication Towers. *The Journal of Wildlife Management* 75 (4):848–855.

Geraci, J.R. 1990. Physiological and Toxic Effects on Cetaceans. In *Sea Mammals and Oil: Confronting the Risks*, edited by Joseph R. Geraci and David J. St. Aubin, 167–192. San Diego, CA: Academic Press.

Gibbs, A.E. and B.M. Richmond. 2015. *National Assessment of Shoreline Change: Historical Shoreline Along the North Coast of Alaska, U.S.-Canadian Border to Icy Cape*. Reston, VA: USGS.

Gibbs, A.E., A.G. Snyder, and B. Richmond. 2019. *National Assessment of Shoreline Change—Historical Shoreline Change Along the North Coast of Alaska, Icy Cape to Cape Prince of Wales*. Open-File Report 2019-1146. Reston, VA: USGS.

Godin, E., D. Fortier, and S. Coulombe. 2014. Effects of Thermo-Erosion Gullying on Hydrologic Flow Networks, Discharge and Soil Loss. *Environmental Research Letters* 9 (10):105010.

Gollop, M.A., J.E. Black, B.E. Felske, and R.A. Davis. 1974. Disturbance Studies of Breeding Black Brant, Common Eiders, Glaucous Gulls, and Arctic Terns at Nunaluk Spit and Philips Bay, Yukon Territory, July 1972. In *Disturbance to Birds by Gas Compressor Noise Simulators, Aircraft and Human Activity in the Mackenzie Valley and the North Slope*, edited by W.W.H. Gunn and J.A. Livingston, 153–201. Calgary, Alberta: Prepared by LGL Ltd. Environmental Research Associates for Canadian Arctic Gas Study, Ltd. and Alaska Arctic Gas Study Co.

Gollop, M.A., J.R. Goldsberry, and R.A. Davis. 1974. Effects of Gas Compressor Noise Simulator Disturbance to Terrestrial Breeding Birds, Babbage River, Yukon Territory, June, 1972. In *Disturbance to Birds by Gas Compressor Noise Simulators, Aircraft and Human Activity in the Mackenzie Valley and the North Slope*, edited by W.W.H. Gunn and J.A. Livingston, 49–96. Calgary, Alberta: Prepared by LGL Ltd. Environmental Research Associates for Canadian Arctic Gas Study, Ltd. and Alaska Arctic Gas Study Co.

Gounder, P.P., R.C. Holman, S.M. Seeman, A.J. Rarig, M. MCEwen, C. Steiner, M.L. Bartholomew, and T.W. Hennessy. 2016. Infectious Disease Hospitalizations Among American Indian/Alaska Native and Non-American Indian/Alaska Native Persons in Alaska, 2010–2011. *Public Health Reports 2017* 132 (1):65–75. doi: 10.1177/0033354916679807.

Grabowski, M.M., F.I. Doyle, D.G. Reid, D. Mossop, and D. Talarico. 2013. Do Arctic-nesting birds respond to earlier snowmelt? A multi-species study in north Yukon, Canada. *Polar Biology* 36 (8):1097–1105.

Graff, N. 2016. *Breeding Ecology of Steller's and Spectacled Eiders Nesting near Barrow, Alaska, 2015*. Fairbanks, AK: USFWS, Fairbanks Field Office.

Green, G. and S. Negri. 2005. *Marine Mammal Monitoring Program, FEX Barging Project, 2005*. Anchorage, AK: Prepared by Tetra Tech EC, Inc. for ASRC Lynx Enterprises.

-----. 2006. *Marine Mammal Monitoring Program, FEX Barging Project, 2006*. Anchorage, AK: Prepared by Tetra Tech EC, Inc. for ASRC Lynx Enterprises.

Green, G.A., K. Hashagen, and D. Lee. 2007. *Marine Mammal Monitoring Program, FEX Barging Project, 2007*. Anchorage, AK: Prepared by Tetra Tech EC, Inc. for FEX LP.

Greene Jr., C., S.B. Blackwell, and M.W. McLennan. 2008. Sounds and Vibrations in the Frozen Beaufort Sea During Gravel Island Construction. *The Journal of the Acoustical Society of America* 123 (2):687–695. doi: 10.1121/1.2821970.

Griffith, B., D.C. Douglas, N.E. Walsh, D.D. Young, T.R. McCabe, D.E. Russell, R.G. White, R.D. Cameron, and K.R. Whitten. 2002. *The Porcupine Caribou Herd*. Biological Science Report 2002-00013. Reston, VA: USGS.

Guay, C.K. and K.K. Falkner. 1998. A Survey of Dissolved Barium in the Estuaries of Major Arctic Rivers and Adjacent Sea. *Continental Shelf Research* 18 (8):859–882.

Guettabi, M. 2017. What Do We Know About the Alaska Economy and Where It Is Heading? Presentation from the University of Alaska, Institute of Social and Economic Research. Anchorage, AK.

Guettabi, M., J. Greenberg, J. Little, and K. Joly. 2016. *Evaluating Differences in Household Subsistence Harvest Patterns between the Ambler Project and Non-Project Zones*. Natural Resource Report NPS/GAAR/NRR 2016/1280. Anchorage, AK: NPS.

Gunsch, M.J., R.M. Kirpes, K.R. Kolesar, T.E. Barrett, S. China, R.J. Sheesley, A. Laskin, A. Wiedensohler, T. Tuch, and K.A. Pratt. 2017. Contributions of Transported Prudhoe Bay Oil Field Emissions to the Aerosol Population in Utqiaġvik, Alaska. *Atmospheric Chemistry and Physics* 17 (17):10879–10892. doi: 10.5194/acp-17-10879-2017.

Gustine, D., P. Barboza, L. Adams, B. Griffith, R. Cameron, and K. Whitten. 2017. Advancing the Match-Mismatch Framework for Large Herbivores in the Arctic: Evaluating the Evidence For a Trophic Mismatch in Caribou. *PLOS ONE* 12 (2):e0171807. doi: 10.1371/journal.pone.0171807.

Guyer, S. and B. Keating. 2005. *The Impact of Ice Roads and Ice Pads on Tundra Ecosystems, National Petroleum Reserve-Alaska (NPR-A)*. Open File Report 98. Anchorage, AK: BLM, Alaska State Office.

Habitat Health Impact Consulting. 2014. *Health Indicators in the North Slope Borough Monitoring the Effects of Resource Development Projects*. Alberta, Canada: Prepared for NSB.

Hannon, S., P. Eason, and K. Martin. 2020. Willow Ptarmigan (*Lagopus lagopus*). In *Birds of the World*, edited by SM Billerman. Ithaca, NY: Cornell Lab of Ornithology.

Hansen, B.B., R. Aanes, I. Herfindal, J. Kohler, and B.-E. Sæther. 2011. Climate, Icing, and Wild Arctic Reindeer: Past Relationships and Future Prospects. *Ecology* 92 (10):1917–1923. doi: 10.1890/11-0095.1.

Harcharek, Q. 2015. *Spatial Analysis of Subsistence with GPS: Final Report*. Barrow, AK: Prepared for ADCCED.

Harrington, F.H. and A.M. Veitch. 1992. Calving Success of Woodland Caribou Exposed to Low-Level Jet Fighter Overflights. *Arctic* 45 (3):213–218.

Hartung, R. 1967. Energy Metabolism in Oil-Covered Ducks. *Journal of Wildlife Management* 31 (4):798–804.

Hastings, M.C. and A.N. Popper. 2005. *Effects of Sound on Fish*. Sacramento, CA: California Department of Transportation.

Hauser, D., V. Moulton, K. Christie, C. Lyons, G. Warner, C. O'Neill, D. Hannay, and S. Inglis. 2008. *Marine Mammal and Acoustic Monitoring of the Eni/PGS Open-Water Seismic Program near Thetis, Spy and Leavitt Islands, Alaskan Beaufort Sea, 2008: 90-Day Report*. Anchorage, AK: Prepared by LGL Alaska Research Associates Inc. and JASCO Research Ltd., for Eni US Operating Co. Inc., PGS Onshore, Inc., NMFS and USFWS.

Hedquist, S.L., L.A. Ellison, and A. Laurenzi. 2014. Public Lands and Cultural Resource Protecion: A Case Study of Unauthorized Damage to Archaeological Sites on the Tonto National Forest, Arizona. *Advances in Archaeological Practice* 2 (4):298–310.

Heim, K.C. 2014. Seasonal Movements of Arctic Grayling in a Small Stream on the Arctic Coastal Plain, Alaska. Master's thesis, University of Alaska, Fairbanks.

Heim, K.C., C.D. Arp, M.S. Whitman, and M.S. Wipfli. 2019. The Complementary Role of Lentic and Lotic Habitats for Arctic Grayling in a Complex Stream-Lake Network in Arctic Alaska. *Ecology of Freshwater Fish* 28 (2):209–221. doi: 10.1111/eff.12444.

Heim, K.C., M.S. Wipfli, M.S. Whitman, C.D. Arp, J. Adams, and A. Falke. 2015. Seasonal Cues of Arctic Grayling Movement in a Small Arctic Stream: The Importance of Surface Water Connectivity. *Environmental Biology of Fishes* 99 (1):49–65. doi: 10.1007/s10641-015-0453-x.

HHS. 2019. Annual Update of the HHS Poverty Guidelines, 2019 Poverty Guidelines for Alaska. *Federal Register* 84, no. 22 (February 1, 2019):1167–1168.

Hicks, A.L. and J.S. Larson. 1997. The Impact of Urban Stormwater Runoff on Freshwater Wetlands and the Role of Aquatic Invertebrate Bioassessment. In *Effects of Watershed Development and Management on Aquatic Ecosystems: Proceedings of an Engineering Foundation Conference*, edited by Larry A. Roesner. New York, NY: American Society of Civil Engineers.

Hinkel, K.M., C.D. Arp, A. Townsend-Small, and K.E. Frey. 2017. Can Deep Groundwater Influx be Detected from the Geochemistry of Thermokarst Lakes in Arctic Alaska? *Permafrost and Periglacial Processes* 28 (3):552–557.

Hoag, H. 2019. Fuzzy Fish: Moldy Fish in an Alaskan River Threaten a Community's Food Supply. Accessed August 7, 2019. https://www.hakaimagazine.com/news/fuzzy-fish/.

Hobbie, J.E. 1982. *Effects of Oil on Tundra Ponds and Streams: Final Report for Period October 1, 1978, to September 30, 1980*. Washington, D.C.: U.S. Department of Energy, Energy Research and Development Administration.

Holmes, W.N., J. Cronshaw, and J. Gorsline. 1978. Some Effects of Ingested Petroleum on Seawater-Adapted Ducks (*Anas platyrhynchos*). *Environmental Research* 17 (2):177–190.

HUD. 2019. FY 2019 Income Limits Summary. FY 2019 Income Limits Documentation System. Accessed May 16, 2019. https://www.huduser.gov/portal/datasets/il/il2019/2019summary.odn.

Hurst, R.J. and N.A. Øritsland. 1982. Polar Bear Thermoregulation: Effect of Oil on the Insulative Properties of Fur. *Journal of Thermal Biology* 7 (4):201–208.

Ice Design & Consult. 2020. *Willow Development Ocean Point Ice Bridge Revision*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

International Council on Clean Transportation. 2015. *A 10-Year Projection of Maritime Activity in the US Arctic Region*. Washington, DC: US Committee on the Marine Transportation System.

IPCC. 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press.

-----. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change*. Geneva, Switzerland: IPCC.

-----. 2018. *Summary for Policy Makers Global Warming of 1.5°C*. Geneva, Switzerland: IPCC.

Johnson, C.B., R.M. Burgess, B.E. Lawhead, J. Neville, J.P. Parrett, A.K. Prichard, J.R. Rose, A.A. Stickney, and A.M. Wildman. 2003. *Alpine Avian Monitoring Program, 2001: Fourth Annual and Synthesis Report*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corp.

Johnson, C.B., R.M. Burgess, A.M. Wildman, A.A. Stickney, P.E. Seiser, B.E. Lawhead, T.J. Mabee, J.R. Rose, and J.K. Shook. 2004. *Wildlife Studies for the Alpine Satellite Development Project, 2003*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc. and Anadarko Petroleum Corporation.

-----. 2005. *Wildlife Studies for the Alpine Satellite Development Project, 2004*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc., and Anadarko Petroluem Corporation.

Johnson, C.B. and B.E. Lawhead. 1989. *Distribution, Movements and Behavior of Caribou in the Kuparuk Oilfield, Summer 1988: Final Report*. Fairbanks, AK: Prepared by ABR, Inc. for ARCO Alaska, Inc.

Johnson, C.B., J.P. Parrett, and P.E. Seiser. 2008. *Spectacled Eider Monitoring at the CD-3 Development, 2007*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation.

Johnson, C.B., J.P. Parrett, P.E. Seiser, and J.K. Shook. 2019. *Avian Studies in the Willow Project Area, 2018*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Johnson, C.B., J.E. Shook, and R.M. Burgess. 2018. *Biological Assessment for the Polar Bear, Spectacled Eider, and Steller's Eider in the GMT-2 Project Area*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Johnson, C.B., J.E. Shook, J.P. Parrett, and P.E. Seiser. 2019. *Avian Studies for the Alpine Satellite Development Project, 2018*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Johnson, C.B., A.M. Wildman, A.K. Prichard, and C.L. Rea. 2019. Territory Occupancy by Yellow-Billed Loons near Oil Development. *Journal of Wildlife Management* 83 (2):410–425.

Johnson, H.E., T. Golden, L.G. Adams, D. Gustine, and E.A. Lenart. 2019. Caribou Use of Habitat near Energy Development in Arctic Alaska. *Journal of Wildlife Management* 58 (1):1–9. doi: 10.1002/jwmg.21809.

Johnson, J. and B. Blossom. 2017. *Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes: Arctic Region*. Special Publication No. 17-01. Anchorage, AK: ADF&G.

Johnson, J.A., R.B. Lanctot, B.A. Andres, J.R. Bart, S.C. Brown, S.J. Kendall, and D.C. Payer. 2007. Distribution of Breeding Shorebirds on the Arctic Coastal Plain of Alaska. *Arctic* 60 (3):277–293.

Johnson, S.R. and D.R. Herter. 1989. *The Birds of the Beaufort Sea*. Anchorage, AK: BP Exploration (Alaska), Inc.

Johnson, S.W., J.F. Thedinga, A.D. Neff, and C.A. Hoffman. 2010. *Fish Fauna in Nearshore Waters of a Barrier Island in the Western Beaufort Sea, Alaska*. NOAA Technical Memorandum NMFS-AFSC-210. Seattle, WA: NMFS and NOAA, Alaska Fisheries Science Center.

Johnstone, J., D.E. Russell, and D.B. Griffith. 2002. Variations in Plant Forage Quality in the Range of the Porcupine Caribou Herd. *Rangifer* 22 (1):83–91.

Joly, K., F.S. Chapin, and D.R. Klein. 2010. Winter Habitat Selection by Caribou in Relation to Lichen Abundance, Wildfires, Grazing, and Landscape Characteristics in Northwest Alaska. *Écoscience* 17 (3):321–333. doi: 10.2980/17-3-3337.

Jorgenson, J.C., J.M. Ver Hoef, and M.T. Jacobson. 2010. Long-Term Recovery Patterns of Arctic Tundra after Winter Seismic Exploration. *Ecological Applications* 20 (1):205–221.

Jorgenson, M.T. and M.R. Joyce. 1994. Six Strategies for Rehabilitating Land Disturbed by Oil Development in Arctic Alaska. *Arctic* 47 (4):374–390.

Jorgenson, M.T., M. Kanevskiy, Y. Shur, J. Grunblatt, C.L. Ping, and G. Michaelson. 2015. *Permafrost Database Development, Characterization and Mapping for Northern Alaska*. Anchorage, AK: Prepared for USFWS, Arctic Landscape Conservation Cooperative.

Joyce, M.R., L.A. Rundquist, L.L. Moulton, R.W. Firth, and E.H. Follmann. 1980. *Gravel Removal Guidelines Manual for Arctic and Subarctic Floodplains*. Washington, D.C.: USFWS, Biological Services Program.

Kelleyhouse, R.A. 2001. Calving-Ground Selection and Fidelity: Teshekpuk Lake and Western Arctic Herds. Master's thesis, University of Alaska, Fairbanks.

Kelly, B.P., O.H. Badajos, M. Kunnasranta, J.R. Moran, M. Martinez-Bakker, D. Wartzok, and P. Boveng. 2010. Seasonal Home Ranges and Fidelity to Breeding Sites among Ringed Seals. *Polar Biology* 33 (8):1095–1109.

Kertell, K. 1996. Response of Pacific Loons (*Gavia pacifica*) to Impoundments at Prudhoe Bay, Alaska. *Arctic* 49 (4):356–366.

Kharaka, Y.K. and W.W. Carothers. 1988. Geochemistry of Oil-Field Water from the North Slope. In *Geology and Exploration of the National Petroleum Reserve in Alaska, 1974 to 1982*, U.S. Geological Survey Paper 1399, edited by G. Gryc, 551–561. Washington, D.C.: USGS.

Kinnetic Laboratories Inc. 2018. *2018 Willow Marine Monitoring Program Report*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

Klimstra, R. 2018. *Summary of Teshekpuk Caribou Herd Photo Census Conducted July 14, 2017*. Fairbanks, AK: ADF&G, Division of Wildlife Conservation.

Klinger, L.F., D.A. Walker, D.M. Walker, and P.J. Weber. 1983. The Effects of Gravel Roads on Alaskan Arctic Coastal Plain Tundra. In *Permafrost: Fourth International Conference Proceedings*, 628–633. Washington, D.C.: National Academy Press.

Kofinas, G., S.B. BurnSilver, J. Magdanz, R. Stotts, and M. Okada. 2016. *Subsistence Sharing Networks and Cooperation: Kaktovik, Wainwright, and Venetie, Alaska*. BOEM Report 2015-023, AFES Report MP 2015-02. Fairbanks, AK: School of Natural Resources and Extension, University of Alaska Fairbanks.

Kolesar, K.R., J. Cellini, P.K. Peterson, A. Jefferson, T. Tuch, W. Birmili, A. Wiedensohler, and K.A. Pratt. 2017. Effect of Prudhoe Bay Emissions on Atmospheric Aerosol Growth Events Observed in Utqiaġvik (Barrow), Alaska. *Atmospheric Environment* 152 (March):146–155. doi: 10.1016/j.atmosenv.2016.12.019.

Kornbrath, R.W. 1995. *Analysis of Historical Oil and Gas Lease Sale and Exploration Data for Alaska*. Vol. 95–11. Fairbanks, AK: ADNR, Division of Geological and Geophysical Surveys.

Kuropat, P.J. 1984. Foraging Behavior of Caribou on a Calving Ground in Northwestern Alaska. Master's thesis, University of Alaska, Fairbanks.

Kutasov, I.M. 2006. Radius of Thawing around an Injection Well and Time of Complete Freezeback. *Journal of Geophysics and Engineering* 3 (2):154–159. doi: 10.1088/1742-2132/3/2/006.

Kutz, S., T. Bollinger, M. Branigan, S. Checkley, T. Davison, M. Dumond, B. Elkin, T. Forde, W. Hutchins, A. Niptanatiak, and K. Orsel. 2015. *Erysipelothrix rhusiopathiae* Associated with Recent Widespread Muskox Mortalities in the Canadian Arctic. *The Canadian Veterinary Journal* 56 (6):560–563.

Lack, D.A. and J.J. Corbett. 2012. Black Carbon from Ships: A Review of the Effects of Ship Speed, Fuel Quality and Exhaust Gas Scrubbing. *Atmospheric Chemistry and Physics* 12 (9):3985–4000. doi: 10.5194/acp-12-3985-2012.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions Between Ships and Whales. *Marine Mammal Science* 17 (1):35–75.

Lamancusa, J.S. 2000. *Human Response to Sound. From Course Syllabus, ME 458 Engineering Noise Control, Fall 2000*. State College, PA: Pennsylvania State University.

Larned, W., R.A. Stehn, and R.M. Platte. 2012. *Waterfowl Breeding Population Survey, Arctic Coastal Plain, Alaska, 2011*. Anchorage, AK: USFWS, Division of Migratory Bird Management.

Larson, W.G., T.S. Smith, and G. York. 2020. Human Interaction and Disturbance of Denning Polar Bears on Alaska's North Slope. *Arctic* 73 (2):195–205.

Laske, S.M., T.B. Haynes, A.E. Rosenberger, J.C. Koch, M.S. Wipfli, M. Whitman, and C.E. Zimmerman. 2016. Surface Water Connectivity Drives Richness and Composition of Arctic Lake Fish Assemblages. *Freshwater Biology* 61 (7):1090–1104. doi: doi:10.1111/fwb.12769.

Lawhead, B.E. 1988. Distribution and Movements of Central Arctic Caribou Herd During the Calving and Insect Seasons. In *Reproduction and Calf Survival: Proceedings of the 3rd North American Caribou Workshop, Chena Hot Springs, Alaska, 4–6 November 1987*, Wildlife Techincal Bulletin No. 8, edited by Raymond D. Cameron, James L. Davis and Laura M. McManus, 8–13. Juneau, AK: ADF&G.

Lawhead, B.E., L.C. Byrne, and C.B. Johnson. 1993. Caribou Synthesis, 1987–1990. In *1990 Endicott Environmental Monitoring Program Final Report*, Vol. V. Anchorage, AK: USACE, Alaska District.

Lawhead, B.E. and D.A. Flint. 1993. *Caribou Movements in the Vicinity of the Proposed Drill Site 3-T Facilities, Kuparuk Oilfield, 1991–1992*. Fairbanks, AK: Prepared by ABR, Inc. for ARCO Alaska, Inc.

Lawhead, B.E., J.P. Parrett, A.K. Prichard, and D.A. Yokel. 2006. *A Literature Review and Synthesis on the Effect of Pipeline Height on Caribou Crossing Success*. Open-File Report 106. Fairbanks, AK: BLM.

Lawhead, B.E. and A.K. Prichard. 2002. *Surveys of Caribou and Muskoxen in the Kuparuk-Colville Region, Alaska, 2001*. Fairbanks, AK: Prepared by ABR, Inc. for Phillips Alaska, Inc.

Lawhead, B.E., A.K. Prichard, M.J. Macander, and M. Emers. 2004. *Caribou Mitigation Monitoring Study for the Meltwater Project, 2003: Third Annual Report*. Anchorage, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Leach, A.G., D.H. Ward, J.S. Sedinger, M.S. Lindberg, W.S. Boyd, J.W. Hupp, and R.J. Ritchie. 2017. Declining Survival of Black Brant from Subarctic and Arctic Breeding Areas. *The Journal of Wildlife Management* 81 (7):1210–1218. doi: 10.1002/jwmg.21284.

Leblond, M., M.-H. St-Laurent, and S.D. Côté. 2016. Caribou, Water, and Ice: Fine-Scale Movements of a Migratory Arctic Ungulate in the Context of Climate Change. *Movement Ecology* 4:1–12. doi: 10.1186/s40462-016-0079-4.

Lenart, E.A. 2015. Units 26B and 26C - Caribou. In *Caribou Management Report of Survey and Inventory Activities, 1 July 2012–30 June 2014*, Species Management Report ADF&G/DWC/SMR-2015-4, edited by P. Harper and L. A. McCarthy, 18-1 to 18-38. Juneau, AK: ADF&G.

-----. 2017. *2016 Central Arctic Caribou Photocensus*. Fairbanks, AK: ADF&G, Division of Wildlife Conservation.

-----. 2018. *Central Arctic Caribou Digital Camera System Photocensus Results*. Fairbanks, AK: ADF&G, Division of Wildlife Conservation.

Lewis, D.B., M. Walkey, and H.J.G. Dartnall. 1972. Some Effects of Low Oxygen Tensions on the Distribution of the Three-Spined Stickleback *Gasterosteus aculeatus (L.)* and the Nine-Spined Stickleback *Pungitius pungitius (L.)*. *Journal of Fish Biology* 4 (1):103–108. doi: 10.1111/j.1095-8649.1972.tb05658.x.

Lewis, S.J. and R.A. Malecki. 1984. Effects of Egg Oiling on Larid Productivity and Population Dynamics. *Auk* 101 (3):584–592.

LGL Alaska Research Associates Inc. 1994. *Mitigation of the Effects of Oil Field Development and Transportation Corridors on Caribou*. Anchorage, AK: Final Report to the Alaska Caribou Steering Committee.

LGL Alaska Research Associates Inc., Greenridge Sciences, and Jasco Applied Sciences, eds. 2013. *Joint Monitoring Program in the Chukchi and Beaufort Seas, 2012*. Anchorage, AK: Prepared for Shell Offshore Inc, ION Geophysical, Inc. and Other Industry Contributors, NMFS, and USFWS.

LGL Ecological Research Associates. 1993. *Guidelines For Oil and Gas Operations in Polar Bear Habitats*. Alaska OCS Study MMS 93-0008. Anchorage, AK: MMS.

Liebezeit, J., G. White, and S. Zack. 2011. Breeding Ecology of Birds at Teshekpuk Lake: A Key Habitat Site on the Arctic Coastal Plain of Alaska. *Arctic* 64 (1):32–44.

Liebezeit, J.R., K.E.B. Gurney, M. Budde, S. Zack, and D. Ward. 2014. Phenological Advancement in Arctic Bird Species: Relative Importance of Snow Melt and Ecological Factors. *Polar Biology* 37 (9):1309–1320. doi: 10.1007/s00300-014-1522-x.

Liebezeit, J.R., S.J. Kendall, S. Brown, C.B. Johnson, P.D. Martin, T.L. McDonald, D.C. Payer, C.L. Rea, B. Streever, A.M. Wildman, and S. Zack. 2009. Influence of Human Development and Predators on Nest Survival of Tundra Birds, Arctic Coastal Plain, Alaska. *Ecological Applications* 19 (6):1628–1644.

Limpinsel, D.E., M.P. Eagleton, and J.L. Hanson. 2017. *Impacts to Essential Fish Habitat from Non-Fishing Activities in Alaska: EFH 5-Year Review, 2010 through 2015*. NOAA Technical Memorandum NMFS-F/AKR-14. Anchorage, AK: NMFS.

Livezey, K.B., J.E. Fernandez, and D.T. Blumstein. 2016. Database of Bird Flight Initiation Distances to Assist in Estimating Effects from Human Disturbance and Delineating Buffer Areas. *Journal of Fish and Wildlife Management* 7 (1):181–191.

Loe, L.E., B.B. Hansen, A. Stien, S. D. Albon, R. Bischof, A. Carlsson, R.J. Irvine, M. Meland, I.M. Rivrud, E. Ropstad, V. Veiberg, and A. Mysterud. 2016. Behavioral Buffering of Extreme Weather Events in a High-Arctic Herbivore. *Ecosphere* 7 (6):e01374. doi: 10.1002/ecs2.1374.

Logerwell, E., M. Busby, C. Carothers, S. Cotton, J. Duffy-Anderson, E. Farley, P. Goddard, R. Heintz, B. Holladay, J. Horne, S. Johnson, B. Lauth, L. Moulton, D. Neff, B. Norcross, S. Parker-Stetter, J. Seigle, and T. Sformo. 2015. Fish Communities across a Spectrum of Habitats in the Western Beaufort Sea and Chukchi Sea. *Progress in Oceanography* 136:115–132. doi: 10.1016/j.pocean.2015.05.013.

Loranty, M.M. and S.J. Goetz. 2012. Shrub Expansion and Climate Feedbacks in Arctic Tundra. *Environmental Research Letters* 7 (1):011005. doi: 10.1088/1748-9326/7/1/011005.

Lysne, L.A., E.J. Mallek, and C.P. Dau. 2004. *Near-Shore Surveys of Alaska's Arctic Coast, 1999–2003*. Fairbanks, AK: USFWS, Migratory Bird Management Waterfowl Branch.

MacKinnon, C.M. and A.C. Kennedy. 2011. Migrant Common Eider, *Somateria mollissima*, Collisions with Power Transmission Lines and Shortwave Communication Towers on the Tantramar Marsh in Southeastern New Brunswick. *Canadian Field-Naturalist* 125 (1):41–46.

Mallory, C.D. and M.S. Boyce. 2017. Observed and Predicted Effects of Climate Change on Arctic Caribou and Reindeer. *Environmental Reviews* 26 (1):13–25. doi: 10.1139/er-2017-0032.

Markon, C.J., S.F. Trainor, and F.S. Chapin, III. 2012. *The United States National Climate Assessment—Alaska Technical Regional Report*. Circular 1379. Reston, VA: USGS.

Martin, P.D., J.L. Jenkins, F.J. Adams, M.T. Jorgenson, A.C. Matz, D.C. Payer, P.E. Reynolds, A.C. Tidwell, and J.R. Zelenak. 2009. *Wildlife Response to Environmental Arctic Change: Predicting Future Habitats of Arctic Alaska*. Report from the Wildlife Response to Environmental Arctic Change (WildReach): Predicting Future Habitats of Arctic Alaska Workshop, 17–18 November, 2008. Fairbanks, AK: USFWS.

Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L.K. Sahu, Y. Zhao, H.E. Fuelberg, W.R. Sessions, G. Diskin, D.R. Blake, A. Wisthaler, and M. Koike. 2011. Seasonal Variation of the Transport of Black Carbon Aerosol from the Asian Continent to the Arctic During the ARCTAS Aircraft Campaign. *Journal of Geophysical Research: Atmospheres* 116 (D5). doi: 10.1029/2010jd015067.

McAninch, J.M.D. 2012. *Baseline Community Health Analysis Report*. Barrow, AK: NSB, Department of Health and Social Services.

McConnell, B., M. Fedak, P. Lovell, and P. Hammond. 1999. Movements and Foraging Areas of Grey Seals in the North Sea. *Journal of Applied Ecology* 36 (4):573–590.

McDowell Group. 2014. *The Role of the Oil and Gas Industry in Alaska's Economy*. Anchorage, AK: Prepared for Alaska Oil and Gas Association

-----. 2017. *The Role of the Oil and Gas Industry in Alaska's Economy*. Anchorage, AK: Prepared for Alaska Oil and Gas Association.

McEachen, H. and K. Maher. 2016. Abstract: First Steps for a Monitoring Program: The Division of Mining, Land, and Water Turns Its Attention to Invasive Plants. Proceedings of the 17th Annual Invasive Species Workshop, Fairbanks, AK.

McFarland, J., B. Morris, C.R. Moulton, and L. Moulton. 2017a. *Fish Populations in Waterbodies of the Willow Project Area: 2017. Final Report*. Anchorage, AK: Prepared by Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

-----. 2017b. *Survey of Lakes in ConocoPhillips Alaska, Inc. Activities Areas, 2017*. Anchorage, AK: Prepared by Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

-----. 2019a. *Fish Populations in Waterbodies of the Willow Project Area: 2018*. Anchorage, AK: Prepared by Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

-----. 2019b. *Survey of Lakes in ConocoPhillips Alaska, Inc. Activities Areas, 2018*. Anchorage, AK: Prepared by Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

McFarland, J., B. Morris, L. Moulton, and C.R. Moulton. 2020. *Fish Surveys in the Northeastern NPR-A, 2019*. Anchorage, AK: Prepared for Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

McFarland, J., W.A. Morris, C.R. Moulton, L. Moulton, and K.M. Ferry. 2019. *Fish Surveys in the Northeastern NPR-A, 2018*. Anchorage, AK: Prepared by Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

McFarland, J., W.A. Morris, C.R. Moulton, L.L. Moulton, and M. Tibbles. 2020. *Draft Fish Surveys in the Northeastern NPR-A, 2019, Data Submittal*. Anchorage, AK: Prepared by Owl Ridge Natural Resource Consultants, Inc. for ConocoPhillips Alaska, Inc.

McGuire, A.D. 2013. *Modeling Thermokarst Dynamics in Boreal and Arctic Regions of Alaska and Northwest Canada: A White Paper*. Fairbanks, AK: Alaska Climate Adaptation Science Center, Thermokarst Working Group of the Integrated Ecosystem Model for Alaska and Northwest Canada.

McIntyre, C., D. Douglas, and M. Collopy. 2008. Movements of Golden Eagles from Interior Alaska During their First Year of Independence. *Auk* 125 (1):214–224.

McIntyre, C. and S. Lewis. 2018. Statewide Movements of Non-Territorial Golden Eagles in Alaska During the Breeding Season: Information for Developing Effective Conservation Plans. *Alaska Park Science* 17 (1):65–73.

McKinnon, L., M. Picotin, E. Bolduc, C. Juillet, and J. Bêty. 2012. Timing of Breeding, Peak Food Availability, and Effects of Mismatch on Chick Growth in Birds Nesting in the High Arctic. *Canadian Journal of Zoology* 90 (8):961–971. doi: 10.1139/z2012-064.

Meixell, B.W. and P.L. Flint. 2017. Effects of Industrial and Investigator Disturbance on Arctic-Nesting Geese. *The Journal of Wildlife Management* 81 (8):1372–1385. doi: 10.1002/jwmg.21312.

Melillo, J.M., T.T. Richmond, and G. Yohe, eds. 2014. *Climate Change Impacts in the United States: Third National Climate Assessment*. Edited by U.S. Global Change Research Program. Washington, D.C.: U.S. Government Printing Office.

Meltofte, H., T. Piersma, H. Boyd, B. McCaffery, B. Ganter, V.V. Golovnyuk, K. Graham, C.L. Gratto-Trevor, R.I.G. Morrison, E. Nol, H.-U. Rösner, D. Schamel, H. Schekkerman, M.Y. Soloviev, P.S. Tomkovich, D.M. Tracy, I. Tulp, and L. Wennerberg. 2007. Effects of Climate Variation on the Breeding Ecology of Arctic Shorebirds. *Bioscience: Monographs on Greenland* 59:1–48.

Merrill, M.D., B.M. Sleeter, P.A. Freeman, J. Liu, P.D. Warwick, and B.C. Reed. 2018. *Federal Lands Greenhouse Emissions and Sequestration in the United States—Estimates for 2005–14*. Scientific Investigations Report 2018-5131. Reston, VA: USGS.

Michael Baker International. 2007. *2006 Colville River Delta and Fish Creek Basin Spring Breakup and Hydrological Assessment*. Document No. 108604-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2014a. *Alpine Area Lakes Recharge Studies*. Document No. 139279-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2014b. *CD5 Lakes Recharge Studies*. Document No. 141010-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2014c. *Evaporation Lakes Recharge Studies*. Document No. 141011-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2015a. *Alpine Area Lakes Recharge Studies*. Document No. 139279-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2015b. *Colville River Delta Spring Breakup Monitoring and Hydrological Assessment*. Document No. 148414-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2017. *Colville River East Channel Stage Frequency Analysis*. Document No. GE-GE01-HHRE-040003. Anchorage, AK: Prepared for Armstrong Energy, LLC.

-----. 2019. *2019 Willow Ice Road Fall Field Trip Report*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2020. *Summary Report, Willow Ice Road - Ocean Point Water Resources Field Investigation*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

Michael Baker Jr. Inc. 2002a. *Alpine Facility and Vicinity Lake Monitoring and Recharge Study*. Document No. 25288-MBJ-DOC-002. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2002b. *Lake Monitoring and Recharge Study, National Petroleum Reserve-Alaska, 2002*. Document No. 25288-MBJ-DOC-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2007a. *Colville River Delta Lakes Recharge Monitoring and Analysis*. Document No. 110919-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2007b. *Lake L9323 Monitoring and Analylsis: Project Note 111012*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2008. *2006–2007 Alpine Drinking Water Lakes Monitoring and Recharge Study*. Document No. 108603-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2009. *Spring Breakup 2009 Lake L9322 Monitoring and Analysis*. Document No. 115159-MBJ-PN-002. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2011. *Alpine Ice Road Recharge Studies*. Document No. 123593-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2012. *Final Alpine Area Lakes Recharge Studies*. Document No. 127660-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2013a. *Alpine Area Lakes Recharge Studies*. Document No. 135205-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2013b. *Cassin Lakes Recharge Study*. Document No. 134783-MBJ-RPT-001. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

Miller, F.L. and A. Gunn. 1979. *Responses of Peary Caribou and Muskoxen to Helicopter Harassment*. Ottawa, Ontario: Environment Canada, Canadian Wildlife Service.

Molnár, P.K., A.E. Derocher, G.W. Thiemann, and M.A. Lewis. 2010. Predicting Survival: Reproduction and Abundance of Polar Bears under Climate Change. *Biological Conservation* 143 (7):1612–1622.

Monda, M.J., J.T. Rattie, and T.R. McCabe. 1994. Reproductive Ecology of Tundra Swans on the Arctic National Wildlife Refuge, Alaska. *Journal of Wildlife Management* 58 (4):757–773.

Montgomerie, R. and K. Holder. 2020. Rock Ptarmigan (*Lagopus muta*). In *Birds of the World*, edited by SM Billerman, BK Keeney, P. G. Rodewald and TS Schulenberg. Ithaca, NY: Cornell Lab of Ornithology.

Morgan, T. and L.B. Attanas. 2018. *Avian Studies in the Kuparuk Oilfield, 2017*. Fairbanks, AK: Data report prepared for ConocoPhillips Alaska, Inc. and the Kuparuk River Unit, Anchorage, AK, by ABR, Inc.

Morris, W. 2000. Seasonal Movements of Broad Whitefish (*Coregonus nasus*) in the Freshwater Systems of the Prudhoe Bay Oil Field. Master's thesis, University of Alaska Fairbanks.

-----. 2003. *Seasonal Movements and Habitat Use of Arctic Grayling (Thymallus arcticus), Burbot (Lota lota), and Broad Whitefish (Coregonus nasus) within the Fish Creek Drainage of the National Petroleum Reserve-Alaska, 2001–2002*. Technical Report No. 03-02. Fairbanks, AK: Prepared for NSB, Department of Wildlife Management and ADNR, Office of Habitat Management and Permitting

Morris, W., L.L. Moulton, J. Bacon, J.R. Rose, and M.S. Whitman. 2006. *Seasonal Movements and Habitat Use by Broad Whitefish (Coregonus nasus) in the Teshekpuk Lake Region of the National Petroleum Reserve-Alaska, 2003–2005*. Technical Report No. 06-04. Fairbanks, AK: Prepared for ADNR, Office of Habitat Management and Permitting

Morris, W.A. and J.F. Winters. 2009. *Liberty Project – Sagavanirktok River Bridge Water Quality/Fish Investigation. Trip Report, April 7 & 8, 2009*. Fairbanks, AK: ADF&G.

Moulton, L.L. 2002. *Water Withdrawal Effects on Ninespine Stickleback and Alaska Blackfish*. Anchorage, AK: Prepared by MJM Research for ConocoPhillips, Alaska.

Moulton, L.L. 2004. *Depth Measurements in the Lower Ublutuoch River, July 30–31, 1999*. Lopez Island, WA: Prepared by MJM Research for ARCO Alaska Inc.

Moulton, L.L. and M.H. Fawcett. 1984. *Oliktok Point Fish Studies - 1983*. Anchorage, AK: Prepared by MJM Research for ARCO Alaska Inc.

Moulton, L.L., B. Morris, C. George, J.R. Rose, and M.S. Whitman. 2007. *Surveys of Fish Habitats in the Teshekpuk Lake Region, 2003–2005*. Lopez Island, WA: Report prepared for NSB, Department of Wildlife Management.

Moulton, L.L. and J. Pausanna. 2006. *Harvest Rates for the 2006 Colville River Broad Whitefish and Burbot Fisheries*. Lopez Island, WA: Report by MJM Research for ConocoPhillips Alaska, Inc.

Moulton, L.L., B. Seavey, and J. Pausanna. 2006. *Harvest Rates for the 2005 Colville River Fall Fishery*. Lopez Island, WA: Report by MJM Research for ConocoPhillips Alaska, Inc.

Moulton, L.L., B. Seavey, and J. Pausanna. 2010. History of an Under-Ice Subsistence Fishery for Arctic Cisco and Least Cisco in the Colville River, Alaska. *Arctic* 63 (4):381–390.

Moulton, V.D., W.J. Richardson, M.T. Williams, and S.B. Blackwell. 2003. Ringed Seal Densities and Noise near an Icebound Artificial Island with Construction and Drilling. *Acoustic Research Letters Online* 4 (4):112–117.

Murphy, S.M. and B.A. Anderson. 1993. *Lisburne Terrestrial Monitoring Program: The Effects of the Lisburne Development Project on Geese and Swans, 1985–1989: Final Synthesis Report*. Fairbanks, AK: Prepared for ARCO Alaska, Inc.

Murphy, S.M. and J.A. Curatolo. 1987. Activity Budgets and Movement Rates of Caribou Encountering Pipelines, Roads, and Traffic in Northern Alaska. *Canadian Journal of Zoology* 65 (10):2483–2490.

Murphy, S.M. and B.E. Lawhead. 2000. Caribou. In *The Natural History of an Arctic Oil Field: Development and the Biota*, edited by Joe C. Truett and Stephen R. Johnson. San Diego, CA: Academic Press.

Murphy, S.M., D.E. Russell, and R.G. White. 2000. Modeling Energetic and Demographic Consequences of Caribou Interactions with Oil Development in the Arctic. *Rangifer Special Issue No. 12*:107–109.

Muto, M.M., V. Helker, R.P. Angliss, B.A. Allen, P.L. Boveng, J.M. Breiwick, M.F. Cameron, P.J. Clapham, S.P. Dahle, M.E. Dahlheim, B. Fadely, M.C. Ferguson, L. Fritz, R. Hobbs, Y. Ivashenko, A.C. Kennedy, J. London, S. Mizroch, R. Ream, E. Richmond, K.E.W. Shelden, R. Towell, P. Wade, J. Waite, and A. Zerbini. 2018. *Alaska Marine Mammal Stock Assessments, 2017*. NOAA Technical Memorandum NMFS-AFSC-378. Seattle, WA: NMFS and NOAA, Alaska Fisheries Science Center.

Myers-Smith, I.H., B.K. Arnesenm, R.M. Thompson, and F.S. Chapin, III. 2006. Cumulative Impacts on Alaskan Arctic Tundra of a Quarter Century of Road Dust. *Ecoscience* 13 (4):503–510.

NADP. 2018. *NADP Program Office, Wisconsin State Laboratory of Hygiene*.

Naito, A.T. and D.M. Cairns. 2014. Patterns of Shrub Expansion in Alaskan Arctic River Corridors Suggest Phase Transition. *Ecology and Evolution* 5 (1):87–101.

NEI. 2020. *Updated Economic Analysis of Proposed Alternatives for the Willow Master Development Plan EIS*. Unpublished Memorandum from Patrick Burden and Leah Cuyno, NEI to Kristen Hansen, DOWL. January 17, 2020.

Nellemann, C. and R.D. Cameron. 1998. Cumulative Impacts of an Evolving Oil-Field Complex on the Distribution of Calving Caribou. *Canadian Journal of Zoology* 76 (8):1425–1430.

Nellemann, C., I. Vistnes, P. Jordhøy, O. Strand, and A. Newton. 2003. Progressive Impact of Piecemeal Infrastructure Development on Wild Reindeer. *Biological Conservation* 113 (2):307–317. doi: 10.1016/S0006-3207(03)00048-X.

Newby, T.C., F.M. Hart, and R.A. Arnold. 1970. Weight and Blindness of Harbor Seals. *Journal of Mammalogy* 51 (1):152–152.

Nicholson, K.L., S.M. Arthur, J.S. Horne, E.O. Garton, and P.A. Del Vecchio. 2016. Modeling Caribou Movements: Seasonal Ranges and Migration Routes of the Central Arctic Herd. *PLOS ONE* 11 (4):e0150333. doi: 10.1371/journal.pone.0150333.

NMFS. 2008. *Recovery Plan for the Steller Sea Lion (Eumatopia jubatus)*. Juneau, AK: NMFS.

-----. 2012. *Letter of Concurrence to BLM for the Proposed National Petroleum Reserve in Alaska Integrated Activity Plan/Environmental Impact Statement*. Anchorage, AK.

-----. 2018. *Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. NOAA Technical Memorandum NMFS-OPR-59. Seattle, WA: NOAA and NMFS.

Noel, L.E., R.H. Pollard, W.B. Ballard, and M.A. Cronin. 1998. Activity and Use of Active Gravel Pads and Tundra by Caribou, *Rangifer tarandus granti*, within the Prudhoe Bay Oil Field, Alaska. *Canadian Field-Naturalist* 112 (3):400–409.

Noise Pollution Clearinghouse. 2019. Online Resource Library. Accessed May 26. http://www.nonoise.org/resource/educat/ownpage/soundlev.htm.

North Pacific Fishery Management Council. 2009. *Fishery Management Plan for the Salmon Fisheries in the EEZ Off Alaska*. Anchorage, AK: Prepared by NPFMC, NMFS, and ADF&G.

-----. 2012. *Fishery Management Plan for Fish Resources of the Arctic Management Area*. Anchorage, AK: Prepared by NPFMC, NMFS, and ADF&G.

North Slope Science Initiative. 2011. NSSI Lakes Data: Mapping Winter Liquid Water Availability in Lakes on the North Slope Coastal Plain of Alaska Using Sythetic Aperture Radar (SAR). http://catalog.northslopescience.org/catalog/entries/4782-nssi-lakes-data-mapping-winter-l

NPS. 2011a. *Air Quality Related Values*. Denver, CO: NPS, Natural Resource Stewardship and Science Air Resources Division.

-----. 2011b. *Everglades and Dry Tortugas National Parks : Noise Source Measurement Summary Report*. Fort Collins, CO: NPS, Natural Resource Program Center.

-----. 2018. Alaska Ecoregions: Tundra and Taiga. Accessed June 2018. https://www.nature.nps.gov/air/studies/criticalLoads/Ecoregions/AK_Taiga_Tundra.cfm.

NRC. 2003. *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope*. Washington, D.C.: National Academies Press.

NSB. 2005. *North Slope Borough Area Wide Comprehensive Plan*. Barrow, AK.

-----. 2011. *2010 Economic Profile and Census, Volume X*. Barrow, AK: Prepared by Carl E. Shepro, David C. Maas, Donald G. Callaway and Jana McAnich.

-----. 2015a. *Comprehensive Annual Financial Report of the North Slope Borough: July 1, 2014–June 30, 2015*. Barrow, AK.

-----. 2015b. *Health Impact Assessment in the North Slope Borough: A Guide for Stakeholders, Decision-Makers and Project Proponents*. Barrow, AK.

-----. 2015c. *Nuiqsut Comprehensive Development Plan, October 2015*. Barrow, AK: NSB, Department of Planning and Community Services.

-----. 2016. *NSB 2015 Economic Profile & Census*. Barrow, AK.

-----. 2017. *Comprehensive Annual Financial Report of the North Slope Borough: July 1, 2016–June 30, 2017*. Barrow, AK.

-----. 2018a. *Current Health Findings*. Utqiaġvik, AK: NSB, Department of Wildlife Management.

-----. 2018b. *NSB Traveler Safety and Environment Plan for the Community Winter Access Trails (CWAT) Project*. Utqiaġvik, AK.

NSBMC. 2019. *NSB Municipal Code 90.40.080*. Utqiaġvik, AK: NSB, Resource Development District.

Nuka Research and Planning Group. 2016. *Bering Sea Vessel Traffic Risk Analysis*. Seldovia, AK: Prepared for Ocean Conservancy.

Ona, E. and O.R. Godø. 1990. Fish Reaction to Trawling Noise: The Significance for Trawl Sampling. *Rapports et Procès-Verbaux des Réunions* 189:159–166.

Ona, E. and R. Toresen. 1988. *Reactions of Herring to Trawling Noise*. Copenhagen, Denmark: International Council for the Exploration of the Sea, Fish Capture Committee.

Øritsland, N.A., F.R. Engelhardt, F.A. Juck, R.J. Hurst, and P.D. Watts. 1981. *Effect of Crude Oil on Polar Bears*. Environmental Studies 24. Ottowa, ON: Indian and Northern Affairs Canada.

Ortega, C.P. 2012. Effects of Noise Pollution on Birds: A Brief Review of Our Knowledge. *Ornithological Monographs* 74 (1):6–22.

Ott, A.G., J.F. Winters, W.A. Morris, and P.T. Bradley. 2014. *North Slope Flooded Gravel Mine Sites: Case Histories*. Technical Report No. 12-04. Juneau, AK: ADF&G, Division of Habitat.

Pacific Flyaway Council. 2018. *Management Plan for the Pacific Population of Brant*. Vancouver, WA: Prepared for USFWS, Division of Migratory Bird Management.

Pangerc, T., S. Robinson, P. Theobald, and L. Galley. 2017. Underwater Sound Measurement Data During Diamond Wire Cutting: First Description of Radiated Noise. *Proceedings of Meetings on Acoustics* 27 (1). doi: 10.1121/2.0000322.

Panzacchi, M., B.V. Moorter, and O. Strand. 2013. A Road in the Middle of One of the Last Wild Reindeer Migration Routes in Norway: Crossing Behaviour and Threats to Conservation. *Rangifer* 33 (sp. 21):15–26. doi: 10.7557/2.33.2.2521.

Parrett, J.P. 2013. Unit 26A - Teshekpuk Caribou Herd. In *Caribou Management Report of Survey and Inventory Activities, 1 July 2010–30 June 2012*, Species Management Report ADF&G/DWC/SMR-2013-3, edited by P. Harper, 314–355. Juneau, AK: ADF&G.

Parrett, L.S. 2007. Summer Ecology of the Teshekpuk Caribou Herd. Master's thesis, University of Alaska, Fairbanks.

-----. 2015. Unit 26A - Teshekpuk Caribou Herd. In *Caribou Management Report of Survey and Inventory Activities, 1 July 2012–30 June 2014*, Species Management Report ADF&G/DWC/SMR-2015-4, edited by P. Harper and L. A. McCarthy, 17-1 to 17-28. Juneau, AK: ADF&G.

Paton, D.G., S. Ciuti, M. Quinn, and M.S. Boyce. 2017. Hunting Exacerbates the Response to Human Disturbance in Large Herbivores While Migrating through a Road Network. *Ecosphere* 8 (6):e01841. doi: 10.1002/ecs2.1841.

Pedersen, S. 1979. *Regional Subsistence Land Use, North Slope Borough, Alaska*. Occasional Paper No. 21. Fairbanks, AK: University of Alaska, Fairbanks, Cooperative Park Studies Unit.

-----. 1986. *Nuiqsut Subsistence Land Use Atlas, 1986 Update*. Report 1986-01. Fairbanks, AK: ADF&G, Division of Subsistence.

-----. 1995. Nuiqsut. In *An Investigation of the Sociocultural Consequences of Outer Continental Shelf Development in Alaska. Vol 5: Alaska Peninsula and Arctic*, Alaska OCS Study MMS 95-014, edited by James A. Fall and Charles J. Utermohle, XXII-1 to XXII-11. Anchorage, AK: Submitted by ADF&G, Division of Subsistence to MMS.

Pedersen, S., R.J. Wolfe, C. Scott, and R.A. Caulfield. 2000. *Subsistence Economies and Oil Development: Case Studies from Nuiqsut and Koktovik, Alaska*. Technical Report MMS 14-35-001-300661. Fairbanks, AK: ADF&G, Division of Subsistence.

Perham, C.J. 2005. *Proceedings: Beaufort Sea Polar Bear Monitoring Workshop, September 3–5, 2003, Anchorage, Alaska*. Alaska OCS Study MMS 2005-034. Anchorage, AK: MMS.

Person, B.T., A.K. Prichard, G.M. Carroll, D.A. Yokel, R.S. Suydam, and J.C. George. 2007. Distribution and Movements of the Teshekpuk Caribou Herd 1990–2005: Prior to Oil and Gas Development. *Arctic* 60 (3):238–250.

Ping, C.L., J.G. Bockheim, J.M. Kimble, G.J. Michaelson, and D.A. Walker. 1998. Characteristics of Cryogenic Soils along a Latitudinal Transect in Arctic Alaska. *Journal of Geophysical Research* 103 (D22):28917–28928.

Plante, S., C. Dussault, J.H. Richard, and S.D. Côté. 2018. Human Disturbance Effects and Cumulative Habitat Loss in Endangered Migratory Caribou. *Biological Conservation* 224:129–143. doi: 10.1016/j.biocon.2018.05.022.

Pollard, R.H., W.B. Ballard, L.E. Noel, and M.A. Cronin. 1996. Parasitic Insect Abundance and Microclimate of Gravel Pads and Tundra within the Prudhoe Bay Oil Field, Alaska, in Relation to Use by Caribou, *Rangifer tarandus granti*. *Canadian Field-Naturalist* 110 (4):649–658.

Post, E., U.S. Bhatt, C.M. Bitz, J.F. Brodie, T.L. Fulton, M. Hebblewhite, J. Kerby, S.J. Kutz, I. Stirling, and D.A. Walker. 2013. Ecological Consequences of Sea-Ice Decline. *Science* 341 (6145):519–524. doi: 10.1126/science.1235225.

Post, E. and M.C. Forchhammer. 2008. Climate Change Reduces Reproductive Success of an Arctic Herbivore through Trophic Mismatch. *Philosophical Transactions of the Royal Society B: Biological Sciences* 363 (1501):2367–2373. doi: 10.1098/rstb.2007.2207.

Prichard, A.K., R.L. Klimstra, B.T. Person, and L.S. Parrett. 2019. Aerial Survey and Telemetry Data Analysis of a Peripheral Caribou Calving Area in Northwestern Alaska. *Rangifer* 39 (1):43–58. doi: 10.7557/2.39.1.4572.

Prichard, A.K., B.E. Lawhead, and J.E. Welch. 2019. *Caribou Distribution and Movements near the Kuparuk Oilfield, 2008–2018*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Prichard, A.K., M.J. Macander, J.H. Welch, and B.E. Lawhead. 2017. *Caribou Monitoring Study for the Alpine Satellite Development Project, 2015 and 2016. 12th Annual Report*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

-----. 2018. *Caribou Monitoring Study for the Alpine Satellite Development Project, 2017. 13th Annual Report*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

-----. 2019. *Caribou Monitoring Study for the Bear Tooth Unit Program, Arctic Coastal Plain, 2018*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Prichard, A.K., J.H. Welch, and B.E. Lawhead. 2017. *Mammal Surveys in the Greater Kuparuk Area, Northern Alaska, 2016*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

-----. 2018. *Mammal Surveys in the Greater Kuparuk Area, Northern Alaska, 2017*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Prichard, A.K., D.A. Yokel, C.L. Rea, B.T. Person, and L.S. Parrett. 2014. The Effect of Frequency of Telemetry Locations on Movement-Rate Calculations in Arctic Caribou. *Wildlife Society Bulletin* 38 (1):78–88. doi: 10.1002/wsb.357.

Quakenbush, L.T. 1988. Spotted Seal, *Phoca largha*. In *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations*, edited by J. W. Lentfer, 107–124. Washington, D.C.: Marine Mammal Commission

Quakenbush, L.T., R.H. Day, B.A. Anderson, F.A. Pitelka, and B.J. McCaffery. 2002. Historical and Present Breeding Season Distribution of Steller's Eiders in Alaska. *Western Birds* 33 (2):99–120.

Ramboll US Corporation. 2017. *Compliance Noise Monitoring: 3-Day Results and Overall Summary*. Lynnwood, WA: Prepared for Raging River Quarry, LLC.

Rawlinson, S.E. 1993. *Surficial Geology and Morphology of the Alaskan Central Arctic Coastal Plain*. Map No. 6. Fairbanks, AK: ADNR, Division of Geological and Geophysical Surveys.

Raynolds, M.A., D.A. Walker, and H.A. Maier. 2006. *Alaska Arctic Tundra Vegetation Map: Conservation of Arctic Flora and Fauna (CAFF)*. Map No. 2. Anchorage, AK: USFWS.

Reanier, R.E. 2017. *Letter Report, Cutural Resources Reconnaissance for the Willow Area, 2017–2018 NPR-A Exploration Program*. Anchorage, AK: Unpublished letter report prepared for ConocoPhillips Alaska, Inc.

-----. 2018. *Letter Report, Cutural Resources Reconnaissance for the Willow Area, 2018–2019 NPR-A Exploration Program*. Anchorage, AK: Unpublished letter report prepared for ConocoPhillips Alaska, Inc.

-----. 2019a. *Letter Report, Cutural Resources Reconnaissance for the 2019 Willow Airport Survey Monuments Project*. Anchorage, AK: Unpublished letter report prepared for ConocoPhillips Alaska, Inc.

-----. 2019b. *Willow Development - Cultural Resources Letter Report*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc. and submitted to BLM

-----. 2020. *Willow Development Option 3 Module Transport Routes Cultural Resources*. Anchorage, AK: Unpublished letter report prepared for ConocoPhillips Alaska, Inc.

Regehr, E.V., C.M. Hunter, H. Caswell, S.C. Amstrup, and I. Stirling. 2010. Survival and Breeding of Polar Bears in the Southern Beaufort Sea in Relation to Sea Ice. *Journal of Animal Ecology* 79 (1):117–127.

Regehr, E.V., K.L. Laidre, H.R. Akçakaya, S.C. Amstrup, T.C. Atwood, N.J. Lunn, M. Obbard, H. Stern, G.W. Thiemann, and Ø. Wiig. 2016. Conservation Status of Polar Bears (*Ursus maritimus*) in Relation to Projected Sea-Ice Declines. *Biology Letters* 12 (12):20160556. doi: 10.1098/rsbl.2016.0556.

Reimers, E. and J. Colman. 2009. Reindeer and Caribou (*Rangifer tarandus*) Response Towards Human Activities. *Rangifer* 26 (2):55–71. doi: 10.7557/2.26.2.188.

Reimers, E., L.E. Loe, S. Eftestøl, J.E. Colman, and B. Dahle. 2009. Effects of Hunting on Response Behaviors of Wild Reindeer. *The Journal of Wildlife Management* 73 (6):844–851.

Reist, J.D., F.J. Wrona, T.D. Prowse, M. Power, J.B. Dempson, R.J. Beamish, J.R. King, T.J. Carmichael, and C.D. Sawatzky. 2006. General Effects of Climate Change on Arctic Fishes and Fish Populations. *A Journal of Human Environment* 35 (7):370–380.

Resio, D.T. and Coastal Frontiers Corporation. 2019. *Extreme Oceanographic Conditions for the Willow Development Nearshore Staging Area*. Moorpark, CA.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*. San Diego, CA: Academic Press.

Richter-Menge, J., M.L. Druckenmiller, and M. Jeffries. 2019. NOAA Arctic Report Card. NOAA OCS, Office of Coast Survey, Accessed May 2020. http://www.arctic.noaa.gov/Report-Card.

Richter-Menge, J., J. Overland, J. Mathis, and E. Osborne. 2017. NOAA Arctic Report Card 2017. Accessed July 2018. http://www.arctic.noaa.gov/Report-Card.

Ritchie, R.J. 2014. *Raptor Surveys at Lakes in the Foothill-Coastal Plain Transition, Colville to Kuk Rivers, NPR-A, Alaska, July 2012 and 2013*. Fairbanks, AK: Prepared by ABR, Inc. for BLM.

Rode, K.D., E.V. Regehr, D.C. Douglas, G.M. Durner, A.E. Derocher, G.W. Thiemann, and S.M. Budge. 2014. Variation in the Response of an Arctic Top Predator Experiencing Habitat Loss: Feeding and Reproductive Ecology of Two Polar Bear Populations. *Global Change Biology* 20 (1):76–88.

Ronconi, R.A., K.A. Allard, and P.D. Taylor. 2015. Bird Interactions with Offshore Oil and Gas Platforms: Review of Impacts and Monitoring Techniques. *Journal of Environmental Management* 147:34–45. doi: 10.1016/j.jenvman.2014.07.031.

Roth, J.E., M.T. Jorgenson, T.C. Cater, W.A. Davis, E.R. Pullman, and G.J. Frost. 2004. *Assessment of Impacts Associated with Rolligon Trails in the Northeastern National Petroleum Reserve-Alaska, 2002–2003*. Anchorage, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Rozell, K.B. and C.B. Johnson. 2020. *Nesting Greater White-Fronted Goose Study at CD-5, National Petroleum Reserve-Alaska: a Synthesis Report, 2013–2019. Draft Report*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Ruggerone, G.T., S. Goodman, and R. Miner. 2008. *Behavioral Response and Survival of Juvenile Coho Salmon Exposed to Pile Driving Sounds*. Seattle, WA: Prepared by Natural Resource Consultants, Inc. for Port of Seattle.

Russell, D.E., A. Gunn, and S. Kutz. 2019. Migratory Tundra Caribou and Wild Reindeers. In *Arctic Report Card: Update for 2018*, edited by E. Osborne, J. Richter-Menge and M. Jeffries, 68–73. Available from https://www.arctic.noaa.gov/Report-Card.

Saalfeld, S.T., D.C. McEwen, D.C. Kesler, M.G. Butler, J.A. Cunningham, A.C. Doll, W.B. English, D.E. Gerik, K. Grond, P. Herzog, B.L. Hill, B.J. Lagassé, and R.B. Lanctot. 2019. Phenological Mismatch in Arctic-Breeding Shorebirds: Impact of Snowmelt and Unpredictable Weather Conditions on Food Availability and Chick Growth. *Ecology and Evolution* 9 (11):6693–6707. doi: 10.1002/ece3.5248.

Schmidt, D.R., R.O. McMillan, and B.J. Gallaway. 1983. *Nearshore Fish Survey in the Western Beaufort Sea: Harrison Bay to Elson Lagoon*. Bryan, TX: Prepared by LGL Alaska Research Associates, Inc. for MMS, NOAA, OSCEAP Research Unit 631.

Schmutz, J.A., K.G. Wright, C.R. DeSorbo, J. Fair, D.C. Evers, B.D. Uher-Koch, and D.M. Mulcahy. 2014. Size and Retention of Breeding Territories of Yellow-Billed Loons (*Gavia adamsii*) in Alaska and Canada. *Waterbirds* 37 (sp1):53–63.

Schueler, T.R., L. Fraley-McNeal, and K. Cappiella. 2009. Is Impervious Cover Still Important? Review of Recent Research. *Journal of Hydrologic Engineering* 14 (4):309–315.

Schweinsburg, R. 1974. Disturbance Effects of Aircraft to Waterfowl on North Slope Lakes, June, 1972. In *Disturbance to Birds by Gas Compressor Noise Simulators, Aircraft and Human Activity in the Mackenzie Valley and the North Slope*, edited by W.W.H. Gunn and J.A. Livingston, 1–48. Calgary, Alberta: Prepared by LGL Ltd. Environmental Research Associates for Canadian Arctic Gas Study, Ltd. and Alaska Arctic Gas Study Co.

Seaman, G.A. 1981. *Mid-Beaufort Coastal Habitat Evaluation Study: Colville River to Kuparuk River*. Anchorage, AK: ADCRA, Office of Coastal Management, and NOAA.

Sedinger, J.S., T.V. Riecke, A.G. Leach, and D.H. Ward. 2019. The Black Brant Population is Declining Based on Mark Recapture. *The Journal of Wildlife Management* 83 (3):627–637. doi: 10.1002/jwmg.21620.

Seiser, P.E. and C.B. Johnson. 2014. *Eider Nest Searches at the CD3 Pad, Ice Road, and Spill-Response Sites on the Colville River Delta, 2013*. Fairbanks, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Senner, N.R., M. Stager, and B.K. Sandercock. 2017. Ecological Mismatches are Moderated by Local Conditions for Two Populations of a Long-Distance Migratory Bird. *Oikos* 126 (1):61–72. doi: 10.1111/oik.03325.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J.T. Overpeck, and M.A. Taboada. 2014. Terrestrial and Inland Water Systems. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects*, edited by C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White, 271–359. Cambridge, United Kingdom: Cambridge University Press.

Sexson, M., J. Pearce, and M. Petersen. 2014. *Spatiotemporal Distribution and Migratory Patterns of Spectacled Eiders*. Alaska OCS Study 2014-665. Anchorage, AK: BOEM.

Sformo, T.L., B. Adams, J.C. Seigle, J.A. Ferguson, M.K. Purcell, R. Stimmelmayr, J.H. Welch, L.M. Ellis, J.C. Leppi, and J.C. George. 2017. Observations and First Reports of Saprolegniosis in Aanaakłiq, Broad Whitefish (*Coregonus nasus*), from the Colville River near Nuiqsut, Alaska. *Polar Science* 14:78–82.

Sharma, S., S. Couturier, and S.D. Côté. 2009. Impacts of Climate Change on the Seasonal Distribution of Migratory Caribou. *Global Change Biology* 15 (10):2549–2562.

Sherman, K., I.M. Belkin, K.D. Friedland, J. O'Reilly, and K. Hyde. 2009. Accelerated Warming and Emergent Trends in Fisheries Biomass Yields of the World's Large Marine Ecosystems. *AMBIO: A Journal of the Human Environment* 38 (4):215–224, 10.

Shook, J.E., J.P. Parrett, C.B. Johnson, and J.E. Welch. 2020. *Avian Studies in the Willow Project Area, 2019*. Anchorage, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Simmons, C.L. 1983. *Sensitivity of Plant Communities and Soil Flora to Seawater Spills, Prudhoe Bay, Alaska*. CRREL Report 83-24. Hanover, NH: USACE, Cold Regions Research and Engineering Laboratory.

Sloan, C.E. 1987. *Water Resources of the North Slope, Alaska*, *Alaska North Slope Geology, Volumes I and II*. Anchorage, AK: Alaska Geological Society.

SLR. 2019. *Volatile Organic Compounds (VOCs) Near the Village of Nuiqsut*. Anchorage, AK: Report prepared for ConocoPhillips Alaska, Inc.

Smith, L.N., L.C. Byrne, C.B. Johnson, and A.A. Stickney. 1994. *Wildlife Studies on the Colville River Delta, Alaska, 1993*. Fairbanks, AK: Prepared by ABR, Inc. for ARCO Alaska, Inc.

Smith, L.N., L.C. Byrne, and R.J. Ritchie. 1993. *Wildlife Studies on the Colville River Delta, Alaska, 1992*. Fairbanks, AK: Prepared by ABR, Inc. for ARCO Alaska, Inc.

Smith, M., N. Walker, C. Free, M. Kirchhoff, N. Warnock, A. Weinstein, T. Distler, and I. Stenhouse. 2012. *Marine Important Bird Areas in Alaska: Identifying Globally Significant Sites Using Colony and At-Sea Survey Data*. Anchorage, AK: Audubon Alaska.

Smith, M.A., N.J. Walker, C.M. Free, M.J. Kirchhoff, G.S. Drew, N. Warnock, and I.J. Stenhouse. 2014. Identifying Marine Important Bird Areas using At-Sea Survey Data. *Biological Conservation* 172 (April):180–189. doi: 10.1016/j.biocon.2014.02.039.

SNAP. 2011. *Climate Change Analysis: An Assessment of Climate Change Variables in the National Petroleum Reserve in Alaska*. Anchorage, AK: Prepared for BLM.

-----. 2018. North Slope Climate Analysis. Accessed June 2018. https://www.snap.uaf.edu/projects/north-slope-climate-analysis.

-----. 2019. Arctic Climate Change Impacts on Ecosystem Services and Society. Accessed May 10. https://www.snap.uaf.edu/projects/arctic-climate-change-impacts-ecosystem-services-and-society.

Spangler, J.D., S. Arnold, and J. Boomgarden. 2006. *Chasing Ghosts: An Analysis of Vandalism and Site Degradation in Range Creek Canyon, Utah*. Ogden, UT: Report prepared by the Colorado Plateau Archaeological Alliance.

SRB&A. 2009. *Impacts and Benefits of Oil and Gas Development to Barrow, Nuiqsut, Wainwright, and Atqasuk Harvesters*. Barrow, AK: Prepared for NSB, Department of Wildlife Management.

-----. 2010a. *Nuiqsut Caribou Subsistence Monitoring Project: Results of 2009 Hunter Interviews*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2010b. *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow*. Alaska OCS Study 2009-003. Anchorage, AK: Prepared for MMS.

-----. 2011. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year Two Hunter Interviews*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2012. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year Three Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2013a. *Aggregate Effects of Oil Industry Operations on Iñupiaq Subsistence Activities, Nuiqsut, Alaska: A History and Analysis of Mitigation and Monitoring.* Alaska OCS Study BOEM 2013-212. Anchorage, AK: BOEM.

-----. 2013b. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 4 Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2014. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 5 Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2015. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 6 Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2016. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 7 Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2017a. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 8 Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2017b. *Social Indicators in Coastal Alaska, Arctic Communities. Final Report*. Alaska OCS Technical Report BOEM 2017-035. Anchorage, AK: Prepared for BOEM.

-----. 2018a. *Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 9 Hunter Interviews and Household Harvest Surveys*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2018b. *Nuiqsut Paisaŋich: A 2018 Addendum*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. 2019. *Nuiqsut Caribou Subsistence Monitoring Project: Years 1 through 10 Final Report*. Anchorage, AK: Prepared for ConocoPhillips Alaska, Inc.

-----. Unpublished. *North Slope Borough Key Informant Subsistence Mapping Project, Barrow and Wainwright*. Unpublished data depicting 1987–1989 Barrow use areas reported during 59 interviews and 1988–1989 Wainwright use areas reported during 19 interviews.

SRB&A and ISER. 1993. *North Slope Subsistence Study: Barrow, 1987, 1988, and 1989*. Alaska OCS Study MMS 91-0086. Anchorage, AK: Prepared for MMS.

Stenhouse, G.B., L.J. Lee, and K.G. Poole. 1988. Some Characteristics of Polar Bears Killed During Conflicts with Humans in the Northwest Territories, 1976–86. *Arctic* 41 (4):275–278.

Stien, J. and R.A. Ims. 2015. Absence from the Nest Due to Human Disturbance Induces Higher Nest Predation in Common Eiders *Somateria mollissima*. *Ibis* 158 (2):249–260.

Stinchcomb, T.R. 2017. Social-Ecological Soundscapes: Examining Aircraft-Harvester-Caribou Conflict in Arctic Alaska. Master's thesis, University of Alaska, Fairbanks.

Stirling, I. 1988. Attraction of Polar Bears, *Ursus maritimus*, to Offshore Drilling Sites in the Eastern Beaufort Sea. *Polar Record* 24 (148):1–8.

Stohl, A. 2006. Characteristics of Atmospheric Transport into the Arctic Troposphere. *Journal of Geophysical Research: Atmospheres* 111 (D11306):1–17. doi: 10.1029/2005jd006888.

Stohl, A., Z. Klimont, S. Eckhardt, K. Kupiainen, V.P. Shevchenko, V.M. Kopeikin, and A.N. Novigatsky. 2013. Black Carbon in the Arctic: The Underestimated Role of Gas Flaring and Residential Combustion Emissions. *Atmospheric Chemistry and Physics* 13 (17):8833–8855. doi: 10.5194/acp-13-8833-2013.

Streever, B. and S. Bishop. 2014. *Long-Term Ecological Monitoring in BP's North Slope Oil Fields through 2013*. Anchorage, AK: Prepared for BP Exploration (Alaska), Inc.

Stuefer, S.L., C.D. Arp, D.L. Kane, and A.K. Liljedahl. 2017. Recent Extreme Runoff Observations from Coastal Arctic Watersheds in Alaska. *Water Resources Research* 53 (11):9145–9163.

Tape, K.D., K. Christie, G. Carroll, and J.A. O'Donnell. 2016. Novel Wildlife in the Arctic: The Influence of Changing Riparian Ecosystems and Shrub Habitat Expansion on Snowshoe Hares. *Global Change Biology* 22 (1):208–219.

Tape, K.D., D.D. Gustine, R.W. Ruess, L.G. Adams, and J.A. Clark. 2016. Range Expansion of Moose in Arctic Alaska Linked to Warming and Increased Shrub Habitat. *PLOS ONE* 11 (4):e0152636. doi: 10.1371/journal.pone.0152636.

Tape, K.D., B.M. Jones, C.D. Arp, I. Nitze, and G. Grosse. 2018. Tundra Be Dammed: Beaver Colonization of the Arctic. *Global Change Biology* 24 (10):4478–4488. doi: 10.1111/gcb.14332.

Tetra Tech EC Inc. 2005. *Marine Mammal Monitoring Program: FEX Barging Project, 2005*. Bothell, WA: Prepared for ASRC Lynx Enterprises, Inc.

-----. 2006. *Marine Mammal Monitoring Program: FEX Barging Project, 2006*. Bothell, WA: Prepared for ASRC Lynx Enterprises, Inc.

-----. 2007. *Marine Mammal Monitoring Program: FEX Barging Project, 2007*. Bothell, WA: Prepared for FEX L.P.

Thompson, S.J., C.M. Handel, R.M. Richardson, and L.B. McNew. 2016. When Winners Become Losers: Predicted Nonlinear Responses of Arctic Birds to Increasing Woody Vegetation. *PLOS ONE* 11 (11):e0164755. doi: 10.1371/journal.pone.0164755.

TORP Terminal LP. 2009. Bienville Offshore Energy Terminal DWP Application Amendment, Volume VI – Environmental Reports, Part 2 of 5. USCG, Accessed April 28, 2020. https://www.regulations.gov/document?D=USCG-2006-24644-0747.

Trefry, J.H., R.D. Rember, R.P. Trocine, and M. Savoie. 2004. *ANIMIDA Task 5: Sources, Concentrations, and Dispersion Pathways for Suspended Sediment in the Coastal Beaufort Sea, Final Report*. Alaska OCS Study MMS 2004-032. Anchorage, AK: MMS.

Trefry, J.H., R.P. Trocine, M.B. Alkire, C.M. Semmler, M. Savoie, and R.D. Rember. 2009. *cANIMIDA Tasks 3 and 4: Sources, Concentrations, Composition, Partitioning and Dispersion Pathways for Suspended Sediments and Potential Metal Contaminants in the Coastal Beaufort Sea, Final Report*. Alaska OCS Study MMS 2009-014. Anchorage, AK: MMS.

Tulp, I. and H. Schekkerman. 2008. Has Prey Availability for Arctic Birds Advanced with Climate Change? Hindcasting the Abundance of Tundra Arthropods using Weather and Seasonal Variation. *Arctic* 61 (1):48–60.

Tveraa, T., A. Stien, B.-J. Bårdsen, and P. Fauchald. 2013. Population Densities, Vegetation Green-Up, and Plant Productivity: Impacts on Reproductive Success and Juvenile Body Mass in Reindeer. *PLOS ONE* 8 (2):e56450. doi: 10.1371/journal.pone.0056450.

U.S. Census. 2017a. Population, Housing Units, Area and Density: 2010 County, County Subdivision, and Place. 2010 Census Summary File 1, GCT-PH1. Accessed February 1, 2017. https://factfinder.census.gov/.

-----. 2017b. Selected Economic Characteristics, 2011–2015 American Community Survey 5-Year Estimates, 2015 Estimates. Accessed February 1, 2017. https://factfinder.census.gov/.

-----. 2018a. American Community Survey Demographic and Housing Estimates, 2012–2016 Community Survey 5-Year Estimates. Accessed February 1, 2018. https://factfinder.census.gov/.

-----. 2018b. Selected Economic Characteristics, 2012–2016 Community Survey 5-Year Estimates. Accessed February 1, 2018. https://factfinder.census.gov/.

Uher-Koch, B.D., J.A. Schmutz, and K.G. Wright. 2015. Nest Visits and Capture Events Affect Breeding Success of Yellow-Billed and Pacific Loons. *Condor* 117 (1):121–129.

Uher-Koch, B.D., K.G. Wright, and J.A. Schmutz. 2019. The Influence of Chick Production on Territory Retention in Arctic-Breeding Pacific and Yellow-Billed Loons. *The Condor: Ornithological Applications* 121 (1):1–11.

UNEP. 2019. Emissions Gap Report. United Nations Environment Programme, Accessed December 2019. https://wedocs.unep.org/bitstream/handle/20.500.11822/30798/EGR19ESEN.pdf?sequence=13.

Urban, F.E. and G.D. Clow. 2016. *DOI/GTN-P Climate and Active-Layer Data Acquired in the National Petroleum Reserve-Alaska and the Arctic National Wildlife Refuge, 1998–2014*. Data Series 977. Reston, VA: USGS.

Urban, F.E. and G.D. Clow. 2018. *DOI/GTN-P Climate and active-layer data acquired in the National Petroleum Reserve–Alaska and the Arctic National Wildlife Refuge, 1998–2016*. US Department of Interior, US Geological Survey.

USACE. 1986. *Accuracy of Computed Water Surface Profiles*. Davis, CA: Prepared by USACE Hydrologic Engineering Center for Federal Highway Administration.

-----. 1987. *Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. Vicksburg, MS: USACE Environmental Laboratory, Waterways Experiment Station.

-----. 2007. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0)*. Report No. ERDC/EL TR-07-24. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

-----. 2012. *Point Thomson Project Final Environmental Impact Statement*. Anchorage, AK.

-----. 2018. *Nanushuk Project Final Environmental Impact Statement*. Anchorage, AK: Prepared by DOWL.

-----. 2019. Appendix D: Economics. In *Unalaska (Dutch Harbor) Channels*. Anchorage, AK.

USEIA. 2016. Rankings: Crude Oil Production, September 2016. Accessed December 27, 2016. http://www.eia.gov/state/rankings/?sid=AK#series/46.

-----. 2018. *Energy-Related Carbon Dioxide Emission by State, 2000–2015*. Washington, D.C.

USFS. 2008. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. San Dimas, CA: USFS, National Technology and Development Program.

USFWS. 2006. Marine Mammals; Incidental Take During Specified Activities 2006–2011. *Federal Register* 71, no. 148 (August 2, 2006):43925–43953.

-----. 2008a. *Birds of Conservation Concern 2008*. Arlington, VA: USFWS, Division of Migratory Bird Management.

-----. 2008b. *Programmatic Biological Opinion for Polar Bears (Ursus maritimus) on Beaufort Sea Incidental Take Regulations*. Fairbanks, AK: USFWS, Alaska Region, Fairbanks Fish and Wildlife Field Office.

-----. 2009. *Final Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling: Consultation with Minerals Management Service*. Fairbanks, AK: USFWS, Alaska Region, Fairbanks Fish and Wildlife Field Office.

-----. 2011. *Programmatic Biological Opinion for Polar Bears (Ursus maritimus), Polar Bear Critical Habitat, and Conference Opinion for the Pacific Walrus (Odobenus rosmarus divergens) on Beaufort Sea Incidental Take Regulations*. Fairbanks, AK: USFWS, Alaska Region, Fairbanks Fish and Wildlife Field Office.

-----. 2013. *Biological Opinion for the National Petroleum Reserve – Alaska Integrated Activity Plan 2013*. Fairbanks, AK.

-----. 2014. Seismic Trails. Accessed July 15. https://www.fws.gov/refuge/arctic/seismic.html.

-----. 2015a. Amendment to the Biological Opinion Regarding the Permitting, Construction, and Operation of GMT1. In *Final Supplemental Environmental Impact Statement: Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth One Development Project. Record of Decision*, Appendix F. Anchorage, AK: BLM.

-----. 2015b. *Arctic National Wildlife Refuge Revised Comprehensive Conservation Plan, Final Environmental Impact Statement, Wilderness Review, and Wild and Scenic River Review*. Anchorage, AK.

-----. 2015c. *Biological Opinion for the Expansion of Mine Site C under POA-1980-307-M5*. Fairbanks, AK.

-----. 2016a. *Intra-Service Biological Opinion for Issuance of 2016–2021 Beaufort Sea Incidental Take Regulations*. Fairbanks, AK: USFWS, Alaska Region, Fairbanks Fish and Wildlife Field Office.

-----. 2016b. Unpublished Data from ACP Aerial Waterbird Population Surveys 1992 to 2016. Fairbanks, AK.

-----. 2019a. *Biological Opinion for Mine Site E Expansion*. Fairbanks, AK.

-----. 2019b. *Fish Passage Design Guidelines*. Hadley, MA: U.S. Fish and Wildlife Service Alaska Fish Passage Program.

-----. 2019c. National Wetlands Inventory. Accessed June 10, 2019. https://www.fws.gov/wetlands/.

-----. 2020a. *Culvert Design Guidelines for Ecological Foundations*. U.S. Fish and Wildlife Service Alaska Fish Passage Program.

-----. 2020b. *Programmatic Biological Opinion for 2020–2021 Impacts on the North Slope*. Fairbanks, AK.

USGS. 2016. Water Quality Samples for Alaska: USGS 15880000 Colville River near Nuiqsut, AK and USGS 15875000 Colville River at Umiat, AK. Accessed August 15, 2016. http://waterdata.usgs.gov/ak/nwis/qwdata/?site_no=15880000 and http://waterdata.usgs.gov/ak/nwis/qwdata/?site_no=15875000.

-----. 2018. The National Map. Accessed January 2019. https://viewer.nationalmap.gov/advanced-viewer/.

-----. 2020a. Current/Historical Observations: USGS 15875000 Colville R at Umiat AK. U.S. https://nwis.waterdata.usgs.gov/usa/nwis/uv/?cb_00060=on&format=html&site_no=15875000&period=&begin_date=2019-09-05&end_date=2019-09-06.

-----. 2020b. Surface Water Data for Alaska: USGS 15875000 Colville River at Umiat AK. https://waterdata.usgs.gov/ak/nwis/uv?site_no=15875000.

Valkenburg, P. and J. Davis. 1985. The Reaction of Caribou to Aircraft: A Comparison of Two Herds. In *Caribou and Human Activity: Proceedings of the 1st North American Caribou Workshop*, edited by A.M. Martell and D.E. Russell, 7–9. Whitehorse, Yukon.

van Gils, J.A., S. Lisovski, T. Lok, W. Meissner, A. Ożarowska, J. de Fouw, E. Rakhimberdiev, M.Y. Soloviev, T. Piersma, and M. Klaassen. 2016. Body Shrinkage Due to Arctic Warming Reduces Red Knot Fitness in Tropical Wintering Range. *Science* 352 (6287):819–821.

Vanderlaan, A.S. and C.T. Taggart. 2007. Vessel Collisions with Whales: The Probability of Lethal Injury Based on Vessel Speed. *Marine Mammal Science* 23 (1):144–156.

Voigt, C., M.E. Marushchak, R.E. Lamprecht, M. Jackowicz-Korczyński, A. Lindgren, M. Mastepanov, L. Granlund, T.R. Christensen, T. Tahvanainen, P.J. Martikainen, and C. Biasi. 2017. Increased Nitrous Oxide Emissions from Arctic Peatlands After Permafrost Thaw. *Proceedings of the National Academy of Sciences* 114 (24):6238–6243. doi: 10.1073/pnas.1702902114.

Wahrhaftig, C. 1965. *Physiographic Divisions of Alaska: A Classification and Brief Description with a Discussion of High-Latitude Physiographic Processes*. Geological Survey Professional Paper 482. Washington, D.C.: U.S. Government Printing Office.

Walker, D.A. 1987. *Disturbance and Recovery of Arctic Alaskan Tundra Terrain: A Review of Recent Investigations*. Hanover, NH: USACE, Cold Regions Research and Engineering Laboratory.

Walker, D.A. and K.R. Everett. 1987. Road Dust and Its Environmental Impact on Alaska Taiga and Tundra. *Arctic and Alpine Research* 19 (4):479–489.

Walker, D.A., M.K. Raynolds, M. Buchhorn, and J.L. Peirce. 2014. *Landscape and Permafrost Change in the Prudhoe Bay Oilfield, Alaska*. Publication AGC 14-01. Fairbanks, AK: University of Alaska, Alaska Geobotany Center.

Walker, D.A., P.J. Webber, E.F. Binnian, K.R. Everett, N.D. Lederer, E.A. Nordstrand, and M.D. Walker. 1987. Cumulative Impacts of Oil Fields on Northern Alaskan Landscapes. *Science* 238 (4828):757–761.

Walker, H.J. and P.F. Hudson. 2003. Hydrologic and Geomorphic Processes in the Colville River Delta, Alaska. *Geomorphology* 56 (3–4):291–303.

Walker, R.J. and R.J. Wolfe. 1987. Subsistence Economies in Alaska: Productivity, Geography, and Development Impacts. *Arctic Anthropology* 24 (2):56–81.

Wang, K., E. Jafarov, I. Overeem, V. Romanovsky, K. Schaefer, G. Clow, F. Urban, W. Cable, M. Piper, and C. Schwalm. 2018. A Synthesis Dataset of Permafrost-Affected Soil Thermal Conditions for Alaska, USA. *Earth System Science Data (Online)* 10 (LA-UR-17-23049).

Ward, D.H., J. Helmericks, J.W. Hupp, L. McManus, M. Budde, D.C. Douglas, and K. Tape. 2016. Multi-Decadal Trends in Spring Arrival of Avian Migrants to the Central Arctic Coast of Alaska: Effects of Environmental and Ecological Factors. *Journal of Avian Biology* 47 (2):197–207.

Ward, D.H., R.A. Stehn, W.P. Erickson, and D.V. Derksen. 1999. Response of Fall-Staging Brant and Canada Geese to Aircraft Overflights in Southwestern Alaska. *The Journal of Wildlife Management* 63 (1):373–381.

Warnock, N.D. and D.M. Troy. 1992. *Distribution and Abundance of Spectacled Eiders at Prudhoe Bay, Alaska: 1991*. Anchorage, AK: Prepared by Troy Ecological Research Associates for BP Exploration (Alaska) Inc.

Wauchope, H.S., J.D. Shaw, Ø. Varpe, E.G. Lappo, D. Boertmann, R.B. Lanctot, and R.A. Fuller. 2017. Rapid Climate-Driven Loss of Breeding Habitat for Arctic Migratory Birds. *Global Change Biology* 23 (3):1085–1094.

Webster, L. and J. Young. 1997. *The Effects of Human Related Harassment on Caribou (Rangifer tarandus)*. Williams Lake, B.C.: Unpublished report prepared for Canadian Ministry of Environment.

Weiffen, M., B. Möller, B. Mauck, and G. Dehnhardt. 2006. Effect of Water Turbidity on the Visual Acuity of Harbor Seals (*Phoca vitulina*). *Vision research* 46 (11):1777–1783.

Weingartner, T.J., S.L. Danielson, R.A. Potter, J.H. Trefry, A. Mahoney, M. Savoie, and L. Sousa. 2017. Circulation and Water Properties in the Landfast Ice Zone of the Alaskan Beaufort Sea. *Continental Shelf Research* 148:185–198. doi: 10.1016/j.csr.2017.09.001.

Weiser, E. and H.G. Gilchrist. 2012. Glaucous Gull (*Larus hyperboreus*). Account 573. In *The Birds of North America*, edited by A. F. Poole. Ithaca, NY: Cornell Lab of Ornithology.

Weladji, R.B., Ø. Holand, and T. Almøy. 2003. Use of Climatic Data to Assess the Effect of Insect Harassment on the Autumn Weight of Reindeer (*Rangifer tarandus*) Calves. *Journal of Zoology* 260 (1):79–85. doi: 10.1017/S0952836903003510.

Wells, A.F., S.L. Ives, T. Christopherson, D. Dissing, G.V. Frost, M.J. Macander, and R.W. McNown. 2018. *An Ecological Land Survey and Integrated Terrain Unit Mapping for the Willow Master Development Plan Area, National Petroleum Reserve-Alaska, 2017–2018*. Anchorage, AK: Prepared by ABR, Inc. for ConocoPhillips Alaska, Inc.

Wendler, G., B. Moore, and K. Galloway. 2014. Strong temperature increase and shrinking sea ice in Arctic Alaska. *Open Atmospgeric Science Journal* 8 (1):7–15.

Wenz, G.M. 1962. Acoustic Ambient Noise in the Ocean: Spectra and Sources. *The Journal of the Acoustical Society of America* 34 (12):1936–1956. doi: 10.1121/1.1909155.

White, C.M., N.J. Clum, T.J. Cade, and W.G. Hunt. 2002. Peregrine Falcon (*Falco peregrinus*). Account 660. In *The Birds of North America*, edited by A. Poole. Ithaca, NY: Cornell Lab of Ornithology.

White, R.G., B.R. Thomson, T. Skogland, S.J. Person, D.E. Russell, D.F. Holleman, and J.R. Luick. 1975. Ecology of Caribou at Prudhoe Bay, Alaska. In *Ecological Investigations of the Tundra Biome in the Prudhoe Bay Region, Alaska*, edited by J. Brown, 151–201. Hanover, NH: U.S. Army Cold Regions Research and Engineering Laboratory.

Whiteman, J.P., H.J. Harlow, G.M. Durner, R. Anderson-Sprecher, S.E. Albeke, E.V. Regehr, S.C. Amstrup, and M. Ben-David. 2015. Summer Declines in Activity and Body Temperature Offer Polar Bears Limited Energy Savings. *Science* 349 (6245):295–298. doi: 10.1126/science.aaa8623.

Williams, M.T., C.S. Nations, T.G. Smith, V.D. Moulton, and C.J. Perham. 2006. Ringed Seal (*Phoca hispida*) Use of Subnivean Structures in the Alaskan Beaufort Sea During Development of an Oil Production Facility. *Aquatic Mammals* 32 (3):311–324.

Wilson, H., W. Larned, and M. Swaim. 2018. *Abundance and Trends of Waterbird Breeding Populations on the Arctic Coastal Plain, Alaska, 1986–2017*. Anchorage, AK: USFWS and MBM, Arctic Coastal Plain Breeding Waterbird Survey.

Wilson, K. 1996. *Design Handbook for Recreational Boating and Fishing Facilities*. Washington, D.C.: States Organization for Boating Access.

Wilson, R.R., L.S. Parrett, K. Joly, and J.R. Dau. 2016. Effects of Roads on Individual Caribou Movements During Migration. *Biological Conservation* 195:2–8.

Wilson, R.R., L.S. Prichard, L.S. Parrett, B.T. Person, G.M. Carroll, M.A. Smith, C.L. Rea, and D.A. Yokel. 2012. Summer Resource Selection and Identification of Important Habitat Prior to Industrial Development for the Teshekpuk Caribou Herd in Northern Alaska. *PLOS ONE* 7 (11):e48697. doi: 10.1371/journal.pone.0048697.

Wolfe, R.J. 2004. *Local Traditions and Subsistence: A Synopsis from Twenty-Five Years of Research by the State of Alaska*. Technical Paper No. 284. Anchorage, AK: ADF&G, Division of Subsistence.

Woodward-Clyde Consultants. 1983. *Oliktok Point and Vicinity 1982 Environmental Studies*. Anchorage, AK: Prepared for ARCO Alaska.

WSDOT. 2015. *Biological Assessment Preparation for Transportation Projects: Advanced Training Manual, Version 2015*. Seattle, WA.

Xu, J.W., R.V. Martin, A. Morrow, S. Sharma, L. Huang, W.R. Leaitch, J. Burkart, H. Schulz, M. Zanatta, M.D. Willis, D.K. Henze, C.J. Lee, A.B. Herber, and J.P.D. Abbatt. 2017. Source Attribution of Arctic Black Carbon Constrained by Aircraft and Surface Measurements. *Atmospheric Chemistry and Physics* 17 (19):11971–11989. doi: 10.5194/acp-17-11971-2017.

Yokel, D., D. Huebner, R. Meyers, D.A. Nigro, and J.M. Ver Hoef. 2007. *Offsetting Versus Overlapping Ice Road Routes from Year to Year: Impacts to Tundra Vegetation*. Anchorage, AK: BLM.

Yokel, D. and J.M. Ver Hoef. 2014. *Impacts to, and Recovery of, Tundra Vegetation from Winter Seismic Exploration and Ice Road Construction*. Anchorage, AK: BLM.

Yokel, D.A., A.K. Prichard, G. Carroll, L.S. Parrett, B. Person, and C. Rea. 2009. Teshekpuk Caribou Herd Movement through Narrow Corridors around Teshekpuk Lake, Alaska. *Alaska Park Science* 8 (2):64–67.

Yokel, D.A., A.K. Prichard, G.M. Carroll, L.S. Parrett, B.T. Person, and C. Rea. 2011. *Caribou Use of Narrow Land Corridors around Teshekpuk Lake, Alaska*. Open File Report No. 125. Fairbanks, AK: BLM.

INDEX

This page intentionally left blank

LIST OF PREPARERS

The EIS was prepared by BLM and with assistance from DOWL and their contractor team, and input from the cooperating agencies, the Air Quality Technical Working Group, and BOEM. Technical input was provided by ConocoPhillips. In addition, numerous employees of the cooperating agencies reviewed portions the EIS and provided constructive suggestions for improvement. The list of preparers is provided in the table below.

List of Preparers

Name	Entity	Project Responsibility
Serena Sweet	BLM	Project Manager
Stephanie Rice	BLM	Project Manager
Ferris Couture	BLM	Project Manager
Racheal Jones	BLM	Project Manager
Alan Peck	BLM	Air Quality; Noise
Casey Burns	BLM	Marine Mammals, Endangered Species Act Consultation
Cathy Hillis	BLM	GIS
Cindy Hamfler	BLM	GIS
Craig Nicholls	BLM	Air Quality
Craig Perham	BLM	Marine Mammals, Endangered Species Act Consultation
Debbie Nigro	BLM	Birds, Endangered Species Act Consultation
Donna Wixon	BLM	Land Management and Use
Eric Geisler	BLM	Soil, Permafrost, and Gravel Resources
Joe Keeney	BLM	Cultural Resources
Joesph Galluzi	BLM	Solid Minerals
K. Melody Debenham	BLM	Spill Risk Assessment; Contaminated Sites
Matthew Whitman	BLM	Fish, Essential Fish Habitat
N. Shelly Jones	BLM	Alternatives
Sarah LaMarr	BLM	Alternatives
Scott Guyer	BLM	Wetlands and Vegetation
Stacey Fritz	BLM	Sociocultural; Subsistence
Stewart Allen	BLM	Economics
Tim Vosburgh	BLM	Terrestrial Wildlife
Thomas St Clair	BLM	Vegetation
V.J. Maisonet	BLM	Air Quality; Climate and Climate Change; Noise
Kristen Hansen	DOWL	Project Manager
Leyla Arsan	DOWL	Assistant Project Manager
Maryellen Tuttell	DOWL	Senior Project Advisor; QA/QC; Public and Agency Engagement Lead; Sociocultural; Economics; Land Ownership and Use; Public Health; Environmental Justice
Zachary Huff	DOWL	Project Coordinator; Technical Editor; Alternatives
Donna Robinson	DOWL	NEPA Writer
Emily Creely	DOWL	Wetlands and Vegetation; Contaminated Sites
Adam Morrill	DOWL	Wetlands and Vegetation; Contaminated Sites

Name	Entity	Project Responsibility
Keri Nutter	DOWL	Soils, Permafrost, and Gravel Resources
Chris Harrington	DOWL	GIS and Graphics
Tim Jameson	DOWL	GIS and Graphics
Lucy O'Quinn	DOWL	Cultural Resources; Administrative Record
Caitlin Kennedy	DOWL	Cultural Resources; Administrative Record
Jovie Garcia	DOWL	Public Involvement Support; Project Administration
Regina Stevens	DOWL	Document Production Manager; Public Involvement Support
Matt Peterson	SWCA	Alternatives Development; NEPA Adequacy; Visual Resources
Amanda Childs	SWCA	Cumulative Effects; NEPA Adequacy
Merlyn Paulson	SWCA	Visual Resources
Chris Bockey	SWCA	Visual Resources
Kari Chalker	SWCA	Managing Editor
Rhiannon Held	SWCA	Technical Editor
Diane Bush	SWCA	Technical Editor
Kerri Linehan	SWCA	Technical Editor
Kristina Stelter	SWCA	Technical Editor, 508 Compliance
Debbi Smith	SWCA	Technical Editor, 508 Compliance
Sue Wilmot	SWCA	Comment Analysis
Krish Vijayaraghavan	Ramboll	Climate Change; Air Quality
Courtney Taylor	Ramboll	Climate Change; Air Quality
Kristen Wallace	Ramboll	Noise
Rick Johnson	ABR	Birds
Alex Prichard	ABR	Terrestrial Mammals
Jason McFarland	Owl Ridge	Fish
Bill Morris	Owl Ridge	Fish
Sheyna Wisdom	Fairweather Sciences	Marine mammals, Endangered Species Act Consultation
Willow Hetrick	Fairweather Sciences	Marine mammals, Endangered Species Act Consultation
Stephen Braund	SRB&A	Subsistence, ANILCA Section 810
Elizabeth Sears	SRB&A	Subsistence, ANILCA Section 810
Paul Lawrence	SRB&A	Subsistence, ANILCA Section 810
James Aldrich	AHC	Water Resources
Ken Karle	HMM	Water Resources
Gary Hayward	NLEC	Spill Risk Assessment, Prevention, and Planning
Joy Huntington	Uqaqti Consulting	Public Engagement; Tribal Consultation

Note: AHC (Arctic Hydrologic Consultants); ANILCA (Alaska National Interest Lands Conservation Act); BLM (Bureau of Land Management); GIS (geographic information systems); HMM (Hydraulic Mapping and Modeling); NEPA (National Environmental Policy Act); NLEC (Northern Lights Environmental Consulting); Owl Ridge (Owl Ridge Natural Resource Consultants, Inc.); QA/QC (quality assurance/quality control); SRB&A (Stephen R. Braund and Associates); SWCA (SWCA Environmental Consultants)